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THE SCHEDULING PROCESS
IN A DEPOT FROM
THE BRAZILIAN AIR FORCE

THESIS

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THESIS

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Abstract

The Brazilian Air Force (BAF) in its logistic structure contains 5 Air Logistic Centers (depots). This thesis concentrates its analysis on one of the most important BAF depots located at São Paulo (PAMASP). This thesis explores the scheduling process currently used in PAMASP. This thesis adopted a managerial approach in a sense that it looked to take a big picture of the current process. The researcher performed field interviews with the goal of describing the process. During the visit to PAMASP, the researcher also gathered problems related to the process.

The recommendations stated on this study were based on the knowledge about scheduling developed in the literature review. This study intends to give managers some material to perform improvements in the current process. The improvements recommended in this study are in the following areas: sequencing rules, due date assignment, cross training, task description, and capacity measurements.

THE SCHEDULING PROCESS IN A DEPOT FROM THE BRAZILIAN AIR FORCE

I. Introduction

General Issue

Brazil is a country with continental dimensions, which means that the Air Force has a complex task to assure the security of Brazilian territory. Consequently, the Brazilian Air Force (BAF) has bases spread along the country operating several different airplanes. Under these circumstances, the logistic activity has an important role in the achievement of defense goals. This activity has been receiving increasing attention since the defense budget continues to decrease every year. This fact has been forcing the Air Force to look for ways to be more effective on the use of its resources, because the budget shrinks but the mission remains the same.

Some examples of the effects of the reduced budget on the Brazilian Air Force operations are highlighted below.

- Consumption of the safety stock of several items, which has dramatically decreased the inventory levels.

- Increasing number of airplanes in the depot waiting for parts (consumables and/or reparables).
- Increasing number of reparables in the shops waiting for parts.

The Material Command (COMGAP/DIRMA) is in charge of providing the support to the operational units. This support is broken down to mainly five depots.

The objective of this thesis will be the scheduling process of a very important depot of the Brazilian Air Force. The "Parque de Material Aeronáutico de São Paulo (PAMASP)," located in São Paulo, currently has the mission to support and overhaul the following aircraft: F-5 "Tiger," F-103 "Mirage," DHC-5 "Buffalo", and EMB-120 "Brasilia".

The focus of this research will be PAMASP's planning division that has the mission of determining and distributing tasks among all the other divisions and shops of the depot. Therefore, the planning staff is always struggling with customer's demand, tight budgets and facilities' constraints (material and capacity). The planning division's goal is to elaborate a plan that magnifies the utility of its resources in order to satisfy the given demand placed by the material command.

General Problem

The increases in the duration times of some aircraft Depot Level Maintenance (DLM) services has forced the depot to focus on its scheduling techniques. The longer the time an aircraft stays at the depot, the more resources are consumed (manpower and facilities) and the less operational the flying units are. The depot's division responsible for scheduling the depot's activities is TPL.

The Planning Division (TPL) performs the process of task assignment and scheduling. This division receives inputs from the customer (COMGAP/DIRMA) about the demand for overhauled aircraft. The output of the planning system is an annual plan distributed to all the other sectors. This plan has the format of a Gantt Chart and is static; in case of delays the next step in sequence is just shifted to the right.

TPL determines when each airplane should start its repair process and when it should finish. The amount and time are based on a process close to a Material Requirement Plan's (MRP) Bill of Materials and Master Production Schedule.

Since the budget has become a strong constraint, problems are developing as highlighted below.

- Aircraft have been spending more time in the depot than they were supposed to spend.
- Shop supervisors complain about the unfeasibility of the plan issued by TPL. Some argue about material constraints, others about personnel constraints, and another group about both.
- Work-in process is increasing.
- The schedule created does not have any scientific criteria. It is created based on personal experiences (it is dependent on the person in charge) and historical data.

Research Objective

Studies identifying the reasons for scheduling problems have never been done on the BAF's depot environment. Therefore, this research intends to identify, in accordance with the scientific literature and local observations, the potential problems in the depot's scheduling process. In addition to identifying problems, some suggestions will be made to reduce or eliminate the problems.

Investigative Questions

1. What is the process currently used to produce the depot's schedules? This question will be answered by determining:
   a) Who are the players?
   b) What are the objectives and constraints?
   c) What is the sequence of actions?
2. What are the theoretical limitations of the current scheduling process?
3. What are the problems associated with the depot's scheduling method?
4. How can the depot best improve?

Scope of the Research

This thesis examines the difficulties of the scheduling process in a Brazilian Air Force depot. It is divided into two main domains:

- Evaluation of the current process based on typical scheduling problems reported in the literature
- Search for possible ways to improve the current process

The sources used in this research will be:

- Interviews with the key players

- Review of scientific literature
- Author's personal experience (four years) in working at Sao Paulo Depot

A limitation will be that TPL also informs each shop about the necessity of field spares demand. However, this study will consider only the aircraft overhaul activity.

Chapter Summary

This chapter presents some problems faced by the Brazilian Air Force in times of limited and shrinking budgets. This study focuses on understanding and improving an important process of a Brazilian Depot, scheduling. The decreasing budgets have required for more efficient and reliable processes. Consequently, problems concerning the capacity of the current scheduling process in generating reliable outputs to management have become an important issue to the depot's operations.

II. Literature Review

Introduction

Before proposing any changes to the current scheduling process, it is necessary to gather relevant information concerning schedules in a remanufacturing environment.

This chapter will present some important concepts in scheduling found in the literature.

Scheduling

The scheduling activity is present in our lives through so many different forms that to define it is a difficult task. For instance, students understand it as a paper that contains the list of classes. Airline workers see it as information about arrival and departure times. And, finally, for a depot worker, a schedule contains information about due dates.

For the purpose of this research, scheduling will be understood as a combination of the following definitions:

- Scheduling concerns the allocation of limited resources to tasks over time. It is a decisionmaking process that has as a goal the optimization of one or more objectives. (Pinedo,1995:1)

- Scheduling involves the arrangement, coordination, and planning of the utilization of resources to achieve an objective. (O'Brien, 1969:2)

Scheduling and Management

In a depot environment, it is possible to state that there is a dependent relationship between scheduling and management activity. Any schedule should be built based on the acquisition of important information such as:

- What to do;
- What is the sequence for the jobs;
- When each job should be done,

This fact demonstrates that the scheduling problems appear just after the management decisions have been made.

> The planner first describes the tasks to be carried out and sets limits on the amount of resources available. The scheduler then takes this information as given and determines how to allocate the available resources to perform the specified tasks. (Baker, 1974:3)

Baker calls attention to the vital elements (resources and tasks) in scheduling. Resources are described in terms of their qualitative and/or quantitative capacities. In the same way, any individual task should be described based on how much it consumes from the available resources; therefore it is mandatory to measure this consumption based on the same standard used to measure resource capacity.

TPL's Tools

This section briefly goes through the techniques that TPL has been using to build its schedules. The literature review will provide information about how each technique works and its limitations. In chapter 4, there will be a discussion about the suitability of these techniques with the depot environment.

Gantt Charts

Invented by Henry L. Gantt in 1917, it is a visual tool for sequencing work on machines and monitoring its progress (Krajewski and Ritzman, 1996:753). The chart provides the user with information about the start and end of the tasks based on a time dimension, i.e., it shows the relationship of the tasks along time.

The chart normally is a horizontal bar chart where the x-axis represents time and the y-axis various steps of the process (or machines). During the project execution, the planned completion and achieved dates are compared which enable an easy visualization of discrepancies.

Some upgrades were done in this tool, mainly to reflect dependency among the tasks. Gantt charts have some limitations, especially when there are many jobs and machines. This feature makes these charts unsuitable for scheduling complex projects that usually involve the term network.

PERT (Program Evaluation and Review Technique)

It was created for the United States Navy's Polaris missile project, which involved 3000 separate contractors and suppliers (Krajewski and Ritzman, 1996:788). It is a network approach where the relations among all the tasks are established. For each task, a stochastic duration is assigned and its start time is dependent on the completion of its logical predecessors.

Aquilano et al (1991:361) outline the steps required to develop and solve a PERT problem:

1. Identify each activity to be done in the project.
2. Determine the sequence of activities and construct a network reflecting the precedence relationships.
3. Determine time estimates for each activity.
4. Calculate the expected time for each activity.

5. Calculate the variances of the activity times.
6. Determine the path with the sequence of activities that requires the longest expected time (critical path).
7. Determine the probability of completing the project on a given date.

CPM (Critical Path Method)

The Critical Path Method was first successfully tested in 1958. The method was developed with the goal of utilizing a computer in scheduling construction programs (O'Brien, 1969:34).

CPM is quite similar to PERT, the main difference relies on the fact that CPM does not use time estimates; instead it uses deterministic values.

The use of network techniques (PERT and CPM) depends on the project's characteristics. Aquilano (1991:60) lists the characteristics that a project must have in order to use network techniques:

- Tasks must be well defined.
- Tasks are independent in terms of being possible alternative sequencing and timing.

- Tasks are ordered; they must follow each order in a given sequence.

Scheduling in a Remanufacturing Environment

Lund (1984:18-23) defines remanufacturing as an industrial process in which worn-out products are restored to like new condition. This process can be justified by the high cost of the equipment to be repaired. A classical example could be found in the defense industry. An airplane, for example, contains many expensive items that discarding them every time they fail would increase operational costs to an unaffordable level. Consequently, there are some organizations called depots that are responsible for disassembling, examining, cleaning, testing and reassembling products in order to restore them to original condition. Guide and Srivastava (1997:38) illustrate the flow of a typical remanufacturing unit (Figure 1) and point out two factors that significantly complicate the traditional methods of Manufacturing Planning and Control (MPC):

a) High degree of uncertainty in material requirement planning.

b) The real condition of the part is known only after inspection, which leads to stochastic routings and lead times.

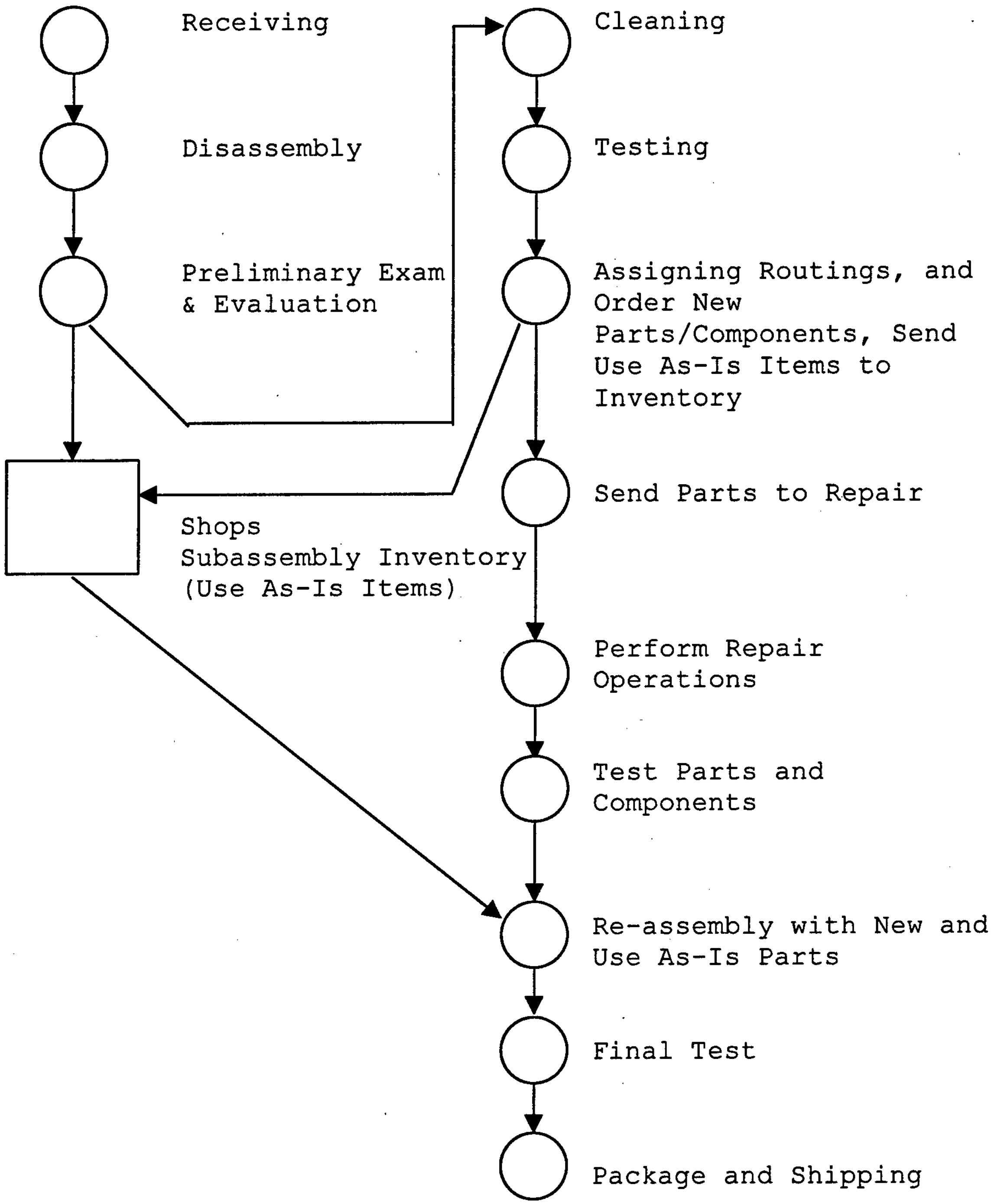

Figure 1 - Flow of Typical Remanufacturing Unit

In addition to those complicating factors, remanufacturing organizations are characterized by having additional complexity during the reassembly operation (Guide and others, 1997:3). For instance, an aircraft has its parts identified by serial numbers and some of those parts should be returned to the same aircraft after they have been repaired.

In a depot there is a mix of jobs because of the nature of the mission. Identical units (F-5's) may compose the jobs arriving at the depot (aircraft), however some repair operations will be unique. The condition of the "identical units" might be different due to age and operation environment. Therefore, some operations might be particular to each unit; for example, inspection results: particular component is still serviceable and does not need to be removed and repaired in one aircraft, but it is necessary to be removed in the next one. However, there still are common operations such as cleaning, painting, and mandatory repairs.

Guide et al (1997:4) define the remanufacturing shop as a hybrid shop that has characteristic of an open job shop (unique routings and work in process) and closed job shop (same end items, components and common work in process).

Relevant Factors During the Depot's Scheduling Process

During the construction of a schedule TPL has to make some decisions that will impact the sequencing, the due-date assignment and the level of available human resources. The understanding of the following factors will help the search for potential solutions.

Priority Sequencing Rules

During any scheduling process, decisions about which job to process next have to be made. Priority sequencing rules specify the job processing sequence and can be applied by a worker or incorporated into a computerized scheduling system that generates a dispatch list of jobs and priorities for each workstation. Following are some sequencing rules commonly used in practice (Krajewski and Ritzman, 1996:756).

1. Earliest due date (EDD) - the job with the earliest due date is scheduled first.
2. First come first served (FCFS) -jobs that first arrived will be first served.

3. Shortest processing time (SPT) - job that requires the least time to be done will be first served.
4. Minimum slack time - slack time is the difference between the due date and the processing time. Jobs with the smallest slacks will be processed first.
5. Earliest finish time - finish time can be calculated by adding the arrival time and processing time. Jobs with the smallest sum will be processed first.

The rules above are static because jobs keep their initial priorities regardless of their progress through the workstations. Dynamic rules allow changes in a job's priority based on how the job progresses through the workstations. Following are some examples of dynamic rules that could be used during a schedule development:

1. Select the job with the smallest value of remaining time until due date divided by total remaining processing time.
2. Select the job with least number of operations remaining.
3. Select the job with the largest number of operations remaining.
4. Select the job whose next queue is the shortest. Final operations receive the highest priority.

5. Select the job with the shortest total processing time remaining.

"A special class of dynamic rules are those which base a job's priority on *current inventory status* as well as the job's progress through the shop" (Hausman and Scudder, 1982:1221). In their study they learned that, in a repairable inventory environment, dynamic rules which use inventory status information perform better (in terms of expected delay) than other rules which ignore inventory status. Some examples of inventory rules accordingly to Hausman and Scudder's study are:

1. Select a job of the component type with the maximum difference between its current net inventory and initial target spares level.
2. Among jobs with negative net inventory, select the one with the smallest total remaining processing time. If the net inventories of all jobs in the queue are non-negative, FCFS is used.
3. Select a job of the component type with the least current on-hand inventory.
4. Select the job with the shortest expected time until stockout. Time is based on expected daily failure rates.

5. Select a job of the component type that is required by the largest number of modules waiting parts for assembly.

Due-Date Assignment

When a job arrives at one shop, someone or some system should make a commitment about when the job will be completed. Managers who deal with schedules always pursue an accurate estimate of the completion date.

Conway et al (1967:229) noted that

> The measure that arouses the most interest in those who face practical problems of sequencing is the satisfaction of pre-assigned due-dates… the ability to fulfill delivery promises on time undoubtedly dominates these other considerations.

Weeks (1979:363) commented that "fulfilling delivery promises depends on assigning predictable or attained due-dates and using labor assignment and priority dispatching procedures to enforce these due-dates."

At first glance, people usually assign a due-date for a specific job based on its complexity, the more complex the job, the more time assigned to keep it. However, studies have found that other factors might be relevant to the due-date assignment task. Weeks learned that due-dates assigned based on expected flow time and shop congestion information may provide more attainable due-dates than rules based only on job characteristics. He concludes that managers should monitor job congestion and job flow times to assign predictable or attainable due-dates based on conditional estimates of job flow time.

Bertrand (1983) also found that the use of workload information could contribute substantially to setting attainable due-dates in job shops.

Workers' Skills

Bobrowski et al (1993:257-268) examines how to assign labor to work centers when differences in capacity requirements exist. They stress the need for more flexible workers as a competitive advantage. Multi-skilled workers can increase responsiveness from the repair system to the natural uncertainty that exists in a production environment. Indeed, Bobrowski et al learned in their study that "existing labor assignment rules are not adequate to produce the best system performance when worker skills vary between workers".

Chapter Summary

In this chapter, an introduction of some important scheduling terms that will be necessary for the following chapters were made. The chapter included some data of the research made about potential problems in a remanufacturing environment as well as a study about the management tools that TPL has been using.

III. Methodology

Overview of Methodology

This chapter describes the procedures taken during the research process to achieve its objectives. This study investigates the current scheduling process used in TPL in three distinct steps. Initially, it is necessary to have a clear comprehension of the scheduling process in order to identify strengths and weaknesses. Total Quality Management theory states that we can only improve a system if we understand it. Interviews with the main players in the process and BAF's publications are the information sources for the construction of a detailed scenario of the current process.

This study does not want to reinvent the wheel in terms of developing a new approach to the depot's scheduling problem. Instead, it will rely on the scientific literature to classify the current process according to the scheduling theory. A better understanding of the current process requires a description in terms of theoretical characteristics or taxonomies. The idea is to narrow the search for potential improvement solutions by categorizing the current process in accordance with the literature.

The last part of the study will be a list of potential scheduling problems that have been faced due to the depot's current process. The idea is to call TPL's attention to important points that if eliminated could improve its scheduling process.

Current Process Description

The description of the current scheduling process will be the answer to the first investigative question:

- How is the process currently used to produce the depot's schedules?

In this first part of the research, there is a descriptive study that is concerned with finding out who, what, where, when, or how much (Cooper and Emory, 1995:116). This study intends to construct a framework that reliably reflects the current process in terms of people and organizations involved; assigned tasks; criteria used to create and revise a schedule; relationships among players; strategies; sequence of events; milestones; objectives and constraints. The possession of this information will enable a clear understanding of the environment that surrounds the depot.

The primary source of data in this study will be the TPL's chief (O-4 or O-5 positions). This position is a focal point for the whole process. This office receives input from the materiel command (COMGAP/DIRMA) regarding the yearly demand of overhauled aircraft that will satisfy the operational necessity. This office is part of the depot's structure; therefore it has knowledge about all the available resources. In short, this office is in charge of, besides other functions, scheduling the depot's resources to accomplish the mission assigned by the higher command.

In-depth interviews were performed to gather data from the players. The people interviewed were TPL's chief, 1TPL's (programming section) chief, 1TPL assistant, two engineers, and three shop supervisors. These interviews were conducted in the Brazilian depot and by telephone and computer (e-mail). It was composed of unstructured (open-ended) questions (see Appendix A). According to Cooper and Emory, "The in-depth interview encourages respondents to share as much information as possible in an unconstrained environment. The interviewer uses a minimum of prompts and guiding questions" (1995:299).

A series of interviews were performed with TPL's chief (currently an O-4) to collect the necessary data for the research. During those interviews the TPL chief was asked to provide information about:

- Organizations and offices involved in the process;
- Goal statement;
- Relationship among the players (offices) involved in the scheduling process;
- Current criteria adopted to build a schedule and to revise it. The criteria should be described in terms of resources allocation decisions and sequencing decisions;
- Constraints of the scheduling process;
- Existing problems.

A secondary source of data was official publications. Brazilian Air Force, as any military organization, has its activities described in several normative documents, and it is no different for the scheduling process.

Categorizing the Current Process

A literature review about scheduling processes was performed. The goal was to identify and characterize the scheduling system based on findings and criteria established in the scientific literature. This phase was important to narrow the scope of the study. At this point, the research is able to answer the second investigative question:

- What are the theoretical limitations of the current scheduling process?

The literature provides this thesis with several studies concerning the scheduling process under distinct conditions and environments. The task will be the description of the current process in terms of theoretical characteristics or taxonomies. The benefit of secondary data is the knowledge about previous studies. The literature review will assist in identifying further research needs, and provide hypotheses about existing problems and potential solutions.

The categorization of the current scheduling process was organized based on the following guidelines:

- Environment;
- Objectives of the scheduling;

- Priority rules and revision criteria;
- Resources and tasks.

Diagnosing the Current Process

The diagnosis of the current process will be the answer to our third investigative question:

- What are the problems and causes associated with the depot's scheduling method?

This step of the research could be called the examination step. Like a medical exam, the goal is to identify the problems associated with the current process. However, if we want to diagnose the process, we will have to deal with "measurement".

Measurement in research consists of assigning numbers to empirical events in compliance with a set of rules. This definition implies that measurement is a three-part process (Cooper & Emory, 1995:141):

1. Selecting observable empirical events.
2. Using numbers or symbols to represent aspects of the events.
3. Applying a mapping rule to connect the observation to the symbol.

What to observe?

Scheduling models have two main components: resources and tasks. Therefore, it is necessary to observe events that characterize all the resources and tasks considered in the scheduling process.

Interviews with TPL's members and TPL's records (past schedules) provided information about the collection of all the resources and their capacity. Under the scope of this research, the research was limited to the existing measurements of resource capacity. Alternative measurements for resource capacity could be discussed, but they are not the main focus of this study and will be referenced for future research.

The same procedure used to gather information necessary to characterize the resources was adopted on task description. Any individual task should be described in terms of the same information as its resource requirement.

How to appraise the current process?

During the interviews with TPL's members, there was a concern about collecting the necessary information regarding what they consider an optimal schedule and what are the performance measurements. The comparison of expected and obtained performance identifies the areas where the system is doing well or poorly. The interviews should also reveal the criteria used during the elaboration of a new schedule and the necessary revisions.

Data to be collected

This study suffers from some restrictions concerning the revelation of reserved data. Since it is an unclassified study, the author will not use from the following list some information that he is not authorized to reveal by the Brazilian Air Force.

The on-site observations and interviews performed aimed to collect the following information necessary to understand and analyze the depot's scheduling process:

- Installed capacity in terms of machinery and manpower;
- Annual demand for overhauled aircraft;
- Historical data about tasks' duration times;
- Description and expected duration of the repair phases;
- Time variance to perform the jobs;
- Sequence of the jobs
- Past variance of planned and actual schedules.

Analysis

A deep and detailed analysis of the whole scheduling process would require simulation studies of the depot activities. However, the scope of this study is to identify potential problem areas of the scheduling process. Therefore, the analysis will be based on knowledge gathered on the literature review applied to the depot's process. In other words, results from studies on scheduling issues will be used to identify potential areas for improvements.

Chapter Summary

This chapter presented the methodology adopted to achieve the objectives of this study, which was divided in three stages:

1. Literature review of scheduling in a remanufacturing environment and identification of main problems associated with this environment;
2. Description of the current process;
3. Based on the data of the previous stages, this study will provide some suggestions to improve the depot's scheduling process.

IV. Data Analysis

Introduction

This chapter consolidates the necessary information concerning the second stage of this study: description of the current process. Along with the process description, this chapter contains comments made by TPL and assembly line personnel. The data presented in this chapter are from field interviews and research of official documents. This chapter is organized in relation to investigative questions number 1 and 3.

Current Process Used in the Depot

This section will aim to answer the first investigative question:

- What is the process currently used to produce the depot's schedules?

Accordingly to the NPA 19-9 (NPA are documents that establish the structure and detailed attributions of a BAF's organization), the Planning Section (1TPL) is subordinate to the TPL's chief. Its duties are programming, forecasting, and verifying the availability of technical and human resources necessary to accomplish the planned schedule.

The Programming Subsection (1TPL-1) is subordinate to the 1TPL's chief. Its duties are the development of a proposed schedule to the Depot and to civilian companies contracted by the Depot. One of 1TPL-1's sectors, "Aircraft Maintenance Programming", is in charge of:

- Developing the schedule to be used in the aircraft overhaul activity.
- Developing PERT/CPM and Gantt charts for the aircraft overhaul activity.
- Defining the workload based on:
  - Inspection cards to be accomplished.
  - Technical bulletins to be implemented.
  - Reparable items to be replaced.
  - Structural repairs necessary.
- Analyzing the reports concerning completion dates issued by the Control Section at the end of each aircraft overhaul. This information eventually can be used in the following schedules.

The Service Instruction IS 66-20 contains instructions about the development of the PAMASP's production schedule. This Instruction states that the production schedule has the objective of establishing the priorities to call aircraft from the bases to the depot in accordance with determinations from the Material and Air Commands.

According to this document, 1TPL is responsible to develop the production schedule, which provides the following information:

- Production need.
- Delivery dates in accordance with the aircraft distribution provided by the Maintenance Division at DIRMA (SDMN). This division, based on operational needs, defines how many aircraft each squadron should have.

The 1TPL's chief (O-3 position) is the one who coordinates and generates the production schedule. The interview was conducted based on an informal conversation concerning the current process. Following are the data collected:

A. The process starts at the Air Command (COMGAR) that presents the operational necessity to the EMAER (Air Force Staff). This happens on the beginning of every year (January). Figure 2 shows a simplified view of the relationship among the players outside the depot.

B. The Material Command (COMGAP) presents to EMAER the logistic capacity.

C. EMAER works as a judge and evaluates both data from COMGAR and COMGAP to make some inferences through two different ways (isolated or combined):

- Reduce the number of hours to be flown by the squadrons (affecting COMGAR proposal).
- Increase the quantity of resources given to COMGAP.

D. COMGAP sends to DIRMA (SDMN) the results from EMAER's decision.

E. SDMN evaluates the data from COMGAP and tries to make it compatible with the Supply division at DIRMA (SDSU).

F. DIRMA informs the depots about the workload for the following year. This information contains the expected depot's production.

G. Each depot will then manage its resources to satisfy the demand proposed by DIRMA. Figure 3 shows a simplified view of the relationship among the players inside the depot.

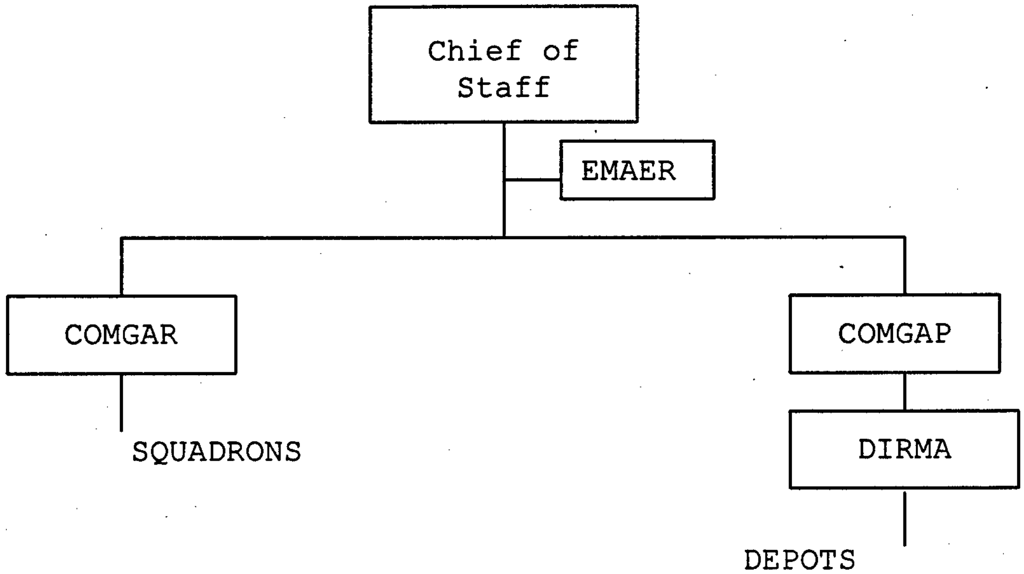

Figure 2 - Simplified BAF Structure

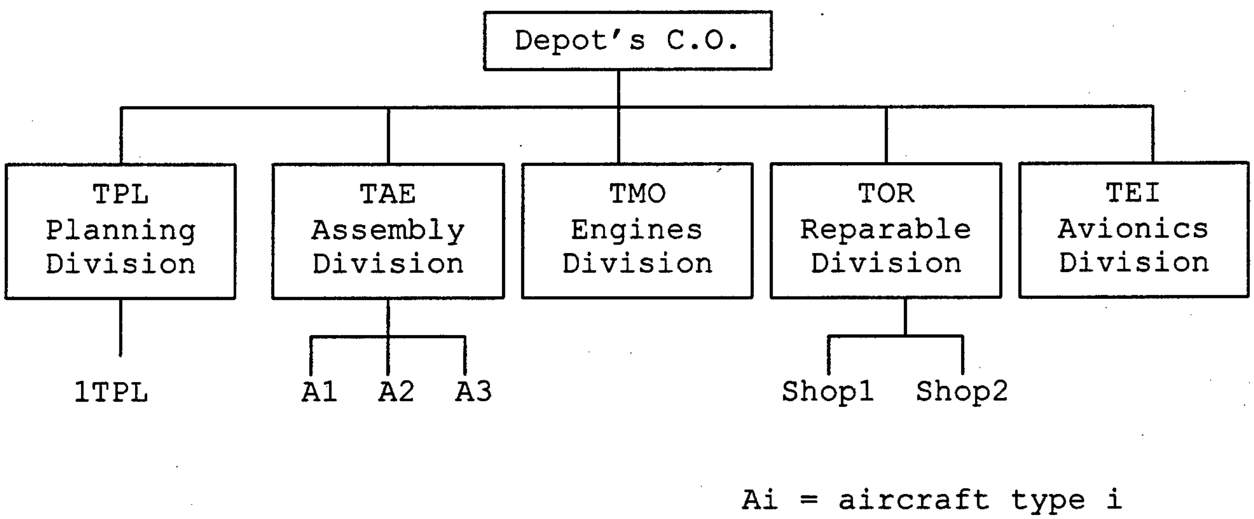

Figure 3 - Simplified Depot's Structure

The schedule for each year is completely built based on historical data. In the past (nobody could say when), someone consolidated all the previous data of how many man-hours each required task consumes. Indeed, there is a chart (a Gantt chart) that contains the entire repair phases such as disassembly, cleaning, inspection, structural repairs, painting, assembly, and operational checks. For each task, it is allocated some amount of time (measured in weeks) necessary to complete the task. TPL's chief also stated that TPL has been building a network of all the activities to start using PERT technique. PERT has not been implemented because TPL lacks people able to work with this tool.

Each aircraft that arrives at the depot enters a queue to be repaired. The decision about when this airplane will start its repair is based on (it is not in a priority order):

- Nature of the repair. Some kind of repairs can require less time to perform or there is a chance of using some temporary unemployed resource. This is a kind of shortest processing time rule.
- First come first serve, in case of similar repairs

* Flight Squadron's necessity. A kind of earliest Due Date rule.

After having defined the priority order of the aircraft's repair, each one will start its service based on the criteria used to build a Gantt chart. At this point, every phase will have a forecasted due date, including the delivery date.

TPL performs a weekly control over the work progress. Shop supervisors inform TPL the percentage of work done. This information is based on the current stage of the work. For example, the phase has a completion time of 10 weeks and consists of five tasks with same amount of time allocated for each one. In case just the first task has been completed, the shop supervisor would say that the work on the phase is 20% done, even if for any particular reason, four weeks have passed since the beginning of the phase. A similar procedure is used by TPL to calculate how much of the repair work has been done. A linear graph is used to portray and calculate the percentage of work done (figure 4). This graph informs the percentage of work done in the phase and the percentage of the whole overhaul done.

During field observations, the control of work done is based just on time; there is no evidence of control based on effective man-hours applied on the task.

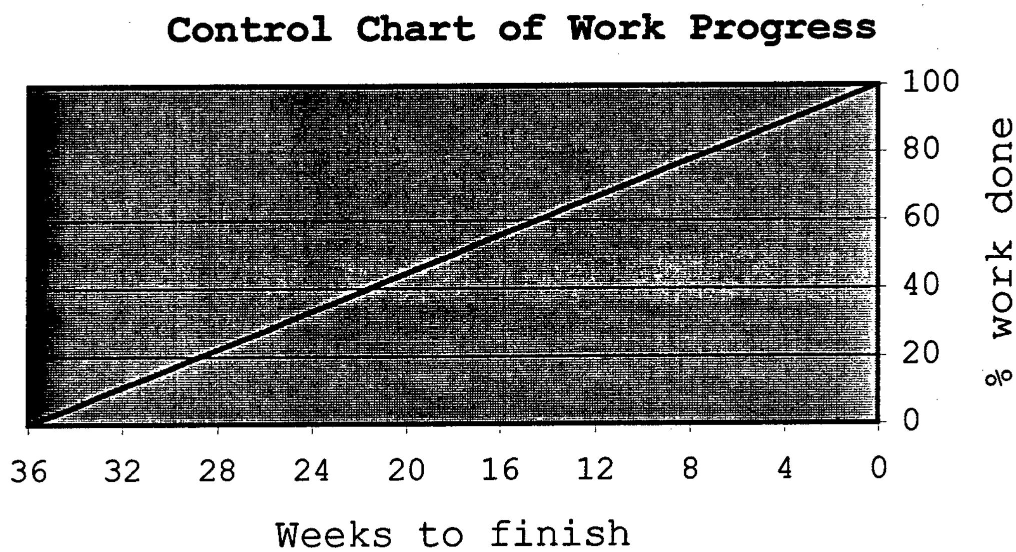

Figure 4 - TPL's Control Chart of Work Progress

TPL needs to keep track of the work in progress and the completion dates, so once a week TPL gathers data about job's completion date from the assembly line. If the initial planned date slips, the immediate action taken is to shift the due date by the reported delay. There is no additional action such as reviewing the assigned due-date (it can be tight) or the current priority rule in use. The same assigned time for the delayed job will still be in effect for the next aircraft. Figure 5 intends to briefly resume the flow of actions described so far.

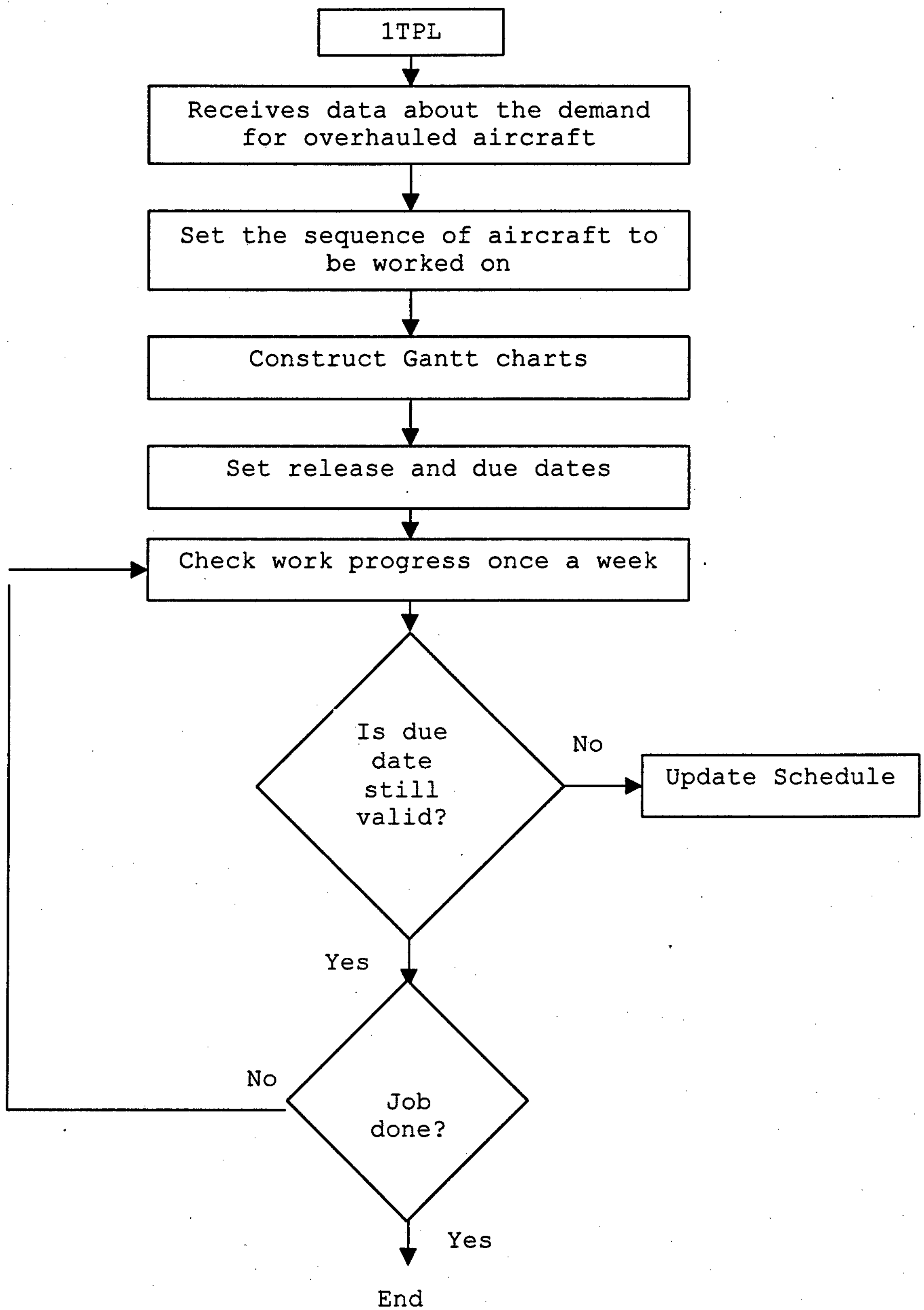

Figure 5 - Simplified Depot Scheduling Process

Finally, TPL's criteria of a good schedule relies on just completing the jobs before the planned due-date, provided that the depot's production meets the demand established by DIRMA.

Problems Associated with the Depot's Scheduling Method

This section will aim to answer the third investigative question:

- What are the problems associated with the depot's scheduling method?

This study gathered a list of problems that are related to the current scheduling process. The sources to the following problems listed are:

- Interviews with TPL's and 1TPL's chief.
- Interviews with shop supervisors. Shop supervisors are typically master sergeant (E-7) rank. Normally they are technicians with experience in flightline and/or depot maintenance and are selected based on their seniority and leadership among each maintenance crew responsible for each airplane.
- Engineers in charge of providing technical support to the overhaul process.

* Author's observations during a visit to the depot's facilities.

When the questionnaire was applied, it was asked to the interviewed provide observed problems and to assign a frequency. The results were consolidated in the following graph. The graph contains the most relevant problems (in terms of frequency) reported.

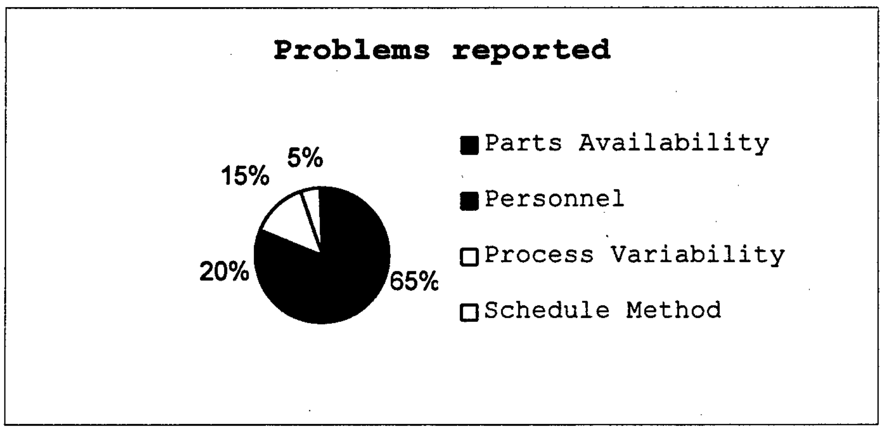

Figure 6 - Problems Reported

In the graph above, "Parts Availability" comprehends the problems related to the absence of parts along the overhaul process. "Process Variability" represents the uncertainty of job routing and task times, usual characteristics of a remanufacture environment.

PROBLEM 1. There is a mix of priority rules in the repair process. TPL normally uses FCFS rule, unless DIRMA changes the priority of one specific aircraft. However in the shop floor, things are slightly different. Preferably, FCFS rule is used, but depending on situations where workflow is being a concern, SPT rule is used. More, in situations where a task needs a missing part, the next job that does not have inventory problems is performed (rule that uses inventory status).

PROBLEM 2. The greatest problem faced during the scheduling accomplishment is the non-availability of reparables when they are needed for assembly.

PROBLEM 3. The reparable shops should have the same production rate as the assembly line. The reparable shops do not work based on the assembly line's needs. The office that controls the items sent to the shops (CCOS) most of the times establishes completion dates without consulting the assembly line.

PROBLEM 4. Workforce problems rely mostly on the fact that not all of the technicians have the same technical level which leads to variance in performance. In addition, the workers are not interchangeable. This fact generates situations where some workers are overloaded.

PROBLEM 5. The fact that workers are not interchangeable compromises the utilization of the workforce. For example, if a hydraulic part is missing at the F-5 assembly line, all hydraulic technicians would be idle, and, at the same time insufficient number of workers might restrict a hydraulic task at the Mirage assembly line.

PROBLEM 6. The supervisors reported that the only capacity measurement made by TPL is based on how many workers are available, and they do not feel confident about the suitability of this parameter.

PROBLEM 7. Tasks are described based on a time dimension. In other words, how many days or weeks does the task require to be accomplished? Shop supervisors reported that the time allocated is reasonable if there is no variance in the process, such as missing parts, lack of workers, and non-predictable jobs. Accordingly to the interviews it seems that these variances have been happening with a high frequency because all the shop supervisors interviewed made this comment. In addition, these comments happened during the direct questions about problem frequency (question "D" in the questionnaire) and during their final thoughts.

PROBLEM 8. Supervisors have also showed a lack of trust on TPL's schedule because of the frequent slips.

PROBLEM 9. Along the several phases of the airplane repair, there is a high variability on the completion times (characteristic of a remanufacturing environment). Most of the time, according to shop personnel, the main reason relies on the fact that the reparable shops do not have the same pace as the assembly line. There are occasions when the aircraft is ready to receive the part before the part is sent to the assembly line.

PROBLEM 10. Since the delays during the repair process are not properly calculated and controlled (schedule updates), a common occurrence has been happening. The workers in the final phase, assembly, have to work extra hours to accomplish the due date or to minimize the delay. This information was provided by all the shop supervisors. They stated that during most of the overhaul services this problem happens.

PROBLEM 11. TPL's control does not take into account additional small jobs directly related to the main task. For example, during the inspection phase, it is necessary to perform non-destructive inspection (NDI) in the wing section. To do that, workers have to move the wing to the inspection sector, rotate it, and bring it back. The time spent in this extra task is not computed by TPL, although it consumes some man-hours. Estimation made by the shop supervisors is that these extra jobs might represent up to 10% of the allocated time.

Chapter Summary

This chapter contains the necessary data about the description of the current scheduling process that has been used in the Brazilian Air Force depot (investigative question number 1). It also contains the problems associated to the current scheduling process that were collected during the visit at the depot's installations (investigative question number 3).

The data collected and problems identified in this chapter will be referenced in the following chapter where analyses and discussion of the current process will be made.

V. Conclusions

Introduction

Most of the data collected by the personal interviews, questionnaires and on-site visit, if presented in this thesis, would turn this research into a Brazilian Air Force classified material. In order to keep this thesis unclassified, classified information was suppressed. On the other hand, not revealing data that support the conclusions presented in this chapter would bring some validation issues.

The selected approach to keep this study unclassified and minimize any validation discussion was to list the data acquired and not revealed but used to draw some conclusions regarding the depot's performance and potential solutions to its scheduling problems:

- Installed capacity in terms of machinery and manpower;
- Annual demand for overhauled aircraft;
- Historical data about tasks' duration times;
- Description and expected duration of the repair phases;

- Time variance to perform the jobs;
- Sequence of the jobs.

This chapter contains the synthesis and discussion of the results of this study. It will answer the investigative questions number 2 and 4, as the other questions (1 and 3) were answered in the previous chapter. The following results, however, were based on, besides the knowledge from the literature, the data listed before. The conclusions were based on data collected that the author would not have authorization to reveal in an unclassified study.

Finally, this chapter will also bring suggestion to some future research.

Question 2 - What are the theoretical limitations of the current scheduling process?

First of all, the depot is immersed in a typical remanufacturing environment with the tasks of disassembling, restoring, and repairing worn out products with the objective of prolonging their serviceable life.

TPL has been using traditional tools and rules to build schedules. However, there are some limitations that make questionable their suitability to a remanufacturing environment characterized by variable routings, uncertainty, and complexity:

- Gantt charts are used to plan and portray the work along time. This tool has great limitations when dealing with large and complex projects. Gantt charts do not identify precedence relationships between the tasks and neither indicate which tasks are critical to complete the project on time.
- Static priority rules such as FCFS and EDD are preferably used. Those rules do not take into account, at any moment, the shop floor condition at the job arrival. Due to the depot's environment, a good suggestion would be the use of dynamic rules that update a job's priority at each operation based on the job's progress.
- Due date's assignment is based just on historical data and job complexity. In the depot, every job is unique, as well as the shop resources at the moment of the job's arrival. Any due date assignment criteria that do not observe the singularities of each job will lack suitability. The current method used by the depot does not identify the singularities of each job.

Finally, it seems that the tools that have been used by TPL are not suitable to the depot's environment.

Question 4 - How can the depot best improve?

This study intends to call TPL's attention to some important factors that affect the whole scheduling process. Following are some points (not in order of importance) that management should reflect about.

Priority Scheduling Rules

The following comments aim to minimize the effects of the lack of consistency in the schedule rules (problem 1 listed in chapter 4).

The current method used by TPL on scheduling rules does not consider the shop condition at the arrival of a job (work in progress, inventory level, workforce). The use of static rules gives the jobs the same priority without regards to job progress and inventory situation. Simulation studies comparing static rules (currently used by TPL) and dynamic rules have showed that rules that include inventory status provide improved performance over other rules (Hausman and Scudder, 1982:1230). Studies have also showed that the importance of workload information for setting adequate priorities. A deeper analysis of this matter would require a construction of a simulation model that represents the depot's repair process. Based on the literature, it is expected that rules that take into account inventory position and workload information should perform better. Some candidates to be evaluated:

- Select a job of the component type with the maximum difference between its current net inventory and initial target spares level;
- Select a job of the component type with the least current on-hand inventory;
- Combination of operation due date information and processing time information.

After the results of the simulation were available, TPL should encourage that whatever the rule adopted, it should be commonly used at TPL and at the shop floor.

Due-Date Assignment

The following comments aim to minimize the effects of the lack of trust on TPL's schedule (problem 8 listed in chapter 4).

Assuming that due dates can be assigned based just on historical data is a naive approach in times of limited resources. Other factors such as work in progress, current shop capacity, inventory level and workload might have an influence on assigning attainable due-dates.

One of the main disadvantages of the current method of due date assignment is the lack of information about the current shop status. Since the remanufacturing environment is dynamic in terms of current conditions, TPL should analyze the current shop floor situation before assigning a due date. As in the issue of sequencing rules, a simulation model of the depot's process would be useful to evaluate the performance of rules that consider shop congestion and job characteristics.

Cross-Training

The following comments aim to minimize the effects of the lack of workforce flexibility (problems 4 and 5 listed in chapter 4).

The private industry has learned that the shop floor has to be responsive to any environmental change, internal or external. An important strategic weapon to increase responsiveness is labor flexibility. When pressures for results increases, the shop floor is required to be more flexible and do extra jobs.

The depot is not an exception to this shop floor requirement. However, it still continues to have rigid job classifications. For example, a hydraulic technician performs just hydraulics from a specific type of aircraft; the same for avionics, assembly and disassembly.

These separations inhibit the shop supervisors from having higher workforce utilization. The interviews with shop supervisors have shown that situations of a certain group of workers being overloaded while another is idle are not uncommon. The shop supervisors try to minimize this problem by utilizing the idle workers in general tasks like cleaning and aircraft moving.

This study suggests that the depot should develop a training program that could supply each technician with extra technical skills. The increase in the workforce flexibility will give the line managers alternatives to better allocate the workforce. For instance, it is reasonable to expect a decrease in schedule delays and work-in-progress if the labor resource is better utilized.

Studies about the impact of worker cross training (Bobrowski and Park, 1989; Park, 1991) have showed that the introduction of labor flexibility improves performance considerably when compared with the condition of no flexibility. However, both studies agreed that the continuous increase in labor flexibility has a diminishing return in shop performance. Since the current level of labor flexibility at the depot is close to zero, cross-training programs are recommended.

Task Description

The following comments aim to minimize the problems related to task description (problems 7 and 11 listed in chapter 4).

The tasks have been described in terms of expected time for completion. This time is calculated by answering the question of how much time the allocated labor capacity will take to perform the task. TPL uses an ideal scenario of no missing parts and that all workers allocated to a particular task are available.

During the field research at the depot, it was possible to verify that this method is generating some problems:

- There is no control of the effective number of hours spent on the task.

- Since the number of available workers fluctuates, the real times do not match with the ones that TPL has.

This study suggests that TPL start accounting the actual number of working hours really used on each task. Shop supervisors should track how many man-hours each task consumes. This information will still provide TPL about the date of completion as well as about tasks that require more labor resources.

For instance, task A needs 16 man-hours to be done. If there is just one worker available, the completion time will be in two days (considering an eight hours shift). However, if the job is planned to be done on the next day, TPL will have to increase the available workforce by one.

Possible ways to control the hours spent on each task can be punch cards or bar coding in which each worker would pass a UPC card before and after accomplishing any task. The idea would be to track workers' activities; the technician would punch-in at the beginning and punch-out at the end of its task. Having this information, TPL would know how many hours each task required.

Another suggestion to facilitate this kind of control would be the reevaluation of the size of the tasks.

Smaller tasks allow better sequencing and elucidate the work process.

Capacity Measurements

The following comments aim to minimize the problems related to TPL's method to measure capacity (problem 6 listed in chapter 4).

TPL has been using a simple measurement for labor capacity: number of available workers. This information was collected through interviews with shop supervisors, and they have not showed confidence in this method of measurement. The fact is that the number of workers available for a specific task fluctuates along time. Another problem related to this kind of measurement is that it does not consider the workers' experience. For example, senior sergeants, for TPL, have the same performance as that of junior sergeants. Therefore, it is expected that the same task done by workers with different levels of experience will take different times and possibly quality level. TPL should find alternative criteria to weight the difference of experience among workers.

Assembly Line Should Set the Production Rate for other Depot Shops

As soon as an aircraft arrives, its reparables are removed and sent to several maintenance shops: avionics, hydraulics, pneumatics, etc. TPL assigns each reparable a due date based on the forecasted date that the assembly line would need this item. This is the end of any connection between the assembly line and the other shops. Since the other shops do not receive the same pressure for meeting the completion dates as the assembly line does, situations where the aircraft is ready to receive the reparable when the same is still being worked on are usual.

This study realized that, as in the TOC's (Theory of Constraints) "drum-rope-buffer" model, the assembly line should work as a "drum", setting the production pace, for all the other shops. TPL should find a device that could work as a "rope" to pull the production rate of the other shops in accordance with the assembly line's rhythm.

Chapter Summary

This study has taken a managerial approach over the depot's scheduling process. The conclusions brought into this chapter should help the depot's managers to identify potential problems in the current scheduling process. Although some statements might lack some data to validate them, this study has struggled to provide as much information as possible to keep it unclassified. Full analysis of the problems commented in this study will be necessary under the Brazilian Air Force environment.

Appendix A

QUESTIONNAIRE

Part I - TPL

A. Is there any official publication in the Brazilian Air Force that regulates the scheduling process? If any, please identify them.

B. Which organizations of BAF have importance in the scheduling process? Please also inform which office requests this kind of job and which one receives this job. (It means: which organizations play a role in the process)

C. What are the goals of the scheduling process under TPL's perspective?

D. Please list all the possible problems that delay completion and that might happening during the scheduling process. For each listed problem, assign a frequency index:

1-very rare 2-rare 3-sometimes 4-most of the time 5-all the time.

E. Please explain the current criteria used by TPL to evaluate a schedule.

F. How are the resources allocated?

G. Please explain the current criteria used to review a schedule

H. Please list the steps that are accomplished to develop a schedule

I. What is the variability in the processing times?

J. How interchangeable are the workers?

Part II - Shops

K. What is your limiting resource? (It means: what is the biggest difficulty in meeting the schedule)

L. How do you measure its capacity?

M. How do you describe a task? What units do you use?

N. If there were no resource constraints, how long would each task take?

O. If we had unlimited labor resources, how long would each task take?

P. Where could we use some of our excess labor to start the production of another job without causing delays to the planned completion time of the current job?

BIBLIOGRAPHY

1. Aquilano, Nicholas J. and Richard B. Chase. Fundamentals of Operations Management. Boston MA: Irwin, 1991.

2. American Institute of Certified Public Accountants. Production Scheduling. New York, NY, 1973.

3. Baker, Kenneth R. Introduction to Sequencing and Scheduling. New York NY: John Wiley & Sons, Inc., 1974.

4. Baker, Kenneth R. "An Investigation of Due-Date Assignment Rules With Constraint Tightness," Journal of Operations Management, 3: 109-120 (February 1981).

5. Bayley, Kerry M. An Investigation of Project Management Techniques for Scheduling RAAF Depot Level Maintenance. MS Thesis, AFIT/GLM/ENS/91S-3. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1991 (AD-A246684).

6. Bertrand, J.W.M. "The Use of Workload Information to Control Job Lateness in Controlled and Uncontrolled Release Production Systems," Journal of Operations Management, 3: 79-92 (February 1983).

7. Bobrowski, Paul M. and Paul S. Park. "Job Release and Labor Flexibility in a Dual Resource Constrained Job Shop," Journal of Operations Management, 8: 230-249 (August 1989).

8. Bobrowski, Paul M. and Paul S. Park. "An Evaluation of Labor Assignment Rules When Workers Are Not Perfectly Interchangeable," Journal of Operations Management, 11: 257-268 (1993).

9. Conway, Richard W. Theory of Scheduling. Reading MA: Addison-Wesley, 1967.

10. Cooper, Donald R. and C. William Emory. Business Research Methods. Homewood IL: Irwin, 1995.

11. Gismondi, Nicola. A Comparison of Consistent Versus Inconsistent Scheduling Rules in a Flow Shop Environment. MS Thesis, AFIT/GAL/LAC/95S-3. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1995 (AD-A300661).

12. Guide, V.D.R Jr. and Rajesh Srivastava. "An Evaluation of Order Release Strategies in a Remanufacturing Environment," Computer Operations Research, 24: 37-47 (January 1997).

13. Guide, V.D.R.JR., Rajesh Srivastava, and Mark Kraus. Scheduling Policies for Remanufacturing. Technical Report, AFIT-LA-TM-96-2. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, January 1997.

14. Hausman, Warren H. and Gary D. Scudder. "Priority Scheduling Rules for Repairable Inventory Systems," Management Science, 28: 1215-1232 (November 1982).

15. Icmeli, Oya and Selcuk Erenguc. "A Branch and Bound Procedure for the Resource Constrained Project Scheduling Problem With Discounted Cash Flows," Management Science, 42: 1395-1408 (October 1996).

16. Icmeli, Oya. Scheduling Problems in Project Management. Ph.D. dissertation. University of Florida, Gainesville FL, 1992.

17. Krajewski, Lee J. and Larry P. Ritzman. Operations Management: Strategy and Analysis. Reading MA: Addison-Wesley Publishing Co. 1996.

18. Lawrence, Stephen R. and Edward C. Sewell. "Heuristic, Optimal, Static, and Dynamic Schedules When Processing Times are Uncertain," Journal of Operations Management, 15: 71-82 (February 1997).

19. Loerch, Andrew G. A New Approach to Production Planning, Scheduling, and Due-Date Quotation in Manufacturing Systems. Ph.D. dissertation. Cornell University, Ithaca NY, 1990.

20. Lund, R. "Remanufacturing," Technology Review, 87: 18-23 (1984).

21. McCutcheon, David M. and Jack R. Meredith. "Conducting Case Study in Operations Management," Journal of Operations Management, 11: 239-256 (1993).

22. McFeely, Daniel J., Wendell Simpson, and Jacob Simons. "Scheduling to Achieve Multiple Criteria in an Air Force Depot CNC Machine Shop," Production and Inventory Management Journal, 38: 72-79 (First Quarter 1997).

23. Ministério da Aeronáutica. Recolhimento de Aeronave. IMA 65-12. Rio de Janeiro Brazil: DIRMA, 12 October 1989.

24. Ministério da Aeronáutica. Mapa Bimestral de Aeronaves. IMA 65-18. Rio de Janeiro Brazil: DIRMA, 30 August 1988.

25. Ministério da Aeronáutica. Processos de Análise para Manutenção. IMA 66-7. Rio de Janeiro Brazil: DIRMA, 10 July 1986.

26. Ministério da Aeronáutica. Planejamento de Material em Manutenções Programadas. IMA 66-19. Rio de Janeiro Brazil: DIRMA, 15 December 1995.

27. Ministério da Aeronáutica. Controle Mensal de Esforço. IMA 67-3. Brasília Brazil: COMGAR, 31 January 1985.

28. Ministério da Aeronáutica. Funcionamento dos Setores da Subseção de Programação (1TPL). IS 66-4. São Paulo Brazil: PAMASP, 6 June 1994.

29. Ministério da Aeronáutica. Programação da Produção da Linha de Aeronaves. IS 66-20. São Paulo Brazil: PAMASP, 2 August 1994.

30. Ministério da Aeronáutica. Regimento Interno Detalhado da Subdivisão de Planejamento e Controle do Parque de Material Aeronáutico de São Paulo. NPA 19-9. São Paulo Brazil: PAMASP, 25 August 1993.

31. Ministério da Aeronáutica. Sistema de Material da Aeronáutica. NSMA 65-1. Brasília Brazil: COMGAP, 13 December 1991.

32. O'Brien, James J. Scheduling Handbook. New York NY: McGraw-Hill Book Company, 1969.

33. Park, Paul S. "The Examination of Worker Cross-Training in a Dual Resource Constrained Job Shop," European Journal of Operational Research, 51: 291-299 (1991).

34. Penlesky, Richard J., William Berry, and Urban Wemmerlöv. "Open Order Due Date Maintenance in MRP Systems," Management Science, 35: 571-584 (May 1989).

35. Pinedo, Michael. Scheduling: Theory, Algorithms, and Systems. Englewood Cliffs NJ: Prentice Hall, 1995.

36. Ragatz, Gary L. "A Note on Workload-Dependent Due Date Assignment Rules," Journal of Operations Management, 8: 377-384 (October 1989).

37. Raman, Narayan. "Minimum Tardiness Scheduling in Flow Shops: Construction and Evaluation of Alternative Solution Approaches," Journal of Operations Management, 12: 131-151 (February 1995).

38. Weeks, James K. "A Simulation Study of Predictable Due-Dates," Management Science, 25: 363-373 (April 1979).

39. Yang, Kum-Khiong and Chee-Chuong Sum. "A Comparison of Resource Allocation and Activity Scheduling Rules in a Dynamic Multi-Project Environment," Journal of Operations Management, 11: 207-218 (1993).

Vita

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13. ABSTRACT (*Maximum 200 Words)*

The Brazilian Air Force (BAF) in its logistic structure contains 5 Air Logistic Centers (depots). This thesis concentrates its analysis on one of the most important BAF depots located at São Paulo (PAMASP). This thesis explores the scheduling process currently used in PAMASP. This thesis adopted a managerial approach in a sense that it looked to take a big picture of the current process. The researcher performed field interviews with the goal of describing the process. During the visit to PAMASP, the researcher also gathered problems related to the process.

The recommendations stated on this study were based on the knowledge about scheduling developed in the literature review. This study intends to give managers some material to perform improvements in the current process. The improvements recommended in this study are in the following areas: sequencing rules, due date assignment, cross training, task description, and capacity measurements.

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The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire** to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765. Your response is **important**. Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?
a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

Man Years__________ $__________

4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

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