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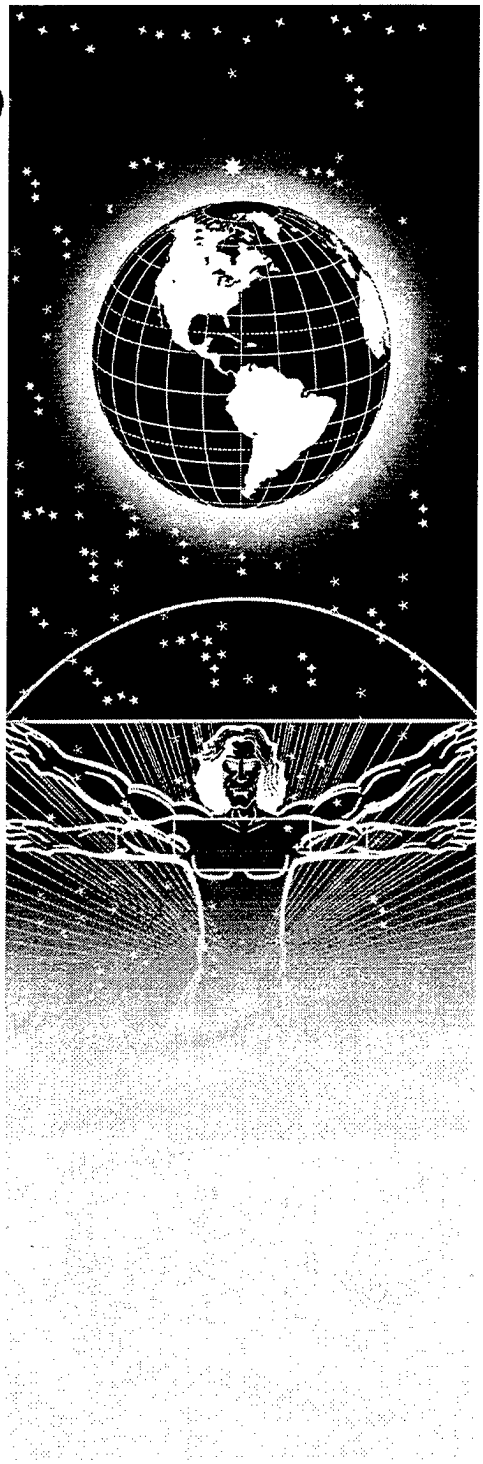

UNITED STATES AIR FORCE ARMSTRONG LABORATORY

Preventing Work-Related Musculoskeletal Illnesses Through Ergonomics: The Air Force PREMIER Program Volume 4A: Level I Ergonomics Methodology Guide For Maintenance/ Inspection Work Areas

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This report describes a methodology which allow technicians with minimal ergonomics training to identify risk factors, select realistic controls, facilitate modifications, and measure the impact of ergonomic modifications to United States Air Force maintenance/inspections workplaces.

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFMC	Air Force Materiel Command
AFOSH	Air Force Occupational Safety and Health
AL/OEMO	Armstrong Laboratory/Occupational Medicine Division
BEF	Bioenvironmental Engineering Flight
CAD	Computer Aided Drafting
CTD	Cumulative Trauma Disorder
EPRA	Ergonomics Problem Area
EWG	Ergonomics Working Group
fc	Foot-Candle
JR/PD	Job Requirements/Physical Demands (Survey)
MIG	Molybdenum Inert Gas
MMH	Manual Materials Handling
PEPA	Potential Ergonomics Problem Area
PHF	Public Health Flight
RM-ANOVA	Repeated Measures Analysis of Variance
RSI	Repetitive Strain Injury
TIG	Tungsten Inert Gas
USAF	United States Air Force
VDT	Video Display Terminal
VWF	Vibration White Finger
WMD	Work-Related Musculoskeletal Disorders
WPAFB	Wright-Patterson Air Force Base

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ABOUT THIS GUIDE

This Level 1 Ergonomics Methodology Guide (Guide) for Maintenance and Inspection Work Areas is designed to be read and implemented by Bioenvironmental Engineers and Bioenvironmental Technicians. The purpose of the Guide is to enable the BEF to identify risk factors, to prioritize problems to select realistic controls, and to facilitate modifications so the Air Force can maintain readiness by improving employee performance and well-being.

This Guide is organized for ease of use. Initially, users will need to rely on all the parts in order to complete the process as it is designed. After they are familiar with the process, they can excerpt only those sections that they need. For example, the Guide is organized so that the parts needed for data collection can be extracted for use in the field. Other parts used in problem prioritization, solution selection, etc., may be left in the BEF shop for later use.

The Guide has **three chapters and six appendices**.

Chapter 1: Introduction provides users and other readers with the background information they need to understand the process. It provides the following information:

- the objectives of the Guide;
- the role of this Guide in the overall ergonomics efforts of the Air Force. In particular, it describes the circumstances in which the Guide is to be used; and
- the criteria and processes that were used to develop the Guide.

Chapter 2 : General Background on Ergonomics provides a brief explanation of the issues that the Guide is intended to address. Although this chapter will be particularly helpful to users who may have limited knowledge of ergonomics, it can serve as a refresher to those who are already knowledgeable. The chapter also provides insight into the intended outcomes of the process and provides the framework for the more detailed ergonomics information included in the other sections.

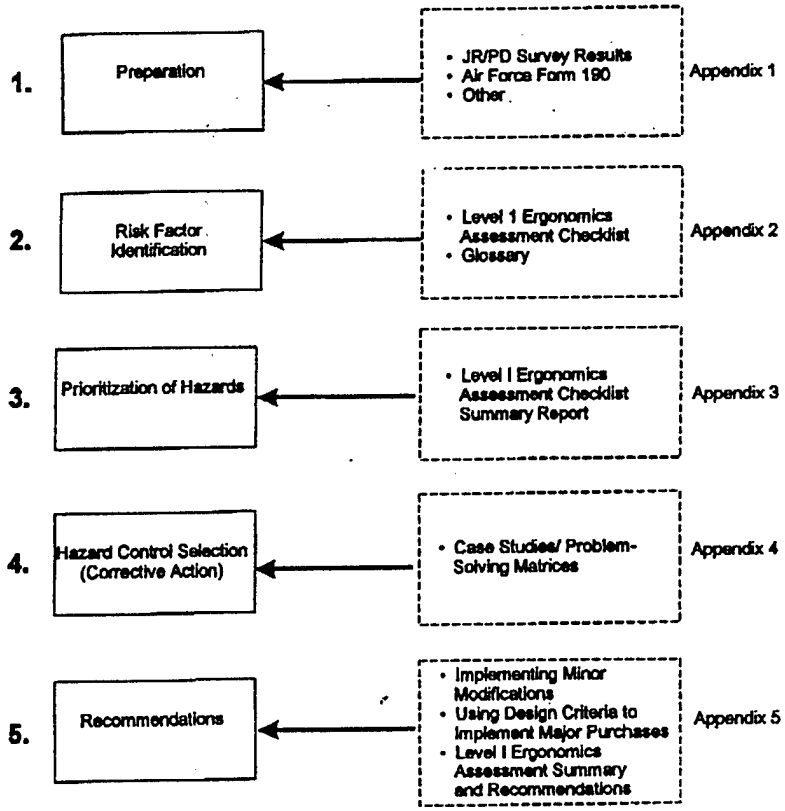
Chapter 3: User's Guide is the heart of the Guide. This section will used to implement the Level I Ergonomics Assessment and Problem-Solving Methodology. It is designed to provide step-by-step instructions to a BEF technician with two to three years of experience. The chapter details the ***Five Step Process*** and refers the user to ***Appendices 1-5,*** which provide the tools required to complete each step in the Methodology and examples of results obtained at each step. (Appendix 6 provides a master copy of each form that is used to apply the Methodology.)

The Five Steps and the tools required are:

Step 1. Preparation
Step 2. Risk Factor Identification
Step 3. Prioritization of Hazards
Step 4. Hazard Control
Step 5. Recommendations

The Level I Ergonomics Assessment and Problem-Solving Methodology for Maintenance and Inspection Work Areas is shown in Figure 1.

Figure 1
Level 1 Assessment Process



Appendices
The Appendices are an integral part of the Guide and are designed for quick reference. Each Appendix relates to a step in the process.

Appendix 1: Preparation
This appendix provides users with a sample summary from the JR/PD Survey, with an Air Force Form 190, and other information that they need to begin the process.

Appendix 2: Risk Factor Identification
This appendix provides users with a sample *Level 1 Ergonomics Assessment Checklist* to use as a guide in completing the checklist they are using on a job. Most importantly, it includes the Glossary which defines each checklist question in detail and provides guidelines on what to look for when observing the jobs.

Appendix 3: Prioritization of Hazards
This appendix provides users with a sample of a completed *Checklist Scoring Summary* so that they know how to score the jobs on which they have completed a checklist.

Appendix 4 : Hazard Control Selection
This appendix is the focal point for identifying the causes of ergonomics risk factors and for selecting corrective actions. *Case Studies* for 50 tasks in Maintenance and Inspection Work Areas (bucking/riveting, welding, etc.) are included here. Case Study problem-solving matrices are organized so that users simply look for the body region and risk factor identified in the Level I Checklist in order to pattern match the cause with corrective actions, risk factor by risk factor. Once users become familiar with the process, this is probably the only appendix that will be needed for subsequent assessments.

Appendix 5: Recommendations
This appendix provides an example of a completed *Summary/Recommendations* form so that the user has guidance when completing Step 5. It also includes the "Implementing Minor Modifications" section, which provides further detail on selected Corrective Actions referred to in the Case Studies.

A section on "Using Design Criteria to Implement Major Purchases" is included to provide users involved in the selection of furniture or accessories, with the ergonomics criteria upon which to evaluate products. The evaluation forms provided can be sent to prospective vendors to help identify which products meet the criteria.

Appendix 6: Blank Forms
This section simply provides the blank forms that users can copy in order to apply the Methodology.

Appendix 7: References/Bibliography
References noted in the Guide and the bibliography for this effort are found in this section.

This Guide enables users to identify risk factors and recommend corrective actions on most of the jobs and tasks they will observe with the assurance that in most cases, a professional ergonomist would have made the same decisions. It will also let them know when they should obtain assistance from Armstrong Laboratory (AL/OEMO) or other ergonomists in cases when the pattern-matching process may not adequately address the problem and a Level 2 Ergonomics Assessment is needed.

In any case, this Guide provides the Air Force with the Methodology it needs to identify and abate ergonomics hazards in a wide range of administrative jobs.

A Research Report describing the development and testing of this Guide is available. Please contact Armstrong Laboratory (AL/OEMO) for further information.

1.0 INTRODUCTION

1.1 PROGRAM OBJECTIVES

The U.S. Air Force has sponsored the development of standard ergonomics assessment methodology guides and management tools which will be integrated into the AFOSH Program. The methodologies and tools will be used as a means to minimize or eliminate work-related musculoskeletal disorders (WMDs) associated with routine exposure to ergonomics risk factors at Air Force installations.

The basic elements of an installation ergonomics program include: Potential Ergonomics Problem Area (PEPA) designation, Ergonomics Problem Area (EPRA) designation and control, work area analysis, medical management, and training and education. Both qualitative (PEPA) and quantitative (EPRA) screening techniques are used in sequential fashion to identify employees at risk. The flow chart in Figure 1.1 describes the ergonomics program process.

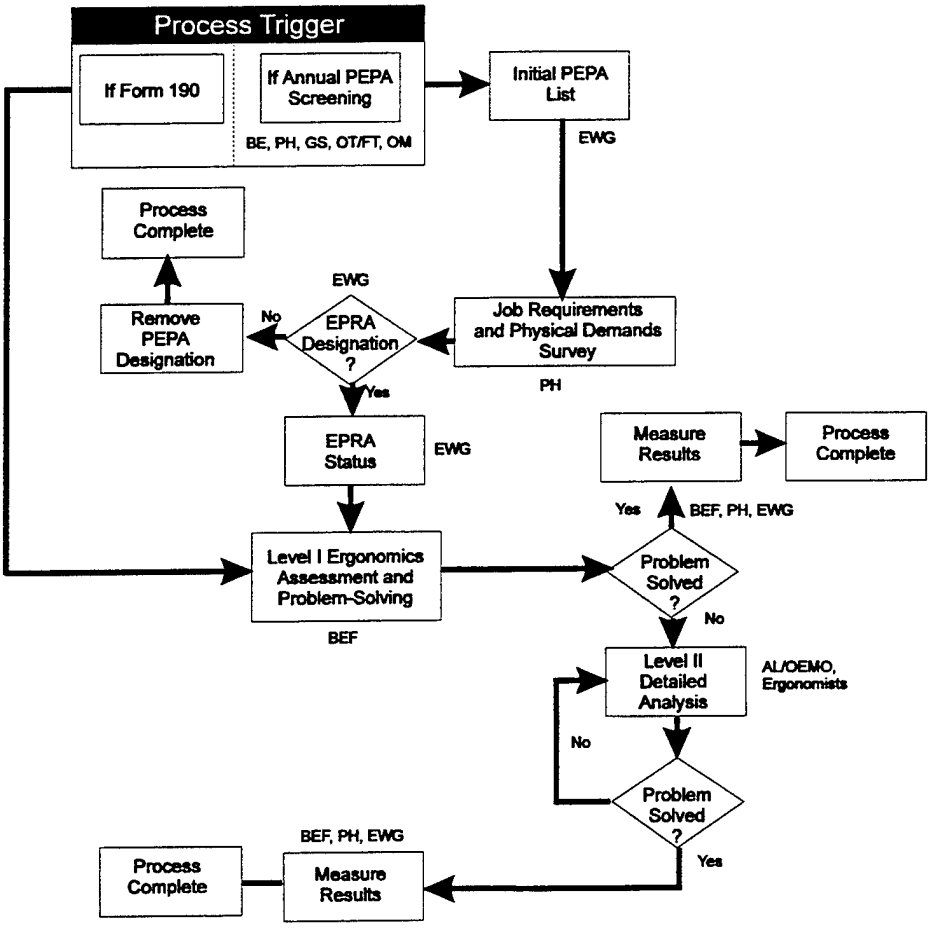


Figure 1.1
Ergonomics Problem-Solving Process

1.2 DEVELOPMENT OF CRITERIA

The Level I Ergonomics Assessment and Problem-Solving Methodology Guide for Maintenance and Inspection Work Areas (hereafter referred to as the Guide) details a process that can be applied to the full variety of Air Force maintenance and inspection jobs.

The Guide was designed to enable a Bioenvironmental Engineer or technician with 2-3 years of experience to conduct aggressive task-based problem-solving efforts in an Ergonomics Problem Area (EPRA). The Guide is designed such that the process can be completed as follow-up to the Job Requirements and Physical Demands Survey (hereafter referred to as the JR/PD Survey) completed by PHF or in response to an Air Force Form 190 investigation.

The Guide was developed in accordance with criteria established by the United States Air Force (USAF). This criteria was that the Guide must be designed to enable users, primarily through visual observations and employee/supervisor interviews, to:

- identify potentially hazardous tasks within a shop and job;
- determine if the content of the job and task(s) meet established ergonomics (risk factor exposure) criteria;
- determine which type(s) of additional (Level II) analyses may be used if further quantification of ergonomics hazards is required; and
- choose from a menu of control options (both short- and long-term) which when implemented, will minimize the risk of musculoskeletal disorders by reducing the hazards identified within the job and tasks.

The Guide must enable the user to complete data collection and analysis of a maintenance and inspection work area in 1-2 hours depending on the number of tasks evaluated. Hazard Control selection and development of a summary report (recommendations) should require 1-2 hours.

The Guide is to include case studies for typical maintenance and inspection tasks. The case studies serve as the basis for the pattern-matching process that will be used to "match" the hazards identified in the tasks with controls that will reduce employee exposure to accordance those hazards.

The Guide is to identify metrics which will be used to judge the impact of ergonomics improvements on employee health, safety, and performance (e.g., quality, productivity).

In addition, the Guide will incorporate information and lessons learned from the JR/PD Survey in order provide an integrated ergonomics analysis and problem-solving process for the Air Force.

1.3 DEVELOPMENT PROCESS

The Guide design is the result of a development and testing process that benefited from the support and cooperation of Air Force personnel at several AFMC locations:

- Armstrong Laboratory (AL/OEMO), Brooks AFB, Texas
- Wright-Patterson AFB, Ohio (WPAFB)
- Eglin AFB, Florida
- Tinker AFB, Oklahoma
- Kelly AFB, Texas
- Patrick AFB, Florida (AFSPC)

1.3.1 Initial Efforts. The development of this Guide began with a review of the scientific literature. The purpose of the review was to compile information on ergonomics analysis tools that would be relevant to the development effort. The goal was to identify methods which would require minimum expertise yet would provide maximum benefit for the USAF. The literature review indicated that there was a lack of validated ergonomics assessment/problem-solving methodologies which satisfied the criteria established by the USAF. However, several tools were identified which served as the basis for individual components of the Guide.

Development continued with site visits to selected USAF installations: Wright-Patterson AFB, Eglin AFB, and Tinker AFB. The purpose of the site visits was to collect data (e.g., videotapes, digital photographs, workstation measurements, employee interview results, etc.) on the job types that would be used for developing Case Study Problem-Solving Matrices. The job types were selected by the Air Force and are consistent with "Types of Work" listed in Section III of the JR/PD Survey which will be used by PHF. Many of the jobs observed the collection of the 50 task-based Case Study Problem-Solving Matrices, listed in Table 1.1, are based on a compilation of the most common elements found in one or more jobs at one or more of the bases.

Table 1.1
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
1	Abrading	• Vehicle Maintenance: Changing Battery	• Tinker AFB
2	Assembly/Disassembly - Internal Components	• Fuel Line Maintenance • Electrical/Light Fixture Maintenance • Plumbing-Toilet/Sink Maintenance • Radio Maintenance	• WPAFB • Tinker AFB • Tinker AFB • Tinker AFB
3	Assembly/Repair - Bench Work	• Radio Maintenance	• Tinker AFB
4	Bolting/Screwing	• Remove Panel: Flight Line	• Eglin AFB
5	Chipping	• Prepare Pavement for Repair	• Eglin AFB
6	Cleaning by Hand	• Corrosion Control • Teeth Cleaning • Scuff, Sand & Paint	• Eglin AFB • WPAFB • Tinker AFB
7	Cleaning with High Pressure Equipment	• Aquamiser	• Tinker AFB
8	Coating/Immersing	• Plating	• Eglin AFB
9	Computer Work	• Heat Treat • Radio Maintenance	• Tinker AFB • Tinker AFB
10	Crimping	• Electrical/Light Fixture Maintenance • Radio Maintenance	• Tinker AFB • Tinker AFB
11	Cutting/Shearing	• Refurbish Aircraft Exterior • Fabricate Aircraft Component	• WPAFB • Eglin AFB
12	Drilling	• Museum Construction • Structural Maintenance: Cabinet Repair	• WPAFB • Eglin AFB
13	Driving (Vehicles)	• Prepare Pavement for Repair	• Eglin AFB
14	Excavating/Shoveling	• Prepare Pavement for Repair	• Eglin AFB
15	Flame Cutting	• Process Structural Component	• Eglin AFB
16	Folding/Fitting	• Parachute Packing • Raft Packing	• WPAFB • WPAFB
17	Forming	• Forming Sheet Metal	• Tinker AFB
18	Gluing/Laminating (Dopping)	• Museum Construction	• WPAFB

Table 1.1 (cont'd)
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
19	Grinding	• Structural Component Fabrication • Refurbish Aircraft Exterior • Process Structural Component • Scuff, Sand & Paint • Case Frame Repair	• WPAFB • WPAFB • WPAFB • Tinker AFB • Tinker AFB
20	Hammering	• Museum Construction • Fabricate Aircraft Component • Vehicle Tire Operation: Breakdown	• WPAFB • Eglin AFB • Tinker AFB
21	Hose Handling	• Aircraft Refueling	• Patrick AFB (AFSPC)
22	Lifting	• Heat Treat	• Tinker AFB
23	Machining	• Fabricate Aircraft Component	• Eglin AFB
24	Masking	• Scuff, Sand & Paint • Heat Treat	• Tinker AFB • Tinker AFB
25	Masoning	• Prepare Pavement for Repair	• Eglin AFB
26	Media Blasting - Blast Cabinet	• Heat Treat	• Tinker AFB
27	Media Blasting - High Pressure Gun	• Media Blasting Booth	• Tinker AFB
28	Melting	• Crown/Bridge Work	• WPAFB
29	Monitoring (of displays)	• Heat Treat	• Tinker AFB
30	Nailing	• Museum Construction	• WPAFB
31	Opening/Closing Heavy Doors	• Remove Panel: Flight Line	• Eglin AFB
32	Ordnance Disposal	• Improvise Explosive Device	• WPAFB
33	Packing	• Parachute Packing • Raft Packing • Improvise Explosive Device	• WPAFB • WPAFB • WPAFB
34	Painting/Spraying	• Corrosion Control • Scuff, Sand & Paint • Vehicle Maintenance: Changing Battery	• Eglin AFB • Tinker AFB • Tinker AFB
35	Paving	• Prepare Pavement for Repair	• Eglin AFB
36	Prying	• Vehicle Tire Operation: Breakdown	• Tinker AFB

Table 1.1 (cont'd)
Maintenance and Inspection Case Study Problem-Solving Matrices in the Guide

Case Study #	Case Study Title	Job/Task Name and Area	Base
37	Pumping	• Crown/Bridgework	• WPAFB
38	Riveting/Bucking	• Repair Cowling • Structural Maintenance: Cabinet Repair	• Tinker AFB • Eglin AFB
39	Sanding	• Corrosion Control	• Eglin AFB
40	Sawing	• Scuff, Sand & Paint	• Tinker AFB
41	Sewing	• Assemble Draperies for Display	• WPAFB
42	Soldering	• Case Frame Repair	• Tinker AFB
43	Stripping/Depainting by Hand	• Refurbish Aircraft Exterior	• WPAFB
44	Stripping/Depainting by Mechanical Methods	• Aquamiser	• Tinker AFB
45	Turning Valves	• Plumbing-Toilet/Sink Maintenance • Liquid Fuels Maintenance	• Tinker AFB • Patrick AFB (AFSPC)
46	Tying/Twisting/Wrapping	• Jet Engine Repair • Parachute Packing • Raft Packing	• Eglin AFB • WPAFB • WPAFB
47	Visual Inspection	• Case Frame Repair	• Tinker AFB
48	Welding	• Process Structural Component • Process Structural Component • Case Frame Repair	• WPAFB Eglin AFB • Tinker AFB
49	Wiring	• Electrical/Light Fixture Maintenance	• Tinker AFB
50	Wrenching/Ratcheting	• Jet Engine Repair • Remove Panel: Flight Line • HVAC-Pipe Fitting	• Eglin AFB • Eglin AFB • Tinker AFB

Based on the results of the literature review and the site visits, the following components of the Guide were developed:

1. User's instructions;
2. A Level I Ergonomics Assessment Checklist;
3. Checklist Glossary;
4. An Ergonomic Summary Report (scoring sheet, case study selection key, and control summary list); and
5. Case Study Problem Solving Matrices (Corrective Actions).

These components were used to test and validate the design of the Guide.

1.3.2 Testing and Validation. The purpose of testing and validation was to establish strengths and limitations of the initial Guide and to identify the need for changes based on quantitative information. The testing and validation was conducted in two phases: alpha testing and beta testing.

Five ADL/TJI ergonomists not directly involved in Guide development participated in the **alpha** testing. The ergonomists commented on the usability of the Guide tools and user's instructions. A second draft of each of the Guide components was developed to reflect those comments. After alpha testing was completed, a consensus score for several measures (e.g., each Job and Environmental Factor question), from the Guide was developed to serve as a testing standard during beta testing.

Ten Air Force personnel were selected to participate in a **beta** test at Hill AFB. These personnel were to be selected to "match" the targeted end-user population: BEF technician with 2-3 years of experience. The ergonomist/facilitator provided a two-hour briefing using a sample job to demonstrate the Guide, use of the tools, and process for completing the assessment and pattern-matching activity. The actual testing process and materials provided were the same as for the alpha test (with the appropriate revisions). Information on usability was obtained during an out-briefing and additional refinements were made to the Guide to improve usability.

For each phase, the results were tested for Usability, Reliability, Sensitivity, and Validity. Usability testing was performed to ensure that the users would be able to apply the Guide as intended. Reliability testing was performed to determine how consistently that application of the Guide yielded the same results. Sensitivity testing was performed to determine if the Level I Assessment can tell the difference between actual risk levels in a job. And finally, validity testing was conducted to measure how closely the results from experienced ergonomists matched the results obtained by Air Force personnel.

Those who are interested in a detailed description of the testing and validation process and results are directed to contract Armstrong Laboratory (AL/OEMO) for further information.

1.4 FREQUENTLY ASKED QUESTIONS ABOUT THE METHODOLOGY GUIDE

Typical questions and answers about the Guide are provided in Table 1.2.

Table 1.2
Typical Questions and Answers About the Guide

Question	Answer
What is the Guide used for?	The Guide enables Bioenvironmental Engineers and technicians to conduct aggressive, task-based problem-solving in an Ergonomics Problem Area (EPRA).
What kind of experience or ergonomics knowledge is required in order to use the Guide effectively?	The Guide was designed for a BEF technician with 2-3 years of technical experience. Although some prior knowledge of ergonomics is a benefit, ergonomics "expertise" is not required for successful application of the Guide.
Is the Guide to be used on all jobs throughout the base?	No. The intent is to use the Guide only in EPRA designated shops EPRA status is designated by the installation Ergonomics Working Group (EWG) based on the results of the JR/PD Survey administered by Public Health Flight (PHF).
When, specifically, is the Guide to be used?	The Guide was designed for use in two primary situations: • as follow-up to the JR/PD Survey if a shop has been classified as an EPRA; or • in response to an AF Form 190 investigation (completed by PHF).
How will I learn how to apply the Guide effectively?	A User's Guide provides a good foundation on which to begin. The Air Force recommends that the user participate in a 2-3 hour briefing in which a trained specialist will demonstrate use of the Guide.

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
How is the Guide organized?	You are reading the Introduction now. Chapter 2 provides basic background information on ergonomics. Chapter 3 is the actual User's Guide. Chapter 3 takes you through a 5-step process for completing the Level I Ergonomics Assessment and Problem-Solving Methodology: Step 1 - Preparation Step 2 - Risk Factor Identification Step 3 - Prioritization of Hazards Step 4 - Hazard Control Selection Step 5 - Recommendations Also included in the Appendices are examples of completed forms so you can see what the results of your work should look like at each step.
What is included in Step 1 - Preparation?	In Step 1, the Guide explains in detail, when to use the Level I Assessment and Problem-Solving Process, logistics (e.g., forms), how to interpret and use data from the completed JR/PD Survey and/or an AF Form 190 for selecting which jobs to focus on during your investigation.
What is included in Step 2 - Risk Factor Identification?	In Step 2, you will be introduced to the Level I Ergonomics Assessment Checklist. It is a practical, observation-based Checklist which does not require the use of gauges or specialized ergonomics analysis equipment. You complete the Checklist by observing the job tasks and talking with the employee.
What is the significance of the Checklist?	The Checklist helps you identify ergonomics risk factors.
Who will interpret the results?	The same person who completed the Checklist will interpret the results. The Checklist results are a direct lead-in to control identification.
What is included in Step 3 - Prioritization of Hazards?	In Step 3, you will be shown how to score the Checklist. The scoring process tells you: • if there is significant concern in the overall job; • what task(s) is the primary source of exposure to ergonomics risk factors; and • what part(s) of the body should be targeted when identifying controls.
How long does it take to complete Steps 2 and 3?	In previous trials BEF technicians with minimal to no prior experience with ergonomics analysis completed the process in a mean time of 16.6 minutes (standard deviation of 10.8 minutes).

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
What is included in Step 4 - Hazard Control Selection?	In Step 4, you will learn about the 50 Case Study Problem-Solving Matrices for maintenance and inspection work. The case studies provide you with a head start on identifying controls or corrective actions which can be implemented to reduce employee exposure to the most common ergonomics risk factors found in administrative tasks. Two categories of controls are provided; modifications and adjustments, and major changes. Approximately 50 percent of the controls can be implemented for little or no cost. For selected controls, in which you need some additional detail to implement correctly, you will be directed to the sections, "Implementing Modifications and Adjustments" or "Using Design Criteria to Implement Major Changes" in Appendix 5.
Will we use all of the case studies for every job?	No. After you have identified the task(s) that exposes the employee to the most significant levels of ergonomics risk factors, the instructions in Step 4 will explain how to select the case study or studies that "match" the task(s).
How exactly is a case study used?	After the appropriate case study is identified, you read through the Case Study Problem-Solving Matrix and "match" the risk factors identified with the Checklist to controls that can be implemented to reduce or eliminate exposure to the risk factor.
What is included in Step 5 - Recommendations?	From Step 4 you will have identified a number of controls that **could** be implemented. In Step 5, the Guide describes the process for developing the final summary report and final list of recommendations which will be provided to the shop supervisor and kept on file in Bioenvironmental Engineering. The Level I Ergonomics Assessment Summary and Recommendations form will enable you to communicate the most important information to the supervisor and establish the basis for implementing controls, planning follow-up, and measuring the results of ergonomics improvements.

Table 1.2
Typical Questions and Answers About the Guide (Cont'd)

Question	Answer
Who gets the completed Level I Ergonomics Assessment Summary and Recommendations form?	One copy of the report is to be kept in the case file for the work center. A copy should also go to the work center supervisor who will be responsible for following-up on the recommendations. Other parties may also be provided with a copy of the report at the discretion of Bioenvironmental Engineering. It is highly recommended that you discuss the report with the work center supervisor and the employee(s) in person in order to promote a fast and effective implementation.
How long does it take to complete Steps 4 and 5?	In previous tests, BEF technicians required a mean time of 12.0 minutes (standard deviation of 7.4 minutes) to complete the pattern matching process and select controls (corrective actions). Completion of the Level I Ergonomics Assessment Summary and Recommendations form is not expected to add much additional time to the process. It is expected that, even for the most complex maintenance and inspection jobs, completion of Steps 4 and 5 should take between 30 and 45 minutes.
Can the results and recommendations for ergonomic improvement be applied throughout the shop?	Even though the Methodology may have been applied to only one job type in a work area (e.g., drilling by a sheet metal mechanic), the results may indicate, for example, that all employees who perform the drilling job may benefit from the same kinds of corrective actions. Since, however, there is so much variation in the physical demands of drilling (e.g., bench work, working on an aircraft exterior, etc.), corrective actions can be applied only as appropriate to the demands of the task within the context of the larger job situation.

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2.0 GENERAL BACKGROUND ON ERGONOMICS

The information in this chapter has been assembled to provide users with limited experience with ergonomics a concise introduction to the science of ergonomics and how employees may be impacted when ergonomics is not adequately incorporated into job or workplace design. Users who have more experience may wish to skip this chapter or scan the pages as a refresher.

2.1 PURPOSE OF ERGONOMICS

Ergonomics is the science that addresses workers' job performance and well-being in relation to their job tasks, tool, equipment, and environment. Good ergonomics means designing tasks and the workplace to fit the workers - instead of the other way around.

The sciences on which the practice of ergonomics is based include: biomechanics, psychology, physiology, anthropometry, engineering, and kinesiology. The first three sciences help to define worker capabilities and limitations (e.g., how much hand strength the average male or female possesses). The other three sciences provide guidelines for designing jobs and workplaces to more closely reflect those capabilities and limitations.

The purpose of applying ergonomics in the workplace is to provide a work environment which maximizes the worker's performance while minimizing the risk of illness and injury to the musculoskeletal and visual systems.

2.2 WORK-RELATED MUSCULOSKELETAL DISORDERS AND RISK FACTORS.

Many of the work-related musculoskeletal disorders (WMDs) are a class of disorders which are also referred to as cumulative trauma disorders (CTDs) or repetitive strain injuries (RSIs).

This type of disorder develops due to an accumulation of stress or damage to the body over time. The body has great recuperative powers if provided with the opportunity to repair itself. However, when job demands are high (e.g., repeated use of awkward positions combined with forceful exertions or high effort) and the recovery time is insufficient, there is an increased likelihood that accumulated damage will lead to a disorder. Figure 2.1 illustrates this relationship.

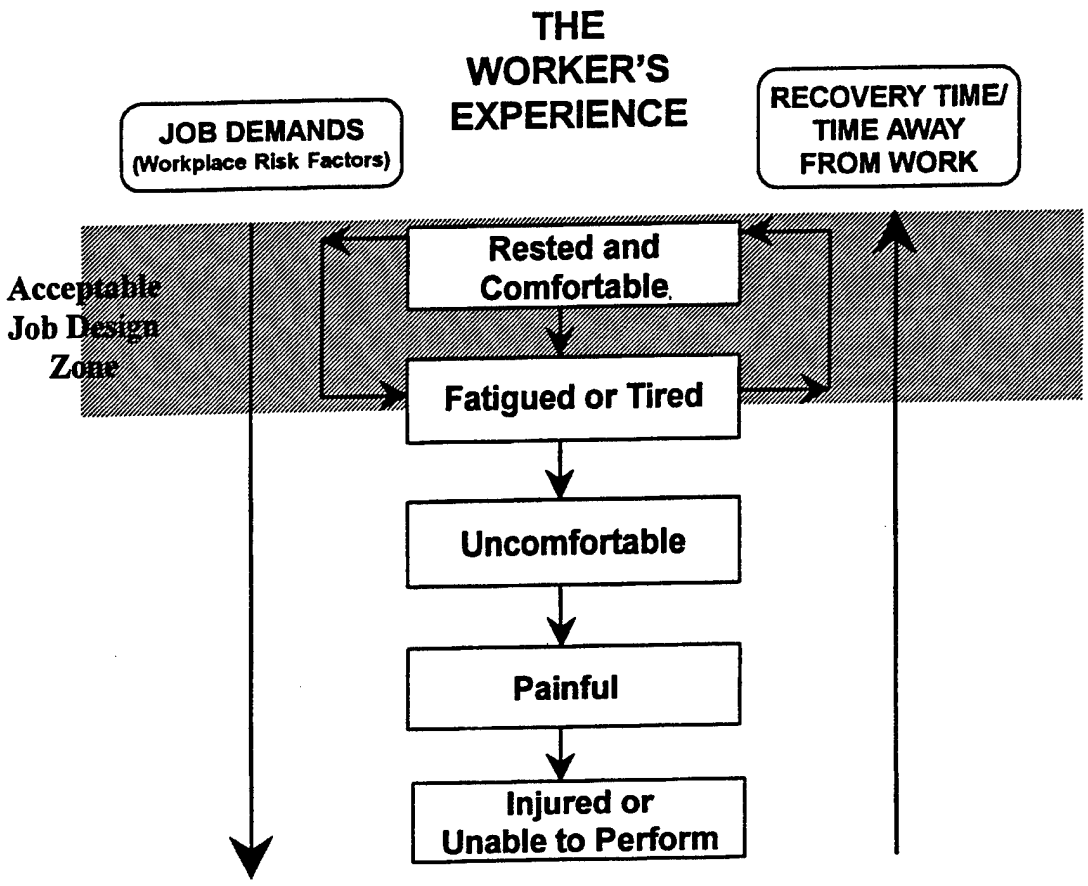


Figure 2.1
The Worker's Experience

Due to the wide variety of demands on the musculoskeletal system from maintenance and inspection work, reports of discomfort, and aches and pains can be just as varied. The following sections describe each of the major body regions, the most common WMDs, and the risk factors which impact the body region.

2.2.1 Shoulder/Neck.

2.2.1.1 Disorders. The following are the most common shoulder and neck disorders found in the industrial workplace as shown in Figure 2.2.

- **Bursitis** - an inflammation of the bursa sac (fluid-filled cushion) in the shoulder joint.
- **Tendonitis** - an inflammation of the muscle tendon, in various regions of the body including the upper arm/shoulder region.
- **Rotator Cuff Tendonitis** - an inflammation of the tendons in the shoulder.
- **Thoracic Outlet Syndrome** - characterized by a compression of the nerves and blood vessels between the neck and shoulder.

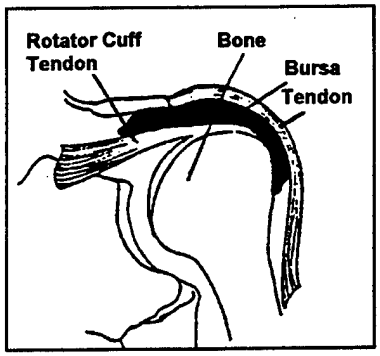


Figure 2.2
Shoulder and Neck Anatomy

2.2.1.2 Ergonomics Risk Factors. Several risk factors common in maintenance and inspection work have been shown to increase the potential for shoulder/neck/arm disorders.

- Stressful positions or movements;
- Static (fixed) work;
- Heavy or forceful work;
- Insufficient recovery or rest pauses; and
- High frequency (repetitive) or high speed movements.

Below is a more complete description of these risk factors:

- Stressful positions or movements - during an extreme reach, tendons and a structure called the bursa sac are stretched. The more extreme the reach, the more stress on the shoulder joint. The most stressful shoulder positions are reaching to the side and behind the body and working over shoulder level.

- Static (fixed position) work - static work means 'fixed position' work. In cases where the height of the work is too high and the worker must raise his/her arms to hold a position or work on a item, the muscles quickly fatigue.

- Heavy or Forceful work - forceful work on the shoulder includes push/pull forces. Examples include having to push or pull a loaded cart across the shop floor or holding a bucking bar to keep stable during a riveting task.

- Insufficient Recovery and Rest Pauses - fixed-position work often results in static muscular fatigue. Fatigue and/or discomfort in the shoulder and neck regions often develops. If no movement opportunities are built into the actual work, rest pauses can be provided which allow the muscles to recover. Specific exercises and stretches can also be performed during rest pauses to prevent the onset of static muscular fatigue.

- High frequency and/or high speed movements - the repeated use of stressful/awkward positions and/or excessive force is the primary concern. In addition, sudden 'jerky' movements cause shock to the joints.

2.2.2 Hands/Wrist/Arm.

2.2.2.1 Disorders. (See Figure 2.3) The following conditions are the most common hand/wrist/arm disorders which may result from industrial work.

1. Tendonitis - an inflammation of the tendons.
2. Tenosynovitis - an inflammation of a tendon sheath most commonly at the wrist.
3. Carpal Tunnel Syndrome - the symptoms are a result of an irritation of the median nerve as it is compressed by surrounding tissue and bony structures in the wrist.
4. De Quervain's Disease - an irritation of the tendons of the thumb.
5. Trigger Finger - an inflammation of the tendon at the joint in any finger.
6. Ganglion Cysts - inflammation of the tendon sheath. The affected sheath swells up with the synovial fluid.
7. Epicondylitis - a tendon irritation of the forearm muscles at the elbow joint.

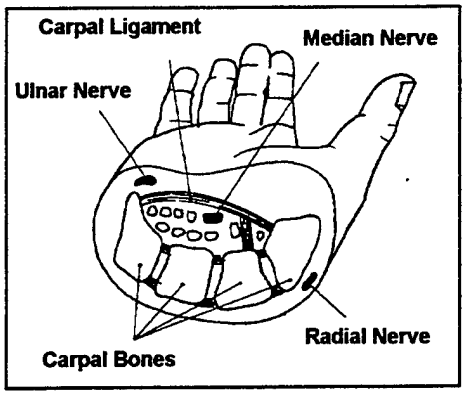


Figure 2.3
Anatomy of the Hand and Wrist

2.2.2.2 Risk Factors. The following lists the most common causes of hand/wrist/arm disorders, also referred to as "risk factors":

- Stressful positions and movements;
- Excessive forces or forceful exertions;
- High frequency or repetitions;

- Extreme duration and/or pace of the task;
- External trauma or mechanical stress;
- Prolonged exposure to vibration; and
- Temperature extremes.

Below is a more complete description of the risk factors. There are several points to remember. First, the presence of a risk factor does not necessarily mean that an injury or CTD will develop. Eliminating or even reducing the presence of any one of the risk factors will reduce musculoskeletal stress.

1. Stressful Positions and Movements - When the wrist is bent, the tendons and other soft tissues are under tension and compression. This stress can create microscopic damage that accumulates during the shift and is repaired by the body during the off-shift. On other jobs, if the stress is excessive, the body's repair system can't keep up.

2. Excessive Forces or Forceful Exertions - Squeezing a manual wire crimper with a tip grip, hammering or lifting a heavy object are examples of forceful exertions.

3. High Frequency or Repetition - Repeating the same task over and over tends to stress the same parts of the body over and over. The concern is not necessarily "repetitive jobs." Rather, the concern is repeated use of awkward postures and/or forces. If the first two risk factors can be eliminated, the 'frequency' of the task will have less impact on the worker.

4. Extreme Duration and/or Pace of the Task - Workers who perform the same stressful task (e.g. grinding, welding) for the entire shift may be more likely to experience localized fatigue than workers who perform the task for shorter periods of time. The practices of using rest pauses or job rotation or adding task variety attempt to reduce the overall impact of task-specific stress.

5. External Trauma or Mechanical Stress - The risk factor describes the effect of pressure points on the body. Examples of external trauma is using the hand or palm like a hammer, or resting the under-arm region on a blunt edge while performing a repair job on an internal component.

6. Prolonged exposure to vibration - segmental or "hand/arm" vibration should be considered as a secondary risk factor since there is no conclusive evidence that there is a direct cause/effect relationship between upper limb WMDs (CTDs) and vibration exposure. It is likely, however, that vibration exposure may increase the presence of other risk factors. For example, since workers tend to grip vibrating or "impact" tools more tightly than non-vibrating tools,

the "forceful exertion" risk factor may increase. Also, since many vibrating tools (e.g., grinders, sanders, etc.) require the worker to repeatedly bend and/or twist the wrist, the stressful posture/repetition combination of risk factors may increase.

Special Note. An accurate assessment of vibration exposure and its potential implications in the development of Raynaud's syndrome (VWF-vibration white finger) or WMDs requires the use of sophisticated measurement equipment. If symptoms such as numbness, swelling of hand tissues, or reduced grip strength are reported, you are encouraged to contact AL/OEMO for assistance.

7. Temperature Extremes, especially cold - should also be considered as a secondary risk factor. Cold or exposure to low temperatures can affect dexterity, sensitivity, and grip strength. The fingers and hands may be exposed to cold temperatures when handling cold materials (e.g., frozen meat), working out doors in cold weather, or when exposed to exhaust air from pneumatic hand tools. Often, however, use of the proper insulating gloves may protect the worker's hands and fingers from exposure to cold.

2.2.3 Back/Torso.

2.2.3.1 Disorders. (See Figure 2.4) As the basis for understanding disorders, the following components are used to understand the various functions of the back/torso anatomy and their function.

- Backbone (spine) - the major support structure of the body.
- Vertebrae - the bones which make up the spine
  - Cervical (C1-C7) supports and controls the movement of the head.
  - Thoracic (T1-T12) supports the upper body and has limited movement.
  - Lumbar (L1-L5) has the greatest flexibility and bridges the upper to lower torso.
  - Sacrum tail bone.

- Spinal cord - conducts impulses for movement and sensation (including pain) to and from the head and body.
- Foramen - spaces between the vertebrae through which spinal nerves exit.
- Discs - sponge-like tissues which separate vertebral bones and prevent the vertebrae from grinding against one another.
- Ligaments - attach one vertebra to the next.
- Muscles - provide support and enable the body to move from one posture to another.

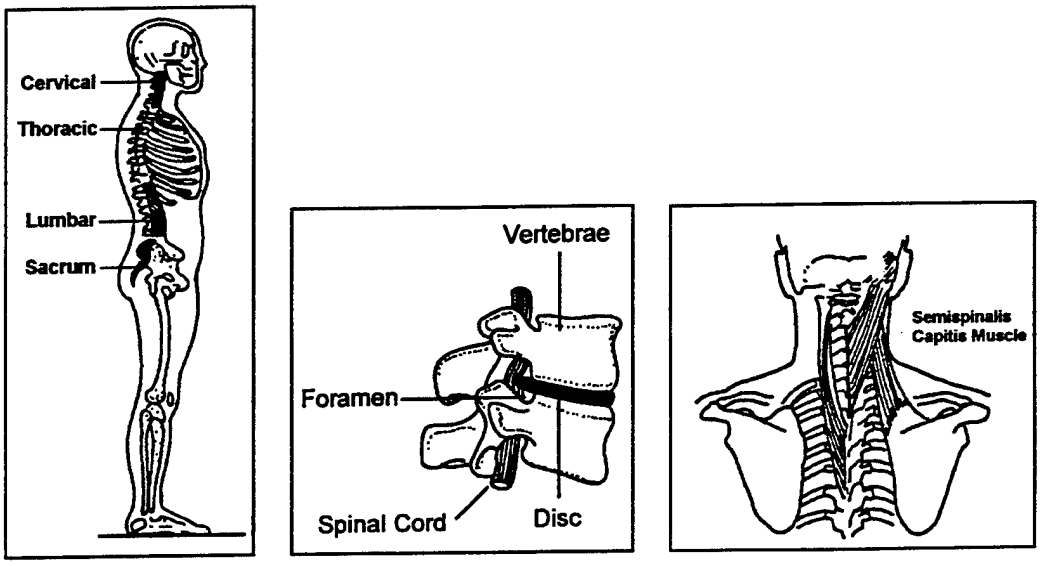


Figure 2.4
Back Anatomy

The following section discusses the common disorders associated with this area of the body:

- Disc Degeneration - with activity, intervetebral discs are stretched, torn, frayed, and worn. This can cause the disc wall to weaken, protrude, and, in some cases, press against the nerves. Weakening of the disc may also cause some narrowing of the space between the vertebra which reduces the size of the hole (foramina) through which the nerve passes as it extends into the legs (as shown in figure 2.5). If the narrowing of this space is significant, pressure may be directed against the nerve.

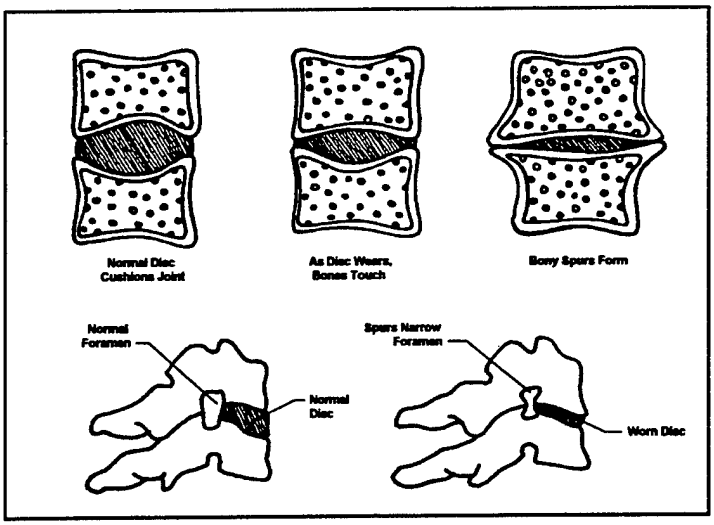


Figure 2.5
Disc Degeneration

- Strains and sprains - tearing or stretching of muscles, tendons or ligaments as shown in Figure 2.6.

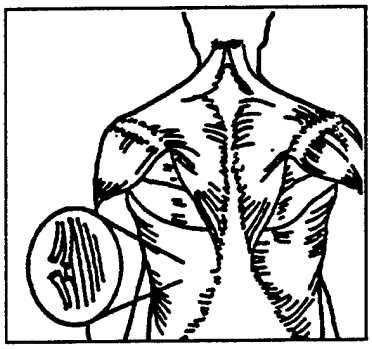


Figure 2.6
Sprains and Strains

2.2.3.2 Risk Factors. The following risk factors have been found to be associated with low back pain and back disorders:

- Awkward Postures - the degree or extent of forward bending appears to be the most significant concern. However, twisting and sideways bending also places uneven force on the spinal discs and muscles.

- High Force or Forceful Exertions - lifting heavy objects or pushing overloaded carts can create an extreme force in the low back. For lifting, the closer to the body that an object can be kept during a lift, the less force in the low back. Both object weight and body position affect the amount of force and stress created in the low back.

- Static (fixed position) Work - when someone sits or stands in a fixed position for a long time, demands are placed upon certain muscles to maintain contraction. This may cause fatigue and discomfort in the low back. On the other hand, if the job is modified to give the worker an opportunity to move in a controlled fashion, the weight of the body is shifted between numerous muscle groups. By sharing the load among different muscles over time, one muscle group is allowed time to rest while another is working. This helps reduce the tendency for fatigue.

- High Frequency Lifting - frequent lifting has been correlated with increased low back injury rates. Studies suggest that using a squat lift (lifting with bent knees and a straight back) puts less pressure on the disc than using a stoop lift (lifting with straight knees and a bent back). Repeatedly bending the spine, especially when twisting is involved, can weaken the disc and lead to injuries such as disc protrusions-a bulging of the outer wall of the disc that can press against the nerve.

- Speed of Movement - the use of smooth body movements during lifting and other materials handling tasks helps reduce the risk of developing low back injury. Jerky or sudden, unexpected movements are associated with high force levels that may create injuries and should be avoided.

- Duration of Lifting- a worker who performs a material handling task continuously over an entire shift may be more likely to experience low back discomfort than a worker who does the job for only two hours. Job rotation can be used to reduce stress to the low back by reducing the duration of exposure to the stressful work.

- Whole-Body Vibration - this is a generalized stressor that impacts virtually the entire body. Although prolonged exposure to whole-body vibration (e.g.,

standing on or driving large construction equipment) may be related to postural fatigue and low back discomfort, little is actually known about its direct affects. The goal is to control the transfer of energy from the vibrating equipment or surface to the employee.

2.2.4 Legs/Feet.

2.2.4.1 Disorders. The following conditions are leg and feet disorders associated with standing, kneeling or bending tasks in maintenance and inspection work areas.

- Bursitis of the knee - an inflammation of the bursa sac in the knee joints.
- Varicose veins - prolonged pooling of the blood in the vein, especially in the lower leg.

2.2.4.2 Risk Factors. The following risk factors have been found to be associated with lower limb disorders.

- Stressful Positions and Movements - kneeling or bending postures increase pressure inside the knee joint. Forced positions of the knees, such as those used when squatting to work in an area with limited access.
- Static Work (fixed positions) - prolonged standing or sitting while the back of the knee/thighs are compressed interferes with circulation. When standing in a fixed position, blood collects in the legs causing increased pressure on the blood vessels and joints.
- Excessive Forces - using the knees to apply pressure to a surface is one example of excessive force. The knee joint is also impacted internally when the worker assumes a kneeling posture.
- External Trauma - kneeling on a hard or uneven surface may cause immediate discomfort and long-term damage to the soft tissues of the knees.

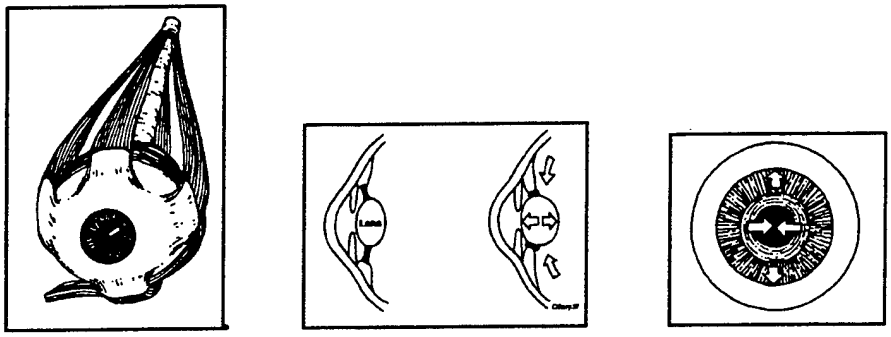
2.2.5 Visual Issues. Eyestrain is less common in industrial tasks than in administrative work. However, maintenance and inspection jobs which require high visual demands may present the risk factors which may contribute to eyestrain or decrease the employee's ability to maintain high quality performance. In addition, since computer work may be part of many maintenance and inspection tasks, a discussion of risk factors is warranted.

2.2.5.1 Visual Complaints. (See Figure 2.7) It is important to know the anatomy of the eyes as a foundation for understanding the sources of complaints.

- Oculomotor muscles - control movement side-to-side and up-and-down and are used whenever they are searching or reading documents or screens.

- Ciliary muscles - control focusing by changing the shape of the lens to hold images in focus. They must adjust for any change in focal length when the eyes are looking at different distances.

- Iris muscles - control light intake (adjust size of pupils according to light intensity) and are affected by the light from the screen, document or surrounding area.



Oculomotor muscles **Ciliary muscles** **Iris muscles**

Figure 2.7
Eye Anatomy

2.2.5.2 Risk Factors. Glare on a worksurface of a VDT screen makes it more difficult for the user to see clearly and easily. Though employees whose tasks have high visual demands complain of visual discomfort, there is no evidence that high visual demands (including VDT use) causes permanent eye damage. The discomfort, however, is real and needs to be addressed. Most of the discomfort results from users having to strain their visual system to compensate for the inadequate viewing conditions, which results in squinting, stretching, etc.

There are two types of **glare**: direct and reflected.

- **Direct glare** is caused by light sources within the visual field. This can cause "disabling glare" because it reduces the contrast at the retina reducing visual performance.

- **Reflected glare** is caused by the light rays bouncing off the surface.

  – It can be specular. Specular means that the operator can see the reflected image of the light source itself or the image of an object or person.

- It can be diffused glare. Light bouncing off floor or ceiling lights may be reflected with no clear visible pattern. The background simply appears brighter.

Other visual complaints include:

- **Excessive or Inadequate Ambient Light** - Many workspaces are too bright or dark for easy viewing, causing the user to adapt by overusing his/her eye muscles.

- **Visual Disorders** - The eye does not always function properly. Some of the visual disorders people experience which affects their being able to see properly when working with or without a VDT are: far-sightedness, near-sightedness, and presbyopia.

- **Amount of Visual Demand** - If workers have intense visual tasks all day and are working with tight schedules, they are more likely to have visual problems. The amount of uninterrupted time spent on visually demanding tasks can affect eyestrain.

2.3 CONCLUSION

One of the main purposes of this Guide is to provide you with the specific ergonomics principles which you can apply to 50 of the most common maintenance and inspection tasks in order to reduce or effectively eliminate employee exposure to the risk factors. The intended result is to reduce the potential for WMDs (and visual problems) while maximizing employee performance.

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3.0 USER'S GUIDE

This Guide will enable you to complete all aspects of the Level Ergonomics Assessment I and Problem-Solving Methodology. After the first few uses of the Guide, you will be able to efficiently identify job and/or task-specific ergonomics risk factors in all types of maintenance and inspection work areas. Most importantly, however, you will be able to control employee exposure to those risk factors by matching practical and effective solutions to the problems that you identify.

3.0.1 When to Use this Guide. There are two situations for which use of the Level I Methodology is intended:

- users responding to an AF Form 190 investigation
- pro-active problem-solving based on results of the JR/PD Survey

For responding to an AF Form 190 investigation, the Methodology can be used to identify a potential job or task-based source of a WMD. For pro-active problem-solving, the Methodology can be used to conduct a systematic evaluation of an EPRA-designated shop. In both situations, the purpose is to specify which specific tasks may be the source of ergonomics hazards, and to identify and prioritize Corrective Actions for those tasks.

3.0.2 Five Step Process. A five step process is provided to keep your work focused and efficient.

- Step 1: Preparation
- Step 2: Risk Factor Identification
- Step 3: Prioritization of Hazards
- Step 4: Hazard Control Selection
- Step 5: Recommendations

The remainder of this section will demonstrate how you can apply the process for both situations.

3.1 STEP 1 - PREPARATION

Item(s) Required:	AF Form 190; or JR/PD Survey Summary Report

The purpose of Step 1 is to help prepare you for the shop visit. It is recommended that you complete Steps 2, 3, and 4 while you are in the shop, and Step 5 after you have returned to the BEF office. After applying the Methodology several times, you can decide what works best for you.

3.1.1 Logistics. In order to prepare for the shop visit and Steps 2, 3, and 4, you will need:

- An appointment with the work center supervisor
- At least one copy of the Level I Ergonomics Assessment Checklist
- At least one copy of the Ergonomics Summary Report
- The relevant Case Study Problem-Solving Matrices (see Note on Case Study Pre-Selection, below)
- A pencil or pen
- A calculator
- The AF Form 190 or results of the JR/PD Survey, depending on the situation.

It will be helpful for you to have a desk or work surface near the workstation for which you are conducting the assessment. You should plan on spending up to one and one half hours in the shop. Some visits will take less time. Others may take more time depending upon the situation and how long you will need to remain in the shop to observe all aspects of the job.

Note on Case Study Pre-Selection:

There are 50 Case Studies that apply to maintenance and inspection work areas:

1 abrading
2 assembly disassembly-internal components
3 assembly repair-bench work
4 bolting/screwing
5 chipping
6 cleaning by hand
7 cleaning with high pressure equipment
8 coating/immersing
9 computer work
10 crimping
11 cutting/shearing
12 drilling
13 driving
14 excavating/shoveling
15 flame cutting
16 folding/fitting
17 forming
18 gluing/laminating (dopping)
19 grinding
20 hammering
21 hose handling
22 lifting
23 machining
24 masking
25 masoning
26 media blasting (blast cabinet)
27 media blasting (high pressure gun)
28 melting
29 monitoring (of displays)
30 nailing
31 opening/closing heavy doors
32 ordnance disposal
33 packing
34 painting/spraying
35 paving
36 prying
37 pumping
38 riveting/bucking
39 sanding
40 sawing
41 sewing
42 soldering
43 stripping/depainting by hand
44 stripping/depainting by mechanical methods
45 turning valves
46 tying/twisting/wrapping
47 visual inspection
48 welding
49 wiring
50 wrenching/ratcheting

For the first few assessments that you do, it is recommended that you take all of the Case Studies to the shop. Later, if you already know the types of tasks that are performed in the shop, you may pre-select the most relevant Case Studies (e.g., if you know that nobody in the shop performs welding work, you may wish to leave this (and others) behind in your office). The Case Studies are located in Appendix 4.

3.1.2 Review of Relevant Data and Job Selection. If you are using the Guide as part of an AF Form 190 investigation, proceed directly to Section 3.2 Step 2 - Risk Factor Identification.

If you are using the Guide to conduct pro-active problem-solving in an EPRA-designated shop, complete the following steps.

Step 1a. Obtain the JR/PD Survey Summary Report for shop from PHF. This Summary Report was used by the installation EWG to determine the work center's EPRA status.

Step 1b. Review Step 7 on page 2 of the Summary Report. Listed in this section are the types of work (e.g., welding, grinding/polishing) which were reported by over 20 percent of the employees. Your objective is to target the Level I Ergonomics Assessment and Problem-Solving Methodology on jobs or job classifications (e.g., electrician, mechanic, etc.) which *include* these types of work or tasks.

Step 1c. Review the Comments provided for Steps 8, 9, and 10 on page 3 of the Summary Report. These Comments, which summarize the comments and suggestions that participants in the survey completed, may identify very specific sources of ergonomics problems and/or improvement opportunities.

Step 1d. Identify the job classification(s) (e.g., AFSC or civilian job series) which include the types of work identified in Step 1b. When you go to the shop, your first task will be to determine how many employees from each job classification you will need to include in your investigation.

An example of an Air Force Form 190 and a completed JR/PD Survey Summary Report is provided in Appendix 1.

3.2 STEP 2 - RISK FACTOR IDENTIFICATION

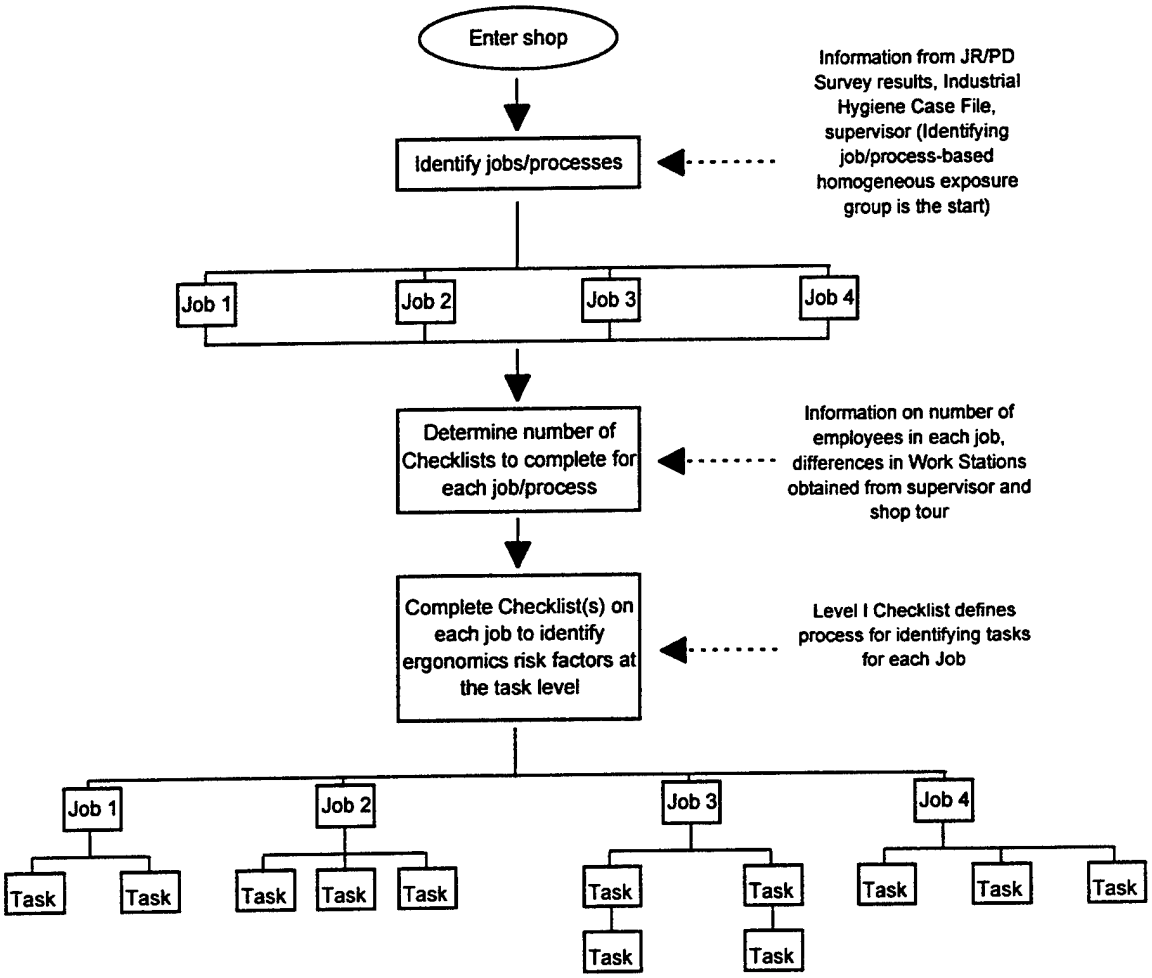
Item(s) Needed:	Level I Ergonomics Assessment Checklist

The purpose of Step 2 is to identify work-related risk factors to which the employee is exposed. You will the use the Level I Ergonomics Assessment Checklist to complete Step 2.

If you are responding to an AF Form 190 investigation, proceed to Step 2d.

If you are using the Guide to conduct pro-active problem-solving in an EPRA-designated shop, complete the following steps. You may also refer to Figure 3.0 to see how process proceeds from entering the shop to performing the actual assessment.

Figure 3.0
Selecting Jobs/Processes to Performing the Assessment



Step 2a. After entering the shop and introductions with the shop supervisor, explain the purpose and process for completing the Level I Ergonomics Assessment Checklist.

Step 2b. Refer to the Industrial Hygiene Case File to identify the primary jobs/processes in the shop. Verify these jobs/processes with the supervisor and ask the supervisor how many employees perform each one of the jobs. (Note: this approach makes your starting point a job or process instead of an individual employee - unless you are responding to a AF Form 190 investigation. The job/process defines the homogeneous exposure group.)

Step 2c. Determine how many employees you need to observe/how many Checklists you will need to complete for each job/process.

There is no firm rule on how many employees is a representative sample of a job classification or homogeneous exposure group. You may want to begin by including 20 percent of the population or 3 employees, whichever number is greater. Or, if there are 3 or fewer employees in a job category, include all of the employees.

The following factors typically determine the number of Checklists that are required:

- the number of different work situations in which the job occurs (e.g., performed on aircraft, performed on bench)
- the number of different types of tools or equipment, or aircraft devices used
- the distribution of critical tasks in the job.

Take the example of the job, "repair fuel housing" in a sheet metal shop. Say that there are two common fuel housing designs that must be repaired, Housing A and Housing B. If both housings are repaired at the same bench (or workstation), if the same equipment and tools are used during the process, and if there is the same amount of grinding, shearing, riveting, etc. for each housing - and the designs do not require the employee to use a completely different work procedure (e.g., one is done standing, one is done sitting), then the Housing A and Housing B jobs can be considered the same. The Checklist(s) competed for Repair Fuel Housing (Housing A) also applies to Repair Fuel Housing (Housing B). If the distribution of critical tasks is appreciably different (e.g, makes up 80 % of Housing A repair but only 20 % of Housing B repair), you will need to conduct the Level I Assessment separately for each repair job.

To complete the appropriate number of Checklists for each job type/process follow the steps below:

- Complete a Checklist for the first work situation noting the tools equipment, and tasks performed.
- Go to the next work situation in which the job is being done
  - If there are no significant differences in the tools, equipment, or distribution of critical tasks for the next work situation, then use the same Checklist (same pieces of paper) for that work situation. Simply observe the job/tasks to make sure that the risk factor exposure is not significantly different.
  - If there are significant differences in the tools, equipment, or distribution of critical tasks, then complete a new Checklist for that work situation.
- Repeat this process for all work situations that make up the representative sample for the job classification. This will result in a single Checklist completed for each homogeneous group in that shop. A homogeneous group is a group of employees and their jobs which have similar characteristics (similar tools, equipment, work situations and critical task distributions). Develop recommendations for each Checklist. These recommendations will

apply (in general) to all work situations in the homogeneous group defined by that Checklist.

3.2.1 Format. The Level I Ergonomics Assessment Checklist is comprised of a cover page and four parts.

- Cover Page
- Part I: Work Content (Description of Tasks Performed)
- Part II: Job Factors Checklist
- Part III: Environmental Factors Checklist
- Part IV: Employee Suggestions

3.2.2 Cover Page. The purpose of the cover page is to identify the work center (shop), location of the work, the name of the Job/Process, etc. You will have one cover page for each Job/Process for which you complete a Checklist. If you complete multiple Checklists for the same Job/Process, you may use the same cover page.

Step 2d. Collect the information for the cover page from the supervisor and/or the employee. Record.

3.2.3 Part I: Work Content (Description of Tasks Performed). Part I helps you get the employee to describe, in a standardized way, the individual tasks which comprise his or her job. Fifty different task types are listed in a "Work Content Matrix." These task types are consistent with the maintenance and inspection task types listed in Part III of the JR/PD Survey. For both analysis tools, the 50 task types were selected as representative of the most common types of maintenance and inspection tasks. Additional space is provided to record other tasks that the employee described.

In order to identify appropriate jobs to assess, you must help the employee (or supervisor) try to think about the jobs and tasks that are the most fatiguing or difficult on the body. Any information from the employee (e.g., "painting the T-tail", etc.) may help you identify several initial targets for your assessment. The second question will help you get an idea from the employee about which of those jobs are done on a regular basis. Your goal is to identify the job (e.g., raft packing) that will become the focus of your Level I assessment. Then, you can proceed to the Work Content Matrix with a specific job in mind.

The Work Content Matrix is designed to allow one of three responses under the "Task Frequency" heading. The frequencies (e.g., low, moderate, high) allow you to categorize the tasks by the amount of time devoted to the task when the job is performed. A gray shaded area is superimposed in the Matrix to make a distinction between routine tasks and tasks which represent a less significant part of the job. The gray shaded area includes tasks which make up over 10% of the job. The gray shaded area also includes

lifting/exertion tasks. All instances of lifting or exertion are considered critical tasks and should be included in the assessment.

Information provided in the completed Matrix is very important. First, it enables you to break a potentially complex job down into smaller component or "tasks" that can be easily analyzed. Second, it enables you to maximize the value of the subsequent assessment by focusing problem-solving efforts on the routine tasks - referred to for the remainder of the assessment as "critical tasks."

Performance measures are also recorded to help you justify the need for ergonomics improvement. For example, if the employee's performance is judged according to the quality of the surface finish on an aircraft component and the current work area arrangement makes the surface more difficult to grind, you may be able to obtain support for fabricating a height-adjustable holding fixture since it may help the employee do a better job faster as well as reduce the potential for a shoulder WMD.

Obtain the following information directly from the employee:

Step 2e. Turn to Page 1, *Part I - Work Content* (Description of Tasks Performed.)

Step 2f. Verify with the employee that the job you are targeting (you identified this job/process for investigation in Step 2b.) is performed on a regular basis (or occurs most frequently) in the shop. Note: If the employee mentions jobs that you do not have in the Industrial Hygiene Case File or that were not mentioned by the supervisor, you may wish to add these jobs to your list of target jobs for the Level I Assessment.

Step 2g. Ask each employee to explain the *purpose of the job*. The objective is to develop a complete understanding of why the job exists and the type of work done by the employee. If a task is not listed on page 2 of the Checklist, use lines 131 and 132 to write in the task names (e.g., meeting with others) and mark the appropriate time estimate.

Step 2h. *Fill out the Work Content Matrix*. Ask the employee to indicate how much time is devoted, each time the job is performed each of the tasks listed in the first column of the Work Content Matrix. Be sure to let the employee know that if a task on the list is not part of the job, they should tell you so. Mark the appropriate circle in the gray shaded *Work Frequency* columns.

Step 2i. *Ask about performance measures*. Ask the employee to describe the performance measures used to measure success in that job. Some employees may not be able to provide this type of information if their performance has not been formally measured in the past. When this is the

case, simply ask the employee, "How would you know whether a person doing your job was doing a good job? - What would you look for?" Record the responses in the *Work Performance* box on the bottom of page 1.

3.2.4 Part II: Job Factors Checklist. The format enables you to perform an ergonomics analysis for each of the critical tasks. The tasks are analyzed individually to identify the specific source of exposure to ergonomics risk factors. It is not usually the "job" (e.g., repair wing strut) that causes fatigue or discomfort. Rather, it is the individual "tasks" (e.g., grinding, welding, etc.) that are the source. You may not be able to change the fact that the employee must repair the wing strut. However, it may be possible to address the part of that job that requires prolonged grinding with a disc grinder. Figure 3.1 shows one page of the Job Factors Checklist.

Figure 3.1
Work Content Matrix from Level I Checklist

Level I - Ergonomics Assessment for Maintenance and Inspection Work Areas

Part I - Work Content (Description of Tasks Performed) (Cont.)

Maintenance and Inspection Task Key List

66. abrading
68. bolting/screwing
70. chipping
71. cleaning by hand
72. cleaning with high pressure equipment
73. coating/immersing
76. crimping
77. cutting/shearing
79. drilling
80. driving (vehicles)
81. excavating
83. flame cutting
84. folding/fitting
85. gluing/laminating (dopping)
86. grinding/buffing/polishing
87. hammering
88. lifting
90. lubricating
91. machining
92. masoning
93. melting
94. molding
95. monitoring (visual displays)
97. nailing
98. opening/closing heavy doors
99. packing/packaging
100. painting/spray painting
101. paving
102. pumping (by hand)
103. riveting/bucking
104. sanding
105. sawing
107. sewing
108. soldering/brazing
110. stripping/depainting by hand
111. stripping/depainting mechanically
113. turning valves
114. tying/twisting/wrapping
116. welding
118. wiring
119. wrenching/ratcheting
121. assembly/disassembly internal component
122. assembly & repair (bench work)
123. computer work
124. hose handling
125. forming
126. masking
127. media blasting (blast cabinet)
128. media blasting (high pressure gun)
129. ordnance disposal
130. prying
131. visual inspection

(Write in others)

131. _____
132. _____

Detailed information on question design, interpretation, and research references, has been submitted to the USAF in a separate Research Report. Further information may be obtained from AL/OEMO.

The *Job Factors* questions have been grouped into five "body zones":

- shoulder/neck (Q1-Q4)
- hands/wrists/arms (Q5-Q11)
- back/torso (Q12-Q18)
- legs/feet (Q19-Q22)
- head/eyes (Q23-Q24)

The body zones are consistent with those used in the JR/PD Survey. The questions are representative of the types of ergonomics risk factors that are most likely to be found in Air Force maintenance and inspection work areas.

The included questions were designed to ensure that each general risk factor type discussed in the scientific literature (e.g., posture, force, repetition, etc.) was reflected. The questions and illustrations were also designed to prevent the need for you to repeatedly refer to a glossary when completing the checklist (A glossary is provided in Appendix 2, to assist you the first few times you use the Checklist). No measurements are required. All of the questions may be answered based on observing the employee at work.

For each question, you can assess the employee's exposure to the Job (risk) Factor as: *Frequently, Sometimes, Occasionally or Never/NA*. First, you will indicate whether or not the task is a "moderate" or "high" frequency component within the overall job. You will then circle the appropriate Job Factor responses under that column. If the Job Factor occurs greater than 50% of the task time (e.g., the employee is exposed to repeated arm forces (question 2) "*more*" rather than "*less*" of the time) and the task is a "moderate" task, you circle the *Frequently* (F=2) response. If the Job Factor occurs between 10% to 50% of the task time and the task is a "moderate" task, your circle the *Sometimes* (S=1) response. If the job factor occurs for less than 10% of the task and the task is a "moderate" task, you circle the *Occasionally* (O=0) response. If the Job Factor does not occur or the question is not applicable to the task you circle the *Never/NA* (N=0) response.

Four response choices are provided for each of the "Moderate" and "High" categories to maximize the consistency of assessment results between users and minimize the need for interpretation and estimating actual time. It is significantly easier to decide if a Job Factor occurs "more" or "less" than 1/2 the time, than it is to make a consistent distinction between 1/3, 2/3, etc. In addition, since many maintenance and inspection jobs include Job Factors that occur, but to a much lesser extent (e.g., <10%), the

"occasional" response choice was added. This was designed to recognize and account for risk factors that will be observed, but will not be observed anywhere near that 50% level. The numerical ratings provided for each response were determined based on the relative contribution of the Job Factor type to work-related musculoskeletal disorders (WMDs) as well as the impact of exposure duration. Providing a numerical rating for each response allows the scoring process to be kept fast and easy.

A numerical Task Score is calculated for each task by adding the numbers in the column. The Task Score represents degree to which the task exposes the employee to ergonomics risk factors. The score is compared to evaluation criteria (*0-3/Low, 4-7/Medium, and 8+/High*) which allows you to establish priorities for problem-solving.

After obtaining a job description and a basic task frequency breakdown from the employee, you are ready to begin the *Part II - Ergonomics Checklist/Job Factors.*

Note: In some cases, the employee will not be performing all of the critical tasks at the time of your observation. When this is the case, ask the employee to demonstrate each of the critical tasks. Complete the Checklist for each task during the demonstration.

Step 2j. Turn to Page 2, Part II - Checklist, Shoulder/Neck and review the definition for Frequently (F), Sometimes (S), Occasionally (O) and Never/NA (N).

Step 2k. From Page 1 of the Checklist, note the tasks from the marked circles in the gray area and write the task(s) on the blank lines under Critical Tasks. If there are more than 3 tasks, put the additional tasks on another checklist.

Step 2l. Moderate (10%-50%) or high (51%-100%). Note that tasks which occur less than 10% of the time are excluded from the Assessment.

Step 2m. Next, answer each question for *each* task by circling (F), (S), (O), (N).

Step 2n. After you have answered *every* question for each task, compute the *Task Scores* (add each column and total at the bottom). The Comments box in the far right column is for additional notes regarding the tasks.

Step 2o. Repeat the identical process four more times. Review each critical task again for Hands, Wrist, Arm, Back/Torso, Legs/Feet, and Head/Eyes, (pages 3-6), recording the results in the same way as for Shoulder/Neck.

3.2.5 Part III: Environmental Factors. Four questions (Q25-Q28) are provided to assess potential exposure to general environmental factors (or stressors). Responses are provided on a 5-point scale. This section of the assessment is completed either by asking the employee to rate each one of the factors or by referring to

environmental data already collected from previous industrial hygiene surveys (e.g., noise, indoor air quality-see Glossary in Appendix 2). Figure 3.2 shows the Environmental Factors.

Figure 3.2
Environmental Factors

Level I Ergonomics Assessment for Maintenance and Inspection Work Areas

Part III - Environmental

Environmental Factors

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
25. Restricted space					
26. Extreme temperatures heat/cold					
27. Noise or distractions					
28. Air quality concerns					

Environmental Score = ☐

Environmental Rating	Low	Med	High
Environmental Score	0-3	4-7	8+

This data indicates perceived employee exposure to environmental factors that may be impacting the way that the employee performs the job/tasks. For example, working in a restricted space may be one of the reasons why the employee must reach or lean forward. The environmental rating is not used to determine the overall job priority score or priority scores for individual tasks. It is, however, accounted for during problem-solving process.

Complete the following.

Step 2p. Turn to page 7, *Part III - Environmental* and answer the questions relating to Environmental Factors and circle the appropriate number.

Step 2q. Total the numbers and write the score in the Environmental Score box and circle the appropriate rating *High, Medium, or Low.*

3.2.6 Part IV: Employee Suggestions. Employee involvement is critical in the problem identification and problem solving processes. Employees who have previously completed the JR/PD Survey may have already provided feedback on improvement opportunities. Your questions for the employee in Part IV have a slightly different focus. The JR/PD Survey asked about general improvement opportunities for the shop. Part IV enables you to record any comments or suggestions that the employee may have on how to improve the job. Employee suggestions are to be thoughtfully considered and evaluated along with the controls provided in the Case Study Problem-Solving Matrices when you develop the final list of recommendations in Step 5.

Step 2r. Ask the employee for any suggestions for Corrective Actions that he/she may have. *The employee may provide you with improvement suggestions during the initial interview.* Record employee comments.

The Level I Ergonomics Assessment Checklist is now finished.

A completed Level I Ergonomics Assessment Checklist and the Checklist Glossary is provided in Appendix 2.

3.3 STEP 3 - PRIORITIZATION OF HAZARDS

Item(s) Needed:	Completed Level I Ergonomics Assessment Checklist Checklist Scoring Summary

The purpose of this step is to "score" the Level I Checklist in order to determine the employee's exposure to ergonomics risk factors from the individual tasks and from the job overall. You will use the Checklist Scoring Summary form to determine the exposure.

3.3.1 The Checklist Scoring Summary Design. There are three parts to the Checklist Scoring Summary:

- Job Description
- Scoring Summary
- Case Study Selection

The Case Study Selection part of the Checklist Scoring Summary form will be discussed in Step 4, HAZARD CONTROL SELECTION.

A *Job Description* section is provided to enable you to briefly summarize the job requirements and the purpose of the job/position.

The *Scoring Summary* design resulted from a combination of findings from the literature review as well as the consensus judgment from experienced ergonomists at TJI/ADL. In the literature, there is a lack of validated methods for determining a "threshold" between "ergonomics problem/risk of WMD" and "no ergonomic problem/no risk of WMD." Therefore, the scoring concept and results generated by the assessment are designed to *prioritize* the need for Corrective Actions based on the highest exposure to ergonomics hazards. In other words, a *High* rating *means that exposure to risk factors which have been associated with WMDs* is high. It does not mean that the risk for injury is high. When interpreting results, you should focus problem-solving efforts on any job, task, body region which is rated *High* or *Medium.*

Priority scores are generated for each body region, for each task, and for the overall job. Figure 3.3 shows the Scoring Summary.

3.3.1.1 Body Region Score. Body Region Scores for each task are determined by totaling the responses to the Job Factor Questions for each task. Body Region scores for the job as a whole are determined by averaging scores across tasks. The averaging process was selected to reflect the beneficial impact of task variety. Consider the following example jobs.

- Job A is comprised of just one task: grinding. This task exposes the shoulder/neck to a *High* level of ergonomics risk factors - Body Part Score = 8. Since there is only one task, the Body Region Priority Score=8, which is a *High* rating.

- Job B is comprised of two tasks: grinding and manual inspection. This grinding task, which is performed for five hours per day, exposes the shoulder/neck to a *High* level of ergonomics risk factors - Body Part Score = 8. The manual inspection task, which is performed for three hours per day, exposes the shoulder neck to a *Low* level of ergonomics risk factors - Body Part Score = 2. The average Body Region Priority Score=5, which is a *Medium* rating.

A comparison of the Body Region Priority Score for each task suggests that Job B is easier on the shoulder than Job A. The *Medium* rating on Job B suggests that, since the employee spends part of the day performing a task (manual inspection), which provides some relief to the shoulder, the overall potential for a shoulder problem is reduced. This is consistent with the ergonomics research literature which indicates that a job designed with task variety should reduce the overall potential for WMD development. Also, since the rating system still indicates that, when grinding is performed, the shoulder is at *High* risk, you are directed to identify controls which reduce exposure to ergonomics risk factors that impact the shoulder during grinding.

Figure 3.3
Scoring Summary Section of the Checklist
Scoring Summary Form

ERGONOMIC SCORING SUMMARY:

Technician _____

Date _____

1. Job Description: Please write out job description.

2. Scoring Summary: Transfer scores from individual scoring sheets.

Body Region	Task Scores					Priority Score by Body Region	Priority Rating by Body Region
	Task Name:	Task Name:	Task Name:	Task Name:		Add across row and divide by # of tasks for average	High: 8+ Med: 4-7 Low: 0-3
Shoulder/Neck					=		High Med Low
Hand/Wrist/Arm					=		High Med Low
Back/Torso					=		High Med Low
Legs/Feet					=		High Med Low
Head/Eyes					=		High Med Low

Select the highest body region score for each task then circle below for High, Med, Low	Highest Score	Highest Score	Highest Score	Highest Score
High: 8+ Med: 4-7 Low: 0-3	High Med Low	High Med Low	High Med Low	High Med Low

Environmental Rating
High Med Low

Overall	
Highest Priority Score by Body Region Score:_____ Body Region:_____	Priority Rating High Med Low

While averaging may not always reflect the precise daily physical experience of the employee, it provides you with a standardized method for determining the impact of overall daily exposure and how to focus problem-solving efforts in order to achieve the desired impact on employee health and safety. This concept can be referred to as high-impact, precision-strike problem-solving.

3.3.1.2 Task Score. The individual Task Score is determined by selecting the highest numerical body region score for that task. The highest numerical body region score is converted into a High, Medium or Low rating. The reason: the feeling of fatigue or pain, which are often precursors to WMD development, is not "averaged" throughout the body by the employee. For example, if exposure to a high level of risk factors causes an employee's shoulder to hurt, the employee does not think, "my shoulder hurts, but the rest of my body is OK, so I must be OK." Rather, the employee reports a shoulder problem because that part of the body hurts. Therefore, if the shoulder is exposed to a high level of ergonomics risk factors, the Task Score reflects that most significant exposure.

3.3.1.3 Overall Job Priority Score. The Overall Job Priority Score, *High*, *Medium*, or *Low*, is determined by selecting the highest Body Region Priority Score. The basis for this scoring concept is identical to that which was described for the Scoring Summary. The Overall Priority Rating is used to determine which jobs need the most immediate attention.

3.3.1.4 Use of the Scores and Ratings. While the Overall Job Priority Rating/Score is used to determine which *jobs* to address first. Task Ratings/Scores are used to determine which *task(s) within the job* need to be the focus of problem-solving efforts. And finally, the Body Region Scores for each task are used to target the identification of controls for the body parts that are exposed to the highest level of ergonomics hazards. Again, the objective is precision-strike focus, with high impact results.

There are three major steps to completing the prioritization of hazards.

Step 3a. Complete the top entries on the form (date, name, etc.).

Step 3b. Complete the *Job Description* section. It is not necessary to write a detailed job description or to transfer the information from the Work Content Matrix. Simply describe the main purpose of the job and what the employee does. (In some cases, the employee may be able to provide a written job description that you may use as the basis of the summary.)

Step 3c. Complete the Scoring Summary.

- The first step is to transfer the names of the *critical tasks* selected for the Level I Ergonomics Assessment Checklist (e.g., welding, grinding) to the *Task Scores* columns.

  Next transfer the *task scores* (column total) from each individual checklist (e.g., *Shoulder/Neck, Hand/Wrist/Arms*) to the appropriate task column. Once you have transferred *all* task scores for *each* critical task it is time to select the highest body region score (per task).

- Next, select the *highest* Body Region Score from each task and write the number in the *Highest Score* box at the bottom of each Task Name column. Then circle the appropriate box below for *High, Medium, or Low* for that task.

- Now add across the rows and calculate the *average* to obtain a *Priority Score by Body Region.* (To obtain the average, add across the row and divide by the number of tasks.) Be sure to calculate the average for all Body Regions (e.g., *Shoulder/Neck, Back/Torso* etc.) and then circle the appropriate response, High, Medium or Low for that body region in the *Priority Rating by Body Region* column.

- From page 7 of the Level I Ergonomics Assessment Checklist transfer *High, Medium or Low* Environmental Rating to the *Environmental Rating* box.

- Finally, at the bottom/right of the page complete the *Overall* box. Into this box, transfer the highest average body region score from the *Priority Score by Body Region* column above and circle *High, Medium or Low.*

A completed Checklist Scoring Summary is provided in Appendix 3.

3.4 STEP 4 - HAZARD CONTROL (Selection of Corrective Actions)

Item(s) Needed:	Completed Checklist Scoring Summary Case Study Problem-Solving Matrices (Appendix 4) Corrective Actions List (Appendix 4)

Part 4 represents the start of the pattern-matching process.

3.4.1 Case Study Selection. Figure 3.4 shows the Case Study selection list from the bottom of the Checklist Scoring Summary.

Figure 3.4
Case Study Selection List

3. <u>Case Study Selections List</u> Select the case studies that match the critical tasks that you identified for this job. Place a ✓in the appropriate boxes below and then turn to the appropriate case study in the Case Study Book.

1	Abrading	☐	26	Media Blasting (Blast Cabinet)	☐
2	Assembly Disassembly-Internal Components	☐	27	Media Blasting (High Pressure Gun)	☐
3	Assembly Repair-Bench Work	☐	28	Melting	☐
4	Bolting/Screwing	☐	29	Monitoring (Of Displays)	☐
5	Chipping	☐	30	Nailing	☐
6	Cleaning By Hand	☐	31	Opening/Closing Heavy Doors	☐
7	Cleaning With High Pressure Equipment	☐	32	Ordnance Disposal	☐
8	Coating/Immersing	☐	33	Packing	☑
9	Computer Work	☐	34	Painting/Spraying	☐
10	Crimping	☐	35	Paving	☐
11	Cutting/Shearing	☐	36	Prying	☐
12	Drilling	☐	37	Pumping	☐
13	Driving	☐	38	Riveting/Bucking	☐
14	Excavating/Shoveling	☐	39	Sanding	☐
15	Flame Cutting	☐	40	Sawing	☐
16	Folding/Fitting	☑	41	Sewing	☐
17	Forming	☐	42	Soldering	☐
18	Gluing/Laminating (Dopping)	☐	43	Stripping/Depainting by Hand	☐
19	Grinding	☐	44	Stripping/Depainting by Mechanical Methods	☐
20	Hammering	☐	45	Turning Valves	☐
21	Hose Handling	☐	46	Tying/Twisting/Wrapping	☐
22	Lifting	☑	47	Visual Inspection	☐
23	Machining	☐	48	Welding	☐
24	Masking	☐	49	Wiring	☐
25	Masoning	☐	50	Wrenching/Ratcheting	☐

The idea is to select the Case Studies/titles that "match" the critical tasks that were identified during the scoring process in Step 3. This is the main connection between the Checklist results and the Case Study Problem-Solving Matrices. It is the foundation of pattern matching.

3.4.2 Case Study Design and Use. The Case Study Problem-Solving Matrices are the subject of Appendix 4. An overview of the Case Study Problem-Solving Matrix design, however, is provided here in the context of the pattern-matching process.

Fifty Case Study Problem-Solving Matrices were developed. The task types which were the basis for the Case Studies were selected by the Air Force and are consistent with "Types of Work" listed in Section III of the JR/PD Survey.

Each of the Case Studies presents the Job Factors commonly associated with the task type. For each Job Factor (e.g., *reaching*), the causes of the Job Factor (e.g., *the work is located too far from the employee*) and a menu of controls that reduce or eliminate the Job Factor (e.g., *remove obstructions between the work location and the employee)* are provided.

The content of the Case Studies is based, in part, on a review of representative Air Force maintenance and inspection tasks. However, the majority of Potential Causes and Corrective Actions - which were generalized such that they may be applied to *any* USAF maintenance and inspection job - were extracted from the results of years of practical applications work completed by experienced ergonomists.

The information is organized in the following sections:

- *Task Title*: In most cases the task title is simply a restatement of the Case Study name.

- *Task Description*: The task description provides details on the type of equipment that is typically used to perform the task (e.g., manual or power tools, etc.), the length of time over which the task is typically performed, and other materials that may be used. Also provided is a list of maintenance and inspection jobs in which the task is performed.

- *Job Performance Measures*: This section indicates which performance measures (e.g., productivity, quality, etc.) are typically impacted by implementing ergonomic improvements. This information, in addition to the job-specific performance measures obtained when completing the Level I Ergonomics Assessment Checklist, could be used by the technician to justify the need for change.

- *Typical Employee Comments*: The information from this section is provided to help you judge whether or not employee comments obtained with the Checklist are consistent with problems or concerns that employees typically report for the task type. In other words, if an employee whose job involves continuous welding comments about stiffness in the neck and shoulders, you can check the "Typical Employee Comments" section of the *Welding* Case Study to see if the complaint is common for employees who weld. This information also helps you determine if you are looking at the most appropriate Case Study(ies) for the job.

- *Level II Analysis*. If you are unable to identify the causes or source of the ergonomics concerns, or if you feel that a more detailed analysis is required (e.g., complex job) each case study recommends the type of Level II analysis that may proved the information you need.

- *Job Factor, Potential Causes, Corrective Actions*. The Case Study design enables you to make a direct match between the Job Factor present in the task, and that same Job Factor in the Problem-Solving Matrix. Figure 3.5 shows part of a Case Study.

Figure 3.5
Example Problem-Solving Matrix

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1.Reaching	• Work location is too high	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding	 ✓ ✓	 ✓	 low low high	 med med med	 med med high
		32. Lower the work piece/worksurface • modify existing table • provide an adjustable height work table	✓	 ✓	low high	med med	med high
	• Welding tool or gas hose must be manually supported, held or steadied 	116. Provide support for the tool • provide a tool balancer for bench work • provide a mobile tool balancer that can be hung overhead for field work		✓ ✓	med med	med med	med med
		113. Provide support for the cable or hose • provide a hook to hang cable in work area	✓		med	med	med
		112. Provide support for the arms • provide flexible armrests		✓	med	med	med

For example, if you observed that the job required the employee to *use repeated reaching or arms held away from the body while unsupported,* it is possible to match that Job Factor with the same Job Factor in the left hand column of the Matrix. For each Job Factor, the ergonomists have identified the most common *Potential Causes* or aspects of the workplace or work procedure that if they are not designed or adjusted properly, can cause the Job Factor to be present. If you were to decide that the arms are held away from the body while unsupported because the *Welding tool or gas hose must be manually supported, held or steadied,* you can then refer to the Corrective Actions list to see what types of controls are available to address the problem. For this example, two choices are provided: *Provide support for the arms (or nearby surface or on flexible arm supports),* and *Provide support for hose or cord (using a wire hook or a mobile tool balancer).* You must decide which of the Corrective Actions would best control or eliminate the Job Factor.

The Case Studies also include information that helps you choose the controls option which is in the best interest of the employee with consideration of the costs. For each control, the *Level of Changes* column indicates if the control is typically a *minor modification* or *major change*. The controls that are listed as minor modifications involve little or no cost. In most cases this level of control can be implemented by making adjustments to the current work area. Approximately 50 percent of the controls provided in the Case Studies are at this level. The major change category includes controls such *as provide a lighter weight tool.* The distinguishing characteristic of major changes is that the shop will need to buy something. They will need to identify a product in a catalogue (e.g., alternative tool, anti-fatigue mat, tool balancer, etc.), have the product delivered for trial, and make a purchase if they find a true benefit. Controls listed in this category may be appropriate but may need to be planned as a long-term change since they may be expensive.

Information on cost is provided only in general categories; *Low, Medium, and High.* This broad categorization was intentional and is based on an Air Force consensus. Every base may have a different idea about what represents *Low, Medium, or High* cost.

Still further, the Case Studies provide information on how implementation of the control is expected to impact quality and/or productivity. This information was compiled based on a consensus decision of experienced ergonomists at TJI/ADL who have seen similar results in their own application work. You may use this information as further justification for change.

3.4.3 Corrective Actions. The next step in the pattern-matching process is to select the Corrective Actions in a Case Study that "match" the problems. As you identify an appropriate Corrective Action in a Case Study, you will check off that selection on the Corrective Actions List. Part of the form provided in Appendix 4 has been excerpted as Figure 3.6.

Figure 3.6
Corrective Actions List

Job Factors

Corrective Actions	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
1. Provide handles with insulating material			A.5.2.2
2. Provide portable heaters			
3. Provide powered assistance for a manual activity			
4. Provide powered or mechanical assistance for door			
5. Provide protection from glare			
6. Provide protection from glare from overhead lights/task lights			
7. Provide shields or barriers from the wind			
8. Provide support for reference documents			
9. Provide support for the arms			
10. Provide support for the cable or hose			A.5.1.2

In the Corrective Actions List, all of the controls from all of the Case Study Problem-Solving Matrices have been provided.

For instance, in the previous example, if you had identified that the job required *Repeated reaching or arms held away from the body while unsupported* and that the cause was, *Welding tool or gas hose must be manually supported, held or steadied* and determined that *Provide support for the hose or cord,* was the appropriate solution, you would then make a "check" mark in the "Action Selected" box for the corrective action *Provide support for the cable or hose*,

The Corrective Action numbers on the list are the same numbers in the Case Studies. This allows you to quickly locate and mark the control when using the Case Studies. Two response columns are provided: minor (modifications and adjustments), and major (major changes). The columns have been blocked such that the check mark is placed in the column that represents the level of control indicated in the Case Studies. This distinction is made in the Corrective Actions list to minimize the amount of time required for developing the final recommendations.

There is one additional column: "Implementation Reference." In this column you have been provided with a page reference in Appendix 5. Included on the referenced pages is additional detail which you may use to "implement" the corrective action. This information will be particularly important as you develop your final recommendations in Step 5.

There are 7 major steps in completing the Hazard Control selection.

Step 4a. Preview the information in the Checklist Scoring Summary to select the Case Study Problem-Solving Matrices most appropriate for identifying controls.

- *Select the Case Study or Studies* that match each of the Critical Tasks whose Task Score is a *High* or *Medium. You may also choose to review case studies for "low" rated tasks at your discretion.*
- Place a check mark in the appropriate box (or boxes) and then turn to the corresponding Case Study Problem-Solving Matrix (or Matrices) in the Case Study Problem-Solving Manual.

Now that you have identified the appropriate Case Study Matrix or Matrices you need to identify Corrective Actions. For this you will need to have the *Level I Ergonomics Assessment,* the *relevant Case Study Problem-Solving Matrices* (Appendix 4) and the *Corrective Actions List* (Appendix 4) pages open for reference. Ideally, you should be near the workstation when identifying appropriate Corrective Actions.

Step 4b. Turn to page 1 of the Corrective Actions List, pages 1 through 3.

Step 4c. Next open Appendix 4 to the Case Study that you selected for a Task (e.g., *welding*) with a *High* or *Medium* task.

Step 4d. Open the Level I Ergonomics Assessment Checklist to Page 2, *Shoulder/Neck.* Look in the task column for *Welding.* Note any of the Job Factor questions that are answered with *F, S or O.*

Step 4e. Select an appropriate Corrective Action - place a check mark in the appropriate box on the Corrective Actions List.

For example, if *Question 1, Reaching* scored *F, S, or O* then you need to suggest a *Corrective Action.* To Select a *Corrective Action* turn back to the Shoulder/Neck section of the Welding Case Study and look for Question 1-*Reaching* under the *Job Factor Column.* Review the *Potential Causes* that apply and select the appropriate *Corrective*

Action. On the Corrective Actions List, record the appropriate Corrective Action. Examine the workstation to make sure the Corrective Action selected will be appropriate.

Step 4f. Repeat Steps 4d and 4e for each Job Factor Question until you have completed the Pattern-Matching (Hazard Control Selection) process for the Task.

Step 4g. Complete Steps 4a through 4f for each of the remaining *High* or *Medium* rated Tasks. You do not need to continue with problem-solving on tasks that were rated *Low.*

3.5 STEP 5 - RECOMMENDATIONS

Item(s) Needed:	Completed Checklist Scoring Summary Completed Corrective Actions List Level I Ergonomics Assessment Summary and Recommendations (Appendix 5)

The purpose of step five is to summarize all of the information from Steps 1- 4 in a way that will enable you to communicate the key problems, causes, and recommendations to the shop supervisor for reducing and/or eliminating employee exposure to ergonomic risk factors. A Level I Ergonomics Assessment Summary and Recommendations form was developed to serve as the basis for a *concise report.*

The intent of the report is for you to summarize the findings of the Level I Ergonomics Assessment Checklist and record if the findings are consistent with previous findings from the AF Form 190 or the JR/PD Survey results, which ever one applies to the situation with which you are dealing. The report also allows you indicate to the shop supervisor which tasks need to be the focus of problem-solving.

The intent is for the supervisor to use the report for planning and implementing Corrective Actions. Since this is a summary, you should transfer only the most important information from the Checklist Scoring Summary and the Corrective Actions List.

Step 5a. Fill in the information on date, workplace identifier, base, etc. on the top of the Level I Ergonomics Assessment Summary and Recommendations form.

Step 5b. In the *Critical Tasks in Priority Order* table, write in the Task Name(s) of any of the Critical Tasks that had a Task Score of *High* or *Medium.* The highest rated task goes in row 1, the next highest in row 2, etc. Note: if the Checklist Scoring Summary indicated that one or more of the Critical Tasks was rated Low, do not list the task(s) in this table.

Step 5c. For each task, circle the *Task Rating* (*High or Medium*). Then, circle the appropriate *Rating* for each *Body Region* (*High or Medium*).

Step 5d. Circle the *Overall Job Rating* (*High or Medium*). Write in the Priority Body Region (e.g., *Shoulder/Neck, Back/Torso, etc.*).

Step 5e. Indicate whether or not your results and findings are consistent with results from the JR/PD Survey (yes or no). Comment as appropriate. For example, one comment could be: "This job may contribute to the high risk factor and discomfort ratings for the shoulder/neck region reported for the shop." If your investigation was not prompted by the JR/PD Survey, check "N/A".

Step 5f. Indicate if the results are consistent with Air Force Form 190 findings (*yes* or *no*). Comment as appropriate. An example comment could be "Each of the tasks performed by the employee exposes the employee to high to medium levels of ergonomics risk factors in the hands/wrists/arms region. This finding is consistent with employee-reported hand/wrist discomfort." If your investigation was not prompted by an Air Force Form 190, check "N/A".

Step 5g. Provide recommendations for follow-up.

This is the final list of Corrective Actions that you wish to present and discuss with the shop supervisor. The list should be based on thoughtful consideration of the appropriateness of each of the controls that you marked in the Corrective Actions List. The idea *is not* to restate all of the controls. The idea *is* to suggest Corrective Actions that you believe should be implemented and that represent the best strategy for affecting workplace changes.

Provide recommendations for *Modifications and Adjustments*. Refer to the Corrective Actions List and look for the controls marked in the "minor" column. Evaluate each of the controls for appropriateness (e.g., will implementing the control reduce employee exposure to ergonomics hazards?) and practicality (e.g., is it realistic?). To evaluate the control, refer to the "Implementation Reference" page number provided for the Corrective Actions. (Note: Not all corrective actions need further explanation than is provided in the case study. For these actions, no reference is provided). In the section "Implementing Minor Modifications," you can obtain additional detail or suggestions on how to implement the control. List the controls in priority order. Indicate

whether or not you expect to see benefits to employee health/safety and/or productivity/quality.

Provide recommendations for *Major Changes and/or Purchases*. Refer to the Corrective Actions List and look for the controls marked in the *major* column. Again, evaluate each of the controls for appropriateness. Also include those controls that you think should be included in the shop's long-term planning or budgeting process for the following period. By indicating whether or not you expect to see benefits to productivity/quality, in addition to employee health/safety, a shop supervisor or manager may be open to hearing more about a potentially major purchase.

When an Implementation Reference is provided, refer to the "Using Design Criteria to Implement Major Purchases" section. In cases where you recommend the purchase of equipment (e.g., lifting device, power tool, etc.), information in this section will help you select the appropriate choice based on ergonomics criteria.

The last step is to present the Summary and Recommendations as shown in Figure 3.7, to the shop supervisor and schedule a date for follow-up to measure the results of workplace improvements.

Figure 3.7
Level I Ergonomics Assessment
Summary and Recommendations

Date (YYMMDD)		Workplace Identifier:	
(use this space for mechanical imprint)		Base	Organization
		Workplace	
		Bldg. No./Location	Room/Area
		AFSC/Job Series	

CRITICAL TASKS IN PRIORITY ORDER

Task Name	Task Rating	Body Regions and Ratings (Circle one for each region)				
		Shoulder/ Neck	Hands/Wrists/ Arms	Back/Torso	Legs/Feet	Head/Eyes
1.	High Med	High Med	High Med	High Med	High Med	High Med
2.	High Med	High Med	High Med	High Med	High Med	High Med
3.	High Med	High Med	High Med	High Med	High Med	High Med
4.	High Med	High Med	High Med	High Med	High Med	High Med

OVERALL JOB RATING

RATING: High Medium (Circle one)	PRIORITY BODY REGION: (circle one) Shoulder/Neck Hand/Wrist/Arm Back/Torso Legs/Feet Head/Eyes

- Findings are consistent with results from Job Requirements and Physical Demands Survey (PHF): ☐ Yes☐ No☐ N/A
  Comment:_____
- Findings are consistent with employee reports of discomfort and/or illness: ☐ Yes☐ No☐ N/A
  Comment:_____

RECOMMENDATION FOR FOLLOW-UP

Modifications and adjustments	Major changes and/or purchases
_____	_____
_____	_____
_____	_____
Expected Benefits (Check all that apply) ☐ Health/Safety ☐ Productivity/Quality	Expected Benefits (Check all that apply) ☐ Health/Safety ☐ Productivity/Quality

INSERT TAB X HERE

APPENDIX 1

Preparation

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APPENDIX 1

This appendix corresponds with Step 1: Preparation. It provides completed examples for:

- a Job Requirements and Physical Demands Survey (JR/PD Survey);
- a JR/PD Survey Summary Report; and
- an AF Form 190.

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JOB REQUIREMENTS AND PHYSICAL DEMANDS SURVEY

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JRPD SURVEY

A completed survey is provided so that you can see the type of information on which the JRPD Survey Summary Report was compiled. One note of caution: the installation EWG does not make conclusions based on responses on individual surveys. This sample is provided only so that you understand the overall process.

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JOB REQUIREMENTS AND PHYSICAL DEMANDS SURVEY

Job Requirements and Physical Demands Survey	Date (YYMMDD) 960912	Workplace Identifier:	0052-XXXX-057A
(use this space for mechanical imprint)		Base: Dover AFB	Organization:
		Workplace: APS Special Handling	
		Bldg. No/Location:	Room/Area: Bay 2
		AFSC/Job Series:	

Gender: Female ○ Male ●

Work Group: Civilian ○ Grade:_____ Military ● Rank: Airman

Age Category: 20 and under ● 21-30 ○ 31-40 ○ over 40 ○

Length of service at this base: less than one year ○ more than one year ●

Length of time in current shop: less than one year ○ more than one year ●

Have you completed this questionnaire before? Yes ○ No ●

Part I - Job Factors

This section enables you to describe what is involved in your job. Indicate how long you do this work on approximately a daily basis.

A. DESCRIPTION OF WORK

SHOULDER / NECK

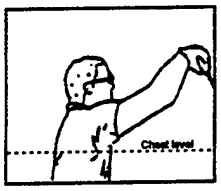

Figure A.

	Never	0-2 hrs.	2-4 hrs.	4-8 hrs.
1. I work with my hands at or above chest level. *(Figure A.)*	○	○	○	●
2. To get to or to do my work, I must lay on my back or side and work with my arms up.	●	○	○	○
3. I must hold or carry materials (or large stacks of files) during the course of my work.	○	●	○	○
4. I force or yank components or work objects in order to complete a task.	○	○	●	○
5. I reach or hold my arms in front of or behind my body (e.g., using a keyboard, filing, handling parts, performing inspection tasks, pushing or pulling carts, etc.). *(Figure B.)*	○	○	●	○

Figure B.

Figure C.

6. My neck is tipped forward or backward when I work. *(Figure C.)*	○	●	○	○

Figure D.

7. I cradle a phone or other device between my neck and shoulder. *(Figure D.)*	●	○	○	○

Part I - Job Factors (continued)

HAND/WRIST/ARM

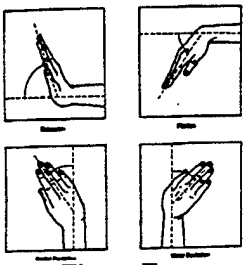

Figure E.

Figure F.

	Never	0-2 hrs.	2-4 hrs.	4-8 hrs.
8. My wrists are bent (up, down, to the thumb or little finger side) while I work. ***(Figure E.)***	○	○	●	○
9. I apply pressure or hold an item/material/tool (e.g., screw driver, spray gun, mouse, etc.) in my hand for longer than 10 seconds at a time.	●	○	○	○
10. My work requires me to use my hands in a way that is similar to wringing out clothes. ***(Figure F.)***	●	○	○	○
11. I perform a series of repetitive tasks or movements during the normal course of my work (e.g., using a keyboard, tightening fasteners, cutting meat, etc.).	○	○	●	○
12. The worksurface (e.g., desk, bench, etc.) or tool(s) that I use presses into my palm(s), wrist(s), or against the sides of my fingers leaving red marks on or beneath the skin.	●	○	○	○
13. I use my hand/palm like a hammer to do certain aspects of my work.	○	●	○	○
14. My hands and fingers are cold when I work.	●	○	○	○
15. I work at a fast pace to keep up with a machine production quota or performance incentive.	●	○	○	○
16. The tool(s) that I use vibrates and/or jerks my hand(s) and arms(s).	●	○	○	○
17. My work requires that I repeatedly throw or toss items.	○	●	○	○
18. My work requires me to twist my forearms, such as turning a screwdriver.	○	●	○	○
19. I wear gloves that are bulky, or reduce my ability to grip.	●	○	○	○
20. I squeeze or pinch work objects with a force similar to that which is required to open a lid on a new jar.	○	○	●	○
21. I grip work objects or tools as if I am gripping tightly onto a pencil.	●	○	○	○

Part I - Job Factors (continued)

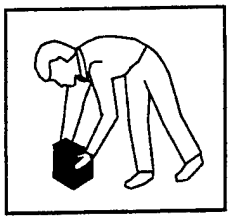

Figure G.

BACK/TORSO

	Never	0-2 hrs.	2-4 hrs.	4-8 hrs.
22. When I lift, move components, or do other aspects of my work, my hands are lower than my knees. *(Figure G.)*	○	○	○	●
23. I lean forward continually when I work (e.g., when sitting, when standing, when pushing carts, etc.).	○	○	●	○
24. The personal protective equipment or clothing that I wear limits or restricts my movement.	●	○	○	○
25. I repeatedly bend my back (e.g., forward, backward, to the side, or twist) in the course of my work.	○	○	○	●
26. When I lift, my body is twisted and/or I lift quickly. *(Figure H.)*	●	○	○	○

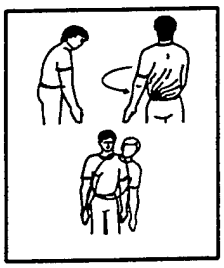

Figure H.

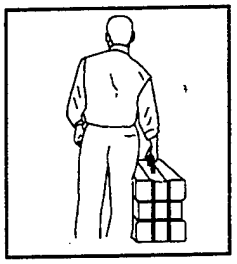

Figure I.

27. I can feel vibration through the surface that I stand on or through my seat.	●	○	○	○
28. I lift and/or carry items with one hand. *(Figure I.)*	○	●	○	○
29. I lift or handle bulky items.	○	●	○	○
30. I lift materials that weigh more than 25 pounds.	○	●	○	○

Part I - Job Factors (continued)

LEGS / FEET

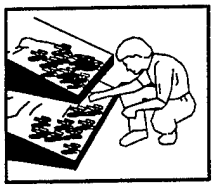

Figure J.

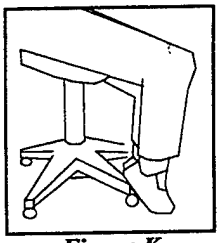

Figure K

	Never	0-2 hrs.	2-4 hrs.	4-8 hrs.
31. My work requires that I kneel or squat. *(Figure J.)*	○	●	○	○
32. I must constantly move or apply pressure with one or both feet (e.g., using foot pedals, driving, etc.).	●	○	○	○
33. When I'm sitting, I cannot rest both feet flat on the floor. *(Figure K.)*	●	○	○	○
34. I stand on hard surfaces.	○	○	○	●

HEAD / EYES

35. I can see glare on my computer screen or worksurface.	●	○	○	○
36. It is difficult to hear a person on the phone or to concentrate because of other activity, voices, or noise in/near my work area...	●	○	○	○
37. I must look at the monitor screen constantly so that I do not miss important information (radar scope).	●	○	○	○
38. It is difficult to see what I am working with (monitor, paper, parts, etc.).	●	○	○	○

Part I - Job Factors (continued)

B. ORGANIZATIONAL FACTORS

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
39. I often feel unclear on what the scope and responsibilities of my job are.	○	●	○	○	○
40. I often feel that I have too heavy of a workload, one that I could not possibly finish during an ordinary workday.	○	●	○	○	○
41. I often feel that I will not be able to satisfy the conflicting demands of various people around me.	○	○	●	○	○
42. I often find myself unable to get information needed to carry out my job.	○	○	●	○	○
43. I often do not know what my supervisor thinks of me, how he/she evaluates my performance.	○	●	○	○	○
44. I often think that the amount of work I have to do interferes with how well it's done.	○	●	○	○	○

C. PHYSICAL EFFORT

45. How would you describe the physical effort required of your job?

6 No exertion at all	7 Extremely light	8	9 Very light	10	11 Light	12	13 Somewhat hard	14	15 Hard	16	17 Very hard	18	19 Extremely hard	20 Maximal exertion
○	○	○	○	○	○	○	●	○	○	○	○	○	○	○

Part II - Your Body's Response to Work Demands

D. DISCOMFORT FACTORS

This section enables you to identify how your body responds to the demands of ***your job***. In each section, answer the first question. If the answer is "no" go to the next column.

Question	Shoulder/Neck	Hands/Wrists/Arms	Back/Torso	Legs/Feet	Head/Eyes
• In the past 12 months, have you experienced any discomfort, fatigue, numbness, or pain that ***relates to your job***?	46. Yes ● No ○ ***If "no", go to question 49***	49. Yes ● No ○ ***If "no", go to question 52***	52. Yes ● No ○ ***If "no", go to question 55***	55. Yes ○ No ● ***If "no", go to question 58***	58. Yes ○ No ● ***If "no", go to question 61***
• How often do you experience discomfort, fatigue, numbness, or pain in this region of the body?	47. Daily ○ Weekly ○ Monthly ●	50. Daily ○ Weekly ○ Monthly ●	53. Daily ○ Weekly ○ Monthly ●	56. Daily ○ Weekly ○ Monthly ○	59. Daily ○ Weekly ○ Monthly ○
• On average, how severe is the discomfort, fatigue, numbness, or pain in this region of the body?	48. Mild ● Moderate ○ Severe ○	51. Mild ● Moderate ○ Severe ○	54. Mild ● Moderate ○ Severe ○	57. Mild ○ Moderate ○ Severe ○	60. Mild ○ Moderate ○ Severe ○

Part II - Your Body's Response to Work Demands (continued)

E. GENERAL QUESTIONS

61. In the past 12 months, have you seen a health care provider for any pain or discomfort that you think **relates to your job**? Yes ○ No ●

62. Do you experience any work-related pain or discomfort that does not improve when you are away from work overnight or over the weekend? Yes ● No ○

63. In the past 12 months, has any work-related pain or discomfort caused you difficulty in carrying out normal activities (e.g., job, hobby, leisure, etc.)? Yes ● No ○

64. Has a health care provider ever told you that you have any of the following conditions which you think might be **related to your work**? Yes ○ No ●

- Tendonitis/Tenosynovitis
- Epicondylitis (Tennis Elbow)
- Thoracic Outlet Syndrome
- Ganglion Cyst
- Bursitis
- Back Strain
- Trigger Finger
- Carpal Tunnel Syndrome
- Knee or Ankle Strain
- Overuse Syndrome

65. Do you have or have you ever had one or more of the following conditions? Yes ○ No ●

- Wrist Fracture
- Thyroid Disorder
- Rheumatoid Arthritis
- Hypertension
- Diabetes
- Kidney Disorders
- Gout

Part III - Work Content

The section below will enable you to describe the content of the work that you do in your current shop.

Fill in the box that describes how frequently you do the task listed, based on the following definitions:

- **Routine:** Performed on three or more days per week.
- **Non-routine:** Performed two days a week or less.
- **Seasonal:** Performed only during certain times of the year
- **Never/NA:** You do not perform this type of work.

No.	Type of Work	Work Frequency (Check one)			
		Routine	Non-Routine	Seasonal	Never/NA
66.	abrading	○	○	○	●
67.	baking	○	○	○	●
68.	bolting/screwing	○	○	○	●
69.	calling (telephone use)	○	○	○	●
70.	chipping	○	○	○	●
71.	cleaning by hand	○	○	○	●
72.	cleaning with high pressure equipment	○	○	○	●
73.	coating/immersing	○	○	○	●
74.	cooking	○	○	○	●
75.	copying	○	○	○	●
76.	crimping	○	○	○	●
77.	cutting/shearing	○	○	○	●
78.	drafting/CAD system use	○	○	○	●
79.	drilling	○	○	○	●
80.	driving (vehicles)	○	○	○	●
81.	excavating	○	○	○	●
82.	filing/general administrative	○	○	○	●
83.	flame cutting/arc cutting	○	○	○	●
84.	folding/fitting	○	○	○	●
85.	gluing/laminating	○	○	○	●
86.	grinding/buffing/polishing	○	○	○	●
87.	hammering	○	○	○	●
88.	lifting	●	○	○	○
89.	loading (pallets, trucks, carts, aircraft)	●	○	○	○
90.	lubricating	○	○	○	●

Part III - Work Content (Continued)

No.	Type of Work	Work Frequency (Check one)			
		Routine	Non-Routine	Seasonal	Never/NA
91.	machining	○	○	○	●
92.	masoning	○	○	○	●
93.	melting	○	○	○	●
94.	molding	○	○	○	●
95.	monitoring (visual displays)	○	○	○	●
96.	mousing (for computer work)	○	○	○	●
97.	nailing	○	○	○	●
98.	opening/closing heavy doors	○	○	○	●
99.	packing/packaging	●	○	○	○
100.	painting/spray painting	○	○	○	●
101.	paving	○	○	○	●
102.	pumping (by hand)	○	○	○	●
103.	riveting/bucking	○	○	○	●
104.	sanding	○	○	○	●
105.	sawing	○	○	○	●
106.	scanning (using bar code readers)	○	○	○	●
107.	sewing	○	○	○	●
108.	soldering/brazing	○	○	○	●
109.	stapling	○	○	○	●
110.	stripping/depainting by hand	○	○	○	●
111.	stripping/depainting mechanically	○	○	○	●
112.	transporting loads on non-powered carts	○	●	○	○
113.	turning valves	○	○	○	●
114.	tying/twisting/wrapping	●	○	○	○
115.	typing/keying	○	○	○	●
116.	welding	○	○	○	●
117.	wheeling loads	○	○	○	●
118.	wiring	○	○	○	●
119.	wrenching/ratcheting	○	○	○	●
120.	writing/illustrating	○	○	○	●
	(Write in others)				
121.	_____	○	○	○	○
122.	_____	○	○	○	○

Part IV - Process Improvement Opportunities

Think about your job as a whole, including routine, non-routine or seasonal work.

Read the questions listed below and **describe the activities** that you or your co-workers think place the greatest demands on your body.

1. Which tasks are the most awkward or require you to work in the most uncomfortable positions?
Throwing tie-down nets over tall pallet loads.

2. Which tasks take the most effort?
Pulling the nets out of baskets. Sometimes nets have bugs or other
things in them.

3. Are there any tools or pieces of equipment that are notoriously hard to work with? (If so, list them below)
No Comment.

4. If you could make any suggestions that would help you do your job more easily or faster or better, what would you suggest?
Have the tie down task be done on the leveler in the bay.

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JRPD Survey Summary Report

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JRPD Survey Summary Report

You will need to refer to this report in cases when you are conducting pro-active problem-solving in EPRA-designated shops. Table A describes parts of the report that may be particularly helpful.

Table A
JRPD Survey Summary Report - Items to Include in Pre-Shop Visit Review

Where	Selected Items/Information	What it Tells You
Page 1	Steps 1, 2, and 3. Items A.1-A.5 and D.1-D.5 are combined using the Ranking Matrix to generate the Priority Rank for the shop. The highest score for any body region (e.g., shoulder/neck, back/torso, etc.) is used as the Priority Rank on which the EWG makes its initial judgment about EPRA status.	Look at the highest body part ratings for the shop as a whole. If the shoulder/neck, for example, gets the highest ratings, you may wish to pay special attention to risk factors/demands on the shoulder as you perform assessments in the shop. Also, if your Level I Checklist results generate a high relative score for the same region, you might conclude that the job/task which is the focus of your assessment, may be contributing to reported shoulder/neck problems throughout the shop.
Page 2	Steps 4 and 5. The Organizational Rating indicates the perceived level of "job stress" in the shop. The Physical Effect Factors score indicates people's overall perception of physical demands (e.g., easy, hard, etc.)	A "high" Organizational Rating could indicate that high levels of job stress (e.g., poor relationship with supervisor, high work load, etc.) throughout the shop may be increasing people's experience with pain and discomfort. While you are not necessarily responsible for dealing with job stress, employees may comment about it during the course of your assessment. A Physical Effect Factors score of 15 or higher indicates that employee's think the over job demands in the shop are "high" (15 = hard on the survey). You should be sensitive to this as you are performing the assessment.

Table A (Cont'd)
JRPD Survey Summary Report - Items to Include in Pre-Shop Visit Review

Where	Selected Items/Information	What it Tells You
Page 2	Step 6. Health care provider score. Activity Interruption percentage.	Health care provider score indicates number of employees who have received prior medical attention for a disorder. Activity Interruption percentage indicates the percentage of employees whose work or home activities have been affected by work-related pain or discomfort.
Page 2	Step 7. List of routine types of work.	This information is particularly important. This is the list of tasks that you will verify with the shop supervisor and from which you may select jobs to include in your proactive assessment.
Page 3	Step 8. Information on "potential concerns" and "improvement opportunities" within the shop.	Information in Step 8 may help you fine tune or prioritize the list of jobs you wish to include in your assessment. Pay close attention to the improvement opportunity remarks. Employees are providing you with some time-saving insight into what may help reduce ergonomics risk factors or pain/discomfort throughout the shop.

JOB REQUIREMENTS AND PHYSICAL DEMANDS SURVEY SUMMARY REPORT

ERPA Status:	EPRA	**Priority Ranking:**	7	**Date:**	260996

Date: 26 September 1996	Workplace Identifier: 0052-XXXX-057A	Base: Dover AFB
Organization:	Workplace: APS Special Handling	Bldg./Location:
Room/Area Bay 2	AFSC:	Civilian Job Series:
Shop Supervisor:	Duty Phone:	Office Symbol:

Step 1	Step 2	Step 3	
Write in the **Risk Factor Rating** for Part I, (questions 1-38, Scoring Sheet pg.1)	Write in the **Discomfort Rating** for Part II, (questions 46-60, Scoring Sheet pg.3)	Look at the "Ranking Matrix" below and enter the **Priority Score** in it's corresponding box.	
A.1 Medium	D.1 Medium	**Shoulder/Neck =**	5
A.2 Medium	D.2 Low	**Hands/Wrist/Arms =**	2
A.3 High	D.3 Medium	**Back/Torso =**	7
A.4 High	D.4 Medium	**Legs/Feet =**	7
A.5 Medium	D.5 Medium	**Head/Eye =**	5

Ranking Matrix

Ranking Matrix for Priority Score	Discomfort High	Discomfort Medium	Discomfort Low
Risk Factor High	9	7	
Risk Factor Medium	8	5	
Risk Factor Low	6		

Select the HIGHEST score for any body part from Step 3 and enter →

Survey Priority Rank: 7

JOB REQUIREMENTS AND PHYSICAL DEMANDS SURVEY SUMMARY REPORT

Step 4

B. Enter **Organizational Rating:** (Questions 39-44, Scoring Sheet pg. 2)	**Comments:**
Low	None

Step 5

C. Enter **Physical Effect Factor Score:** (Question 45, Scoring Sheet pg.2)	**Comments:**
13.47	None

Step 6

E. Enter the score for each of the General Questions: (Questions 61-65, Scoring Sheet pg. 4)

E.1 Health Care Provider Score 7 %	**Comments:**
E.2 Recovery Time Score 52.63 %	**Comments:** Likely EPRA. If not, compare with discomfort ratings and consider an ergonomic evaluation.
E.3 Activity Interruption Score 47.37 %	**Comments:** Almost half the employees report that work-related pain/discomfort has affected job performance/hobbies.
E.4 Previous Diagnosis Score 31.58 %	**Comments:** A pre-existing WMO may be inflating the survey priority rank.
E.5 Contributing Factors Score 26.32 %	**Comments:**

Step 7

F. List below each of the routine types of work which had shop percentage scores over 20%. (Items 66-122, scoring sheet page 5)

Type of Work	%	Type of Work	%
Loading	95		
Lifting	95		
Packing/Packaging	72		
Tying/Twisting/Wrapping	26		

JOB REQUIREMENTS AND PHYSICAL DEMANDS SURVEY SUMMARY REPORT

Step 8	
Review Part IV (Questions 1-3) to identify tasks, tools, equipment, etc., that employees listed as potential concerns. Comment as appropriate.	**Comments:** *Handling nets/Tie-downs seem to require significant effort.*
Review Part IV (Question 4) to identify potential improvement opportunities. Comment as appropriate.	**Comments:** *Check to see if task can be performed using existing height adjustment device in the adjacent work area.*
Step 9	
Injury/Illness Data: Review the injury/illness history from this shop. Attach information and comment as appropriate.	**Comments:** *One employee has had surgery on both wrists (Carpal Tunnel Syndrome)*

Step 10
Conclusions / Recommendations Summary

Shop Status

EPRA

Recommendations for follow-up:

Refer to Bioenvironmental Engineering for Level I Assessment. Suggest beginning by investigating the demands of loading and lifting tasks most frequently performed in the shop.

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AF Form 190

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AF Form 190

Attached is a completed AF Form 190. Table B describes parts of the report that may be particularly helpful.

Table B
AF Form 190 - Items to Include in Pre-Shop Visit Review

Selected Items/Information	What it Tells You
Items 6 and 10. Work Location and Occupation (Job Title/AFSC)	This information may help you pin point the possible job or workstation source of reported potential ergonomics problems.
Item 25. Describe Job Tasks that Resulted in Exposure to Hazardous Materials/Agents (Specify the material/agent).	The more specific the information, the more helpful it will be to prepare for your assessment. Ideally, the description will provide, not only information on the physical movements that may be the source of stress (e.g., radial, ulnar deviation), but information on a specific job or series of tasks in which those movements occur. It is the task-specific information which will help you decide where to begin the Level I Assessment.
Item 12. Diagnosis and Relevant Medical Data.	This description will help you focus your assessment. In other words, while you will be completing the Level I Ergonomics Assessment Checklist in order to assess exposure for all of the body regions, knowing in advance that the person is suffering from a lateral epicondylitis (elbow) may make you more sensitive to risk factors for that body region.
Step 31. Bioenvironmental Survey.	One of the primary purposes of the Level I Ergonomics Assessment and Problem-Solving Guide for Maintenance and Inspection Work Areas is to provide you with the tools to supplement your own ergonomics expertise and enable you to complete this section.

FPO

Copy of completed AF Form 190

(Insert here)

OCCUPATIONAL ILLNESS / INJURY REPORT

(THIS FORM IS SUBJE... TO THE PRIVACY ACT OF 1974 - Use Blanket F... DD Form 2005) 95-487

PATIENT IDENTIFICATION

I.				
1. NAME (Last, First, MI) [redacted] 95-222	2. SSAN [redacted]	3. GRADE ☐ MIL ☒ CIV	4. SEX ☒ M ☐ F	5. AGE 35
6. ...K LOCATION B... 2121/FLAP SHOP	7. DUTY PHONE 63860	8. ORGANIZATION AND SYMBOL OC-ALC/LIPPBS	9. INSTALLATION TINKER AFB, OK 73145	
10. OCCUPATION (Job Title/AFSC) A/C SHEETMENTAL MECHANIC/3806/WG-10		11. SUPERVISOR (Name and Duty Phone) [redacted]		

INCIDENT / ILLNESS DATA

II.	
12. DATE AND TIME OF EXPOSURE: SINCE 1988 ILLNESS: FEB 95	13. STATUS AT TIME OF EXPOSURE ☒ ON DUTY ☐ OFF DUTY ☐ LEAVE ☐ TDY ☐ OTHER
14. DURATION OF EXPOSURE 7 YEARS, 6 MONTHS, 25 DAYS (~9 mo)	15. WITNESS (Name and Phone) NONE

16. DESCRIPTION OF SYMPTOMS AT ONSET OF ILLNESS

"This has happened in Bldg. 2121. My job calls for the use of alot of power tools such as drill motors, rivet guns, etc. I do alot of overhead and below knee work. My right elbow has started hurting me and has progressively gotten worse."

MEDICAL DATA

III.		
17. DIAGNOSIS AND RELEVANT MEDICAL DATA (Indicate affected body parts) RIGHT LATERAL EPICONDYLITIS	18. CLASSIFICATION [2]	OSHA CODE
	OCCUPATIONAL SKIN DISEASE	21
	DUST DISEASE OF LUNGS	22
	RESPIRATORY CONDITION DUE TO TOXIC AGENT	23
	SYSTEMATIC EFFECT OF TOXIC MATERIAL (poisoning)	24
	DISORDER DUE TO PHYSICAL AGENT (Other than toxic material)	25
	X DISORDER DUE TO REPEATED TRAUMA (Exclude hearing loss)	26
	OTHER OCCUPATIONAL DISEASE	29

Ic 69- 72632

☐ FATALITY	☐ RESULTED IN UNCONSCIOUSNESS	19. DATE/TIME OF INITIAL TREATMENT/DIAGNOSIS [redacted]ULY 95/1422-1545	20. MEDICAL FACILITY 72D AMDS/SGPFO, OMS, BLDG. 3001

21. TREATMENT ADMINISTERED (Check One) ☒ FIRST AID [1] ☐ DEFINITIVE CARE (Specify In Remarks)

DISPOSITION OF PATIENTS

22. YES	NO		NO. OF DAYS	
	X	RETURN TO NORMAL DUTY	0	ADMITTED TO HOSPITAL
	X	REFER TO PRIVATE PHYSICIAN	0	PLACED ON [redacted]
	X	EXCUSED FOR REST OF DUTY DAY	7	RETURN TO [redacted]

23. NAME OF MEDICAL OFFICER [redacted] MAJ, USAF, MC, FS, 044F3

MAJOR
MEDICAL CORP
AFSC: 044F3
72 MG, TINKER AFB OK 73145-3065

24. REMARKS

DEFINITIVE CARE NOT SPECIFIED BY THE ATTENDING PHYISICIAN.

ENVIRONMENTAL DATA

IV.

25. DESCRIBE JOB TASKS THAT RESULTED IN EXPOSURE TO HAZARDOUS MATERIALS / AGENTS (Specify the material / agent)

Mr[redacted]s duties is primarily a standing operations with most parts positioned on work tables or fixtures of various fixed heights in either the Back or flap shop. He corrects defects and sheet metal "skins" and frames by using a variety of handheld tools. Operations include: removing trivets with drills, using cleco pliers to install clecos to hold parts , countersinking bolt holes with a drill, shooting rivets while using various guns (e.g. rivet and cherry loc) and while holding various sizes of bucking bars, microshaving rivets, cutting sheet metal with manual or pneumatic shears, sanding and bufing various edges, wiring some fastners with safety wire pliers, using hammers, mallets and files, painting and cleaning parts, installing brakcets using am impact wrench

V. CASE CLASSIFICATION

26. OCCUPATIONAL INCIDENT	27. TYPE	28. WORKPLACE IDENTIFIER	30. DATE (YYMMDD)
☒ YES ☐ NO	☐ INJURY ☒ ILLNESS	0 1 8 8 D A D O 2 0 6	950130

29. REVIEWING OFFICER [redacted] MD, CHIEF OMS, 09356C

1. One-time treatment of minor scratches, cuts, burns, and splinters which do not require professional care.
2. See AFR 127-12.

AF FORM 190, OCT 81 (EF-V1) (PerFORM PRO) PREVIOUS EDITION IS OBSOLETE.

31. BIOENVIRONMENTAL ENGINEERING SURVEY *(Summarize investigation of patient's exposure. Indicate results of appropriate measurements and assessment of protective measures. Consultant reports of or in lieu of this survey should be referenced and attached.)*

Erogmonic stresses include, vibration transmitted to the arms and hands from shooting rivets with various guns and holding bucking bars (this is a high level of exposure, the high level implies that employees use vibrating tools more than four hours distributed over the entire day, or more than 30 minuts continuously or repetitively), forceful exertions are required due to: (1) holding heavy tools (i.e., cherry loc gun weighs 10 pounds), (2) using unbalanced tools (i.e., like some of the rivet and impact guns), (3) using manual shears, and (4) working with hard metal. Static work posture is required to use tools with one-finger triggers, localized contact stress to the palm of the hand due to holding bucking bar no designed handle/grip, repetitive wrist deviation are to insert and remove clecos using cleco pliers, repeated wrist extensions and flexion is present when using riveting gun. (this can lead to carpal tunnel syndrome), awkward postures (i.e., forward forearm rotations, elevated shoulders) due to work surfaces and fixtures with fixed heights and to improper match between work surfaces and grip of hand tool, repeated manipulations, deviations and twisting of the wrist while using tools (e.g., hammers, pliers, mallets (this can lead to ganglion cysts, tendonitis or epicondylitis), forced exertions are necessary to lift, pull and push heavy aircraft parts, wrists are flexed due to incorrect height of keyboard. These stresses have been related to ergonomic type conditions.

Consult with Bioenvironmental Engineering concluded that no further information could be provided that could assist in determining the occupational relationship of this condition. Bioenvironmental Engineering has identified these ergonomic stresses, made appropriate recommendations for corrective action and is tracking the recommendations for implemtation.

AFMC FORM 12 RECEIVED: 27 JUL 95
AF FORM 190 SENT TO SGPFO: 31 Jul 95
AF FORM 190 RECEIVED FROM SGPFO: 95/08/08
FINAL DATA ENTRY: 95/08/08

returned from OMS for Signature of block 31, 2 Aug 95
Sent back to OMS 3 Aug 95

32. DATE	33. SURVEY PERFORMED BY
9 5 0 7 2 8	[redacted] SSgt, USAF, NCOIC, Occupational Health, Public Health Flight

AF FORM 190, OCT 81 *(REVERSE) (EF-V1) (PerFORM PRO)*

INSERT TAB X HERE

APPENDIX 2

Risk Factor Identification

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APPENDIX 2

This Appendix corresponds with Step 2: Risk Factor Identification, and includes:

- The Level I Ergonomics Assessment Checklist Glossary; and
- A sample of a completed Level I Ergonomics Assessment Checklist

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LEVEL I ERGONOMICS
ASSESSMENT CHECKLIST GLOSSARY

Appendix 2

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This Glossary provides additional information on each question in the Checklist. For each Job Factor question, the glossary provides:

- An explanation of the ergonomics risk factors upon which the Job Factor question is based;
- An explanation of how exposure to the Job Factor impacts the person;
- Assistance in determining if the Job Factor is present and if it is present at the level specified in the question; and,
- Examples and hints of what to look for in the workplace.

Note: As you gain experience using the Level I Ergonomics Assessment Checklist and with ergonomics in general, your reliance on this Glossary should decrease significantly.

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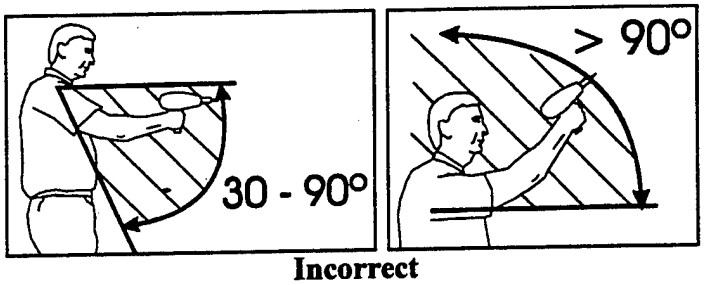
Table 1
Checklist Question 1

Question: Repeated reaching or arms held continuously away from body while unsupported



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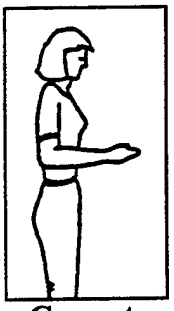


Correct

Targeted Risk Factor Table

	Risk Factor		Risk Factor
x	Stressful Positions or Movements	x	Static (fixed position) work
	Heavy of forceful work	x	High Frequency (repetitive) or high speed movements

Background Discussion

Highly repetitive reaching over a period of time can result in excessive wear of the shoulder joint, rotator cuff tendons, and bursae. Holding the arms away from the body continuously (without support) causes static muscular effort. Static muscular effort produces discomfort in a matter of seconds because the energy stored in the muscle is rapidly depleted and the constricted muscles restrict the flow of replenishment energy and oxygen to the muscle.

What to Look For

This Job Factor is scored when one or both arms is held away from the body or reaches repeatedly away from the body. The shoulder posture is measured from the shoulder joint referencing the upper arm posture with respect to a vertical reference passing through the upper body.

- The *below shoulder level* Job Factor is scored when the upper arm is observed to be approximately 30-90° away from the torso while the task is being performed.

- The *above shoulder level* Job Factor is scored when the upper arm is observed to be greater than 90° away from the torso during while the task is being performed.

Table 1
Checklist Question 1 (cont'd)

This assumes that the torso is upright and in a vertical orientation. If the arms are hanging down while bending this does not count as reaching unless the person reaches past the shoulders. If the person reaches past the shoulders while bending, this is scored as an *above shoulder level* reach.

As a general rule, reaching would be considered to be "repeated" if the person reaches, on average, every 30 seconds or more frequently. Holding the arms away from the body "continuously" would be considered to be occurring if the holding position is maintained for at least 10 seconds at a time.

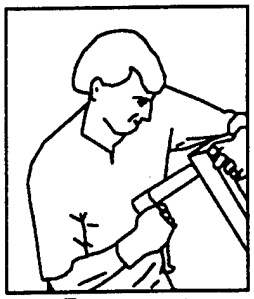
Examples of tasks in which reaching would be scored include:

- working overhead;
- working in restricted spaces; or,
- accessing work objects which are far from the body.

References: 1, 2, 3, 4, 5, 6, 7, 8

Table 2
Checklist Question 2

Question: Arm forces: Repeated arm forces exceeding 10 lb. (4.5 kg) (e.g. roughly equivalent to lifting a gallon of milk) or holding/carrying materials exceeding 25 lb. (11.4 kg) for more than three steps



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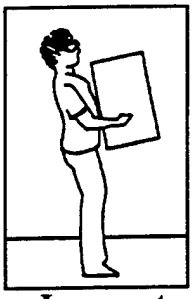

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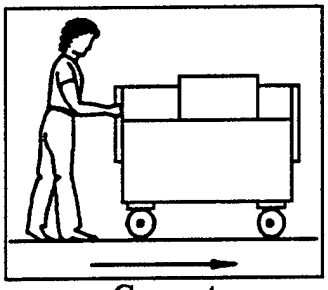


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements		Static (fixed position) work
x	Heavy or forceful work		High frequency (repetitive) or high speed movements

Background Discussion

Forceful use of the arm, repeatedly, over a period of time can result in wear of the shoulder joint, rotator cuff tendons, and bursae.

Holding and carrying heavy materials for long periods of time can also wear the shoulder joint and create fatigue from static muscular effort.

What to Look For

The *repeated arm forces* portion of the Job Factor is scored if the force required to perform the task exceeds 10 lb. (4.5 kg) and the arm forces must reoccur (on average) at least every 30 seconds. Lifting a gallon of water or milk is about 8 lb. (3.6 kg) So if the task seems to exceed the force required to lift a gallon of liquid the Job Factor is present.

Table 2
Checklist Question 2 (cont'd)

Examples of tasks in which repeated arm forces would be scored include:

- Swinging a heavy hammer; or,
- Yanking on a stuck component to remove it from a machine.

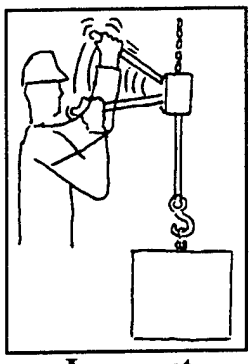
The *holding/carrying materials* portion of the Job Factor is scored if the person carries items which weigh more than 25 lb. (11.4 kg) for more than three steps at a time. This means that in order for the Job Factor to be scored, the item must be carried more than three steps (about 10 feet (3 meters) or more).

Examples of tasks in which holding/carrying materials would be scored include carrying tools or pieces of equipment that weigh more than 25 lb. (11.4 kg) for long distances.

References: 9, 10, 11, 12, 13, 14

Table 3
Checklist Question 3

Question: High speed, sudden shoulder movements (e.g., opening a stuck door, pulling and yanking on a stuck component to remove it)



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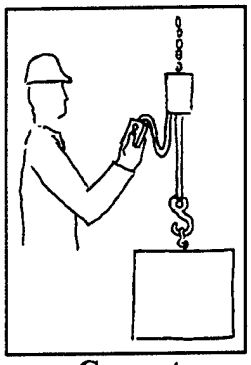


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions or Movements		Static (fixed position) work
	Heavy or forceful work	x	High frequency (repetitive) or high speed movements

Background Discussion

High speed sudden shoulder movements generate very high forces internally in the shoulder joint. These movements can result in wear and excessive damage to the shoulder joint, rotator cuff tendons, and bursae.

What to Look For

This Job Factor is scored when the arms are observed to be moving with high velocity during the task, such as sudden or jerky movements. High speed, sudden shoulder movements typically occur in tasks where high forces are also required.

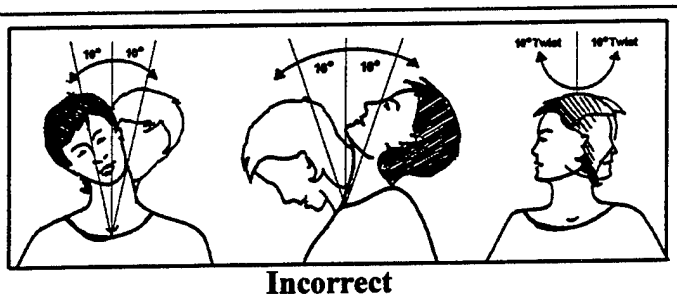
Examples of high speed or sudden shoulder movements may include:

- Any kind of heavy hammering activity (however, using a small hammer to tap might not constitute high speed, sudden shoulder movements);
- Yanking on a stuck component to move it;
- Opening a stuck door;
- Throwing objects.

References: 15, 16

Table 4
Checklist Question 4

Question: Head/neck bent, tilted, or twisted (>10°) (e.g., craning neck looking into tight spaces)



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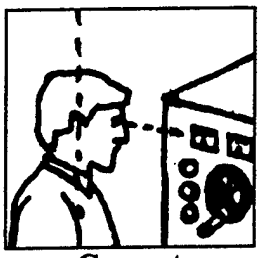


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions or Movements	x	Static (fixed position) work
	Heavy or forceful work		High frequency (repetitive) or high speed movements

Background Discussion

Generally, the concern with the head and neck is associated with prolonged use of awkward postures. Maintaining these postures causes static muscular effort since muscles are held in a state of contraction in order to support the head. Static muscular effort produces discomfort in a matter of seconds because the energy stored in the muscle is rapidly depleted and the constricted muscles restrict the flow of replenishment energy and oxygen to the muscle.

What to Look For

This Job Factor is scored when the head is observed to be bent or tilted greater than 10° in any direction (see picture labeled incorrect). The head angle is estimated by observing the orientation of the head with respect to the axis of the torso. Continuous or repetitive twisting of the neck greater than 10° to the left or right is scored as well. The correct posture (see picture labeled correct) occurs when the head angle is approximately 0° (or less than 10° bending).

As a rule of thumb, bending of the head/neck *continuously* would be considered to be occurring if the posture is maintained for at least 10 seconds at a time. Bending of the head/neck would be considered to be *repeated* if the person bends the head, on average, every 30 seconds or more frequently.

Table 4
Checklist Question 4 (cont'd)

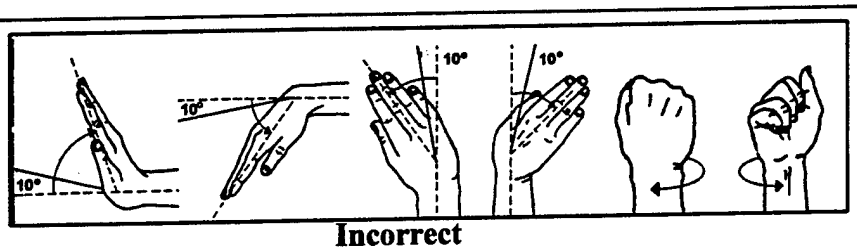
Examples of head/neck bent, tilted, or twisted would include:

- Performing overhead work;
- Performing detailed inspections in poor lighting conditions (e.g., leaning forward); and,
- Working in a restricted space and looking around an obstruction to see the work.

References: 1, 17, 18, 19, 20, 21, 22

Table 5
Checklist Question 5

Question: Bent wrists/repeated wrist movements (>10° in any direction) or repeated forearm rotation (e.g., turning a screw driver, Allen wrench)



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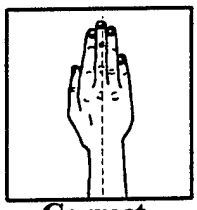

Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions or Movements		Exposure to Hard Edges
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
x	Static (fixed position) work		

Background Discussion

Bending the wrist may significantly increase pressure inside the carpal tunnel. Increased pressure on tendons and nerves over time can lead to an accumulation of damage which can lead to tendonitis (i.e., inflammation of tendons) or carpal tunnel syndrome (i.e., compression of the median nerve). Awkward wrist postures also reduces grip strength.

Repeated rotation of the forearms over a period of time can contribute to epicondylitis which is an inflammation of tendons which attach at the elbow joint.

What to Look For

This Job Factor is scored when the wrist is bent greater than 10° in any direction. (see picture labeled incorrect).

The wrist angle can be estimated by comparing two reference lines to each other. The first reference line, representing the wrist posture, is created by the point at the center of the knuckles and the point at the center of the wrist. The second reference line, representing the forearm, is created by the point at the center of the wrist and the point at the center of the elbow. A straight wrist (see picture labeled correct) has an angle of approximately 0° (or bending less than 10°).

Table 5
Checklist Question 5 (cont'd)

Caution: The neutral (resting) posture of the hand and wrist may appear to be tilted back approximately 10°.

Continuous or repetitive rotation of the forearms of greater than 10° inward or outward is scored as well.

As a general rule, bending of the wrist would be considered to be *repeated* if the person bends the wrist, on average, every 30 seconds or more frequently.

Examples of bent wrists/repeated wrist movements would be using a pistol-shaped power driver to drive screws on a horizontal surface.

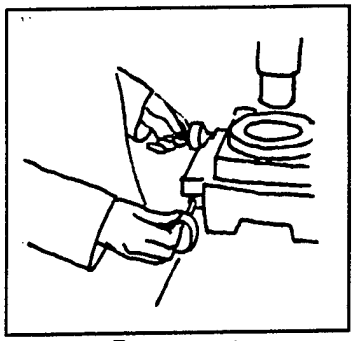
Examples of repeated forearm rotation would include:

- Repetitive use of a screw driver or other torquing tool;
- Turning of knobs or small valves;
- Twisting wires during wiring tasks.

References: 4, 21, 23, 24, 25, 26, 27

Table 6
Checklist Question 6

Question: Repeated manipulations with fingers (e.g., repetitive computer keying tasks, removing small screws, electrical wiring tasks)



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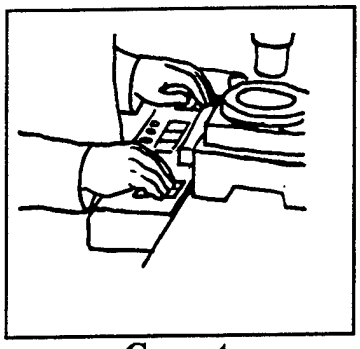


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements		Exposure to Hard Edges
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
	Static (fixed position) work		

Background Discussion

Highly repetitive finger movements over a period of time can increase stress on the tendons which control finger movement.

What to Look For

This Job Factor is scored when there is significant finger movement observed in a task. Typically, there is a pattern of finger movements that are repeated frequently. As a general rule, if there is a finger movement which repeats at least once every four seconds, then this Job Factor is scored.

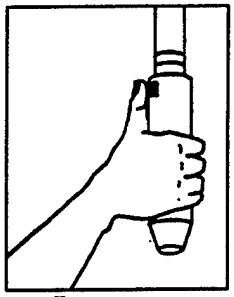
Examples of repeated finger movements would include:

- Repetitive keying tasks;
- Repetitive handling of small components;
- Removing small screws; and,
- Some electrical wiring tasks.

References: 25, 26

Table 7
Checklist Question 7

Question: Hyperextension of finger/thumb (e.g., using pliers with a wide handle span) or repeated single finger activation (e.g., single finger triggers on power tools)



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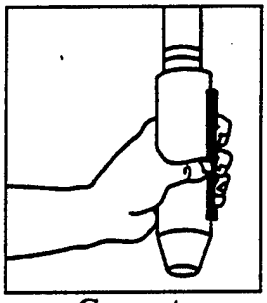

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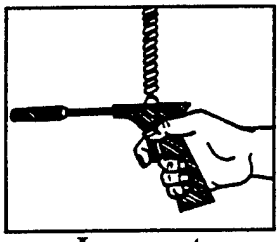

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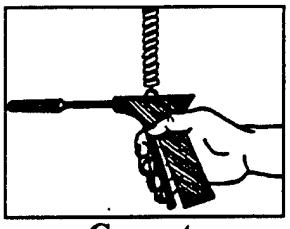


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions or Movements		Exposure to Hard Edges
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
	Static (fixed position) work		

Background Discussion

Hyperextension of finger/thumb and repeated single finger activation may increase the stress on the tendons and muscles controlling those fingers. In hyperextended positions, tendon/ muscle groups are stretched to limits of their range. When this occurs, the structures are much more susceptible to damage.

What to Look For

This Job Factor is scored when one or more fingers (or the thumb) is held away from the rest of the hand. Finger/thumb hyperextension describes the activity of over extending (e.g.,. pointing) the finger or thumb. This Job Factor would be scored if the extension is

Table 7
Checklist Question 7 (cont'd)

beyond a relaxed range of movement or is held in the position for a prolonged period of time.

This Job Factor may also be scored when the task requires repetitive movements of a single finger or the thumb. As a general rule, extension of the fingers *continuously* would be considered to be occurring if the posture is maintained for at least 10 seconds at a time. Finger extension, considered to be *repeated* if the person bends the wrist, on average, every 30 seconds or more frequently.

Examples of hyperextension of finger/thumb include:

- using pliers or cutting tools with a wide handle span that causes the person to spread the hand wide to operate the tool; and
- using a power tool with a trigger which is far away from the center of the grip.

Examples of repeated single finger activation include:

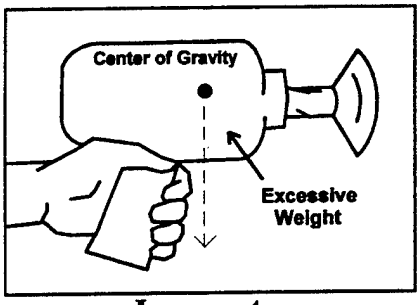
- using power tools with a trigger which can only be operated with a single finger trigger; and,
- pressing buttons or controls.

References: 22, 28

Table 8
Checklist Question 8

Question: Hand/grip forces:

fingertip force: > 2 lb. (.9 kg) (e.g., 2 lb. is roughly equal to holding fingernail clippers closed)
full hand force: > 8 lb. (3.6 kg) (e.g., 8 lb. is roughly equal to holding a 8 lb. tool or holding a gallon of milk)



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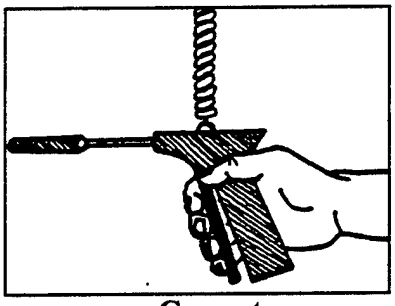


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements		Exposure to Hard Edges
x	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
x	Static (fixed position) work		

Background Discussion

Repeated forceful use of the hands or fingers over a period of time can result in significant stress to the tendons, ligaments, nerve, and other soft tissues. There is an increased likelihood for employees to report discomfort when a job requires forceful use of the hands or fingers. The presence of this *force* risk factor in a job may be one of the most significant contributors to reports of hand and wrist discomfort for employees in maintenance and inspection areas.

A common example of high hand forces (see picture labeled incorrect) are tools which are heavy or unbalanced (i.e., the center of gravity of the tool is directly above the center of the grip.

What to Look For

This Job Factor is scored when forces are estimated to exceed the guidelines for two different types of grips.

Table 8
Checklist Question 8 (cont'd)

This Job Factor is scored when the fingertip force exceeds 2 lb.(.9 kg). 2 lb. is roughly equal to holding fingernail clippers closed. A fingertip grip or *pinch grip* involves gripping primarily with the fingertips.

This Job Factor can also be scored when the full hand force exceeds 8 lb. (3.6 kg). 8 lb. is roughly equal to holding a 8 lb. (3.6 kg) tool or holding a gallon of milk. In order for a grip to qualify as a full hand grip or *power grip* there must be: (1) contact between the object and the palm of the hand and (2) a slight overlap of the thumb and fingers around the object. If both of the conditions are not met, the grip should be considered as a fingertip grip.

This Job Factor may also be scored when the task requires repetitive movements of a single finger or the thumb. As a general rule, extension of the fingers *continuously* would be considered to be occurring if the posture is maintained for at least 10 seconds at a time. Grip forces, considered to be *repeated* if the person bends the wrist, on average, every 30 seconds or more frequently.

Examples of forceful fingertip grips include:

- Using the fingers/finger tips like a biological clamp to stabilize a part; or,
- Applying substantial force to insert or remove snap fit components.

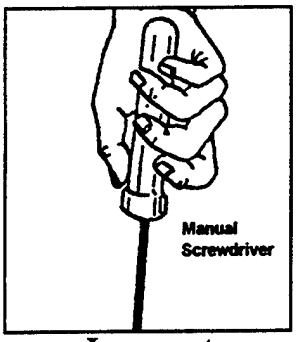
Examples of forceful full hand grips include:

- Holding a heavy power tool that weighs more than 8 lb.; or,
- Tightening a bolt or nut with a manual wrench.

References: 9, 11, 29, 30

Table 9
Checklist Question 9

Question: High speed hand/wrist/arm movements (e.g., yank components with fingers, using the hand as a hammer) **or** Vibration, impact, or torque to the hand (e.g., using a nail gun or other power tools and equipment)



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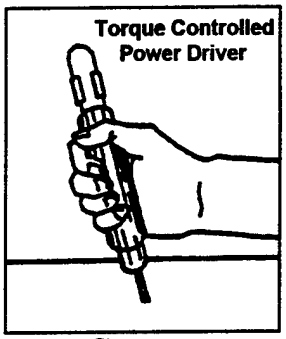

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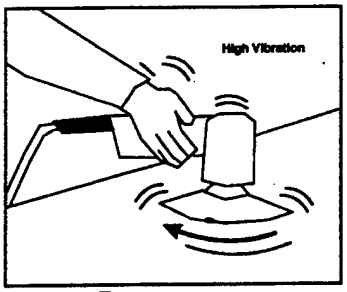

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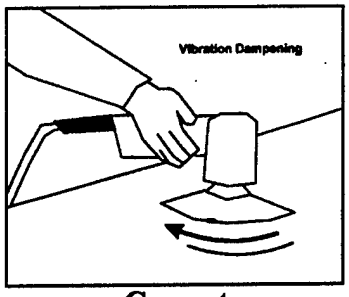


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements		Exposure to Hard Edges
x	Excessive Forces or Forceful Exertions	x	Exposure to Vibration
x	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
	Static (fixed position) work		

Background Discussion

High speed hand movements may produce excessive internal forces to the wrist. Excessive forces can damage tendons and nerves over a period of time.

Prolonged exposure to vibration, impact, and torque can reduce circulation and damage soft tissues. Vibrations, impact, and torque also tend to cause the worker to increase the grip to maintain control--creating an additional, compounding Job Factor, force.

Table 9
Checklist Question 9 (cont'd)

What to Look For

This Job Factor is scored when high speed or sudden hand/wrist/arm movements are observed in the task. In some cases, high speed, hand/wrist/arm movements occur in tasks where high forces are also occurring (e.g., removing stuck components).

Examples of high speed hand/wrist/arm movements include:

- Yanking on a stuck component with fingers to remove it;
- Repetitive use of a hammer such as in nailing tasks; and,
- Using the hand as a hammer.

This question is also scored if any vibration, impact or torque is observed in the task. For the Level I Checklist there is no minimum intensity for this Job Factor. Regardless of the intensity of the exposure, if vibration, impact or torque is observed in the task, the question is scored.

Note: Measuring vibration exposure requires a detailed evaluation which is beyond the level and scope of this document. If you require evaluation of vibration exposure, contact AL/OEMO for consultative assistance.

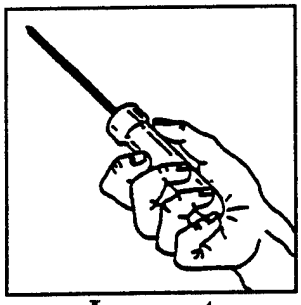
Examples of vibration, impact, or torque to the hand would include:

- Using various types of rotating or oscillating power tools such as power drills, air ratchets, grinders, sanders, or chain saws.
- Using various types of tools which deliver a blow or impact such as jack hammers, nail guns, staple guns, or rivet guns.

References: 4, 31

Table 10
Checklist Question 10

Question: Exposure to hard edges (e.g., tool handle or work area presses into fingers or palm of hands)



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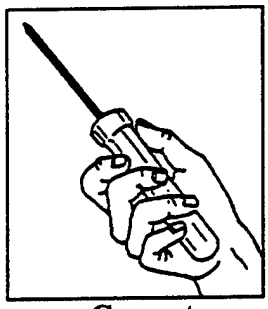


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements	x	Exposure to Hard Edges
	Excessive Forces or Forceful Exertions		Exposure to Vibration
	High frequency (repetitive) or high speed movements		Temperature Extremes (especially cold)
	Static (fixed position) work		

Background Discussion

Hard edges which press into the hand, wrist, or arm can place pressure on nerves or tendons which pass close to the surface of the skin. This can result in wear and damage to these structures over a period of time.

What to Look For

This Job Factor is scored when the hands, wrists or arms are exposed to a hard or sharp edges or corners. The term *exposed to a hard edge* means that the hard edge presses into the skin and tissues of the hand, wrist or arm for some portion of the task. Note: If a hard edge is present but does not press into the body, the Job Factor is **not** scored.

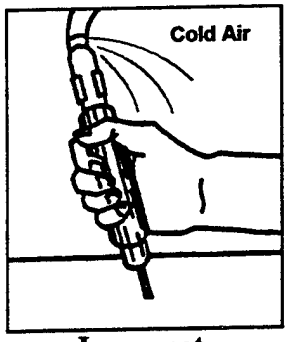
Exposure to hard edges may be caused by:

- Tool handles or components with square corners, protrusions, or hard edges;
- Work surfaces with a square edge (as opposed to a rounded, bull-nose edge); and
- Resting the arms/elbows on equipment to stabilize the hands during work.

References: 4, 21, 31

Table 11
Checklist Question 11

Question: Hands and fingers exposed to cold temperatures (e.g., working outside in winter environment, cold exhaust air from tool blows on hand/wrist)



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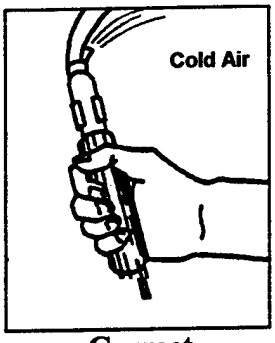


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions or Movements		Exposure to Hard Edges
	Excessive Forces or Forceful Exertions		Exposure to Vibration
	High frequency (repetitive) or high speed movements	x	Temperature Extremes (especially cold)
	Static (fixed position) work		

Background Discussion

Exposure to cold temperatures can reduce blood flow to the fingers and hands. This may cause the body's natural healing process to slow which allows micro-trauma created from exposure to other Job Factors to accumulate more quickly. Flexibility of the tendons and joints may also decrease with a corresponding increase in stress and muscle fatigue.

What to Look For

This Job Factor is scored when the person is in an environment where there is a tendency for the hands and fingers to become cold.

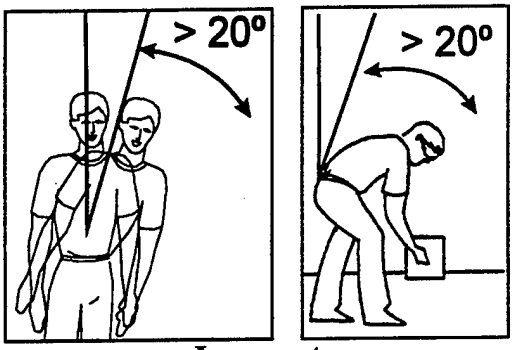
Examples of exposure to cold temperatures include:

- Doing hand-intensive work on the flight line or in cold or windy conditions for more than 15 minutes without a break;
- Exhaust air from an air-powered tool blows on hands and fingers; and,
- Gripping a tool handle which conducts heat away from the hand.

References: 4

Table 12
Checklist Question 12

Question: Repeated forward or side-ways bending movements (>20°) (e.g. lifting from floor level)



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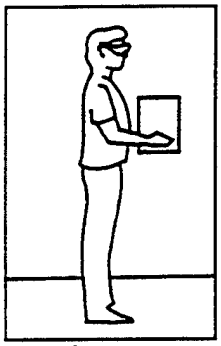


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Awkward Positions or Movements		Static (fixed position) work
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		

Background Discussion

Repeated forward or sideways bending causes the pressure on the muscles and intervertebral discs of the spine to be unevenly distributed. Forward or sideways bending can contribute to muscle fatigue as well increase the potential for back injuries (e.g., sprains/strains, disc herniation).

What to Look For

This Job Factor is scored when the person is bent forward or to the side more than 20° vertical.

As a general rule, bending of the back would be considered to be *repeated* if the person bends the back, on average, every 30 seconds or more frequently.

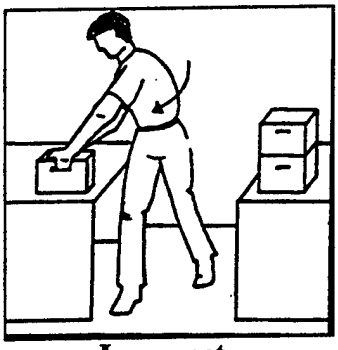
Examples of repeated forward or side-ways bending movements would include:

- handling of items below knee level; and,
- reaching for tools or components which are too far away from the work.

References: 3, 21, 32, 33

Table 13
Checklist Question 13

Question: Twisting of the lower back (e.g. rushing while lifting, pulling, open a stuck door)



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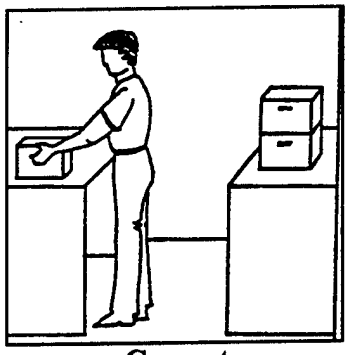


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Awkward Positions or Movements		Static (fixed position) work
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		

Background Discussion

Twisting may be one of the most damaging movements for the spinal discs because of the shear force created during twisting. Repeated twisting over a period of time can accelerate wear of the cartilage and plates and fibrous tissue of the disc itself.

What to Look For

This Job Factor is scored when twisting of the lower back is observed while the task is being performed.

Due to the difficulty in estimating twisting angle, there is no minimum twist angle required to score this Job Factor. If any twisting of the lower back is observed to reoccur in the task, the Job Factor should be scored.

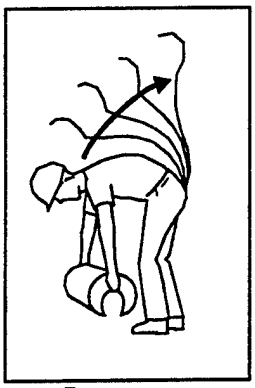
Examples of twisting of the lower back would include:

- turning while moving an object in a restricted space; or,
- turning to transfer an object while seated in a chair that does not swivel.

References: 15

Table 14
Checklist Question 14

Question: High speed, sudden movements with the back



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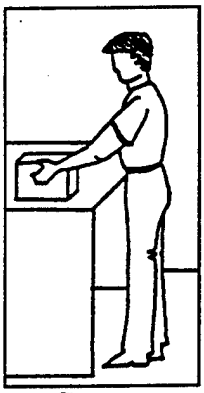


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Awkward Positions or Movements		Static (fixed position) work
	Excessive Forces or Forceful Exertions		Exposure to Vibration
x	High frequency (repetitive) or high speed movements		

Background Discussion

High speed movements of the back can generate high forces internally throughout the spine, muscles, and other supporting tissues. Research indicates that high speed movements (acceleration) may increase the risk of back injury.

What to Look For

This Job Factor is scored when jerky or sudden movements of the back are observed while the task is being performed. It is common to see these movements in tasks which also require large forces.

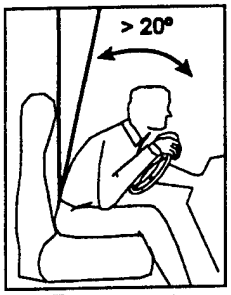
Examples of high speed or sudden movements include:

- Lifting a very heavy object that is difficult to grasp (e.g., man hole cover);
- Opening a stuck door;
- Pushing a large piece of rolling equipment up a ramp, or over a crack in the floor; and
- Rushing while handling an object.

References: 15

Table 15
Checklist Question 15

Question: Static, awkward back postures (for >10 sec at a time).
While standing, continuous leaning forward or to the side (>20°).
While seated, continuous leaning forward (>20°) or poor lower back posture (e.g., poor lower back support, no support for feet.



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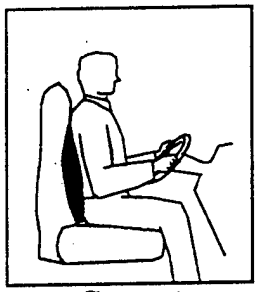

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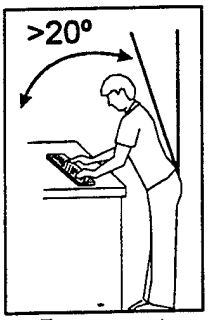

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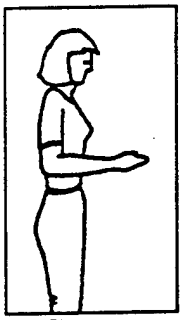


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Awkward Positions or Movements	x	Static (fixed position) work
	Excessive Forces or Forceful Exertions		Exposure to Vibration
	High frequency (repetitive) or high speed movements		

Background Discussion

Leaning forward continuously (without support for the body) causes static muscular effort. Static muscular effort produces discomfort in a matter of seconds because the energy stored in the muscle is rapidly depleted and the constricted muscles restrict the flow of energy and oxygen to the muscle.

Table 15
Checklist Question 15 (cont'd)

What to Look For

This Job Factor is scored when the person is observed leaning forward or to the side for a prolonged period of time (at least 10 seconds at a time). Leaning forward becomes a risk factor when the individual maintains this posture for a period of time. It is not as significant a risk factor when the individual is simply making a change in his/her posture.

The Job Factor is scored only if the angle of bending of the upper body with respect to vertical exceeds 20°.

This Job Factor is also scored when a person in a seated position has poor lower back posture. Poor lower back posture is exhibited by a lack of an inward curve in the lower back. That is, the lower back area looks slightly rounded. Poor lower back posture while seated may be caused by lack of adequate lower back support.

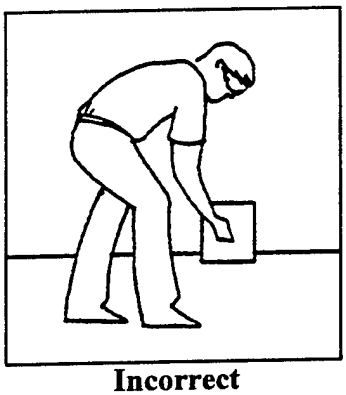
Examples of static, awkward back postures would include:

- Leaning forward to perform a task which is too low or too far away;
- Leaning forward or sideways, while holding or guiding a heavy panel into position (e.g., installing wing slats);
- Sitting in a chair without a backrest; and,
- Sitting in a chair with a seat pan which is too deep (can't sit against the backrest).

References: 21, 32, 33

Table 16
Checklist Question 16

Question: Lifting forces



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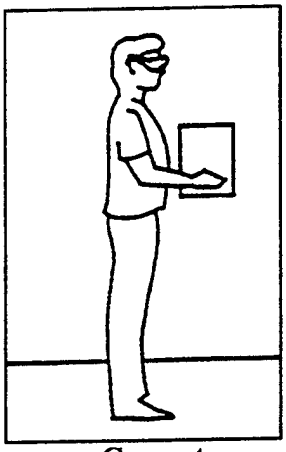


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Awkward Positions or Movements		Static (fixed position) work
x	Excessive Forces or Forceful Exertions		Exposure to Vibration
	High frequency (repetitive) or high speed movements		

Background Discussion

Research has shown that as the forces in the lower back increase, frequency of complaints of lower back pain may increase. Forces can be high due to an awkward body posture (and the resulting additional forces in the back) as well as the weight of the object handled.

What to Look For

This Job Factor may be scored for four different situations:

- When the person handles a 50-70 lb. (22.7-31.8 kg.) object while the torso is upright **and** the elbows are close to the body. The torso can be considered "upright" as long as the person is not bent forward more than 20 degrees from vertical. The elbows can be considered "close" to the body as long as the angle between the torso and upper arm is no greater than 15 degrees. Notice that in order to meet this criteria, both the back and the arms must be in a good posture. In this example, the body is in a good position but the weight is significant.

Table 16
Checklist Question 16 (cont'd)

- When the person handles a 10-40 lb. (4.5-18.1 kg.) object while the person is bent forward **or** is reaching. (e.g., upper body is bent greater than 20° from vertical or the upper arms are more than 15° from the torso). Notice that this portion of the Job Factor is scored if the person is either bending or reaching (or both bending and reaching) while lifting. In this example, the body is in a stressful position but the weight is minimal.

- When the person handles an object which weighs more than 70 lb. (31.8 kg.) while the upper body is upright **and** the elbows are close to the body (e.g., torso is bent forward no more than 20 degrees and the angle between the upper arm and the torso is no more than 15 degrees). Notice that in order to meet this criteria, both the back and the arms must be in a good posture. In this example, the body is in a good position but the weight is excessive.

- When the person handles an object which weighs greater than 40 lb. (18.1 kg.) while bent forward **or** reaching (e.g., the torso is bent more than 20° from vertical or the upper arms are more than 15° from the body). Notice that this portion of the Job Factor is scored if the person is either bending or reaching (or both bending and reaching) while handling an object. In this example, the body is in a stressful position and the weight is significant.

Examples of situations where high lifting forces may be created include:

- Lifting/handling heavy equipment or supplies;

- Lifting objects from floor level;

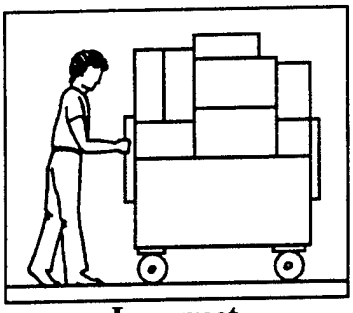
- Lifting a cowl door (e.g., aircraft engine) to stabilize it during installation; and,

- Lifting a 2-gallon pail of solvent from a shipping pallet and placing it on a high storage shelf.

References: 21, 34

Table 17
Checklist Question 17

Question: Pushing or pulling where the initial force > 50 lb. (22.7 kg.) (e.g. pushing/pulling a full two-drawer file cabinet across a carpeted floor)



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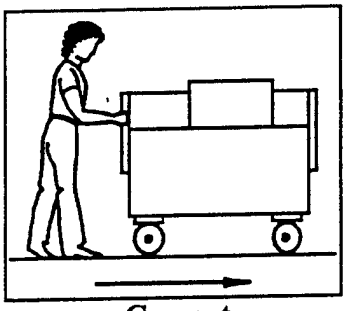


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Awkward Positions or Movements		Static (fixed position) work
x	Excessive Forces or Forceful Exertions		Exposure to Vibration
	High frequency (repetitive) or high speed movements		

Background Discussion

There are several factors that impact the stresses created by pushing and pulling tasks. These factors include: the height of the hands (e.g., shoulder level, waist level, knee level), the distance the object is moved, and the frequency of the activity (e.g., one push/pull every minute or one push every 30 minutes, etc.).

The push/full force reference of 50 pounds (22.7 kg.) is provided to reflect the capabilities of the female population for initial (e.g., get the item moving) push/pull forces. While the actual capabilities of the entire work force vary due to strength, this reference is presented as a starting point and is within the scope of the Level I Analysis. If this Job Factor is found in the job, the user is encouraged to contact AL/OEMO and request a Level II Analysis. The Level II Analysis considers factors like, body/hand position, frequency, distance traveled, as well as weight.

What to Look For

This Job Factor is scored when the person pushes or pulls an object with an initial force of greater than 50 pounds (22.7 kg.). A weight of 50 pounds (22.7 kg.) is roughly equipment to the force required to push a full two-drawer file cabinet across a carpeted floor. This Job Factor can also be scored if the person shows substantial exertion push or pull the object.

Table 17
Checklist Question 17 (cont'd)

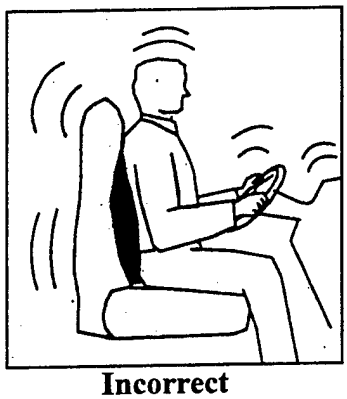
Examples of pushing or pulling include:

- Pushing or pulling heavy rolling equipment (especially with worn wheels);
- Transporting pallets of material with a hand pallet jack; or,
- Sliding a large work piece on a work surface or the floor.

References: 12

Table 18
Checklist Question 18

Question: Whole body vibration felt through floor surface (e.g. operating heavy machinery)



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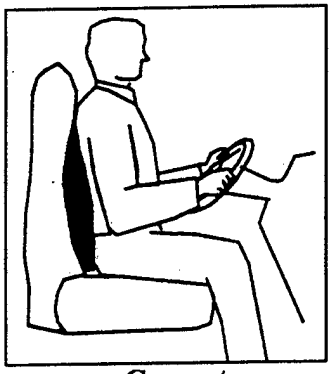


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Awkward Positions or Movements		Static (Fixed Position) Work
	Excessive Forces or Forceful Exertions	x	Exposure to Vibration
	High Frequency (Repetitive) or High Speed Movements		

Background Discussion

Whole body vibration should be considered as a general stressor or secondary risk factor to the body, and the lower back in particular. This is because, while workers exposed to whole body vibration (e.g., long distance truck drivers, heavy equipment operators) have reported muscular and back disorders at a rate greater than that for the general population, a precise cause-effect relationship has not been shown. What seems to be consistent in the research is that potential effect on the employee is most likely in the whole-body resonance frequency range--the range in which there is maximum mechanical vibration energy transfer between the vibration source and the body with an actual amplification of the vibration by the body. For sitting tasks, the frequency range is 3-5 Hz. For standing tasks, the range is 4-7 Hz. Since the measurement of vibration is well beyond the scope of the Level I Assessment, any questions about vibration exposure should be directed to AL/OEMO.

What to Look For

This Job Factor is scored, when the person is exposed (any level) to whole body vibration. Whole body vibration is typically transmitted through a floor surface or seat. There is no minimum intensity for this Job Factor.

Table 18
Checklist Question 18 (cont'd)

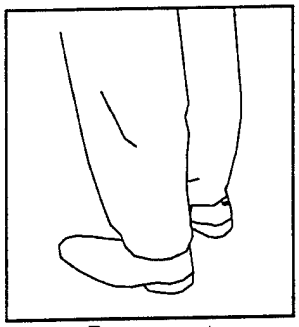
Examples of situations where whole body vibration may be present include:

- Operation of heavy equipment such as back hoes, bull dozers, or cranes, or fork trucks; and
- Working on or around large pieces of machinery.

References: 35, 45

Table 19
Checklist Question 19

Question: Fixed position, standing static effort in legs (e.g. standing on hard floor surfaces)



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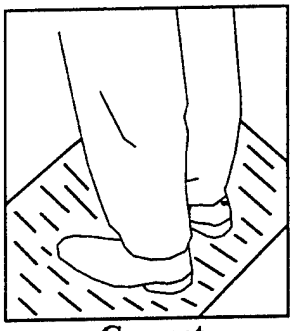


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions of Movements	x	Static (Fixed Position) Work
	Excessive Forces		Exposure to Hard Edges

Background Discussion

Standing in one position for prolonged periods can contribute to pooling of the blood in the veins especially in the lower leg. Such conditions can contribute to varicose veins, swelling of the tissues in the lower legs and feet, and blisters in the swollen areas. Prolonged standing can also increase muscle fatigue in the lower back.

What to Look For

This question is scored when the person is observed standing in a fixed position for prolonged periods of time (e.g., 30 minutes at a time or longer) on a hard floor surface (such as concrete or tile). The question is not scored if the person is standing on a compressible surface such as an anti-fatigue mat, or if the person walks throughout the task.

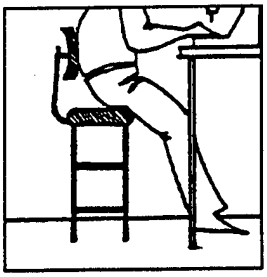
Examples of standing in a fixed position would include:

- Working at a lathe or machine for long periods of time;
- Working under an exhaust hood in a laboratory; or,
- Standing on a work platform while servicing an aircraft.

References: 3, 21

Table 20
Checklist Question 20

Question: Exposure to hard edges on legs, knees, and feet (e.g., kneeling on a hard surface, standing on rungs of a ladder, leaning against a hard edge, or exposure to hard front edge of seat).



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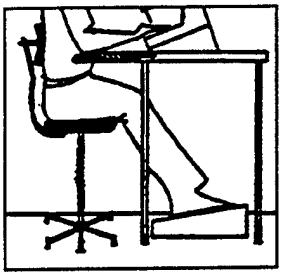


Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
	Stressful Positions of Movements		Static (Fixed Position) Work
	Excessive Forces	x	Exposure to Hard Edges

Background Discussion

Hard edges which press into the legs or buttocks can place pressure on muscles, vessels, nerves, and other soft tissue which pass close to the surface of the skin. Pressure on these tissues can restrict circulation and impact sensation.

What to Look For

This Job Factor is scored when the legs, knees or feet are exposed to a hard or sharp edge which presses into the skin while tasks are being performed. Note: Sharp edges may exist in the work area. If they don't contact the body, this Job Factor is not scored.

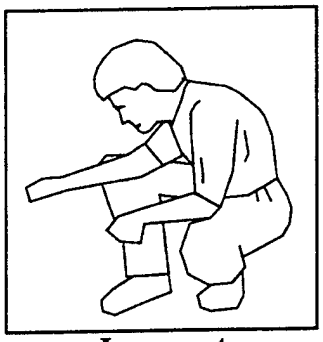
Examples of exposure to hard edges on legs, knees, and feet would include:

- Leaning against a hard edge to stabilize the body working on overhead on a large piece of machinery;
- Kneeling on a hard surface such as metal or concrete;
- Standing for prolonged periods on round or narrow rung of an extension ladder; or,
- While sitting, the hard front edge of the seat presses into the back of the legs.

References: 21

Table 21
Checklist Question 21

Question: Awkward leg postures (e.g. kneeling, squatting, crawling, or knee hyperextension)



Incorrect

Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions of Movements		Static (Fixed Position) Work
	Excessive Forces		Exposure to Hard Edges

Background Discussion

Kneeling or squatting questions have been included in the OSHA checklist. Kneeling or squatting for extended periods of time can create stress and strain on the ligaments of the knee. Kneeling can also create direct pressure on the bursa sac in the knee joints and causes inflammation or bursitis of the knee.

What to Look For

This question is scored when the legs are in an awkward posture for a prolonged period of time (greater than 10 seconds at a time). These awkward postures include squatting, kneeling, crawling on hands and knees, or knee hyperextension. Knee hyperextension is an over extension of the lower leg (leg looks like it is bent backwards at the knee) which increases the pressure in the knee joint.

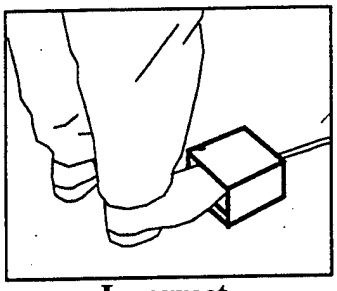
Examples of awkward leg postures include:

- Kneeling or squatting to work on a control panel which is low to the floor;
- Leaning forward over a thigh high guard to access a part (knee hyperextension); or,
- Working in a restricted space which requires crawling or squatting.

References: 21, 36

Table 22
Checklist Question 22

Question: Standing foot pedal (e.g., using foot pedal while standing)



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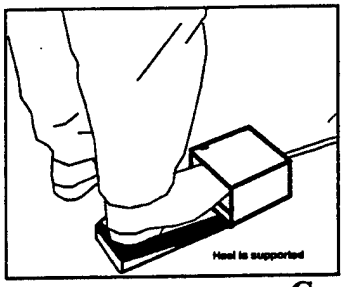

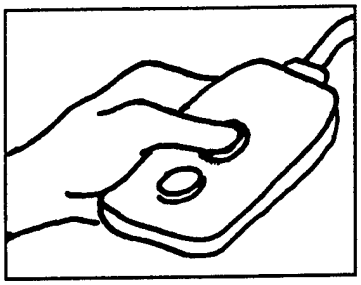

Correct

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Stressful Positions of Movements	x	Static (Fixed Position) Work
	Excessive Forces		Exposure to Hard Edges

Background Discussion

Use of foot pedals while standing can create problems for the back as well as the legs by causing the back to be in an unbalanced posture for prolonged periods of time. Use of foot pedals are of concern when the foot must be on the pedal continuously, when the legs cannot be alternated on the foot pedal, or when the person cannot rest the heel while actuating the pedal.

What to Look For

This Job Factor is scored when the person is required to use foot pedal while standing and when the position of the foot pedal leg looks different from the position of the support leg.

Examples include:

- Using a foot pedal while operating blasting equipment; or
- Using a foot pedal for welding operations.

References: 21

Table 23
Checklist Question 23

Question: Difficult to see/light levels too low /too high (e.g., see detail).

Targeted Risk Factors

	Risk Factor		Risk Factor
x	Excessive Glare/Excessive Light		Static (fixed position) work
x	Inadequate Light		

Background Discussion

Light levels which are too low or too high can increase the potential for eyestrain and errors. Light levels which are too low tend to produce low contrast, requiring the eyes to work harder to see. Light levels which are too high tend to increase glare. The inappropriate light level may decrease employee performance in visual inspection tasks as well as during computer use.

What to Look For

This Job Factor is scored when the lighting conditions are poor (too high or too low) for performing the required tasks.

The desired light levels vary depending upon the type of task performed.

Task	Recommended Light Levels in foot-candles (lux)
Working spaces where visual tasks are not generally performed (e.g., hallways)	10-20 (100-200 lux)
Rough bench work and machine work (e.g., cutting pieces, building crates, bulk packaging)	20-50 (200-500 lux)
Reading computer screen	20-50 (200-500 lux)
General inspection, fine assembly (e.g., using a lathe, sanding, polishing)	50-100 (500-1,000 lux)
Extra fine bench and machine work, extra fine assembly, detailed inspection (e.g., electronic maintenance, inspecting for surface defects)	500-1,000 (5,000-10,000 lux)

Table 23
Checklist Question 23 (cont'd)

Examples of difficult visual conditions include:

- Visual inspection of gauges which are in a dark area or are covered with a grease film;
- Viewing a computer monitor screen in bright conditions (near a window); or,
- Reading schematics/engineering drawings in areas where light levels are less than 50 fc.

References: 20

Table 24
Checklist Question 24

Question: Intensive visual tasks, staring at work objects for long periods (e.g., inspection, troubleshooting).

Targeted Risk Factors

	Risk Factor		Risk Factor
	Excessive Glare/Excessive Light	x	Static (fixed position) work
	Inadequate Light		

Background Discussion

Intensive visual demands which occur over a prolonged period of time can contribute to eyestrain because of static muscular effort imposed on the eye muscles.

What to Look For

This Job Factor is scored when the person performs intensive visual tasks which involve continuous inspection, monitoring or staring at work objects or a screen. The key characteristic is **continuous** and **intensive** staring and the deliberate focusing of attention. Most of the tasks that you will encounter in the maintenance and inspection environment will not involve intensive visual tasks.

Examples of intensive visual tasks include:

- Visual inspection activities;
- Continuous systems monitoring activities (e.g., control room, control panel monitoring);
- Diagnosing and trouble shooting electrical or mechanical problems; and,
- Machining or lathing of parts.

References: 37

Table 25
Checklist Question 25

Question: Restricted space

Targeted Risk Factors

	Risk Factor		Risk Factor
	Excessive Noise		Extreme Temperatures
x	Awkward body postures/movements		Poor Air Quality

Background Discussion

Restricted space is not the same as "confined space." Space is often restricted when there is limited access to where the work must be performed such as reaching through a small access panel to repair a fuel line. If adequate space is not available, the individual may have difficulty performing the task efficiently. Productivity may also be compromised.

What to Look For

This Job Factor is scored when the person works in a workspace which is physically inadequate in size for the tasks performed, such as access panels, or full cell work. If there are obstacles that interfere with movement and performance of tasks this question should also be scored.

Examples of restricted space include:

- Working in man-holes;
- Working in the interior of aircraft or other pieces of equipment; and,
- Maneuvering in areas where there are many obstructions.

References: 38

Table 26
Checklist Question 26

Question: Extreme Temperatures - chronically low or high temperatures or extreme fluctuation.

Targeted Risk Factors

	Risk Factors		Risk Factors
	Excessive Noise	x	Extreme Temperatures
	Static Work Postures		Poor Air Quality

Background and Discussion

Most individuals feel comfortable in a work environment when the air temperature is between 68°- 76° F or 20 - 26° C. The normal body temperature is 98.6° F (37° C). In the summer, skin temperature is around 95° F (37° C) and in the winter is approximately 91.4° F (33° C). Many M/I tasks occur in hangers where temperature cannot be controlled to maximize worker comfort. In addition, some M/I tasks occurred outdoors under extreme climatic conditions (e.g., flight line in winter). Extreme conditions can be controlled using portable heaters or ventilation units. Uncontrolled temperature extremes should be scored.

What to Look For

Extreme temperatures, chronically low or high temperatures, or extreme fluctuation in temperature in the work environment. Individuals may complain of being too cold or too hot affecting their ability to concentrate or increasing their feeling of fatigue especially when the individual feels too warm. Ask the employee to help you rate this risk factor based on their perception. If the employee comments that the temperature is always a problem or that the temperature reaches extreme levels, mark the *strongly agree response*. If the employee simply states that temperature is *sometimes* a problem, mark the *agree response*.

References: 39, 41

Table 27
Checklist Question 27

Question: Noise or distractions

Targeted Risk Factors

	Risk Factors		Risk Factors
x	Excessive Noise		Extreme Temperatures
	Static Work Postures		Poor Air Quality

Background Discussion

In the work environment, there are many sources of noise including:

- machinery, equipment, generators or AGE;
- power tools;
- aircraft, engines (operative and testing);
- pressurized systems (airlines, compressors); or
- HVAC systems.

Not only can noise from these sources be annoying and create distractions for the worker, prolonged exposure to excessive noise may cause permanent hearing loss.

What to Look For

You may answer the question in two ways. First, ask the employee about his/her perception of noise. Check off the appropriate response. Second, review AFOSH STD 48-19, (Chapter 2) and previous industrial hygiene noise surveys performed for the shop. If noise levels can be controlled with hearing protection, check the *neutral* response. If noise levels are controlled with hearing protection **but** employees still complain about noise, check the *agree* response.

References: 40, 42, 43

Table 28
Checklist Question 28

Question: Air quality concerns

Targeted Risk Factors

	Risk Factors		Risk Factors
	Excessive Noise		Extreme Temperatures
	Static Work Postures	x	Poor Air Quality

Background Discussion

The air quality issue is complex. Work environments can contain a number of air, contaminants and odors. Odors do not necessarily represent a hazardous condition. Lack of odors, on the other hand, does not necessarily represent a safe condition (e.g., carbon monoxide).

What to Look For

It is not the purpose of the Level I Checklist to determine/identify exposures to potentially unsafe air contaminants. These assessments and measurements are performed as part of industrial hygiene surveys. Rather, the purpose of the Level I checklist *air quality concerns* question is to identify if employees perceive that there is a problem. Concern may increase physiological stress and the potential impact of exposure to other risk factors. Ask the employee to help you rate air quality concerns. If a concern is indicated, you may need to review results of past industrial hygiene surveys or evaluate the need for BEF to perform additional surveys.

References: 39, 44

SAMPLE LEVEL I ERGONOMICS ASSESSMENT CHECKLIST

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Level I Ergonomics Assessment Checklist for Maintenance and Inspection Work Areas	Survey Date (YYMMDD) 96-10-09	**Workplace Identifier:**	
(use this space for mechanical imprint)		Base Dover AFB	Organization 96ABW
		Workplace Survival Equipment	
		Bldg. No/Location 306	Room/Area A
		AFSC/Job Series	
		Job Name:	
BEF Technician: _____ Sign			

Part I - Work Content (Description of Tasks Performed)

For this section, work with the employee to determine those reoccurring jobs/tasks that are most difficult on the body. Ask the employee the following questions:

- "In terms of stress to the body, what are the most difficult, fatiguing jobs/tasks that you do?"
- "Which of those jobs/tasks do you perform on a regular basis (or occur most frequently)?"

Using the Maintenance and Inspection Task Key List as a reference, write in the task names in the work content matrix below. If the employee mentions tasks which are not included on the Task Key List, write-in the additional tasks in the Task Key List. **Note: If the person mentions several jobs which each have multiple tasks, complete a separate checklist for each job.**

For each task performed, determine the approximate task frequency using the following proportions of job time:

> 50 % (High): The total percentage of work time spent performing the task is greater than 50%.

10-50 % (Moderate): The total percentage of work time spent performing the task is between 10 and 50%.

< 10 % (Low): The total percentage of work time spent performing the task is less than 10%.

For each task, check the most appropriate circle in the Work Content Matrix below to indicate approximate task frequency. If lifting/high force exertions occur in the task, indicate by checking the appropriate circle.

WORK CONTENT MATRIX

Task	Lifting / Exertion Occur in Task	Task Frequency (Check one)		
		(Low) 0-9%	(Moderate) 10-50%.	(High) 51-100%
1. Folding/Fitting	○	○	○	●
2. Tying/Twisting/Wrapping	○	●	○	○
3. Packing	●	○	●	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○

▒ = Critical tasks are indicated by the shaded boxes in the Work Content Matrix. Critical tasks are tasks which occur greater than 10% of the job time or which involve lifting or high forces.

ONLY COMPLETE THE CHECKLIST FOR CRITICAL TASKS.
LOW FREQUENCY TASKS WITH LIFTING OR EXERTION ARE SCORED AS MODERATE FREQUENCY.

Performance Measures

How is your performance measured? *Performance is based on project completion. There is no formal process for evaluation.*

Level I - Ergonomics Assessment for Maintenance and Inspection Work Areas Page 2

Part I - Work Content (Description of Tasks Performed) (Cont.)

Maintenance and Inspection Task Key List

66. abrading
68. bolting/screwing
70. chipping
71. cleaning by hand
72. cleaning with high pressure equipment
73. coating/immersing
76. crimping
77. cutting/shearing
79. drilling
80. driving (vehicles)
81. excavating
83. flame cutting
84. folding/fitting
85. gluing/laminating (dopping)
86. grinding/buffing/polishing
87. hammering
88. lifting
90. lubricating
91. machining
92. masoning
93. melting
94. molding
95. monitoring (visual displays)
97. nailing
98. opening/closing heavy doors
99. packing/packaging
100. painting/spray painting
101. paving
102. pumping (by hand)
103. riveting/bucking
104. sanding
105. sawing
107. sewing
108. soldering/brazing
110. stripping/depainting by hand
111. stripping/depainting mechanically
113. turning valves
114. tying/twisting/wrapping
116. welding
118. wiring
119. wrenching/ratcheting
121. assembly/disassembly internal component
122. assembly & repair (bench work)
123. computer work
124. hose handling
125. forming
126. masking
127. media blasting (blast cabinet)
128. media blasting (high pressure gun)
129. ordnance disposal
130. prying
131. visual inspection

(Write in others)

131. _____
132. _____

Part II - Checklist, Shoulder / Neck

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name: Folding/Fitting — Task Frequency: Moderate 10-50%	Task Name: Folding/Fitting — Task Frequency: High 51-100%	Task Name: Packing — Task Frequency: Moderate 10-50%	Task Name: Packing — Task Frequency: High 51-100%	Task Name: — Task Frequency: Moderate 10-50%	Task Name: — Task Frequency: High 51-100%	Comments
1. **Reaching** *repeated reaching or arms held continuously away from body while unsupported*							
Below shoulder level (arm 30-90° away from body)	F S O N 1 1 0 0	F S O N 3 2 1 0	F S O N 1 1 0 0	F S O N 3 2 1 0	F S O N 1 1 0 0	F S O N 3 2 1 0	
Above shoulder level (arm > 90° away from body)	F S O N 3 2 1 0	F S O N 4 3 1 0	F S O N 3 2 1 0	F S O N 4 3 1 0	F S O N 3 2 1 0	F S O N 4 3 1 0	
2. **Arm forces:** **Repeated arm forces** exceeding 10 lb. (4.5 kg.) *(e.g. roughly equivalent to lifting a gallon of milk)* **or** **Holding/carrying materials** *exceeding 25 lb.(11.3kg.) for more than three steps*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
3. **High speed, sudden shoulder movements** *(e.g., opening a stuck door, pulling and yanking on a stuck component to remove it)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	Forcing the last of the raft into the container
4. **Head/neck bent, tilted, or twisted** (>10°) *(e.g., craning neck looking into tight spaces)*	F S O N 3 2 1 0	F S O N 6 3 1 0	F S O N 3 2 1 0	F S O N 6 3 1 0	F S O N 3 2 1 0	F S O N 6 3 1 0	Looking down into fixture during packing
Task Scores = (column total)		6	7				

Part II - Checklist, Hands/Wrists/Arms

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name: *Folding/Fitting* — Task Frequency: Moderate 10-50%	Task Name: *Folding/Fitting* — Task Frequency: High 51-100%	Task Name: *Packing* — Task Frequency: Moderate 10-50%	Task Name: *Packing* — Task Frequency: High 51-100%	Task Name: — Task Frequency: Moderate 10-50%	Task Name: — Task Frequency: High 51-100%	Comments
5. **Bent wrists/repeated wrist movements** (>10° in any direction) **or repeated forearm rotation** *(e.g., turning a screw driver, Allen wrench)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
6. **Repeated manipulations with fingers** *(e.g., repetitive computer keying tasks, removing small screws, electrical wiring tasks)*	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	
7. **Hyperextension of finger/thumb** *(e.g., using pliers with a wide handle span)* **or repeated single finger activation** *(e.g., single finger triggers on power tools)*	F S O N 1 0 0 0	F S O N 3 1 0 0	F S O N 1 0 0 0	F S O N 3 1 0 0	F S O N 1 0 0 0	F S O N 3 1 0 0	
8. **Hand/grip forces** *fingertip force: > 2 lb.(.9 kg.) (e.g., 2 lb. is roughly equal to holding fingernail clippers closed full hand force: > 8 lb. (3.6 kg.) (e.g., 8 lb. is roughly equal to holding a 8 lb. tool or holding a gallon of milk)*	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	*Some forcing of raft into container*
9. **High speed hand/wrist /arm movements** *(e.g., yank components with fingers, using the hand as a hammer)* ***or*** **Vibration, impact, or torque to the hand** *(e.g., using a nail gun or other power tools and equipment)*	F S O N 3 1 0 0	F S O N 5 2 1 0	F S O N 3 1 0 0	F S O N 5 2 1 0	F S O N 3 1 0 0	F S O N 5 2 1 0	
10. **Exposure to hard edges** *(e.g., tool handle or work area presses into fingers or palm of hands)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
11. **Hands and fingers exposed to cold temperatures** *(e.g., working outside in winter environment, cold exhaust air from tool blows on hand/wrist)*	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	
Task Scores = (column total)		5	5				

Part II - Checklist, Back/Torso

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name: *Folding/Fitting* — Task Frequency: Moderate 10-50%	Task Name: *Folding/Fitting* — Task Frequency: High 51-100%	Task Name: *Packing* — Task Frequency: Moderate 10-50%	Task Name: *Packing* — Task Frequency: High 51-100%	Task Name: — Task Frequency: Moderate 10-50%	Task Name: — Task Frequency: High 51-100%	Comments
12. **Repeated forward or sideways bending movements** (>20°) (e.g. lifting from floor level)	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
13. **Twisting of the lower back** (e.g. rushing while lifting, pulling, open a stuck door)	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	
14. **High speed, sudden movements** *with the back*	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	
15. **Static, awkward back postures** *(for >10 sec at a time)* ***While standing,*** *continuous leaning forward or to the side* (>20°) **or** ***While seated,*** *continuous leaning forward* (>20°) *or poor lower back posture (e.g., poor lower back support, no support for feet)*	F S O N 2 1 0 0	F S O N 6 2 1 0	F S O N 2 1 0 0	F S O N 6 2 1 0	F S O N 2 1 0 0	F S O N 6 2 1 0	Constantly leani forward when packing into fixture
16. **Lifting forces**							
• *50-70 lb. (22.7-31.8 kg.) while upright w/ load close to body or*	F S O N 3 2 2 0	F S O N 4 3 2 0	F S O N 3 2 2 0	F S O N 4 3 2 0	F S O N 3 2 2 0	F S O N 4 3 2 0	
• *10-40 lb. (4.5-18.1 kg.) while bending or reaching*							
• *> 70 lb.(31.8 kg.) while upright w/ load close to body or*	F S O N 6 5 4 0	F S O N 7 6 4 0	F S O N 6 5 4 0	F S O N 7 6 4 0	F S O N 6 5 4 0	F S O N 7 6 4 0	Heave lift of packaged raft into and out of the fixture
• *> 40 lb. (18.1 kg.) while bending or reaching*							
17. **Pushing or pulling** *(initial force > 50 lb. (22.7 kg.) (e.g. pushing/pulling a full two-drawer file cabinet across a carpeted floor)*	F S O N 3 2 1 0	F S O N 4 3 2 0	F S O N 3 2 1 0	F S O N 4 3 2 0	F S O N 3 2 1 0	F S O N 4 3 2 0	
18. **Whole body vibration** *felt through floor surface (e.g. operating heavy machinery)*	F S O N 2 1 0 0	F S O N 4 2 1 0	F S O N 2 1 0 0	F S O N 4 2 1 0	F S O N 2 1 0 0	F S O N 4 2 1 0	
Task Scores = (column total)		11	14				

Part II - Checklist, Legs/Feet

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

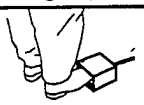
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

	Job Factor	Task Name: *Folding/Fitting* — Task Frequency		Task Name: *Packing* — Task Frequency		Task Name: — Task Frequency		Comments
		Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	
	19. **Fixed position, standing** *static effort in legs (e.g. standing on hard floor surfaces)*	F S O N 2 1 0 0	F S O N 3 **2** 1 0	F S O N **2** 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
	20. **Exposure to hard edges on legs, knees, and feet** *(e.g., kneeling on a hard surface standing on rungs of a ladder, leaning against a hard edge, exposure to hard front edge of seat)*	F S O N 2 1 0 0	F S O N 5 **2** 1 0	F S O N **2** 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	*Kneeling on floor during initial folding*
	21. **Awkward leg postures** *(e.g. kneeling, squatting, crawling, or knee hyperextension)*	F S O N 2 1 0 0	F S O N 5 **2** 1 0	F S O N 2 1 0 **0**	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
	22. **Standing foot pedal** *(e.g., using foot pedal while standing)*	F S O N 1 0 0 0	F S O **N** 3 2 1 **0**	F S O **N** 1 0 0 **0**	F S O N 3 2 1 0	F S O N 1 0 0 0	F S O N 3 2 1 0	
	Task Scores = (column total)		*6*	*3*				

Part II - Checklist, Head/Eyes

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

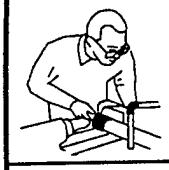
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

	Job Factor	Task Name: *Folding/Fitting* — Task Frequency: Moderate 10-50%	Task Name: *Folding/Fitting* — Task Frequency: High 51-100%	Task Name: *Packing* — Task Frequency: Moderate 10-50%	Task Name: *Packing* — Task Frequency: High 51-100%	Task Name: — Task Frequency: Moderate 10-50%	Task Name: — Task Frequency: High 51-100%	Comments
	23. **Difficult to see/light levels too low /too high.** *(e.g., see detail)*	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
	24. **Intensive visual tasks, staring at work objects for long periods** *(e.g., inspection, troubleshooting)*	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
	Task Scores = (column total)		0	0				

Part III - Environmental

Environmental Factors

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
25. Restricted space	0	(0)	0	1	4
26. Extreme temperatures heat/cold	0	0	(0)	1	4
27. Noise or distractions	0	0	(0)	1	4
28. Air quality concerns	0	0	(0)	1	4

Environmental Score = 0

Environmental Rating	(Low)	Med	High
Environmental Score	0-3	4-7	8+

Part IV - Employee Suggestion

Ask the employee for any suggestions for corrective actions that they may have.
Put locks on wheels so fixture/cart doesn't move when we're placing raft

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APPENDIX 3

Prioritization of Hazards

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APPENDIX 3

This Appendix corresponds with Step 3: Prioritization of Hazards and includes:

- completed example of a Checklist Scoring Summary form.

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SAMPLE CHECKLIST SCORING SUMMARY

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CHECKLIST SCORING SUMMARY

Technician *(Name)* **Date** *(Date of Analysis)*

1. Job Description: Please write out job description.

Two employees are responsible for folding and packing a life raft into a bag. A backing fixture is used to facilitate packing. The employees must lift the raft in and out of the fixture.

2. Scoring Summary: Transfer scores from individual scoring sheets.

Body Region	Task Scores					Priority Score by Body Region	Priority Rating by Body Region
	Task Name: *Fold/Fit*	**Task Name:** *Packing*	**Task Name:**	**Task Name:**		**Add across row and divide by # of tasks for average**	High: 8+ Med: 4-7 Low: 0-3
Shoulder/Neck	*6*	*7*	**note:6.5 was rounded up to 7*		=	**7*	High (Med) Low
Hand/Wrist/Arm	*5*	*5*			=	*5*	High (Med) Low
Back/Torso	*11*	*14*	**note: 12.5 was rounded up to 13*		=	**13*	(High) Med Low
Legs/Feet	*6*	*3*	**note: 4.5 was rounded up to 5*		=	**5*	High (Med) Low
Head/Eyes	*0*	*0*			=	*0*	High Med (Low)

Select the highest body region score for each task then circle below for High, Med, Low	Highest Score *11*	Highest Score *14*	Highest Score	Highest Score
High: 8+ Med: 4-7 Low: 0-3	(High) Med Low	(High) Med Low	High Med Low	High Med Low

Environmental Rating
High Med (Low)

Overall Job Priority Score	
Highest Avg. Score by Body Region *13* Body Region *Back*	(High) Med Low

3. <u>Case Study Selections List</u> Select the case studies that match the critical tasks that you identified for this job. Place a ✓in the appropriate boxes below and then turn to the appropriate case study in the Case Study Book.

1	abrading	☐	26	media blasting (blast cabinet)	☐
2	assembly disassembly-internal components	☐	27	media blasting (high pressure gun)	☐
3	assembly repair-bench work	☐	28	melting	☐
4	bolting/screwing	☐	29	monitoring (of displays)	☐
5	chipping	☐	30	nailing	☐
6	cleaning by hand	☐	31	opening/closing heavy doors	☐
7	cleaning with high pressure equipment	☐	32	ordnance disposal	☐
8	coating/immersing	☐	33	packing	☑
9	computer work	☐	34	painting/spraying	☐
10	crimping	☐	35	paving	☐
11	cutting/shearing	☐	36	prying	☐
12	drilling	☐	37	pumping	☐
13	driving	☐	38	riveting/bucking	☐
14	excavating/shoveling	☐	39	sanding	☐
15	flame cutting	☐	40	sawing	☐
16	folding/fitting	☑	41	sewing	☐
17	forming	☐	42	soldering	☐
18	gluing/ laminating (dopping)	☐	43	stripping/depainting by hand	☐
19	grinding	☐	44	stripping/depainting by mechanical methods	☐
20	hammering	☐	45	turning valves	☐
21	hose handling	☐	46	tying/twisting/wrapping	☐
22	lifting	☑	47	visual inspection	☐
23	machining	☐	48	welding	☐
24	masking	☐	49	wiring	☐
25	masoning	☐	50	wrenching/ratcheting	☐

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APPENDIX 4

Hazard Control Section

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APPENDIX 4

Case Study Problem-Solving Matrices for Maintenance and Inspection Work Areas.

This Appendix includes:

- a sample completed Corrective Actions List; and
- 50 case studies.

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CORRECTIVE ACTION LIST
(MAINTENANCE AND INSPECTION WORK AREAS)

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Corrective Action List (Maintenance and Inspection Work Areas)

Select the corrective action from the **case studies** pages paying particular attention to the body regions that are primary and secondary concerns. Place a ✓ in the appropriate boxes below as you select from each case study.

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
1. Alternate between sitting and standing tasks			A.5.2.4
2. Avoid high force tasks while seated			A.5.2.4
3. Change a pinch grip to a power grip			
4. Change lifting/carrying task into a rolling or sliding task			A.5.2.7
5. Change posture frequently			A.5.2.4
6. Call for assistance if necessary			
7. Direct cold air away from the hands			A.5.1.2
8. Distribute intensive activities throughout the process			
9. Eliminate exposure to hard edges	X		
10. Eliminate need to constantly hold trigger			A.5.1.2
11. Eliminate unnecessary tasks			
12. Encourage appropriate seasonal clothing			
13. Encourage ergonomic work techniques	X		
14. Encourage person to have visual disorders corrected			
15. Heat metal/material to make more pliable			
16. Improve cleat design			
17. Improve floor condition		X	
18. Improve visual access to work			
19. Improve wheel condition			

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
20. Incorporate rest pauses			
21. Increase handle length to improve leverage			A.5.1.2
22. Increase light levels			
23. Increase room temperature			
24. Increase size of work surface			
25. Increase task variety			A.5.2.4
26. Increase weight of work piece			
27. Lower light levels			
28. Lower the chair			A.5.2.5
29. Lower the handle			
30. Lower the monitor/screen			
31. Lower the person			A.5.2.5
32. Lower the work piece/work surface			A.5.2.5
33. Maintain bolts and screws			
34. Maintain hand tool/power tools			A.5.2.2
35. Maintain tracks, rollers, and movement mechanisms			
36. Minimize material which must be removed manually			
37. Modify facilities to decrease handling			
38. Move closer to the work location			A.5.2.3
39. Move monitor/screen closer to body			
40. Move monitor/screen further away from body			

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
41. Move work piece closer to body			
42. Obtain patient's assistance			
43. Place the trigger/switch to allow a comfortable hand/arm position			
44. Position mouse/input device next to the keyboard			
45. Position the monitor/screen in front of the body			
46. Provide a ball-bearing rotation table			
47. Provide a carrying container for tools/supplies			A.5.2.7
48. Provide a cart			A.5.2.7
49. Provide a flat/level keyboard			
50. Provide a foot pedal which requires the correct amount of force to use			
51. Provide a foot pump			
52. Provide a footrail or footrest			A.5.2.6
53. Provide a full-sized input device			
54. Provide a high friction gripping surface			A.5.2.2
55. Provide a hook-type tool to pull items			
56. Provide a keyboard which does not require excessive keying forces			
57. Provide a larger worksurface			
58. Provide a lighter weight door			
59. Provide a lighter weight tool			A.5.1.2
60. Provide a magnifying glass			
61. Provide a mechanical lift device		X	A.5.1.1

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
62. Provide a multi-finger trigger			A.5.1.2
63. Provide a padded, compressible surface to lay on			
64. Provide a padded, compressible surface to sit on			
65. Provide a palm rest			
66. Provide a power tool			A.5.1.2
67. Provide a powered cart			
68. Provide a shorter handle to reduce arm movement			
69. Provide a smaller container			A.5.2.7
70. Provide a spring release mechanism on plier-type tools			A.5.1.2
71. Provide a storage bag which is easy to pack/unpack		X	
72. Provide a swivel connection for air hose			A.5.2.2
73. Provide a telephone head set			
74. Provide a tool that minimizes exposure to vibration/impact/ torque			A.5.1.2
75. Provide a tool which can be used with both hands			A.5.1.2
76. Provide a tool which requires minimal force to use			A.5.1.2
77. Provide a tool with an appropriate handle angle			A.5.1.2
78. Provide a wheel barrow			
79. Provide a work surface which is adjustable in height		X	
80. Provide adequate leg clearance			
81. Provide adequate toe clearance			
82. Provide adequate work space			

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
83. Provide an adjustable height lift table			
84. Provide an adjustable mirror			
85. Provide an alternative keyboard			
86. Provide an appropriate anti-fatigue mat		X	
87. Provide an appropriate chair/stool			
88. Provide an appropriate handle diameter			A.5.1.2
89. Provide an appropriate handle grip span on plier-type tools			A.5.1.2
90. Provide an auxiliary table			
91. Provide anti-vibration materials			A.5.2.2
Provide appropriate abrasive material			
93. Provide appropriate gloves			
94. Provide appropriate handles			A.5.1.2
95. Provide appropriate knee protection	X		
96. Provide appropriate shoe inserts	X		
97. Provide appropriate solvent solution			
98. Provide automatic or semi-automatic feed for fasteners			
99. Provide bolt and screw head designs which are durable			
100. Provide computer glasses			
101. Provide controls which do not require excessive forces			
102. Provide displays which are readable and easy to understand			

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
103. Provide extensions for tools			A.5.2.2
104. Provide handles with insulating material			A.5.1.2
105. Provide portable heaters			
106. Provide powered assistance for a manual activity			
107. Provide powered or mechanical assistance for door			
108. Provide protection from glare from natural light			
109. Provide protection from glare from overhead lights/ task lights			
110. Provide shields or barriers from the wind			
111. Provide support for reference documents			
112. Provide support for the arms			
113. Provide support for the cable or hose			A.5.2.2
114. Provide support for the head			
115. Provide support for the lower back			
116. Provide support for the tool			A.5.1.2
117. Provide support for the upper body			
118. Provide support for the work piece			
119. Provide wheels			
120. Raise the chair			A.5.2.5
121. Raise the handle			
122. Raise the monitor/screen			
123. Raise the person			A.5.2.5
124. Raise the work piece/work surface	X		A.5.2.5
125. Recess container into work surface			
126. Reduce carry distance			
127. Reduce depth of storage container			A.5.2.7

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
128. Reduce force required to install or remove the component		X	
129. Reduce number of fasteners used			
130. Reduce the angle a person has to turn to transfer an item			A.5.2.7
131. Reduce weight of work piece			
132. Remove obstructions			A.5.2.3
133. Replace abrasive or cutting material frequently			
134. Replace standing foot pedals with alternative controls			
135. Reposition foot pedal			A.5.2.6
136. Rotate the work piece			
137. Sharpen blades frequently			
138. Stand to perform task			A.5.2.4

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
139. Store materials in the same orientation in which they are used			
140. Use alternative fasteners			
141. Use heavy excavation equipment (e.g., back hoes)			
142. Use two or more persons to perform the transfer	X		A.5.2.7
143. Wear appropriate shoes			
144. Provide a machine/automate			
145. Modify foot pedal			A.5.2.6

CASE STUDY PROBLEM-SOLVING MATRICES

Appendix 4

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The 50 case study problem-solving matrices provided on the following pages link the problems identified with the Level I Ergonomics Assessment Checklist and Checklist Scoring Summary to strategies or options which you may use to control ergonomics hazards. The matrices are presented in Table 1 below.

Table 1
Directory of Case Study Problem-Solving Matrices

Case Study			
1	Abrading	26	Media Blasting - Blast Cabinet
2	Assembly/Disassembly - Internal Components	27	Media Blasting - High Pressure Gun
3	Assembly/Repair - Bench Work	28	Melting
4	Bolting/Screwing	29	Monitoring (of displays)
5	Chipping	30	Nailing
6	Cleaning by Hand	31	Opening/Closing Heavy Doors
7	Cleaning with High Pressure Equipment	32	Ordnance Disposal
8	Coating/Immersing	33	Packing
9	Computer Work	34	Painting/Spraying
10	Crimping	35	Paving
11	Cutting/Shearing	36	Prying
12	Drilling	37	Pumping
13	Driving (Vehicles)	38	Riveting/Bucking
14	Excavating/Shoveling	39	Sanding
15	Flame Cutting	40	Sawing
16	Folding/Fitting	41	Sewing
17	Forming	42	Soldering
18	Gluing/Laminating (Dopping)	43	Stripping/Depainting by Hand
19	Grinding	44	Stripping/Depainting by Mechanical Methods
20	Hammering	45	Turning Valves
21	Hose Handling	46	Tying/Twisting/Wrapping
22	Lifting	47	Visual Inspection
23	Machining	48	Welding
24	Masking	49	Wiring
25	Masoning	50	Wrenching/Ratcheting

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CASE STUDY - Abrading	
TASK TITLE: Abrading	
Task Description:	Abrading involves the use of a manual (sandpaper, file, etc.) or powered (pneumatic/hydraulic hand sanders) tools to remove or shape material. Additionally, the parts can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which abrading is performed include (not necessarily limited to): • aircraft maintenance • sheet metal repair • facility maintenance • model shop
Job Performance Measures Most Often Impacted by Abrading:	• Surface finish • Speed of task completion.
Typical Employee Comments about Abrading:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso, or legs/feet. The primary body parts affected are typically: shoulders/neck, hands/wrists/arms and back/torso The secondary body parts affected are typically: legs/feet.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• provide a step stool	✓		med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Work piece must be manually supported, held, or steadied	118. Provide support for the work piece					
		• provide a clamp to place work piece at the desired height and orientation	✓		med	low	med
	• Abrading tool power supply hose/cord must be manually supported, held or steadied	113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		med	low	low
	• Work location is too far away (see Figure 1.1)	38. Move closer to the work location					
		• remove obstructions	✓		med	med	med
		• get on top of the work (and provide knee pads)	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med

Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
	• Abrading is performed on a flat work surface	136. Rotate the work piece • turn the work piece to an upright or angled position	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide a tool with a grip which is oriented vertically while the tool is in use		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Worker must apply downward pressure	133. Replace abrasive/cutting material frequently	✓		low	high	high
		34. Maintain hand tool/power tools • minimize force	✓		med	med	med
		66. Provide a power tool • provide a tool with the capacity to handle the required work without causing the operator to over exert		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work surface is too high	123. Raise the person					
		• provide a step stool	✓		med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Work surface is too low	124. Raise the workpiece/worksurface					
		• raise part with a hoist		✓	med	med	med
		• raise on adjustable table		✓	med	med	med
		32. Lower the worker					
		• provide a stool (see Figure 1.2)	✓		med	med	med
		Figure 1.2					

Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is too high	123. Raise the person					
		• provide a step stool	✓		med	med	med
		• provide an adjustable platform		✓	high	med	med
		32. Lower the work piece/work surface	✓		med	med	med
	• Work is in an awkward location or orientation	136. Rotate the work piece					
		• manually turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Abrading is performed on a flat work surface	136. Rotate the work piece					
		• turn the work piece to an upright or angled position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle					
		• provide a tool with a grip which is oriented vertically while the tool is in use		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyper - extension of finger/thumb or repeated single finger activation	• Use of tool with single trigger concentrates stress	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)	✓		med	med	med
8. Hand/grip forces	• The type of tool is not appropriate for the amount of material that must be removed	133. Replace abrasive/cutting material frequently	✓		low	high	high
		34. Maintain hand tools/power tools	✓		low	med	med
		66. Provide a power tool • provide a tool with the capacity to handle the required work without causing the operator to overexert		✓	med	med	med
	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture or clamp which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible, high friction surface		✓	med	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		• wrap tool handle	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter					
		• provide a tool with an appropriate handle diameter between 1"-1.5".		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• The tool has not received proper maintenance	34. Maintain hand tools/power tools					
		• perform periodic maintenance on all tools	✓		low	med	med
	• Abrading tools produce hand/arm vibration	74. Provide a tool that minimizes exposure to vibration/impact/torque					
		• provide a tool which minimizes exposure to vibration		✓	med	med	med
		• provide a tool with vibration absorbing materials built into the handles		✓	med	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5"(12.7cm) in length • wrap the tool handle	 ✓	✓ ✓	 med med low	 med med med	 med med med
	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	 ✓	 ✓	 low med	 med med	 med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓	med med	med med	med med
	• Air tool exhaust blows on wrist	7. Direct cold air away from the hands • modify the existing tool/add an air diverter • provide a tool which does not direct air to the hands	 ✓	 ✓	 med med	 med med	 med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs (Refer to question 15)	N/A					
13. Twisting of the lower back	• Work space is cramped or access is limited	117. Provide support for the upper body • provide a pad/mat • provide a device to support the upper part of the body	✓	✓	low med	med med	med med
	• Work piece orientation is inappropriate	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface is too low (see Figure 1.3)	124. Raise the work piece/work surface					
		• use a hoist		✓	med	med	med
		• raise the worktable with blocks or risers	✓		low	med	med
	Figure 1.3	31. Lower the worker					
		• provide a stool for low work locations	✓		med	med	med
	• Inadequate lower back support	115. Provide support for the lower back					
	• Inappropriate chair adjustment.	• adjust back rest to support lower back while seated	✓		low	med	med
	• Inappropriate chair design	• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide a chair with adequate lower back support		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.4) **Figure 1.4**	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest	✓		med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/work surface • use a hoist		✓	med	med	med
		31. Lower the worker • provide a stool	✓		med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels					
		• provide task light		✓	med	med	med
		• increase overall light levels to meet the needs of tasks		✓	med	med	med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work					
		• increase size of text	✓	✓	med	med	med
		• increase the legibility of text	✓	✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Assembly/disassembly - internal components	
TASK TITLE: Assembly/disassembly - internal components	
Task Description:	Assembly/disassembly often involves the use of manual or power tools. The characteristic that makes this assembly/disassembly task unique is that the task is being performed on an internal component. The component is in a fixed location (e.g., inside the aircraft wing, wall, or other machine) and access to the part is typically severely limited. In some cases the employee must reach into or work through a small access opening to perform the work. In other cases, the employee must crawl into and work from inside a small compartment. Typical jobs in which assembly/disassembly is performed include (not necessarily limited to): • fuel line maintenance • hydraulics
Job Performance Measures Most Often Impacted by Assembly/disassembly:	• Speed of task completion (as measured against standard) • Integrity of seals • No foreign objects can be left inside aircraft
Typical Employee Comments about Assembly/disassembly:	Employees typically complain about discomfort in the hands/wrists and elbows. Depending on the work location and the type of access, employees may report a variety of complaints from knees (due to kneeling or squatting), shoulders (from constant reaching), and back and neck (from working in awkward postures for prolonged periods. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Grip Force Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (see Figure 1.1)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• remove adjacent access panel if possible		✓	med to high	med	med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med

Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Manual procedure or tool requires excessive force	76. Provide a tool which requires minimal force to use • provide manual tool to replace "by hand" work		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Component must be held in place	118. Provide support for the work piece • provide manual clamps/fixtures to hold components in place during assembly or removal	✓	✓	med	med	med
3. High speed, sudden shoulder movements	• Manual procedure or tool requires high speed movements	76. Provide a tool which requires minimal force to use • provide manual tool to replace "by hand" work		✓	med to high	med	med to high
4. Head/neck bent or twisted	• Work location too high or too low.	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding 32. Lower the work piece/work surface • change (e.g., invert) the orientation of the component, or machine.	✓ ✓	✓ ✓ ✓	med low high med	med med med med	med med med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Light levels are too low for task	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Lack of direct visual access to work location (see Figure 1.2)	84. Provide an adjustable mirror • provide an articulating mirror to provide better visual contact to parts inside the access hole		✓	med	med	med
	Figure 1.2						
	• Lack of adequate support for head	114. Provide support for the head • provide neck roll or brace to support head if head must be tipped backward or forward when performing work		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Manual procedure or tool requires bent wrists	76. Provide a tool which requires minimal force to use					
		• provide power tool to replace forceful work with manual tool		✓	med	med	med
		• provide manual tool to replace hand work		✓	med	med	med
	• Using the wrong type of tool can cause bent wrists	77. Provide a tool with an appropriate handle angle					
		• provide in-line power tools for horizontal surfaces		✓	med	med	med
		• provide pistol grip power tools for vertical surfaces		✓	med	med	med
		• provide power tool with a handle which can be angled/bent for different nut driving tasks		✓	med	med	med
		• use tube gun for tube (e.g., fuel line, hydraulic line) fasteners.		✓	med	med	med
	• Work location is too far away	103. Provide extensions for tools					
		• provide extensions and angles on wrenches in order to access bolt with minimal reaching		✓	med	med	med
		38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Manual tightening/loosening on small bolts, nuts & screws	66. Provide a power tool.		✓	med	med	med
7. Hyperextension of finger/thumb or repeated single finger activation	• Wide spans on tools such as vise grips cause finger and thumb hyperextension	13. Encourage ergonomic work techniques • use two hands when possible	✓		low	med	med
		89. Provide an appropriate handle grip span on plier-type tools • provide a tool with a handle span less than 3"		✓	med	med	med
		• use crescent wrenches or appropriately sized sockets	✓		low	med	med
	• Tool requires single finger trigger activation	62. Provide a multi-finger trigger • extend current trigger	✓	✓	med	med	med
		• provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Component must be held in place	118. Provide support for the work piece • provide manual clamps/fixtures to hold components in place during assembly or removal	✓	✓	med	med	med
		• replace pliers with vice grips for holding, squeezing or stabilizing parts during installation	✓	✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool is too heavy	59. Provide a lighter weight tool					
		• provide light-weight tools		✓	med	med	med
		75. Provide a tool which can be used with both hands					
		• add an auxiliary handle or extension to enable employee to hold/stabilize tool with two hands	✓	✓	med	med	med
	• Lack of friction between hand/fingers and tools or components	76. Provide a tool which requires minimal force to use					
		• provide thin, anti-slip gloves	✓		low	high	high
		• clean components (e.g., remove dirt, grease etc.) prior to handling	✓		low	high	high
	• Manual procedure or tool requires forceful grips	76. Provide a tool which requires minimal force to use					
		• provide manual tool to replace hand work		✓	med	med	med
		• provide power tool to replace forceful work with manual tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Power tools produce hand/arm vibrations	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low to med	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping		✓	med	med	med
		• attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5" (3.8 cm))	✓		low	med	med
9. High speed hand/wrist/arm movements or vibraion, impact, or torque to the hand	• Power tool causes impact and torque to the hand	34. Maintain hand tools/power tools • provide regular maintenance and lubrication for tools	✓		low	med	med
		76. Provide a tool which requires minimal force to use • provide tools with torque releases to minimize forces required to control the tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med
	• Work area has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• lay a blanket or cushion over hard edges		✓	med	med	med
		• redesign work piece or component to eliminate hard edges					

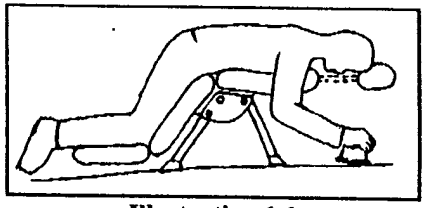
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand • Work area is too cold	7. Direct cold air away from the hands • direct exhaust air away from hands		✓	med	med	med
		• provide tool which does not blow cold air on the hands		✓	med	med	med
		93. Provide appropriate gloves • provide gloves of the right size and type of material to match the task Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work space or access is limited	63. Provide a padded, compressible surface to lay on					
		• provide a pad/mat	✓		low	med	med
		• provide a device to support the upper body while working		✓	med	med	med
		132. Remove obstructions					
		• remove hoses, carts, access covers	✓		low	high	high
14. High speed, sudden movements	• Item is stuck in location • Item is difficult to install or remove	74. Provide a tool that minimizes exposure to vibration/ impact/torque					
		• use lubricant where feasible	✓		low	med	med
		• modify design of component or subsystem to reduce forces during installation or removal		✓	med to high	med	med
		• use tool to "pry" instead of pull.	✓		low	med	med

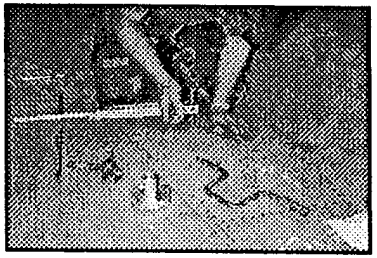
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Inappropriate back support	117. Provide support for the upper body • provide padded, portable leaning rests for working in areas which prevent the use of a chair or stool. (see Illustration 1.1)		✓	med	med	med
		 **Illustration 1.1**					
	• Work location is too low	124. Raise the work piece/work surface					
		• elevate with an available hoist	✓		low	med	med
		• provide a stationary platform or ramp		✓	med	med	med
		• provide a height-adjustable work platform		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
	• Light levels too low	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Component is too heavy	61. Provide a mechanical lift device					
		• use portable lift cart to raise/position component	✓	✓	med	low	med
		• get it close to install point		✓	med	low	med
		• place the part on temporary hangers to avoid lifting while part is being positioned	✓	✓	med	low	med
		142. Use two or more persons to perform the transfer	✓		low	low	low
17. Pushing or pulling	• High forces are required to install or remove the component	74. Provide a tool that minimizes exposure to vibration/impact/torque					
		• use lubricant where feasible	✓		low	med	med
		• modify design of component or subsystem to reduce forces during installation or removal		✓	med to high	med	med
		• "pry" component away instead of pulling	✓		low	med	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Standing surface is hard	86. Provide appropriate anti-fatigue mat		✓	med	med	low
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee (see Figure 1.3)	95. Provide appropriate knee protection					
		• provide knee pads		✓	med	med	med
		• provide a pad or cushion to kneel on	✓		low	low	low
	 **Figure 1.3**						
	• Work area has hard edges	9. Eliminate exposure to hard edges					
		• lay a blanket or cushion over hard edges	✓		low	low	med
		• redesign work piece or component to eliminate hard edges		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	31. Lower the person • provide a chair/stool to sit on • provide knee pads • provide a pad or cushion to kneel on	 ✓	 ✓ ✓	 med med med	 med med med	 med med med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low for task	22. Increase light levels • provide a task light which is easy to adjust	✓		med	med	med
		• increase room lighting		✓	high	high	high
24. Intensive visual tasks, staring at work objects for long periods	• Task lacks variety	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

CASE STUDY -Assembling/Repairing (bench work)	
TASK TITLE: Assembling/Repairing (bench work)	
Task Description:	Bench work involving assembly and repair typically involves performing precise work on small to moderate sized component. This work often involves tasks such as wiring, cutting, crimping, soldering, melting, coating, drilling, bolting/screwing, and gluing. Additional recommendations may be found in the case studies related to these activities. Bench work can be performed in either a standing or seated posture. **Consider using this case study to identify postural problems and recommendations in any situation where bench work is performed.**
Job Performance Measures Most Often Impacted by Assembling/Repairing (bench work):	• Time required to complete task • Quality of work (e.g., free of defects)-task specific
Typical Employee Comments about Assembling/Repairing (bench work):	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, shoulders/neck and middle back/lower back. The primary body regions of concern are: hands/wrists/arms, shoulders/neck The secondary body regions of concern are: back/torso
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	120. Raise the chair					
		• adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet	✓		med	med	med
		32. Lower the work piece/worksurface					
		• modify existing table (best if only one person is using the table)	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Reaching for components on the back of the work bench • Components/work piece are located too far away • Components/work piece are located too high	41. Move work piece closer to body					
		• place frequently used components closer to the person	✓		low	med	high
		• infrequently used components should be removed from the workstation or placed at arm's length	✓		med	med	high
	• Reaching over components/clutter	• store smaller quantities of components at the workstation at once	✓		low	med	high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		32. Lower the work piece/worksurface • Lower component storage containers which are frequently used		✓	med	med	high
	• Tool/workpiece must be manually supported, held or steadied	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		118. Provide support for the work piece • provide a fixture to support the work piece (fixtures which allow the work piece to be rotated into different positions are helpful)		✓	med	med	med
		112. Provide support for the arms • provide adjustable arm supports for high precision or long duration tasks that require the arms to be away from the body		✓	med	high	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	41. Move work piece closer to body	✓		low	med	med
		38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
	• Orientation of work piece or tool handle causes the arm to be held away from the body. (see Figure 1.1)	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece to an upright position	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide a tool with an in-line grip when a vertical tool axis is desired		✓	med	med	med
		• provide a tool which can be angled/bent for different work orientations		✓	med	med	med

Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Manual tool requires high forces	66. Provide a power tool • obtain a power tool which reduces forces and time required		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
3. High speed, sudden shoulder movements	• See specific case study for more detailed causes and solutions	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/worksurface					
		• raise the worktable with blocks		✓	low	med	med
		• provide an adjustable table		✓	high	med	med
		• provide a fixture (e.g., table-top riser) to raise the work piece into a comfortable viewing position		✓	med	med	med
		• lower the chairs.	✓		low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• provide adequate leg clearance to allow seated postures (e.g., remove obstructions)	✓	✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	120. Raise the chair					
		• adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet		✓	low	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece	✓		low	med	med
	• Light levels are too low	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	high	med
		• increase room lighting		✓	high	high	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Orientation of work piece or tool handle causes the wrist to be bent	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece to an upright position	✓		low	med	med
		77. Provide a tool with an appropriate handle angle			med	med	med
		• provide a tool with an in-line grip when a vertical tool axis is desired		✓			
		• provide a tool with a pistol grip when a horizontal tool axis is desired		✓	med	med	med
		• provide a tool which can be angled/bent for different work orientations		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Component container is too deep • Components are difficult to access	127. Reduce depth of storage container		✓	med	med	med
		125. Recess container into worksurface • critical components can be placed in recessed storage containers on the worksurface		✓	med	med	med
		136. Rotate the work piece • tilt component containers towards the person to increase access		✓	med	med	med
		132. Remove obstructions • the side of the component container should dip down to allow easier access to components		✓	med	med	med
	• Work location is too high	120. Raise the chair					
		• adjust the chair upward	✓		low	med	med
		• provide a cushion to raise the person, if the chair will not raise high enough	✓		med	med	med
		• when the chair is raised, a foot rest may be necessary to support the feet		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		32. Lower the work piece/worksurface • modify existing table (best if only one person is using the table) • provide an adjustable height work table	✓	✓ ✓	med high	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of power tool with single finger trigger(see Figure 1.2) **Figure 1.2**	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger • extend trigger on existing tool (if feasible and safe)	✓	✓ ✓	med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible, high friction surface		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer		✓	med	med	med
		113. Provide support for the cable or hose • provide a tool balancer to support cables		✓	med	med	med
		• provide a hook to support hose	✓	✓	med	med	med
	• Tool is too heavy	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibraion, impact, or torque to the hand	• See specific case study for more detailed causes and solutions	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med
		• wrap the tool handle	✓		low	med	med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from hands • provide tool which does not blow cold air on the hands		✓	med	med	med
		• attach an air diverter		✓	med	med	med
	• Tool handle conducts heat away from hand	104. Provide handles with insulating material • cover metal handles with insulating material	✓		low	med	med
	• Work area is too cold	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		93. Provide appropriate gloves • (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Reaching for components on the back of the work bench • Components/work piece are located too far away • Components/work piece are located too high	41. Move work piece closer to body • place frequently used components closer to the person • infrequently used components should be removed from the workstation or placed at arm's length • store smaller quantities of components at the workstation	✓ ✓ ✓		med med low	med med med	med med med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface/work piece is too high	32. Lower the work piece/worksurface					
		• lower component storage containers which are frequently used		✓	med	med	high
	• Work is too low	124. Raise the work piece/worksurface					
		• raise the table on blocks		✓	low	med	med
		• provide an adjustable table		✓	high	med	high
		• provide a fixture (e.g., table-top riser) to raise the work piece into a comfortable viewing position		✓	med	med	med
		• lower the chairs.	✓		low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• provide adequate leg clearance to allow seated postures (e.g., remove obstructions)	✓	✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work is too far from the employee	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate lower back support while sitting • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
		• adjust the height of the chair to allow person to lean back in the chair while working	✓		low	med	med
		• provide a foot rest to support the feet	✓	✓	med	low	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back		✓	med	med	med
		• provide a chair with adequate lower back support		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (If occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
		1. Alternate between sitting and standing tasks	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded compressible surface to sit on. • to reduce exposure to front edge of seat	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med
	• Workstation has hard edges	9. Eliminate exposure to hard edges					
		• remove obstructions under bench	✓	✓	med	med	med
		• round off exposed edges	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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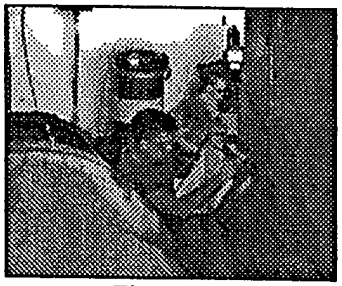
CASE STUDY - Bolting/Screwing	
TASK TITLE: Bolting/Screwing	
Task Description:	Bolting/screwing involves installing or removing nuts and bolts. These tasks can be done at a variety of heights and angles. Both hand and power tools are employed depending upon the task requirements. Typical jobs in which bolting/screwing is performed include (not necessarily limited to): • assembly • general maintenance Bolting/screwing may be performed on flat or upright surfaces directly on aircraft, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Bolting/Screwing:	• Consistent torque • No errors (e.g. , missing bolts, incorrect bolts) • Speed of completion of the job
Typical Employee Comments about Bolting/Screwing:	Employees typically report fatigue and discomfort in the hands/wrists/arms, shoulders/neck, and back/torso. Primary: The primary body parts affected are the hands/wrists/arms and shoulders/neck Secondary: In some cases, the back/torso can also be affected
Suggested Level II Analysis:	Grip Force, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool, platform or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface					
		• modify existing table	✓		med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is too far away (see Figure 1.1)	103. Provide extensions for tools					
		• provide extensions and angles on wrenches in order to access bolts with minimal reaching	✓		low	med	med
	 Figure 1.1	38. Move closer to the work location	✓	✓	med	med	med
		• remove obstructions					
		41. Move work piece closer to body	✓		low	med	med
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools		✓	med	med	med
		38. Move closer to the work location					
		• remove obstructions	✓	✓	low	med	med
		136. Rotate the workpiece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Wrenching is performed on flat work piece with a pistol-shaped power tool	136. Rotate the work piece • turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • provide a power tool that has an in-line handle for flat surfaces		✓	med	med	med
		• provide power tool with a handle which can be angled/bent for different nut driving tasks		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • provide power tools which can meet the necessary torque specification		✓	med	med	med
		• provide racheting tools with multiplying gears to reduce forces		✓	med	med	med
		• increase handle length to improve leverage		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • use a tool of minimal weight		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Containers of bolts and nuts are carried	48. Provide a cart • to eliminate carrying	✓	✓	med	med	med
		47. Provide a carrying container for tools/supplies • provide a hip pouch to eliminate carrying in hand	✓		low	med	med
3. High speed, sudden shoulder movements	• Work pace/work volume causes high speed arm movements while manually torquing bolts	76. Provide a tool which requires minimal force to use • use power tool whenever possible		✓	med	med	med
		• for high torque applications, provide power tools which are self supporting (e.g., has a tool support arm)(do not have to be held in position by the person) are preferred. These supports could take the form of support arms, or torque bars		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too high (or is overhead) (see Figure 1.2)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		114. Provide support for the head					
		• for long duration wrenching tasks which are overhead, provide a chair with a reclining backrest, a head support and arm supports		✓	med	med	med
	Figure 1.2						
	• Work location is blocked or is in an inappropriate orientation	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		136. Rotate workpiece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Manual wrenching causes awkward wrist and forearm movements	66. Provide a power tool • use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓	med	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	med	med	med
	• Torquing is performed on flat work piece with a pistol-shaped power tool	77. Provide a tool with an appropriate handle angle • provide in-line power tools for flat surfaces		✓	med	med	high
6. Repeated manipulations with fingers	• Tightening small bolts or screws with a small wrench or with the fingers causes repetitive finger movements	66. Provide a power tool • use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyper-extension of finger/thumb or repeated single finger activation	• Wide spans on tools such as vise grips cause finger and thumb hyperextension	13. Encourage ergonomic work techniques • use two hands when possible	✓		low	med	med
		89. Provide an appropriate handle grip span on plier-type tools • provide a tool with a handle span less than 3"		✓	med	med	med
		• use crescent wrenches or appropriately sized sockets	✓		low	med	med
	• Using power tool causes repeated single finger trigger activation	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Power tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a welding tool of minimal weight		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a power tool with a handle diameter of 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • provide power tools which can meet the necessary torque specification		✓	med	med	med
		• provide racheting tools with multiplying gears to reduce forces		✓	med	med	med
		• increase handle length to improve leverage		✓	med	med	med
		• provide tools with torque releases to minimize forces required to control the tool		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Power tool causes impact and torque to the hand	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low	med	med
		76. Provide a tool which requires minimal force to use • provide tools with torque releases to minimize forces required to control the tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		• provide torque reaction mechanisms to absorb torque associated with rotary power tools used for bench work		✓	med	med	med
	• Manual torquing causes high speed movements	66. Provide a power tool • use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and checking).		✓	med	med	med
	• Power tools produce hand/arm vibrations	34. Maintain hand tool/power tools • provide regular maintenance and lubrication for tools	✓		low	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping		✓	med	med	med
		• attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5")	✓		low	med	med
		• Provide a pulse controlled tool if possible. Avoid impact-type power tools (such as impact wrenches) whenever possible		✓	high	med	med

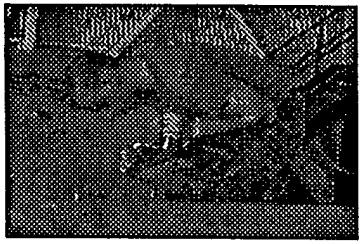
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	med to high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand • Work area is too cold	7. Direct cold air away from the hands • direct exhaust air away from hands		✓	med	med	med
		• provide tool which does not blow cold air on the hands		✓	med	med	med
		93. Provide appropriate gloves • Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.3)	124. Raise the work piece/worksurface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person	✓	✓	med	med	med
		• provide a chair/stool to sit on					
	 **Figure 1.3**						
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece (bench work)	✓		low	med	med
		• rotate the work piece manually		✓	med	med	med
		• provide a fixture to allow the work piece to be rotated					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece (bench work)	✓		low	med	med
		• turn the work piece manually		✓	med	med	med
		• provide a fixture to allow the work piece to be rotated	✓	✓	med	med	med
		• remove obstructions prior to performing task					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • provide a pad/mat	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/worksurface • provide a fixed table to support work piece		✓	med	med	high
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body		✓	med	med	med
		• provide a device to support the head and upper body while the person is working					
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					

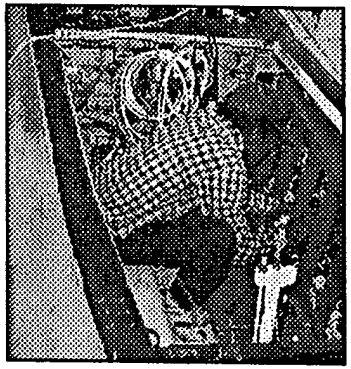
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
17. Pushing or pulling	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • provide power tools which can meet the necessary torque specification • provide racheting tools with multiplying gears to reduce forces • increase handle length to improve leverage		✓ ✓ ✓	med med med	med med med	med med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide attachable knee pads	✓		med	med	med
		• provide a pad or cushion to kneel on	✓			med	med
	• Workstation or workpiece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	med to high	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low (see Figure 1.4)  **Figure 1.4**	124. Raise the work piece/worksurface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on • provide knee pads • provide a pad or cushion to kneel on 8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure 82. Provide adequate workspace • add access panels to increase access • increase the size of access ports to increase access	 ✓ ✓ ✓

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot candles (500-1000 lux) for wrenching tasks • provide a task light which is easy to adjust	✓	✓	high med	high med	high med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY -Chipping	
TASK TITLE: Chipping	
Task Description:	There are many different types of chipping tasks such as: chipping using a jack hammer (size may vary) or chipping using a chipping style bit mount onto a back hoe. The task is performed for varying amounts of time depending on complexity. Typical jobs in which chipping is performed include (not necessarily limited to): • road maintenance and repair. Chipping may be performed on a flat or curved surface such as the flat surface of a roadway vs. the edge of a side walk. Access to the area location may vary due to adjacent barriers such as walls.
Job Performance Measures Most Often Impacted by Chipping:	• Quality of the product (chipping). • Speed of completion of chipping task.
Typical Employee Comments about Chipping:	Employees typically complain about discomfort and/or stiffness in the shoulder/neck, hand/wrist/arm, back and legs/feet. Primary concern: shoulder/neck, hand/wrist/arm. Secondary concern: back, legs/feet.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Vibration Measurement, Biomechanical Lifting Analysis.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
	• Controls and levers within cab of backhoe too far away	38. Move closer to the work location • adjust seat forward	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Pulling hoses is difficult – Hoses caught on equipment – Poor floor surface or standing surface condition	17. Improve floor condition • repair cracks and gaps in floor • free hoses from interference	✓ ✓	✓	med low	low med	med low
	• Pulling controls levers is difficult – Poor control lever maintenance – Poor control lever design	101. Provide controls which do not require excessive forces • contact supplier to investigate adjustable levers and smoother traveling levers		✓	med to high	med	high
	• Carrying and lifting jack hammer	126. Reduce carry distance • transport jack hammer on back of truck from location to location	✓		low	med	med
		• when unloading jack hammer ensure vehicle is next to work area	✓		low	med	med

Shoulder/Neck (Cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location too low for prolonged periods causes strain on the neck (see Figure 1.1)	20. Incorporate rest pauses	✓		low	med	med
		13. Encourage ergonomic work techniques					
		• encourage employee to look up frequently	✓		low	med	med
	Figure 1.1						
	• Work location positioned behind operator when in back hoe	20. Incorporate rest pauses	✓		low	med	med

Hand/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/ repeated wrist movements or repeated forearm rotation	• Control lever location too high (back hoe)	123. Raise the person • adjust seat higher • provide seat cushion	 ✓ ✓		 low low	 med med	 med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Chipping tool must be manually supported or steadied. (see Figure 1.2)	13. Encourage ergonomic work techniques					
		• let tool do the work	✓		low	med	med
		• hands are to act only to maintain alignment	✓		low	med	med
		• keep the tool in as close to a straight upright position as possible.	✓		low	med	med
	Figure 1.2						
	• Duration of holding concentrates stress in hands.	13. Encourage ergonomic work techniques					
		• release grip periodically	✓		low	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter					
		• provide jack hammer with an appropriate hand diameter between 1"-1.5" (2.5-3.8 cm).		✓	med	med	med
		• if tool handle diameter is less than 1", wrap the tool handle	✓		low	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Tool or control levers emit high levels of vibration – Poor tool maintenance	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration	✓		low	med	med
		74. Provide a tool that minimizes exposure to vibration/ impact/torque • provide a tool that creates less vibration		✓	med	med	med
		• modify existing tool; wrap handles with vibration dampening grips	✓		low	med	med
		93. Provide appropriate gloves • provide appropriate anti-vibrating gloves (caution should be used to prevent excessive hand forces)		✓	med	med	med
	– Poor technique	13. Encourage ergonomic work techniques • encourage employee to maintain a "loose" grip	✓		low	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length.		✓	med	med	med
	• Controls lever knobs have hard edges (back hoe)	88. Provide an appropriate handle diameter					
		• provide knobs of at least 1.5" (3.8 cm) and not greater than 3.0" (7.6 cm)		✓	med	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med
		93. Provide appropriate gloves	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Prolonged use of chipping tool	141. Use heavy excavation equipment (e.g., back hoes) • use backhoe with chipping bit on arm for long duration tasks with good access.		✓	med to high	med	high
	• Poor technique causes bending	13. Encourage ergonomic work techniques • encourage employee to maintain tool in upright position	✓		low	med	med
13. Twisting of the lower back	• Work positioned behind worker when in cab (truck)	18. Improve visual access to work • alternative back hoe design.		✓	high	high	high
	• Work location is blocked or too far away	132. Remove obstructions	✓	✓	med	med	med
14. High speed, sudden movements	• Rarely occurs. If so, refer to lifting case study	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Leaning forward in seat	115. Provide support for the lower back			low	med	med
		• modify or adjust existing seat	✓		low	med	med
		• ensure person sits back in seat to utilize back support	✓		low	med	med
		• adjust back support forward	✓				
		• insert additional back support such as a commercial back rest or cushion.		✓	med	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
16. Lifting forces	• Weight of the jack hammer requires high lifting forces when moving or lifting jack hammer	126. Reduce carry distance					
		• closer to work site to unload jack hammer.	✓		low	med	med
		4. Change lifting/carrying task into a rolling or sliding task					
		• slide jack hammer off edge of truck bed slide one end to the ground and then lift jack hammer upright.	✓		low	low	med
		32. Lower the work piece/work surface			med to high		
		• fabricate storage compartment on side of truck to house jack hammer so that it is low.		✓		low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lifting heavy pieces of concrete – low work height – poor hand holds	131. Reduce weight of work piece • break up concrete section into smaller pieces 141. Use heavy excavation equipment (e.g., back hoes) • remove concrete pieces with the aid of a bobcat loader.	✓	✓	low med to high	low med	med high
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Design and maintenance of seat and mounting increases vibration exposure (back hoe)	87. Provide an appropriate chair/stool • seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical 35. Maintain tracks, rollers, and movement mechanisms • repair seat base		✓ ✓	high med	med med	med med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3) **Figure 1.3** • Design or poor condition of foot pedals (industrial equipment) may increase force requirements.	96. Provide appropriate shoe inserts. 50. Provide a foot pedal which requires the correct amount of force to use • repair foot pedals • contact vehicle supplier – 4-10 lb. minimum – 20 lb. maximum	✓ ✓	 ✓ ✓	low med med	med med med	med med med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges • use a cushion to eliminate exposure to pressure point • provide seating with rounded front edge of seat	 ✓	 ✓	 low med	 med med	 med med
21. Awkward leg postures	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					
23. Difficult to see/light levels too low/too high	• Light levels are too low during task	22. Increase light levels • provide a flood light with adjustable intensity	✓	✓	high	high	high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Cleaning by hand (detail work)	
TASK TITLE: Cleaning by hand (detail work)	
Task Description:	There are many different types of cleaning by hand (detail work). Cleaning by hand involves the use of precise hand tools (e.g., picks, small files) to remove bits and pieces of foreign objects. Task duration is dependent on the complexity. Typical jobs in which cleaning by hand (detail work) is performed include: • dental work • cleaning of technical equipment (building masks, microscopes). Cleaning by hand (detail work) may be performed on flat, angled, and upright surfaces, directly on equipment or in confined spaces.
Job Performance Measures Most Often Impacted by Cleaning by Hand (Detail Work):	• Quality of the cleaning (e.g., material removed completely) • Speed of completion of cleaning task
Typical Employee Comments about Cleaning by Hand (detail work):	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• provide a height adjustable chair		✓	med	med	med
		• stand up to perform work task	✓		low	low	low
		• use a step stool, platform or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface		✓	high	med	med
		• provide adjustable table					
		117. Provide support for the upper body					
		• rest arms on nearby surfaces	✓		low	med	med
		• provide height adjustable armrests		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• tilt patient's head towards dental assistant	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low for prolonged periods causes stress on the neck	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table		✓	high	med	med
		• adjust dental chair head support to position patient's head higher	✓		low	med	med
		20. Incorporate rest pauses	✓		low	med	med
		13. Encourage ergonomic work techniques					
		• encourage employee to look up frequently.	✓		low	med	med
	• Work location is positioned flat on work surface (see Figure 1.1)	136. Rotate the work piece					
		• provide a fixture to angle work piece		✓	med	med	med
		• adjust dental chair head support to position patient's head higher	✓		low	med	med
		• ask patient to tilt his/her head towards dental assistant	✓		low	med	med

Figure 1.1

Hand/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using straight cleaning tool on flat horizontal surface	77. Provide a tool with an appropriate handle angle • angle handle of tool		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		42. Obtain patient's assistance	✓		low	med	med
	• Work location is too high	123. Raise the person	✓		low	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
		79. Provide a work surface which is adjustable in height • adjustable table		✓	high	med	med
		28. Lower the (patient's) chair	✓		low	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Task requires repeated motions	66. Provide a power tool		✓	med	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Duration of holding the tool concentrates stress in the hands	20. Incorporate rest pauses	✓		low	med	med
		66. Provide a power tool • to reduce duration		✓	med	med	med to high
	• Handle diameter is too small (see Figure 1.2)	88. Provide an appropriate handle diameter • provide cleaning tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med

Figure 1.2

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle grip is not compressible	54. Provide a high friction gripping surface • wrap tool with compressible grip • provide tool with a compressible handle (Caution: provide compressible grips which can be sterilized)	✓	✓	low med	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Design or poor condition of tool emits high levels of vibration	34. Maintain hand tool/power tool • inspect and repair tool on a regular basis to eliminate unnecessary vibration 74. Provide a tool that minimizes exposure to vibration/ impact/torque • provide a tool that emits less vibration	✓	✓	low to med med	med med	med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Work station has hard or square edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓ ✓		low low	med med	med med
11. Hands and fingers exposed to cold temperatures	• Frequent washing of hands in cold water may be an exposure source	13. Encourage ergonomic work techniques • wash hands in warm water 93. Provide appropriate gloves	✓ ✓		low low	med low	med low
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for the work piece • raise the dental chair higher		✓ ✓ ✓	med high low	med med med	med med med

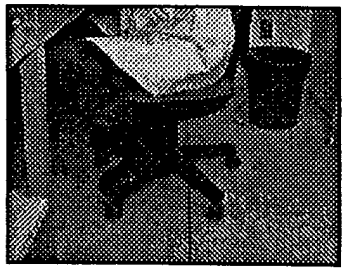
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for the work piece		✓	high	med	med
		• raise the dental chair higher	✓		low	med	med
	• Work location is too far away	41. Move work piece closer to body	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• angle the patient's head towards the dental assistant	✓		low	med	med
		117. Provide support for the upper body		✓	med to high	med	med

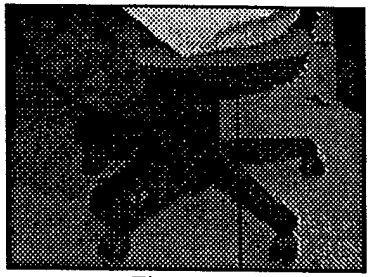
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• adjust back rest to support the lower back	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	96. Provide appropriate shoe inserts	✓		low	med	med
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square (see Figure 1.3)  Figure 1.3	87. Provide an appropriate chair/stool					
		• use a cushion to eliminate exposure to pressure point	✓		low	med	med
		• provide seating with rounded front edge of seat		✓	med	med	med
	• Under surface of work is square	9. Eliminate exposure to hard edges					
		• use padding to cover square edge	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Leg room is limited under work surface (see Figure 1.4) Figure 1.4	138. Stand to perform task	✓		low	med	med
		79. Provide a work surface which is adjustable in height • provide work surface with adequate vertical and forward leg room	✓	✓	low to high	med	med
	• Feet are unsupported when seated. (see Figure 1.5)  Figure 1.5	52. Provide a footrail or footrest	✓	✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	31. Lower the person • provide a chair/stool to sit on	✓	✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Cleaning - High Pressure	
TASK TITLE: Cleaning - High Pressure	
Task Description:	Washing an aircraft involves applying an aqueous, somewhat slippery, wash solution to the body of the aircraft, scrubbing the aircraft, washing the solution off, and repeating. Power wash equipment is available and is used for much of the operation. However, parts of the cleaning operation require manual labor such as setting up or adjusting the cleaning equipment; donning the personal protective equipment; and, hauling much of the equipment (high pressure nozzles, scrub brushes, squeegees, fluid containers, etc.). Typical jobs in which Cleaning with high pressure equipment is performed include: • air craft cleaning • cleaning large and small industrial equipment • cleaning the outside of facilities. This case study can be applied to washing done on horizontal, vertical, or overhead surfaces on aircraft, and heavy industrial equipment.
Job Performance Measures Most Often Impacted by Cleaning - High Pressure:	• Quality of the washing job • Speed of completion of the washing task
Typical Employee Comments about Cleaning - High Pressure:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands /wrists/arms, and legs/feet. Primary: All body parts listed above are primary concerns.
Suggested Level II Analysis:	NIOSH lifting equation (for lifting demand of the job), Dynamic Task Analysis; Grip Force Measurement.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
1. Reaching	• Work location is too high	123. Raise the person • provide an adjustable platform or scaffolding		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		136. Rotate the work piece • use rotating adjustable platform to house and position industrial parts for cleaning		✓	high	high	high
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Pull hoses – Poor housekeeping – Poor floor condition	17. Improve floor condition • repair cracks or gaps in floor • improve housekeeping	✓	✓	high low	med med	med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
	• High pressure sprayer must be manually supported, held or steadied (see Figure 1.1) **Figure 1.1**	20. Incorporate rest pauses 116. Provide fixture • attach/pivot spray gun on a tripod	✓	 ✓	low med	med med	med high
3. High speed movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low or too high	13. Encourage ergonomic work techniques • incorporate rest pauses	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is too high	123. Raise the person • use an adjustable platform or scaffolding		✓	high	med	high
	• Lack of support for tool means employee must bend wrist to direct spray	116. Provide fixture • support/pivot spray gun on tri-pod		✓	med	med	high
	• Handle shaped trigger requires wrist to bend to direct spray	77. Provide a tool with an appropriate handle angle • modify tool handle		✓	med	med	med
6. Repeated manipulations with fingers	• Tightening bolts or screws with a wrench or with the fingers can cause repetitive finger movements	66. Provide a power tool • use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening and final check).		✓	med	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger concentrates stress (see Figure 1.2) Figure 1.2	62. Provide a multi-finger trigger • extend current trigger • provide a tool with a multi-finger trigger		✓ ✓	med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
8. Hand/grip forces	• High pressure sprayer handle must be manually supported, held or steadied	54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		116. Provide support for the tool • support/pivot spray gun on tri-pod		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a sprayer of minimal weight		✓	high	high	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
	• Trigger required constant holding	62. Provide multifinger trigger • incorporate latch mechanism into trigger design (must comply with safety requirements)		✓	med	med	high

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Tool emits high levels of vibration	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration	✓		low	med	med
		• wrap handles with vibration dampening grips	✓		low	med	med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med
		• wrap handles with padding	✓		low	med	med
11. Hand and fingers exposed to cold temperatures	• Work area is too cold	110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		low	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med

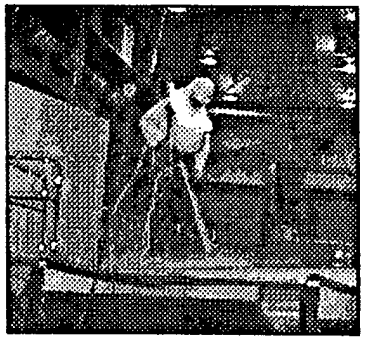
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	31. Lower the person • provide a mobile chair or stool to sit on (e.g. under wing areas) • kneel or squat for short durations when working at low levels (provide adequate knee protection)	✓ ✓	✓	med low	med med	med med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions from the work area 136. Rotate the work piece • provide a rotating platform that locks into position to allow small pieces to be rotated.	✓	✓	low high	med high	med high
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back positions	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
16. Lifting forces	• Refer to Lifting case study						
17. Pushing or pulling	• Initial setup requires movement of heavy equipment	48. Provide a cart • provide a powered cart to carry and move the equipment		✓	med	med	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3)  Figure 1.3	96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low	31. Lower the person • provide a chair or stool to sit on	✓	✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • provide adjustable intensity flood light • increase room lighting		✓ ✓	med high	high high	high high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Coating/Immersing	
TASK TITLE: Coating/Immersing	
Task Description:	Coating/Immersing involves dipping parts into dip tanks to apply a coating. Part weight and size can vary considerably. The task is typically performed in a standing position. Since the liquid in the dip tanks may be caustic, hangar/fixtures are used to immerse the parts. Small parts may be secured to hangars using small clips. Large parts may simply be hung on a hook. Coating/immersing is performed in (not necessarily limited to): • general maintenance areas. In this case study, the assumed situation is that the operator is required to hold the hangar and move the parts in and out of the dip tanks. In Air Force applications, this job is expected to be low volume.
Job Performance Measures Most Often Impacted by Coating/Immersing:	• Quality of surface finish. • Quality of work.
Typical Employee Comments about Coating/Immersing:	The most common complaint from employees is discomfort and/or stiffness in the hands/wrists/arms and shoulders/neck.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Biomechanical Lifting Analysis

Shoulders/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Loading height is too high • Sides of dip tanks are too high	123. Raise the person • provide a fixed platform to elevate worker for all dip tanks		✓	high	med	high
		32. Lower the work surface • lower the height of the dip tanks (should be no higher than 30" (76cm) above the floor.		✓	high	med	high
	• Raising and lowering of hangers	61. Provide a mechanical lift device • provide an overhead manual pulley system above tanks to raise and lower hangars		✓	med	med	med
	• Absence of tow space	80. Provide adequate leg clearance • provide toe space of 6" X 6" (15 cm X 15 cm)		✓	high	med	high
2. Arm forces: Repeated arm forces or holding/carrying materials	• Repeated manual dipping of large parts	61. Provide a mechanical lift device for dipping large components • provide an overhead hoist with a basket attachment for dipping parts		✓	high	med	med
		• provide an overhead manual pulley system.		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Design of the dipping tool causes wrist movements while dipping parts	77. Provide a tool with an appropriate handle angle • provide a dipping tool which allows the person to keep the wrist straight while dipping		✓	med	med	med
	• Design clamps on hanger may require wrist movements to tighten	140. Use alternative fasteners • use lockable clamps; avoid the use of pressure or screw-down clamps		✓	high	med	high
6. Repeated manipulations with fingers	• Tasks are hand-intensive	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety • alternate dipping big parts with small parts	✓		low	med	med
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Person is holding hanger or part	118. Provide support for the work piece • provide an overhead stationary hook to hanger part above tank as it drains	✓	✓	med	med	med
	• Inappropriate design of clamps for small parts	140. Use alternative fasteners		✓	high	med	high
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is cold	93. Provide appropriate gloves (must be safe for use in area with liquid/caustic materials)		✓	med	med	med

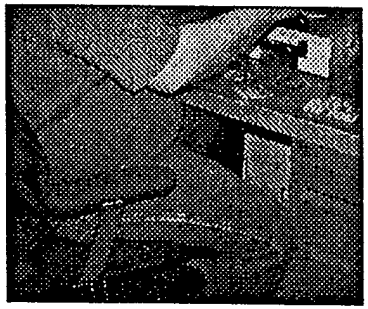
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Loading height is too high • Sides of dip tanks are too high	123. Raise the person • provide a fixed platform to elevate worker for all dip tanks		✓	high	med	high
		32. Lower the work surface • lower the height of the dip tanks (should be no higher than 30" (76 cm) above the floor).		✓	high	med	high
13. Twisting of the lower back	• Raising and lowering of hangers	61. Provide a mechanical lift device • provide an overhead manual pulley system above tanks to raise and lower hangers		✓	med	med	med
	• Absence of toe space	80. Provide adequate leg clearance • provide toe space of 6" x 6" (15 cm x 15 cm)		✓	high	med	high
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Manual holding of parts/hanger above dip tank while fluid drains	118. Provide support for the work piece. • provide an overhead stationary hook to hang part above dip tank.	✓	✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Repeated manual dipping of large parts	61. Provide a mechanical lift device • provide an overhead hoist with a basket attachment for dipping parts • provide an overhead manual-pulley-system to raise and lower hangars		✓ ✓	med med	med med	med med
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	96. Provide appropriate shoe inserts	✓		low	low	low
		143. Wear appropriate shoes	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Knees press against front of dip tank (see Figure 1.1)  **Figure 1.1**	9. Eliminate exposure to hard edges • cover surface with rubber	✓		low	low	low
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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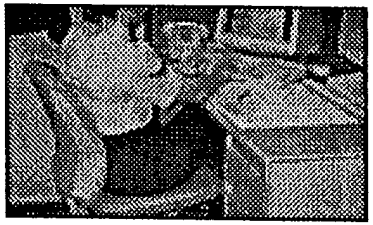
CASE STUDY - Computer Work	
TASK TITLE: Computer Work	
Task Description	Computer work involves the use of a computer to perform a variety of tasks related to maintenance and inspection activities. Computer work typically involves the use of a keyboard and, sometimes, an additional input device (e.g. a mouse or trackball). Typical jobs in which computer work is performed include (not necessarily limited to): • computerized record keeping • tracking of preventative maintenance inspections (PMIs) • ordering parts • writing reports and memos Computer work may be performed at a seated or standing work station or (via a laptop or a palmtop computer) in a variety of locations. In the maintenance inspection environment the issues or ergonomic concerns associated with computer work are generally less significant than for administrative areas since the duration of the task is lower. The key issues are discussed here for additional detail the user is directed to the computer work case study contained in the Level I Guide for Administrative Work Areas
Job Performance Measures Most Often Impacted by Using a Computer:	• Speed of completion of tasks. • Error free completion of tasks.
Typical Employee Comments about Using a Computer:	For computer work, employees typically complain about discomfort and/or stiffness in the hands/wrists, arms, shoulders/neck, and head/eyes. The primary body regions affected are: head/eyes, hands/wrists/arms, and shoulder/neck. The secondary body regions affected are: back/torso and legs/feet.
Suggested Level II Analysis:	Postural analysis, light level analysis.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Keyboard/mouse too high. (see Figure 1.1)  **Figure 1.1**	32. Lower the work surface • set the height of the keyboard/mouse support surface so that the person's elbows are at the same height as the keyboard	✓		low	low	med
		• position the mouse at the same height as the keyboard	✓		low	med	med
		123. Raise the person	✓		low	low	med
		120. Raise the chair • set the height of the chair so that the person's elbows are at the same height as the keyboard or mouse Note: in some cases, a footrest will be required in order to support the person's feet	✓		low	low	med
	• Chair positioned too far away	38. Move closer to the work location • move chair closer to keyboard/ edge of work surface	✓		low	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Lack of leg clearance under desk.	80. Provide adequate leg clearance • remove clutter from under work surface. • remove cross beams if possible to increase clearance	✓		low	low	low
				✓	med	low	low
	• Arms of chair or other obstructions interfere with moving chair closer (see Figure 1.2)	132. Remove obstructions • remove or adjust armrests, pencil drawers or other obstructions if they prevent the person from moving close enough to the work station	✓		low	med	med
	• Mouse/input device is too far away from the body • Mouse not positioned next to keyboard.	44. Place the mouse/input device next to the keyboard • position mouse next to keyboard • position mouse and keyboard so the forearm can be rested on the work surface while keying and mousing	✓ ✓		low low	low low	med med

Figure 1.2

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Keyboard tray is too small	44. Place the mouse/input device next to the keyboard					
		• Replace the current keyboard tray with a tray which accommodates a mouse/input device and a keyboard		✓	med to high	med	med
		• add an attachment or extension to the side of the current tray	✓		low	med	med
	• Items used frequently not positioned close to the body.	41. Move work piece closer to body					
		• Items which are used every few minutes or more should be placed close to the body	✓		low	low	med
	• Employee is not conscious of poor work habits.	13. Encourage ergonomic work techniques	✓		low	low	med
		• encourage person to minimize reaching by arranging materials and documents according to frequency of use	✓		low	low	med
		• help person understand how to adjust the chair properly	✓		low	low	med
		• encourage person to take frequent rest pauses			low	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Cradling of phone between the head and shoulder	73. Provide a telephone headset • provide a selection of head set types to choose from (e.g., over-the-head, over-the-ear) for employees who must key and talk on the phone for prolonged periods		✓	med to high	med	high
		• encourage employee to hold the phone with their hand	✓		low	med	med
		• discourage employee from talking on the phone while keying	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Document positioned flat on work surface	111. Provide support for reference documents					
		• provide a document holder		✓	med	low	med
		• position document at the same height and angle as the monitor.	✓		low	low	med
		• if document is handled, flipped or written on, an inclined work surface is preferred.	✓		low	low	med
		• place document on side of dominant eye.	✓		low	low	med
	• Monitor positioned too low	122. Raise the monitor/screen - monitor should be positioned such that the top of the screen is between 0-4" (0-10 cm) below eye height:	✓		low	med	med
		• use a monitor riser, CPU/hard drive, or other stable surface to position monitor at the correct height					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor positioned too high (head tipped backwards) (see Figure 1.3)	30. Lower the monitor/screen					
		• monitor should be positioned such that the top of the screen is between 0-4" (0-10 cm) below eye height:	✓		low	med	med
		• remove the hard drive from under the monitor	✓		low	med	med
		• use a monitor riser, or other stable surface to position monitor at the correct height	✓		low	med	med
	Figure 1.3						
	• Monitor and keyboard not aligned due to inadequate work station depth	45. Position the monitor/screen in front of the body					
		• position monitor so that it is directly behind the keyboard - this allows the body to be in alignment and prevents twisting of the neck	✓		low	med	med
		• provide a work surface that is deep enough to support the keyboard and the monitor screen. For large monitors, this indicates a work surface which is at least 30" (76.2 cm) deep.		✓	med	med	med
		• provide a work surface that is large enough for computer and paper tasks.		✓	med to high	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor is too high for bifocal user.	100. Provide computer glasses • provide monofocal computer glasses		✓	med	med	med
		30. Lower the monitor/screen for bifocal users, place monitor directly on the work surface so that the head is upright not tilted back	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Keyboard/mouse too high.	32. Lower the work piece/work surface • if the work surface/keyboard tray is adjustable in height, lower/set the height of the keyboard/mouse support surface so that the person's elbows are at the same height as the keyboard/mouse	✓		low	low	med
		120. Raise the chair • set the height of the chair so that the person's elbows are at the same height as the keyboard or mouse Note: in some cases, a footrest will be required in order to support the person's feet	✓		low	low	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Keyboard is sloped towards the person	49. Provide a flat/level keyboard (note: "flattening" the keyboard can help flatten the wrist)					
		• lower the feet on the back of the keyboard	✓		low	low	med
		• adjust the keyboard support surface so the keyboard is flat and level	✓		low	low	med
	• Resting wrists inappropriately on front edge of keyboard or on wrist rest	13. Encourage ergonomic work techniques					
		• maintain straight wrists while keying and while resting the hands	✓		low	low	med
		• rest hands on arm rests of work surface in between data entry tasks	✓		low	low	med
		65. Provide a palm rest	✓		low	low	low
		• palm rests provide a place to rest hands in between sets of key strokes. Encourage the person to avoid resting the hands on the palm rest while keying					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Using wrist movement to move mouse rather than arm movement	13. Encourage ergonomic work techniques • encourage person to use a forearm movement to move the mouse rather than a wrist movement	✓		low	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Keying or mousing habits (e.g., repetitive stretching of thumb to use space bar)	13. Encourage ergonomic work techniques • encourage person to practice keeping the hands and fingers in a relaxed position	✓		low	med	med
		• keep the wrists straight and flat	✓		low	med	med
		• keep the fingers together and slight curved	✓		low	med	med
		• use the forearms to move around on the keyboard instead of "reaching" with fingers	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Keying/typing speed and length of task.	11. Eliminate unnecessary tasks • program macro keys to reduce keying.	✓		low	low	med
	• Length of task without a work break.	28. Incorporate rest pauses	✓		low	med	med
		33. Increase task variety	✓		low	med	high
	• Person has tendency to grasp mouse too hard	13. Encourage ergonomic work techniques • encourage person to practice keeping a light grip on the mouse	✓		low	med	med
	• Keys feel stiff; require excessive force to activate	56. Provide a keyboard which does not require excessive keying forces		✓	high	med	med
	• Keys lack appropriate tactile and auditory feedback ("click").	• maintain or replace keyboard					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Individual rests wrists on edge of work surface.	9. Eliminate exposure to hard edges	✓		low	med	med
		• move keyboard forward so forearms rest evenly on surface	✓		low	med	med
		• for keyboard use, provide a palm rest	✓		low to med	med	med
		• eliminate the hard edge by replacing the hard edge with a "bull-nose"/rounded edge					
	• Not enough room on work surface to support forearm for mousing.	24. Increase size of work surface		✓	med	med	med
		• install keyboard tray that accommodates mouse, keyboard					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		23. Increase room temperature		✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Reaching for items too far from body.	41. Move work piece closer to body • move documents and other reference materials into work zone.	✓		low	med	med
	• Chair arms interfere with moving chair closer.	132. Remove obstructions • remove or lower armrests.	✓		low to med	med	med
13. Twisting of the lower back	• Leg obstructions • Restricted leg clearance	80. Provide adequate leg clearance • eliminate leg obstructions	✓		low	med	med
	• Monitor and keyboard not aligned • Monitor in the corner of desk • Inadequate work station depth • Inadequate work space	45. Position the monitor/screen in front of body • position monitor so that it is directly behind the keyboard this allows the body to be in alignment and prevents twisting of the neck	✓		low	med	med
		• provide a work surface which is deep enough for a monitor and a keyboard. (at least 30" (76.2 cm) in depth is preferred, 36" (91.5 cm) for larger monitors)		✓	low to high	med	high
		If paper and computer tasks are performed at the same work station, provide a work surface which is large enough for both tasks		✓	low to high	med	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Rarely occurs	• N/A					
15. Static, awkward back postures	• Monitor greater than 30" (76 cm) from eye causes the person to lean forward to read monitor	41. Move work piece closer to body • position monitor between 18 and 30" (46-76 cm) from eyes 22"-24" (56-61 cm) is a good distance for many people 18. Improve visual access to work • increase font size of text - font size of at least 12 point is recommended for screen distances of 18"-30" (46-76 cm). - font sizes of greater than 12 point are recommended for screen distances of greater than 30" (76 cm)	✓ ✓		low low	med low	med low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back • pull chair forward and lean back while working • attach a small pillow to back rest to support lower back • provide a chair with adequate lower back support	 ✓ ✓ ✓ 	 ✓	 low low low high	 med med med med	 med med med med
	• Keyboard is too low • Mouse/input device is too low • Documents are too low • Chair too high	124. Raise the work piece/work surface • raise the fixed table with risers • provide an adjustable table 31. Lower the person • provide a chair/stool to sit on 28. Lower the chair • adjust the chair height lower to reduce the need to lean forward	 ✓ ✓ ✓	 ✓ 	 low high low to med low	 med med med med	 med high med med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Person tends to lean forward while working	13. Encourage ergonomic work techniques					
		• Encourage person to sit back and relax while working	✓		low	med	med
		• Encourage person to push his or her chair toward the work station in order to reduce the tendency to bend	✓		low	med	med
	• Keyboard or paperwork is too far away	38. Move closer to the work location					
		• pull the chair closer to the work station	✓		low	med	med
		• stand closer to the work station	✓		low	med	med
		41. Move the work piece closer to the body					
		• move the keyboard closer to the body	✓		low	med	med
	• Seat pan on chair is too deep	115. Provide support for the lower back					
		• attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		• provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate foot support prevents person from obtaining proper back support • Chair too high causes person not lean against back rest	52. Provide a footrail/footrest • provide a footrest which allows both the heels and toes to be supported - a box or several ring binders taped securely together can also be used (for additional information on footrest design refer to Level I Guide for Administrative Work Areas	✓		low	low	low
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing on hard surfaces	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts • inserts should be made of a high performance material such as a gel filled or viscous-damping media that is durable (open-cell foam inserts tend to break-down quickly and lose ability to distribute forces)	✓		low	low	low
	• Inadequate foot support	52. Provide a footrail/footrest • provide a footrail which allows the person to rest one foot at a time		✓	low	low	low
	• Seat pan which is too deep causes pressure on back of legs	115. Provide support for the lower back • attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	high	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
20. Exposure to hard edges on legs, knees, and feet	• Hard edge on front of seat pan	64. Provide a compressible, padded surface to sit on					
		• provide a cushion for the seat pan to prevent contact with hard edge	✓		low	med	med
		• provide a chair with a rounded front edge on the seat pan		✓	high	med	med
	• Seat pan which is too deep causes pressure on back of legs	115. Provide support for the lower back					
		• attach a pillow to back rest to decrease the seat pan depth and support the lower back	✓		low	med	med
		• provide a chair with an adequate/adjustable seat pan depth and adequate lower back support		✓	high	med	med
21. Awkward leg postures	• Inadequate foot support causes legs to be tucked back or causes person to cross legs	52. Provide a footrail/footrest - provide a footrest which allows both the heels and toes to be supported - a box or several ring binders taped securely together can also be used	✓		low	low	low
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off monitor or other shiny surfaces.	109. Provide protection from glare from overhead lights/task lights					
		• provide screen hood/visor.	✓		low	med	med
		• position monitor between rows of overhead lights.	✓		low	med	med
		• tilt monitor down so that it is parallel to the floor.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off monitor or other shiny surfaces.	109. Provide protection from glare from overhead lights/task lights					
		• direct task light away from screen and eyes.	✓		low	med	med
		• turn off the task light	✓		low	med	med
		• move monitor screen out from underneath fixed task lights	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off monitor or other shiny surfaces.	108. Provide protection from glare from natural light • orient work station so that the monitor screen is perpendicular to the window. • adjust window coverings • provide window coverings	✓ ✓	 ✓	low low med to high	med med med	med med med
	Light levels too high: in particular, for computer tasks (for more detail on the impact of lighting, refer to Level I Guide for Administrative Work Areas)	27. Lower the light levels • 20-50 fc (200-500 lux) is an appropriate range of light levels for computer tasks. • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels are too low: in particular, for reading tasks	22. Increase light levels • provide task light (50-100 fc is an appropriate range of light levels for reading tasks) • increase overall light levels to meet the lighting needs of computer and paper tasks (50 fc is an appropriate light level where both computer and paper tasks are performed)		✓ ✓	med med	med med	med med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Uncorrected visual disorders cause the person to lean forward to read monitor or documents	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Font/character size too small to read on computer screen.	18. Improve visual access to work • increase font size of text font size of at least 12 point are recommended for screen distances of 18"-30" (46-76 cm). font sizes of greater than 12 point are recommended for screen distances of greater than 30" (76 cm)	✓		low	med	med
	• VDT screen dirty.	18. Improve visual access to work • clean screen regularly.	✓		low	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Crimping	
TASK TITLE: Crimping	
Task Description:	Crimping involves using a manual or power tool to compress two pieces of metal or wire together with a metal band/strap or compress an aluminum connector onto the end of a piece of wire. The manual crimper often resembles a pair of pliers and is commonly used in field applications or on aircraft (fixed work locations). The power crimper is often powered by hydraulic or electrical methods. Typical jobs in which crimping is performed include (not necessarily limited to): • aircraft maintenance • utilities maintenance/installation • electronics maintenance
Job Performance Measures Most Often Impacted by Crimping:	• Quality of crimp (strength) • Speed of task completion
Typical Employee Comments about Crimping:	Employees typically complain about discomfort or stiffness in the following areas: hands/wrists/arms and shoulders/neck. The primary body parts affected are typically: hands/wrists/arms The secondary body parts affected are typically: shoulders/neck
Suggested Level II Analysis:	Grip Force Measurement, Elemental Task Analysis

Shoulder/Neck

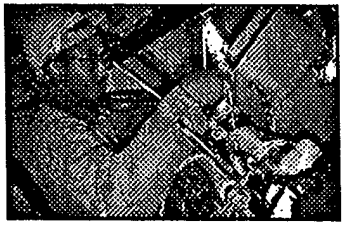
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	Work location is too high	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is too far away (see Figure 1.1)	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med

Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work surface is too high or too low (see Figure 1.2) Figure 1.2	123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface 136. Rotate the work piece • turn the work piece so the wrist can be straight while using crimper	✓ ✓ ✓	✓ ✓ ✓	med med med low	med med med med	med med med med

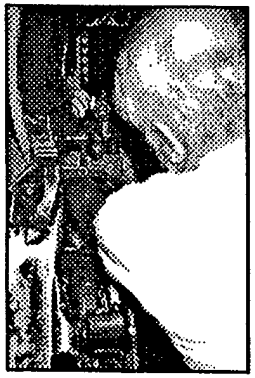
Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is too high (see Figure 1.3)  **Figure 1.3** • Work orientation is awkward	66. Provide a power tool 123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface 136. Rotate the work piece • manually turn the work piece so the wrist can be straight while using crimper	✓	✓ ✓ ✓	med med med med	med med med med	med med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single trigger concentrates stress • Handle span is too large on manual tool • The pliers type tool does not have a spring between the shafts of the handle	62. Provide a multi-finger trigger • extend current trigger 77. Provide a tool with an appropriate handle angle • achieve a smaller span 70. Provide a spring release mechanism on pliers-type tools		✓ ✓ ✓	low to med med low to med	med med med	med med med

Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture to support work piece		✓	med	med	med
		76. Provide a tool which requires minimal force to use • provide a manual tool that crimps with a ratchet mechanism		✓	med	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque		✓	med	med	med
	• Handle span is too large	88. Provide an appropriate handle diameter • provide a tool handle with a compressible grip surface		✓	med	med	med
		• provide a tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8cm).		✓	med	med	med
	• The type of tool is not appropriate for the amount of crimping (frequency or effort) that must be performed	66. Provide a power tool		✓	med	med	med

Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• The work piece must be moved and turned	118. Provide support for the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	high
		• use clamps to hold surrounding wires away from the wire/area where crimping must occur	✓		low	med	high
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges (see Figure 1.4)  Figure 1.4	94. Provide appropriate handles					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7 cm) in length		✓	med	med	med

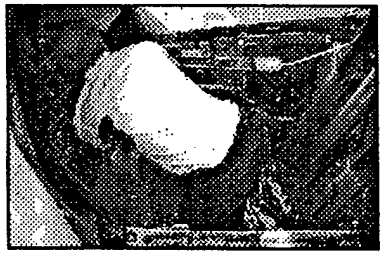
Hands/Wrist/Arm-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	 ✓ ✓		 low low	 med med	 med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓	med low	med med	med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface is too high/too low (see Figure 1.5) **Figure 1.5**	123. Raise the person • provide a step stool • provide an adjustable platform 32. Lower the work piece/work surface • extend wire length, if appropriate to lower the work (crimp) height; raise completed bundle when finished	✓	✓ ✓ ✓	med med med	med med med	med med med
	• Finish quality must be visually inspected	22. Increase light levels • provide task lighting that is easy to adjust • ensure that light levels are 200-250 lux (20-25 foot-candles)		✓ ✓	med med	med high	med high

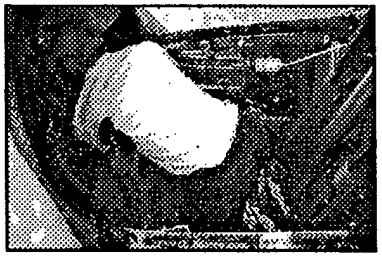
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Work space is cramped or access is limited (see Figure 1.6)  **Figure 1.6**	117. Provide support for the upper body • provide a pad/mat • provide a device to support the upper part of the body 38. Move closer to the work location • remove panel or sheet metal to provide additional access	✓	✓ ✓	low med to high med	med med high	med high low
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Chair is inadequate	87. Provide an appropriate chair/stool	✓	✓	med	med	med
	• Work surface is too low (see Figure 1.7)	124. Raise the work piece/work surface	✓	✓	med	med	med
	Figure 1.7						
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges (see Figure 1.8)  **Figure 1.8**	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges		✓	med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					
21. Awkward leg postures	• Work surface is to low	124. Raise the work piece/ work surface	✓	✓	med	med	med
		31. Lower the person • provide a stool to sit on	✓	✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Cutting/Shearing	
TASK TITLE: Cutting/Shearing	
Task Description:	Cutting/shearing involves using hand shears, powered hand shears, manual or powered table-top cutting boards to cut materials. Hand cutting/shearing typically occurs at a work bench or table. Using the cutting board sometimes involves carrying and holding the material. Typical jobs in which cutting/shearing is performed include (not necessarily limited to): • sheet metal fabrication
Job Performance Measures Most Often Impacted by Cutting/Shearing:	• Efficient completion of work • Minimal errors/dimensional accuracy
Typical Employee Comments about Cutting/Shearing:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms (from operating a manual hand shear) and legs/feet (from using manual foot control to operate table top cutting board. Primary: Hands/Wrists/Arms Secondary: Legs/Feet
Suggested Level II Analysis:	Grip Force, Dynamic Task Analysis

Shoulders/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too far away from worker	21. Increase handle length to improve leverage • lengthen handle to increase leverage		✓	med	med	med
	• Work location is too high	32. Lower the work piece/work surface	✓	✓	med	med	high
	• Operation of the table-top cutter involves shoulder movements	123. Raise the person	✓	✓	med	med	high
		66. Provide a power tool • provide a powered cutter • use a cutting board instead of manual hand shear		✓ ✓	med med	med med	med high
2. Arm forces: Repeated arm forces or holding/carrying materials	• Manual shears require high forces	34. Maintain hand tools/power tools • sharpen shears or replace cutting surfaces regularly	✓		low	high	med
		• lubricate and adjust moving parts to reduce forces	✓		med	med	med
		21. Increase handle length to improve leverage • lengthen handle to increase leverage		✓	med	med	med
		66. Provide a power tool • provide a power cutter		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Angle of handles on scissors	77. Provide a tool with an appropriate handle angle • provide shears with a handle orientation which allows a more straight wrist while cutting		✓	med	med	med
	• Using hand shears on horizontal surface	136. Rotate the work piece • angle the work piece (e.g., incline upward, drafting table style) to improve wrist posture	✓		low	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of powered hand shear with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extended current trigger • provide an appropriate tool with a multi-finger trigger • provide an automatic cut repeat to eliminate constant hold down of trigger	✓	✓ ✓ ✓	med med med	med med med	med med med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Inappropriate use of manual tool for repetitive or forceful task	66. Provide a power tool • provide a powered cutter • use cutting board instead of manual and sheat		 ✓ ✓	 med med	 med med	 med high
	• Handle diameter is too large	88. Provide an appropriate handle diameter • handle diameter between 1-1.5" (2.5-3.8 cm) on power tool		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for power tool		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Hard/sharp edges present on work station or work piece	9. Eliminate exposure to hard edges	✓		low	med	med
		• round off edges	✓		low	med	med
		• covering hard edges					
		93. Provide appropriate gloves		✓	med	med	med
	• Tool handle has sharp edges	9. Eliminate exposure to hard edges		✓	med	med	med
		• provide shear handles with round, smooth, compressible grips		✓	med	med	med
		• provide shear handle sizes with adequate space for fingers for persons with large hands	✓		low	med	med
		• wrap handles with padding					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work surface too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece	✓	✓ ✓	med med	med high	med high
	• Location of work too low	31. Lower the person • provide a chair/stool to sit on	✓	✓	med	high	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• If occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Excessive stroke or travel of manual foot lever	50. Provide a foot pedal which requires the correct amount of force to use • provide electric or power foot pedal		✓	med	med	high
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights. • remove glossy or shiny surfaces from work area • place the work station so that it faces a wall or partition. • install parabolic louvers to direct light down on the surface.	✓ ✓ ✓	 ✓ ✓	low low med high	med med med med	med med med med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window. • adjust window coverings • provide window coverings	✓ ✓	 ✓	low low med to high	med med med	med med med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare. • turn off the task light. • shield task light to prevent it from shining into eyes.	✓ ✓	 ✓	low low low to med	med med med	med med med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Drilling	
TASK TITLE: Drilling	
Task Description:	The task is performed for varying amounts of time depending on the complexity of the task. The task can be performed on wood, metal, plastic, rock or other material. The size of the drill bit will vary with the size of hole or bolt required. The effort associated with the task is often a function of; bit type and condition, speed and power of the drill, material type and technique.
Job Performance Measures Most Often Impacted by Drilling:	There are many different types of drilling processes such as electric drill and drill press. Typical jobs in which drilling is performed include: • metal fabrication • carpentry • assembly and repair Drilling may be performed on flat or upright surface directly on aircraft, equipment, bench tops, and on a variety of surface shapes.
Job Performance Measures Most Often impacted by Drilling	• Quality of drilling (e.g., straightness of hole) • Speed of completion of drilling task
Typical Employee Comments about Drilling:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulder/neck, hands/wrists/arms, back/torso, legs/feet or head/eyes. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool, platform or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Drill must be manually supported, held or steadied (see Figure 1.1)	117. Provide support for the upper body					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
	Figure 1.1						
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Drilling is performed on flat work surface	103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		136. Rotate work piece (bench work) • turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • provide a drill tool with an in line grip or 90° off-set grip		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Improper bit/material combination • Inadequate drill or speed • Poor technique	76. Provide a tool that requires minimal force to use • provide an alternative drill bit design		✓	med	med	high
		13. Encourage ergonomic work techniques • let the tool do the work	✓		low	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface (bench work) • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	med	med	med
		• raise platform of drill press	✓	✓	med	med	med
		31. Lower the person • provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		13. Encourage ergonomic work techniques • educate worker to look up frequently	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	med	med	med
		32. Lower the work piece/work surface	✓	✓	low to med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	low med	low med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace • increase the size of access ports to increase access		✓	high	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using pistol grip drill on horizontal surface	136. Rotate work piece (bench work) • rotate the work piece manually • provide a fixture to allow the work piece to be rotated	✓	 ✓	 low med	 med med	 med med
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	82. Provide adequate workspace • increase the size of access ports to increase access		✓	high	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder • provide an adjustable platform or scaffolding	✓	✓ ✓	med med	med med	med med
		32. Lower the work piece/work surface	✓	✓	low to med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of drill with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extend current trigger • provide a multi-finger trigger tool (e.g., enough surface for two fingers)	✓	✓ ✓	med high	low med	med med
8. Hand/grip forces	• Drill tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	high	med	med
		54. Provide a high friction gripping surface • wrap the tool handle with a compressible grip surface	✓		low	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a drill of minimal weight		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with handle diameter between 1"-1.5" (2.5-3.5 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Design or poor condition of tool may expose employee to high levels of vibration	34. Maintain hand tools/power tools • inspect and repair tool on a regular basis to eliminate unnecessary vibration. 74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a tool that emits less vibration	✓	✓	low med	med med	med med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length		✓ ✓	med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges					
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	high	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	med	med	med
		• raise platform of drill press	✓	✓	low	med	med
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece manually	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated		✓	med	med	low
	• Work space or access is limited	117. Provide support for the upper body					
		• provide a pad/mat	✓		low	med	med
		• provide a device to support the upper body while welding (see illustration)		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		8. Distribute intensive activities throughout the process	✓	✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body					
		• provide a device to support the head and upper body while the person is working		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location	✓		low	low	low
		32. Remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated	✓		med	med	low
		8. Distribute intensive activities throughout the process		✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body		✓	med	med	med
		• provide a device to support the head and upper body while the person is working					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support (see Figure 1.2) **Figure 1.2**	115. Provide support for the lower back • pull chair forward and lean back while working • adjust back rest to support lower back • attach a small pillow to back rest to support lower back • provide chair with lower back support	✓ ✓ ✓	 ✓	 low low low med	 low low med med	 low low med med
16. Lifting forces	• Initial setup may require the placement of the part on the workbench.	61. Provide a mechanical lift device • provide a hoist to place the unit on the workbench		✓	high	med	med
17. Pushing or pulling	• Initial setup requires movement of heavy equipment	48. Provide a cart • provide a powered cart to carry and move the equipment		✓	med	med	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3) **Figure 1.3**	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges					
		• use a cushion eliminate exposure to pressure point	✓		low	med	med
		• provide chair with rounded front edge of seat		✓	med	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	high	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface (bench work)					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	med	med	med
		31. Lower the person					
		• provide a chair/stool to sit on	✓		low	med	med
		8. Distribute intensive activities throughout the process		✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low for task	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting		✓ ✓	med high	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Driving	
TASK TITLE: Driving	
Task Description:	Driving may be involved when operating commercial vehicles (automobiles, trucks, and vans), industrial equipment (paving equipment, backhoes, riding lawnmowers and graders) and recreational vehicles (snowmobiles and quads). Typical jobs in which driving is performed include (not necessarily limited to): • road maintenance and repair • lawn maintenance • trenching • base surveillance
Job Performance Measures Most Often Impacted by Driving:	No formal process has been established to measure quality driving performance.
Typical Employee Comments about Driving:	Employees typically complain about discomfort and/or stiffness in the back and legs/feet.
Suggested Level II Analysis:	Postural Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Controls levers within cab too far away	38. Move closer to the work location • move seat forward • add backrest pad if seat cannot be moved forward	 ✓ ✓		 low low	 low med	 low med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Pulling levers is difficult due to poor control lever maintenance • Pulling levers is difficult due to poor control lever design • Turning steering wheel is difficult due to steering wheel design if not power steering wheel (see Figure 1.1) **Figure 1.1**	101. Provide controls which do not require excessive forces • contact supplier to investigate adjustable levers and smoother traveling levers 106. Provide powered assistance for a manual activity • steering wheel contact supplier to investigate power steering		 ✓ ✓	 high high	 med med	 med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location positioned behind operator when in backhoe, grader or forklift	20. Incorporate rest pauses	✓		low	med	med
		84. Provide an adjustable mirror	✓		low	med	med

Hand/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Control lever location too high (back hoe, grader or forklift)	123. Raise the person • adjust seat higher, if possible • provide seat cushion	 ✓ ✓		 low low	 low low	 low low
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Control levers or steering wheel emit excessive vibration.	101. Provide controls which do not require excessive forces • Maintain equipment • provide levers or steering wheel that have vibration dampening materials	✓	 ✓	 low high	 low low	 low low

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	23. Increase room temperature • turn on heaters in vehicle	✓		low	low	med
		93. Provide appropriate gloves	✓		low	low	low

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change	Cost	Quality	Productivity
12. Repeated forward or sideways bending movements	• Lever positioned too far away	38. Move closer to the work location • move seat forward • insert additional back support such as a commercial back rest or cushion	 ✓ ✓		 low low	 low med	 low med
	• Leaning forward in seat (back hoe) (see Figure 1.2) **Figure 1.2**	115. Provide support for the lower back • ensure person sits back in seat to utilize back support • adjust back support forward • insert additional back support such as a commercial back rest or cushion.	 ✓ ✓ ✓		 low low low	 med med med	 med med med
13. Twisting of the lower back	• Work positioned behind worker when in cab	84. Provide an adjustable mirror • allow individual to see behind vehicle	 ✓		 med	 med	 med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change	Cost	Quality	Productivity
15. Static, awkward back postures	• Leaning forward in chair	115. Provide support for the lower back					
		• ensure person sits back in seat to utilize back support	✓		low	low	med
		• adjust back support forward	✓		low	low	med
		• insert additional back support such as a commercial back rest or cushion.		✓	med	low	med
		• provide an appropriate chair		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Poor design and maintenance of seat and mounting may increases vibration exposure	87. Provide an appropriate chair/stool					
		• seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical	✓		med	med	med
		• maintain equipment	✓		med	low	low

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Hard edge of seat digs into under surface of thigh	64. Provide a padded, compressible surface to sit on • cut padding and recover seat pan to allow for a waterfall or downward curved edge • provide appropriate seating		✓ ✓	med med	low low	med med
21. Awkward leg postures	• Foot pedals are positioned too far away	38. Move closer to the work location • move seat forward • attach blocks/extensions securely to foot pedals	✓ ✓		low low	low low	low low
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Excavating/Shoveling	
TASK TITLE: Excavating/Shoveling	
Task Description:	Excavating involves the use of a shovel. The shovel may be stored on a vehicle or within the vehicle. The task performed for varying amounts of time depending on the complexity of the shoveling task. Typical jobs in which shoveling is performed include (not necessarily limited to): • road maintenance and repair • gardening • trenching
Job Performance Measures Most Often Impacted by Shoveling:	Speed of the shoveling task.
Typical Employee Comments about Shoveling:	Employees typically complain about discomfort and/or stiffness in the shoulder/neck, back and legs/feet.
Suggested Level II Analysis:	Dynamic Task Analysis, Biomechanical Lifting Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work is too far away - (manual shoveling)	132. Remove obstructions to get closer to the work	✓		low	med	med
	• One hand must hold shovel near the scoop	103. Provide extensions for tools • provide handle attachment that can be attached to the shaft of the shovel	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Shovel is too heavy • Ground is too hard for shoveling	59. Provide a lighter weight tool	✓		low	med	med
		144. Provide a machine/automate • use a backhoe		✓	high	med	high
3. High speed, sudden shoulder movements	• Poor shoveling technique	20. Incorporate rest pauses	✓		low	med	med
		13. Encourage ergonomic work techniques • pace the work task.	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location too low for prolonged periods causes strain on the neck	20. Incorporate rest pauses 13. Encourage ergonomic work techniques	✓		low	med	med
		• encourage employee to look up frequently	✓		low	med	med
	• Work location positioned behind operator when in back hoe	20. Incorporate rest pauses	✓		low	med	med

Hand/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Control lever location too high (back hoe)	123. Raise the person • adjust seat higher • provide seat cushion	 ✓ ✓		 low low	 med med	 med med
	• Control lever distance traveled too far (back hoe)	101. Provide controls which do not require excessive forces • appropriate control levers • contact supplier to investigate adjustable levers and smoother traveling levers		 ✓ ✓	 med med	 med med	 med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide shovel with an appropriate hand diameter between 1"-1.5" (2.5-3.8 cm).		✓	med	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Non-compressible surface on handle	54. Provide a high friction gripping surface • provide a shovel with a compressible handle surface	✓		med	med	med
9. High speed hand/wrist/arm movements or vibraion, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length.		✓	med	med	med
	• Controls lever knobs have hard edges (back hoe)	9. Eliminate exposure to hard edges • a knob with a round smooth handle, smooth knob with no ridges or edges	✓		med	med	med
		• provide knobs of at least 1.5" and not greater than 3.0"	✓		med	med	med

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		med	med	med
		93. Provide appropriate gloves	✓		med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• One hand must hold shovel near the scoop	103. Provide extensions for tools • provide shovel handle attachment		✓	med	med	med
	• Task duration is too long.	141. Use heavy excavation equipment (e.g., backhoes) • Use backhoe for long duration tasks with good access.		✓	high	med	high
		20. Incorporate rest pauses	✓		low	med	med
	• Leaning forward in seat (back hoe)	115. Provide support for the lower back					
		• ensure person sits back in seat to utilize back support	✓		low	med	med
		• adjust backrest forward	✓		low	med	med
		• insert additional back support such as a commercial back rest or cushion.	✓		low	med	med
13. Twisting of the lower back	• Work positioned behind worker when in cab	18. Improve visual access to work • investigate alternative backhoe design.		✓	high	high	high
	• Work location is blocked or too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Twisting with the lower back instead of feet to transfer load of dirt/sand etc.	13. Encourage ergonomic work techniques	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Leaning forward in seat	115. Provide support for the lower back • ensure person sits back in seat to utilize back support • adjust back support forward • insert additional back support such as a commercial back rest or cushion. 87. Provide an appropriate chair/stool	✓ ✓ ✓		low low med med	med med med	med med med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
18. Whole body vibration	• Design and maintenance of seat and mounting increases vibration exposure (back hoe)	87. Provide an appropriate chair/stool • seating should incorporate vibration absorption qualities in base support of the seat either air or mechanical		✓	med	med	med
		• repair seat base	✓		low to med	med	med
	• Tight trousers increases the potential for low back pain	12. Encourage appropriate seasonal clothing • employees in industrial equipment to wear loose fitting trousers.	✓		med	med	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide attachable knee pads	✓	✓	med	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Flame Cutting	
TASK TITLE: Cutting Metal Using Flame	
Task Description:	There are certain types of welding processes which lend themselves to rough metal cutting also. The focus of this case study is cutting with a torch. See welding case study for further information on welding. Typical jobs in which flame cutting is performed include: • metal fabrication • assembly/repair • structural maintainance • salvage operations Flame cutting may be performed on flat or upright surfaces directly on aircraft, pipes, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Flame Cutting:	• Quality of weld or cut • Speed of completion of flame cutting task
Typical Employee Comments about Flame Cutting:	Due to the wide variety of work situations, employees may report fatique or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, back/torso, or legs/feet. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, Postural, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Flame cutting tool or gas hose must be manually supported, held or steadied	112. Provide support for the arms					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
		113. Provide support for hose or or cord					
		• use wire hook to hang hose on nearby structure	✓		low	med	med
		• provide mobile tool balancer		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		132. Remove obstructions	✓		low	med	med

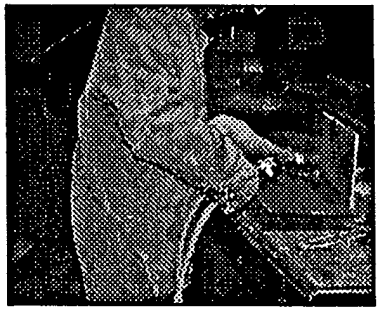
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Flame cutting is performed on flat work surface	136. Rotate the work piece • allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide a flame cutting tool with a pistol shaped grip (i.e. right angle)		✓	med	med	med
		• provide flame cutting tool with a nozzle which can be angled/bent for different flame cutting tasks		✓	med	high	med
2. Arm forces: Repeated arm forces or holding/carrying materials	Pulling hoses and carts is difficult • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • repair cracks or gaps in floor		✓	med to high	low	med
		• provide ramps to compensate for minor differences in floor height		✓	med to high	low	med
		• Improve housekeeping	✓		low	low	med
		19. Improve wheel condition • provide wheels with appropriate bearings and tread composition		✓	med	low	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.1)	124. Raise the work piece/work surface		✓	med	med	med
	Figure 1.1	31. Lower the person		✓	high	med	high
		87. Provide an appropriate chair/stool • to sit on for all or parts of the task	✓		low	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Use of head movement to lower face shield is stressful	13. Encourage ergonomic work techniques • raise or lower the shield with hand	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using straight flame cutting tool on horizontal surface (see Figure 1.2)  **Figure 1.2**	77. Provide a tool with an appropriate handle angle • attach a pistol-type handle to flame cutting tool • flame cutting tool with a pistol-type handle • flame cutting tool with a nozzle which can be angled/bent for different flame cutting tasks	✓	✓ ✓	low med med	med med high	med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Flame cutting tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece		✓	med	med	med
		54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible grip surface		✓	med	med	med
		add a grip cover	✓		low	med	med
	• Tool is too heavy	116. Provide support for the tool					
		• provide a tool balancer		✓	med	med	med
		• flame cutting tool of minimal weight		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter					
		• flame cutting tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• a handle of at least 5" in length		✓	med	med	med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		low	med	med

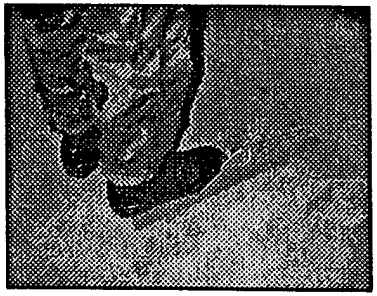
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓		low	med	med
		83. Provide an adjustable height lift table		✓	high	med	high
		87. Provide an appropriate chair/stool to lower the person	✓		low	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Lack of support for body in awkward postures.	117. Provide support for the upper body • provide a pad/mat	✓		low	med	med
		• provide a device to support the upper body while flame cutting		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		83. Provide an adjustable height lift table • to suport work piece		✓	high med	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
16. Lifting forces	• Initial setup may require the placement of the part on the workbench.	61. Provide a mechanical lift device • provide a hoist to place the unit on the workbench		✓	high	med	med
17. Pushing or pulling	Pulling hoses and carts is difficult • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • repair cracks or gaps in floor • provide ramps to compensate for minor differences in floor height		✓ ✓	med to high med to high	med med	med med
		19. Improve wheel condition • repair wheels on carts • provide wheels with appropriate bearings and tread composition	✓	✓	low med	med med	med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3)  **Figure 1.3**	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓		low	med	med
		83. Provide an adjustable-height lift table		✓	high	med	high
		87. Provide an appropriate chair/stool	✓		low	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Folding/Fitting	
TASK TITLE: Folding/Fitting	
Task Description:	Folding involves the manual turning of light or heavy fabric in a specified pattern. The fold pattern must be followed for each type of product (patterns outlined in product manual). Most folding patterns are performed by two individuals due to the size of the product. Typical jobs in which folding is performed include (not necessarily limited to): • Parachute packing • Raft packing Folding may be performed on the floor or on a table surface. This case study includes only the folding part of parachute and raft packing which requires minimal force. The actions associated with packing the folded material into the case is reflected in the "Packing" case study.
Job Performance Measures Most Often Impacted by Folding:	• Adherence to the folding pattern. • Speed of completion of folding task.
Typical Employee Comments about Folding:	Employees typically complain about discomfort in the shoulders, backs, legs/feet. Primary concerns: back, legs/feet. Secondary concerns: shoulders.
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person • use a step stool, platform or ladder		✓	med	med	med
		32. Lower the work piece/work surface		✓	low	med	med
	• Size of material requires reaching	142. Use two or more persons to perform the transfer	✓		low	low	low
2. Arm Forces: Repeated armforces orolding/carry-ing materials	• Pulling fabric is difficult (see Figure 1.1) **Figure 1.1**	13. Encourage ergonomic work techniques • minimize high speed movements while pulling fabric • avoid rushing	✓ ✓		low low	med med	med med
	• Carrying folded rafts more than three steps	48. Provide a cart • use a floor dolly to move folded raft	✓		low	med	med
		61. Provide a mechanical lift device		✓	high	low	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Rarely occurs	N/A					

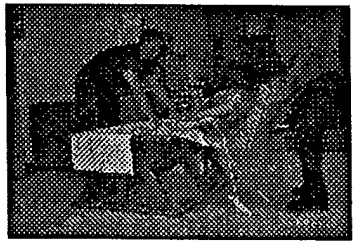
Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

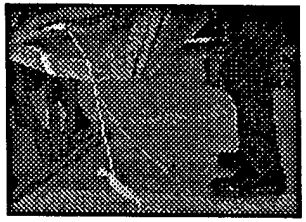
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.2)  **Figure 1.2**	124. Raise the work piece/work surface • provide a fixed table to support workpiece • provide an adjustable table for workpiece		✓ ✓	med high	med med	med high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	13. Encourage ergonomic work techniques 132. Remove obstructions • remove unnecessary items from the work area	✓ ✓		low low	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting Forces	Lifting heavy folded objects • low height • no hand holds	61. Provide a mechanical lift device • lifting hoist to move raft or work piece		✓	high	med	high
		• use straps to lift item	✓		low	med	med
		142. Use two or more persons to perform the transfer	✓		low	med	med
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing on hard surface (see Figure 1.3)  **Figure 1.3**	96. Provide appropriate shoe inserts 86. Provide an appropriate anti-fatigue mat	✓		low med	low med	low med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work height too low (see Figure 1.4)	13. Encourage ergonomic work techniques • periodically stand up to change position.	✓		low	med	med
	 Figure 1.4						
	• Hard Surface	95. Provide appropriate knee protection		✓	med	med	med
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		124. Raise the work piece/work surface • prevent kneeling	✓		low	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Forming	
TASK TITLE: Forming	
Task Description:	Forming is a manual task which is typically performed to create a small volume (e.g., one) of special purpose metal parts. The process involves forcing, deforming, or pressing a piece of sheet metal around a wood mold or pattern. The pattern defines the shape of the final part. Depending on the part shape, tools such as hammers, or other heavy weight metal bars may be used. Typical jobs in which forming may occur include (not necessarily limited to): • metal fabrication • model shop • zone or facilities maintenance. The task is usually performed on a work table and may require the use of a vise to stabilize the pattern.
Job Performance Measures Most Often Impacted by Forming:	Dimensional accuracy, time taken to completion.
Typical Employee Comments about Forming:	Employees report that manual forming is one of the hardest or most physically demanding jobs in the department. The primary body regions affected by manual forming include the hands/wrists/arms, shoulder/neck and (upper)back/torso. The secondary body region affected is the (lower) back/torso.
Suggested Level II Analysis:	Grip Force Measurement, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	position Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• The work piece is too high	32. Lower the work piece/work surface • lower the work table or bench	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carry-ing materials	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
	• Material is difficult to form/mold	15. Heat metal/material to make more pliable • provide gloves to protect hands from heat		✓	med	med	med
3. High speed, sudden shoulder movements	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
	• Material is difficult to form/mold	15. Heat metal/material to make more pliable • provide gloves to protect hands from heat		✓	med	med	med
4. Head/neck bent or twisted	• Work piece orientation is awkward	136. Rotate the work piece • rotate the work piece manually by changing its in the vice	✓		low	med	med
		• provide a special purpose fixture		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide an vibration-controlled impact tool		✓	high	med	high
	• Maintaining grip on manual tool is difficult	54. Provide a high friction gripping surface • provide padding/wrapping to provide a compressible gripping surface on hammer or other tools	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Use of manual tool is inappropriate for the task	66. Provide a power tool • provide a vibration-controlled impact tool		✓	high	med	high
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" in length		✓ ✓	med med	med med	med med
	• Workstation has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓	✓	low med med	med med med	med med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too high • Work location is too low	32. Lower the work • piece/work surface lower the work table or bench 123. Raise the person • provide a stable platform 124. Raise the work piece/work surface • raise the work station on blocks • raise the fixture or vise • provide an adjustable work table	✓ ✓ ✓ ✓	 ✓	low low low low med	med med med med med	med med med med med
13. Twisting of the lower back	• Work piece orientation is awkward	136. Rotate the work piece • rotate the work piece manually by changing its position in the vice • provide a special purpose fixture	✓	 ✓	low med	med med	med med
14. High speed, sudden movements	• Excessive dirt and/or dust, and presence of water or lubricant on floor	17. Improve floor condition • improve housekeeping • clean/dry floor prior to performing the task • wear the appropriate shoes/sole for floor surface and work environment	✓ ✓ ✓		low low low	low low low	low low low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
	• Standing in a fixed position for prolonged periods	13. encourage ergonomic work techniques					
		• encourage employee to walk periodically	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Gluing/Laminating (Dopping)	
TASK TITLE: Gluing/Laminating (Dopping)	
Task Description:	Gluing/Laminating involves the use of primarily three tools: a paint brush to apply the glue and thinner, a heat gun to warm the surface and make it pliable, and finally a sealing iron to seal the applied dacron and base material. Many times the gluing/laminating process is performed on the aircraft while it is on the ground, thus requiring the individual to perform work overhead or very low to the ground. Typical jobs in which sanding is performed include (not necessarily limited to): • aircraft maintenance/restoration • model shop
Job Performance Measures Most Often Impacted by Gluing/Laminating:	Integrity of surface and joints.
Typical Employee Comments about Gluing/Laminating:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms, and sometimes the lower back. Primary concerns: Shoulders/Neck Secondary concerns: Hands/Wrists/Arms, and Body/Torso
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (see Figure 1.1)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		112. Provide support for the arms		✓			
		• provide adjustable arm support for long duration tasks in one position			med	high	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Supporting tools for long periods	116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med

Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high (see Figure 1.2)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform			med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
	Figure 1.2						
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• turn the work piece	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Handle angle on tool causes awkward wrist postures	77. Provide a tool with an appropriate handle angle					
		• provide a tool with a pistol-type handle		✓	med	med	med
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool		✓	med	med	med
	• Using the paint brush results in wrist movements	11. Eliminate unnecessary tasks					
		• provide a roller or a special purpose spray gun for applying glue and thinner		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs.	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of heat gun with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)	✓	✓	med	med	med
		10. Eliminate need to constantly hold trigger • provide a tool with "cruise control". Toggle switches that allow continuous operation without holding the trigger down		✓	med	med	med
8. Hand/grip forces	• Tool must be manually supported, held or steadied	116. Provide support for the tool • provide a mobile tool balancer that can be hung overhead for field work (e.g., like an "I.V. rack)		✓	med	med	med
		113. Provide support for the cable or hose • provide a hook to hang cable in work area	✓	✓	med	low	low
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" (2.5-3.8 cm) is appropriate for this task		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length • wrap tool handle	 ✓	 ✓ 	 med med low	 med med med	 med med med
11. Hands and fingers exposed to cold temperatures	• Work area is tool cold	93. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs-most binding is of a stable nature	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	low med	low med
		117. Provide support for the upper body • Provide a device to support the upper body while working		✓	med	med	med
	• Work space or access is limited (such as internal to a structure	63. Provide a padded, compressible surface to lay on	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• raise the work with a hoist		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	low
		41. Move work piece closer to body	✓		low	med	low
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate lower back support while seated	115. Provide support for the lower back					
	• Inappropriate chair adjustment.	• adjust back rest to support lower back	✓		low	med	med
	• Inappropriate chair design	• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide a chair with adequate lower back support		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3) Figure 1.3	85. Provide an appropriate anti-fatigue mat	✓		med	low	low
		96. Provide appropriate shoe inserts	✓		med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide knee pads	✓		med	med	med
		• provide a cushion to kneel on	✓		low	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• raise the work using a hoist		✓	med	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	low	med	med
		• provide knee pads			low	med	med
		• provide a pad or cushion to kneel on	✓		low	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Grinding	
TASK TITLE: Grinding	
Task Description:	Grinding involves the use of a manual (file) or powered (pneumatic or hydraulic hand grinders) tools to remove or shape material. The work piece is often metal or wood. Additionally, the work piece can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which grinding is performed include: • aircraft maintenance • sheet metal repair • facility maintenance • model shop Grinding may be performed on flat or upright surfaces directly on aircraft, equipment, bench tops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Grinding:	• Quality of finished surface (consistency, free of defects, no overgrind) • Speed of completion of grinding task.
Typical Employee Comments about Grinding:	Employees typically report discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms. Primary: The primary body parts affected are the shoulder/neck and hand/wrists/arms Secondary: In some cases the back/torso and legs/feet are affected as well (although don't typically comment).
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
		112. Provide support for the arms					
		• rest arms on nearby surfaces	✓		low	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process					
		• perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Tool requires high forces to remove material	92. Provide appropriate abrasive material • substitute higher grit media removal of large amounts of material	✓		low	med	med
		• Grind in stages with different grit to achieve appropriate finish	✓		low	med	med
		34. Maintain hand tools/power tools	✓		low	med	med
	• Large quantity of material must be removed	66. Provide a power tool • obtain a heavier duty tool which reduces forces and time required to remove material		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide power tools of minimal weight (particularly for lighter grinding tasks)		✓	med	med	med
3. High speed, sudden shoulder movements	• Manual grinding or filing requires high speed arm movements	66. Provide a power tool, whenever possible		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.1) **Figure 1.1**	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece		✓	med	med	med
		• tilt the work piece toward the worker	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	med
		31. Lower the person	✓		med	med	med
		• provide a stool to sit on					
		8. Distribute intensive activities throughout the process					
		• perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Light levels are too low	22. Increase light levels					
		• (provide light levels at the task of 50-100 foot-candles (500-1000 lux)) for grinding tasks (precision grinding tasks require more light: 100 fc (1000 lux)or more)		✓	med	med	med
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Tool handle orientation causes awkward postures	77. Provide a tool with an appropriate handle angle • provide multiple tool designs for complex parts		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated	✓		med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of power tool with single finger trigger concentrates stress on finger	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Hand grinding may cause excessive fingertip forces	118. Provide support for the work piece • provide and mount small parts (that must be held against a grinding wheel) to a grinding block with an attached handle so that pressure is applied with a full hand grip rather than a finger press		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a clamp	✓		low	med	med
		54. Provide a high friction gripping surface • wrap the tool handle	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a tool of minimal weight when appropriate		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide tool with an appropriate handle diameter between 1"-1.5" (2.5-3.8 cm)		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Vibration often causes person to apply more force to control the tool	74. Provide a tool that minimizes exposure to vibration/impact/torque • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5" (3.8 cm))		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Power tools produce hand/arm vibrations	74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5" (3.8 cm))		✓ ✓	med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	low	low
		• round off exposed edges		✓	med	low	low
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from the hands					
		• provide tool which does not blow cold air on the hands		✓	med	med	med
		93. Provide appropriate gloves					
		• caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task	✓		med	low	low

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work area is too cold	23. Increase room temperature	✓		low	low	med
		105. Provide portable heaters		✓	med	low	med
		110. Provide shields or barriers from the wind		✓	med	low	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.2) **Figure 1.2**	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	high
		31. Lower the person • provide a stool for working on low areas	✓		low	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece manually	✓		low	med	med
		• provide a fixture to allow work piece to be rotated		✓	med	med	med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		83. Provide an adjustable height lift table		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work) • rotate the work piece manually • provide a fixture to allow work piece to be rotated	✓	✓	low med	med med	med med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	117. Provide support for the upper body • provide a device to support the head and upper body while the person is working		✓	med	med	med
		115. Provide support for the lower back					
		• pull chair forward and lean back while working	✓		low	low	low
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support	✓		med	low	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (If it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	Standing surface is hard	86. Provide appropriate anti-fatigue mat	✓		med	low	low
		96. Provide appropriate shoe inserts	✓		med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges					
		• Use a cushion eliminate exposure to pressure point	✓		low	low	low
		• provide chair with rounded front edge of seat	✓		med	low	low
	• Work station has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	low	low
		• round off exposed edges		✓	low	low	low
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Hammering	
TASK TITLE: Hammering	
Task Description:	Hammering involves the use of a hammer to pound nails or shape a variety of materials. The hammering task can be done at a variety of heights and locations. Task duration is dependent on the complexity or nature of the product. Tools used in hammering can include rubber mallets, sledge hammers, and framing (e.g., carpenter's) hammers. Typical jobs in which nailing is performed include: • basic shaping of metal forms • aligning and straightening structures • general maintenance Hammering may take place on bench tops or fixtures, directly on structures or equipment, or on the floor.
Job Performance Measures Most Often Impacted by Hammering:	• Quality of the final product (free of defects, appearance) • Speed of completion of task
Typical Employee Comments about Hammering:	Personnel typically report fatigue or discomfort in the hands/wrists/arms and shoulders/neck. Primary: The primary body regions affected the hands/wrists/arms and shoulders/neck. Secondary: In some cases, back/torso and legs/feet are also affected.
Suggested Level II Analysis:	Grip Force Measurement, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform			med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table (cut legs)	✓		low	med	med
		• provide an adjustable height work table		✓	high	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Manual hammering causes high forces	11. Eliminate unnecessary tasks/repeated pounding • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required (e.g., number of nails)	✓		med	med	med
		• use a hammer which is large enough/heavy enough	✓		low	med	med
		66. Provide a power tool		✓	med	high	high
	• Inappropriate technique may increase force	13. Encourage ergonomic work techniques • encourage person to use minimal force in order to perform task	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Manual nailing requires high speed movements	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		66. Provide a power tool • provide a pneumantic nail gun		✓	med	high	high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/ work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		136. Rotate the work piece					
		• rotate the work piece manually	✓				
		• provide a fixture to allow the work piece to be rotated		✓	low med	med med	med med

Hand/Wrist/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Manual hammering requires wrist movements	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		77. Provide a tool with an appropriate handle angle • provide tools with an appropriate handle angle for the position of the work		✓	med	med	med
		66. Provide a power tool • provide a pnumatic nail gun		✓	med	high	high

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture to the support the work piece		✓	med	med	med
		54. Provide a high friction gripping surface • provide a hammer handle with a compressible grip surface		✓	med	med	med
		• wrap the handle with friction tape	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide appropriate sized hammer for the particular task		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Manual hammering causes impact to the hand and wrist	11. Eliminate unnecessary tasks • determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		low	med	med
		66. Provide a power tool • provide a pnumatic nail gun		✓	med	high	high

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		13. Encourage ergonomic work techniques					
		• encourage person to use minimal force in order to perform task	✓		low	med	med
		• encourage employee to release grip (slightly) at the point of impact	✓		low	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med
		93. Provide appropriate gloves					
		• (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/ work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions	✓	✓	med	med	med
		139. Rotate the work piece					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Manual hammering can cause high speed movements in the lower back	11. Eliminate unnecessary tasks					
		• determine if there are actions which could prevent the need to hammer or reduce the amount of hammering required	✓		med	med	med
		13. Encourage ergonomic work techniques					
		• encourage person to use minimal force in order to perform task	✓		low	med	med
		• encourage the person to maximize the benefit of momentum and tool weight (e.g., chopping wood)	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		2. Avoid high force tasks while seated					
		• perform high force hammering tasks while standing	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing on hard surface	96. Provide appropriate shoe inserts	✓		low	low	low
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		52. Provide a footrail or footrest	✓	✓	med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Hard edges in work area contact legs/knees • Kneeling required	95. Provide appropriate knee protection	✓	✓	med	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/ work surface					
		• place the work piece on a fixed table	✓		med	med	med
		• provide an adjustable height table		✓	high	med	high
		• provide a support fixture		✓	med	med	med
		87. Provide an appropriate chair/stool - stool should be stable, low to the ground and able to roll - stool provides an alternative to kneeling or squatting		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

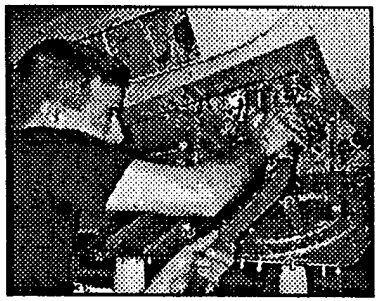
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot-candles (500-1000 lux) for hammering tasks • increase room lighting • if necessary, provide a task light which is easy to adjust	 ✓	✓ ✓ ✓	high high med	high high med	high high med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Hose Handling	
TASK TITLE: Hose Handling - Aircraft Refueling	
Task Description:	Hose handling activities in this example describe the process used to refuel a fighter aircraft. The fuel is delivered to the aircraft by a fuel truck. The individual pulls the fuel hose from the truck, carries/drags the hose to the aircraft, and raises and secures the hose fitting to the aircraft. After re-fueling, the hose is removed from the aircraft. The spool on which the hose is carried on the truck is used to re-wind the hose. Typical jobs in which hose handling is involved include: • aircraft refueling • fire fighting • liquid fuels maintenance/attaching and detaching hoses. This case study addresses potential ergonomics issues associated with a moving and handling low pressure hoses.
Job Performance Measures Most Often Impacted by Hose Handling:	• Avoidance of spills. • Speed of task completion.
Typical Employee Comments about Hose Handling:	Employees typically identify discomfort in the shoulder and back from dragging the hose and lifting it to the refueling locations. In some cases, there may be a concern for the hands and fingers due to the difficulty in and detaching hoses and clamps. Primary concerns: back/torso, shoulder/neck Secondary concerns: hands/wrists/arms.
Suggested Level II Analysis:	Dynamic Task Analysis, Grip Force Measurement, Push/Pull Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Refueling point is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
	• Inappropriate technique used to drag hose	13. Encourage ergonomic work techniques			low	med	med
		• face the direction of travel when moving hoses	✓		low	med	med
		• hold hose close to the body at waist level or over the shoulder	✓				
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carry distance • locate the fuel / truck as close to the air craft as possible.	✓		low	low	med
		13. Encourage ergonomic work techniques					
		• unwind the fuel hose (at least partially) prior to dragging the hose to the aircraft; avoid simultaneous pulling and unwinding of the hose from the truck.	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Wear or damage to hose clamp or material build-up can make clamp difficult to seal and remove. (see Figure 1.1)  **Figure 1.1**	35. Maintain tracks, rollers, or movement mechanisms • regularly clean and repair hose connectors/clamps • replace damaged clamps • replace worn hoses with hoses that are enclosed in a low friction casing - facilitates sliding	✓	 ✓ ✓	low med high	med med med	med med high

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carry distance • locate the truck as close to the air craft as possible.	✓		low	low	med
		13. Encourage ergonomic work techniques • unwind the fuel hose (at least partially) prior to dragging the hose to the aircraft; avoid simultaneous pulling and unwinding of the hose from the truck.	✓		low	low	med
		75. Provide a tool which can be used by both hands • use a hook (handle sized for both hands) to drag the hose instead of gripping the hose itself.	✓		med	low	med
	• Wear or damage to hose clamp or material build-up can make clamp difficult to seal or remove	35. Maintain tracks, rollers, or movement mechanisms • regularly clean and repair hose connectors/clamps	✓		low	med	med
		• replace damaged clamps		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs.	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs	N/A					
13. Twisting of the lower back	• Inappropriate work technique while moving hose	13. Encourage ergonomic work techniques • face the direction of travel when moving hoses • hold hose close to the body at waist level or over the shoulder	✓ ✓		low low	low low	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Hose is heavy • Lifting hose from ground level increases force in the low back	13. Encourage ergonomic work techniques • place hose over the shoulder immediately upon removal from truck - never let hose reach the end of the hose reach the ground.	✓		low	low	med
17. Pushing or pulling	• Weight of hose, distance traveled, and friction between the hose and the ground	126. Reduce carrying distance • locate the fuel truck as close to the aircraft as possible. 35. Mountain tracks, rollers, or movement mechanism. • replace worn hoses with hoses that are enclosed in a low friction casing - facilitating sliding.	✓	✓	low high	low med	med high
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Lifting	
TASK TITLE: Lifting	
Task Description:	Lifting involves the manual handling of items of varying weights and sizes. It involves the transfer of items at between varying heights and locations (floor/shelves or a work surface). Pushing and pulling typically occur while moving carts or pieces of equipment. Pushing and pulling can also occur while removing and installing components. • Lifting/pushing/pulling are components of many jobs.
Job Performance Measures Most Often Impacted by Lifting:	• Speed of completion of the larger task. • Component damage during handling.
Typical Employee Comments about Lifting:	Employees typically complain about discomfort in the back/torso, legs/feet, hands/wrists, arms, and shoulders/neck. Primary: The primary body part affected is typically the **back/torso** Secondary: The following body parts are also affected: shoulders/neck, hands/wrists/arms, and legs/feet may also be affected.
Suggested Level II Analysis:	NIOSH Lifting Equation, Biomechanical Lifting Analysis, Push/Pull Force Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Object is too high	32. Lower the work piece/work surface					
		• place heaviest items below shoulder height (50" (127 cm) or less)	✓		low	med	med
		• place heaviest items on middle shelves of storage racks	✓		low	med	med
	• Object is too far away	38. Move closer to the work location	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Item is too heavy	61. Provide a mechanical lift device		✓	high	low	med
		131. Reduce weight of work piece		✓	med	med	med
		142. Use two or more persons to perform the transfer	✓		low	low	low
		26. Increase weight of work piece					
		• ensures that the item will be handled mechanically		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• High forces required to install or remove component	128. Reduce force required to install or remove the component					
		• use lubricant where feasible	✓		low	med	med
		• modify design of component or subsystem to reduce forces during installation or removal		✓	high	med	med
	• Rolling/sliding resistance of cart or piece of equipment causes high forces	19. Improve wheel condition					
		• repair wheels on carts or equipment	✓		med	med	med
		• install appropriate wheels		✓	low to med	med	med
	• Cart or piece of equipment is too heavy to be pushed manually	131. Reduce weight of work piece					
		• reduce number of items or weight of items on cart	✓		low	low	med
		67. Provide a powered cart		✓	med to high	low	med
	• Floor/surface condition causes high forces during a rolling or sliding task	17. Improve floor condition					
		• improve housekeeping	✓		low	low	med
		• repair cracks or gaps in floor		✓	med	low	med
		• provide ramps to compensate for minor differences in floor height		✓	med to high	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Carry distance is more than three steps	126. Reduce carry distance • arrange storage and work areas to reduce travel distances	✓		low	low	med
		48. Provide a cart • to transport materials		✓	med	low	med
		11. Eliminate unnecessary tasks • eliminate or combine handling tasks	✓		low	low	med
		• transport items in larger quantities instead of handling them individually	✓		low	low	med
		37. Modify facilities to decrease handling • widen doors to allow materials to be handled on carts		✓	high	low	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Speed of lift	13. Encourage ergonomic work techniques • encourage person to avoid rushing while handling items	✓		low	low	med
	• Item is stuck in location • Item is difficult to install	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	 ✓	 low high	 med med	 med med
4. Head/neck bent or twisted	• Inadequate head room causes awkward postures	82. Provide adequate workspace • store item in area where there is adequate headroom	✓		low	low	med
		• use flow-racks to cue items to the front of a storage rack		✓	high	low	high
		55. Provide a hook-type tool to pull items		✓	low	low	med

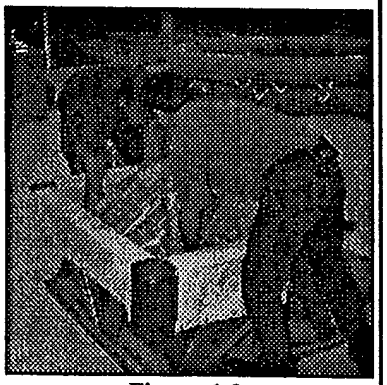
Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Shape of grasping location (handle) on work piece causes awkward wrist positions	94. Provide appropriate handles • provide handles which pivot slightly to permit a straight wrist during handling • provide cut-outs on boxes or containers		✓ ✓	med med	low low	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Item is difficult to grasp • Item has no handles • Item is slippery (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimum force to use • provide handles with compressible grips 61. Provide a mechanical lift device	✓	✓	med med to high	low low	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓ ✓	med med	med med	med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Object is too low (see Figure 1.2)  **Figure 1.2**	124. Raise the work piece/work surface					
		• place heaviest items between knuckle and shoulder height (25"-50") (64-127 cm)	✓		low	low	low
		• provide a fixed table to support work piece		✓	low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• place heaviest items on middle shelves of storage racks	✓		low	low	med
	• Object is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to the body	✓		low	med	med
	• Lifting item out of a deep container causes awkward bending	69. Provide a smaller container	✓	✓	med	low	med
	• Item is handled in a restricted space	82. Provide adequate work space		✓	low to med to	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Person tends to use the back to lift instead of using the legs to assist in the lift (check to make sure that there is no contributing factor in the workplace)	13. Encourage ergonomic work techniques • provide training on ergonomics principles and lifting techniques • encourage person to use leg muscles to lift	✓ ✓		low low	low low	med med
13. Twisting of the lower back	• Access is restricted to a component that needs to be removed	82. Provide adequate workspace • improve access during installation and removal	✓		low	low	high
	• Item is handled in a restricted space	61. Provide mechanical lift device • provide mechanical assistance for handling the load		✓	med to high	low	med
	• Work area layout	130. Reduce the angle a person turn to transfer an item • for example, if the transfer involves a 180 degree twist, move the source or destination to reduce the twist to 90 degrees or less	✓		low	low	med
	• Person tends to twist with the back instead of using the legs and feet to pivot	13. Encourage ergonomic work techniques • provide training on ergonomics principles and lifting techniques • encourage person to use legs pivot when handling a load	✓ ✓		low low	low low	med med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Item is stuck in location • Item is difficult to install or remove	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	✓	low high	low med	med high
	• Person tends to lift with a jerky motion instead of a smooth motion	13. Encourage ergonomic work techniques • encourage person to avoid rushing while handling items	✓		low	low	med
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Item is too heavy	61. Provide a mechanical lift device		✓	high	low	med
		131. Reduce weight of work piece (object)	✓		low	low	med
		142. Use two or more persons to perform the transfer	✓		low	low	med
		26. Increase weight of work piece • ensures that the item will be handled mechanically		✓	high	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• High forces are required to install or remove the component	128. Reduce force required to install or remove the component • use lubricant where feasible • modify design of component or subsystem to reduce forces during installation or removal	✓	✓	low high	low low	med med
17. Pushing or pulling	• Rolling/sliding resistance of cart or piece of equipment causes high forces	19. Improve wheel condition • repair wheels on carts or equipment • provide wheels with appropriate bearings and tread composition	✓	✓	low med	low low	med med
	• Cart or piece of equipment is too heavy to be pushed manually	131. Reduce weight of work piece • reduce number of items or weight of items on cart	✓		low	low	med
		67. Provide a powered cart • provide motorized assistance to transport cart or piece of equipment		✓	high	low	high
	• Floor/surface condition causes high forces during a rolling or sliding task	17. Improve floor condition • improve housekeeping • repair cracks or gaps in floor • provide ramps to compensate for minor differences in floor height	✓	✓ ✓	low med high	low low low	med med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work object is too low	124. Raise the work piece/ work surface	✓	✓	med	med	med
		118. Provide support for the work piece					
		• provide an adjustable table for work piece		✓	high	med	high
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Machining	
TASK TITLE: Machining	
Task Description:	Machining involves the use of a hydraulic cutting tool (e.g., Computer Numerically Controlled-CNC) to cut/form a shape out of a piece of metal. The employee must load the piece of metal, cycle the machine, and then remove the finished product. Additionally, the employee typically performs a series of test measurements. In some cases, the employee may need to grind the piece after machining is completed. Typical jobs or work areas in which machining is performed include (not necessarily limited to): • aircraft maintenance • facility maintenance • model shop
Job Performance Measures Most Often Impacted By Machining:	• Dimensional accuracy of finished product • Speed of task completion
Typical Employee Comments about Machining:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso or legs/feet The primary body parts affected are typically: shoulders/neck, hands/wrists/arms and back/torso The secondary body parts affected are typically: legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis, Light Measurement, Lighting Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body • modify fixture		✓	low	med	med
	• Work location or bin is too low	83. Provide an adjustable-height lift table • provide a spring loaded pallet jack to elevate the parts bin		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• The work piece is too heavy	61. Provide a mechanical lift device • provide a mechanized method for installing and removing the work piece.		✓	med	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Finish quality must be visually inspected and measured	22. Increase light levels • provide task lighting which is easy to adjust	✓		med	med	med
		136. Rotate the work piece • turn the work piece to an upright or tilted position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Inappropriate fixture design	136. Rotate the work piece • manually turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		66. Provide a power tool • replace manual clamps with a hydraulic fixture		✓	high	high	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of tool with single trigger concentrates stress	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
		• provide electronic caliper to eliminate thumb action		✓	high	med	med
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied during grading or inspection	118. Provide support for the work piece • provide a fixture to support work piece		✓	med	med	med
		118. Provide support for the work piece • provide a tool balancer for bench work		✓	med	med	med

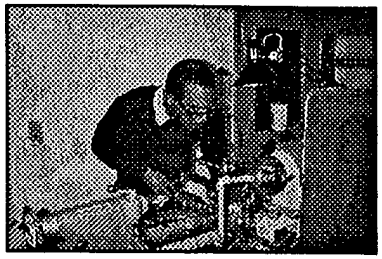
Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with an appropriate handle diameter between 1"-1.5".		✓	med	med	med
	• The work piece must be moved and turned	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• The tool has not received proper maintenance	34. Maintain hand tools/power tools • perform periodic maintenance on all tools	✓		low	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• The hand is inadequately protected	74. Provide a tool that minimizes exposure to vibration/ impact/torque • Provide and attach a compressible anti-vibration surface to the tool handle		✓	med	med	med
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface is too low (see Figure 1.1)  **Figure 1.1**	124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin 136. Rotate the work piece • turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated or raised 83. Provide an adjustable-height lift table • use for part storage	 ✓ 	 ✓ ✓ ✓	 med low med med med	 med med med med med	 med med med med med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					

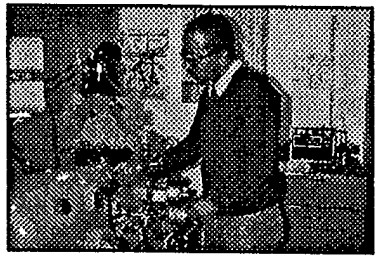
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work surface is too low • Load point too far away	124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin 38. Move closer to the work location • remove guards during load/unload • redesign fixture to locate part closer to employer	✓	✓ ✓	med low high	med low low	med med med
16. Lifting forces	• The work piece is too heavy	61. Provide a mechanical lift device • provide a mechanized method for installing and removing the work piece. 124. Raise the work piece/work surface • provide a spring loaded pallet jack to elevate the parts bin		✓ ✓	high med	med med	med med
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts		✓	low	low	low
		52. Provide a footrail or footrest	✓	✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• provide gloves to protect hands		✓	low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Finish quality must be visually inspected (see Figure 1.2)  **Figure 1.2**	22. Increase light levels • provide task lighting which is easy to adjust • ensure that light levels are 200-250 lux (20-25 foot-candles)	✓	✓	med high	med high	med high

CASE STUDY - Masking	
TASK TITLE: Masking	
Task Description:	Masking involves the use masking tape paper (or other material) to cover an area that is not to be painted during the paint spraying or hand painting process. This task includes covering the area prior to painting and then the removal of the masking after the painting task is completed. Objects may be fixed in a vice or mounted, supported on a table surface or free standing. Task duration is dependent on the part complexity. Typical jobs in which masking is performed include: • vehicle painting • aircraft painting • painting of technical equipment Masking may be performed on flat, angled, and upright surfaces directly on equipment or in tight or restricted space work areas.
Job Performance Measures Most Often Impacted by Masking:	Quality of the masking (e.g., prevent over-spray and related re-work) Speed of completion of masking task
Typical Employee Comments about Masking:	Since the body position varies depending on the part employees may complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists/arms. back/torso and legs/feet. Primary concerns: depends on the task Secondary concerns: depends on the task
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Elemental Task Analysis, Light Measurement, Lighting Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool, platform or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		136. Rotate work piece (bench work)					
		• turn the work piece	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process					
		• perform activity as bench work rather than on the aircraft/structure	✓	✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		38. Move closer to the work location					
		• move person closer to the work	✓		low	med	med
		• provide sit-stand capability		✓	med	med	med
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools					
		• provide tools to smooth down tape while minimizing reaching		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking • design component for access • design component to allow the use of a mechanical mask		✓ ✓ ✓	med med med	med med med	med med med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	• N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface • provide an adjustable height table or fixture to support the work piece		✓	high	med	med
		31. Lower the person • provide a chair/stool to sit on for all or parts of the task	✓		med	med	med
	• Work location is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (benchwork) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		114. Provide support for the head • provide a cushion to support the head	✓		low	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access • increase the size of access ports to increase access		✓ ✓	high high	med med	high med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot-candles (500 - 1000 lux) for masking tasks (precision masking tasks require more light: 100 fc (1000 lux) or more)		✓	high	high	high
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists repeated wrist movements or repeated forearm rotation	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece • provide a fixture to orient the work piece to allow straight wrist postures		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • the handle angle should allow the wrists to remain straight while working		✓	med	med	med
		79. Provide a work surface which is adjustable in height		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure	✓		med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking • design component for access • design component to allow the use of a mechanical mask		✓ ✓ ✓	med med med	med med med	med med med
6. Repeated manipulations with fingers	• Handling masking tape requires repeated finger movements, particularly while placing and smoothing the tape down	3. Change a pinch grip to a power grip • provide specialized tools for smoothing tape		✓ ✓	med med	med med	med med
7. Hyper extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Tearing or cutting tape	76. Provide a tool which requires minimal force to use • provide a tape dispenser which cuts tape to length		✓	med	high	high
	• High forces associated with pressing and smoothing down tape	3. Change a pinch grip to a power grip • provide specialized tools for smoothing tape		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Holding heavy rolls or bundles of masking tape	116. Provide support for the tool • provide a dispenser which is mounted so that the tape is maintained at an appropriate height		✓	med	high	high
	• Work piece must be manually supported	118. Provide support for the work piece • use jig or fixture to reduce/ eliminate the need to manually support the work piece		✓	med	med	med
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	med	med
9. High speed hand/wrist/arm movements or vibraion, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• lay a material or padding over the hard edges	✓		low	low	low
		• redesign work piece or component to eliminate hard edges		✓	med	med	med
		• round off exposed edges	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface too low • Work surface too far away	124. Raise the work piece/work surface					
		• provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		31. Lower the person					
		• provide chair or stool	✓		med	med	med
		136. Rotate work piece (bench work)					
		• manually reorient the work piece	✓		low	med	med
		• provide a jig or fixture to allow the work piece to be rotated		✓	med	med	med
		103. Provide extensions for tools					
		• provide extensions on application tools to reduce bending		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		8. Distribute intensive activities throughout the process					
		• perform some activities as bench work rather than on the aircraft/structure	✓	✓	med	med	med
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Design of component	11. Eliminate unnecessary tasks					
		• redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Location of work	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, an eliminate reaches		✓	med	med	med
		38. Move closer to the work location	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	low
		• provide a fixture to allow the piece to be rotated	✓		med	med	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		117. Provide support for the upper body • provide a padded surface to support upper body where work requires a bent or awkward posture		✓	med	med	med
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform activity as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Design of component	11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• pull chair forward and lean back while working	✓		low	low	low
		• adjust backrest to support lower back	✓		low	low	low
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• If occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• If occurring, see Lifting Case Study	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest		✓	low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold work piece (bench work)		✓	med	med	med
		31. Lower the person • provide chair		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Design of component	82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		11. Eliminate unnecessary tasks • redesign component to eliminate or reduce masking		✓	med	med	med
		• design component for access		✓	med	med	med
		• design component to allow the use of a mechanical mask		✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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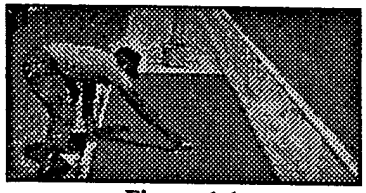
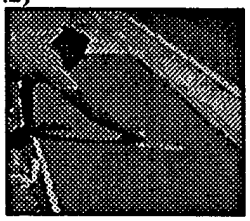
CASE STUDY - Masoning	
TASK TITLE: Masoning	
Task Description:	Masonry work involves the use of a number of hand tools of various sizes and shapes. The task may include pouring concrete, smoothing and finishing concrete with treadle. The masonry task can be done at a variety heights and angles. Task duration is dependent on the complexity or nature of the job. Typical jobs in which masoning is performed include (not necessarily limited to): • road maintenance and repair • construction Some aspects of brick work are also included in this case study.
Job Performance Measures Most Often Impacted by Masoning:	Integrity of the concrete, level surface. Speed of the masonry task.
Typical Employee Comments about Masoning:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, back and legs/feet.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Dynamic Task Analysis, NIOSH Lifting Analysis (if applicable).

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high • Work location is too far away (see Fig 1.1)  **Figure 1.1**	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		117. Provide support for the upper body • move with the work side to side- move feet rather than the arms		✓	med	med	high
		20. Incorporate rest pauses	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Carrying and lifting bricks – holding/lifting unstable loads – no hand holds	48. Provide a cart • transport bricks on transport trolley		✓	med	med	med
	• Throwing bricks or other supplies up to higher elevations or to scaffold	61. Provide a mechanical lift device • use a bucket and pulley system to raise and lower supplies		✓	med	med	high
3. High Speed sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Looking down to monitor quality of work	20. Incorporate rest pauses	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists repeated wrist movements or repeated forearm rotation	• Using hand treadle tool on a horizontal surface (see Figure 1.2)  **Figure 1.2**	77. Provide a tool with an appropriate handle angle • provide angled/bent tool handle for different tasks • Add a multi-position hinge to current tool handles to maximize flexibility	✓	✓	med low	med med	med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Tool or materials are too heavy • Handle is too heavy or large for easy gripping	59. Provide a lighter weight tool 13. Encourage ergonomic work techniques • avoid picking up more than one brick at a time • pick up items at a point where the weight is balanced	✓ ✓	✓	med low low	med med med	med med med

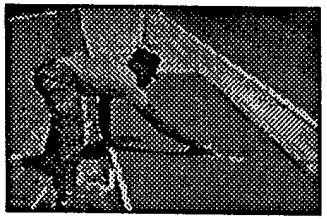
Hands/Wrists/Arms(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		76. Provide a tool which requires minimal force to use • all tools which must be pulled or used as spreaders should be equipped with full handles		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Design or poor condition of tamping tool can expose worker to high levels of impact or vibration	74. Provide a tool that minimizes exposure to vibration/impact/torque • inspect and repair tool on a regular basis to eliminate unnecessary vibration • provide a tool that emits less vibration 13. Encourage ergonomic work techniques • keep the tamping tool upright and level • let the weight of the tamping tool do the work-the worker should only guide the tool	✓ ✓ ✓	 ✓ 	 med med low low	 med med med med	 med med med med
10. Exposure to hard edges	• Rarely occurs	N/A					

Hands/Wrists/Arms(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	110. Provide shields or barriers from the wind		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		low	med	med
		93. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.3)  **Figure 1.3**	20. Incorporate rest pauses	✓		low	med	med
		31. Lower the person • provide a chair or stool to sit on (for certain bricking applications)	✓	✓	med	med	med
		117 Provide support for the upper body		✓	med	med	high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions	✓		low	med	med
		38. Move closer to the work location	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static awkward back postures	• Work location is too low	20. Incorporate rest pauses	✓		low	med	med
		31. Lower the person • provide a chair or stool to sit on (for certain bricking applications)	✓	✓	med	med	med
		117 Provide support for the upper body		✓	med	med	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Lifting weights such as stacks of bricks or tamper or stacks of reinforcement bars – holding/lifting unstable loads – no hand holds	61. Provide mechanical lift device • transport bricks on transport trolley	✓		med	med	med
		• use straps at each end to load and use two employees to carry the load	✓		med	med	med
		• use a bucket and pulley system to raise and lower bricks or other materials		✓	med	med	med
		78. Provide a wheel barrow		✓	med	med	med
		126. Reduce carry distance • drive vehicle closer to work area to unload bricks	✓		low	low	high
		13. Encourage ergonomic work techniques	✓		low	med	med
		4. Change lifting/carrying task to a rolling or sliding task • add wheels to tamping tool or other heavy or bulky equipment to facilitate transport to the work area		✓	med	med	high

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
17. Pushing or pulling	• Pushing or pulling wheel barrel – Poor wheel design – Poor wheel maintenance	19. Improve wheel condition • repair wheels • provide wheels with appropriate bearings and tread composition 13. Encourage ergonomic work techniques • avoid overloading carts or wheel barrels	✓ ✓	 ✓ 	med med low	med med med	med med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees and feet	• Kneeling causes external pressure to the knees	95. Provide appropriate knee protection					
		• provide knee pads		✓	med	med	med
		• provide a cushion to kneel on	✓		low	med	med
21. Awkward leg positions	• Work location is too low	31. Lower the person					
		• provide a stool or chair to sit on, if appropriate	✓		med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Mediablasting - Blast Cabinet	
TASK TITLE: Mediablasting - Blast Cabinet	
Task Description:	Media blasting involves using an air system in which grit is entrained making a very abrasive stream. This combination is effective for removing paint, rust, and other coatings. It is particularly effective for removing coverings and coatings from irregularly shaped surfaces (generally metals) where sanding or liquid dunking is not possible or practical. This task is performed while standing or sitting on a tall stool. Hands are placed into gloves which are extended into the media blasting enclosure or cabinet. The part to be cleaned/stripped is inside of the enclosure as is the high pressure nozzle. The abrasive stream is then aimed, via the nozzle, to the surfaces of the part to be cleaned/stripped. The part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Parts are loaded and unloaded through a door in the side of the enclosure. Typical jobs in which media blasting is performed include (not necessarily limited to): • coating and plating operations • finishing/painting operations • rework operations.
Job Performance Measures Most Often Impacted by Mediablasting:	Complete removal of desired material Completion of task in desired period of time
Typical Employee Comments about Mediablasting:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, the shoulders/neck, the lower back, and the legs/feet. The primary body regions of concern are: shoulders/neck, hands/wrists/arms The secondary body regions of concern are: back/torso, legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Posture Analysis

Shoulders/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Arm portals are too high • Work piece is too high	123. Raise the person • provide several fixed-height platforms which can be easily moved into place for different sized people	✓		low	med	med
		• provide a height-adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface • provide an ability to adjust the height of the work piece inside the cabinet	✓		low	med	med
		112. Provide support for the arms • provide a padded, compressible surface to rest arms	✓		low	med	med
		• provide adjustable arm supports that are mounted at the base of the arm portals		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Force required to control blasting nozzle	116. Provide support for the tool • provide an articulating arm to support and resist the reaction force of the blasting nozzle		✓	med	med	med

Shoulders/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Holding work piece while blasting	118. Provide support for the work piece • provide a fixture or clamp to stabilize the work piece • the fixture should allow the component to be rotated (as necessary to present all surfaces which need to be blasted)		✓ ✓	med high	med med	med high
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low • Worker cannot view part detail necessary without bending neck	124. Raise the work piece/work surface • add risers inside cabinet 136. Rotate the work piece • provide a fixture to allow the component to be rotated to the desired position	✓	 ✓	low med	med med	med med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Orient manual positions of the component • The need to position the blast nozzle	136. Rotate the work piece • provide a fixture to allow the component to be rotated to the desired position 75. Modify the tool • add an auxiliary handle to the nozzle • redesign the nozzle/hose to incorporate hinge/pivot feature		✓ ✓ ✓	med med med	med med med	med med high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Positioning nozzle creates resistance • Inadequate grip surface	116. Provide support for the tool • provide an articulating arm support to resist the reaction force of the blasting nozzle. This tool support should have a pivot capability to allow the operator to guide the tool without applying a large amount of force		✓	med	med	med
		145. Modify the tool • add an auxiliary handle		✓	low	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• High speed movements required for some blasting tasks	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med
	• Blasting causes exposure to vibration	116. Provide support for the tool • provide a tool balancer that absorbs the shock and vibration		✓	med	med	med
		74. Provide a tool that minimizes exposure to vibration/ impact/ torque • provide a nozzle with vibration dampening material built into the handle		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Hard edges on blasting nozzle	9. Eliminate exposure to hard edges • provide a nozzle with a handle which is round and smooth with no ridges or edges		✓	med	med	med
		• cover or wrap hard edges (Caution: be sure not to increase the handle diameter significantly greater than 1.5". This can increase grip forces required)	✓		low	med	med
	• Hard edges on arm portals	9. Eliminate exposure to hard edges • pad the edges of the arm portal with a compressible material	✓		med	med	med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs	N/A					
13. Twisting of the lower back	• Picking up the blast nozzle from the bottom of the cabinet • Reaching to access remote areas of the work piece	116. Provide support for the tool • provide a tool balancer • provide a hook 118. Provide support for the work piece • provide a fixture to support the work piece the fixture should allow the component to be rotated (as necessary to present all surfaces which need to be blasted)	 ✓ 	 ✓ ✓ 	 med low med	 med med med	 med med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Arm portals are too low • Work piece is too low	124. Raise the work piece/ work surface					
		• raise the height of the arm portals so everyone can operate the blast cabinet without having to bend over	✓	✓	med	med	med
		• provide an ability to adjust the height of the work piece using risers inside cabinet		✓	med	med	med
		31. Lower the person					
		• provide a chair (assumes that leg clearance is available for sitting) or sit stand stool		✓	med	med	med
		• provide several fixed-height platforms which can be easily moved into place for different sized people	✓		low	med	med
		• provide an height-adjustable platform		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Inadequate leg clearance for sitting	80. Provide adequate leg clearance • provide a blast cabinet that provides adequate leg clearance for sitting while blasting		✓	med	med	med
	• Inadequate lower back support • Inappropriate chair adjustment	115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
	• Inappropriate chair design	• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide a chair with adequate lower back support		✓	med	med	med
16. Lifting forces	• if occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	87. Provide an appropriate chair/stool		✓	med	med	med
		5. Change posture frequently	✓		low	med	med
		52. Provide a footrail or footrest	✓	✓	med	low	low
		86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Knees press against hard side of cabinet	9. Eliminate exposure to hard edges • attach a pad to the blast cabinet to protect the knees	✓		low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Standing foot pedal causes awkward leg and back postures	134. Replace standing foot pedals with alternative controls • provide a remote, hand operated control		✓	med	med	med
		145. Modify footpedal					
		• provide a heel block	✓		low	med	med
		• recess footpedal off the front end of a platform	✓		low	med	med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels					
		• provide task light		✓	med	med	med
		• increase overall light levels to meet the needs of tasks		✓	med	med	med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work					
		• increase size of text	✓	✓	med	med	med
		• increase the legibility of text x	✓	✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute instensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Mediablasting - High Pressure Gun	
TASK TITLE: Mediablasting -High Pressure Gun	
Task Description:	Media blasting involves using a high pressure fluid or air system in which grit is entrained making a very abrasive stream. This combination is effective for removing paint, rust, and other coatings. It is particularly effective for removing coverings and coatings from irregularly-shaped surfaces (generally metals) where sanding or liquid dunking is not possible or practical. This task is performed while standing inside of a large enclosure with the part(s) to be cleaned/stripped. The worker is in full body protective clothing including helmet and face shield. The abrasive stream is aimed, via the nozzle, to the surfaces of the part to be cleaned/stripped. The part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Parts are loaded and unloaded through a door in the side of the enclosure. Typical jobs in which media blasting is performed include (not necessarily limited to): • coating and plating operations • finishing/painting operations • rework operations
Job Performance Measures Most Often Impacted by Media Blasting-High Pressure Gun:	• Complete removal of desired material • Completion of task in desired period of time
Typical Employee Comments about Media Blasting-High Pressure Gun:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, the shoulders, the neck, and the legs/feet. The primary body regions of concern are: shoulders/neck, hands/wrists/arms The secondary body regions of concern are: In cases where heavy components must be repositioned or lifted, the back may also be impacted, legs/feet.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface					
		• modify/lower existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is fixed	136. Rotate the work piece					
		• provide a turntable to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
	• Surfaces that must be sprayed are flat/horizontal orientation	136. Rotate the work piece					
		• provide a turntable to allow the work piece to be rotated from flat to upright		✓	med	med	med
		• turn the work piece to an upright position, manual	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Force required to control blasting nozzle • Inadequate gripping surface	116. Provide support for the tool • provide a tool balancer to support and resist the reaction force of the blasting nozzle		✓	med	med	med
		94. Provide appropriate handles • attach an auxiliary handle with a hose clamp	✓		low	med	med
	• Hose must be manually supported, held or steadied	113. Provide support for the tool • provide a tool balancer to support the hoses		✓	med	med	med
		• use a hanger or hook to keep the hose off the floor	✓	✓	med	low	low
		• put hose over shoulder/use shoulder as hose support	✓		low	med	med
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists /repeated wrist movements or repeated forearm rotation	• Inappropriate tool handle for the task	77. Provide a tool with an appropriate handle angle					
		• provide a tool with a pistol-type handle		✓	med	med	med
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two-finger or a four-finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)	✓	✓	med	med	med
8. Hand/grip forces	• Tool must be manually supported, held or steadied; force from nozzle increases force	113. Provide support for the cable or hose • provide a hook to hang cable in work area		✓	med	med	med
	• Nozzle provides high force to hands	116. Provide support for the tool • provide a tool balancer to support and resist the reaction force of the blasting nozzle (this tool support should have a pivot capability to allow the operator to guide the tool without applying a large amount of force and articulating arm is preferred for this application)		✓	high	med	high
	• Tool is too heavy	59. Provide a lighter weight tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" (2.5-3.8cm) is appropriate for this task		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Blasting causes exposure to vibration	116. Provide support for the tool • provide a tool balancer; an articulating arm absorbs shock and vibration		✓	high	med	med
		74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a tool with vibration dampening material built into the handle		✓	high	med	med
		• wrap the handle with vibration damping material		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

Hands/Wrists/Arms(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold • Metal tool body is not insulated	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		104. Provide handles with temperature insulating material		✓	med	med	med
		93. Provide appropriate gloves	✓	✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a turntable fixture (that locks) to allow the work piece to be rotated		✓	med	med	med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓	✓	med	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs (if it occurs, see the Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • increase enclosure lighting		✓	med	high	high
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Melting (Small Parts)	
TASK TITLE: Melting (Small Parts)	
Task Description:	Melting of small parts involves heating a substance (such as wax) and applying it to a part requiring many fine movements. This task may be performed from the seated or standing position. Hand tools with pencil size grips may be employed to perform the task. Task duration is dependent on the complexity or nature of the product. Typical jobs in which melting small parts is performed include (not necessarily limited to): • dental lab
Job Performance Measures Most Often Impacted by Melting (Small Parts):	Final quality of product (characteristics identified by lab).
Typical Employee Comments about Melting (Small Parts):	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms and shoulders/neck.
Suggested Level II Analysis:	Grip Force, Postural Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work is performed in a restricted space	41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
	• Jig or fixture is not available	136. Rotate the work piece • provide fixture or jig with rotational capability		✓	med	med	med
	• Work location is too high or too far away	83. Provide an adjustable height lift table		✓	high	med	med
		123. Raise the person • use a step stool • provide an adjustable platform	✓	✓ ✓	low high	med med	med high
		41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Lighting is not appropriate for the detail required	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
		• provide a task light with a magnifying glass		✓	med	high	high
	• Object is located flat on the work surface	136. Rotate the work piece • provide a fixture or jig with rotational capability		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work objects are located too far away	41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
		136. Rotate the work piece • provide fixture with rotational capability		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Work piece must be hand held	136. Rotate the work piece • provide a fixture or jig with rotational capability		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has sharp or hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		112. Provide support for the arms		✓	med	med	med
		• add padded arm rest extensions to table top					
	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" (12.7cm) in length		✓	med	med	med
		• wrap handle with fabric tape	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface too low	124. Raise the work piece/work surface • raise the table onto blocks	✓		low	med	med
	• Lighting is not appropriate for the detail required	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
		• provide a task light with a magnifying glass		✓	med	high	high
	• Movement around work area is restricted	79. Provide a work surface which is adjustable in height		✓	med	med	med
		81. Provide adequate toe clearance • provide toe spaces at standing work stations		✓	med	med	med
13. Twisting of the lower back	• Work objects are located too far away	41. Move work piece closer to body • move supplies and tools within easy reach	✓		low	med	med
		136. Rotate the work piece • provide fixture		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Chair is inappropriate for task	115. Provide support for the lower back • adjust the chair's backrest forward • provide a chair which has an adjustable floating backrest	✓	 ✓	 low med	 med med	 med med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
		52. Provide a footrail or footrest	✓	✓	med	low	low
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓ ✓		low low	med med	med med
	• Work surface does not have toe spaces	81. Provide adequate toe clearance • provide toe spaces at standing work stations.		✓	med	med	med
21. Awkward leg postures	• Chair is too high/dangling feet	52. Provide a footrail or footrest	✓	✓	med	low	low
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light					
		• orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights					
		• adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Monitoring	
TASK TITLE: Monitoring	
Task Description:	For maintenance and inspection tasks, monitoring is generally performed within the context of another task such as machining or pressure checking. Monitoring refers to the process of continually or repeatedly viewing gauges or computer screens. The monitoring task is similar to using a computer and to machine aided visual inspection. Monitoring differs from using a computer in that using a computer involves keying or other data entry while monitoring is primarily limited to viewing of the information. The distinction between monitoring and inspection is that monitoring involves processed information (a gauge, dial or readout) while inspection is looking at the item itself.
Job Performance Measures Most Often Impacted by Monitoring:	• Ensuring that the system performs appropriately • Detection and correction of parameters which impact safety, system performance, and product quality.
Typical Employee Comments about Monitoring:	Employees most often report fatigue or discomfort in the following body regions: shoulders/neck, or head/eyes.
Suggested Level II Analysis:	Postural Analysis, Light measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Rarely occurs	N/A					
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Display is improperly positioned -too high -too low -off-center	18. Improve visual access to work • position frequently accessed displays 0-4" below eye level	✓	✓	med	med	low
		• position frequently accessed displays directly in front of person	✓	✓	med	med	low
		• angle off-center displays towards the person	✓	✓	med	med	low
	• Display is too far away	39. Move monitor/screen closer to body • position displays between 18"-30"(46-76 cm) 22-24"(56-61 cm) is a good distance for general tasks		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Readouts are too small	18. Improve visual access to work					
		• use digital displays only when exact values are needed		✓	low to high	med	med
		• use analog displays when trends, ranges or status values are needed		✓	low to high	med	med
		• ensure that all numbers and messages are easily readable (character height at least .25") for normal (18-30"(46-76 cm)) viewing distances		✓	low to high	med	med
	• Light levels are too low	22. Increase light levels					
		• provide a task light which is easy to adjust	✓		med	med	med
		• increase room lighting		✓	high	high	high

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/ thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Display is too low	30. Lower the monitor screen • position frequently accessed displays 0-4" (0-10cm) below eye level	✓		low	med	low
	• Display is too far away	39. Move monitor/screen closer to body • position displays between 18"-30" (45.7-76.2 cm) • 22"-24" (55.9-61 cm) is a good distance for general tasks		✓	low to high	med	med
	• Display readout is too small	18. Improve visual access to work • use digital displays only when exact values are needed		✓	low to high	med	med
		• use analog displays when trends, ranges or status values are needed		✓	low to high	med	med
		• ensure that all numbers and messages are easily readable (character height at least .25"(.64 cm)) for normal (18-30"(46-76cm)) viewing distances		✓	low to high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		14. encourage person to have visual disorders corrected • regular eye exams • use of tri-focals or other prescription glasses suited to viewing monitor distances without backwards neck bending	✓	✓	med med	med med	med med
13. Twisting of the lower back	• Display is off center	18. Improve visual access to work • position frequently accessed displays directly in front of person • angle off-center displays towards the person	✓ ✓		med med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Display readout is too small	124. Raise the work piece/work surface • raise the monitor	✓		low	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back • pull chair forward and lean back while working • attach a small pillow to back rest to support lower back • provide a chair with adequate lower back support	 ✓ ✓ ✓ 	 ✓	 low low low med	 low low low med	 med med med med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	low	low
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on • use a cushion eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med to high	med	med
	• Work station has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Light levels too high	27. Lower the light levels		✓	high	low	med
	• Gauges/Displays are poorly positioned	18. Improve visual access to work					
		• position frequently accessed displays 0-4" (0-10 cm) below eye level	✓	✓	med	med	med
		• position frequently accessed displays directly in front of person	✓	✓	med	med	med
		• angle off-center displays towards the person	✓	✓	med	med	med
	• Glare reflected on monitor or off work surface	109. Provide protection from glare from overhead lights/task lights					
		• provide screen hood/visor.	✓		med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
		• position monitor between overhead lights.	✓	✓	med	low	low
		• tilt monitor down to change the angle of reflection	✓		low	low	low

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Task light causes glare	109. Provide protection from glare from overhead lights/task lights • direct task light away from screen and eyes	✓		low	low	low
	• Position of window in relation to monitor (in front or behind person) causes glare	108. Provide protection from glare (from natural light) • place monitor perpendicular to the window.	✓	✓	med	low	low
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med	med	med
	• Monitor positioned too close to eyes.	40. Move monitor/screen further away from body • position monitor 18 -30" (46-76 cm) from the eyes	✓	✓	med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Monitor positioned too far from eyes.	39. Move monitor/screen closer to body • position monitor 18 -30" (46-76 cm) from the eyes		✓	med	med	med
	• Uncorrected visual disorders.	14. Encourage person to have visual disorders corrected					
		• encourage person to have eyes checked and corrected for visual disorders.	✓		low	med	med
		• use of tri-focals or other prescription glasses suited to viewing monitor distances without backwards neck bending		✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Task lacks variety	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

CASE STUDY - Nailing	
TASK TITLE: Nailing	
Task Description:	Nailing involves the use of a hammer or nail gun to drive nails into a variety of materials. The hammering task can be done at a variety of heights and locations. Task duration is dependent on the complexity or nature of the product. Hammers and nail guns vary in size and weight depending on the size nail to be used and the type of material to be nailed. Typical jobs in which nailing is performed include: • carpentry • crating or other wood assembly processes • general maintenance Nailing may take place on bench tops, directly on wood structures, or on the floor.
Job Performance Measures Most Often Impacted by Nailing:	• Quality of the final product (structural integrity, free of defects, appearance) • Speed of completion of task
Typical Employee Comments about Nailing:	Personnel typically report fatigue or discomfort in the hands/wrists/arms, shoulders/neck and lower back. Primary: The primary body regions affected are typically the hands/wrists/arms and shoulders/neck. Secondary: In some cases, the following body regions are also affected: back/torso.
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Grip Force Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	low	med	med
		• provide a fixed platform or scaffolding	✓	✓	med	med	med
		32. Lower the work piece/work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Number of fasteners determines the amount of nailing required	129. Reduce number of fasteners used	✓	✓	low to med	med	med
		140. Use alternative fasteners					
		• Use fasteners (such as screws) that reduce number of fasteners needed		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Manual nailing causes high forces	66. Provide a power tool • use a power tool which does not require high force or high speed movements to activate (see Design Criteria section for power tool design criteria)		✓	med	med	med
	• Nail gun is heavy	59. Provide a lighter weight tool • provide lighter weight tool • provide appropriate sized hammer for each task		✓ ✓	med med	med med	med med
	• Carrying pieces of wood over long distances is fatiguing for arms	48. Provide a cart • use an available cart to transport wood	✓		low	med	high

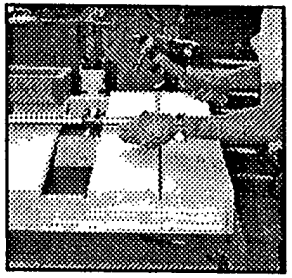
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Manual nailing causes high speed movements	66. Provide a power tool • use a power tool which does not require high force or high speed movements to activate (see Design Criteria section for power tool design criteria) 140. Use alternative fasteners • Use fasteners (such as screws) that reduce number of fasteners needed		✓ ✓	med med	med med	med med
4. Head/neck bent or twisted	• Rarely occurs to any significant exposure level	N/A					

Hand/Wrist/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Manual nailing causes wrist movements (see Figure 1.1) **Figure 1.1** • Nailing is performed on flat work piece with a pistol-shaped nail gun.	77. Provide a tool with an appropriate handle angle • use a power tool which does not require awkward wrist movements or postures (see Design Criteria section for power tool design criteria) 136. Rotate the work piece • turn the work piece to an upright position/angle forward	 ✓	 ✓	 med low	 med med	 med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Using nail gun causes repeated single finger trigger activation	62. Provide a multi-finger trigger • provide a tool with a two-finger trigger		✓	med	med	med

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied (see Figure 1.2)	118. Provide support for the work piece • use clamp to stabilize part		✓	med	med	med
	 **Figure 1.2**	54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		• wrap the hammer handle with friction tape	✓		low	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide appropriate sized nail gun for the particular task		✓	med	med	med
	• Force required to activate the nail gun is excessive	34. Maintain hand tools/power tools • repair and lubricate tool to minimize forces required to activate	✓		low to med	med	med
		76. Provide a tool which requires minimal force to use • provide a nail gun with minimal force required to activate		✓	med	med	med

Hand/Wrist/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Force required to pound nails is excessive	140. Use alternative fasteners • Use fasteners (such as screws) that reduce number of fasteners needed and reduce forces required		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Manual nailing causes high speed movements and impact	66. Provide a power tool • provide a pneumatic nail gun		✓	med	med	med
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves • (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	✓		med	med	med
		105. Provide portable heaters		✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs (See question 15, static awkward postures)	N/A					
13. Twisting of the lower back		132. Remove obstructions	✓		low	med	med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • provide a pad/mat	✓		med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 66. Provide a power tool • increase the speed of the task to decrease the time bent forward.		✓ ✓ ✓	med med high	med med med	med med high
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing on hard surface	96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Hard edges in work area contact legs/knees • Kneeling required	95. Provide appropriate knee protection	✓		med	med	med
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface • place the work piece on a fixed table • provide a support fixture	✓	✓	low med	med med	med med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Opening/Closing Heavy Doors	
TASK TITLE: Opening/Closing Heavy Doors	
Task Description:	Opening and closing of heavy doors is a task which often must be performed prior to initiating or completing the primary work tasks. The types of doors may include large hangar doors that move sideways on tracks, doors that move up and down on rollers or tracks, and large hinged doors on buildings or pieces of equipment. The defining characteristics of doors in this case study is that they are moved, not removed (i.e., it is never necessary to manually support the full weight of the door).
Job -- Performance Measures Most Often Impacted by Opening/Closing Heavy Doors:	There are typically no performance measures associated with the Open/Close Heavy Doors task. However, a door which is difficult to move may be left open making temperature control inside a shop difficult to maintain.
Typical Employee Comments about Opening/Closing Heavy Doors:	Employees do not typically complain about fatigue and discomfort associated with opening/closing heavy doors. They are, however, typically concerned about hurting their backs when they must deal with a door that is in disrepair or that is otherwise difficult to move. Primary body regions affected (or injured) include the shoulders, and lower back. Secondary body parts affected may include legs/feet, and sometimes the hands.
Suggested Level II Analysis:	Biomechanical Lifting Analysis, Push/Pull Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
1. Reaching	• Rarely occurs	N/A					
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Weight of door is excessive	107. Provide powered or mechanical assistance for door					
		• modify existing door		✓	med	med	med
		• add counter balance to decrease effort		✓	med	med	med
		• add a motor to eliminate manual opening/closing		✓	med	med	med
		58. Provide a lighter weight door					
		• replace heavy door with light-weight door		✓	high	med	med
		61. Provide a mechanical lift device		✓			
		• use a hoist/lifting device to assist in opening /closing vertical doors			high	med	high
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms	✓		med	med	med
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		low	med	med
		• Clean and lubricate tracks, rollers or movement mechanisms.					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
3. High speed, sudden shoulder movements	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• move door slowly and increase speed as the door begins to move	✓		low	low	low
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	med	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	med	med
4. Head/ neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation 10. Exposure to hard edges	• Handle or gripping surface is too small or does not exist	94. Provide appropriate handles • modify existing door • provide auxiliary handle: – avoid use of "cut-out" for handle – if "cut-out" is necessary, provide a vertical bar inside cut-out to enable the person to use a full hand grip • attach external vertical handle		✓ ✓ ✓	med med med	med med med	med med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
8. Hand/grip forces	• Handle or gripping surface is too small, is inappropriate, or does not exist	3. Change a pinch grip to a power grip • replace fingertip latches with larger latches that can be activated using the whole hand		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
12. Repeated forward or sideways bending movements	• Handle is too low (see Figure 1.1) **Figure 1.1** • Door location/access is too far away	121. Raise the handle • raise the door handle		✓	med	med	med
		55. Provide a hook-type tool to pull items • use a hook to initiate a pull from floor level	✓	✓	low to med	med	med
		132. Remove obstructions • remove obstructions along the path of travel	✓	✓	low to med	med	med
13. Twisting of the lower back	• Handle or gripping surface is too small or does not exist	94. Provide appropriate handles • modify existing door		✓	med	med	med
		• provide auxiliary handle: – avoid use of "cut-out" for handle		✓	med	med	med
		– if "cut-out" is necessary, provide a vertical bar inside cut-out to enable the person to use a full hand grip	✓		med	med	med
		• attach an external vertical handle					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• provide training to illustrate proper method	✓		low	low	low
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• push rather than pull, whenever possible	✓		low	low	low
		• face the direction of movement when pushing	✓		low	low	low
		• use 2 hands or keep the body balanced when pulling	✓		low	low	low
14. High speed, sudden movements	• Procedure used by employee places unnecessary stress on shoulder	13. Encourage ergonomic work techniques					
		• provide training to illustrate proper method	✓		low	low	low
		• use entire body and momentum (lean) to move door	✓		low	low	low
		• move door slowly and increase speed as the door begins to move	✓		low	low	low
	• Tracks, rollers or movement mechanism are worn or out of alignment	35. Maintain tracks, rollers, and movement mechanisms.					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	low	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	low	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
15. Static, awkward back postures	• Rarely occurs						
16. Lifting forces	• Weight of door is excessive	107. Provide powered or mechanical assistance for door.					
		• modify door		✓	med	med	med
		• add counter balance to decrease effort	✓	✓	med	med	med
		• add a motor to eliminate manual opening/closing		✓	med	med	med
		58. Provide a lighter weight door					
		• replace heavy door with light-weight door		✓	high	med	med
	• Tracks, rollers or movement mechanism are worn or out of alignment	61. Provide a mechanical lift device					
		• a hoist/lifting device to assist in opening /closing vertical doors		✓	high	med	high
		35. Maintain tracks, rollers, and movement mechanisms					
		• inspect and repair (as required) tracks, rollers or movement mechanism	✓		med	med	med
		• clean and lubricate tracks, rollers or movement mechanisms.	✓		low	high	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		✓ Quality	✓ Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Ordnance Disposal	
TASK TITLE: Ordnance Disposal	
Task Description:	Ordnance disposal involves responding to the discovery of an unidentified device or possible explosive device. A team of individuals responds to identify the device and determine whether or not the device is an active explosive. Completing these procedures often requires members of the team to repeatedly walk large distances (e.g., 300 - 1000 meters) to and from the device. Heavy pieces of equipment are also carried by the employee over these distances. After the team has determined the status of the device, the device is exploded/deactivated, or otherwise removed from the area. The task involves loading/unloading equipment (e.g., x-ray) onto trucks, traveling to the site, donning specially designed protective gear, and completing the tasks described above.
Job Performance Measures Most Often Impacted by Ordnance Disposal:	Response time is a primary measure of performance. Factors that appear to impact that response time include: • time to unpack and don the protective suit; • time to load equipment onto truck; and • time to unpack/prepare equipment for use in the field. The measure of success is safety, avoidance of injury to individuals or damage to the surrounding area.
Typical Employee Comments about Ordnance Disposal:	Employees first comment about the weight and bulk of the protective suit and the increased fatigue that the suit causes while walking great distances. Primary body parts affected, based on employee complaints of discomfort, are the arms, shoulders, and low back. Secondary concerns are for the legs and feet.
Suggested Level II Analysis:	Dynamic Task Analysis, Biomechanical Lifting Analysis, Metabolic Energy Expenditure Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• The employee is too low for "dressing" the other employee with protective suit (see Figure 1.1) **Figure 1.1**	123. Raise the person • provide a stable work platform to assist with dressing torso, shoulders and head • employee being dressed can step up or down to different heights	✓ ✓	✓	med low	med med	med med
2. Arm forces: Repeated arm forces or holding/carry-ing materials	• The need to carry heavy equipment over great distances increases stress	48. Provide a cart • place all equipment cases on permanent rollers or wheel carts • fabricate a carrier equipped with a wheel to transport individual pieces of equipment to and from the device 131. Reduce weight of work piece • light-weight equipment and /or storage containers		✓ ✓ ✓	med med high	med med med	med med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Complexity of suit design increases demands and hands and wrists	11. Eliminate unnecessary tasks • simplified suit design		✓	high	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Working in a cold environment exposes the hands to cold.	104. Provide handles with insulating material • add insulating material to equipment handles to prevent heat transfer		✓	med	med	med
		12. Encourage appropriate seasonal clothing	✓		med	med	med
		93. Provide appropriate gloves	✓		low	med	med

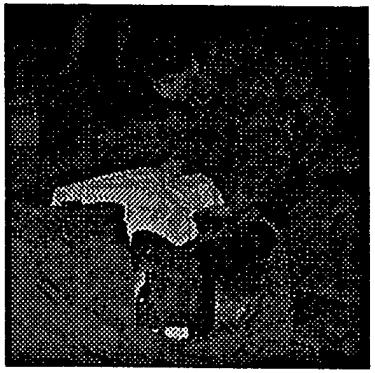
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Ground level storage of equipment and containers (see Figure 1.2) **Figure 1.2**	83. Provide an adjustable-height lift table • large collapsible work platform/table on which equipment and containers can be placed as they are unloaded from the truck.		✓	high	med	high
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso-(cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• The need to manually carry portable equipment increases force.	48. Provide a cart • fabricate a carrier equipped with a wheel to roll individual pieces of equipment to and from the device location		✓	med	med	med
	• Inappropriate storage container design increases handling requirements	11. Eliminate unnecessary tasks • equip storage cases with hinges so that they may be opened without the employee having to lift and support the weight of the cover.		✓	med	med	med
	• Equipment and suit is stored away from the truck	11. Eliminate unnecessary tasks • dedicated storage area • storage on secured trucks to enable team to store suits and all equipment on trucks; eliminate the need for transferring equipment		✓ ✓	med med to high	med med	med med
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Knees are exposed to hard edges during kneeling	95. Provide appropriate knee protection • reinforce knee area of protective suit to provide cushioned surface for kneeling		✓	med	med	med
21. Awkward leg postures	• Storage of equipment and cases at floor or ground level requires the employee to kneel or squat (see Figure 1.3)  **Figure 1.3**	124. Raise the work piece/work surface • provide large collapsible work platform/table on which equipment and containers can be placed as they are unloaded from the truck.		✓	high	med	high
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • equip truck or team with area flood light		✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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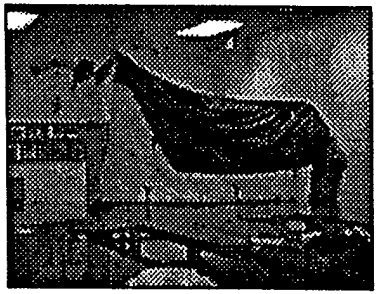
CASE STUDY - Packing	
TASK TITLE: Packing	
Task Description:	Packing involves lifting the product and placing it into a container. Once it is placed into the container the individual manually pulls the edges of the fabric together to produce a complete package. Cords are manually pulled through the holds of the outer fabric to tighten and size piece. The packing pattern must be followed for each type of product (patterns outlined in product manual). Most packing patterns are performed by two individuals due to the size of the product and the force required to pack the work piece. Typical jobs in which folding is performed include (not necessarily limited to): • Parachute packing • Raft packing The packing process can be performed on a table or on the floor surface.
Job Performance Measures Most Often Impacted by Packing:	Quality of the product (packing). Speed of packing
Typical Employee Comments about Packing:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms, back and legs/feet. Primary concern: back/torso and legs/feet Secondary concern: hands/wrists/arms
Suggested Level II Analysis:	Dynamic task analysis, Postural Analysis, Grip Force Measurement

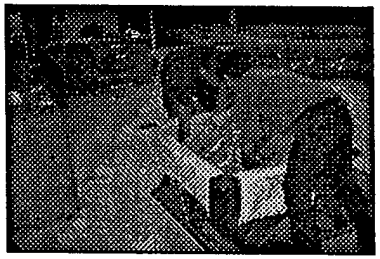
Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (see Figure 1.1)	123. Raise the person • use a step stool, platform or ladder	✓	✓	low to med	med	med
	 **Figure 1.1**	32. Lower work piece		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location • remove obstruction	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	Pulling cords or container is difficult (see Figure 1.2)	55. Provide a hook-type tool to pull items					
		• provide curved hook to assist pulling cord.	✓	✓	low to med	med	med
		26. Improve floor condition					
		• repair cracks or gaps in floor		✓	med to high	med	med
		and		✓			
		• provide ramps to compensate for minor differences in floor height	✓		med to high	med	med
		• Improve housekeeping			low	med	med
	Figure 1.2						
	• Poor hand holds						
	• Poor housekeeping						
	• Poor floor condition						
	• Carrying folded packed work piece more than three steps	48. Provide a cart					
		• provide trolley to move work piece		✓	med	med	med
		61. Provide a mechanical lift device		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.3)  **Figure 1.3**	124. Raise the work piece/work surface • provide a fixed table to support work piece		✓	med	med	med
		13. Encourage ergonomic work techniques • educate person to work in a kneeling position when item is located on floor surface (provide knee protection).	✓		low	med	med
	• Work location is too high	123. Raise the person • provide fixed height platform		✓	med	med	med

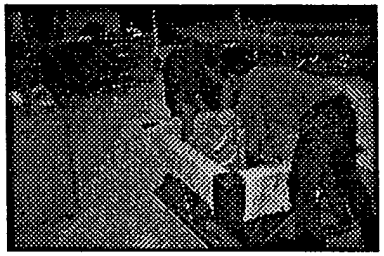
Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
	• Work location is too high	123. Raise the person • use a fixed platform		✓	med	med	med
6. Repeated manipulations with fingers	• Task is repetitive in nature requiring similar movement patterns.	20. Incorporate rest pauses	✓		low	med	med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Excessive force required to tighten cord and pack	13. Encourage ergonomic work techniques • twist cord around T-hook to assist with pulling cords. • use knee rather than hand to push down on pack when item is located on floor surface.	 ✓ ✓		 low low	 med med	 med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Small diameter of the cord	3. Change a pinch grip to a power grip • twist cord around a small rod to change the grip from a pinch to a power grip.	✓		low	med	med
9. High speed hand/wrist/arm movement or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has hard or sharp material edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges	✓	✓	low med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

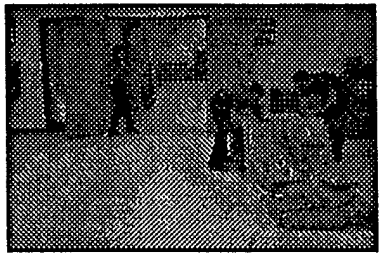
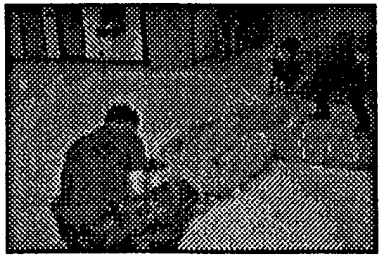
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work Location is too low (see Figure 1.4)  **Figure 1.4**	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide and adjustable table for work piece		✓ ✓	med high	med med	med high
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually 132. Remove obstructions	✓ ✓		low low	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	Lifting heavy packed objects • low height • no hand holds	61. Provide a mechanical lift device • provide lifting hoist to move raft or work piece		✓	high	med	high
		13. Encourage ergonomic work techniques • educate person on two man lift procedure	✓		low	med	med
17. Pushing or pulling	Pulling/pushing storage containers is difficult • Poor housekeeping • Poor floor condition • Lack of wheels on container	17. Improve floor condition • repair cracks or gaps in floor		✓	high	med	med
		• provide ramps to compensate for minor differences in floor height		✓	high	med	med
		• improve housekeeping	✓		low	med	med
		13. Encourage ergonomic work techniques • position packing container so that it does not have to be moved after loading	✓		low	med	med
		119. Provide wheels • mount wheels onto bottom of container		✓	med	med	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

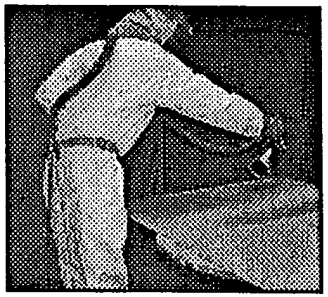
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing on hard surface (see Figure 1.5)  **Figure 1.5**	96. Provide appropriate shoe inserts 86. Provide an appropriate anti-fatigue mat	✓	✓	low med	med med	med med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work height too low (see Figure 1.6)  **Figure 1.6**	1. Alternate between sitting and standing tasks • periodically stand up to change position. 95. Provide appropriate knee protection	✓ ✓		low med	med med	med med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

CASE STUDY - Painting/ Spraying	
TASK TITLE: Painting/Spraying	
Task Description:	Painting involves the use of a paint applicator such as a roller, or paint spray gun. Painting can be performed on a variety of surfaces and/or objects. Typical jobs in which painting is performed include: • construction • aircraft maintenance • vehicle maintenance Painting may be performed on vertical, horizontal, overhead, or floor surface, and on or under a variety of different surfaces/shapes.
Job Performance Measures Most Often Impacted by Painting:	Coverage and surface finish. Task completion on schedule.
Typical Employee Comments about Painting:	The most common reports of discomfort have been of the hand/wrist, shoulder and neck. The concentration can vary with the method used for paint application. Primary concerns are: shoulder/neck, hand/wrist/arm Secondary concerns are: back/torso, legs/feet
Suggested Level II Analysis:	Grip Force Measurement, Dynamic Task Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	103. Provide extensions for tools • provide extensions on roller to improve arm posture while painting overhead or on high walls		✓	med	high	high
		123. Raise the person • use a step stool or ladder • provide a platform or scaffolding • provide painter's stilts	✓	✓ ✓ ✓	med high med	med med med	med high high
	• Painting is performed on flat work surface (see Figure 1.1)  **Figure 1.1**	103. Provide extensions for tools • provide extensions on roller to improve arm posture while painting overhead		✓	med	med	med
	• Orientation of parts or spray technique requires a top to bottom (spraying from high to low) pattern	136. Rotate work piece • change from vertical to horizontal orientation to allow side-to-side spray pattern (arms move, wrists stay straight).	✓	✓	low to med	high	med
		13. Encourage ergonomic work techniques • spray in a side-to-side pattern	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	Pulling hoses and carts used for spray paint systems • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	✓ ✓	 ✓ ✓ ✓	low low to med low med high	med med med med med	med med med med high
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too high (see Figure 1.2) **Figure 1.2**	114. Provide support for the head • provide a head and neck support which rests on the shoulders for continuous overhead work 123. Raise the person • provide a fixed platform • provide scaffolding 32. Lower the work piece/work surface • reduce height of existing table • provide an adjustable height work table 103. Provide extensions for rollers	 ✓	 ✓ ✓ ✓ ✓ ✓	low med high med high med	med med med med med med	med med high med high med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using wrist movements to paint with a brush or spray gun.	13. Encourage ergonomic work techniques					
		• encourage person to use arm movements rather than wrist movements while painting	✓		low	med	med
		• spray in a side-to-side pattern rather than an up-and down-pattern	✓		low	med	med
		106. Provide powered assistance for a manual activity			low to med	med	med
		• use a roller or a paint gun instead of a paint brush whenever large surfaces are being painted		✓			
	• Part is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		103. Provide extensions for tools		✓	med	med	med
		• to access tight locations					
	• Work location is too high causing awkward wrist positions	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform or scaffolding		✓	high	med	high
		• provide painter's stilts		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of painting gun with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two finger or a four finger trigger • extend trigger on existing tool (if feasible and safe) 10. Eliminate need to constantly hold trigger • provide a tool with a toggle switch that allows continuous operation without holding the trigger down		✓ ✓ ✓	med med med	med med med	med med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Part must be manually supported, held or steadied	118. Provide support for work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		113. Provide support for the cable or hose • provide a hook to hang spray in gun hose		✓	med	med	med
		• support air hose with a belt clip		✓	med	med	med
		76. Provide a tool which requires minimal force to use		✓	med	med	med
		• provide a swivel attachment for air hose on paint gun		✓	med	med	med
		• support air hose with a tool balancer or belt clip					
	• Tool is too heavy	116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight tool • Provide lighter weight housing for spray gun		✓	high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a handle which is round and smooth with no ridges or edges • provide a handle of at least 5" (12.7 cm) in length (provide adequate clearance for gloves)		✓ ✓	med med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs to any significant degree	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.3) **Figure 1.3**	124. Raise the work piece/ surface • provide a fixed table to support part	✓	✓	low to med	med	med
		• provide an adjustable table for part		✓	high	med	high
		• angle part using a wooden frame fixture		✓	med	high	med
		31. Lower the person • provide a chair/stool to sit on	✓	✓	low to med	med	med
13. Twisting of the lower back	• Work location is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work space or access is limited (such as under a structure)	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		124. Raise the work surface • use a hoist/lift device to raise the structure to create improved access		✓	high	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support part • provide an adjustable table for work piece 8. Distribute intensive activities throughout the process • perform the most awkward painting tasks intermittently if possible	✓	✓ ✓ ✓	low to med high med	med med med	med med med
16. Lifting forces	• Rarely occurs	• N/A					
17. Pushing or pulling	Pulling hoses and carts • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	✓ ✓	 ✓ ✓ ✓	low med low med med to high	med med med med med	med med med med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.4) **Figure 1.4**	96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide knee pads • provide a cushion to kneel on	 ✓ ✓		 low low	 med med	 med med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	low to med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
		31. Lower the person					
		• provide knee pads	✓		low	med	med
		• provide a chair/stool to sit on	✓		low	med	med
		• provide a pad or cushion to kneel on	✓	✓	low to med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

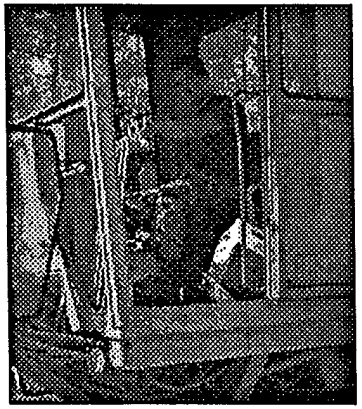
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low.	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Paving	
TASK TITLE: Paving	
Task Description:	Paving involves the operation of heavy equipment. The paver spends the majority of time in a seated position operating equipment levers (levers operate in a horizontal throw pattern). The duration of the task depends on the paving job assigned that day. Typical jobs in which paving is performed include (not necessarily limited to): • road repair and maintenance
Job Performance Measures Most Often Impacted by Paving:	• Integrity of the surface.
Typical Employee Comments about Paving:	Employees typically complain about discomfort and/or stiffness in the hands/wrists/arms and back. The primary areas of concern are the hands/wrists/arms, back/torso and legs/feet. The secondary areas of concern are the shoulders/neck.
Suggested Level II Analysis:	Postural Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Task is repetitive and lacks variety	20. Incorporate rest pauses	✓		low	med	med
	• Controls are located too far away from employee (see Figure 1.1)	87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan, proper lumbar support and the ability move forward		✓	high	med	med
	 **Figure 1.1**						
	• Lack of arm supports	112. Provide support for the arms • provide flexible arm supports or pad contact surface with compressible material.		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Windshield is dirty or broken	18. Improve visual access to work • replace windshield if broken • clean windshield if dirty.	✓	✓	med low	med med	med med
	• Absence of sun visor	108. Provide protection from glare of natural light • provide sun visor for cab's interior		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/ repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					

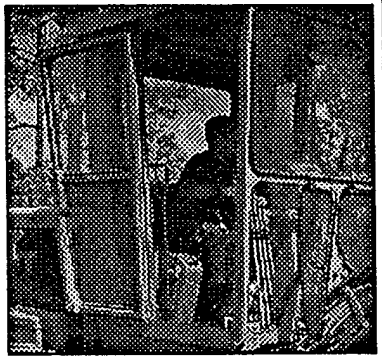
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Vibration from the steering wheel is not damped. (see Figure 1.2) **Figure 1.2**	91. Provide anti-vibration materials • provide anti-vibration padding for the steering wheel 93. Provide appropriate gloves • provide anti-vibration gloves		✓ ✓	med med	med med	med med
10. Exposure to hard edges	• The window edges and other cab interior surfaces create edges of concentrated stress	9. Eliminate exposure to hard edges • pad contact surface with compressible material	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold or cab interior is cold	105. Provide portable heaters 93. Provide appropriate gloves	 ✓	✓	med low	med med	med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Seat faces away from work area	82. Provide adequate work space • purchase future trucks with swivel seat capability		✓	high	med	high
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Task lacks variety (see Figure 1.3) **Figure 1.3** • Inadequate seating	25. Increase task variety 20. Incorporate rest pauses 87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan and proper lumbar support	✓ ✓	 ✓	low low high	med med med	med med med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• The vibration damping materials are in need of maintenance or seating mounts are inadequate. (see Figure 1.4)  **Figure 1.4**	87. Provide an appropriate chair/stool • provide chair with a vibration dampening seat pan and proper lumbar support.		✓	high	med	med
		12. Encourage appropriate clothing • encourage operator to wear loose fitting clothing	✓		low	low	low
		20. Incorporate rest pauses	✓		low	med	med

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Cab has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med
21. Awkward leg postures	• Seat is improperly positioned in a small cab	87. Provide an appropriate chair/stool • provide height adjustable chair with a vibration dampening seat pan and proper lumbar support		✓	med	med	med
		• adjust seat backward/extended foot controls is necessary		✓	med	med	med
		80. Provide adequate leg clearance • move personal items	✓		low	med	med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high.	• Windshield is dirty or broken	18. Improve visual access to work • replace windshield if broken • clean windshield if dirty.	✓	✓	med low	med med	med med
	• Absence of sun visor	108. Provide protection from glare of natural light • provide sun visor for cab's interior	✓		low	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Prying	
TASK TITLE: Prying	
Task Description:	This task involves using a pry-bar or crow-bar to loosen or remove a door, lid, or component. In some cases, a screw driver or other tool is enlisted for the task. The working end of the tool is positioned on or near the part that is to be pried apart. Sometimes the pry bar needs to be hammered or forced into place. Once positioned force is applied to the handle to pry apart the two pieces. Typical jobs in which prying is performed include (not necessarily limited to): • shipping • warehousing • wood shop • fabrication • maintenance (e.g., tire repair) The primary ergonomics concern with prying is force.
Job Performance Measures Most Often Impacted by Prying:	Task performed in desired amount of time.
Typical Employee Comments about Prying	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists and sometimes in the back. Primary: hand/wrist/arm and shoulders/neck Secondary: back/torso
Suggested Level II Analysis:	Grip Force Measurement, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Rarely occurs	N/A					
2. Arm forces: Repeated arm forces	• High forces required to pry object	21. Increase handle length to improve leverage • provide longer pry bars to minimize reaching		✓	med	med	med
3. High speed sudden shoulder movements	• High forces required to pry object	76. Provide a tool which requires minimal force to use • provide a pry bar with a hammering location		✓	med	med	med
		• use a hammer/mallet to work the component loose gradually	✓		low	med	med
		32. Lower the work piece/work surface • this would allow the person to use more of his/her body weight to perform the task while the arms are in a strong position		✓	med	med	med
		144. Provide a machine/automate • purchase a machine for tire maintenance		✓	high	med	high
4. Head/neck bent or twisted	• Rarely occurs to any significant exposure	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists repeated wrist movements or repeated forearm rotation	• Rarely occurs	N/A					
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Inadequate or slippery grip surfaces on the pry bar	54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible grip surface		✓	med	med	med
		• increase "handle" on pry bar; provide space for two-hand grip		✓	med	med	med
		66. Provide a power tool					
		• provide hydraulic tool separate parts (e.g., jaws of life)		✓	high	med	high
	• Handle is not long enough	21. Increase handle length to improve leverage		✓	med	med	med
	• Resistance between surfaces is high	76. Provide a tool which requires minimal force to use					
		• Provide a pry bar with a hammering location		✓	med	med	med
		• Use a hammer/mallet to work the component loose gradually	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Manual prying may require repeated, jerky movements.	66. Provide a power tool • provide a hydraulic tool to separate parts		✓	high	med	high
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs to any significant exposure level	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs to any significant level	N/A					
13. Twisting of the lower back	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • Provide a mat to cover sharp or blunt surfaces so that the worker can get closer to the work location	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Forces required to pry object loose	76. Provide a tool which requires minimal force to use • Provide a pry bar with a hammering location • Use a hammer/mallet to work the component loose gradually	✓	✓	med low	med med	med med
15. Static, awkward back postures	• Rarely occurs	N/A		✓	high	med	high
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs						
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Pumping	
TASK TITLE: Pumping	
Task Description:	The pumping task is general performed within the context of a larger job or task. The pumping task can vary in scope from a small hand pump requiring very little force, to a large pump such as a floor jack involving significant forces.
Job Performance Measures Most Often Impacted by Pumping:	• Completion of task in a reasonable amount of time.
Typical Employee Comments about Pumping:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, or back/torso. The primary body regions of concern are: shoulders/neck, back/torso The secondary body regions of concern are: hands/wrists/arms
Suggested Level II Analysis:	Grip Force Measurement, Elemental Task Analysis.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Pump handle position is too high	123. Raise the person • provide a stable platform		✓	med	med	med
		32. Lower the work piece/worksurface • position the pump handle near elbow level		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • change the pump handle angle or bend the handle		✓	med	med	med
	• Pump handle covers too much travel	51. Provide a foot pump • for low frequency high force tasks		✓	med	med	med
		66. Provide a power tool • use electric or air power to activate the pump		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Pumping forces are high	76. Provide a tool which requires minimal force to use • install a longer handle to increase leverage		✓	med	med	med
		• use a multiplying gear		✓	med	med	med
		• use a foot pump		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Inappropriate use of manual pump.	106. Provide powered assistance for a manual activity • use electric or air power to activate the pump		✓	med	med	med
4. Head/neck bent or twisted	• Visual Access is limited due to awkward pump position or obstructions	18. Improve visual access to work • position the display towards the operator's line of vision while the person is activating the pump • remove obstructions	 ✓	✓	med to high low	med med	med med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Pump handle is too small	103. Provide extensions for tools • provide a longer handle so that the activity is more focused on the arm than the hands/wrists		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand		91. Provide appropriate tool • use electric or air power to activate the pump		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • wrap the handle • provide a handle of at least 5" (12.7 cm) in length; add an extension		✓ ✓	med med	med med	med med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 12. Provide appropriate gloves	 ✓	✓	med low	low low	med med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Pump handle position inappropriate	124. Raise the work piece/worksurface • position the pump handle near elbow level		✓	med	low	low
		77. Provide a tool with an appropriate handle angle • change the pump handle angle or bend the handle		✓	med	med	med
		103. Provide extensions for tools • Install a longer handle		✓	med	med	med
13. Twisting of the lower back	• Rarely occurs	N/A					
14. High speed, sudden movements	• Pumping forces are high	76. Provide a tool which requires minimal force to use • use a multiplying gear		✓	med	med	med
		66. Provide a power tool • use electric or air power to activate the pump		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Pumping forces are high (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimal force to use • install a longer handle • use a multiplying gear 66. Provide a power tool • use electric or air power to activate the pump		✓ ✓ ✓	med med med	med med med	med med med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Foot pump is used regularly	58. Modify foot pedal • recess foot pedal to keep both heels on floor		✓	med	low	med
		• add a heel block	✓	✓	low to med	low	med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Riveting/Bucking	
TASK TITLE: Riveting/Bucking	
Task Description:	Riveting and bucking involves placement and fastening of rivets to hold sheet metal to a metal frame or to other sheet metal. The task requires a hard, heavy surface to pound against (i.e., the buck, a fist-sized, or smaller, piece of metal and a tool to pound with, being either a hammer or powered riveter. The flat head of the rivet is held by the buck on one side while the rivet is flattened out on the other by the hammer or riveter. Other tools used may be a metal stick to position the holes of the two pieces being mated, cleats which also act as guides, grinders, drills, screwdrivers, and pliers. Typical work locations in which sheet metal riveting and bucking are performed might include: • the shop floor • in jigs • on the aircraft itself. Riveting and bucking may be performed on vertical, horizontal, overhead, or on a variety of different surface shapes.
Job Performance Measures Most Often Impacted by Riveting/Bucking:	• The quality of the rivet • The speed of task completion.
Typical Employee Comments about Riveting/Bucking:	Employees commonly report of upper extremity, back, foot discomfort. Employees repeatedly identify stabilizing the buching bar as a primary source for upper extremity discomfort. Primary: varies depending on the task Secondary: varies depending on the task
Suggested Level II Analysis:	Grip Force Measurement, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool, platform or ladder	✓	✓	low to med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		med	med	med
	• Gun must be manually supported, held or steadied	117. Provide support for the upper body					
		• rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away from worker • Work location is blocked or is in an inappropriate orientation	41. Move work piece closer to body • provide adjustable height table or work surface • provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓ ✓	high med	med med	high med
		38. Move closer to the work location • move person closer to the work • provide sit-stand capability	✓	✓	low med	med med	med med
		112. Provide support for the arms • rest arms on nearby surfaces • provide flexible arm rests	✓	✓	low med	med med	med med
		8. Distribute intensive activities throughout the process • perform activity as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		103. Provide extensions for tools		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Force required to perform operation is high (see Figure 1.1) **Figure 1.1**	76. Provide a tool which requires minimal force to use • provide alternative riveter 116. Provide support for the tool • provide a jig such that the riveter and buck are not held simultaneously		✓ ✓	high med	med med	high med
3. High speed, sudden shoulder movements	• Rarely occurs	• N/A					

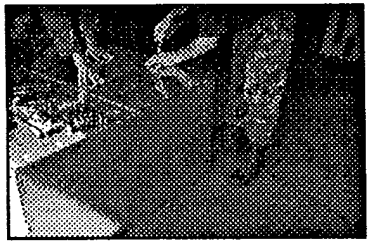
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece	✓	✓	low to med	med	med
		• provide an adjustable table		✓	high	med	med
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med to high	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		114. Provide support for the head					
		• Provide a cushion to support the head	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 foot-candles (500 - 1000 lux)		✓	high	high	med
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using riveter or buck on surface which requires poor orientation of riveter (see Figure 1.2)  **Figure 1.2** • Difficult to reach riveting or bucking operation	136. Rotate the work piece (bench work) • provide a fixture to orient the work piece to allow straight wrist postures		✓	med	med	med
		77. Provide a tool with an appropriate handle angle • the handle angle should allow the wrists to remain straight while working		✓	med	med	med
		79. Provide a work surface which is adjustable in height		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Setup and cleaning require many finger movements • Handling and placing rivets requires many manipulations	16. Improve cleat design 98. Provide automatic or semi-automatic feed for fasteners • riveter with automatic or semi-automatic feed		✓ ✓	med med	med med	med med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Single-finger trigger	62. Provide a multi-finger trigger • provide a tool with a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Work piece must be manually supported, held, or steadied	118. Provide support for the work piece • jig or fixture that supports the work piece such that the orientation and position allow easier access to part • develop support for the tool for riveter • develop a clampable buck for some tasks		✓ ✓ ✓	med med med	med med med	med med med
	• Tool is too heavy	59. Provide a lighter weight tool • reduce the weight of the riveter		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Air hose must be manually supported, held, or steadied	112. Provide support for the arms • rest arms on nearby surfaces • provide flexible armrests	✓	✓	low med	low med	low med
		113. Provide support for the cable or hose • use hook to hang hose on nearby structure	✓		low	med	med
		116. Provide support for the tool		✓	med	med	med
	• Work piece must be manually repositioned	118. Provide support for the work piece • use jig or fixture to reduce/ eliminate the need for gripping		✓	med	med	med

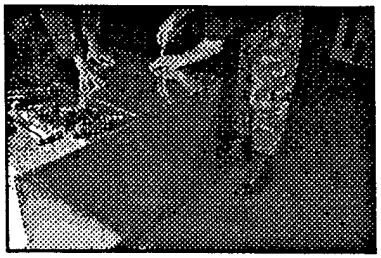
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements (impact)	• Excessive vibration (see Figure 1.3) **Figure 1.3**	74. Provide a tool that minimizes exposure to vibration/impact/ torque • riveter with better vibration characteristics • improved maintenance scheduling • provide vibration dampening material on handle		✓ ✓ ✓	med med med	med med med	med med med
10. Exposure to hard edges	• Hard/sharp edges present in worksite • Work piece has hard or sharp edges • Tool handle has sharp edges	9. Eliminate exposure to hard edges • use gloves that are: - cut resistant - high friction - padded palms • modify or purchase a new handle for tools with: - padding to reduce/eliminate contact - handle with increased surface area	✓	✓	low to med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		9. Eliminate exposure to hard edges • by covering sharp edges or exposed corners: - with padding - by rounding off	✓	✓	low to med	med	med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface too low (see Figure 1.4)  **Figure 1.4**	124. Raise the work piece/work surface					
		• provide an adjustable work surface	✓		high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches	✓		med	med	med
		31. Lower the person					
		• provide chair or stool		✓	med	med	med
		136. Rotate the work piece					
		• manually reorient the work piece	✓		low	med	med
		• provide a jig or fixture to allow the work piece to be rotated		✓	med	med	med
		77. Provide a tool with an appropriate handle angle					
		• reorient riveter handle		✓	med	med	med
		• reorient buck handle		✓	med	med	med
		103. Provide extensions for tools					
		• riveter with lengthened handle		✓	low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Location of work	41. Move work piece closer to body					
		• provide adjustable height table or work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓	med	med	med
		38. Move closer to the work location	✓		low	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location	✓		low	low	low
		32. Remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	low
		• provide a fixture to allow the work piece to be rotated		✓	med	med	low

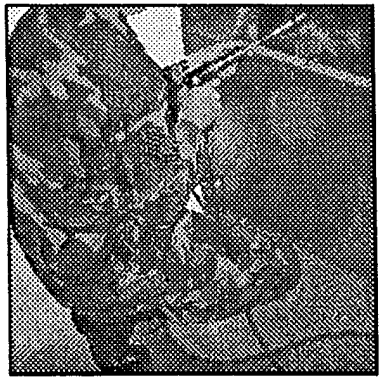
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		117. Provide support for the upper body • provide a padded surface to support upper body where work requires a bent or awkward posture		✓	med	med	med
		103. Provide extensions for tools		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform activity as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• pull chair forward and lean back while working	✓		low	low	low
		• adjust back rest to support lower back	✓		low	low	low
		• attach a small pillow to back rest to support lower back	✓		low	low	low
		• provide chair with lower back support		✓	med	low	low
16. Lifting forces	• if occurring, see Lifting Case Study	N/A					
17. Pushing or pulling	• if occurring, see Lifting Case Study	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓	✓	low to med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Work location is too low(see Figure 1.5)  **Figure 1.5**	124. Raise the work piece/work surface					
		• provide an adjustable work surface		✓	high	med	high
		• provide fixture or jig which can hold part, reorient part either horizontally or vertically, and eliminate reaches		✓	med	med	med
		31. Lower the person					
		• provide chair		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust	✓	✓	med	med	med
		• increase room lighting		✓	med	high	med
	• Task lacks variety	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

CASE STUDY - Sanding	
TASK TITLE: Sanding	
Task Description:	Sanding involves the use of manual (sandpaper, file, etc.) or powered (pneumatic/electric/hydraulic hand sanders) tools to remove or shape material. The work piece is often metal or wood. Additionally, the work piece can be fixed (in a vise) or supported (mounted on a structure). Typical jobs in which sanding is performed include: • aircraft maintenance • sheet metal repair • facility maintenance • model shop. Sanding may be performed on flat or upright surfaces directly on aircraft, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Sanding:	• Quality of finished surface (consistency, free of defects) • Speed of completion of sanding task.
Typical Employee Comments about Sanding:	Employees typically report discomfort and/or stiffness in the shoulders/neck and hands/wrists/arms. Primary: The primary body parts affected are the shoulder/neck and hand/wrists/arms Secondary: In some cases the back/torso and legs/feet are affected as well.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (see Figure 1.1)	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		112. Provide support for the arms	✓				
		• rest arms on near-by surfaces			low	med	med
		• provide flexible armrests		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (benchwork)	✓				
		• rotate the work piece manually			low	med	med
		• provide a fixture to allow the work piece to be rotated	✓	✓	med	med	med
		103. Provide extensions for tools		✓	med	med	med

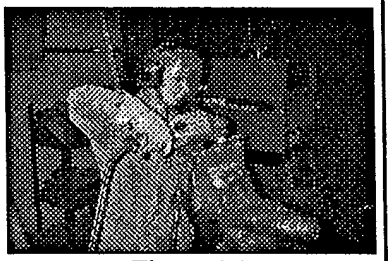


Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Tool requires high forces to remove material • Large quantity of material must be removed	66. Provide a power tool • substitute a high grit sand paper for remove large amounts of material	✓	✓	low to med	med	med
		133. Replace abrasive or cutting material frequently	✓		low	med	med
		76. Provide a tool which requires minimal force to use • use power tool whenever possible		✓	med	med	high
		• obtain a heavier duty tool which reduces forces and time required to remove material		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool is too heavy	59. Provide a lighter weight tool • provide power tools of minimal weight (particularly for lighter sanding tasks)		✓	med	med	med
3. High speed, sudden shoulder movements	• Manual sanding requires high speed arm movements	66. Provide a power tool use power tool whenever possible		✓	med	med	high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to raise the work piece	✓	✓	low to med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece(benchwork) • turn the work piece • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		114. Provide support for the head • Provide a cushion to support the head	✓		low	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access • increase the size of access ports to increase access		✓ ✓	high high	med med	high med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide light levels at the task of 50-100 fc (500 - 1000 lux) for sanding tasks -precision sanding tasks require more light: 100 fc (1000 lux or more)		✓	high	high	high
		• provide a task light which is easy to adjust	✓	✓	med	med	med
		• increase room lighting		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is too high	123. Raise the person • use a step stool or ladder • provide an adjustable platform or scaffolding	✓	✓ ✓	med high	med med	med high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	• Work location is too low (see Figure 1.2)	124. Raise the work piece/work surface • provide a fixed table to raise the work piece • provide an adjustable table	✓	✓ ✓	med high	med med	med high
		31. Lower the person • provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med

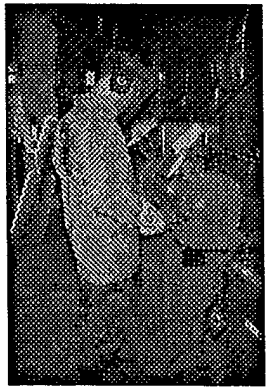
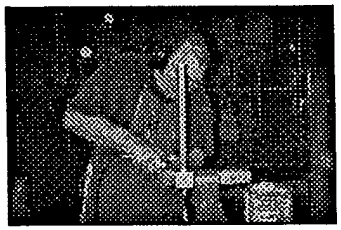
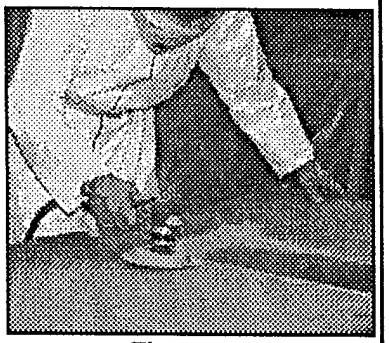


Figure 1.2

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool handle orientation causes awkward postures (see Figure 1.3)  **Figure 1.3**	77. Provide a tool with an appropriate handle angle orientation for specific tasks		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work) • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
		82. Provide adequate workspace • perform activity as bench work rather than on the aircraft/structure		✓	med	med	med
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of power tool with single finger trigger concentrates stress on finger (see Figure 1.4)  **Figure 1.4**	62. Provide a multi-finger trigger		✓	med	med	med
8. Hand/grip forces	• Hand sanding causes excessive fingertip forces	3. Change a pinch grip to a power grip • provide a sanding block with an attached handle so that pressure is applied with a full hand grip rather than a finger press	✓	✓	low to med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Welding tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a vice fixture to support work piece		✓	med	med	med
		54. Provide a friction gripping surface • provide a tool handle with a compressible grip surface • wrap the handle	✓	✓	med low	med med	med med
		116. Provide support for the tool provide a method to support the tool for bench work		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • provide a sander of minimal weight		✓	med	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Handle diameter is too large	75. Provide a tool that can be used with both hands		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Hand sanding causes high speed movements • Power tools produce hand/arm vibrations	66. Provide a power tool • use power tool whenever possible 74. Provide a tool that minimizes exposure to vibration/impact/torque • provide a power tool with internal vibration damping • attach vibration damping material to tool handle (Caution: adding to the handle should not cause the tool diameter to be larger than 1.5"(3.8 cm))		✓ ✓ ✓	med med med	med med med	med med med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" (14.7 cm) in length		✓ ✓	med med	med med	med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges					
	• Work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• lay a blanket or cushion over hard edges to eliminate hard edges					
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from the hands					
		• provide tool which does not blow cold air on the hands		✓	high	med	med
		• Add an alternative air hose connection		✓	med	med	med
		93. Provide appropriate gloves					
		• Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task		✓	med	med	med
	• Work area is too cold	23. Increase room temperature	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves		✓	low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work space or access is limited	117. Provide support for the upper body					
		• Provide a device to support the head and upper body while the person is working		✓	med	med	med
14. High speed, sudden movements	• Hand sanding causes high speed movements	66. Provide a power tool					
		• use power sander whenever possible		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		8. Distribute intensive activities throughout the process		✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body		✓	med	med	med
		• provide a device to support the head and upper body while the person is working					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work) • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
		117. Provide support for the upper body • provide a device to support the head and upper body while the person is working		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	115. Provide support for the lower back • adjust back rest to support lower back • pull chair forward and lean back while working • attach a small pillow to back rest to support lower back • provide chair with lower back support	✓ ✓ ✓	✓	low low low med	med med med med	med med med med
16. Lifting forces	• Rarely occurs (If it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on					
		• Use a cushion to eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool					
		• provide chair with rounded front edge of seat		✓	med	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• redesign work piece or component to eliminate hard edges		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
		31. Lower the person					
		• provide a chair/stool to sit on		✓	med	med	med
		• provide a pad or cushion to kneel on	✓		med	med	med
		• provide knee pads	✓		med	med	med
		8. Distribute intensive activities throughout the process		✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Sawing	
TASK TITLE: Sawing	
Task Description:	Sawing involves using a manual or powered (pneumatic or electrical) tool to cut or shape material. Often the material is wood, but occasionally can be fiberglass. Additionally, the material can be affixed to a work surface (with a clamp) held by hand, or pushed through the machine. Typical jobs in which sawing is performed include (not necessarily limited to): • model shop • facility/structural maintenance • shipping/receiving/transport
Job Performance Measures Most Often Impacted by Sawing:	• Speed of task completion • Quality of cut
Typical Employee Comments about Sawing:	Employees typically have complaints about discomfort or stiffness in the following areas: shoulders/neck, hands/wrists/arms, back/torso and legs/feet. The primary body parts affected are typically: hands/wrists/arms, shoulders/neck and back/torso. The secondary body parts affected are typically: legs/feet.
Suggested Level II Analysis:	Grip Force Measurement, Postural Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Repeated activation of on/off switch	32. Lower the work piece/work surface • provide alternative means for activation of on/off switch (e.g., foot control)		✓	med	med	med
		• lower the switch		✓	med	med	med
	• Material retrieved is too high	123. Raise the person • provide a step stool	✓		low	med	med
		32. Lower the work piece/work surface • lower part storage		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/carry-ing materials	• Material supported is too heavy	90. Provide an auxiliary table • provide auxiliary table to support load	✓	✓	med	med	med
3. High speed, sudden shoulder movements	• Type of tool used is not appropriate for the amount of material to be cut	66. Provide a power tool		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Rarely occurs	• N/A					
6. Repeated manipulations with fingers	• Rarely occurs	• N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of power saw with single finger trigger concentrates stress	62. Provide a multi-finger trigger • extend current trigger • provide a tool with a multi-finger trigger		✓ ✓	med med	med med	med med
8. Hand/grip forces	• Material supported is too heavy or awkward	90. Provide an auxiliary table • provide auxiliary table to support load	✓	✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements	• The tool has not received proper maintenance	34. Maintain hand tools/power tools • perform periodic maintenance on all tools	✓		low to med	med	med
	• The hand is inadequately protected	74. Provide a tool that minimizes exposure to vibration/impact/torque • provide and attach a compressible anti-vibration surface to the tool handle		✓	med	med	med
	• Lack of clamping device increases employee contact with vibrating surface	118. Provide support for the work piece • provide a fixture or jig to hold the work piece		✓	med	med	med
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
		• provide appropriate gloves	✓		low	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• provide appropriate gloves	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters	✓		med	med	med
	• Tool exhaust blows on wrist	7. Direct cold air away from the hands		✓	med	med	med
		93. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work table is too low	124. Raise the work piece /work surface • raise the saw or leg extensions.	✓	✓	low to med	med	med
13. Twisting of the lower back	• Material supported is too heavy or awkward	124. Raise the work piece/work surface • provide auxiliary table to support load	✓	✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
16. Lifting forces	• Material supported is too heavy or awkward	90. Provide an auxiliary table • provide auxiliary table to support load	✓	✓	med	med	med
		61. Provide mechanical lifting device • use a hoist to handle large items		✓	high	med	med
17. Pushing or pulling	• Material supported is too heavy or awkward	90. Provide auxiliary table • provide auxiliary table to support load	✓	✓	med	med	med
		48. Provide a cart	✓	✓	med	med	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.1) **Figure 1.1**	86. Provide an appropriate anti-fatigue mat 96. Provide appropriate shoe inserts	 ✓	✓	med low	med med	med med
20. Exposure to hard edges on legs, knees, and feet	• Rarely occurs	N/A					
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Finish quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust • provide task lighting that allows for 200-250 lux (20-25 foot-candles) 136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓ ✓	 ✓ ✓	low high low med	med high med med	med high med med

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CASE STUDY - Sewing	
TASK TITLE: Sewing	
Task Description:	Sewing involves the use of a sewing machine to join two or more pieces of fabric. Typically the tasks are performed on a single needle machine by a seated employee. Typical jobs in which sewing is performed include (not necessarily limited to): • survival equipment • life support • museum/exhibit production.
Job Performance Measures Most Often Impacted by Sewing:	Quality of product, time taken to completion.
Typical Employee Comments about Sewing:	There appears to be a significant difference in symptoms or complaints of fatigue and soreness between high and low volume sewing jobs. Fatigue and discomfort complaints also increase as the fabric or material thickness increases and/or the workability decreases. For employees who do report symptoms, the primary body parts affected are the shoulder/neck (one shoulder usually worse than the other), hands/wrist/arm, and lower back. The secondary body parts affected are the legs/feet due to constant use of foot pedals.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work surface is too high	32. Lower the work piece/work surface					
		• adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	med
		120. Raise the chair	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• The practice of manually ripping a seam during disassembly or rework	13. Encourage ergonomic work techniques					
		• work procedure training	✓		low	med	med
		• pre-cut thread at regular intervals across seam	✓		low	med	med
		• rip the seam in small sections; avoid ripping in one motion	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work surface is too low	124. Raise the work piece/work surface • adjust current work surface	✓		low	med	med
		28. Lower the chair	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
	• Light levels are too low	22. Increase light levels • repair/replace bulb on existing task light	✓		low	med	med
		• reposition task light to prevent glare or bright spot on the needle plate	✓		low	med	med
		• provide a task light with variable intensity		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• The work surface is flat	136. Rotate the work piece • adjust the work surface • angle work surface toward operator	✓ ✓		low low	med med	med med
	• The chair is too low	120. Raise the chair	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
	• The work surface is too high	32. Lower the work piece/work surface • adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Use of manual scissors for cutting and trimming thread increase stress to the wrists	66. Provide a power tool • automatic cutter that should be activated by "healing" the foot pedal. Caution must be used in the design to prevent errors from accidental activation		✓	high	med	high

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Rarely occurs	N/A					
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work surface edge is sharp or unpadded	9. Eliminate exposure to hard edges • round off exposed edges • provide padding for edges • provide a work surface with rounded edges	✓ ✓	✓	low low med	med med med	med med med
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

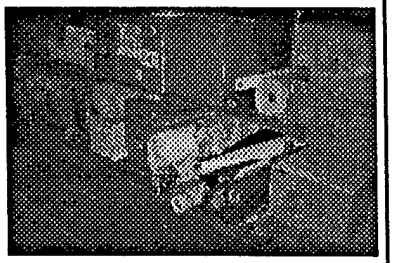
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface too low	124. Raise the work piece/work surface • adjust current work surface	✓		low	med	med
		79. Provide a work surface which is adjustable in height		✓	high	med	high
		28. Lower the chair	✓		low	med	med
13. Twisting of the lower back	• Location of material and supplies is too low	48. Provide a cart • establish height at same level as machine table (e.g., 29-30 " (74-76 cm) above the floor)	✓	✓	med	med	med
		90. Provide an auxiliary table • fixed, stationary or mobile • adjustable in height	✓	✓ ✓	med med	med med	med med
14. High speed, sudden movements	• Large pieces of material get caught on sharp corners of small work table	57. Provide a larger work surface • increase the size of the existing worktable	✓		med	med	med
		• fabricate table extensions to increase the size to the largest piece of material	✓		med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Inappropriate seating (see Figure 1.1) **Figure 1.1**	86. Provide an appropriate chair		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Large bolts of fabric/ticking are too heavy for manual handling (see Figure 1.2)	131. Reduce weight of work piece • decrease weight of bolt by ordering shorter lengths of fabric		✓	med	med	med
	 **Figure 1.2**	61. Provide a mechanical lift device • a special purpose hoist/manipulator to handle bolts of fabric		✓	high	med	high
	• Fabric is stored in an orientation which is different than that which is required for use	139. Store materials in the same orientation in which they are used • store the bolts in a horizontal orientation	✓		low	med	med
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Rarely occurs	N/A					
20. Exposure to hard edges on legs, knees, and feet	• Hard or sharp edges and restricted space under machine table interferes with legs	80. Provide adequate leg clearance • reposition the waste tray • modify the machine support 9. Eliminate exposure to hard edges • provide padding for sharp edges	✓ ✓	 ✓ 	low med low	med med med	med med med
21. Awkward leg postures	• Foot pedal is too close or too far away from the employee • Foot pedal is too far away • Foot pedal in not aligned with chair/employee	135. Reposition foot pedal • move the foot pedal away from employee • move the foot pedal closer to the employee • align the foot pedal with the chair • locate the foot pedal to achieve a 100-105 degree angle at the knee and ankle	 ✓ ✓ ✓ 	 ✓	 low low low med	 med med med med	 med med med med
22. Standing foot pedal	• Use of mechanical foot pedal	76. Provide a tool which requires minimal force to use • electronic foot pedal		✓	med	med	med

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Soldering	
TASK TITLE: Soldering	
Task Description:	Soldering involves the melting of metal to complete electrical connections. Soldering is typically employed in tasks involving electrical wiring and circuitry. Equipment used includes metal solder wire and a solder gun. Typical jobs in which welding is performed include: • electrical assembly/repair • dental lab • circuit board manufacturing/repair • model shop Soldering may be performed on flat or upright surfaces inside electrical cabinets, on equipment, or on benchtops.
Job Performance Measures Most Often Impacted by Welding:	• Quality of electrical connection (consistency, free of defects) • Speed of completion of task
Typical Employee Comments about Welding:	Employees most often report fatigue or discomfort in the shoulders/neck, hands/wrists/arms, and head/eyes. Primary: The primary body region affected are shoulders/neck, hands/wrists/arms, and head/eyes Secondary: In some situations, the back/torso and legs/feet can also be affected
Suggested Level II Analysis:	Postural Analysis, Dynamic Task Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table		✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		112. Provide support for the arms					
		• Rest arms on near-by surfaces	✓		low	med	low
		• Provide flexible armrests		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		112. Provide support for the arms					
		• Rest arms on near-by surfaces	✓		low	med	low
		• Provide flexible armrests		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs. If it occurs, refer to Lifting case study	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for all or parts of the task	✓	✓	med	med	med
		• lower the chair	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		31. Lower the work piece					
		• modify existing table		✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
		114. Provide support for the head					
		• provide a cushion or neck roll if back of head is on the ground	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		132. Remove obstructions	✓		low	med	med
	• Small details are difficult to see	60. Provide a magnifying glass					
		• provide a magnifying glass when the level of detail is high and the task is performed continuously for substantial periods of time		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust • increase room lighting	✓	✓ ✓	med med	med med	med med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Shape of soldering gun handle requires employee to bend wrist	77. Provide a tool with an appropriate handle angle					
		• attach a pistol-type handle to soldering gun		✓	med	med	med
		• provide a soldering gun with a pistol-type handle		✓	med	med	med
		• provide soldering gun with a tip which can be angled/bent for different tasks		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	132. Remove obstructions	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	med
		32. Lower the work piece/work surface	✓	✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Positioning wires and small components requires finger movements	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low to med	med	med
		8. Distribute intensive activities throughout the process					
7. Hyperextension of finger thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Holding wires, components, or circuit boards in place during soldering	118. Provide support for the work piece					
		• provide devices to hold wires or components in place temporarily during soldering		✓	med	med	med
		• provide flexible fixtures for holding circuit boards (fixtures which allow the component to be tilted at various angles and rotated are recommended; pivoting or ball and socket based fixtures work well)		✓	med	med	med
		54. Provide a high friction gripping surface/cover		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • if tool is held like a pencil a diameter of approximately 0.5" (1.5 cm) is recommended • if tool is held like a hammer a diameter of approximately 1"-1.5" (2.5-3.8 cm) is recommended		✓ ✓	med med	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges • lay a blanket or cushion over hard edges • Redesign work piece or component to eliminate hard edges	✓ ✓ ✓	 ✓	low low low med to high	med med med med	med med med med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves • Remove fingers to maximize dexterity	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
		• lower existing chair	✓		low	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		• pull the chair forward towards the work	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide chair with lower back support		✓	med	med	med
		13. Encourage ergonomic work techniques					
		• alternate between sitting and standing tasks	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Feet cannot reach the floor	52. Provide a footrail or footrest • provide a foot rest to support the feet	✓		low	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or foot rest	✓		low	low	med
		13. Encourage ergonomic work techniques • alternate between sitting and standing tasks	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a padded, compressible surface to sit on • use a cushion eliminate exposure to pressure point	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med
	• Feet are dangling while sitting in chair	52. Provide a footrail or footrest • provide a footrest to support feet	✓		low	med	med
	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide knee pads	✓		med	med	med
		• provide a pad or cushion to kneel on	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• Redesign work piece or component to eliminate hard edges		✓	high	med	med
	• Work station has leg obstructions or no leg clearance	9. Eliminate exposure to hard edges					
		• eliminate obstructions	✓		low	med	med
		• provide adequate leg clearance		✓	med	med	med
	• Work station is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	med to high	med	high

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person	✓		med	med	med
		• provide a chair/stool to sit on					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text x	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute instensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Stripping/de-painting by hand	
TASK TITLE: Stripping/de-painting by hand	
Task Description:	Stripping/de-painting by hand is a process where a solvent is applied to a surface order to remove the finish on that surface. The individual doing this task may use either brushes or rags to apply the solvent. Many times the process appears to involve wiping down a surface (e.g., wood or metal) with a liquid. The process may be done by placing the piece on a work bench or the individual may stand/sit/kneel on or near the structure (e.g., aircraft).
Job Performance Measures Most Often Impacted by Stripping/de-painting by Hand:	Amount of material removed in a time period. Quality of surface (consistency, free of mars)
Typical Employee Comments about Stripping/de-painting by Hand:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck, hands/wrists, back and legs. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task Analysis, Elemental Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location too high	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/ work surface	✓	✓	med	med	med
		117. Provide support for the upper body					
		• rest arms on near-by surfaces					
		• provide flexible arm rests	✓		low	med	med
				✓	med	med	med
		90. Provide an auxiliary table					
		• provide a fixture or jig to allow the work to be repositioned		✓	med	med	med
	• The concentration of solvent is not strong enough for the amount of material to be removed	97. Provide appropriate solvent solution		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • modify work platform to position employee closer to work		✓	med	med	high
		132. Remove obstructions	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• The concentration of solvent being used is not strong enough for the amount material to be removed	97. Provide appropriate solvent solution		✓	med	med	med
	• The method used is not appropriate for the amount of material to be removed.	66. Provide a power tool • evaluate the possibility of mechanical stripping		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location too high (see Figure 1.1)	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
	Figure 1.1						
	• Finish quality must be visually inspected	22. Increase light levels					
		• provide task lighting which is easy to adjust	✓		med	med	med
		• provide task lighting that allows for at least 75fc foot-candles (750 lux)	✓		med	med	med
	• Work location is too low	31. Lower the person					
		• provide a stool	✓	✓	med	med	med
		124. Raise the work piece		✓	med	med	med

Hand/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/ repeated wrist movements or repeated forearm rotation	• The type of tool used is not appropriate for the amount of material to be removed.	66. Provide a power tool		✓	med	med	med
	• Work surface is too high or too far away	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface	✓	✓	med	med	med
		136. Rotate the work piece					
		• rotate the piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hypertension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hand/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• The type of tool used is not appropriate for the amount of material to be removed.	66. Provide a power tool		✓	med	med	med
	• The concentration of solvent being used is not strong enough for the amount of material to be removed	97. Provide appropriate solvent solution	✓	✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work surface is too high or too far away	123. Raise the person • Provide a step stool • provide an adjustable platform (see Figure 1.2) **Figure 1.2** 32. Lower the work piece/work surface	✓	✓ ✓ ✓	med high med	med med med	med high med
13. Twisting of the lower back	• The type of tool used is not appropriate for the amount of material to be removed. (see Figure 1.3) **Figure 1.3**	66. Provide a power tool • evaluate the feasibility of mechanical stripping.		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work surface is in an awkward orientation	136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
	• Work space is cramped or access is limited	63. Provide a padded, compressible surface to lay on to get closer to the work	✓		low	med	med
		117. Provide support for the upper body • provide a mobile stool with a back rest to support the upper body		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward postures	• Work space is cramped or access is limited	63. Provide a padded, compressible surface to lay on	✓		low	med	med
		117. Provide support for the upper body • provide a mobile stool with a back rest to support the upper body		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work surface is too far away	132. Remove obstructions	✓		low	med	med
		124. Raise the work piece/work surface • use risers	✓		low	med	med
		31. Lower the worker • provide a stool to sit on	✓		low	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓		low	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/ work surface	✓	✓	med	med	med
		31. Lower the worker					
		• provide a stool to sit on	✓	✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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CASE STUDY - Stripping/depainting by Mechanical Methods	
TASK TITLE: Stripping/depainting by Mechanical Methods	
Task Description:	Stripping/depainting by mechanical methods is a process where rust, paint, and other coatings are removed from metal or wood surfaces via mechanized methods. The methods usually involve attaching a grinding wheel or other abrasive material to a drill, or the heating of a surface with a heat gun and then removal by hand. Depending on the object's size and complexity, this task can be performed standing or sitting. Often when the material is worked on, it is clamped onto a work surface to prevent shifting. Then, the part is then moved, rotated, or otherwise manipulated such that all necessary surfaces are accessible to the operator. Typical jobs in which stripping/depainting - mechanically is performed include (but not necessarily limited to): • sheet metal fabrication • HVAC maintenance • facility maintenance
Job Performance Measures Most Often Impacted by Stripping/de-Painting By Mechanical Methods:	Time to completion vs. amount of material removed, avoidance of surface damage Quality of surface (consistency, free of mars)
Typical Employee Comments about Stripping/depainting by Mechanical Methods:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists, although back and leg stress can be common in some applications. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task Analysis, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	low	low
		• provide a fixed platform		✓	med	low	low
		• provide an adjustable manlift or scaffolding (for aircraft)		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table	✓		med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Tool requires high forces to remove material	76. Provide a tool which requires minimal force to use					
	• Large quantity of material must be removed	• replace grinding media regularly	✓		low	med	med
		• repair the tool for maximum performance	✓		low	med	med
		13. Encourage ergonomic work techniques					
		• let the tool do the work	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.1)	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table to raise and/or angle part towards the worker		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on for some of the task	✓	✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high

Figure 1.1

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Handle angle on tool causes awkward wrist postures	77. Provide a tool with an appropriate handle angle					
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool, when appropriate		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or a ladder	✓	✓	med	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable manlift or scaffolding		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of tool with single finger trigger	62. Provide a multi-finger trigger					
		• provide a tool with a two finger or a four finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)		✓	med	med	med
		10. Eliminate need to constantly hold trigger		✓	med	med	med
		• provide a tool with toggle switches that allow continuous operation without holding the trigger down					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool requires high forces to remove material • Large quantity of material must be removed	76. Provide a tool which requires minimal force to use • substitute a higher grit for removal of large amounts of material	✓		low	med	med
		• replace grinding media regularly	✓		low	med	med
		• repair the tool for maximum performance	✓		low	med	med
		66. Provide a power tool • obtain a heavier duty tool which reduces forces and time required to remove material		✓	med to high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Tool must be manually supported, held or steadied	54. Provide a high friction gripping surface					
		• provide a tool handle with a compressible, high friction surface		✓	med	med	med
		• wrap the handle with friction tape	✓		low	med	med
		116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work, if appropriate		✓	med	med	med
		113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		low	med	med

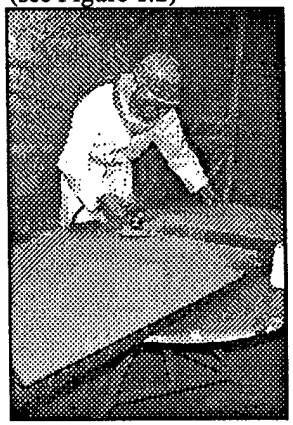
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Cold exhaust from air powered tool blows on hand	7. Direct cold air away from hands • provide tool which does not blow cold air on the hands		✓	med	med	med
		• provide an air diverter on existing tools		✓	med	med	med
		93. Provide appropriate gloves • (Caution: gloves of an inappropriate material or size can cause person to increase hand forces to perform task)	✓		low	med	med
	• Work area is too cold	23. Increase room temperature		✓	med	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		93. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs (see question #15)	• N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

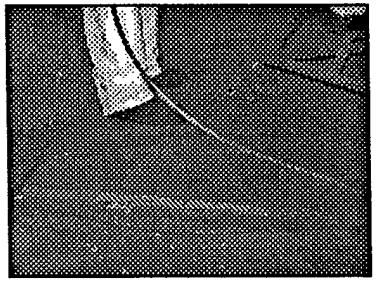
Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Work location is too low (see Figure 1.2)	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	 **Figure 1.2**						
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
	• Inadequate lower back support	115. Provide support for the lower back					
	• Inappropriate chair adjustment.	• adjust back rest to support lower back	✓		low	med	med
	• Inappropriate chair design	• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		provide a chair with adequate lower back support		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.3)  **Figure 1.3**	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	64. Provide a cushion • to reduce exposure to front edge of seat	✓		low	med	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide knee pads	✓		low	med	med
		• provide a cushion to kneel on	✓		low	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓		low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Rarely occurs	N/A					
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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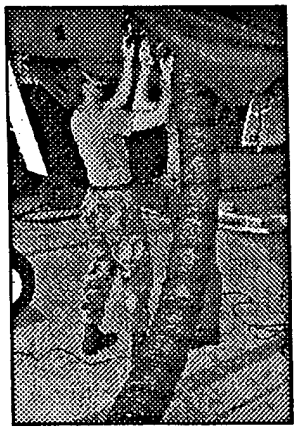
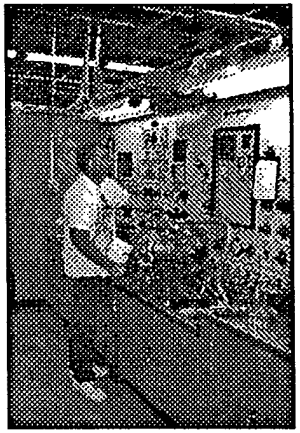
CASE STUDY - Turning Valves	
TASK TITLE: Turning Valves	
Task Description:	Valves are turned for a variety of reasons. Some valves are turned to achieve a desired level of acceptance of a piece of equipment being tested on a machine. Other valves are turned (usually with a much greater force or resistance) to control the flow of liquid (e.g., fuel or water) through a piping system. Valves may be small (e.g., fist-sized) or large (e.g., steering wheel-sized) and may be circular or disguised as a lever. Typical tasks that involve turning valves include: • Fuel Access Tester • Oxygen Mask Tester • Facility Maintenance Boiler Rooms • Liquid Fuels Maintenance. The task of turning valves can be performed on the floor, on bench tops, and overhead.
Job Performance Measures Most Often Impacted by Turning Valves:	Ability of the worker to turn valve quickly to the desired position.
Typical Employee Comments about Turning Valves:	Employees typically complain about discomfort and/or stiffness in the back, wrists, and shoulders. The primary body regions of concern are: back/torso, shoulder/neck The secondary body regions of concern are: hands/wrists
Suggested Level II Analysis:	Postural Analysis, Grip Force Measurement, Push/Pull Force Measurement

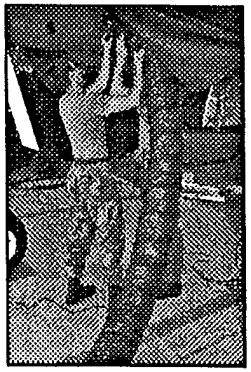
Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (eg., turning valves in boiler room) (see Figure 1.1)  **Figure 1.1**	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface • relocate frequently used valves to 38"-42" (92cm-107cm)		✓	high	med	high

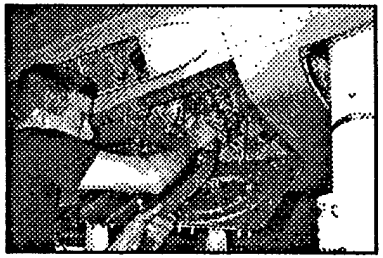
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away (eg.,valve or lever location is too far away (see Figure 1.2)  **Figure 1.2**	38. Move closer to the work location 132. Remove obstructions	✓ ✓		low low	med med	med med
2. Arm forces	• Valve condition makes turning difficult • Valve design requires high force	101. Provide control which does not require excessive forces • inspect and replace valves to minimize force • remove rust/lubricate valves as needed • provide alternative lever/valve design	 ✓	 ✓ ✓	 med low high	 med med med	 high high high

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too high (see Figure 1.3)  **Figure 1.3**	123. Raise the person • use a step stool, platform or ladder to read gauges • provide an adjustable platform 32. Lower the work piece/work surface • lower gauges	✓	✓ ✓ ✓	med high med to high	med med med	med high med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is blocked or is in an inappropriate orientation (see Figure 1.4)  **Figure 1.4**	136. Rotate the work piece • turn the gauge	✓		low	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Valve is blocked or is in an inappropriate orientation	132. Remove obstructions		✓	med to high	med	high
	• Valve is too high	123. Raise the person • use a step stool or ladder	✓	✓	med	med	med
		32. Lower the work piece/work surface • lower the valve		✓	high	med	high
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Valves require high force to turn – large motions for small increments of change – high frictional forces of mechanics or valve due to design or maintenance of valve	101. Provide controls which do not require excessive forces • inspect and maintain equipment to ensure valves are maintained to minimize forces • design valves to reduce high force characteristics of valves	✓	✓	low to med high	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Rarely occurs	N/A					
11. Hands and fingers exposed to cold temperatures	• Rarely occurs	N/A					

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Valve location is too low (see Figure 1.5) **Figure 1.5**	124. Raise the work piece/work surface • place the valve location at 38"-42" (92cm-107cm) above the floor		✓	high	med	high
	• Work location too far away	38. Move closer to the work location • step over obstructions	✓		low	med	med
		132. Remove obstructions • re-design piping		✓	high	med	high
13. Twisting of the lower back	• Valve location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the valve orientation		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	96. Provide appropriate shoe inserts	✓		low	low	med
20. Exposure to hard edges on legs, knees, and feet	• Front edge of seat is hard or square	9. Eliminate exposure to hard edges • Use a cushion eliminate exposure to pressure point	✓		low	low	med
		87. Provide an appropriate chair/stool • provide chair with rounded front edge of seat		✓	med	low	med
	• Piping system on floor (if kneeling)	9. Eliminate exposure to hard edges • provide padding for edges/pipes and surrounding structure • provide knee pads	✓ ✓		low low	low low	med med
21. Awkward postures	• Valve that is too low may require worker to kneel or squat	124. Raise work piece/work surface • place valve location at 38"-42" (92cm-107cm)		✓	high	med	high
		9. Eliminate exposure to hard edges • provide knee pads	✓	low	low	med	
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Light levels are too low/too high	• Light levels are too low for reading gauges	22. Increase light levels • increase room lighting • clean gauge/replace glass	✓	✓	med low	med low	med low
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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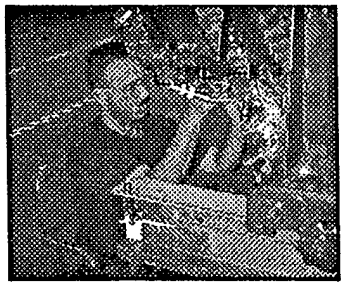
CASE STUDY - Tying/Twisting/Wrapping	
TASK TITLE: Tying/Twisting/Wrapping	
Task Description:	Tying/twisting/wrapping involves the use of hands or a manual tool to tie, seal or combine two or more strands of material together. Many times the material can either be thread, wire or cloth (e.g., laces). Jobs in which tying/twisting/wrapping is performed include (not necessarily limited to): • aircraft engine maintenance • life support • parachute packing • electrical maintenance Tying/twisting/wrapping can occur at any level on a work bench, the floor of an aircraft, or overhead.
Job Performance Measures Most Often Impacted by Tying/Twisting/ Wrapping:	• Quality of product (degree of tightness). • Speed of the tying/twisting/wrapping task.
Typical Employee Comments about Tying/Twisting/Wrapping:	Employees typically complain about discomfort and/or stiffness in the shoulders/neck and hands/wrists. If the individual is standing, a secondary complaint can be in the back/torso and legs/feet.
Suggested Level II Analysis:	Postural Analysis, Elemental Task Analysis, Grip Force Measurement.

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person • use a step stool, platform or ladder	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
	• Arms must be manually supported, held or steadied (see Figure 1.1)	112. Provide support for the arms • rest arms on near-by surfaces	✓		low	med	med
		• provide flexible armrests		✓	med	med	med
	 **Figure 1.1**						
	• Work location is too far away	38. Move closer to the work location	✓		low	med	med
		132. Remove obstructions	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		132. Remove obstructions	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					
4. Head/neck bent or twisted	• Work location is too low (see Figure 1.2) Figure 1.2	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table 31. Lower the person • provide a chair/stool to sit on for all or parts of the task 13. Encourage ergonomic work techniques • encourage person to look up frequently	✓ ✓ ✓	✓ ✓ ✓	med high med low	med med med med	med high med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform		✓	med	med	med
		32. Lower the work piece/work surface		✓	med	med	med
	• Light levels are too low during task	22. Increase light levels					
		• provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Repetitive nature of the work task	66. Provide a power tool		✓	med	med	med
		20. Incorporate rest pauses	✓		low	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	med	med	med
		32. Lower the work piece/work surface		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
6. Repeated manipulations with fingers	• Repetitive nature of the work task.	20. Incorporate rest pauses 66. Provide a power tool	✓	✓	low med	med med	med med
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• Task requires material to be very tight • Diameter of tie requires pinch grip	66. Provide a power tool 20. Incorporate rest pauses	✓	✓	med low	med med	med med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges		✓	high	med	med
		• Redesign work piece or component to eliminate hard edges					
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves					
		• remove fingers to maintain dexterity	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low (see Figure 1.3) **Figure 1.3**	124. Raise the work piece/work surface • provide a fixed table to support work piece • provide an adjustable table for work piece 31. Lower the person • provide a chair/stool to sit on	✓ ✓	✓ ✓ ✓	med high med	med med med	med high med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • turn the work piece manually provide a fixture to allow the work piece to be rotated	✓	 ✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard (see Figure 1.4) **Figure 1.4**	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges					
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• Redesign work piece or component to eliminate hard edges		✓	high	med	med
21. Awkward leg postures	• Rarely occurs	N/A					
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Visual Inspection	
TASK TITLE: Visual Inspection	
Task Description:	Visual inspection involves an employee inspecting the surface of a material, component, or system to determine the presence of material or processing defects (cracks, incomplete welds, frayed cables, etc.). This task is often done after a prior task has been completed (e.g., visual inspection of rivet depth after riveting.). The employee may use a flashlight or magnifying glass to highlight the area of interest. Additionally, gloves may be worn if the employee is required to inspect the surface using the fingers. Because visual inspection is required for the completion of many different tasks, the employees may be required to stand or sit by the work piece (e.g., riveting on an aircraft) or perform the tasks at a workbench (e.g., soldering electronic components). Typical jobs in which visual inspection is performed include (not necessarily limited to): • aircraft maintenance • sheet metal repair • facility maintenance • model shop • radio repair
Job Performance Measures Most Often Impacted by Visual Inspection:	• Quality of surface (consistency) • Speed of task completion • Error detection
Typical Employee Comments about Visual Inspection:	Due to the wide variety of work situations, employees may complain about discomfort or stiffness in any of the following areas: shoulders/neck, hands/wrists/arms, back/torso, legs/feet, or head/eyes. The primary body parts affected are typically: shoulders/neck, back/torso and head/eyes The secondary body parts affected are typically: legs/feet, and hands/wrists/arms
Suggested Level II Analysis:	Postural Analysis, Light Measurement

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	low	low
		41. Move work piece closer to body	✓		low	low	low
		112. Provide support for the arms					
		• rest arms on nearby surface	✓		low	med	med
		• provide flexible arm supports		✓	med	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Work surface is too high or too low	123. Raise the person					
		• provide a step stool	✓	✓	med	med	med
		• provide an adjustable platform		✓	high	med	high
		32. Lower the work piece/work surface		✓	med	med	med
		136. Rotate the work piece					
		• turn the work piece to an upright position	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		8. Distribute intensive activities throughout the process					
		• modify assembly/inspection process so that visual inspection occurs throughout the process rather than at the final stage		✓	med	med	med
		84. Provide an adjustable mirror		✓	med	med	med
		60. Provide a magnifying glass		✓	med	med	low

Hands/Wrist/Arm

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Work location is too high	123. Raise the person • provide a step stool • provide an adjustable platform 38. Move closer to the work location 136. Rotate the work piece • manually turn the work piece to an upright position • provide a fixture to allow the work piece to be rotated	✓ ✓ ✓	✓ ✓ ✓	med high low low med	med med med med med	med high low med med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Rarely occurs	N/A					
8. Hand/grip forces	• The material to be inspected must be held or supported	118. Provide support for the work piece • provide a fixture or jig to aide in holding the material		✓	med	med	med

Hands/Wrist/Arm (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • provide padding for edges • round off exposed edges • lay a blanket or cushion over hard edges • redesign work piece or component to eliminate hard edges	✓ ✓ ✓	✓ ✓	low med low med to high	low low low med	low low low med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	105. Provide portable heaters 23. Provide appropriate gloves	✓	✓	med low	low low	med med

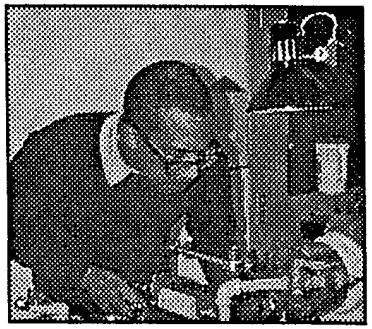
Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work piece/surface is too low	31. Lower the person • provide a step stool	✓		low	high	med
		117. Provide support for upper body		✓	high	med	med
		124. Raise the work piece/work surface		✓	med to high	high	med
		136. Rotate the work piece • turn the work piece to an upright position	✓	✓	low	med	med
		• provide a fixture to allow the work piece to be rotated or raised		✓	med	med	med
		84. Provide an adjustable mirror • provides visual access to sides of part without bending back		✓	med	med	med
		60. Provide a magnifying glass		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
13. Twisting of the lower back	• Work space is cramped or access is limited	117. Provide support for the upper body		✓	high	low	high
		63. Provide a padded, compressible surface to lay on	✓		low	low	low
	• Work piece orientation is too awkward	136. Rotate the work piece • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	 ✓	 low med	 med med	 low med
		84. Provide an adjustable mirror • provide better visual access		✓	med	med	med
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Chair is inadequate	87. Provide an appropriate chair/stool		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work piece/surface is too low (see Figure 1.1)  **Figure 1.1**	124. Raise the work piece/work surface	✓		low	low	low

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med
		8. Distribute intensive activities throughout the process • modify assembly/inspection process so that visual inspection occurs throughout the process rather than at the final stage	✓		low	med	med
		84. Provide an adjustable mirror	✓		low	med	med
		60. Provide a magnifying glass		✓	med	med	med
16. Lifting forces	• Rarely occurs	N/A					
17. Pushing or pulling	• Rarely occurs	N/A					
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
		52. Provide a footrail or footrest	✓		low	med	med
		87. Provide an appropriate chair/stool		✓	med	med	med
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges	✓		med	med	med
		• provide padding for edges	✓		low	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges					
21. Awkward leg postures	• Work surface is too low	124. Raise the work piece/work surface		✓	med	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Glare directly from a light source: looking towards a task light (see Figure 1.2) **Figure 1.2**	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare. • turn off the task light. • shield task light to prevent it from shining into eyes.	 ✓ ✓	 ✓	 low low low to med	 med med med	 med med med
	• Glare from a task light reflected off equipment or worksurface.						
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		 ✓ ✓	 med med	 med med	 med med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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CASE STUDY - Welding	
TASK TITLE: Welding	
Task Description:	There are many different types of welding processes including TIG/MIG welding, Arc welding, and spot welding. Depending on the process, equipment such as torches, accompanying compressed gas canisters, wire feed units, or consumable electrodes may be used. Typical jobs in which welding is performed include: • metal fabrication • assembly/repair • structural maintenance Welding may be performed on flat or upright surfaces directly on aircraft, pipes, equipment, benchtops, or on a variety of surface shapes.
Job Performance Measures Most Often Impacted by Welding:	• Quality of weld (consistency, free of defects) • Speed of completion of welding task
Typical Employee Comments about Welding:	Due to the wide variety of work situations, employees may report fatigue or discomfort in any of the following body regions: shoulders/neck, hands/wrists/arms, back/torso, legs/feet, or head/eyes. Primary: varies depending on task Secondary: varies depending on task
Suggested Level II Analysis:	Grip Force Measurement, Postural, Dynamic Task Analysis

Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓	✓	med	med	med
		• provide a fixed platform	✓	✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/worksurface					
		• modify existing table		✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high
	• Welding tool or gas hose must be manually supported, held or steadied (see Figure 1.1)	116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		113. Provide support for the cable or hose					
		• provide a hook to hang cable in work area	✓		med	med	med
		112. Provide support for the arms					
		• provide flexible armrests		✓	med	med	med

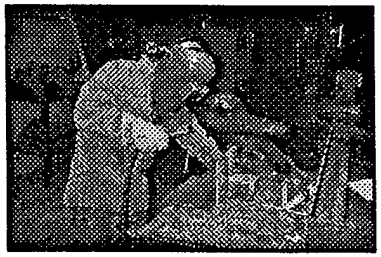
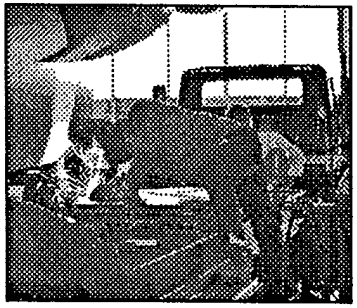


Figure 1.1

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away (see Figure 1.2)	38. Move closer to the work location • remove obstructions	✓		low	med	med
	 **Figure 1.2**	41. Move work piece closer to body	✓		low	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels are too low	22. Increase light levels • provide a task light which is easy to adjust		✓	med	med	med
		• increase room lighting		✓	high	high	high
	• Use of head movement to lower face shield	11. Eliminate unnecessary tasks • provide face shield with a visor adjusts to different light levels and eliminates the need to constantly raise and lower the face shield		✓	med	med	med
		13. Encourage ergonomic work techniques • encourage person to raise or lower the shield with hand if feasible	✓		low	med	med
2. Arm forces: Repeated arm forces or holding/ carrying materials	• Rarely occurs	N/A					
3. High speed, sudden shoulder movements	• Rarely occurs	N/A					

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
4. Head/neck bent or twisted	• Rarely occurs	N/A					

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Using straight welding tool on horizontal surface	77. Provide a tool with an appropriate handle angle					
		• provide a tool with a pistol-type handle		✓	med	med	med
		• provide a tool which can be angled/bent for different tasks		✓	med	med	med
		• attach a pistol-type handle to tool		✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
		• rotate the work piece manually	✓		low	med	med
		8. Distribute intensive activities throughout the process		✓	med	med	med
		• perform some activities as bench work rather than on the aircraft/structure					
		82. Provide adequate workspace					
		• add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too high	123. Raise the person • use a step stool or a ladder • provide a fixed platform • provide an adjustable platform or scaffolding	✓	✓ ✓ ✓	med med high	med med med	med med med
		32. Lower the work piece/worksurface		✓	med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyperextension of finger/thumb or repeated single finger activation	• Use of welding tool with single finger trigger	62. Provide a multi-finger trigger • provide a tool with a two finger or a four finger trigger		✓	med	med	med
		• extend trigger on existing tool (if feasible and safe)		✓	med	med	med
		10. Eliminate need to constantly hold trigger • provide a tool with toggle switches that allow continuous operation without holding the trigger down		✓	med	med	med
		45. Modify controls • use a foot pedal if feasible		✓	med	med	high

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Welding tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • provide a fixture which places the work piece at the appropriate height and (as needed) allows the work piece to be manipulated.		✓	med	med	med
		54. Provide a high friction gripping surface	✓		low	med	med
		• wrap the tool handle		✓	med	med	med
		• provide a tool handle with a compressible, high friction surface					
		113. Provide support for the cable or hose	✓		low	med	med
		• provide a hook to hang cable in work area					
	• Tool is too heavy	116. Provide support for the tool					
		• provide a tool balancer for bench work		✓	med	med	med
		• provide a mobile tool balancer that can be hung overhead for field work		✓	med	med	med
		59. Provide a lighter weight tool		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a tool with a handle diameter of between 1"-1.5" is appropriate for this task		✓	med	med	med
	• Attaching/removing manual clamps is difficult	76. Provide a tool which requires minimal force to use • provide manual clamps which require no more than 8 lb. to operate		✓	med	med	med
		66. Provide a power tool • provide powered clamps		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					

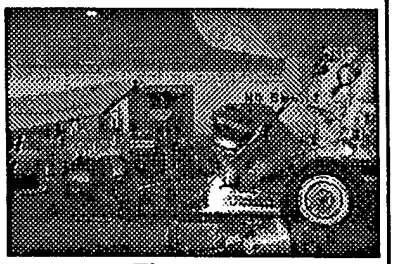
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a handle which is round and smooth with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges					
		• provide padding for edges		✓	low	med	med
		• round off exposed edges	✓		med	med	med
		• provide elbow pads		✓	med	med	med
		• lay a blanket or cushion over hard edges	✓		low	med	med
		• modify the design the work piece to eliminate hard edges		✓	high	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	23. Increase room temperature	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med
		96. Provide appropriate gloves	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Work location is too low	124. Raise the work piece/worksurface					
		• provide a fixed table to support work piece		✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
		117. Provide support for the upper body					
		• provide a device to support the upper body while welding		✓	med	med	med
	• Work location is too far away	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation	136. Rotate work piece (bench work)					
		• turn the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Rarely occurs	N/A					
15. Static, awkward back postures	• Work location is too low (see Figure 1.3)	124. Raise the work piece/worksurface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
	 **Figure 1.3**						
	• Work location is too far away (see Figure 1.4)	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		41. Move work piece closer to body	✓		low	med	med
		136. Rotate work piece (bench work)					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med
	Figure 1.4						

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
	• Inadequate lower back support • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide a chair with adequate lower back support		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
16. Lifting forces	• Lifting and handling compressed gas bottles on and off welding carts requires excessive force • (See Lifting case study for additional causes and corrective actions)	4. Change a lifting/carrying task into a rolling or sliding task • provide a fold-out ramp to allow gas bottles to be rolled up into position as opposed to lifted • lower the base of the gas storage area as close to the ground as possible to minimize the slope of ramp 61. Provide a mechanical lift device • to transfer gas bottles to and from the welding cart 11. Eliminate unnecessary tasks • provide remote, bulk supply of welding gas		✓ ✓ ✓ ✓	med med med med to high	med med med med	med med med med
17. Pushing or pulling	Pulling hoses and carts • Poor housekeeping • Poor floor condition • Poor wheel maintenance • Poor wheel design	17. Improve floor condition • keep floor free of debris • repair cracks or gaps in floor 19. Improve wheel condition • repair wheels • provide wheels that are roll more easily 67. Provide a powered cart	✓ ✓	 ✓ ✓ ✓	low low to med low med high	med med med med med	med med med med high
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	85. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection					
		• provide knee pads	✓		low	med	med
		• provide a cushion to kneel on	✓		low	med	med
	• Work station or work piece has hard edges	9. Eliminate exposure to hard edges	✓		low	med	med
		• provide padding for edges	✓		med	med	med
		• round off exposed edges	✓		low	med	med
		• lay a blanket or cushion over hard edges		✓	med to high	med	med
		• redesign work piece or component to eliminate hard edges					

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low (see Figure 1.5) **Figure 1.5**	124. Raise the work piece/worksurface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person • provide a chair/stool to sit on	✓	✓	low to med	med	med
		8. Distribute intensive activities throughout the process • perform some activities as bench work rather than on the aircraft/structure		✓	med	med	med
		82. Provide adequate workspace • add access panels to increase access		✓	high	med	high
		• increase the size of access ports to increase access		✓	high	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels					
		• provide task light		✓	med	med	med
		• increase overall light levels to meet the needs of tasks		✓	med	med	med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work					
		• increase size of text	✓	✓	med	med	med
		• increase the legibility of text	✓	✓	med	med	med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

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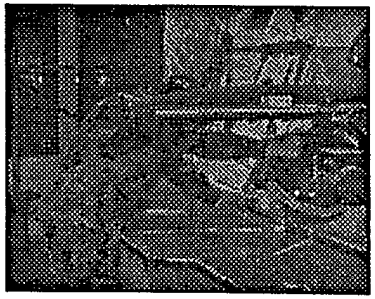
CASE STUDY - Wiring	
TASK TITLE: Wiring	
Task Description:	There are two basic types of wiring tasks. The first task involves securing two or more objects by twisting or crimping them together. Often the employee will precut the amount of wire from a roll before joining the objects. It is also possible that the employee will have to remove the insulation (coating) from the wire once the task is completed. The tools most commonly used are pliers (e.g., needle-nose) and wire strippers and cutters. The second type of wiring occurs when electrical wires or pneumatic hoses are threaded or pushed between two structures. This commonly occurs when offices/automobiles/appliances are being repaired. Here, the wire can be either precut, or pulled from a roll. The most common tool used is pliers. In both cases, the location of the wiring task can vary tremendously, thus, this task can be performed while standing or sitting. Typical jobs in which wiring is performed include (but not necessarily limited to): • automobile maintenance • HVAC system maintenance • facility maintenance • radio maintenance
Job Performance Measures Most Often Impacted by Wiring:	• Time to completion • Integrity of wiring system (e.g., does it work)
Typical Employee Comments about Wiring:	The most common complaint from employees is discomfort and/or stiffness in the shoulders/neck and hands/wrists. The primary body parts affected are typically: hands/wrists/arms and shoulders/neck. The secondary body parts affected are typically: back/torso and legs/feet.
Suggested Level II Analysis:	Postural Task Analysis, Dynamic Task Analysis, Grip Force Measurement, Elemental Task Analysis, Light Measurement

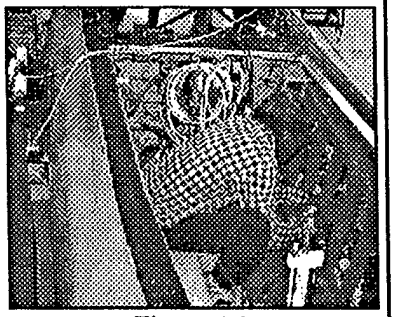
Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Repeated reaching or arms held away from body while unsupported	• Work location too high	123. Raise the person • provide a step stool/ladder • provide a platform or scaffold	✓	✓ ✓	med med	med low	med med
		112. Provide support for the arms • rest arms on near-by surfaces • provide flexible arm rests that can be attached to nearby surfaces.	✓	✓	low med	low low	med med
	• The work piece must be manually supported or held	118. Provide support for the work piece • provide a clamp for stabilizing or holding back any surrounding wires.	✓	✓	med	med	med
	• Work location is too far away (see Figure 1.1)  **Figure 1.1**	38. Move closer to the work location • remove obstructions • remove additional access panels	✓ ✓		low low	low low	low low

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces exceeding 10 lb.	• Interference or "hang up" when pulling wires	140. Use alternative fasteners • use fish tape and pull wires with two hands	✓		low	med	med
		• clear hang-up prior to pull	✓		low	med	med
	• Many rolls of wire must be transported from one area to another	48. Provide a cart • provide a cart which mounts the spools horizontally and feeds the wire via rollers to a nozzle		✓	med	med	med
3. High speed, sudden shoulder movements	• The wire must be pulled / yanked to be joined	128. Reduce force required to install or remove the component • provide rollers at the wire roll and at the top and bottom edges of the openings to decrease frictional forces		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• The wire must be pulled / yanked through the insulation	128. Reduce force required to install or remove the component • coat the wire with soapy water to decrease the friction required	✓		low	med	med
4. Head/neck bent or twisted	• Work location too low (see Figure 1.2)  **Figure 1.2**	31. Lower the person • provide a chair or stool for the employee to sit on	✓	✓	med	med	med
	• Work location too high	123. Raise the person • provide a step stool/ladder • provide a platform or scaffold	✓	✓ ✓	med med	med med	med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust - provide task lighting that allows for 20-25 foot-candles (200-250 lux).		✓	med	med	med
		60. Provide a magnifying glass • provide a stand supported magnifying glass that has a built in light		✓	med	med	med
		136. Rotate the work piece • rotate the piece manually • provide a fixture to allow the work piece to be rotated	✓	✓	low med	med med	low med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• The type of tool used is not appropriate for the twisting/crimping required.	76. Provide a tool which requires minimal force to use • Provide an appropriate tool that allows for crimping and quick twisting		✓	med	med	med
		• crimp instead of using twist wires	✓		low	med	med
	• There is a large amount of insulation to be removed	34. Maintain hand tools/power tools	✓		low	low	med
		• provide tools which have sharp cutting edges and aligned jaws		✓	med	low	med
		• provide stripping tools which strip wire as pliers are closed.		✓	med	low	high
		• provide automatic wire stripper; pre-strip wires.					
	• Work surface is too high or too far away	123. Raise the person • provide a step stool	✓	✓	med	med	med
6. Repeated manipulations with fingers	• Repetitive nature of the work task • Unscrewing and tightening of terminal leads	20. Incorporate rest breaks	✓		low	low	low

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
7. Hyperextension of finger/thumb or repeated single finger activation	• Pliers do not have a spring-loaded handle	91. Provide an appropriate tool • provide a tool that has a self-opening spring between the handles		✓	med	low	med
		66. Provide a power tool		✓	med	med	med
8. Hand/grip forces	• Wires or bundles must be held and manipulated.	118. Provide support for the work piece • provide a clamp that secures the work object or holds back wires during task	✓		low	low	med
	• The wire must be pulled / yanked through the pieces to be joined	128. Reduce force required to install or remove the component • provide rollers at the wire roll and at the top and bottom edges of the openings to decrease frictional forces and "hang-up"		✓	med	low	med
		• coat the wire with soapy water to decrease the friction required	✓		low	low	low
	• The tool used for twisting/crimping requires high grip forces.	76. Provide a tool which requires minimal force to use • provide an appropriate tool that allows for crimping and quick twisting		✓	med	med	med
		• provide a power crimping tool		✓	med to high	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
9. High speed hand/wrist/arm movements or vibration, impact, or torque to the hand	• Rarely occurs	N/A					
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges • provide a tool with a round, smooth handle with no ridges or edges • provide a handle of at least 5" in length • wrap the tool handles		✓ ✓ 	med med low	med med med	med med med
	• Work station has hard or sharp edges (see Figure 1.3)	9. Eliminate exposure to hard edges • provide padding for edges	✓		low	med	med

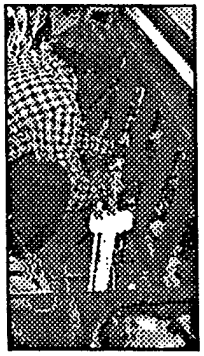
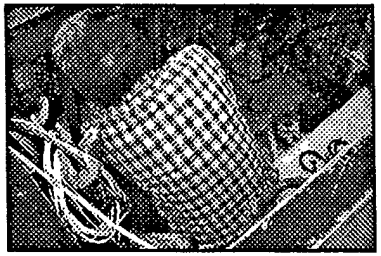


Figure 1.3

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves	✓		low	med	med
		105. Provide portable heaters		✓	med	med	med
		110. Provide shields or barriers from the wind		✓	med	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs	N/A					
13. Twisting of the lower back	• Work space is cramped or access is limited (see Figure 1.4)  **Figure 1.4**	63. Provide a padded, compressible surface to lay on • provide a pad/mat 117. Provide support for the upper body	✓	 ✓	low med	med med	med med
14. High speed, sudden movements	• Rarely occurs	N/A					

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
15. Static, awkward back postures	• Inadequate lower back support while seated • Inappropriate chair adjustment. • Inappropriate chair design	115. Provide support for the lower back • adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide a chair with adequate lower back support		✓	med	med	med
	• Work location is too low • Work location is too far away	31. Lower the person • provide a chair or stool	✓	✓	med	med	med
		38. Move closer to the work location • remove obstructions	✓		low	med	med
		136. Rotate the work piece • provide a fixture to allow the work piece to be rotated		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Quality must be visually inspected	22. Increase light levels • provide task lighting which is easy to adjust		✓	med	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Many rolls of wire must be transported from one area to another	48. Provide a cart • provide a cart which mounts the spools horizontally and feeds the wire via rollers to a nozzle		✓	med	low	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	52. Provide a footrail	✓	✓	med	low	med
		86. Provide appropriate anti-fatigue mat		✓	med	low	med
		96. Provide appropriate shoe inserts	✓		low	low	med
20. Exposure to hard edges on legs, knees, and feet	• Work station has hard or sharp edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med
21. Awkward leg postures	• Work surface is too low (kneeling)	31. Lower the person • provide a low stool	✓	✓	med	low	med
		95. Provide appropriate knee protection • if kneeling is required.	✓		low	low	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Glare directly from a light source: looking towards an overhead light • Glare from an overhead light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • position work between overhead lights.	✓		low	med	med
		• remove glossy or shiny surfaces from work area	✓		low	med	med
		• place the work station so that it faces a wall or partition.	✓	✓	med	med	med
		• install parabolic louvers to direct light down on the surface.		✓	high	med	med
	• Glare directly from a light source: looking towards an uncovered window • Glare from an uncovered window reflected off equipment or worksurface.	108. Provide protection from glare from natural light • orient work station so that the person faces perpendicular to the window.	✓		low	med	med
		• adjust window coverings	✓		low	med	med
		• provide window coverings		✓	med to high	med	med
	• Glare directly from a light source: looking towards a task light • Glare from a task light reflected off equipment or worksurface.	109. Provide protection from glare from overhead lights/task lights • adjust the task light to reduce glare.	✓		low	med	med
		• turn off the task light.	✓		low	med	med
		• shield task light to prevent it from shining into eyes.		✓	low to med	med	med

Head/Eyes (cont'd)

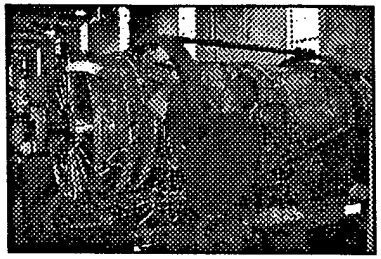
Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Light levels too high.	27. Lower the light levels • remove pairs of fluorescent light bulbs from overhead fixtures. Note: this should be done with the appropriate technical assistance and the agreement of co-workers in the area.		✓	low to med	med	med
	• Light levels too low:	22. Increase light levels • provide task light • increase overall light levels to meet the needs of tasks		✓ ✓	med med	med med	med med
	• Uncorrected visual disorders cause the person to lean forward to see work	14. Encourage person to have visual disorders corrected	✓		low	med	med
	• Text too small to read. • Text is difficult to read (poor quality)	18. Improve visual access to work • increase size of text • increase the legibility of text	✓ ✓	✓ ✓	med med	med med	med med
24. Intensive visual tasks, staring at work objects for long periods	• Length of work task without a change of position for the eyes.	8. Distribute intensive activities throughout the process • perform intensive visual tasks for short periods throughout the day (as opposed to in one continuous session).	✓		low	med	med

Head/Eyes (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
		20. Incorporate rest pauses • periodically look away from screen.	✓		low	med	med

CASE STUDY - Wrenching/Ratcheting	
TASK TITLE: Wrenching/Ratcheting	
Task Description:	Wrenching/ratcheting involves installing or removing nuts and bolts. These tasks can be done at a variety of heights and angles. Socket, box-end, and open-end wrenches are employed. Wrenches can vary in size from small hand wrenches to large, two-handed torque wrenches. Typical jobs in which wrenching/ratcheting is performed include (not necessarily limited to): • assembly • general maintenance Wrenching may be performed on flat or upright surfaces directly on aircraft, equipment, or bench tops.
Job Performance Measures Most Often Impacted by Wrenching/Ratcheting:	• Constant torque • No errors (e.g. missing bolts, incorrect bolts) • Speed of completion of the job
Typical Employee Comments about Wrenching/Ratcheting:	Employees typically report fatigue and discomfort in the hands/wrists/arms, shoulders/neck, and back/torso. Primary: The primary body parts affected are the hands/wrists/arms and shoulders/neck Secondary: In some cases, the back/torso can also be affected.
Suggested Level II Analysis:	Grip Force Measurement, Postural Analysis, Dynamic Task Analysis

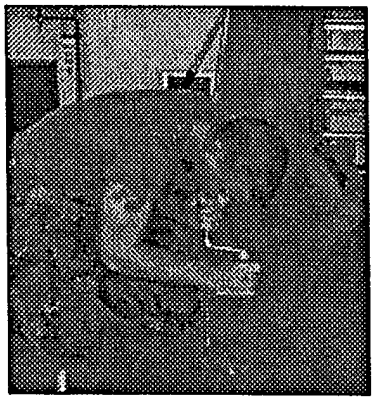
Shoulder/Neck

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
1. Reaching	• Work location is too high (see Figure 1.1)  **Figure 1.1**	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide a fixed platform	✓		low	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table	✓		low	med	med
		• provide an adjustable height work table		✓	high	med	high
		112. Provide support for the arms	✓	✓			
		• Rest arms on near-by surfaces			low	med	med
		• Provide arm rests which clamp on to adjacent work surfaces when prolonged work is anticipated			med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too far away	103. Provide extensions for tools • provide extensions and angles on wrenches in order to access bolt with minimal reaching	✓	✓	med	med	med
		38. Move closer to the work location • remove obstructions	✓		low	med	med
	• Work space or access is limited	117. Provide support for the upper body		✓	med to high	med	med
		63. Provide a padded, compressible surface to lay on	✓		low	med	med
		103. Provide extensions for tools • provide extensions for ratchets to increase access	✓		med	med	med
		77. Provide a tool with an appropriate handle angle • provide angled or off-set wrenches for tight spaces	✓		med	med	med
	• Repeated arm movements required for task	20. Incorporate rest pauses	✓		low	med	med
		25. Increase task variety	✓		low	med	med

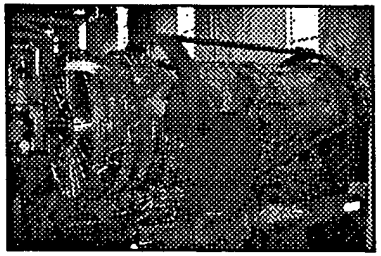
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
2. Arm forces: Repeated arm forces or holding/carrying materials	• Use of manual tool for high force or repeated torquing (see Figure 1.2) • Torque specifications require high forces	66. Provide a power tool • use a power tool whenever feasible (use manual tool at end of cycle if final torque check is required)	✓	✓	med	med	high
	 **Figure 1.2**	76. Provide a tool which requires minimal force to use • provide ratcheting tools with multiplying gears to reduce forces		✓	high	med	med
		• increase handle length on wrench to improve leverage		✓	med	med	med
	• Tool is too heavy	59. Provide a lighter weight tool • use tool of minimal weight		✓	med	med	med
	• Inadequate maintenance of tools can increase force requirements	34. Maintain hand tools/power tools • increase frequency of periodic maintenance and inspection		✓	med	med	med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Carrying tools and containers of nuts and bolts	48. Provide a cart • to eliminate carrying	✓	✓	med	med	med
		47. Provide a carrying container for tools/supplies • provide a hip pouch to eliminate carrying in hand	✓	✓	med	med	med
	• Wear or corrosion of components	33. Maintain bolts and screws • use penetrating oil, if allowable to help reduce resistance		✓	low	med	med
3. High speed, sudden shoulder movements	• Work pace/work volume causes high speed arm movements while manually torquing bolts	66. Provide a power tool • use power tool whenever possible		✓	high	med	med
		• for high torque applications, power tools which are self supporting (do not have to be held in position by the person) are preferred		✓	high	med	med
		13. Encourage ergonomic work techniques • use smooth movements	✓		low	med	med
		• avoid rushing	✓		low	med	med

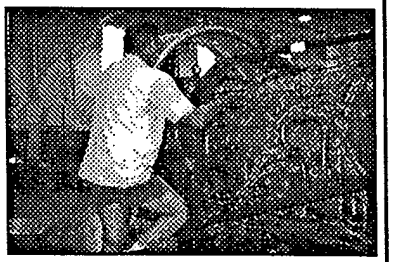
Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
	• Torque wrenches with torque releases cause sudden movements or "jerks"	66. Provide a power tool • use power tool whenever possible • for high torque applications, power tools which are self supporting (do not have to be held in position by the person) are preferred		✓ ✓	med med	med med	med med
4. Head/neck bent or twisted	• Work location is too high (or is overhead) (see Figure 1.3)  **Figure 1.3**	123. Raise the person • use a step stool or ladder • provide a fixed platform • provide an adjustable platform or scaffolding 32. Lower the work piece/work surface • modify existing table • provide an adjustable height work table 114. Provide support for the head • for long duration wrenching tasks which are overhead, provide a chair with a reclining backrest, and head support. • provide a neck rest pillow	✓	✓ ✓ ✓ ✓ ✓ ✓ ✓	med med high med high med low	med med med med med med med	med med high med high med med

Shoulder/Neck (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• raise the assemble (e.g., engine) using a hoist or other support device.		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	136. Rotate the work piece					
		• rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Hands/Wrists/Arms

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
5. Bent wrists/repeated wrist movements or repeated forearm rotation	• Manual wrenching can require awkward wrist and forearm movements (see Figure 1.4)	66. Provide a power tool					
		• use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for final torque check)		✓	med	med	med
	 **Figure 1.4**						
	• Work location is too high	123. Raise the person					
		• use a step stool or ladder	✓		low	med	med
		• provide a fixed platform		✓	med	med	med
		• provide an adjustable platform or scaffolding		✓	high	med	high
		32. Lower the work piece/work surface					
		• modify existing table	✓	✓	med	med	med
		• provide an adjustable height work table		✓	high	med	high

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓	✓	med	med	med
	• Work location is blocked or is in an inappropriate orientation	38. Move closer to the work location					
		• remove obstructions	✓		low	med	med
		136. Rotate the work piece					
		• rotate the work piece manually	✓	✓	low	med	med
		• provide a fixture to allow the work piece to be rotated			med	med	med
6. Repeated manipulations with fingers	• Rarely occurs	N/A					
7. Hyper-extension of finger/thumb or repeated single finger activation	• Wide spans on tools such as pliers or channel locks can cause finger and thumb hyperextension	13. Encourage ergonomic work techniques					
		• use two hands when possible	✓		low	med	med
		89. Provide an appropriate handle grip span on pliers-type tools					
		• provide a tool with a handle span less than 3"		✓	med	med	med
		• use crescent wrenches or appropriately sized sockets		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
8. Hand/grip forces	• Tool or work piece must be manually supported, held or steadied	118. Provide support for the work piece • to support work piece		✓	med	med	med
		54. Provide a high friction gripping surface • provide a tool handle with a compressible grip surface		✓	med	med	med
		• wrap tool handle with friction tape	✓		low	med	med
		116. Provide support for the tool • provide a tool balancer for bench work		✓	med	med	med
	• Tool is too heavy or not balanced	59. Provide a lighter weight tool		✓	med	med	med
	• Handle diameter is too large	88. Provide an appropriate handle diameter • provide a power tool with a handle diameter of 1"-1.5" (2.5-3.8 cm)		✓	med	med	med

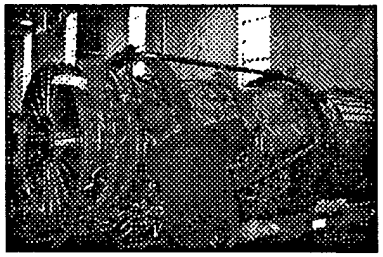
Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use • provide ratcheting tools with multiplying gears to reduce forces		✓	high	med	med
		• increase handle length to improve leverage on manual tools		✓	med	med	med
9. High speed hand/wrist/arm movements or vibration, impact or torque to the hand	• Manual torquing causes high speed movements	66. Provide a power tool • use power tool whenever possible		✓	med	med	med
		• use power tool to do the majority of the torquing (when necessary, use manual wrenches only for tightening)		✓	med	med	med
	• Use of power tools or impact wrenches exposes worker to vibration	74. Provide a tool that minimizes exposure to vibration/impact/ torque • provide pulse tools instead of impact wrenches		✓	med	med	med

Hands/Wrists/Arms (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
10. Exposure to hard edges	• Tool handle has hard edges	9. Eliminate exposure to hard edges					
		• provide a tool with a round, smooth handle with no ridges or edges		✓	med	med	med
		• provide a handle of at least 5" in length		✓	med	med	med
		• wrap tool handle	✓		low	med	med
	• Work station or work piece has hard or sharp edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med
11. Hands and fingers exposed to cold temperatures	• Work area is too cold	93. Provide appropriate gloves		✓	med	med	med
		105. Provide portable heaters	✓		low	med	med

Back/Torso

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
12. Repeated forward or sideways bending movements	• Rarely occurs (see question #15)	N/A					
13. Twisting of the lower back	• Work location is blocked or is in an inappropriate orientation (see Figure 1.5)  Figure 1.5	136. Rotate the work piece (bench work) • turn the work piece manually • provide a fixture to allow the work piece to be rotated	✓	 ✓	 low med	 med med	 med med
	• Work space or access is limited	63. Provide a padded, compressible surface to lay on • Provide a pad/mat	✓		low	med	med
		117. Provide support for the upper body		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
14. High speed, sudden movements	• Corroded or stuck fittings	66. Provide a power tool • use power tool whenever possible		✓	high	med	med
		33. Maintain bolts and screws • use penetrating oil, if allowable to help reduce resistance	✓		low	med	med
		13. Encourage ergonomic work techniques	✓		low	med	med
		• use smooth movements	✓		low	med	med
		• avoid rushing					
15. Static, awkward back postures	• Work location is too low	124. Raise the work piece/work surface • provide a fixed table to support work piece	✓	✓	med	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• raise the assembly (e.g., engine) using a hoist or other lift device)		✓	high	med	high
	• Work location is too far away	38. Move closer to the work location • remove obstructions	✓		low	med	med
		136. Rotate the work piece • rotate the work piece manually	✓		low	med	med
		• provide a fixture to allow the work piece to be rotated		✓	med	med	med

Back/Torso (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
	• Chair or stool provides inadequate back support	115. Provide support for the lower back					
		• adjust back rest to support lower back	✓		low	med	med
		• pull chair forward and lean back while working	✓		low	med	med
		• attach a small pillow to back rest to support lower back	✓		low	med	med
		• provide chair with lower back support		✓	med	med	med
16. Lifting forces	• Rarely occurs (if it occurs, see Lifting case study)	N/A					
17. Pushing or pulling	• Torque specifications require high forces	76. Provide a tool which requires minimal force to use					
		• provide power tools which can meet the necessary torque specification		✓	med	med	med
		• provide ratcheting tools with multiplying gears to reduce forces		✓	high	med	med
		• increase handle length to improve leverage and enable a balanced two-hand grip		✓	med	med	med
18. Whole body vibration	• Rarely occurs	N/A					

Legs/Feet

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
19. Fixed position, standing	• Standing surface is hard	86. Provide an appropriate anti-fatigue mat		✓	med	med	med
		96. Provide appropriate shoe inserts	✓		low	med	med
20. Exposure to hard edges on legs, knees, and feet	• Kneeling causes external pressure to the knee	95. Provide appropriate knee protection • provide a pad or cushion to kneel on	✓		low	med	med
	• Work piece has hard edges	9. Eliminate exposure to hard edges • lay a blanket or cushion over hard edges	✓		low	med	med

Legs/Feet (cont'd)

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
21. Awkward leg postures	• Work location is too low	124. Raise the work piece/work surface					
		• provide a fixed table to support work piece	✓		low	med	med
		• provide an adjustable table for work piece		✓	high	med	high
		• raise assembly (e.g., engine) using a hoist or other lift device		✓	high	med	high
		31. Lower the person					
		• provide a chair/stool to sit on	✓		low	med	med
		• provide knee pads, if kneeling is required	✓		low	med	med
		• provide a pad or cushion to kneel on	✓		low	med	med
22. Standing foot pedal	• Rarely occurs	N/A					

Head/Eyes

Job Factor	Potential Causes	Corrective Action	Level of Changes		Cost	Impact On	
			✓ Minor Modification	✓ Major Change		Quality	Productivity
23. Difficult to see/light levels too low/too high	• Light levels are too low	22. Increase light levels • Provide light levels at the task of 50-100 foot-candles (500-1000 lux) for wrenching tasks • if necessary, provide a task light which is easy to adjust	 ✓	✓	high low	high med	high med
24. Intensive visual tasks, staring at work objects for long periods	• Rarely occurs	N/A					

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APPENDIX 5

Recommendations

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APPENDIX 5

This Appendix corresponds with Step 5: Recommendations. It provides information on:

- Using Design Criteria to Implement Major Purchases (Section A.5.1);
- Implementing Minor Modifications (Section A.5.2); and,
- a Sample Completed Level I Ergonomics Assessment Summary and Recommendations form.

The *Using Design Criteria to Implement Major Purchases* section is to be used in situations where you are asked to provide ergonomics criteria for selecting a new, potentially major piece of equipment such as a chair, monitor support, or other item. Since the focus of this section is on design and selection criteria for major purchases, and since a shop may not be able to implement this type of recommendation right away, you may only need this in special situations. Each time you do an assessment, you may still want to make the shop supervisor aware that you can provide assistance in helping to evaluate future purchases to help them select equipment with features that provide the most benefit to employees while providing the most value to the shop. Again, the "Implementation Reference" column on the Corrective Action List refers directly to information provided in this section.

The *Implementing Minor Modifications* section provides you with guidance on how to actually make or implement the minor modifications - changes and adjustments to existing workstations, chairs, equipment, etc. - that you would have already identified using the case studies. The "Implementation Reference" column on the Corrective Action List refers directly to the information provided in this section. The information complements that provided in the case studies and it will be helpful each time you apply the Level I process.

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USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

Appendix 5

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A.5.1 USING DESIGN CRITERIA TO IMPLEMENT MAJOR PURCHASES

In this section, design criteria have been "converted" into evaluation criteria which you may use when selecting new or replacement tools or equipment. Criteria are provided for:

- Lifting Devices (e.g., hoists, cranes); and,
- Hand Tools/Power Tools.

To enable you to use this information correctly and efficiently in the future, a "Product Evaluation Worksheet" is provided for each item. The worksheets are provided at the end of the section as "forms" which you may copy. In the past, some individuals have sent similar worksheets to product manufacturers or vendors to request information on the ergonomics features of their products. The remainder of this section provides you with the information upon which the worksheets are based.

A.5.1.1 Criteria for Lifting Devices.

The following criteria are for overhead lift devices such as cranes or hoists in which a load hangs from a hook, strap or other connector (e.g., articulating arm).

Lifting devices are often critical for providing assistance in handling heavy loads. There are two major issues which must be considered when selecting a lifting device: convenience and safety.

- ***Convenience.*** If the lift device is time consuming to use, the task requires more time to perform and increases the frustration of personnel. This often discourages personnel from using the device.
- ***Safety.*** If the lift device itself contributes to high forces or static and awkward body postures, this can result in musculoskeletal injuries. Other safety issues such as guarding and alarms must be considered as well.

  Additional guidance for lifting devices is also provided in AFOSH Standard 91-46, *Manual Material Handling.*

A.5.1.1.1 Ease of Use Specifications. The following criteria specify convenience and ease of use requirements for the lifting device.

1. The capacity of the lifting device should match the weight range for the items handled. Using a lift device with a much higher capacity than the items handled usually results in a lift device which is difficult to use and requires too much time to

hook-up. This discourages the employee from using the lift device and return to manual handling. Using a lift device with a lower capacity than the items handled creates serious safety hazards.

2. The lift device **must be easy to use**. The lifting device should make the work easier, not harder. This means using the lift device should take a minimum amount of time to move and attach. The following features assist with ease of use.

    - Quick connect/disconnects for slings or end-effectors are critical to minimize time to attach or remove the hoist from the item being handled. There must also be safety features to prevent the item from being accidentally disconnected.

    - The lift device should maneuver easily and quickly without causing the person to lose control of the load.

    - Controls used to operate the lift device (on-off, up-down, fore-aft) should be clearly labeled, easy to understand, and easy to actuate.

3. The lift device must allow the person to perform the specific handling tasks. This means the lift device must be designed for its specific applications. For instance, some tasks require careful positioning of the load prior to placement. This requires a lift device with slow speed options. If not, the person can waste a large amount of time positioning the lift device because it keeps overshooting its target.

A.5.1.1.2 Ergonomic/Safety Specifications. The following criteria specify ergonomic requirements for the lifting device. Consideration of these criteria help ensure that musculoskeletal risk factors are not created during use of the equipment.

- Lift devices (particularly gantry cranes and jib cranes) should not require excessive force to operate. For instance, a jib or gantry crane should not require the user to exert to get it to move. Figures A-1 and A-2 depict typical jib and gantry cranes.

- Controls should not require excessive hand forces or cause the fingers to be stretched or extended during operation.

- Controls should not require awkward wrist, arm, back or neck postures to operate.

- The lift device should not have hard or sharp edges which could come in contact with the hand or other part of the body.

- Lift devices should meet all applicable safety requirements including: preventing exposure to pinch/crush hazards and providing appropriate guarding for all moving parts. In addition, the strength of hooks, straps or other connectors must be designed such that the risk of unintentionally releasing/dropping the item being lifted is eliminated. Lift devices which move loads over head; or can reverse direction suddenly should be equipped with an alarm or other warning signal (flashing light) to warn others that the lift device is in use. There may be other health and safety criteria not mentioned here which should be examined as a part of a complete equipment evaluation.

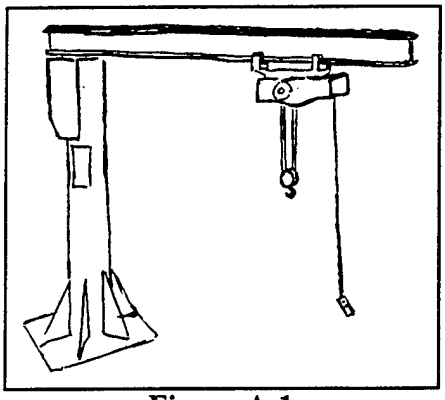


Figure A-1
Jib Crane

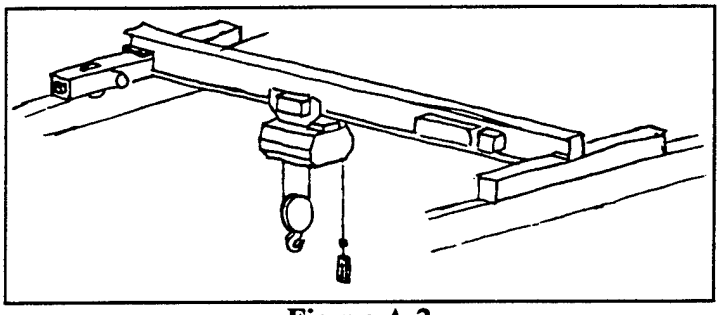


Figure A-2
Gantry Crane

Lift Device Evaluation Worksheet

Table A.1 presents a worksheet to determine whether a lift device has basic ergonomic features. This worksheet is provided to help you systematically evaluate various lift device designs.

Table A.1
Lift Device Evaluation Worksheet

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Lift Capacity	Range	Capacity of the lift device should match the range of weights handled.			
Ease of Use	Overall	Time required to use the lift device should be comparable to (or less than) the time required to handle the load manually.			
	Connection/ Disconnect-ion	Connecting/disconnecting the load to/from the lift device should be quick, simple, and easy.			
	Mobility	The lift device should be quick and easy to maneuver without loss of control or stability.			
	Control understand-ability	Controls used to operate the lift device should be easy to identify, understand and actuate.			
Capabilities	Movement Capabilities	The movement capabilities of the lift device should match the movement requirements of the task (e.g., slow speeds or incremental movement).			
Force Requirements	Transport Forces	Forces required to move or operate the lift device should be negligible.			
	Control Actuation Forces	Controls which require constant pressure to continue operation should not require a significant amount of force. Forces should be substantially below 2 lb. (0.9 kg.).			
	Exposure to hard edges	Lift devices should avoid exposing the operator to hard or sharp edges (particularly those which could press in to the hand).			
Posture Requirements	Posture Requirements	Lift devices should encourage a comfortable and neutral body posture during use. Lift device should not contribute to bent wrists, reaching, and awkward back/neck postures.			
Safety Requirements		The lift device should prevent (at least): exposure to pinch/crush hazards, moving internal components, and falling objects.			
Comments:					

A.5.1.2 Criteria for Hand Tools / Power Tools.

The following major issues which must be considered when developing or selecting a hand tool or power tool:

- ***The tool must be designed for the task(s) being performed.*** A tool is not considered to be ergonomically appropriate unless it performs well for specific tasks. For example, it is possible to have a tool which is very well designed for one task and poorly suited for a different task.

- ***The tool should be flexible enough to be useful in a variety of work situations.*** In other words, if a tool can be used in a number of situations, it reduces the number of tools required, making the work easier.

- ***The tool should encourage neutral and comfortable body postures.*** The tool should allow the user to maintain straight wrists, prevent reaching, and encourage an upright back and head posture during performance of specific tasks.

- ***The tool should not require excessive forces.*** Criteria are defined below.

- ***The tool should not expose the user to hard edges, excessive vibration, impact, or torque.*** The tool should prevent or minimize exposure to these risk factors.

A.5.1.2.1 General Principles. The following general principles apply to tool selection:

- Provide a power or semi-automatic tool for tasks that require high forces or large amounts of repetition.

- A hand tool (or non-power tool) is acceptable when the applied forces are low and the amount repetition is low.

- A tool must have a handle. Tools that do not have handles that are sized for the hand (e.g., some alynn wrenches) tend to cause hard edges which press into the hand and increase grip forces.

- Where more than a minimal amount of force is required to perform the task, a power grip (i.e., full hand) handle is generally preferred over tools which require a pinch (i.e., fingertip) grip.

- For low-force high-precision tasks, a pinch grip is generally preferred.

- Tools should be able to be easily used with either the left or right hand.

- Tools should be easy to use and easy to maintain.

A.5.1.2.2 Grip Angle Guidelines for Different Tasks. The following guidelines direct the selection of a tool grip angle for particular tasks (see Table A.2 below). These guidelines are most helpful for rotary tools (such as power drills and nut drivers) but also can be applied to other types of tools (hammers, pliers).

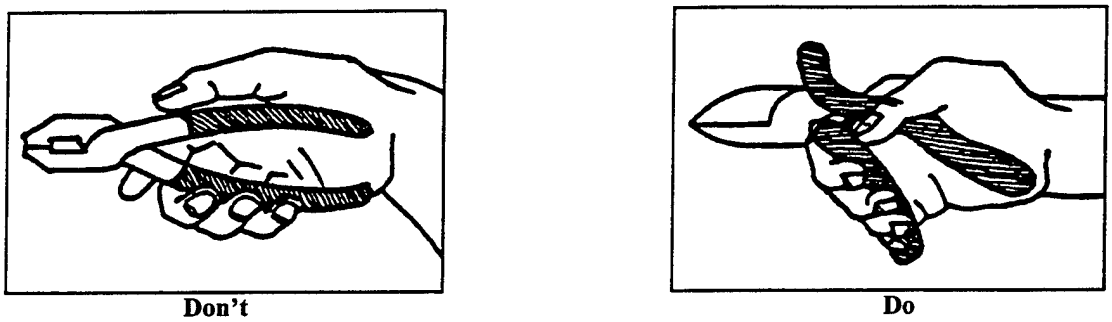


Figure A-3
Handle Angle Criteria

The idea behind these guidelines is to: ***bend the tool not the wrist*** as shown in Figure A-3. The task requirements determine the necessary direction of the tool. The geometry of the human body determines the necessary direction of the handle.

- If the task being performed requires a vertical tool axis and the tool will be held at elbow height, then an in-line or straight grip will generally provide a neutral arm and wrist position.

- If the task being performed requires a horizontal tool axis and the tool will be held at elbow height, then a pistol-type grip will generally provide a neutral arm and wrist position.

Table A.2 provides recommended grip angles for different required tool axis directions and different expected ways in which the tool would be handled.

Table A.2 Recommended Grip Angle for Different Task Requirements

Required Tool Axis Direction	**Approximate Expected Location of Tool**		
	Elbow Height	***Knuckle Height***	***Shoulder Height***
Vertical	in-line/straight grip	pistol-type grip	pistol-type grip*
Horizontal	pistol-type grip	in-line/straight grip	in-line/straight grip*

*Note: Tasks which require use of tools at or above shoulder level create risk factors for the shoulder which should be addressed (i.e., modifying the task or tool, supporting the tool, providing a tool extension).

It may be beneficial if tools have multiple handles or handle which can be oriented for different work situations. By reducing the number of tools required, this allows the tool to be more flexible and easy to use. In addition, the handle location and orientation must take into account visual access to the work. The handle location and orientation must allow the user to see the work without having to tilt or bend the head and/or back.

A.5.1.2.3 Criteria for Tool Forces. The following criteria provide guidelines for selecting a tool which minimizes applied forces. The basic concept is to ensure that forces required to use the tool are minimal.

- Full hand grip force required to use any tool should be less than 8 lb. (3.6 kg.).
- Fingertip grip force required to use any tool should be less than 2 lb. (0.9 kg.).
- The tool should allow two hands when applied forces are high or when additional control is needed. The tool should also allow the user to adjust and vary hand position to minimize the build-up of fatigue.
- The tool should weigh as little as possible. Generally, the tool should weigh no more than 5 lb. (2.3 kg.) without the use of tool support. The only possible exception would be when the tool weight is used to improve tool performance (e.g., sledge hammers). However, even though a power tool may be heavier than a hand tool version, it might be preferable as a long term solution over doing it manually.
- The center of gravity of the tool should be close to (or at) the grip location. This helps to improve the balance of the tool and prevents unnecessary additional grip forces.
- The number of cables and hoses attached to the tool should be minimized and they should be minimal in weight. Generally, hoses and cables should not increase the overall weight of the tool to more than 5 lb. (2.3 kg.) without the use of a mechanical tool support device.
- Cables and hoses attachment locations should be positioned to maintain proper tool balance and minimize interference and drag while using the tool. Swivel attachments for cables can further reduce forces associated with supporting or moving the tool.

- Smooth, compressible, high friction grip surfaces reduce grip forces required to control and use the tool.

- Handle length for torquing tools (i.e., torque wrenches, pry bars) should be in proportion to the amount force required. That is, longer torquing tools reduce required forces to perform the torquing task. The handle should be long enough to keep the grip forces below the force guidelines stated above.

- Force required to activate the trigger should be the minimum force required to sense the actuation of the trigger and return the trigger quickly to an off position when the trigger is not actuated (typically less than 1 lb. or 0.5 kg.).

- The forces required to connect/disconnect the power tool should be insignificant. For example, forces required to connect to electrical outlets or air supplies should be insignificant.

- When continuous activation of the trigger is necessary, one option is to provide a "cruise control" feature which allows the trigger to be engaged without constantly holding the trigger. As an alternative, power tools which are activated by pressure can be effective as well. For example, there are powered nut drivers which are activated when there is sufficient pressure applied to the bit.

- Plier-type tools should have a spring release mechanism to aid in opening the pliers. The spring tension should be established so the plier tool opens when not being compressed. However, the additional force required to close the pliers against that spring tension should be minimal. That is, the spring tension should not make it more difficult to close the tool.

A.5.1.2.4 Criteria for Handle Size and Shape. The following criteria specify the size and shape of the tool handle. These criteria apply for both hand and power tools.

- Grip Diameter for a full hand grip tool should be between 1-1.5" (2.5-3.8 cm.). This is based on the grip diameter of a small female hand. Designing for the small person's hand, in this case, makes the tool usable for the entire population. However, for special tasks, it may be desirable to customize the handle diameter by building up the diameter of the grip surface to the handle for persons with larger hands. Compressible foam grips are available on the market to accomplish this.

- Grip Diameter for a fingertip grip tool should be between 0.25-0.5" (0.6-1.3 cm.).

- Plier-type tools should have a span of less than 3" (7.6 cm.). This prevents excessive extension of the thumb and fingers to grasp the tool in the open position. The 3" (7.6 cm.) is again based on the small hand.

- The handle length should be at least 4" (10.2 cm.). 5" (12.7 cm.) is preferred. This is necessary to prevent the end of the handle from pressing in the palm of the hand (see Figure A-4). This also increases the control of the tool and reduces grip forces required. The 4-5" (10.2-12.7 cm.) is based on a large person's hand to ensure that the handle will be long enough regardless of the size of the hand.

- There should be no hard/sharp edges or abrupt curves on the tool that could press into the user's hand or body. Avoid ridges or channels for individual fingers. Hard edges which press into the hand over a period of time can cause a number of musculoskeletal disorders to the hand or arm.

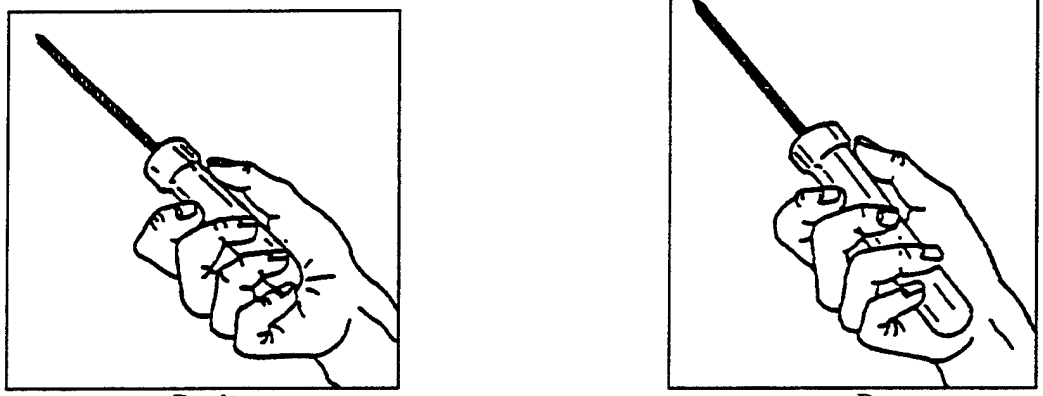


Figure A-4
Handle Length Criteria

A.5.1.2.5 Criteria for Trigger Size and Shape. The following criteria specify the size and shape of the trigger. These criteria apply to those tools which have triggers but also can be applied to buttons on tools in some cases.

- Triggers and buttons should be positioned to allow activation without causing isolated extension of fingers or the thumb. Triggers and buttons should allow the hand to remain in a resting position during actuation. (see Figure A-5)

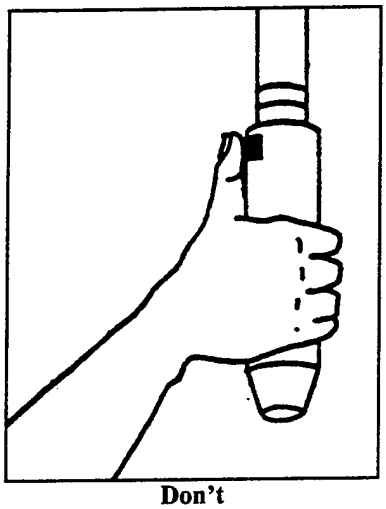
- The minimum trigger length is 1.5" (3.8 cm.). 2-2.5" (5.1-6.4 cm.) is preferred. This permits two finger activation of the trigger.

- The recommended trigger width is 0.5-1" (1.3-2.5 cm.). This minimizes exposure to a hard edge on the trigger and allows the entire pad of the finger to contact the trigger.

- The depth of the trigger should be 0.125-0.375" (0.318-0.953 cm.) to minimize extension of the index and middle fingers while pressing the trigger.

- The trigger should have a small range of movement to minimize finger movement.

- The trigger should have large smooth curves. No hard edges or points (particularly at the end of the trigger).



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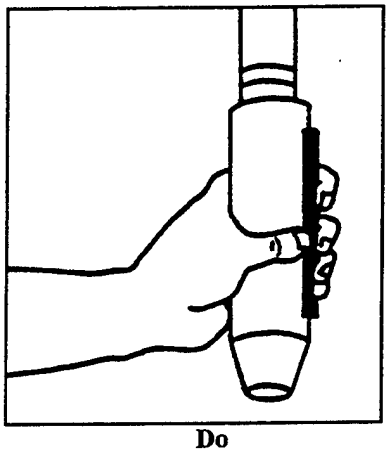

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Figure A-5
Trigger/Button Location Criteria

A.5.1.2.6 Additional Criteria. The following criteria specify other key features of tools.

- Handle materials should prevent heat from being conducted away from the hand. Tool should not have bare metal handles. Handles which are coated with a rubberized insulating surface are preferred.

- Air powered tools should not cause cold air to blow on hands. Exhaust air should be routed away from the user. Exhaust from gasoline powered tools should similarly be directed away from the user.

- Ideally, power tools should not expose the user to vibration, torque, or impact while the tool is being used. Some vibration, however, will always be present because most power tools use reciprocating or rotating frictional working ends to remove material. This is how drills, saws, and sanders work. Very few manufacturers have been successful in eliminating all perceptible vibration from such types of tools. So, if vibration can be felt during a tool trial, the user should not get the impression that the tool is not ergonomically designed. Exposure to vibration can actually be assessed to determine whether or not prolonged use of the tool exposes the user to vibration that is well under the recommended limits (see below). The tool should be durable and easy to maintain in order to minimize the increase of vibration, torque or impact as the tool and contact surfaces wear. If torque or impact is generated by the tool in order to perform the task, the maximum amount of the vibration, torque, or impact should be absorbed by:

  - damping mechanisms internal to the tool; and/or
  - damping materials built in to the tool handle; and/or
  - mechanical tool support mechanisms.

- In general, try to avoid the use (or purchase) of impact tools, when feasible, when choosing a power solution. Impact wrenches can introduce a significant source of impact stress and vibration by the very nature of the tool's torquing mechanism. In many cases, low impact, low vibration, "pulse" tools may be a solution. Pulse tools and other tools with advanced vibration dampening systems like counterbalancing mechanisms or piston-spring systems tend to be much more expensive ($400+) than traditional power tools. In addition, if these types of tools are used to replace existing tools, employees should be briefed on the tools capabilities and unique performance characteristics. The "feel" is different and, without a briefing, many employees may find the tool unacceptable when it's capabilities may actually be a direct match to those of the traditional tool.

- Exposure to working levels of vibration over the 50-200 Hz frequency range should be minimal. Measurement of vibration and impact requires special equipment and is generally considered to be best performed as a part of Level II Ergonomics Analysis. For additional information, refer to ANSI Standard S3.34.

Torque can be measured with a torque wrench. Maximum acceptable torque for an in-line power tool is 2.4 ft-lb. (3.2 Nm). For a pistol-shaped power tool, the maximum acceptable torque is 6.6 ft-lb. (9.0 Nm). Joseph and Long (1991). One of the purposes of shut-off mechanisms in torquing tools, is to prevent the user being exposed to torque levels in excess of these maximums. Ideally, employee exposure to torque should be

minimized. These guidelines are provided as maximum torque levels, worst-case exposure scenario (e.g., as a nut is "torqued" into final (tight) position).

Hand Tool/Power Tool Evaluation Worksheet

Table A.3 presents a worksheet to determine whether a hand tool/power tool has basic ergonomic features. This worksheet is provided to help you systematically evaluate various tool designs.

Table A.3
Hand Tool/Power Tool Evaluation Worksheet

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
General	Handiness	Tool should be easily used with either the left or right hand.			
	Repetition	Tool should minimize repetitive movements.			
	Ease of Use	Tool should be easy to use.			
	Ease of Maintenance	Tool should be easy to maintain.			
Grip Angle	Wrist and Arm Posture	Handle angle and location should allow a straight wrist and neutral arm position while the tool is being used.			
	Back and Neck Posture	Handle angle and location should allow the user to see the work without having to tilt or bend the head or back.			
Force Requirements	Activation Forces	**Full hand** grip forces required to use tool should be less than 8 lb. (3.6 kg.)			
		Fingertip grip force required to use tool should be less than 2 lb.(0.91 kg.)			
	Two hand activation	Tool should allow two hands when applied forces are high or when additional control is needed.			
	Tool Weight	Tool (and associated cables/hoses) should weigh less than 5 lb. (2.3 kg.) or be mechanically supported.			
	Tool Balance	Tool's center of gravity should be close to or at the grip location.			
	Cable/Hose Attachment	Cables and hoses should be attached to minimize interference and drag.			
	Handle Surface	Grip surfaces should be high friction and slip-resistant.			
		Grip surfaces should be compressible.			
	Handle Shape	There should be no hard/sharp edges or abrupt curves that the contact user's hand or body. Avoid ridges or channels for individual fingers.			
	Handle for Torquing Tools	For torquing tools, the handle should be long enough to prevent grip forces above 8 lb. (3.6 kg.)			

Comments:

Table A.3
Hand Tool/Power Tool Evaluation Worksheet (Cont'd.)

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Force Requirements Cont'd	Trigger Force	Force required to activate the trigger should be insignificant (considerably less than 1 lb. or 0.5 kg.)			
	Trigger Function	Tool should avoid continuous activation of a trigger.			
	Connection Force	Force required to connect/disconnect the power tool should be insignificant.			
	Spring Release (Plier-Type Tools)	Plier-type tools should have a spring release mechanism. The spring tension should be minimal.			
Handle Size	Grip Diameter	Grip Diameter for a full hand grip tool should be between 1-1.5" (2.5-3.8 cm.).			
		Grip Diameter for a fingertip grip tool should be between 0.25-0.5" (0.6-1.3 cm.).			
		It should also be possible to increase the diameter of the handle if needed.			
	Handle Span on Plier-Type Tools	Plier-type tools should have a span of less than 3" (7.6 cm.).			
	Total Grip Length	4" (10.2 cm.) minimum, 5" (12.7 cm.) preferred			
Trigger/ Buttons	Trigger/ Button Location	Triggers and buttons should be positioned to prevent extension of fingers or the thumb.			
	Trigger/ Button Shape	Trigger should have large smooth curves. No hard edges or points (particularly at the end of the trigger).			
	Trigger Length	1.5" (3.8 cm.) minimum, 2-2.5" (5.1-6.4 cm.) preferred			
	Trigger Width	0.5-1.0" (1.3-2.5 cm.).			
	Trigger Ridge Depth	0.125" - 0.375" (0.318-0.953 cm.)			
	Trigger Range of Movement	Trigger should have a small range of movement.			

Comments:

Table A.3
Hand Tool/Power Tool Evaluation Worksheet (Cont'd.)

Date:	**Evaluator:**
Job:	**Type:**
Manufacturer:	**Model Number:**
Model Name:	**Price:**

Category	Parameter	Measure	Meets Criteria Yes	Meets Criteria No	N/A
Misc.	Heat Conduction	Tool handle should be coated or rubberized (tool handles should not be bare metal)			
	Routing of Air Exhaust	Air powered tools should not blow cold air on hands.			
	Torque/ Impact	Tool should not expose the user to excessive torque or impact.			
	Vibration	Tool should not expose the user to excessive vibration.			

Comments:

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IMPLEMENTING MINOR MODIFICATIONS

Appendix 5

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A.5.2 IMPLEMENTING MINOR MODIFICATIONS

This section is presented as a concise "how-to" manual for constructing (or working toward) an ergonomically correct work station given different types of furniture, different types of task, and different sizes of people.

A.5.2.1 General Considerations and Approach. When modifying the work station, tools or equipment at a work area, it is important to consider all of the tasks performed that may be impacted by that modification. The following must always be kept in mind:

- Keep the work area flexible;
- Avoid creating a different type of safety hazard;
- Make sure that materials used are appropriate for the area (e.g., special considerations for sterile areas); and
- Rely on employees to help identify quick fix improvement possibilities.

Whenever possible, try to build in adjustability and flexibility at the work station as this will allow a variety of tasks to be performed more comfortably by a number of employees. For example, an individual who is 5'2" will have different requirements for worksurface height (lower to the ground) than a fellow employee who is 6'0". Adjustability enables each employee to accommodate the work area to suit his/her specific needs. Prior to equipment, tool or work station modification it is important to avoid creating a maintenance or other safety hazard. For example, constructing a "too small" platform may create a tripping hazard; an individual could fall off the platform. Placing a piece of anti-fatigue matting in a high traffic area may create a tripping hazard. Employee input is important to help define the specific modification and monitor its effectiveness. To maximize the effectiveness of employee input and avoid creating false expectations several statements can be made prior to problem-solving. For example:

- Define the specific issue to be addressed (e.g., reduce the number of times the employee must lift an object, reduce the degree of bending, etc.);
- State that, "at this time" the changes that can be made need to be limited to adjusting or making better use of the current work area, work platforms, or equipment (i.e., new purchases of new equipment can be suggested, but will not be evaluated until the next budgeting period); and
- Remind employees that, since they are all different, an adjustment which works for one of them may not be appropriate for the others.

A.5.2.2 Improving Existing Tools. The purpose of modifying existing tools is to make them a better fit for the hand. When contemplating changes to an existing tool it is important to consider the task being performed, the size of the employee's hand, and the "safeness" of changing a feature of the tool. For example, padding may be added to wrap and build-up a tool handle diameter that is too small for an employee. However, if the padding is loosely fit and the tool will be used around moving equipment, that padding may create a safety hazard. The idea of building up the handle diameter is valid. A better solution may be to add a slip-on rubber sleeve. There are several things that can be considered for improving existing tools: tool maintenance, handle diameter, handle length, air hose connection, and anti-vibration materials.

A.5.2.2.1 Tool Maintenance. Maintaining or servicing existing tools is often a good start at improving tool performance and employee comfort. Consider the factors listed below.

- Tool blades, grinding stones, and bits should be regularly checked and replaced to ensure that they are sharp for optimum performance. A dull bit or blade will impact the quality of finish and often require the employee to work longer on the task to achieve the desired outcome. Maintenance of blades, bits and grinding stones may be done in the immediate work area according to a maintenance or replacement schedule (provided by the supplier or manufacturer). In some cases, the tool may have to be sent to the manufacturer for precise maintenance routines (replacement tools may be provided).

- Motors should be regularly serviced and, where necessary, lubrication should be performed regularly as specified by the manufacturer of the tool.

- Tool balancers should be regularly adjusted to balance the weight of the tool. Adjustment will be required when the employee appears to be pulling ("fighting the pull"). When a tool is not balanced the weight of the tool must be compensated by the user in order to keep it balanced. This increases fatigue and affects the quality of the work.

A.5.2.2.2 Handle Diameter. Establishing the optimum diameter maximizes the strength of the hand. A properly sized tool will reduce grip force requirements.

- Optimum tool diameter is between 1.5 to 2.2 inches (although some special purpose tools such as a pencil grinder may require a smaller diameter). Select the most appropriate handle diameter that will fit the employee. Increasing tool diameter can be accomplished using sponge padding or commercial grips. It is important the adaptation is secure and snugly fits around the tool. Also consider that the material added takes into account the thickness of gloves that the employee typically wears.

A.5.2.2.3 Handle Length. Handle length may be increased to reduce pressure points in the palm or increase the mechanical advantage.

- A recommended minimum handle length is 5 inches. It is important that the handle travel through the palm and not end in the palm.

- Adapting a tool that is too short can be accomplished by welding an extension to a steel handle. If this is done one must ensure edges are smooth and the extension is integrated (in line) with the previous handle. Wooden and plastic handles are very difficult to adapt since there is no secure method to add additional material. For tools made of these materials, employees have sometimes used special purpose tape and wooden extensions. It may be possible to order a new handle, which is longer in length from the manufacturer.

- Adaptation can also be accomplished by purchasing an inexpensive commercial handle that meets the specification for length and diameter. This method will be a more feasible solution for hammers, for example. For power tools, commercial handles may be available, but in most cases a tool upgrade will have to be examined as the best alternative

A.5.2.2.4 Air Hose Connection. An appropriate connection can decrease grip force requirements. Utilize a swivel or universal joint connector to minimize drag on the hose. Another option is to fabricate a simple hanger (like an "I.V." tube stand) to elevate and support air hoses. This will also reduce drag along the floor and make the tool easier to position.

A.5.2.2.5 Anti-vibration Materials. Anti-vibration materials used as grip covers or sleeves should be used with caution. Adding these materials may increase the handle diameter to an inappropriate size. In addition, anti-vibration grips may not control vibration at the frequencies which impact the hand the most at the operating frequency of the tool. The benefits may actually be in grip force reduction since a compressible grip can make the tools easier to control.

A.5.2.3 Getting Closer to the Work. The individual should be able to get as close as possible to the work to avoid excessive reaching which can create stress on the muscles of the back and shoulders. There are two primary strategies that you can use to modify the work area: remove obstructions from the floor, and, from the employee and the work.

A.5.2.3.1 Remove Obstructions from the Floor

- Poor housekeeping is often the main contributor to obstacles in the work area. In order to keep the employee as close to the work as possible, help him or her identify and then remove obstructions from the floor such as air hoses, boxes,

tools and carts. The work area should be maintained and items should be placed in designated storage areas.

A.5.2.3.2 Remove Obstructions Between the Worker and the Work. There are several strategies to consider.

- If another part (or panel) is in front of the area that needs to be accessed, remove that part prior to working inside the area.

- If the fixture supporting the part restricts access, reorient the work piece or investigate the feasibility of modifying the fixture (e.g., removing or relocating a panel or kick-plate).

- Consider lowering a work platform (when used) to provide clear access under the work. This may allow the employee to stand up straight while moving within the work area or while servicing the part.

A.5.2.4 Adding Variety to the Work Position. One of the most effective strategies for improving comfort/preventing fatigue in the low back and legs is to build in task variety/alternating standing and seated tasks. Below are factors which you may consider when helping employees identify (or confirm) which of their tasks might be done best from a seated position, and which might be done best from a standing position.

A.5.2.4.1 Sitting. The desirable seated posture is shown in Figure A-6. Sitting is most appropriate when the following conditions are present:

- All items needed in the short term task cycle can be easily supplied and handled within the seated work place;

- No large forces are required, such as handling heavy objects;

- Fine assembly is required.

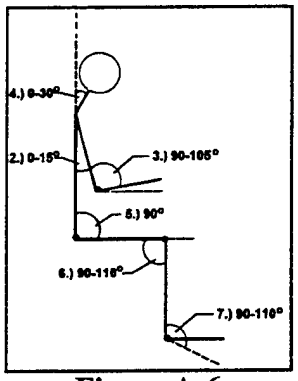


Figure A-6
Recommended Seated Posture

A.5.2.4.2 Standing. The desirable standing posture is shown in Figure A-7. Standing is most appropriate when the following conditions are present:

- A greater range of movement is required for reaching;
- It is not appropriate or possible to allow knee room; and,
- The point of operation can't be lowered (for sitting).

Although standing has the advantage of providing for a greater range of motion, it has the disadvantage of placing stress on the back and legs, and causing pooling of blood in the lower legs. Employees should be encouraged to avoid locking their knees and to walk or move around periodically to prevent static muscular fatigue. Employees should also be encouraged to use cushioned shoe inserts (e.g., sorbothane material or other impact/shock-absorbing material).

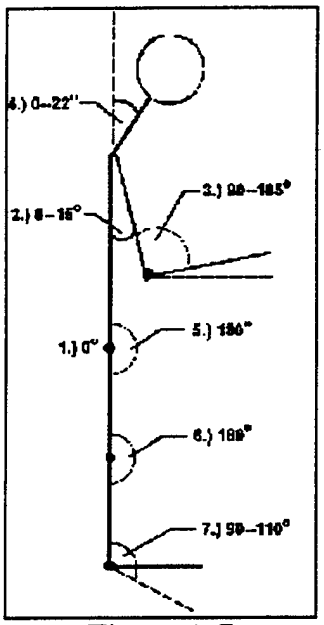


Figure A-7
Recommended Posture

A.5.2.5 Improving the Work Height. Improving the work height can result in significant improvements to low back, shoulder, and in some cases, wrist comfort. It is not simply a matter of raising or lowering the work. Rather, your goal is to try to optimize the relationship between the height of the employee and the height of the primary work location.

A.5.2.5.1 Single-Employee Use Workbench. When only one employee uses a workstation or bench, the best approach is to help the employee customize his/her work area. The following items should be considered.

- Establish height so the work table is low enough to handle the largest work piece and allow the employee to work in a neutral position. (For aircraft, establish the work platform so that it is low enough to enable the employee to work on the lowest point from a comfortable seated or standing position. Higher points of work can be reached using additional (stable) risers.)

- Build simple table top risers out of wood or a similar material to increase the effective work height for smaller/shorter work pieces.

- Raise the height for taller employees by putting table legs on blocks.

- Lower the height for shorter employees by cutting the legs of the current tables, or adjust the leg height if the table has adjustable leg extenders.

A.5.2.5.2 Multiple-Employee Use Workbench. When more than one employee must use the work area, flexibility is the key.

- If the work table is a fixed height, consider setting up for taller employees-raise table up on blocks.

- Provide a stable platform for shorter employees.

A.5.2.5.3 Fixed Position Point of Operations (e.g., Aircraft)

- Consider adding temporary but stable risers for shorter employees who work on elevated platforms.

- Suggest the use of a stool or chair to have employee sit to do a task which may be too low for comfortable standing work.

A.5.2.6 Improving Comfort with Foot Pedal Use

A.5.2.6.1 Standing Work. The primary objective is to prevent the employee from maintaining a "flamingo" or single-leg stance. The main concern is for employees who use foot pedals for a significant part of the shift. The following factors should be considered.

- **Option 1** - Build up a simple platform riser and place the foot pedal off the front surface so both heels are on the platform and the action of the foot is down (keep a 90-120 degree angle between the foot and the lower leg). To provide adequate leg room, you may need to remove obstructions to allow a distance of at least 10 inches between the end of the foot and the closest vertical surface.

- **Option 2** - Add a heel riser (block of wood) to the heel end of the foot pedal. This option may not be as effective as Option 1 but it will help to distribute body weight more evenly across both legs and the back muscles.

A.5.2.6.2 Seated Work. The primary objective is to keep the feet and legs in the neutral position. The position of most foot pedals (with the exception of vehicles) can be re-positioned. The guidelines are presented below.

- Foot pedal stability is critical. Add a non-slip surface or a weight to the base of the foot pedal to increase stability.

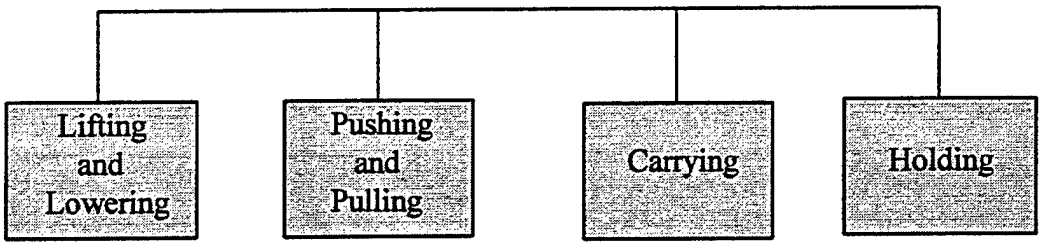
- The foot pedal should be height, angle and horizontally adjustable to accommodate multiple employees. Build a riser out of wood, place under the foot pedal to enable height adjustability.

- Adjust the side-to-side position and distance away from the body to maintain angles of 100-110° between the back and the thigh and the lower leg, 100-110° between the foot and the lower leg. Both legs should be centered with the body.

- You may need to remove leg obstructions (like the under table scrap chute on a sewing machine table or garbage can under a worksurface).

A.5.2.7 Reducing the Demands of Manual Handling. Manual materials handling (MMH) is one of the most important aspects of work to which ergonomic principles should be applied, particularly in the prevention of low back pain and injuries.

Manual materials handling involves general types of activities.



Typically, MMH tasks in maintenance and inspection tasks require the worker to perform a combination of the above activities. The ability of the employee to handle materials safely is a function of the following factors:

- Task characteristics;

- Material/container characteristics; and,

- Worker or handling characteristics.

A.5.2.7.1 Task Characteristics. Consider the following when identifying the types of modifications that can be made to reduce exposure to risk factors.

- Reduce twisting motions by re-organizing the work area to provide sufficient space for the entire body to turn when handling items or when pushing or pulling carts.

- Reduce excessive forces by encouraging the employee to use available mechanical aids such as hoists, cranes. If aids are difficult to use make a note of the reasons why and communicate this information to the shop supervisor or shop mechanic. It may be possible that a repair or minor modification to the hoist may make it easier to use.

- Limit stacking of light weight objects to shoulder height.

- Keep heavy objects at knuckle height.

- Keep wheels on carts well maintained.

- Keep objects close to the body when lifting or carrying.

- If a tool belt is used, distribute tools evenly on both sides. Encourage the employee to remove the tool belt and place it on a small work table, whenever possible. The goal is to avoid having the tool belt (especially if the weight is unevenly distributed) place an additional load on the spine and muscles of the back.

A.5.2.7.2 Material/Container Characteristics. Consider the following when identifying the types of modifications that can be made to reduce exposure to risk factors.

- Reduce excessive forces by distributing the weight/items evenly in a container.

- Container should have handles whenever possible

- Use the minimum size and lightest weight container possible for transferring loads.

- Place containers on carts and push the cart instead of carrying the load.

- Add wheels to small, heavy containers and use a hook to drag/roll them across the floor.

- Clearly label the container or item with its correct weight to help employees to decide how to handle the material.

A.5.2.7.3 Worker and Handling Characteristics. Consider the following when identifying the types of modifications that employees can be encouraged to make to how they work to reduce exposure to risk factors.

- Maintain a straight back when lifting, using the leg muscles to lower the body and lift the load.
- Keep the body balanced.
- During lifting or transferring loads, turn with the feet rather than twist the trunk.
- Share the load/lift with another employee (buddy lift).
- Avoid quick movements when two people are lifting an object, make sure both employees have a firm hand hold before starting the lift. Lift the load with a smooth body motion.
- When lifting, keep the load as close to the body as possible.
- Avoid overloading carts.
- Know the weight of the load being lifted. Make sure when using the buddy lift that both people can handle the load. Do not proceed with the lift if one employee is straining to maintain the lift.
- Alternate handling heavy loads with light loads, whenever possible.

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LEVEL I ERGONOMICS ASSESSMENT
SUMMARY AND RECOMMENDATIONS
SAMPLE

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LEVEL I ERGONOMICS ASSESSMENT
SUMMARY AND RECOMMENDATIONS

Date (YYMMDD)		Workplace Identifier:	
(use this space for mechanical imprint)		Base DOVER AFB	Organization 96 ABW
		Workplace SURVIVAL	EQUIPMENT
		Bldg. No./Location 306	Room/Area A
		AFSC/Job Series	Job Name

CRITICAL TASKS IN PRIORITY ORDER

Task Name	Task Rating	Body Regions and Ratings (Circle one for each region)				
		Shoulder/Neck	Hands/Wrists/ Arms	Back/Torso	Legs/Feet	Head/Eyes
1. PACKING	(High) Med	High (~~Med~~)	High (Med)	(High) Med	High Med	High Med
2. FOLDING /FITTING	(High) Med	High (Med)	High (Med)	(High) Med	High (Med)	High Med
3.	High Med	High Med	High Med	High Med	High Med	High Med

OVERALL JOB RATING

RATING: (High) Medium (Circle one)	PRIORITY BODY REGION: SHOULDER/NECK HAND/WRIST/ARM (circle one) LEGS/FEET (BACK/TORSO) HEAD /EYES

- Findings are consistent with results from Job Requirements and Physical Demands Survey (Public Health): ☐ Yes ☐ No ☒ N/A
  Comment: INVESTIGATION CONDUCTED IN RESPONSE TO AF FORM 190
- Findings are consistent with employee reports of discomfort and/or illness: ☒ Yes ☐ No
  Comment: COMPLAINTS OF BACK DISCOMFORT ARE SUPPORTED BY RESULTS

RECOMMENDATION FOR FOLLOW-UP

Modifications and adjustments

-Provide appropriate knee protection/knee pads

-Provide shoe inserts

-require that two employees share the task of lifting raft in and out of packing fixture

Expected Benefits (Check all that apply): ☐ Health/Safety ☒ Productivity/Quality

Major changes and/or purchases

-Consider fabricating a simple table to provide an elevated surface for folding raft (keep employees from kneeling on floor) - Consider modifying current packing fixture to tip sideways (roll or slide raft into fixture), tip up to pack, tip back down to unload.

Expected Benefits (Check all that apply): ☒ Health/Safety ☒ Productivity/Quality

BEF (Sign) _____

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APPENDIX 6

Forms

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Sample Level I Ergonomics Assessment Checklist for Maintenance and Inspection Work Areas

Appendix 6

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Level I Ergonomics Assessment Checklist for Maintenance and Inspection Work Areas	Survey Date (YYMMDD)	**Workplace Identifier:**	
(use this space for mechanical imprint)		Base	Organization
		Workplace	
		Bldg. No/Location	Room/Area
		AFSC/Job Series	
		Job Name:	

BEF Technician: _____
Sign

(FORM)

Level I - Ergonomics Assessment for Maintenance and Inspection Work Areas

Part I - Work Content (Description of Tasks Performed)

Technician: _____

Date: _____

For this section, work with the employee to determine those reoccurring jobs/tasks that are most difficult on the body. Ask the employee the following questions:

- "In terms of stress to the body, what are the most difficult, fatiguing jobs/tasks that you do?"
- "Which of those jobs/tasks do you perform on a regular basis (or occur most frequently)?"

Using the Maintenance and Inspection Task Key List as a reference, write in the task names in the work content matrix below. If the employee mentions tasks which are not included on the Task Key List, write-in the additional tasks in the Task Key List. **Note: If the person mentions several jobs which each have multiple tasks, complete a separate checklist for each job.**

For each task performed, determine the approximate task frequency using the following proportions of job time:

> 50 % (High): The total percentage of work time spent performing the task is greater than 50%.

10-50 % (Moderate): The total percentage of work time spent performing the task is between 10 and 50%.

< 10 % (Low): The total percentage of work time spent performing the task is less than 10%.

For each task, check the most appropriate circle in the Work Content Matrix below to indicate approximate task frequency. If lifting/high force exertions occur in the task, indicate by checking the appropriate circle.

WORK CONTENT MATRIX

Task	Lifting / Exertion Occur in Task	Task Frequency (Check one)		
		(Low) 0-9%	(Moderate) 10-50%	(High) 51-100%
1.	○	○	○	○
2.	○	○	○	○
3.	○	○	○	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○

= Critical tasks are indicated by the shaded boxes in the Work Content Matrix. Critical tasks are tasks which occur greater than 10% of the job time or which involve lifting or high forces.

ONLY COMPLETE THE CHECKLIST FOR CRITICAL TASKS.
LOW FREQUENCY TASKS WITH LIFTING OR EXERTION ARE SCORED AS MODERATE FREQUENCY.

Performance Measures

How is your performance measured? _____

_____

_____

Part II - Checklist, Shoulder / Neck

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

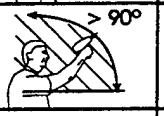
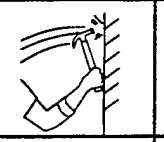
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

	Job Factor	Task Name:		Task Name:		Task Name:		Comments
		Task Frequency		Task Frequency		Task Frequency		
		Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	
	1. **Reaching** *repeated reaching or arms held continuously away from body while unsupported*							
	Below shoulder level (arm 30-90° away from body)	F S O N 1 1 0 0	F S O N 3 2 1 0	F S O N 1 1 0 0	F S O N 3 2 1 0	F S O N 1 1 0 0	F S O N 3 2 1 0	
	*Above shoulder level (arm > 90° away from body)*	F S O N 3 2 1 0	F S O N 4 3 1 0	F S O N 3 2 1 0	F S O N 4 3 1 0	F S O N 3 2 1 0	F S O N 4 3 1 0	
	2. **Arm forces:** **Repeated arm forces** exceeding 10 lbs. (4.5 kg.) *(e.g. roughly equivalent to lifting a gallon of milk)* ***or*** **Holding/carrying materials** *exceeding 25 lb.(11.3kg.) for more than three steps*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
	3. **High speed, sudden shoulder movements** *(e.g., opening a stuck door, pulling and yanking on a stuck component to remove it)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
	4. **Head/neck bent, tilted, or twisted** (>10°) *(e.g., craning neck looking into tight spaces)*	F S O N 3 2 1 0	F S O N 6 3 1 0	F S O N 3 2 1 0	F S O N 6 3 1 0	F S O N 3 2 1 0	F S O N 6 3 1 0	
	Task Scores = (column total)							

(FORM)

Part II - Checklist, Hands/Wrists/Arms

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

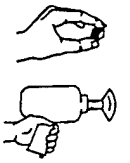
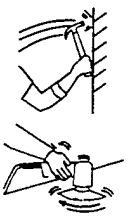
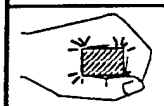
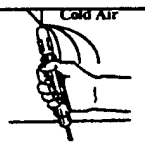
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name:		Task Name:		Task Name:		Comments
	Task Frequency		Task Frequency		Task Frequency		
	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	
5. **Bent wrists/repeated wrist movements** (>10° in any direction) or **repeated forearm rotation** *(e.g., turning a screw driver, Allen wrench)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
6. **Repeated manipulations with fingers** *(e.g., repetitive computer keying tasks, removing small screws, electrical wiring tasks)*	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	
7. **Hyperextension of finger/thumb** *(e.g., using pliers with a wide handle span)* **or repeated single finger activation** *(e.g., single finger triggers on power tools)*	F S O N 1 0 0 0	F S O N 3 1 0 0	F S O N 1 0 0 0	F S O N 3 1 0 0	F S O N 1 0 0 0	F S O N 3 1 0 0	
 8. **Hand/grip forces** *fingertip force: > 2 lb.(.9 kg.) (e.g., 2 lb. is roughly equal to holding fingernail clippers closed full hand force: > 8 lb. (3.6 kg.) (e.g., 8 lb. is roughly equal to holding a 8 lb. tool or holding a gallon of milk)*	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	
 9. **High speed hand/wrist /arm movements** *(e.g., yank components with fingers, using the hand as a hammer)* ***or*** **Vibration, impact, or torque to the hand** *(e.g., using a nail gun or other power tools and equipment)*	F S O N 3 1 0 0	F S O N 5 2 1 0	F S O N 3 1 0 0	F S O N 5 2 1 0	F S O N 3 1 0 0	F S O N 5 2 1 0	
 10. **Exposure to hard edges** *(e.g., tool handle or work area presses into fingers or palm of hands)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
 11. **Hands and fingers exposed to cold temperatures** *(e.g., working outside in winter environment, cold exhaust air from tool blows on hand/wrist)*	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	F S O N 1 0 0 0	F S O N 2 1 0 0	
	Task Scores = (column total)						

(FORM)

Part II - Checklist, Back/Torso

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name: Task Frequency Moderate 10-50%	Task Name: Task Frequency High 51-100%	Task Name: Task Frequency Moderate 10-50%	Task Name: Task Frequency High 51-100%	Task Name: Task Frequency Moderate 10-50%	Task Name: Task Frequency High 51-100%	Comments
12. **Repeated forward or sideways bending movements** (>20°) (e.g. lifting from floor level)	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
13. **Twisting of the lower back** (e.g. rushing while lifting, pulling, open a stuck door)	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	
14. **High speed, sudden movements** *with the back*	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	F S O N 3 1 0 0	F S O N 4 2 1 0	
15. **Static, awkward back postures** *(for >10 sec at a time)* ***While standing,*** *continuous leaning forward or to the side* (>20°) **or** ***While seated,*** *continuous leaning forward* (>20°) *or poor lower back posture (e.g., poor lower back support, no support for feet)*	F S O N 2 1 0 0	F S O N 6 2 1 0	F S O N 2 1 0 0	F S O N 6 2 1 0	F S O N 2 1 0 0	F S O N 6 2 1 0	
16. **Lifting forces**							
• *50-70 lb. (22.7-31.8 kg.) while upright w/ load close to body or*	F S O N 3 2 2 0	F S O N 4 3 2 0	F S O N 3 2 2 0	F S O N 4 3 2 0	F S O N 3 2 2 0	F S O N 4 3 2 0	
• *10-40 lb. (4.5-18.1 kg.) while bending or reaching*							
• *> 70 lb.(31.8 kg.) while upright w/ load close to body or*	F S O N 6 5 4 0	F S O N 7 6 4 0	F S O N 6 5 4 0	F S O N 7 6 4 0	F S O N 6 5 4 0	F S O N 7 6 4 0	
• *> 40 lb. (18.1 kg.) while bending or reaching*							
17. **Pushing or pulling** *(initial force > 50 lb. (22.7 kg.)) (e.g. pushing/pulling a full two-drawer file cabinet across a carpeted floor)*	F S O N 3 2 1 0	F S O N 4 3 2 0	F S O N 3 2 1 0	F S O N 4 3 2 0	F S O N 3 2 1 0	F S O N 4 3 2 0	
18. **Whole body vibration** *felt through floor surface (e.g. operating heavy machinery)*	F S O N 2 1 0 0	F S O N 4 2 1 0	F S O N 2 1 0 0	F S O N 4 2 1 0	F S O N 2 1 0 0	F S O N 4 2 1 0	
Task Scores = (column total)							

(FORM)

Part II - Checklist, Legs/Feet

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

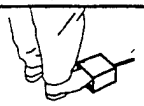
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

Job Factor	Task Name:		Task Name:		Task Name:		Comments
	Task Frequency		Task Frequency		Task Frequency		
	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	
19. **Fixed position, standing** *static effort in legs (e.g. standing on hard floor surfaces)*	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
20. **Exposure to hard edges on legs, knees, and feet** *(e.g., kneeling on a hard surface standing on rungs of a ladder, leaning against a hard edge, exposure to hard front edge of seat)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
21. **Awkward leg postures** *(e.g. kneeling, squatting, crawling, or knee hyperextension)*	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	F S O N 2 1 0 0	F S O N 5 2 1 0	
 22. **Standing foot pedal** *(e.g., using foot pedal while standing)*	F S O N 1 0 0 0	F S O N 3 2 1 0	F S O N 1 0 0 0	F S O N 3 2 1 0	F S O N 1 0 0 0	F S O N 3 2 1 0	
Task Scores = (column total)							

Part II - Checklist, Head/Eyes

Job Factors

For each Job Factor, select the appropriate Job Factor frequency score using the following guidelines:

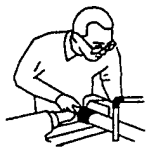
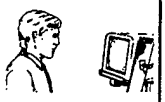
Frequently (F): Job Factor occurs for greater than 50% of the task

Sometimes (S): Job Factor occurs for 10-50% of the task

Occasionally (O): Job Factor occurs for less than 10% of the task

Never (N): Job Factor does not occur or does not apply

Critical Tasks

	Job Factor	Task Name:		Task Name:		Task Name:		Comments
		Task Frequency		Task Frequency		Task Frequency		
		Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	Moderate 10-50%	High 51-100%	
	23. **Difficult to see/light levels too low /too high.** *(e.g., see detail)*	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
	24. **Intensive visual tasks, staring at work objects for long periods** *(e.g., inspection, troubleshooting)*	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	F S O N 2 1 0 0	F S O N 3 2 1 0	
	Task Scores = (column total)							

(FORM)

Part III - Environmental

Environmental Factors

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
25. Restricted space	0	0	0	1	4
26. Extreme temperatures heat/cold	0	0	0	1	4
27. Noise or distractions	0	0	0	1	4
28. Air quality concerns	0	0	0	1	4

Environmental Score = ☐

Environmental Rating	Low	Med	High
Environmental Score	0-3	4-7	8+

Part IV - Employee Suggestion

Ask the employee for any suggestions for corrective actions that they may have.

ERGONOMIC SCORING SUMMARY

Technician_____

Date _____

1. Job Description: Please write out job description.

2. Scoring Summary: Transfer scores from individual scoring sheets.

Body Region	Task Scores					Priority Score by Body Region	Priority Rating by Body Region
	Task Name:	**Task Name:**	**Task Name:**	**Task Name:**		**Add across row and divide by # of tasks for average**	High: 8+ Med: 4-7 Low: 0-3
Shoulder/Neck					=		High Med Low
Hand/Wrist/Arm					=		High Med Low
Back/Torso					=		High Med Low
Legs/Feet					=		High Med Low
Head/Eyes					=		High Med Low

Select the highest body region score for each task then circle below for High, Med, Low	Highest Score	Highest Score	Highest Score	Highest Score
High: 8+ Med: 4-7 Low: 0-3	High Med Low	High Med Low	High Med Low	High Med Low

Environmental Rating
High Med Low

Overall	
Highest Priority Score by Body Region Score:_____ Body Region:_____	Priority Rating **High** **Med** **Low**

(FORM)

Corrective Action List (Maintenance and Inspection Work Areas)

Select the corrective action from the **case studies** pages paying particular attention to the body regions that are primary and secondary concerns. Place a ✓ in the appropriate boxes below as you select from each case study.

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
1. Alternate between sitting and standing tasks			A.5.2.4
2. Avoid high force tasks while seated			A.5.2.4
3. Change a pinch grip to a power grip			
4. Change lifting/carrying task into a rolling or sliding task			A.5.2.7
5. Change posture frequently			A.5.2.4
6. Call for assistance if necessary			
7. Direct cold air away from the hands			A.5.1.2
8. Distribute intensive activities throughout the process			
9. Eliminate exposure to hard edges			
10. Eliminate need to constantly hold trigger			A.5.1.2
11. Eliminate unnecessary tasks			
12. Encourage appropriate seasonal clothing			
13. Encourage ergonomic work techniques			
14. Encourage person to have visual disorders corrected			
15. Heat metal/material to make more pliable			
16. Improve cleat design			
17. Improve floor condition			
18. Improve visual access to work			
19. Improve wheel condition			

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
20. Incorporate rest pauses			
21. Increase handle length to improve leverage			A.5.1.2
22. Increase light levels			
23. Increase room temperature			
24. Increase size of work surface			
25. Increase task variety			A.5.2.4
26. Increase weight of work piece			
27. Lower light levels			
28. Lower the chair			A.5.2.5
29. Lower the handle			
30. Lower the monitor/screen			
31. Lower the person			A.5.2.5
32. Lower the work piece/work surface			A.5.2.5
33. Maintain bolts and screws			
34. Maintain hand tool/power tools			A.5.2.2
35. Maintain tracks, rollers, and movement mechanisms			
36. Minimize material which must be removed manually			
37. Modify facilities to decrease handling			
38. Move closer to the work location			A.5.2.3
39. Move monitor/screen closer to body			
40. Move monitor/screen further away from body			

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
41. Move work piece closer to body			
42. Obtain patient's assistance			
43. Place the trigger/switch to allow a comfortable hand/arm position			
44. Position mouse/input device next to the keyboard			
45. Position the monitor/screen in front of the body			
46. Provide a ball-bearing rotation table			
47. Provide a carrying container for tools/supplies			A.5.2.7
48. Provide a cart			A.5.2.7
49. Provide a flat/level keyboard			
50. Provide a foot pedal which requires the correct amount of force to use			
51. Provide a foot pump			
52. Provide a footrail or footrest			A.5.2.6
53. Provide a full-sized input device			
54. Provide a high friction gripping surface			A.5.2.2
55. Provide a hook-type tool to pull items			
56. Provide a keyboard which does not require excessive keying forces			
57. Provide a larger worksurface			
58. Provide a lighter weight door			
59. Provide a lighter weight tool			A.5.1.2
60. Provide a magnifying glass			
61. Provide a mechanical lift device			A.5.1.1

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
62. Provide a multi-finger trigger			A.5.1.2
63. Provide a padded, compressible surface to lay on			
64. Provide a padded, compressible surface to sit on			
65. Provide a palm rest			
66. Provide a power tool			A.5.1.2
67. Provide a powered cart			
68. Provide a shorter handle to reduce arm movement			
69. Provide a smaller container			A.5.2.7
70. Provide a spring release mechanism on plier-type tools			A.5.1.2
71. Provide a storage bag which is easy to pack/unpack			
72. Provide a swivel connection for air hose			A.5.2.2
73. Provide a telephone head set			
74. Provide a tool that minimizes exposure to vibration/impact/ torque			A.5.1.2
75. Provide a tool which can be used with both hands			A.5.1.2
76. Provide a tool which requires minimal force to use			A.5.1.2
77. Provide a tool with an appropriate handle angle			A.5.1.2
78. Provide a wheel barrow			
79. Provide a work surface which is adjustable in height			
80. Provide adequate leg clearance			
81. Provide adequate toe clearance			
82. Provide adequate work space			

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
83. Provide an adjustable height lift table			
84. Provide an adjustable mirror			
85. Provide an alternative keyboard			
86. Provide an appropriate anti-fatigue mat			
87. Provide an appropriate chair/stool			
88. Provide an appropriate handle diameter			A.5.1.2
89. Provide an appropriate handle grip span on plier-type tools			A.5.1.2
90. Provide an auxiliary table			
91. Provide anti-vibration materials			A.5.2.2
92. Provide appropriate abrasive material			
93. Provide appropriate gloves			
94. Provide appropriate handles			A.5.1.2
95. Provide appropriate knee protection			
96. Provide appropriate shoe inserts			
97. Provide appropriate solvent solution			
98. Provide automatic or semi-automatic feed for fasteners			
99. Provide bolt and screw head designs which are durable			
100. Provide computer glasses			
101. Provide controls which do not require excessive forces			
102. Provide displays which are readable and easy to understand			

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
103. Provide extensions for tools			A.5.2.2
104. Provide handles with insulating material			A.5.1.2
105. Provide portable heaters			
106. Provide powered assistance for a manual activity			
107. Provide powered or mechanical assistance for door			
108. Provide protection from glare from natural light			
109. Provide protection from glare from overhead lights/ task lights			
110. Provide shields or barriers from the wind			
111. Provide support for reference documents			
112. Provide support for the arms			
113. Provide support for the cable or hose			A.5.2.2
114. Provide support for the head			
115. Provide support for the lower back			
116. Provide support for the tool			A.5.1.2
117. Provide support for the upper body			
118. Provide support for the work piece			
119. Provide wheels			
120. Raise the chair			A.5.2.5
121. Raise the handle			
122. Raise the monitor/screen			
123. Raise the person			A.5.2.5
124. Raise the work piece/work surface			A.5.2.5
125. Recess container into work surface			
126. Reduce carry distance			
127. Reduce depth of storage container			A.5.2.7

Corrective Action List (Maintenance and Inspection Work Areas) Cont'd

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
128. Reduce force required to install or remove the component			
129. Reduce number of fasteners used			
130. Reduce the angle a person has to turn to transfer an item			A.5.2.7
131. Reduce weight of work piece			
132. Remove obstructions			A.5.2.3
133. Replace abrasive or cutting material frequently			
134. Replace standing foot pedals with alternative controls			
135. Reposition foot pedal			A.5.2.6
136. Rotate the work piece			
137. Sharpen blades frequently			
138. Stand to perform task			A.5.2.4

Job Factors

Corrective Action	Action Selected		Implementation Reference (Appendix 5)
	Minor	Major	
139. Store materials in the same orientation in which they are used			
140. Use alternative fasteners			
141. Use heavy excavation equipment (e.g., back hoes)			
142. Use two or more persons to perform the transfer			A.5.2.7
143. Wear appropriate shoes			
144. Provide a machine/automate			
145. Modify foot pedal			A.5.2.6

(FORM)

SUMMARY AND RECOMMENDATIONS

Date (YYMMDD)		Workplace Identifier:	
(use this space for mechanical imprint)		Base	Organization
		Workplace	
		Bldg. No./Location	Room/Area
		AFSC/Job Series	Job Name

CRITICAL TASKS IN PRIORITY ORDER

Task Name	Task Rating	Body Regions and Ratings (Circle one for each region)				
		Shoulder/Neck	Hands/Wrists/ Arms	Back/Torso	Legs/Feet	Head/Eyes
1.	High Med	High Med	High Med	High Med	High Med	High Med
2.	High Med	High Med	High Med	High Med	High Med	High Med
3.	High Med	High Med	High Med	High Med	High Med	High Med
4.	High Med	High Med	High Med	High Med	High Med	High Med

OVERALL JOB RATING

RATING: High Medium (Cirlcle one)	**PRIORITY BODY REGION: SHOULDER/NECK HAND/WRIST/ARM** **(circle one) LEGS/FEET BACK/TORSO HEAD /EYES**

- Findings are consistent with results from Job Requirements and Physical Demands Survey (Public Health): ☐ Yes ☐ No ☐ N/A
  Comment:_____
- Findings are consistent with employee reports of discomfort and/or illness: ☐ Yes ☐ No
  Comment:_____

RECOMMENDATION FOR FOLLOW-UP

Modifications and adjustments	Major changes and/or purchases
_____	_____
_____	_____
_____	_____
_____	_____
Expected Benefits ☐ Health/Safety (Check all that apply) ☐ Productivity/Quality	Expected Benefits ☐ Health/Safety (Check all that apply) ☐ Productivity/Quality

BEF (Sign) _____

(FORM)

INSERT TAB X HERE

APPENDIX 7

References/Bibliography

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REFERENCES

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