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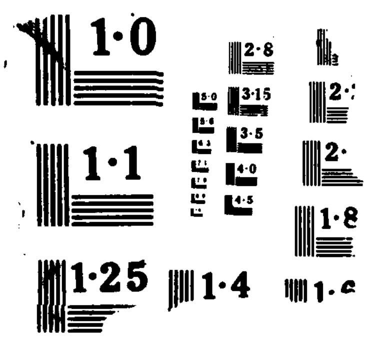
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Report: NCSU/DLA-87/1 CDRL A004

MANUFACTURING TECHNOLOGY FOR APPAREL AUTOMATION

Phase II and III Activity

Edwin M. McPherson
North Carolina State University
School of Textiles
Box 8301
Raleigh, NC 27695-8301

15 July 1987

Interim Report for First Half Year 1987

Contract DLA900-87-C-0509 (January - July)

Approved for public release;
distribution is unlimited.

Prepared for
Defense Logistics Agency
Production Management Support Office
DLA-PR Cameron Station
Alexandria, VA

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SUMMARY

NCSU has specified design concepts for apparel material handling units for the purpose of reducing the labor content in the production of apparel or military sewn products. The design concepts have been offered to existing equipment producers for bid on all or part of the equipment units. The modules specified include pickup and placement devices, orienting and alignment devices, equipment feeding devices and, finally, dispose or stacking devices. Wherever practical, existing commercially proven equipment is to be utilized or modified to satisfy systems requirements.

Flexibility in equipment is sought through the use of programmable computers or computer chips. The selection of a vendor to produce all or elements of the system has been guided by the vendor's demonstrated capability to produce original equipment at market value costs. Commercially viable equipment must generate operating cost savings which will recapture the equipment investment within a reasonable time span. If the modules developed do not do this, then the apparel industry will not buy the units. A primary constraint in this project is the requirement that the modules be an attractive investment for apparel manufacturers. Only one vendor stayed within these bounds.

At the time of this interim report, a contractor has been selected; however, an award cannot be made until a formal six months contract extension is provided by DLA to NCSU. Based on an oral approval, this report includes an adjusted MMP chart which reflects activity to date.

Parallel activity to vendor selection includes studies on the assembly of garments and definition of flexibility within an apparel context. This activity is proceeding on schedule.

PREFACE

The monthly interim reports are summarized in this semiannual report. Activity to date has included work performed by

Ms. Carol Carrere
Dr. T. G. Clapp
Dr. H. Hamouda
Dr. T. J. Little
Mr. E. M. McPherson
Dr. W. K. Walsh

As well as other staff and graduate students as needed.

INTRODUCTION

1.0 Under the contract signed by DESC 12/16/86 and received by the NCSU School of Textiles 1/2/87, agreed to activity has been divided into five phases, of which the first four are to be immediately undertaken by NCSU within the base period. There are:

1.1 Phase I, Project Management. Provide, in accordance with paragraph 3.1 of the Statement of Work (SOW), North Carolina State University's Technical Proposal, Manufacturing Technology for Apparel Automation, April 86.

Project management shifts in its requirements between phases. After setting up the initial Management Master Plan (see appended chart), there are basic Department of Defense accounting, reporting and review activities which apply to all phases. This means that North Carolina State University had to put in place reporting and accounting controls at the outset. Monitoring and managing the project becomes more complex as vendors are reviewed and selected. Working with vendors requires field reviews by appropriate NCSU staff or by consultants as problems arise. From time to time, it is anticipated that reliable students may work on the vendor premises to check progress and assist where appropriate.

1.2 Phase II, Establishment of Garment Subassemblies. Provide, in accordance with paragraph 3.2 of the SOW, Attachment 1, Section C, North Carolina State University's Technical Proposal, Manufacturing Technology for Apparel Automation, April 1986.

A requirement for extending use of the modularized work station to as broad a base as seems reasonable is one of the tasks outlined in the DLA objectives. This requires further investigations of operation sequences and assembly parts in both military and civilian apparel. In one sense this activity is a market survey to determine potential users of work station groups. Manipulation of this data base should provide insight into future areas for automation as well as a basis for establishing the rules of flexiblity within an apparel environment.

1.3 Phase III, Recommend a Set of Modularized Work Unit Groups. Provide, in accordance with paragraph 3.3 of the SOW, Attachment 1, Section C, North Carolina State University's Technical Proposal, Manufacturing Technology for Apparel Automation, April 1986.

There are several inventor/entrepreneurs as well as a number of small to medium equipment firms which have been evaluated to determine which individuals or firms are able to bring modularized equipment into practical use at a reasonable price. This analysis involves not only prior history of reliability but also such other items as financial stability, employed manpower, the skills of the firms' manpower, and the shop equipment. Because of the broad scope of the apparel automation project, units may be spread over more than one vendor or the vendor may subcontract some elements being produced. As an example, an electronics shop may be on all control systems while a mechanical shop is used for mmovement mechanisms. Where subcontractors are proposed, they must also be visited.

1.4 Phase IV, Design, Construction and Testing of Modularized Work Unit Groups. Provide, in accordance with paragraph 3.4 of the SOW, Attachment 1, Section C, North Carolina State University's Technical Proposal, Manufacturing Technology for Apparel Automation, April 1986.

NCSU is planning to provide for a staff presence to assist and work with the vendor or subcontractor. As an example, graduate students from the School of Engineering may be utilized in preparing drawings for small firms which lack adequate staff. The activity here will be largely that of monitoring progress against pre-established bench marks.

PROGRESS BY PHASES (2 January - 15 July 1987)

Phase I, Project Management.

Under this phase an MMP activity chart (Appendix I) was prepared. Each month progress on the project was indicated by marking off the point of activity as shown in Appendix I for 6/15/87. This reporting format was reviewed. It was suggested that as an MMP report, it could be improved by coding anticipated trip activity and by noting the dollar value for each phase. At the same time it was reported bidders on the equipment could not produce it within 12 months (i.e., AMF 2 years, ARK 18 months, Singer/Tech-Style 17 months). The MMP charts were, as a result of this discussion, extended by six months which would allow the vendor/builders a total of 18 months to complete and test the first work cell (see Appendix II). Appendix II shows the level of activity for the first six months of the contract.

This is the first report utilizing the MIL-STD-847B of 7 November 1983 which was received 7/14/87. The DD Form 1473 report documentation page will be prepared by DLA and will be forwarded to ONRR and DESC. To sum up project management activity to date, seven reports have been prepared and forwarded to DESC and DLA.

A ten member Industrial Review Board (IRB) has been reviewed by DLA. Calls were made to the prospects. Invitations to join the board to oversee this contract's activities were mailed 7/2/87. Eight members have accepted the invitation.

Industry - IRB members - invited by mail 7/2/87:

*Manny Gaetan	-	Bobbin
*Max Tripp	-	Sunbrand
*Ernst Schraymayer	-	Jet Sew
Hubert Blessing	-	Levi Strauss
*John Nicolson	-	Tennessee Apparel
*John Wilcox	-	K.S.A. (alternate Jerry Armfield)
*Joe Off	-	$(TC)^2$
David Adcock	-	Allwear Manufacturing
*Dan Gearing	-	DLA
*Don Moffitt	-	DPSC

*Accepted as of 7/14/87

NCSU expects the following staff to also participate in the Review Board meetings:

Ed McPherson	-	TMT Principal Investigator
Tim Clapp	-	TES ME
Hechmi Hamouda	-	TES EE
W. K. Walsh	-	TES Associate Dean for Research
Trevor Little	-	TMT, Associate Investigator
Karen Hersey	-	Director, Technology Administrator
Gerry Isley	-	IE, School of Engineering
Linda Jackson	-	Contracts Director, Research

Reports sent in to DLA and DESC included a variety of attachments beyond the MMP progress report.

Data submitted and attachments to date and resubmitted in this report include:

Preliminary equipment specificiations	- Appendix III
Singer/TechStyle Proposal	- Appendix IV
Cole Associates Proposal (ARK, Inc.)	- Appendix V
Daily News Record article (3/9/87)	- Appendix VI
Daily News Record article (3/13/87)	- Appendix VIII
Proposal Review questions (Singer and TechStyle)	- Appendix VIII
Singer Trip Report - T. Clapp	- Appendix IX
Singer Trip Report - H. Hamouda	- Appendix X
Proposal Review questions - ARK, Inc.	- Appendix XI
ARK Trip Report - T. Clapp	- Appendix XII
ARK Trip Report - H. Hamouda	- Appendix XIII
ARK Proposal Clarification	- Appendix XIV

Phase II, Garment Subassemblies.

This phase is designed to provide DLA contractors access to improved methods of garment assembly. Prior to the beginning of this current contract, DLA and $(TC)^2$ had financed an exploratory investigation in acquiring operation sequences. This was the data base from which NCSU started.

Table I, Products on the Computer File
January 1987

Surgical gowns, drapes	3
Shirts; work, dress, long sleeve, short sleeve	20
Jeans; men's, youth, ladies'	176
Pants; work, dress, slacks	17
Coveralls	1
Men's coats	93
Hosiery	4
Lingerie	12
Sleepwear	4
Sweaters	3
	333

This computer file was built from operation sequence data gathered in the beginning. This file contains 333 sequences. The file states the operation, operation time, equipment, and indicates by sequence number how to set up a production line. To this initial data base, NCSU has added those operatio sequences provided by DSPC and some additional sequences provided by industry (211 sequences). Approximately 85 more sequences have been provided by DuPont and $(TC)^2$ sources.

In order to make this data available in a useful comparative form, NCSU had to increase the memory of the apparel lab computer; purchase linkage hardware and software to join with an IBM PC; purchase an IBM PC; install the commingled system; buy software that will allow TI data to be drawn into the

IBM system; buy and install a data management system; establish links with the ApparelNet - Network; and finally write programs to rearrange the data in varying sequences so that data could be reviewed. Samples of the results of some of these programs are included in the appendices.

Style Number and Style Description	Appendix XV
Operation Description	Appendix XVI
Styles in Each Operation	Appendix XVII
Percent Contribution of an Operation to a Style based on: $\frac{\text{SAM OP}}{\text{SAM TL}} \times 100$	Appendix XVIII

As these illustrations show, the new file has a substantial amount of trade name or firm reference still to be deleted. In addition, there are still some terminology ambiguities to be reconciled. It is anticipated that as comparisons are made between different product lines, still more variances in terminology will require review.

The style number and style description report represents an index bringing together like items from whatever source. This index allows the user to rapidly assess the file depth in various apparel areas. It also becomes the basis for seeking out additional operation sequences from other sources to strengthening the data base.

Sorting by operation description allows the user to compare standard allowed minutes from several firms or the government for operations carrying the same or similar names. As an example, Page 2 of this report shows several different sewing machines being used to face pockets with a wide range of times being allowed for the operation. When the proposed work cell (Appendix III) is completed, these time variations should be eliminated. This file best expresses the fact that there is a wide range of manufacturing approaches in use in the apparel industry.

While general products show some commonality in construction techniques, the concensus shows:

1. A wide variety of manufacturing procedures within similar garments.
2. A wide variety of labor standards and their components within similar garments.
3. A wide variety of material handling (throughput) policies and techniques within similar garments.

Sorting by the number of styles in each operation is another way of establishing the depth of the data base within any single operation. Eventually this sort will lead to additional areas of investigation for operational improvements.

Calculating the importance of any single operation to the labor content of a group of styles is one way of determining the impact of a change on that style's cost. When a group of these operations are combined, the impact on costs increase. As the file is broadened and selected operation groups are captured, a variety of equipment options should emerge.

None of this activity could be done by computer until June. Prior to June, operation analyses were done manually. The specification establishing the basis for equipment in Appendix III was manually calculated. As more analytical programs are developed, the uses for the specified production activities in Appendix III should broaden.

Phase III, Recommend a Set of Modularized Work Unit Groups.

During January Drs. Clapp and Hamouda completed a work cell specification (see Appendix III) which was sent to DLA for review. The specification differs from current automated or semi-automated apparel assembly equipment in that it requires the matching, sewing and final assembly of three cloth parts of irregular shapes. From this beginning, it should be possible at a future time to apply these principles to other sizes and shapes and other garments than the combat trousers (and civilian pants) specified in this work unit.

In order to assure widest possible publicity for potential project bidders, two articles were published by The Daily News Record (Men's Apparel Trade Publication). (See Appendix VI 3/9/87 and VII 3/13/87 for articles.) From these articles some phone calls were received expressing interest. The reviewed, corrected and edited specification, together with sample pockets, were sent to nine firms:

Hubert Blessing
Levi Strauss Richardson TX

Bill Cole
Cole and Associates/ARK, Inc.

John E. Hinkle
AMF Richmond, VA

Will Joyce
TexNology Systems

Jim Lower
Singer

Joe Off
AMF Richardson, TX

Herman Rovin
TechStyle

Ernest Schraymayer
Jet Sew

John Le Tourneur
Union Special

Inquiries were received from Synergy Company (to produce a full garment by molding), Knoxville Equipment (to provide bobbin thread counters) and Memphis Apparel Service (to provide pocketing).

On April 8, 1987, the work cell specification was reviewed by NCSU by Herman Rovin, TechStyle, and Jim Lower, Singer, for the purpose of creating a joint bid.

On April 9, 1987, the work cell specification was reviewed by Bill Cole and Charles Sandborn of ARK, Inc.

On April 14, 1987, the work cell specifiation was reviewed by Norman Cleaver of AMF Apparel Equipment Division.

By May 15, proposals were received from Singer/Techstyle and ARK, Inc., which are appended (Appendices IV and V). AMF requested an extension in time and advised NCSU that they could not complete the work cell in under two years.

Visits were made to Singer/TechStyle and to Cole Associates by Drs. T. Clapp and H. Hamouda for the prupose of evaluating facilities proposal integrity and obtaining specific answers to questions arising from proposal review by NCSU. Copies of questions and trip reports are attached.

Proposed Review questions (Singer/TechStyle)	- Appendix VIII
Singer Trip Report - T. Clapp	- Appendix IX
Singer Trip Report - H. Hamouda	- Appendix X
Proposal Review questions (ARK, Inc.)	- Appendix XI
ARK Trip Report - T. Clapp	- Appendix XII
ARK Trip Report - H. Hamouda	- Appendix XIII
ARK Proposal Clarification	- Appendix XIV

To sum up the proposals, NCSU faced two problems. The Singer/TechStyle proposal at $793,000 requires more money than was budgeted for the project as well as 17 months to complete versus a specification request for 12 months.

The ARK proposal at $393,000 is within the budget but requires 18 months to complete.

An all day meeting was held with Dan Gearing and Don O'Brien to review progress to date. It was decided to request an extension of time for the development of the work cell unit. This request was prepared by Dr. W. K. Walsh and NCSU is awaiting written response. Meetings have been held with Karen Hersey, Director, Technology Administration, in preparation for letting a contract to ARK, Inc. However, no action can be taken until NCSU has a written extension. No notification to either vendor will be made until the extension is received.

Another factor has emerged from the Singer/Techstyle proposal. Jim Lower of Singer, who was working with Herman Roven, has left Singer. This makes it doubtful that a valid proposal exists.

It is anticpated that equipment negotiations will be completed by 1 August 1987. Then normal monitoring according to checkpoint dates will begin.

APPENDICES

No.	Title
I.	Old MMP Graph
II.	Adjusted MMP Graph
III.	Preliminary Equipment Specifications
IV.	Singer/TechStyle Proposal
V.	Cole Associates Proposal (ARK, Inc.)
VI.	Daily News Record article (3/9/87)
VII.	Daily News Record article (3/13/87)
VIII.	Proposal Review Questions (Singer/TechStyle)
IX.	Singer Trip Report - T. Clapp
X.	Singer Trip Report - H. Hamouda
XI.	Proposal Review Questions - ARK, Inc.
XII.	ARK Trip Report - T. Clapp
XIII.	ARK Trip Report - H. Hamouda
XIV.	ARK Proposal Clarificaton
XV.	Style Number and Style Description
XVI.	Operation Description
XVII.	Styles in Each Operation
XVIII.	Percent Contribution of an Operation to a Style based on: $\frac{\text{SAM OP}}{\text{SAM TL}} \times 100$

6/15/87

CHART F

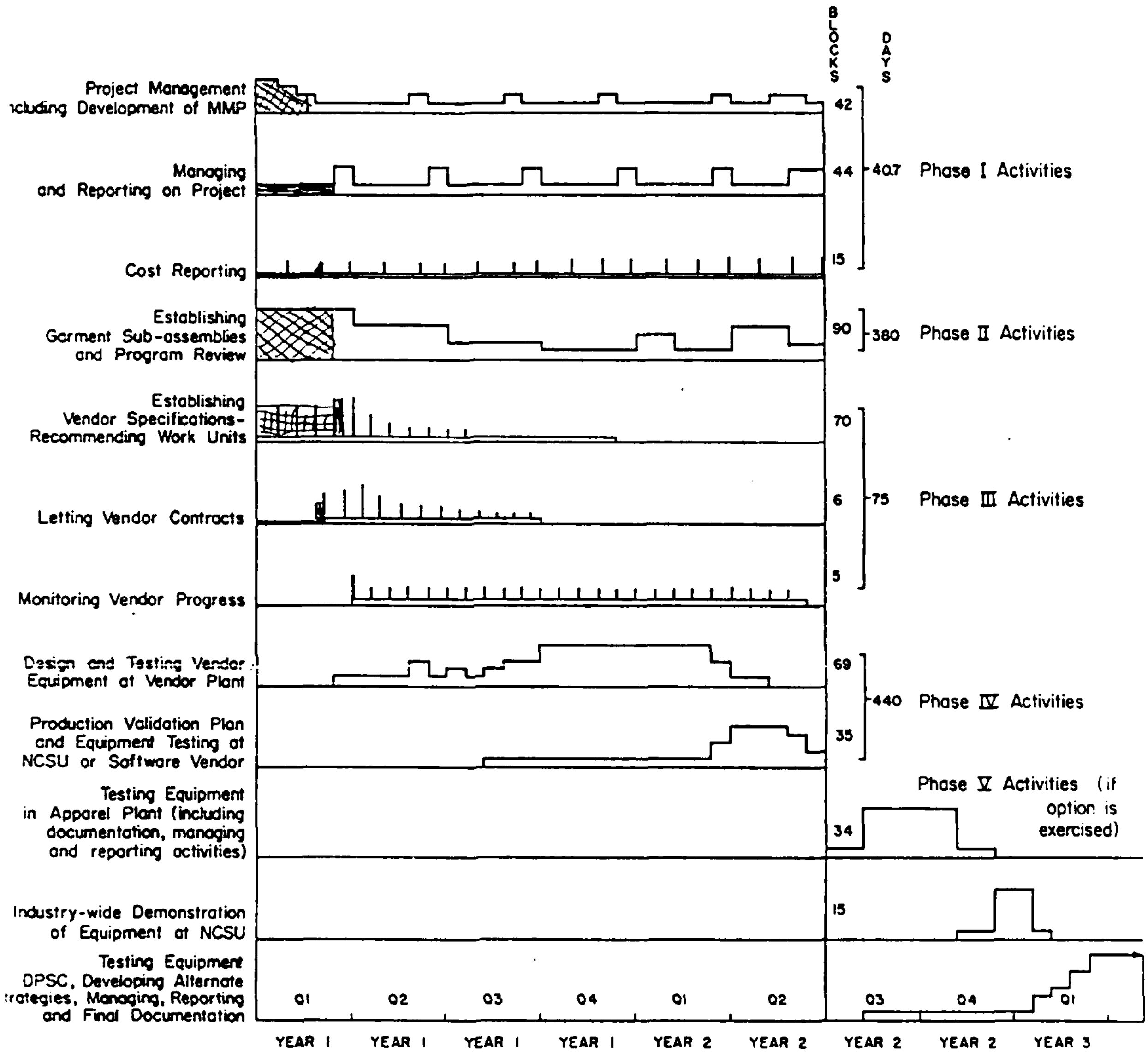
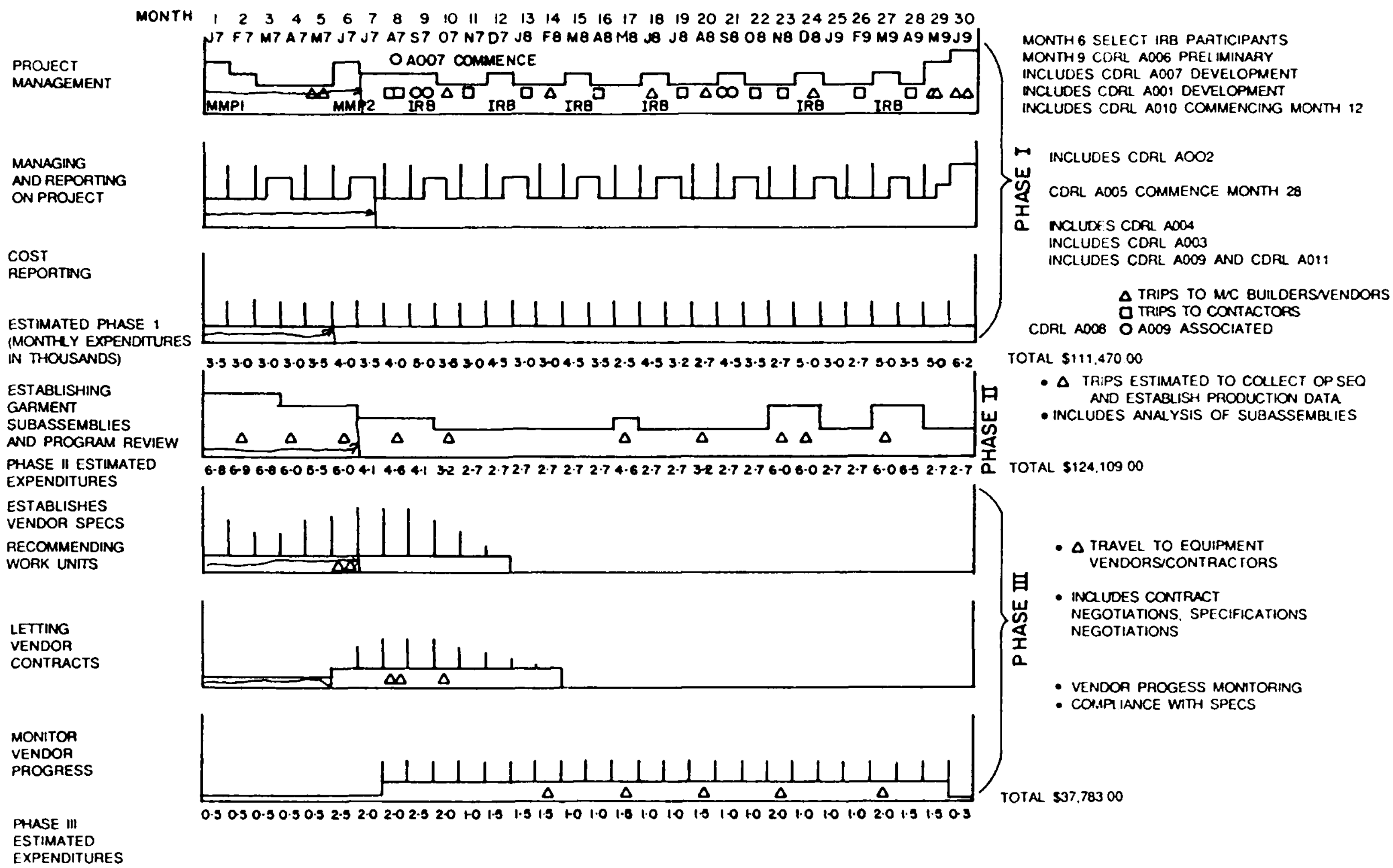


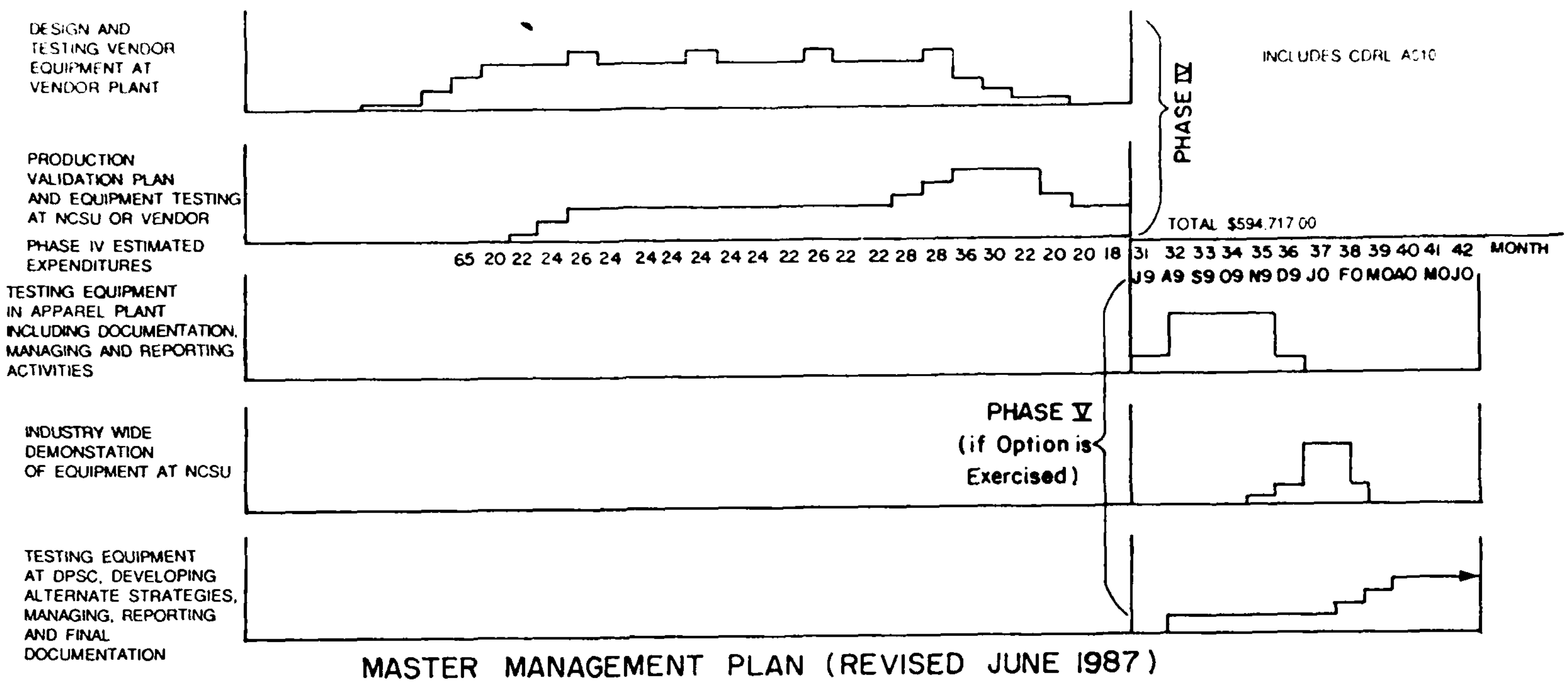
CHART F: Time Phased Activity for Project (estimated)
(This will be subject to change during development of MMP.)

APPENDIX I

DLA 900-87-C-0509 PROPOSAL NO. 86-0849 NCSU-SCHOOL OF TEXTILES JUNE 1987



APPENDIX II



MASTER MANAGEMENT PLAN (REVISED JUNE 1987)

Proposal for

COMBAT TROUSER UNIFORM FRONT POCKET WORK CELL SYSTEM

Submitted to:

North Carolina State University
School of Textiles

May 15, 1987

SINGER

Manufacturer Applied Robotic Sewing

Manufacturer Applied Robotic Sewing

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SINGER

SINGER

NORTH AMERICAN SEWING PRODUCTS DIVISION

May 11, 1987

Professor Edwin McPherson
North Carolina State University
School of Textiles
Department of Textile Engineering and Science
Box 8301
Raleigh, NC 27695-8301

Dear Ed:

Enclosed is the "bid response" to Dr. Hechmi Hamouda's March 12th letter inviting Singer Sewing to submit a bid to develop, test and apply a flexible, fully-automated robotic work cell to produce combat trouser uniform front pocket work as well as civilian slacks, dress pants and related work wear. The bid reflects a Singer Sewing Company commitment to apply its complete robotic sewing capabilities to the project and a plan to sub-contract major portions of the development stage of the project to Mr. Herman Rovin's company, TechStyle, Inc.

As you know, both Singer and TechStyle have already done considerable system development work in fully automated robotic work cells. TechStyle's previous work could be particularly useful in completing the initial production system. Singer Sewing with work sub-contracted to TechStyle, would be willing to accept full responsibility for an integrated system.

Ed, we appreciate your inclusion of the Singer/TechStyle joint resource in your bid process and hope that you will conclude that we are the most creative, experienced, capable and financially sound resource to complete this development work.

Sincerely,

James M. Lower
Vice President
Robotic Systems

JML/pd 1/1.3
Enc.

cc: H. Rovin, President
TechStyle, Inc.

IN BRIEF

Singer Sewing Div. Names Vento V-P

EDISON, N.J. — Vincent R. Vento has been named vice-president, robotic systems for the North American Sewing Products division of Singer Sewing Co. He succeeds James M. Lower, who resigned to pursue other opportunities, the company said.

Vento joined Singer in 1958 in the Kearfott division in Wayne, N.J., where he was a prime contributor to developments in the field of inertial navigation. He transferred to the North American Sewing Products division in 1985.

Lower, who had been with the firm 22 years, had been head of robotics systems since December 1986.

Stephen J. Kind, president of the North American Sewing Products division, said Singer "continues to make rapid strides in commercializing TCTC technology. Current plans call for fabrication by the end of the year of three transfer lines for automating the sewing of trouser side seams, inseams and waistbands, as well as coat back center seams, sleeve outseams, inseams and cuffs."

He said Singer has been marketing products of its Manufacturer Applied Robotic Systems (MARS) robotic sewing technology for auto trim application, carpet and rug binding, wash cloth manufacture and carpet sample production.

I. BID OVERVIEW

Manufacturer Applied Robotic Systems

By copy of this package the Singer Sewing Company, in concert with our primary sub-contractor TechStyle, Inc. (H. Rovin), is submitting this bid to North Carolina State University to supply within one year a production performing in-line system capable of automatically sewing and stacking a combat trouser uniform front pocket consisting of a pocket, a facing and a bearer.

The proposed system will be capable of accommodating various uniform pocket sizes and civilian pockets as well and will consist of 8 modular units which will be used in combination to ply separate, feed, register, combine, join sew, stack and control the final product. The feed system will also have the capability to load parts consecutively as well as to flip and load parts consecutively or on an alternate basis as required.

While this bid is focused on combining the 3 components of the uniform front pocket, Singer Sewing and TechStyle, Inc. are agreeable to including the in-line capability to also bag the pocket.

This bid includes a commitment from the Singer Sewing Company to not only design and assemble the production unit but to complete successful in-plant testing consistent with the performance and productivity specifications incorporated in this bid. North Carolina State University will receive complete documentation of all parts, system hardware and software and can be assured that all work will conform with national standards and defined military specifications. More specifically, the proposed work cell will be capable of producing both right and left faced front pockets for a combat trouser (B.D.U.) as per Section 12A through 12F or Mil-T 44047A dated September 9, 1982. The pocket bagging system if elected would do the 12G operations.

The system would be designed to produce pockets in four seconds and would achieve at least 90% uptime and 97% part quality performance levels. Modules would be designed for easy hardware changeover to accommodate any variation in style or size that might require more than a simple programming change. With an annual system capacity to produce 3.2 million pockets per year (2 shifts) and with an estimated production system selling price of approximately $250,000, it is estimated that any user can achieve a four year payback on the facing equipment system even with only 1 shift utilization. Paybacks on 2-shift utilization would be approximately two years.

This bid is issued as a fixed price contract for $720,522 ($793,000 if North Carolina State University would prefer to include the pocket bagging station as well) and Singer Sewing is agreeable to committing to complete a "ready to in-plant test" system by June 15, 1988 if Singer is advised in June by North Carolina State University that Singer and TechStyle have been selected to complete the development of the system.

Manufacturer Applied Robotic Sewing

II. BIDDER QUALIFICATIONS

A. SINGER SEWING COMPANY

Singer Sewing is a worldwide leader in the manufacturing and marketing of consumer and industrial sewing equipment. Singer is the acknowledged leader in robotic sewing technology with the application of in-line production and pre-production robotic systems with leading U.S. manufacturers of automotive trim (General Motors, Ford, Chrysler, etc.), textile products (Collins & Aikman, Burlington, J.P. Stevens, etc.) and apparel (Union Underwear, Lee Company, etc.).

In addition to the Singer Sewing Company's considerable experience and current capabilities in the field of total system garment automation, Singer is the key commercialization and product application resource of the Textile Clothing Technology Corporation $(TC)^2$ which provides additional access to leading edge robotic and material handling technology equipment. Singer Sewing and $(TC)^2$ have a particular interest in a strong working relationship with North Carolina State University and hope that acceptance of this bid will forge an additional link in that relationship.

B. TECHSTYLE, INC.

TechStyle, Inc. has been in business since 1970, designing and developing specialized machinery for the textile and apparel industries. TechStyle and its Company President, Mr. Herman Rovin have long been recognized as a particularly creative and cost effective resource in the development of soft goods material handling and sewing equipment systems.

TechStyle developed and presented the first "Sewbotic Work Cell" system for trouser and jean pocket sewing in the form of a working proof of concept system at the 1984 Bobbin Show in Atlanta, Georgia. This proof of concept system was developed for the U.S. Department of Commerce (Contract No. 99-26-071-69-30). TechStyle, Inc. was sub-contracted by the Georgia Institute of Technology to engineer, design and build the appropriate hardware. The work cell concept and module description which is profiled in North Carolina State University's preliminary equipment specifications closely approximates the proof of concept hardware which still resides at TechStyle's facility in Piedmont, South Carolina.

In summary, Singer Sewing is confident of our combined abilities to complete the proposed system development and to complete the obligation within the time period and budget level proposed.

Manufacturer Applied
Robotic Sewing

III. PROJECT APPROACH OVERVIEW

In addition to the front pocket system approach which is detailed in the following section, Singer Sewing in concert with TechStyle, Inc. will present to North Carolina State University as part of this proposal an overall plan for automated and semi-automated in-line manufacturing of the complete Battle Dress Uniform using the Sewbotic Work Cell approach in combination with other robotic vision and material handling systems. The proposal will include both the combat jacket as well as the combat trouser. Most of the flat work (such as pockets, outseams, etc.) will be handled by Sewbotic Work Cells similar to those incorporated in the front pocket system. More difficult assembly operations will require the use of more complex robotic end-effectors and vision systems with the recognition that selected operations may still require some direct labor support.

In addition to the above, Singer Sewing will profile the industry-wide civilian application opportunities to apply both the front pocket system technology and the total technology related to the overall in-line production automation of the complete Battle Dress Uniform.

The foregoing reports will be available to North Carolina State University in June, 1988 in conjunction with the completion of the hardware.

IV. PROPOSED UNIFORM FRONT POCKET SYSTEM APPROACH

(SYSTEMS ILLUSTRATED IN EXHIBITS 1-3)

Manufacturer Applied Robotic Systems

The proposed work cell known as the Sewbotic Work Cell shall consist of the following modules.

1. Three Feeder Modules (Includes Ply Separation Module) - These units will accept input product (1 for pockets, 1 for facings and 1 for bearers) and will be capable of reliable, repeatable, ply separation and feeding at the rate of one ply per four seconds. The feeder modules will incorporate an adjustable indexing capability and will be equipped with elevator stackers and feed arms capable of taking individual plys directly from cut stacks of material and reliably introducing them to the total work cell.

2. Three Flipper Modules - These units will accept single plys from bundles cut face to face and flip over alternate (face down) plys prior to them being transferred to the registration module. For bundles cut all face up, the ply would be held but not flipped to await transfer to the registration module or the entire module eliminated for those who cut all face up.

3. Four Registration Modules - These units will register each of the three pieces of cloth individually and in juxtaposition to each other and will accurately orient them to a fixed starting position. The fourth module will re-orientate the sub-assembly as it exits the first join sew station.

4. One Combiner Module - This unit will serve to combine the bearer and the pocket to each other after their respective registrations have been completed at their previous registration work stations. The bearer and the pocket will be accurately matched to each other at the combiner module for feeding into the follow-on join sew work station.

5. Two Join Sew Station Modules - These units will serve to join the bearer to the pocket and to feed the two pieces to a follow-on registration station. This follow-on registration station would work in concert with the facing registration station which would act as a combiner to place the facing on the bearer pocket sub-assembly which would then feed the three pieces to a second join sew station module to perform the second sewing operation. Lockstitch machines would incorporate the Singer Automatic Bobbin Changer currently in in-plant use with selected Singer robotic sewing systems.

6. One Rotary Stacker Module - This unit would accept the first production of the finished pocket from the second join sew work station module and stack it in a rotary fashion conducive to being re-fed into the next cell for the next sequential operation (Note: in the case of the proposed follow-on pocket bagging system the rotary stacker would follow the bagging operation with the additional bagging work station included in the production system).

IV. PROPOSED UNIFORM FRONT POCKET SYSTEM APPROACH

7. Twelve Sewbot Modules - These units will do all the picking, placing and transferring of cloth pieces between the aforementioned modules. All Sewbots will have a vertical "Z" motion capability for picking up or placing parts down. They will all consist of one linear axis (X axis) for longitudinal transfer direction. They may or may not have a transverse (Y axis) or a rotation (W axis) capability as the particular application would require. The X,Y, & W axes will all be servo controlled and remotely programmable. The size of each module will be chosen to accommodate the size of the product being assembled.

8. Control Module (Console) - This unit will be comprised of microprocessor computer-controls which will direct and monitor the operational status of each of the above six modules. In addition, the control module will be capable of programming each of the individual modules and total system to respond to changes in product size, style or type of material.

Exhibit 2 profiles the total pocket facing system (Exhibit 3 incorporates the optional proposed pocket closing work cell).

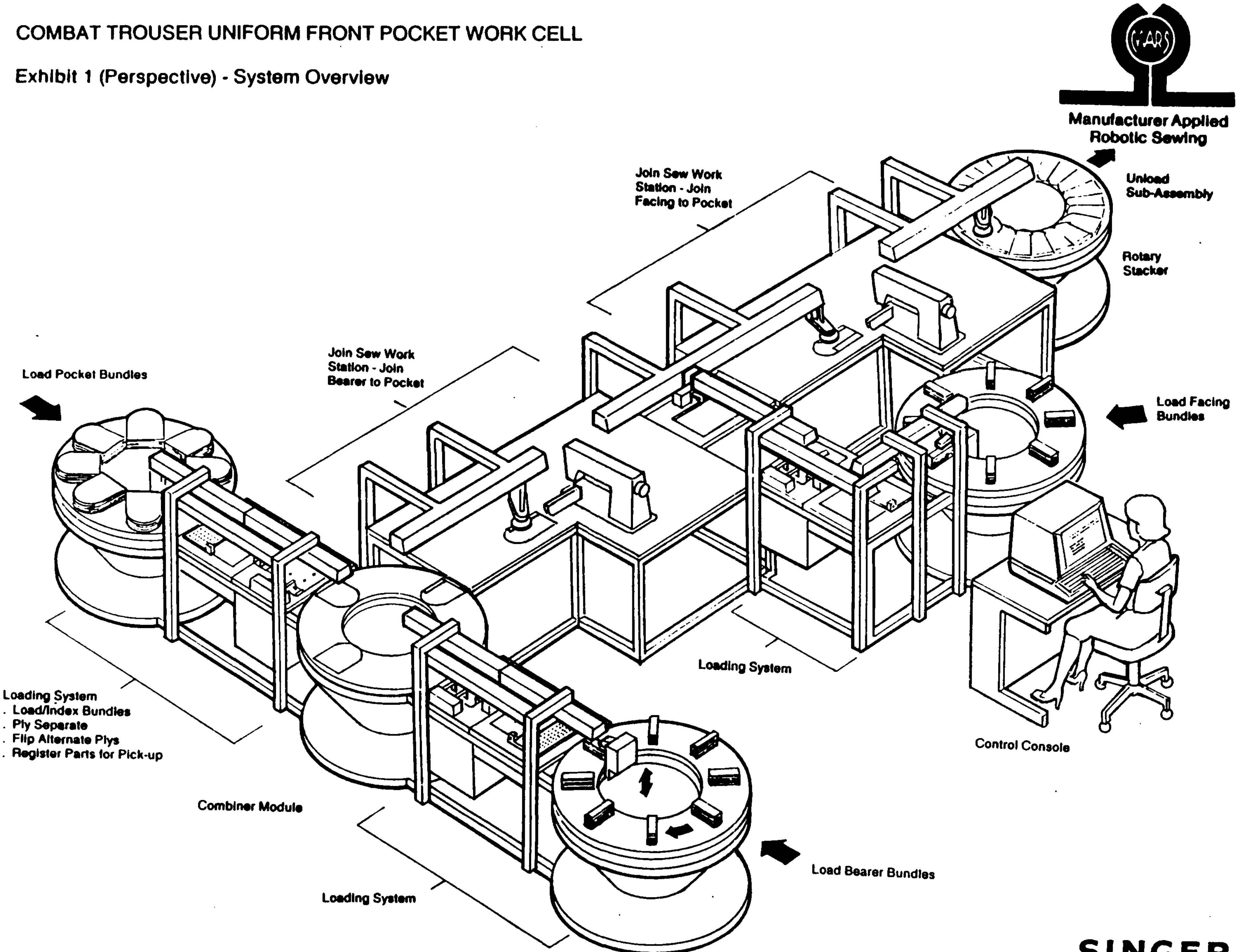
Military bearers and facings will be attached to the pocket by folding under the sewn edge and joining them with a 301 type stitch. Civilian pocket facings and welts will also be attached in a similar manner.

The complete cell will occupy approximately 225 square feet including the computer-control console. Each module will be controllable either independently or as a coordinated sector of the total work cell. All modules will be free standing but can be joined together mechanically to form a rigid integral structure. In addition, all the modules will be electronically linked to a main control processor. As mentioned previously, the system would produce one faced (2 facings) pocket every four seconds. The hardware will conform to the codes outlined in North Carolina State University's preliminary specificatons. The power requirements for the Sewbotic Work Cell are estimated as follows:

. 220V AC-30-10A-50-60HZ
. 90 PSI air @ 8-10 CFM
. Vacuum--unable to specify at this time

COMBAT TROUSER UNIFORM FRONT POCKET WORK CELL

Exhibit 1 (Perspective) - System Overview



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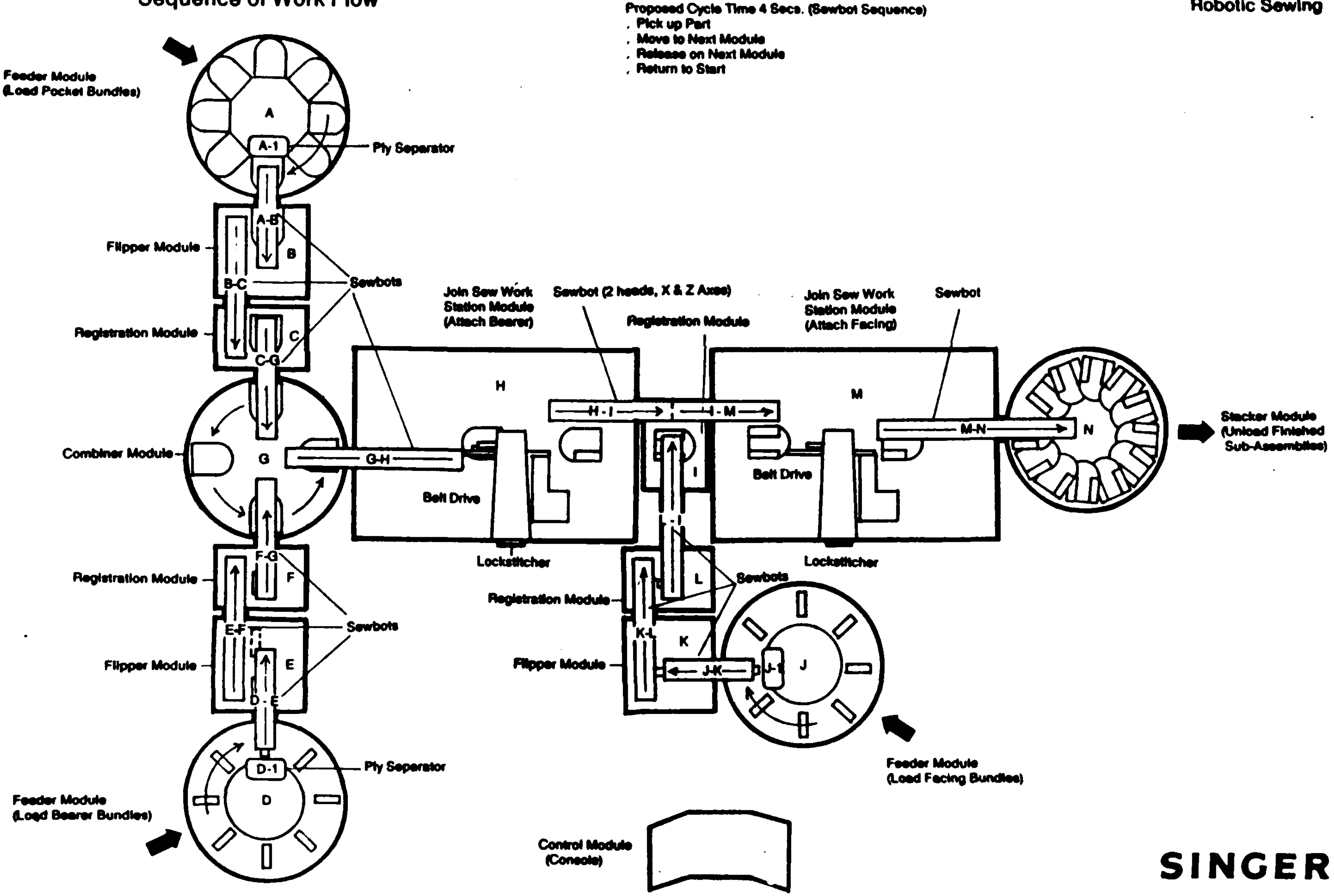
COMBAT TROUSER UNIFORM FRONT POCKET WORK CELL

Exhibit 2 (Plan View) - Configuration of Modules and Sequence of Work Flow



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COMBAT TROUSER UNIFORM FRONT POCKET WORK CELL

Exhibit 3 (Plan View) - Configuration of Modules with Optional Pocket Bagging Work Cell

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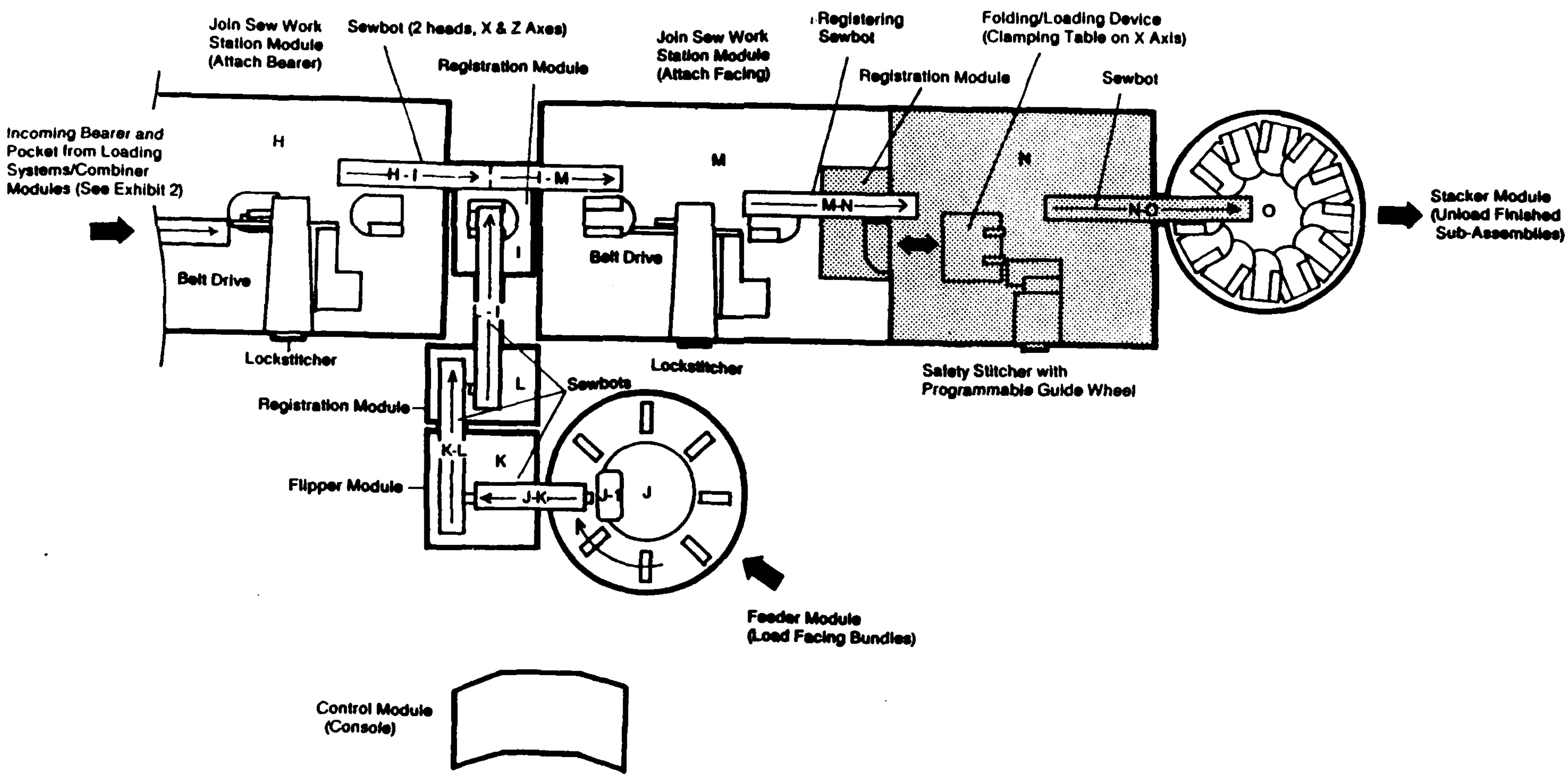

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V. SYSTEM FEATURES VERSUS SPECIFICATIONS

- The proposed work cell will be capable of producing faced only front pockets for uniform combat trousers. It will accommodate all sizes.

- The proposed work cell will be capable of producing faced only front pockets for civilian slacks, dress pants and work pants (all sizes).

- The proposed work cell will produce faced only front pockets for all sizes of civilian pockets falling within the "on-seam" or "casual seams" of dress slacks. (Note: Work pants front pockets fall under the category of 'on-seam' pockets consisting of either one or two facings. Uniform dress trouser front pockets also fall in the 'on-seam' category).

- The proposed work cell will be capable of joining other two or three piece assemblies but may require:

  1. Program changing
  2. And/or mechanical change of work stations if different sewing heads are to be used
  3. And/or operator mechanical adjustment. (Note: All work stations will be mounted on wheels and capable of being quickly substituted. Furthermore, all mechanical changes will be simple snap-on tasks.

- The entire work cell will be designed in a manner such as to maintain at least a 95% uptime level.

- All rotary feeders and stackers will be identical in construction.

- All registration modules will be identical in construction.

- All sewbots will be identical in construction less those axes that are not required.

- All sewbots will be capable of having their end-effectors quickly replaced.

- The work station will be capable of being quickly replaced by having it mounted on wheels and aligned with the combiner table.

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V. SYSTEM FEATURES VERSUS SPECIFICATIONS

- Cutting of pockets may be hand cut, die-cut or cut by automated cutting systems such as the "Gerber-Cutter". The accuracy of cut parts will of course be better and more conducive to automated assembly if die-cut or Gerber-cut. Tolerance requirements will be established between Singer Sewing/TechStyle and North Carolina State University.

- Cutting may be face-to-face or all face up. The integrity of 'shade-match' and/or piece marking will be maintained. The integrity of right side-wrong side (such as the camouflaged surfaces of military pockets, facings and bearings) will be maintained.

- Raw product inspection will probably not have to be accomplished prior to entering the work cell, i.e., soiled or bad cloth or partial pieces in the lay, though it might be necessary to sort and tag lays to maintain uptime and the integrity of shade-matching and sequencing. With the system designed to accommodate parts direct from stack, all ply separation and feeding systems will incorporate sensors to accomplish emergency stops for partial pieces and bad cloth.

VI. PRODUCTIVITY AND USER ECONOMICS

Production quantity versions of the automated pocket facing system are projected to cost approximately $165,000 and to be available to end-users for approximately $250,000.

Since the manual handling and sewing of facings and bearers is approximately six seconds each and since the automated sytem will produce completed assemblies at the rate of four seconds per pocket, the proposed automated system should produce approximately a 4 year payback on a 1-shift basis and a 2 year payback on a 2-shift basis. It is estimated that the inclusion of a pocket bagging station section would add approximately $70,000 to the aforementioned $250,000 selling price but that this total system would reduce customer paybacks on a 1-shift basis to approximately 3 years and on a 2-shift basis to less than 2 years.

The proposeo automated pocket facing system would produce approximately 7,000 pockets per day per shift or a total of 14,000 pockets on a daily 2-shift basis. This would result in an overall work cell system which would produce seven times the minimum daily unit output requirement (referred to in North Carolina State's production specifications as 2,000 pockets per day minimum) at a selling price which is only six times the aforementioned defined acceptable level selling price.

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VII. SYSTEM DEVELOPMENT SCHEDULING

Below is an overview of the total system development schedule:

. June 1987 - Advice from North Carolina State regarding bid.

. August 1987 - Complete preliminary definition of design & conduct initial product design review.

. October 1987 - Complete product design process and begin to order long lead time components.

. November 1987 - Begin assembly of key modules.

. December 1987 - Continue assembly of product including testing of critical modules.

. February 1988 - Integrate components into a complete system.

. March/April 1988 - Test and debug system in-house.

. May 1988 - Complete testing and documentation.

. June 1988 - Review operating system for release for factory test.

We would establish detailed milestones consistent with the above for funding flow and to assure the close interface and involvement of key North Carolina State program managers.

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VIII. SYSTEM DEVELOPMENT COST

Below is a profile of the system development cost for the total work cell from a direct material, direct labor system design and support perspective. Since component volumes for this first initial system will be very small and since there will be extensive additional labor costs related to assembly of this first unit, we are estimating that the total variable cost to assemble the system will be approximately $446,199 (approximately 2.5 times the projected cost of production product).

Listed below is a summary of these costs by module (Exhibit A) with the material costs profiled by purchased components (Exhibit B). Exhibit C is the direct labor hours and cost associated with the assembly, wiring, testing and model shop work required to complete each module. In addition to the $446,199 of direct material and direct labor expenses, we are projecting $184,323 of combined Singer/TechStyle engineering design and drafting cost (Exhibit D) and $90,000 to cover software programming, field test, start-up and field service support. The resulting total budgeted cost of $720,522 summarized below does include overhead absorption but includes no profit for Singer Sewing or TechStyle. We expect the production system to be saleable and would like an agreement from North Carolina State University to have the opportunity for Singer and TechStyle together to share 50% of the revenues of the initial system sale (assuming a $250,000 selling price, OUT OF SPEC $125,000 would be available to Singer/TechStyle and $125,000 would revert to North Carolina State University with the successful in-plant testing and completion of the project). The monies reverted to North Carolina State could also be used to complete the development and testing of the proposed add-on pocket bagging station.

Direct Material	$223,410
Direct Labor	222,789
Design & Engineering	184,323
Program Support Costs	90,000
	$720,522 ← OVER BUDGET

Note: North Carolina State University will be responsible for coordinating the supply of all pocketing materials required for testing purposes.

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EXHIBIT A

TOTAL WORK CELL COST, MATERIAL AND LABOR

UNIT	MATERIAL COST	LABOR COST	UNIT COST	UNITS PER CELL	TOTAL MATERIAL COST	TOTAL LABOR COST	TOTAL COST
FEEDER MODULE	$7,835.00	$7,203.60	$15,038.60	3	$23,505.00	$21,610.80	$45,115.80
FLIPPER MODULE	1,945.00	7,099.20	9,044.20	3	5,835.00	21,297.60	27,132.60
PLY SEPARATOR	1,820.00	3,862.80	5,682.80	3	5,460.00	11,588.40	17,048.40
REGISTRATION MODULE	11,870.00	15,451.20	27,321.20	4	47,480.00	61,804.80	109,284.80
COMBINER MODULE	7,835.00	7,203.60	15,038.60	1	7,835.00	7,203.60	15,038.60
FACE ATTACH WORK STATION	12,150.00	4,280.40	16,430.40	2	24,300.00	8,560.80	32,860.80
STACKER MODULE	7,835.00	7,203.60	15,038.60	1	7,835.00	7,203.60	15,038.60
SEWBOT	7,430.00	6,264.00	13,964.00	12	89,160.00	75,168.00	164,328.00
CONSOLE	12,000.00	8,352.00	20,352.00	1	12,000.00	8,352.00	20,352.00
					$223,410.00	$222,789.00	$446,199.60

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EXHIBIT B

MATERIALS AND PARTS COST BREAKDOWN PER MODULE

ITEM	PNEU-MECH PURCHASED	ELECT PURCHASED	VENDOR MFG.	TOTAL PURCHASE COST
FEEDER MODULE	$4,110.00	$1,525.00	$2,200.00	$7,835.00
STACKER MODULE	4,110.00	1,525.00	2,200.00	7,835.00
COMBINER MODULE	4,110.00	1,525.00	2,200.00	7,835.00
REGISTRATION MODULE	4,850.00	3,750.00	3,270.00	11,870.00
FACE ATTACH WORK STATION	9,800.00	8,750.00	5,750.00	24,300.00
FLIPPER MODULE	905.00	500.00	540.00	1,945.00
PLY SEPARATOR	280.00	400.00	1,140.00	1,820.00
CONSOLE	800.00	10,000.00	1,200.00	12,000.00
SEWBOT	1,580.00	3,750.00	2,100.00	7,430.00

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EXHIBIT C

DIRECT LABOR PER MODULE (INCLUDES 20% FRINGE AND 45% O.H.)

ITEM: ROTARY FEEDER/ROTARY STACKER/COMBINER

	HOURS	RATE	TOTAL
ASSEMBLY	120	$20.88	$2,505.60
WIRING	160	20.88	3,340.80
TESTING	40	20.88	835.20
MODEL SHOP	20	26.10	522.00
			$7,203.60

ITEM: REGISTRATION MODULE

	HOURS	RATE	TOTAL
ASSEMBLY	240	20.88	5,011.20
WIRING	200	20.88	4,176.00
TESTING	200	20.88	4,176.00
MODEL SHOP	80	26.10	2,088.00
			$15,451.20

ITEM: FACE ATTACH WORK STATION MODULE

	HOURS	RATE	TOTAL
ASSEMBLY	120	20.00	2,505.60
WIRING	120	20.88	2,505.60
TESTING	120	20.88	2,505.60
MODEL SHOP	40	26.10	1,044.00
			$8,560.80

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EXHIBIT C

DIRECT LABOR PER MODULE (INCLUDES 20% FRINGE AND 45% O.H.)

ITEM: FLIPPER MODULE	HOURS	RATE	TOTAL
ASSEMBLY	80	20.88	$1,670.40
WIRING	40	20.88	835.20
TESTING	120	20.88	2,505.60
MODEL SHOP	80	26.10	2,088.00
			$7,099.20
ITEM: SEWBOT			
ASSEMBLY	80	20.88	1,670.40
WIRING	100	20.88	2,088.00
TESTING	80	20.88	1,670.40
MODEL SHOP	32	26.10	835.20
			$6,264.00
ITEM: PLY SEPARATOR			
ASSEMBLY	25	20.88	522.00
WIRING	20	20.88	417.60
TESTING	40	20.88	835.20
MODEL SHOP	80	26.10	2,088.00
			$3,862.80
ITEM: CONSOLE			
ASSEMBLY	80	20.88	1,670.40
WIRING	120	20.88	2,505.60
TESTING	200	20.88	4,176.00
			$8,352.00

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EXHIBIT D

ENGINEERING, DESIGN AND DRAFTING COSTS

	HOURS	RATE	TOTAL
ELECTRICAL ENGINEER	880	39.66	$34,900.80
MECHANICAL ENGINEER	880	39.66	34,900.80
ELECTRICAL DESIGN	1,240	27.76	34,422.40
MECHANICAL DESIGN	1,240	27.76	34,422.40
ELECTRICAL DRAFTING	880	15.86	13,956.80
MECHANICAL DRAFTING	2,000	15.86	31,720.00
			$184,323.20

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IX. GLOSSARY OF TERMS

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1. Ply - A piece of cloth from the cutting room.

2. Element - A piece of cloth that has been worked on but no other piece has been added, i.e.; a hem on a pocket or a hem on a shirt front.

3. Sub-assembly - Any two or more pieces of cloth that have been joined together such as a collar or cuff or a pocket with one facing attached.

4. Component - A sub-assembly that has been completed to its final state before being put on to the final body part, such as a complete faced bagged turned and topstitched pocket or a complete top stitched collar.

5. Final assembly - Completed garment.

6. Single work station - A work station that does one operation.

7. Tandem work station - A work station that does more than one operation.

8. Unit - A free standing piece of hardware that does a specific task. In this context, there are the following basic units; also called module:

    a) multi-feeder unit
    b) rotary feeder unit
    c) rotary combiner unit
    d) rotary combiner and clamp unit. This is basically a combiner unit to which clamps have been added to hold more than one piece together.
    e) work station unit
    f) rotary stacker unit
    g) sewbot
    h) registration unit

IX. GLOSSARY OF TERMS

9. Sewbotic work cell - A combination of any of the above units arranged to perform a specific task.

10. Single work cell - A work cell where only one piece has to be handled or fed.

11. Dual work cell - A work cell where two pieces have to be handled.

Examples:

S	-	Single work cell
D	-	Dual work cell
T	-	Triple work cell
SWS	-	Single work station performing only one sewing operation
TWS	-	Tandem work station
S-SWS	-	A work cell that works on only one piece and does only one operation
S-TWS-2	-	A work cell that works on only one piece and does two operations
S-TWS-3	-	A work cell that works on only one piece but does three operations, etc.
D-SWS	-	A work cell that combines two pieces and performs only one operation on them
T-TWS-3	-	A work cell that combines three pieces and performs three operations on them

PROPOSAL

FOR THE DESIGN, MANUFACTURE AND TESTING OF

PROTOTYPE AUTOMATED WORK CELL SYSTEM

FOR THE MANUFACTURE OF
COMBAT UNIFORM TROUSER FRONT POCKETS

PREPARED BY:

ARK, INCORPORATED
P.O. BOX 636
SHELBYVILLE, TENNESSEE 37160

MAY 15, 1987

APPENDIX V

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PURPOSE

The purpose of the proposed endeavor is to design, prove the concept, fabricate, test and debug, revise where necessary and prepare for actual testing in an apparel manufacturing plant one automated work cell system for the manufacture of pant front pockets.

Military combat trouser uniform front pockets will be the initial product used for this work, but all design and fabrication will be done keeping in mind that the system should be convertible to civilian slacks, dress pants and related work wear.

SCOPE

Trouser front pockets consist of the pocket and two different facings, sometimes referred to as the facing and the bearer. There is a left and right front pocket, the respective parts of which are mirror images of each other.

The system must be automatically able to pick up the pocket, locate and register the pocket so that the facing can be properly positioned, transfer this registered assembly to the sewing head, sew the facing, repeat this process for the other facing or the bearer, then reorient this assembly so that the pocket can be properly folded in half, sew the pocket bag and finally stack the completed sub-assembly.

The system must be able to accommodate a full range of sizes of combat uniform front pockets which, in turn, assures that it will be able to handle almost all civilian pockets.

DESIGN REQUIREMENTS

The safety, reliability and durability of the equipment to be designed will conform to the National Codes and Standards applicable to and in use in the areas where this equipment will be utilized, i.e. apparel manufacturing plants. The following codes and standard documents will apply. In case of conflict between references, the order of precedence is as shown:

A. The OSHA Codes and Standards

B. The ASME Codes and Standards.

C. The IEEE Electronic Communications Codes and Standards.

D. The Military Specifications.

Each module of each given machine will be electronically controlled and monitored by a control unit, both separately and in coordination with other modules. A formal description of the control architecture will be developed that is compatible with or a subset of MAP (Manufacturing Automation Protocol). An error message will be generated by each module in case of improper functioning. The message will be transmitted to the control unit which will interpret it and then transmit a signal to trigger the appropriate action. The operational speed of each module will be optimized and regulated in order to maintain an overall constant flow of product through the robotic system with minimum idle running time at each module. Every effort will be made to keep the required maintenance simple. The control system will provide warning devices indicating trouble spots and machine malfunctions.

DOCUMENTATION

Design documentation will be provided with the prototype showing how the design and equipment meet the technical and safety requirements as specified. Drawings will include the proposed drawing, the initial outline and the connecting detail drawings, and the final assembly cross section drawings with material lists. These documents will be submitted for review and approval and will include a list of all parts and components used in the system, a detailed performance report, a structural design report, and the operating and maintenance instructions including spare parts list and maintenance schedule.

ECONOMICS

Existing technology will be used to keep pricing reasonable. Restated, it is not the part of this proposal to invent a better ply separating and pick-up device. Instead, the best commercially available pick-up device for the specific purpose will be incorporated into the design of this system. Likewise, commercially available sewing heads with known reliability and performance will be utilized with little or no modification.

It is extremely difficult to predict in advance the cost of an automated work cell system when the system is manufactured in quantity for general use by the apparel industry by an established machinery manufacturer. However, the importance of developing a system that is economically justifiable by most apparel manufacturers is fully understood. Every effort will be made to keep the total price of the mass produced system between $25,000 and $40,000 at retail, depending on the rate of production of the final system. Additionally, it is understood that most new apparel manufacturing equipment's retail price is based on its value to the end user in terms of the savings generated rather than on the actual cost of manufacturing the equipment. Thus, the retail price of the resulting system may well be based on factors other than the actual cost of manufacturing the system.

CONCEPT

Our concept of the entire system is three separate stand-alone machines, each with its own purpose, for the reasons detailed in the description of each machine, which follows:

Turn and Divide Machine

Many apparel manufacturing plants spread and cut fabric in pairs where possible. Alternate layers of fabric off the roll are spread on a cutting table face to face. After cutting, each cut stack contains alternate left and right parts facing each other in the stack. These parts are mirror images of each other.

There are advantages and disadvantages to pair cutting when compared to ply cutting where all of the fabric is spread face up (or face down) and the resulting cut stacks are all left parts or all right parts.

The primary advantage of pair cutting is that corresponding parts (i.e. the left front pocket and the right front pocket for a given pair of pants) end up the same size and shape even if the manual cutting machine operator has not followed the pattern line exactly. Another advantage is that pair spreading is quicker (requires less labor) than face one way spreading, when the spreading is done manually.

The primary disadvantage of pair cutting is in the sewing room because, when the pattern parts are marked randomly to achieve the best fabric utilization, the statistical odds are that 50% of the time the part on top of the stack will not be the part needed next by the operator. For example, the operator is ready to sew the right pocket but the left pocket is on top of the stack. The left pocket must be picked up and temporarily disposed of to make the right pocket available to the operator for sewing. This disadvantage has an even greater effect on automated sewing systems. Obviously, an automated system designed to sew from pair cut parts must be able to (a) recognize which piece is on top of the stack, (b) temporarily remove and hold or discard the unneeded piece, (c) then pick up and orient the correct piece. This must be repeated for each individual part of the sub-assembly being produced.

There is a trend away from pair cutting in the industry, especially by larger manufacturers whose volume enables them to justify automated spreading and cutting equipment, such as Gerber cutting. The accuracy of automated cutting negates the primary advantage of pair cutting. Additionally, ply marking frequently offers fabric utilization advantages over pair marking because there are twice as many pattern parts in the marker and this improves the opportunity to arrange the patterns to optimize fabric use. Restated, a ply spread is twice as long and half as high as a pair spread for a given quantity of garments.

For the reasons given above, it is proposed that the first machine in the system be a turn and divide machine. Its purpose will be to take a stack of pair cut parts and separate it into separate stacks of left and right parts.

This machine would only be needed by those apparel manufacturers who spread and cut fabric in pairs. Obviously, an apparel manufacturer using automated equipment producing ply cut parts already has separate stacks of left and right parts.

Turn and divide machines are not new technology. Most of the components are available commercially. We have manufactured turn and divide machines since 1982. Productivity varies depending on the fabric and the part size, but is generally in the 1500 to 2000 pieces per hour range.

Facing Serging Machine

Prior experience has taught us that automatically orienting fabric and guiding it through folders, although possible, is both more difficult and less reliable than other construction methods. Because of this we prefer to eliminate fabric folding where possible on automated systems. Military specifications allow for the facing and bearer edges to either be serged or folded under.

We propose that the facing and bearer edges be automatically serged by a separate, stand-alone machine.

The serging machine will be self programming with a closed loop control system. It will serge the edge of either facings or bearers of any size that can be handled on the 24"x24" work surface without readjustment or reprogramming.

A stack of ply cut facings or bearers is placed in the loading tray. The machine automatically picks up the top ply using a commercially available ply separate and pick-up device (such as JetSew's Clupicker), orients and transports the part to the needle, serges the edge with automatic edge guiding, cuts the thread and stacks the completed piece.

Productivity, based on 10 stitches per inch of 503 type stitching as required by the military specifications, is estimated at 1136 pieces per hour, or sufficient facings and bearers for 2272 pair of pockets per 8 hour shift. Productivity will be somewhat greater on smaller parts such as typical commercial slack pocket facings and bearers.

Another reason for proposing that the small parts serging machine be a separate unit is because of its other potential uses, such as automatically serging work pant flies.

Assembly Machine

The assembly machine will be by far the most complex of the three. It will have the ability to merge the three parts of the sub-assembly, feed, register and position the facing and bearer on the pocket, attach them to the pocket, and finally fold the pocket in half and sew it into a bag. Because of this complexity, the assembly machine will be described in a separate section which follows:

Assembly Machine Description

The assembly machine will be designed to assemble the three components of both left pockets and right pockets. For practicality, the expected mode of operation will be to assemble a stack (or bundle) of left front pockets, then quickly re-program the machine to assemble the mating bundle of right front pockets. As stated, the machine is designed to work off of ply cut parts (or pair cut parts that have been turned and divided in two separate stacks) and with facings and bearers whose appropriate edges have been pre-serged. The only folder included in the assembly machine is the device to fold the pocket in half and prepare it for bagging.

The assembly machine will include the following modules:

Feeding Module

There will be three feeding modules, one for the facing, one for the bearer and one for the pocket. Each will utilize the best commercially available ply separating and pick-up device for the specific purpose. Each feeding module will be remotely programmable and in constant electronic two-way communication with the control unit.

Registration Module

The task of the registration module is to orient individual plies in proper position for combination with other plies. There will be three separate registration modules, one to orient the pocket and the facing, another to orient the bearer and the pocket and a third somewhat different module to orient the pocket edges after folding prior to bagging. Each unit will be individually programmable and in constant electronic two-way communication so that it may be monitored by the control unit.

Combining Module

The purpose of combining module is to combine individual parts and position them for sewing. There will be two combining modules, one for the pocket and facing and another for the pocket and bearer. Each will be individually programmable and monitored by the control unit. It will be necessary for these two combining modules to work in series because, once combined, the facing will be sewn to the pocket before the bearer is brought into position.

Sewing Module

There will be three separate sewing modules, two of which will be very similar. Prior experience has taught us that, where possible, it is more practical to clamp the fabric pieces to be sewn together and move the sewing head along the appropriate path rather than to guide limp fabrics by a stationary sewing head. This is especially true when omni-directional sewing equipment can be used such as the Pfaff 438 lockstitch (301 stitch) sewing heads planned for attaching the facing and the bearer. Re-stated, it is more practical to accurately control the movement of a rigid mass such as a sewing head as opposed to controlling limp plies of fabric.

The third sewing module will contain a safety stitch sewing head with the stitch type 515, 516 or 519 (as required by the military specifications). There is no omni-directional sewing equipment available for these stitch types because the machine must be kept tangential to the sewn path. Therefore, in this case the folded and aligned fabric will be guided through the sewing head.

Each sewing module's control system will be remotely programmable and in constant electronic communication with the control unit so that its operation may be monitored.

Folding Module

There will be one folding module. Its purpose will be to fold the pocket in half after the facing and bearer have been attached and align the pocket edges for bagging. This unit will be individually programmable for size changes and will be monitored by the control unit.

Stacking Module

The purpose of the stacking module is to take the completed sub-assembly and stack the bagged pocket for the next use. This unit will be self programming and will also be constantly monitored by the control unit.

Control Unit

The control unit is composed primarily of a microprocessor. Its purpose is to control and monitor the operational status of each of the above modules. In response to monitoring status, the control unit will be able to re-program the modules individually for size or part changes. Additionally, the re-programming procedure may emanate as a response to error messages emitted by the working modules.

Productivity

Productivity of the assembly machine is estimated in the broad range of 500 to 1000 pockets per hour, or pockets for 2000 to 4000 pair of pants per 8 hour shift.

DEVELOPMENT

The development of an automated system such as this typically takes the following steps:

Concept

Our concept for the proposed system is presented in this proposal.

Initial Design

This is the process of committing the concept to paper in the form of preliminary drawings, specifications and parts list. It includes the initial process of searching the market to select the best commercially available components.

Proof of Concept

As the name implies, this is the first bench top model machine used to prove the basic concepts of the design. It is not intended to ever be a fully functional machine, but it does prove to everyone's satisfaction that the concepts are valid.

Initial Prototype

The initial prototype is the first functional machine, but it is not intended for use on the sewing factory floor; therefore, it may not be designed with the full OSHA guarding or totally automatic controls. In building the initial prototype, we make use of the primary conpontents (such as sewing heads) that were purchased for the proof of concept device.

The initial prototype phase concludes after the machine has sewed a few hundred dozen production pockets, even though it required special attention during this test. We do not recommend installing the initial prototype on the sewing factory floor for production testing. It is better to bring the work to be sewn to the machine in the shop where the machine was made.

The result of initial prototype testing tells us how the final prototype unit needs to be built.

Actual Prototype

This is the first machine designed and built to be installed on the apparel plant manufacturing floor for extensive testing. Again, it makes use of basic components purchased earlier. In fact, it is frequently possible to make the final prototype from the initial prototype without extensive basic rework.

TIME REQUIREMENTS

One of the first steps after awarding the contract should be the development of a Gantt chart with critical path for the complete project. This should be done by the contractor selected working together with appropriate North Carolina State University personnel.

ARK's facilities are limited. The project as presented would require between 16 and 18 calendar months for us to complete. The actual starting date would depend upon our workload at the time we are favored with the contract. However, assuming July 15, 1987 is the starting date, the system would be ready for apparel plant testing between November 15 1988 and January 15, 1989. Preliminary testing in our shop could begin several months earlier.

PRICE AND TERMS

We are pleased to quote $393,000 for the complete project as described. Terms are 10% advance deposit with the contract and regular monthly progress payments over the ensuing term of the contract. Each progress payment, of course, would be fully justified with the appropriate documentation as required.

At this time we respectfully decline to bid on individual components or modules. Additional detail needs to be known, such as who we would be working with. Please allow us to reconsider after additional information is available.

QUALIFICATIONS OF ARK, INCORPORATED

ARK has designed, fabricated and installed custom automated machinery primarily for the sewn products industry for the past 17 years. We have earned an excellent reputation for quality, dependability and delivery. References upon request.

DAILY NEWS RECORD, MONDAY, MARCH 9, 1987

Textile School At N.C. State Seeks Inventors

NEW YORK — The School of Textiles at North Carolina State University, Raleigh, N.C., is looking for inventors with products or ideas to take part in a research and development program for the apparel industry.

The textile school received a $1.2 million federal contract from the Defense Logistics Agency, Cameron Station, Va., to develop inexpensive systems for assembling garments, according to visiting associate professor Ed McPherson, who heads the program. The first product for development, he said, will be a work center to sew side pockets for military combat trousers. Other projects using this center will be developed by the agency and North Carolina State University. McPherson said the first system to be developed will have to pick up, put down and align the elements of the pocket, sew both pocket facings to the pocket and then stack the pocket. The center will include transport and positioning of the pocket and its elements for the sewing operation.

A requirement of the development, McPherson said, is that it can be converted to use in the production of civilian apparel. It must be low-cost and economical and enable apparel manufacturers to speed up an operation or do more than available from devices in use today.

McPherson can be reached at School of Textiles, North Carolina State University, Raleigh, N.C., 27695-8301 or at (919) 737-7871. Prior to joining the staff at the School of Textiles, McPherson was with Kellwood, as director of manufacturing operating systems; H.D. Lee, as chief engineer, and other firms.

APPENDIX VI

Uncle Sam Wants a Stitch in Time in Case of Military Mobilization

Continued from Page 1

and textile executives are questioning whether their industry is becoming a national defense problem, because production is shrinking under the weight of imports. They feel the industry today may not be large enough to meet military demands during a total mobilization.

A spokesman for DLA told DNR the search is on for methods of rapidly manufacturing military apparel, should the need arise for quick and heavy mobilization of men for the armed forces. Today's apparel manufacturing equipment and know-how, the government fears, won't meet the new pressures.

The NCSU project is for development of inexpensive systems for assembling garments, and the first product for development will be a work center to sew side pockets for military combat trousers, with other projects to follow. The Textile School is looking for inventors who can contribute devices, systems or ideas to the project. Developments from this effort must be inexpensive and of a design that can be converted to use in the production of civilian apparel.

The spokesman for DLA said this was originally a Department of Commerce project that DLA took over.

The DLA's latest announcement states that the objective of the 1987 program, called the Apparel Advanced Manufacturing Technology Demonstrations, is to "increase the use of advanced technology by apparel manufacturers and to strengthen the industrial base for mobilization."

The agency states the program is designed to help apparel manufacturers produce test batches of military and civilian apparel, assess the capabilitiesand limitations of advanced apparel manufacturing technology, solve manufacturing problems, experiment with new manufacturing methods, develop new equipment and train personnel in the operation of advanced equipment.

Up to three demonstration sites in three different states will be established, equipped with the latest manufacturing technology. The sites will be managed by universities or non-profit research institutions under contract with the agency's Defense Electronics Supply Center (DESC) in Dayton, Ohio.

Site selections will be made on the basis of various evaluation factors, including the degree of industry participation in proposed coalitions. Apparel manufacturers, electing to participate, can influence site selections.

DESC will procure the services and material necessary for the program. The site managers will be required to form coalitions of apparel and textile manufacturers, equipment suppliers and other members of the textile and apparel manufacturing community.

NCSU has two things going for it in apparel technology—the DLA project and the Textile Clothing Technology Corp. (TCTC) program. Will these efforts overlap? A Textile School spokesman said the R&D programs are different. The TCTC products will be more expensive and sophisticated than the DLA's. But a major advantage is the exchange of ideas expected between the groups in each project.

Uncle Sam Wants A Stitch in Time For Mobilization

By MATTHEW KASTEN

NEW YORK — Uncle Sam will spend more than $2 million this year so that he doesn't get caught with his pants down in the event of a national emergency.

The money is to be pumped into apparel technology research to develop equipment and know-how for speedy production of the latest military field uniforms. Handing

WATCH

out the funds is the Defense Logistics Agency (DLA), Cameron, Va., which last year gave $1.2 million to the Textile School of North Carolina State University, Raleigh.

This year, more than $2 million is up for grabs to the most qualified parties.

The government is, in effect, saying to apparel manufacturers and their equipment suppliers—Uncle Sam Wants You!

The money is being spent at a time when many U.S. apparel

See UNCLE SAM, Page 7

APPENDIX VII

PROPOSAL REVIEW by TGC

COMPANY: SINGER AND TECHSTYLE

BID: $793,000 (with bagger)

TIME FRAME: 12 mo.

PRODUCTION PRICE: $250k AT 3500 pairs/SHIFT

QUESTIONS:

Are multiple modules similar? (ie: Can the facing feeder be used to feed pockets?)

What company has primary responsibility for the project?

Who will build the hardware?

Who will make the detail drawings?

If you were given the contract today, how many people would begin working on the project and how many would be hired for what jobs?

If you were asked today to submit detailed drawings, maintenance schedules, ect. for all of the equipment, what percentage of the system information could you provide?

How much of this system is commercially available and production proven?

Can you have this system ready for production testing in 1 year?

Estimated floor space of system 225 sq.ft. (with bagger ?)

How many operators are required and at what skill level?

How many maintenance personnel are required and at what skill level?

Assume pockets are no longer needed, What other small parts can be made using the equipment in the system?

How many apparel plants run 2 shifts?

What is the average manufacturer's annual production of pockets?

System efficiency? 90% x 97% = 87.3%

How did you estimate these efficiencies(supporting evidence)?

Can system be operated manually in the event of a module failure?

Estimate overall maintenance cost.

APPENDIX VIII

MODULES: 3 FEEDERS; 3 FLIPPERS; 5 REGISTRATION; 1 COMBINER;
2 JOIN/SEW; 1 STACKER; 1 CONTROL MODULE;
13 SEWBOTS; 1 FOLD/BAGGER

30 modules total; 9 different modules

FLEXIBILITY:

MODULAR: yes
STYLE VARIATION:
OTHER SMALL PARTS:

CONVERSION PERFORMANCE:

SIZE
TIME:
COMPLEXITY (MECHANICAL;ELECTRICAL):
SKILL(OPERATOR):

STYLE
TIME:
COMPLEXITY (MECHANICAL;ELECTRICAL):
SKILL(OPERATOR):

CONSTRUCTION:

COMPLEXITY:
MATERIALS:
ESTIMATED LIFE:

MAINTENANCE:

SPARE PARTS LIST:
ESTIMATED PART LIFE:
ESTIMATED MAINTENANCE COST(TIME)/YEAR:
LABOR:
MATERIAL:
LABOR SKILLS REQUIRED:
DESCRIBE MAINTENANCE TASKS:

ACCESSIBILITY FOR MAINTENANCE:

FOLLOW STANDARD CODES (OSHA, ASME, IEEE, MILITARY SPECS): yes

MODULAR DESIGN REQUIREMENTS:

- 24x24 WORK AREA
- FLEXIBLE HEIGHT ADJUSTMENT
- yes - COMMON MECHANICAL AND ELECTRICAL CONNECTIONS
- WHEELS(EASILY TRANSPORTABLE)
- yes - INDEPENDENT CONTROL SYSTEM
- OPERATOR TROUBLE INDICATION SYSTEM

APPENDIX IX

TRAVEL REPORT

June 8, 1987

TO: Ed McPherson

FROM: T. Clapp TLC

SUBJECT: Summary of trip to Singer Sewing Company

SUMMARY

Dr. Hamouda and I visited Singer Sewing Company on May 29, 1987 to examine the technical facilities for developing a combat trouser uniform front pocket work cell system. Technical aspects of the proposed design were also addressed.

The facilities and technical staff are adequate to design, construct, and test the DLA front pocket work cell. Singer has experience with a variety of technologies that can be used in the development of the DLA work cell. These technologies include pickup mechanisms, transfer mechanisms, sewing modules, and control systems.

Singer is committed to automating apparel manufacturing. This commitment is illustrated by the (TC)2 program. A large portion of our time was spent reviewing the (TC)2 system and Singer's involvement to develop production systems. Economic justification of these types of systems requires high production schedules and preferably two shift operation. The (TC)2 program is behind schedule, but we were assured that this delay would not affect the DLA project.

Singer takes primary responsibility for completing the specifications as presented by NCSU. Although the proposed work cell is designed by Techstyle, Singer does not know how much of the proposed design will be developed. Consequently, it is difficult to assess the technical aspects of the modules in the work cell. Work cell flexibility, mechanical complexity, and efficiency can not be estimated without more details of the design. It is Singer's intentions to negotiate with NCSU and others during an initial product design review scheduled for August 1987 (page 9 in Singer proposal) to make design changes to the proposed work cell.

In summary, the technical staff and facilities at Singer are adequate. Singer clearly stated that they are responsible for the project. They stated that they are committed to expanding the work cell to other assembly operations. The modules in the work cell have not been defined by Singer; consequently, the percentage of existing production-proven equipment is unknown and cannot be technically evaluated.

FACILITIES AND TECHNICAL SUPPORT

Singer has two plants in New Jersey. The Fairfield plant primarily supports the development of production (TC)2 systems. The Edision plant is primarily a robotics application center.

At the Fairfield plant, we were given a detailed report on the (TC)2 project. Engineering changes to the (TC)2 machine were highlighted. An intensive effort is in progress to apply the (TC)2 technology in a manufacturing environment. New technologies such as vision and robotics are being used in this system. The Fairfield plant has the technical staff and facilities to design, construct, and test a work cell system.

At the Edision plant, Singer technology is applied to build sewing systems for a variety of industrial applications. We saw video tapes of Robotic systems developed for the carpet, automotive, and textile industries. In the plant, we saw the front jeans pocket assembly system that was demonstrated at the 1986 Bobbin Show. This system used two Singer MARS robots to transfer and guide the fabric under the sewing heads. This system demonstrated much of the technology that could be applied to the DLA work cell system, but the productivity of the demonstration system was low. The cost of this system was estimated to be $250,000. We were also shown a machine being developed to take two stacks of material, separate each ply, combine and sew the parts together. This system was in the prototype stage of development.

The Singer portion of the DLA project would be developed at the Edision plant. The technical staff and facilities are adequate to develop the DLA sewing system.

TECHNICAL EVALUATION OF PROPOSED WORK CELL

This section involves an inquiry as to the conceptual design, operation, and productivity of the proposed work cell.

The conceptual design of the work cell as shown in Exhibits 1, 2, and 3 in the Singer proposal was developed by Techstyle. All of the modules are Techstyle designs. The quotation of the work cell modules are based on the the modules shown in the illustrations. The conceptual design shown in Exhibits 1, 2, and 3 is not necessarily the actual design. A decision as to the actual design has not been determined. Singer has the pieces of technology that may be incorporated in the work cell, but there is no application of this technology in the current proposal. It is thought that preliminary design discussions would be conducted to determine the actual design to be constructed. Therefore, the number of Techstyle designed modules is unknown.

The uncertainty of the proposed design made it difficult to ask technical questions relating to individual modules. (Example: Q. Why are the feeder modules round? A. We may not use round feeders. A belt type feeder may be used.) Consequently, questions concerning module design, reliability, flexibility, productivity, and mechanical complexity could not be answered.

Questions concerning the work cell were answered in general terms. The work cell is design to produce a pocket every 4 seconds. The maintenance skills to repair the work cell will be minimized. Singer will provide additional maintenance training if necessary. The modules will be portable. The work cell is designed as a series of independent modules controlled by one operator. The operator will monitor the control unit and tend the loading and unloading stations.

The question of work cell efficiency was addressed. The 90% efficiency stated on page 1 of the Singer proposal is used for calculating the production rates required in their economic analysis. On page 6, the 95% uptime level of the work cell needs clarification. There exist a serious question concerning the actual efficiency of the work cell given the proposed configuration of modules. Can the modules obtain individual efficiencies high enough to obtain a 95% work cell efficiency?

The proposed work cell design has not been critically analyzed in this report because Singer stated that many of the modules in this design may changed.

Singer also stated that the 12 month development period must be extended to 15 months if the bagging module is included in the work cell.

APPENDIX X

MEMORANDUM June 5, 1987

TO: Ed McPherson

FROM: H. Hamouda

SUBJECT: Report on the proposal submitted by Singer Co. and the field trip to their facility

The following paragraphs are my report about the site visit, Dr. Tim Clapp and I had on Friday, May 29, 1987 to the Fairfield, N. J. and Edison, N.J. facilities of Singer Co. This report is also subsequent to the review of the proposal submitted by the same company, and to the discussion, about the technical aspects of the project, we have with the persons submitting the proposal.

The proposal submitted to the NCSU, School of Textiles on May 15, 1987 is titled: Combat Trouser Uniform Front Pocket Work Cell System.

To my best understanding, the purpose of our site visit was to evalute the facilities where the project, if granted, will be developed. The other purpose was to check the adequacy of the staff and the manpower for technical support, which will be involved with the same project. We were advised not to discuss prices and costs nor to suggest solutions or technical details during this site visit.

Technical Expertise

The concerned contractor technical expertise was attempted to be proven based upon a long presentation about an automated prototype for folding and sewing suits' sleeves. The system was developed and put together for (TC)² from a design made by Draper Lab. During their presentation about the production proven prototype, a lot of emphasis was made about Singer proficiency in sewing, high-tech system, and their adoption of a sophisticated vision system and its accompanying computer hardware and software.

They advanced that their prototype is production proven and that only minor hardware changes will make the (TC)² system able to be used in many other potential applications. The same automated sewing systems developed and built by Singer for (TC)² was upgraded from the initial prototype SNO to SN1 and SN2. The late models are the same as the initial one with some modifications for improvement.

Some technical aspect that were encountered during the development of the SNO prototype were also presented such as the use of retroflective surface in order to help enhance the vision system. Few more details about the vision system, the computing software and the vaccum support were also presented during the Singer initial presentation.

Design Approach

By mean of the Singer presentation about their previous involvment with (TC)² project on other projects, a parallel was attempted to be established between these previous experiences and the DLA project, the reason of our visit. The parallel is in the fact that Singer, backed by their previous achievement and by their reputation, they claimed that this always deliver a production performance version of machine and not a proof of concept prototype. They also claimed that this type approach (theirs) differentiate them from other bidders and that is the reason they believe that their bid should be higher then many other bidders. Even in this type of project where the work cell system, as it was conceived by the preliminary specifications, has never been proven on a production line, Singer will take care on the conversion of this notion from proof of concept to a production performance system.

Concerning their technical approach for the design and development of the system, Singer suggested that three persons with previous training at the Draper Lab will be assigned the study, design, and development of this project. The three persons will have a background in system integration, mechanical design, and electrical design, one background per person. A cost reduction design/analysis will feature in the project and also a usage justification for other production application of the system after a definition/analysis of these applications.

They stated that they are used to hard demanding customers, and as a manner of fact, the very first project they started with was for a very hard demanding company which they did not mention by name.

Testing Approach

To assure a reliable production functioning of the system and not only a verification of proof of concept, the testing approach will be part of the design. Based on a design review team meeting periodically, most design and testing requirements will be made. This review process will help decide if such occurences such as the usage of video camera or photovoltaic cell for the initial orientation system. Singer representatives asked for two (2) extra months for production testing of the system and three (3) more months if NCSU, School of Textile decides to add the bagger option which Singer has suggested as an addition to the project.

It was also added that may be the system will be built initially in South

Carolina at Rovin's facilities, then shipped to Fairfield, N.J., for testing. It was added that by building the initial system in S.C facilities, it will make it easier for NCSU, School of Textiles to review and supervise the development of the project. In case of testing difficulties encountered, more testing will be made at the Fairfield, NJ plant. They were not sure if this particular approach will be taken, the final decision will be made by the design review team, once they start working on this project.

System Operability and Maintenance

The modularity concept of the work cell was not well defined for there is no basic design available yet. Although few drawing were supplied with the proposal, the system drawn is only a suggestion based on Rovin's conception of the system. Consequently not much has been mentioned about the system operability and maintenance. Singer representatives suggested that no reprogramming is required by the system for a change of ply size for instance, but for a change of product a data input modification is necessary. The software will be the same, only numerical input will be modified.

The electrical and electronic communication and status monitoring and control will be maintained by a full CPU unit.

To operate such system, personnel familiar with the equipment is needed. As for the level of familiarity, it was defined as familiarity acquired by a training to the board level. One hour/week of preventive maintenance is necessary, and telephone support will be provided in case of problems where no diagnosis can be made. For occasional help people will be sent out for technical support.

For such design, Singer representatives suggested the involvement of end-users during the design and development of the system. Worries about material handlings problem were also mentioned. The need for material handling modules should be looked at for more suggestions. Singers representatives claim that existing work stations for material handling task already exist and has been tested from operability point of view but no production testing has been done yet. Finally it was suggested that a lot of judgements are to be made to determine the level of production, reliability, operability, maintenance, staffing personnel, etc....

Conclusion

During this field trip to Singer facilities at Fairfield and Edison, NJ and during the discussion we have had with Singer representative, it was made clear that the biddings will come from Singer and not from Rovin, and that Singer will assume total responsability for the carrying-on of the project and not Rovin. Rovin's modules, which were introduced through Singer's bidding proposal may be used for the work cell, but more studies and suggestions are needed to determine if that specific model will be the final one.

A lot of concern was shown by Singer representatives about the picking technique to be used, which will be the limiting agent for the flexibility of the system. For material handling reasons the system can not be made to be versatile from the type of material to be handled point of view.

Although the facility and the in house technical capability and support were very impressive in both the facilities we visited, no final nor concrete perception of the system was presented by Singer.

APPENDIX XI

PROPOSAL REVIEW by TGC

COMPANY: ARK, INC.

BID: $393,000

TIME FRAME: 16-18 mo.

PRODUCTION PRICE: AT 2-4k pairs/SHIFT

GENERAL QUESTIONS:

What is the average manufacturer's annual production of pockets?

Can system be operated manually in the event of a module failure?

Estimate overall maintenance cost.

Are multiple modules similar? (ie: Can the facing feeder be used to feed pockets?)

Who will build the hardware?

Who will make the detail drawings?

If you were given the contract today, how many people would begin working on the project and how many would be hired for what jobs?

If you were asked today to submit detailed drawings, maintenance schedules, ect. for all of the equipment, what percentage of the system information could you provide?

How much of this system is commercially available and production proven?

Can you have this system ready for production testing in 16 mo.?

Estimated floor space of system:

How many operators are required and at what skill level?

How many maintenance personnel are required and at what skill level?

Assume pockets are no longer needed, What other small parts can be made using the equipment in the system?

How many apparel plants run 2 shifts?

System efficiency?

How did you estimate these efficiencies(supporting evidence)?

Can system be operated manually in the event of a module failure?

Estimate overall maintenance cost.

Can we get a sketch of the layout?

Can you estimate the TOTAL system cost?

How are you going to move the material?

Can you estimate the ROI and payback?

MODULES: 5 FEEDERS; 2 COMBINERS; 1 TURN/DIVIDE; 1 SERGE;
4 STACKERS; 3 REGISTRATION; 2 SEW(301); 1 SEW(BAG);
1 FOLD; 1 CONTROLLER

21 MODULES TOTAL; 10 DIFFERENT MODULES; ____ COMMERCIALLY AVAIL.

FLEXIBILITY:

MODULAR:
STYLE VARIATION:

CONVERSION PERFORMANCE:

SIZE:
TIME:
COMPLEXITY (MECHANICAL;ELECTRICAL):
SKILL(OPERATOR):

STYLE:
TIME:
COMPLEXITY (MECHANICAL;ELECTRICAL):
SKILL(OPERATOR):

MAINTENANCE:

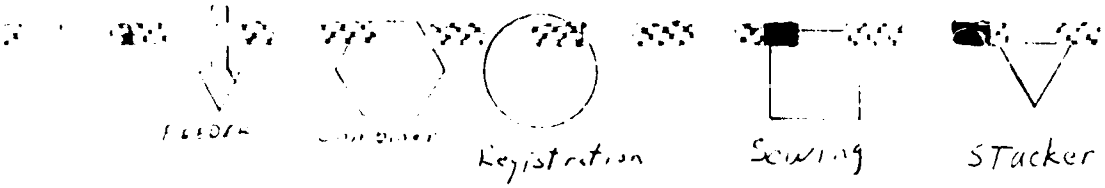
SPARE PARTS LIST:
ESTIMATED PART LIFE:
ESTIMATED MAINTENANCE COST(TIME)/YEAR:

LABOR:
MATERIAL:

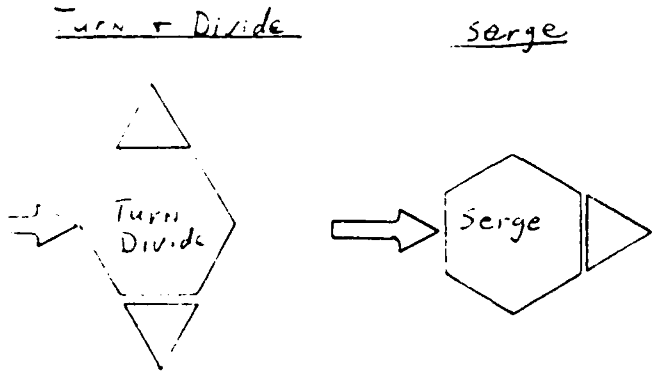
LABOR SKILLS REQUIRED:
DESCRIBE MAINTENANCE TASKS:

ACCESSIBILITY FOR MAINTENANCE:

FOLLOW STANDARD CODES (OSHA, ASME, IEEE, MILITARY SPECS): yes

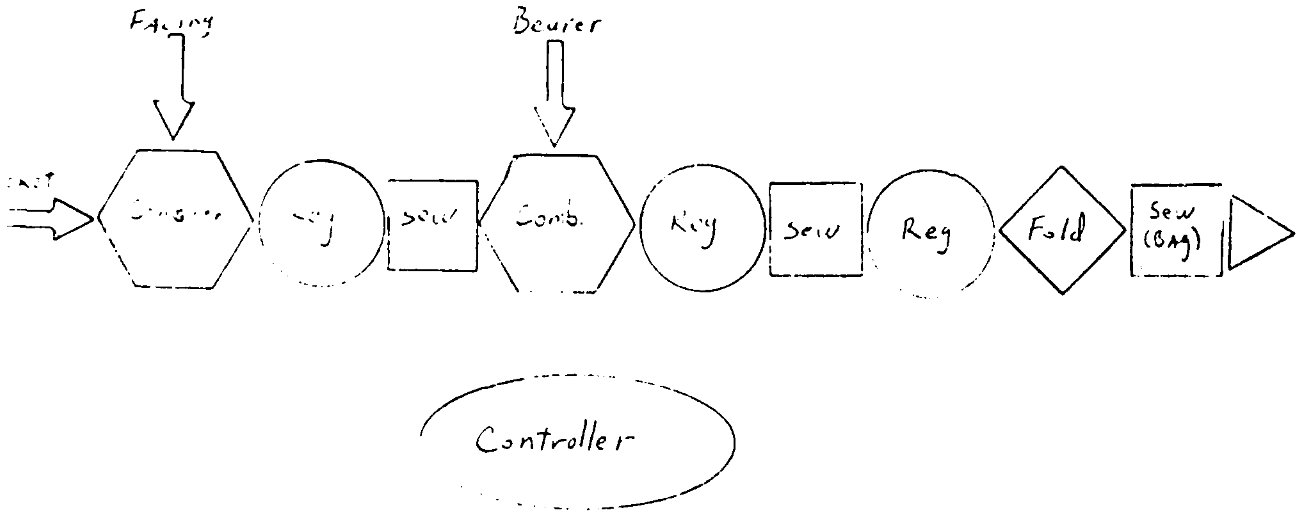


APK



Modules

5	Feeders
2	Combiners
1	Turn + Divide
1	Serge
4	Stackers
3	Registration
2	Sew (301)
1	sew (BAG 515 -)
1	Fold
1	Controller



APPENDIX XII

TRAVEL REPORT

June 11, 1987

TO: Ed McPherson

FROM: T. Clapp TGC

SUBJECT: Summary of trip to ARK, Inc.

SUMMARY

Dr. Hamouda and I visited ARK, Inc. on June 2, 1987 to examine the technical facilities for developing a combat trouser uniform front pocket work cell system. Technical aspects of the proposed design were also addressed.

ARK, Inc. is a small firm that produces machinery for apparel and textile related companies. It is a sister corporation to Cole and Associates. Cole and Associates primarily consults for apparel and textile related companies. Cole and Associates and ARK, Inc. provide total services to companies. Their experience and knowledge of the apparel manufacturers are tremendous assets in the development of equipment systems that the apparel manufacturers could economically justify and purchase.

The facilities and technical staff are adequate to design, assemble, and test the DLA front pocket work cell. ARK, Inc. normally uses a variety of qualified sub-contractors to perform specific tasks such as electrical design and drafting.

The conceptual design of the work cell was clearly presented and defended. It is based on many years of apparel manufacturing experience. Approximately 60 to 80 percent of the hardware in

the work cell is commercially available to minimize costs and increase the chance of success in production. A primary concern in the design is to assure acceptable production efficiency levels. This is achieved by minimizing direct linking of modules. The work cell requires only one operator who would serve primarily as a tender loading and unloading modules.

The work cell is modular and flexible. The turn and divide system can handle many small parts. Serging system can serge bearers, facings, and other small parts with no modifications. The assembly system can quickly switch from right to left pockets. It can be programmed to handle a variety of pocket sizes and styles. These systems are designed to operate independently in remote locations of the plant or be controlled by the main control module.

ARK, Inc. stated that a prototype would be ready for extensive production testing in 16 to 18 months from contract approval. ARK, Inc. works closely with a military contractor located 15 miles away. ARK, Inc. suggested that this facility be an ideal location to test the work cell.

In summary, the proposal submitted by ARK, Inc. is well founded. The design is solid. ARK, Inc. has the experience in apparel machinery development to accomplish the proposed work. This experience with apparel manufacturers is very important in designing a system that will be productive and economically justifiable. The proposed design reflects this experience.

FACILITIES AND TECHNICAL SUPPORT

ARK, Inc. is a small firm that is run primarily by two men. These men have extensive experience with the apparel and textile related industries as consultants and machinery manufacturers. ARK, Inc. has five technicians that have multiple skills such as welding, machining, pneumatic control, and electrical installation. These persons are primarily responsible for the assembly, testing, and modification to initial prototypes and production machines. A large portion of the technical support is provided by sub-contractors. ARK, Inc. regularly uses qualified sub-contractors to perform specific tasks such as welding, machining, electrical design, and detailed drafting. As an example, an electrical design engineer was present during our visit to discuss possible control systems for the work cell. ARK, Inc. described the technical services in the area that would be available to support the development of a DLA work cell. We asked them to submit a list of these firms.

The facilities at Ark, Inc. are designed primarily for machinery assembly, testing, and modification. A shop area has the necessary equipment to construct or modify prototype machines. A 6,000 square foot addition has just been completed to expand the facilities.

During our visit, we were allowed to see a mechanical system designed by ARK, Inc. for a textile related company. The system concept was innovative. The mechanical design was clean and efficient. The system was well constructed. ARK, Inc. described parts of the system developed by sub-contractors, such as the electrical system, the welded frame, and numerous machine parts. The system was designed to be operated and maintained with similar skills already existing in the company.

TECHNICAL EVALUATION OF PROPOSED WORK CELL

This section involves an inquiry as to the conceptual design, operation, and productivity of the proposed work cell.

The conceptual design discussed during or visit is the same as in ARK, Inc.'s proposal. ARK, Inc. stated that they had tried to combine existing technology to design a productive and affordable work cell. The design is presented as three small systems to achieve the work cell specifications.

A turn and divide machine would separate stacks of small parts cut face-to-face into stacks of right and left parts. The components of the turn and divide machine are commercially available. ARK, Inc. has built a similar turn and divide machine. The machine requires only a tender or part-time operator with no special skills. It is considered to be very flexible because only one location point is required to separate any small part. The machine would be used to separate pockets, facings and bearers with no modifications. The turn and divide machine can run as a separate unit or be controlled be the master control module in the work cell.

The turn and divide machine is not directly connected with the other modules for the following reasons: 1) the productivity is much higher than the sewing modules (12,000 to 16,000 pieces per shift), 2) the machine can be located in the cutting room or other desired area, 3) the machine efficiency does not affect other operations, and 4) apparel plants that do not cut face-to-face do not need the turn and divide machine.

The second system in the work cell would be a serging system for serging the facings and the bearers. This system consists of a feeder module, a serging module, and a stacker module. The components of this system are also commercially available. The serger will be self programming with a closed loop control system. This system is very flexible because no reprogramming is necessary to serge most small parts. The serger can serge a facing and a bearer with no modifications. The serging machine can run as a separate unit or be controlled be the master control module in the work cell. Only a tender or part-time operator is required to load and unload the system. The serging system is capable of serging enough facings and bearers to produce 4544 pockets per shift.

The serging system is not directly connected with the other modules for the following reasons: 1) the productivity is much higher than the sewing modules (9088 pieces per shift), 2) stacks of facings and bearers will be alternately serged, 3) the machine can be located in any desired area, and 4) the machine efficiency does not affect other operations.

The third system in the work cell is the assembly system. This system combines and sews the facing and pocket, combines and sews the bearer to the pocket, and bags the pocket. This system consists three feeder modules, three registration modules, two combining modules, three sewing modules, one control module, one folding module, and one stacking module. The feeder, sewing, folding, and stacking modules are commercial units. The technology required to combine and register the parts is available. No additional skills will be required to maintain the system. The skill level of the operator is dependent on the degree of flexibility desired.

The proposed design minimizes limp fabric handling by holding the parts stationary during the facing and bearer sewing operations. The sewing head moves along a programmed path. As the parts change styles or sizes the program would change. The control system would contain a range of sizes and styles programmed in storage for operator selection. Additional flexibility would require that an employee be able to program the sewing module when a new style is introduced.

ARK, Inc. expressed concern about the system efficiency when three sewing modules are linked directly. ARK, Inc. asked if direct linking was a requirement. The NCSU specifications do not make this requirement. I asked ARK, Inc. to submit a conceptual sketch of their work cell. They said that they would submit one based directly on their proposal and would submit an alternative sketch addressing their concern about system efficiency.

The complete work cell would require one operator. The operator would tend the various loading and unloading stations. The control module would monitor the work cell, alert the operator of any problems, and provide instructions required to correct the problem.

Approximately 60 to 80 percent of the machines in the proposed work cell is commercially available. Development work is required on portions of the work cell, but this work is minimized by incorporating a high percentage of existing technology.

The proposed work cell design is clearly presented and defended. The design reflects a knowledge of apparel machinery and apparel manufacturing.

Memorandum June 10, 1987

TO: ED McPherson

FROM: H. Hamouda

SUBJECT: Report on the proposal submitted by Cole & Associates and the field trip to their facility

The following paragraphs are my report about the site visit, Dr. Tim Clapp and I had on Tuesday, June 2, 1987 to the Shelbyville, TN. facilitites of Cole and Associates. This report is also subsequent to the review of the proposal submitted by the same company, and to the discussion, about the technical aspects of the project, we have with the concerned company representatives.

The proposal submitted to the NCSU, School of Textiles on May 15, 1987 is titled: Proposal for the Design, Manufacture and Testing of Prototype Automated Work Cell System for the manufacture of Combat Trouser Uniform Front Pocket Work Cell System.

To my best understanding, the purpose of our site visit was to evaluate the bidder's perception of the project, to evaluate the facilities where the project, if granted, will be developed. The other purpose was to check the adequacy of the staff and the manpower for technical support, which will be involved with the same project. We were advised not to discuss prices and costs nor to suggest solutions or technical details during this site visit.

Technical Expertise and Facilities

An informal presentation was made by Cole and Associates representative about the size of their facilities and their contents and their technical staff. The in house facilities cover two x 6,000 sq.ft, one of which is in the process of being finished. Cole & Associates is in reality two companies merged together. Coles which is a consulting firm for engineering systems, and Ark which is taking care of the enhancement of the engineering activities. Both companies together, have designed, built, installed, and trained for production systems they have put together to the standard requirement of the concerned industry.

Cole & Associates representatives emphasized the fact their geographical location is a great contributor to their technical expertise. The way they are located and the way they operate allow them to have access to a long list of contractors tied with space industry, NASA, and having experience with high precision work for customers as demanding as the federal government. They claim that they have established a network of highly qualified contractors which are located in the vicinity of Cole & Associates facilities. It was indicated that Cole & Associates major advantages and expertise are the fact that they have extensive apparel background and they are only 15 miles away from Tennessee Apparel, a major pants supplier to the U. S. military. Cole & Associates representative added also that they are closely involved with Tennessee Apparel, (TA), and they proved that alliance by arranging a visit to TA after our site visit to Cole & Associates facilities. Their facility includes a small workshop with basic tool-machinery where they were in the process of mounting and testing a machinery p--duct they built and designed. No drawing facilities nor engineering support were seen during the visit.

DLA Project Design Approach

Although no schematic of the work cell system was provided with the proposal Cole & Associates submitted to NCSU, School of Textiles, Cole & Associates representatives seem to have a clear perception of the system configuration. It seems to the bidder that the work cell will be more efficient if part of it, the turn and divide module, was kept at the cutting room. The remaining of the other modules of the work cell will reside on the floor of another designated area. The purpose of the separation is to elliminate the sorting at the work station level, of left and right plies when they are cut face to face. Ultimately, the turn and divide module will be elliminated from the work cell network, once the cutting room start using a Gerber cutter, or other devices which lay the fabric back to face. It was mentioned that the apparel industry is heading toward this last trend of cutting.

The design of the work cell will also focus on the fact that the bulk of its expected users are small military apparel contractors who are working on four different contracts most of the time, and they tend to specialize in one type of garment. Their production rate is in the range of less than 7,000 garment/day. Given this, Cole & Associates representatives believe that the practicality and the pricing of the system to be developed should meet the needs of the expected users mentioned above.

The bidder envision the system to be run, controlled, and monitored by a programmable controller unit based on a network of relay system and probably a servo-control capability will be added to the work cell if it seems necessary.

The design team will include in house and contracted members with expertise in mechanics, electronic, pneumatic, and fluidistic logic if required to this project. One of the bidders' contractors temporarily participated in our meeting with Cole & Associates representatives, although he was introduced as an electronic expert, he seemed to be knowledgeable in system-control and had suggested the use of servo-control unit to the work cell system.

Concerning the material handling, they suggested that they will probably use either a needle or a clue piker depending on the nature of the fabric and the operation. The bidders were not concerned about the problems that may occur with the complexity of material handling. They stated that they will search for the picker which will fulfill the task and they will attach it to the system.

Testing Approach

Based on their previous experience and expertise with machinery they have built in the past, and they are building now. They claim they have developed enough skill for testing one-of-a-kind machines that they put together, and it seems that an unwritten testing procedure already exist within the firm.

Testing will start first on the lab floor where the first prototype is being built, then the prototype will be moved to a real production environment where more extensive tests will be made. Subsequent adjustments will be done to deliver the product to the specifications agreed upon. Some comfort was shown concerning their feeling about their testing of the turn and divide device for they have previous experience with such equipment.

The controlling system which will be used with the work cell will have the ability to indicate, through a CRT, the status of the operation and the problems if any. It will also prompt the operator to take appropriate action. This controlling system will be used extensively during testing for acquisition of data and parameters of the process and for their analysis.

System Operability and Maintenance

No drawings or diagrams were submitted with the proposal about the work cell, although when asked about that, Cole & Associates representatives assured us that a set of drawings of at least the system conception will be made available to us within the two weeks following our site visit. Without these diagrams and drawings, it is difficult to predict the operability of the system and its maintenance. When the bidder was asked about that, they advanced that to operate the system a technician is needed to run the work cell and a mechanic time on the floor is also needed. No specifications were given concerning the level of skill of the technician, nor the amount of time needed from the mechanic to attend and maintain the system. It was also added that some low skill level intervention may be needed. If some change is needed because of product change, the work cell will be flexible enough to take that, no reprograming of the machine will be needed but some small mechanical adjustment will be necessary.

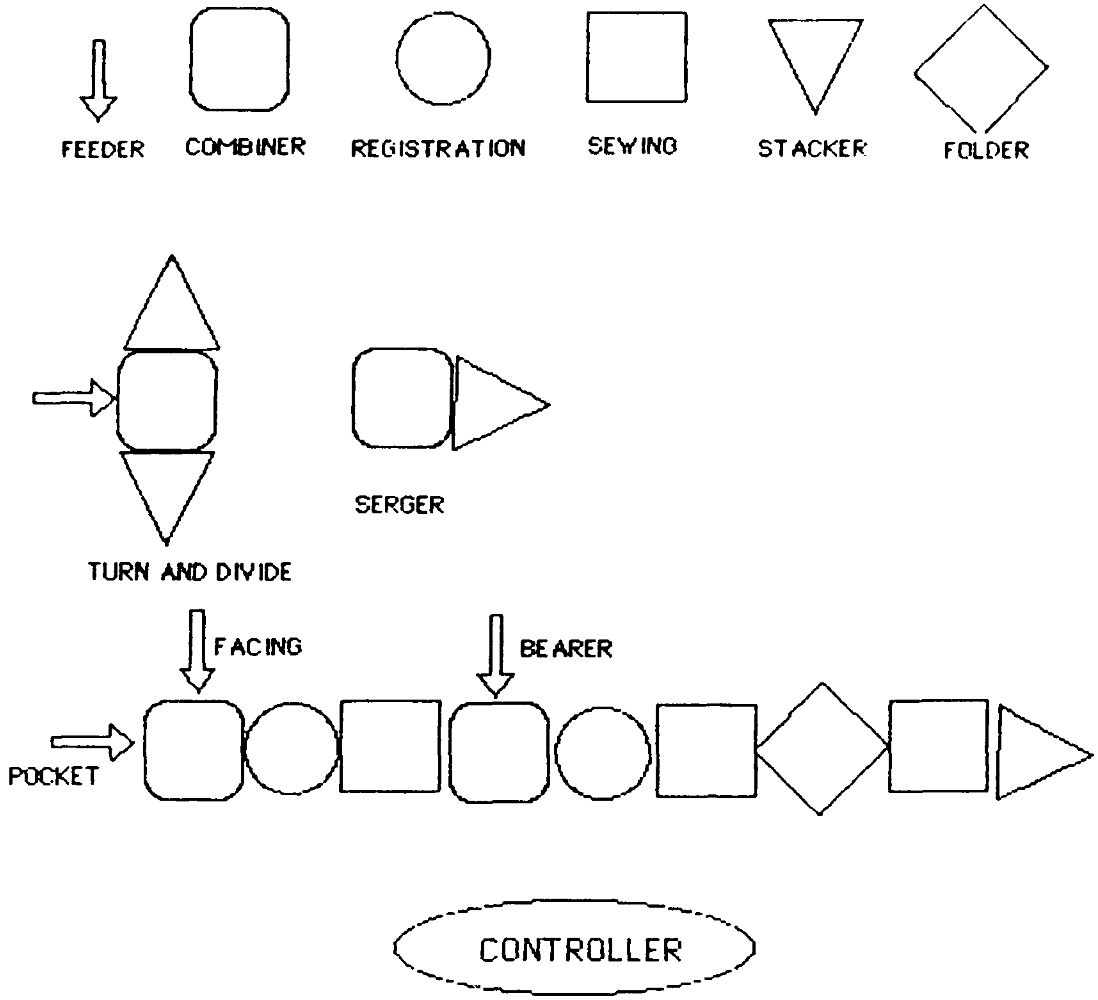
In general, it was claimed that the system operability will be run from a centralized communication system linking all the electric and pneumatic networks to a central unit. The protocol between modules will be based on action-reaction principle. No details about maintenance of the work cell were presented only the fact that maintenance will be cost related to the sewing head. In this area, sewing head maintenance, Cole & Associates representatives claim they have in-house expertise and skills.

Some details were also given about the floor space the work-cell will occupy: The turn and divide will take 2 x 4 or 3 x 3 ft of space from the cuting room, and possibly a surger which will occupy a 4 x 4 ft area. The entire system will occupy a total area between 100 and 150 sq. ft.

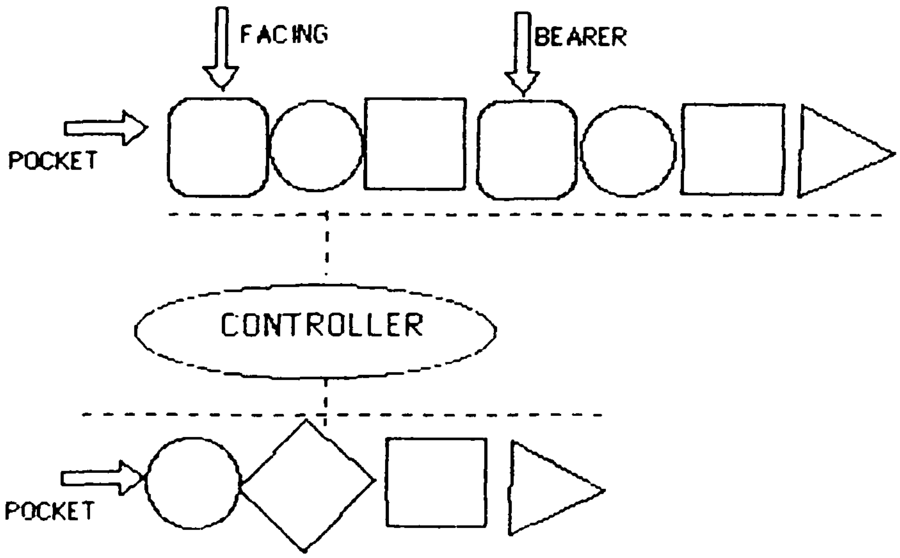
Conclusion

The impression I had from the site visit and the discussion with the bidder was that Cole & Associates is technically able to carry on this project. This opinion is based on the fact of their previous experience with apparel industry and based on the fact that their perception of the system was clear and structured, although no diagram nor drawing of the work cell was provided yet. They also pointed out that as of the date of our disucssion almost 50% of the work cell system as they perceive it is known and available technology, the other half is there too but needs some configuration changes and details to be worked out. Finally a question about the manufacturing rights was raised concerning who will own these rights once the work cell system is built.

APPENDIX XIV



ALTERNATIVE METHOD



ARK INC.

CONCEPTUAL DRAWING OF
MODULAR POCKET SYSTEM

ARK, INCORPORATED

LIST OF SUBCONTRACTORS

Sheet Metal Fabrication

1. Redd Sheet Metal
   Blue Ribbon Parkway
   Shelbyville, Tennessee 37160
   615/684-0339

2. Bobo Sheet Metal
   804 Union Street
   Shelbyville, Tennessee 37160
   615/684-3706

3. Guthrie Machine
   2121 North Jackson Street
   Tullahoma, Tennessee 37388
   615/454-9625

Electrical/Electronic

1. Richardson Electric, Inc.
   Amnicola Highway at Appling Street
   Chattanooga, Tennessee 37401
   615/625-2921

2. The Automation Center
   933 Woodland Street
   Nashville, Tennessee 37210
   615/228-5544

3. Arrel Enterprises
   2607 Leman Ferry Road
   Huntsville, Alabama 35800
   205/534-5853

Industrial Plating, Anodizing, Powder Coating

1. Guthrie Machine
   2121 North Jackson Street
   Tullahoma, Tennessee 37388
   615/454-9625

AD-A194 943 MANUFACTURING TECHNOLOGY FOR APPAREL AUTOMATION PHASES 1 AND 2(U) NORTH CAROLINA STATE UNIV AT RALEIGH E M MCPHERSON 15 JUL 87 NCSU/DLA-87/1 DLA900-87-C-0509

2/2

UNCLASSIFIED

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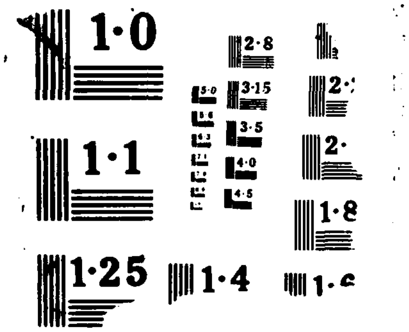
NL


1·0
2·8
3·15
3·5
4·0
4·5
1·1
1·8
1·25
1·4

2. S&H Plating Service
2805 Lebanon Road
Nashville, Tennessee
615/889-5095

3. Custom Powdercoating
308 Tampa Drive
Nashville, Tennessee
615/832-3949

Parts Fabrication

1. Simpson & Associates
119 Prince Street
Shelbyville, Tennessee 37160
615/684-9807

2. J&J Machinists
507 Depot Street
Shelbyville, Tennessee 37160
615/684-3810

3. Wego Precision Machine
Industrial Parkway
Shelbyville, Tennessee 37160
615/684-0941

4. Guthrie Machine
2121 North Jackson Street
Tullahoma, Tennessee 37388
615/454-9625

5. Westco Machine Company
Old Nashville Highway
Murfreesboro, Tennessee 37130
615/895-0033

EXAMPLES OF ARK MACHINERY

Sewing

Elastic Loop Machines for tensionless cutting, forming and sewing of waistband loops for pull on slacks, pantyhose, etc.

Rail Seamers (up to 28 feet) primarily for the Home Fashion Industry.

Large Area Automatic Sergers and Binders.

Automatic Small Part Sergers (Single Ply Guidance).

Automatic Pickup Devices to feed PROM controlled tackers.

Sleeve Seamers (Double Ply Guidance).

Buttonhole Indexers for large parts as shower curtains.

Zipper Tape Feeders.

Treadle Rod Air Valves.

Automatic Three and Four Side Cut and Sew Machines for rectangular products as pillow cases, shop towels, bags, etc.

Cutting

Marker Inspect-Rewind-Cut A Part Machines.

GERBERcutter Bristle Washers.

GERBERcutter Blade Groover.

GERBERcutter Conveyorized Take Off Tables.

Flotation Transfer Tables for Fixed Bed GERBERcutters.

Custom Cutting Table Flotation Systems for both Gerber and conventional installations.

Portable Battery Powered Gantry Cranes for Handling Large Rolls.

Custom ~~Trim~~ Turn and Divide Machines.

Custom Panel Cutters for Short Lays, Draperies, etc.

Custom Mucket Bars for absolute control of spread ends.

Rail Seamers for sewing small rolls into large rolls.

Fabric Inspection Machines for lofted products.

Warehousing

Custom Conveyors to handle large fabric rolls.

Conveyor Turntables for large fabric rolls.

Hanger Diverters and Counters.

Finished Goods Box Diverters.

Finished Goods Box Compressors.

STYLE # & STYLE DESCRIPTION

Page 1. File is "HUNTLEY:OUT.TEXT". Printed on June 11, 1987.

1	110-50xx	[redacted] PANTS
2	110-56xx	TYPE IV WORK PANTS
3	118-2041	LAUNDRY PANT--D/C
4	118-37xx	BEDFORD CORD PANT - COMMERCIAL
5	118-70xx	WORK PANT
6	118-95xx	[redacted] UNIFORM PANT
7	118-9803	[redacted] FLARE
8	12345	DAN
9	200-0041	MENS [redacted] - ZIPPER FLY
10	200-0141	MENS [redacted] SLIM - ZIPPER FLY
11	200-0241	MENS JEAN - BUTTON FLY
12	200-0341	MENS BOOT CUT [redacted]
13	200-10xx	MENS [redacted] BOOT CUT [redacted]
14	200-12xx	MENS [redacted] BOOT CUT [redacted]
15	200-14xx	MENS CORD BOOT CUT [redacted] D/IFR
16	200-15xx	STRAIGHT LEG [redacted] - CORDUROY
17	200-19xx	MENS BOOT CUT [redacted]
18	200-20xx	STRAIGHT LEG [redacted] - TWILL
19	200-21xx	[redacted] BOOT CUT FLARE
20	[illegible]	MENS BOOT CUT [redacted] - WASHED
21	200-7241	MENS [redacted] - WASHED
22	200-7341	MENS SLIM [redacted] - WASHED
23	201-0541	[redacted] BOOT CUT [redacted]
24	201-0745	MENS BOOT CUT [redacted]
25	201-0941	MENS BOOT CUT FLARE
26	201-23xx	BOOT CUT [redacted]
27	201-24xx	BOOT CUT FLARE - STRETCH DENIM
28	202-0341	WIDE [redacted] FLARE
29	202-0441	WIDE [redacted] FLARE/WASHE[redacted]
30	202-0449	WIDE [redacted] FLARE
31	202-0941	MENS STRETCH DENIM [redacted] FLARE
32	202-15xx	[redacted] FLARE - CORDUROY
33	202-16xx	[redacted] WIDE [redacted] - BEDFORD CORD
34	203-0341	YOUTHS BOOT CUT [redacted] BOYCONST
35	203-10xx	YOUTHS BOOT CUT [redacted]
36	203-12xx	YOUTHS BOOT CUT [redacted] PRES
37	203-14xx	BOOT CUT [redacted] (BOYS CONST.)
38	205-0341	BOYS BOOT CUT [redacted] BOYCONST
39	205-10xx	BOYS BOOT CUT [redacted]
40	205-12xx	BOYS [redacted] BOOT CUT [redacted]
41	205-14xx	BOYS CORDUROY BOOT CUT [redacted]
42	220-0041	RIDER JACKET - DENIM
43	220-10xx	RIDER JACKET - CURED
44	220-1216	MENS WESTERN JACKET
45	220-19xx	[redacted] JACKET - ROUGH HIDE
46	220-7041	[redacted] JACKET - WASHED
47	223-0041	[redacted] JACKET - BOYS/YOUTH
48	224-1916	LADIES [redacted] - ROUGH HIDE
49	225-46xx	KNIT [redacted] JACKET
50	240-0041	BOYS [redacted]
51	240-7041	BOYS [redacted] WASHED 240-0041
52	240-9849	BOYS BOOT CUT [redacted]
53	240-9949	BOYS BOOT CUT [redacted]
54	241-0041	YOUTHS [redacted]
55	241-7041	YOUTH [redacted] WASHED 241-0041
56	241-9849	YOUTH BOOT CUT [redacted]
57	241-9949	YOUTH BOOT CUT [redacted]
58	242-0029	BOYS BOOT CUT [redacted]

APPENDIX XV

Page 2. File is "HUNTLEY:OUT.TEXT". Printed on June 11, 1987.

59	2- 0109	BOYS BOOT CUT [redacted]
60	349	BOYS BOOT CUT [redacted]
61	2 -1	BOYS [redacted] BOOT CUT [redacted]
62	24 741	BOYS BOOT CUT [redacted] - [redacted]
63	242-0549	BOYS BOOT CUT [redacted]-SUITING
64	242-0629	BOYS BOOT CUT [redacted]-NAPSUITING
65	242-0749	BOYS BOOT CUT [redacted]NAPSUITING
66	242-0829	BOYS BOOT CUT[redacted]SUITING
67	242-0940	BOYS BOOT CUT [redacted]-SUITING
68	242-1010	BOYS BOOT CUT [redacted]-SUITING LF
69	242-15XX	BOYS BOOT CUT FLARE -CORDUROY
70	242-1620	BOYS BOOT CUT [redacted]-SUITING [redacted]
71	242-21XX	BOYS BOOT CUT [redacted]SUIT
72	242-5041	BOYS HUSKY BOOT CUT [redacted]
73	242-7341	BOYS BOOT CUT [redacted] WASHED
74	242-97XX	BOYS BOOT CUT [redacted]
75	243-0029	YOUTHS BOOT CUT [redacted]
76	243-0109	YOUTHS BOOT CUT [redacted]
77	243-0249	YOUTHS BOOT CUT [redacted]
78	243-0441	YOUTHS [redacted] BOOTCUT [redacted]
79	243-0541	YOUTH BOOT CUT [redacted] FLARE [redacted]
80	243-0549	YOUTHS BOOT CUT [redacted]SUITING
81	243-0629	YOUTH BOOT CUT [redacted]-NAP SUIT
82	243-0749	YOUTH BOOT CUT [redacted]-NAP SUIT
83	243-0829	YOUTHS BOOT CUT [redacted]-SUITING
84	243-0940	YOUTHS BOOT CUT [redacted]-SUITING
85	243-1010	YOUTHS BOOT CUT [redacted]-SUIT- [redacted]
86	243-15XX	YOUTHS BOOT CUT FLARE-CORDUROY
87	243-1620	YOUTH BOOTCUT [redacted]-SUITING [redacted]
88	243-21XX	YOUTH BOOTCUT [redacted] SUIT.
89	243-5041	YOUTH HUSKY BOOT CUT [redacted]
90	243-7341	YOUTHS BOOT CUT [redacted] WASHED
91	243-97XX	YOUTH BOOTCUT [redacted]
92	244-0041	HUSKY [redacted]
93	250-7041	[redacted] JACKET-BOYS/YOUTH WASHED
94	260-2444	LADIES WESTERN [redacted] JEAN
95	260-25XX	LADIES WESTERN [redacted] JEAN CORD
96	260-2641	LADIES WESTERN STRETCH DENIM
97	261-0541	LADIES WESTERN SCOOP PKT JEAN
98	270-19XX	LADIES [redacted] JACKET
99	270-20XX	LADIES WESTN SHIRT JKT HOPSCOT
100	270-2141	LADIES WESTERN JACKET - DENIM
101	270-2149	LADIES WESTERN JKT WASHED DENM
102	270-2741	LADIES WESTERN JKT-10 OZ DENIM
103	270-2749	LADIES WESTERN JKT-WASHED DENM
104	275-21XX	LADIES WESTN KNIT SHIRT JACKET
105	275-2241	LADIES WESTN KNIT SHIRT JACKET
106	275-24XX	LADIES WESTN KNIT SHIRT JACKET
107	275-27XX	LADIES WESTN KNIT SHIRT JACKET
108	275-35XX	LADIES WESTN KNIT SHIRT JACKET
109	300-1141	[redacted]SCOOP POCKET JEAN
110	300-19XX	[redacted] JEAN
111	300-33XX	[redacted] JEAN
112	309-0241	[redacted] MENS CUT JEAN LOT [redacted]
113	309-1109	[redacted]FLARE LOT [redacted]
114	319-4120	[redacted] LADIES WEST FLARE [redacted]
115	320-3741	[redacted]SHIRT JACKET - CHAMBRAY
116	340-12XX	[redacted] MISSES SHIRT JACKET

Page 3. File is "HUNTLEY:OUT.TEXT". Printed on June 11, 1987.

117	340-2210	[redacted]SHIRT JACKET
118	340-2341	[redacted] SHIRT JACKET-10OZDENIM
119	340-2844	[redacted] SHIRT JACKET CHAMBRAY
120	340-4141	[redacted] JKT-PANEL REV-DENIM
121	340-4941	[redacted] PANEL JKT BRUSHED DENM
122	340-5741	[redacted] JKT-PANEL REV-WASHED
123	355-01XX	[redacted] MISSES KNIT SHIRT JKT
124	355-0241	[redacted] MISSES KNIT SHIRT JKT
125	400-0041	[redacted] JEAN
126	400-0341	[redacted]STRAIGHT LEG - WASHED
127	400-04X	[redacted] STRAIGHT LEG
128	400-16XX	STRAIGHT LEG
129	400-1841	[redacted]STRAIGHT LEG - DENIM
130	400-1941	[redacted] STRAIGHT LEG-WASHED DENIM
131	410-0741	FOUR PKT BELL-ZIPPER - DENIM
132	410-0841	FOUR PKT BELL-BUTTON-DENIM
133	410-1241	FOUR PKT BELL-WASHED 410-0841
134	410-35XX	KNIT JEAN OPEN CONSTRUCTION
135	410-6449	FOUR PKT BELL-WASHED DNM BTN
136	410-6641	FOUR PKT BELL-WASHED 410-0741
137	410-7041	SAILOR JEAN - WASHED DENIM
138	410-8049	FOUR PKT BELL-WASHED DNM BTN
139	411-0241	[redacted] FLARE
140	411-03XX	[redacted] FLARE
141	411-04XX	[redacted] FLARE
142	411-0541	[redacted] BELL
143	411-1044	WIDE STRIDER - CHAMBRAY

SORT BY: OPERATION DESCRIPTION

(2)

OPERATION #		SAM		OPERATION DESCRIPTION
0000-0024-00-L-OYJ	85-07-29	26.7300		CUTTING [redacted] STRIP - BOYS HEAVY DENIM 60 PR.
0000-ES03-00-L-OMC	85-08-03	21.3060		CUTTING [redacted] STRIP JACKET
0000-ES03-00-L-OWC	85-08-01	21.3060		CUTTING [redacted] STRIP JACKET
0000-ES03-00-L-OYC	85-08-06	21.3060		CUTTING [redacted] STRIP JACKET
0000-0026-00-L-OYJ	85-07-29	30.4920		CUTTING [redacted] STRIP - BOYS DIRECTIONAL - 60 PR.
0000-0025-00-L-OYJ	85-07-29	21.7800		CUTTING [redacted] STRIP - BOYS NON-DIR - 72 PR.
0000-0019-00-L-OWP	85-06-17	43.3860		CUTTING MEN'S [redacted] WORK PANT, 84 PR
0000-0004-00-L-OMJ	85-06-24	30.5700		CUTTING MENS DIRECTIONAL, 72 PR WOVEN
0000-0015-00-L-OMC	85-08-05	45.9060		CUTTING MENS [redacted] JACKET - DIRECTIONAL WESTERN
0000-0002-00-L-OWP	85-06-20	20.6040		CUTTING MENS NON-DIR, 72 PAIR, WOVEN
0000-0002-00-L-OMJ	85-06-24	20.6040		CUTTING MENS NON-DIRECTIONAL, 72 PR, WOVEN
0000-0002-00-L-OWJ	85-07-03	20.6040		CUTTING MENS NON-DIRECTIONAL, 72 PR, WOVEN
0000-0002-00-L-OYJ	85-07-29	20.6040		CUTTING MENS NON-DIRECTIONAL, 72 PR, WOVEN
0000-0018-00-L-OMC	85-07-30	19.7760		CUTTING MENS [redacted] DENIM JACK-ESTIMATED
0000-0018-00-L-OWC	85-07-30	19.7760		CUTTING MENS [redacted] DENIM JACK-ESTIMATED
0000-0018-00-L-OYC	85-07-30	19.7760		CUTTING MENS [redacted] DENIM JACK-ESTIMATED
0000-0001-00-L-OMJ	85-06-21	29.1420		CUTTING MENS WOVEN - NON-DIR, 60 PAIR
0000-0001-00-L-OWJ	85-07-03	29.1420		CUTTING MENS WOVEN - NON-DIR, 60 PAIR
0000-0001-00-L-OYJ	85-07-29	29.1420		CUTTING MENS WOVEN - NON-DIR, 60 PAIR
0000-0001-00-D-MRS	85-09-09	0.0000		CUTTING SHIRTS
0000-0001-00-F-MRS	85-09-10	0.0000		CUTTING SHIRTS
0000-0001-00-H-MSS	85-09-10	0.0000		CUTTING SHIRTS
0000-0001-00-J-MRS	85-09-04	0.0000		CUTTING SHIRTS
0000-0001-00-K-MRS	85-09-09	0.0000		CUTTING SHIRTS
0000-0012-00-L-OYJ	85-06-28	26.1300		CUTTING YOUTHS DIRECTIONAL, 72 PAIR, WOVEN
0000-0001-00-R-MRS	85-10-15	49.2000		CUTTING, HANDSTAMP, SEPARATE, STAMP SIZE LABEL
0000-0007-00-L-OYJ	85-06-28	25.6260		CUTTING-BOYS DIRECTIONS, 60 PR, WOVEN
0000-0005-00-L-OYJ	85-06-28	13.0140		CUTTING-BOYS NON-DIR, 72 PAIR, WOVEN
0000-0001-00-R-WRS	85-10-15	34.2000	MARKEM	CUTTING-SHADEMARK, SEPARATE, STAMP SIZE ON COLLAR
0000-0009-00-L-OYJ	85-06-24	23.2140		CUTTING-YOUTHS HEAVY DENIM, 60 PAIR
0000-0008-00-L-OYJ	85-06-27	15.9420		CUTTING-YOUTHS NON-DIR., 72 PAIR, WOVEN
0403-0501-00-C-OWP	85-09-18	21.3600		DART AND FINISH HIP POCKET (TAB)
0502-0201-00-G-OCP	85-09-27	23.9000	269W108	DART BACKS
0502-0501-00-L-OWP	85-06-17	31.7580	LOCK ST	DART BACKS - 3 IN DART - AUTO MACHINE
0502-0101-00-L-OWJ	85-07-08	47.0460	LOCK ST	DART BACKS - 6 IN. DART - STAY DART - SGL NDL
0502-0101-00-L-AWJ	85-07-09	46.7580	LOCK ST	DART BACKS - 6 IN. DART - STAY DART - SGL NDL
0502-5001-00-L-OMC	85-08-07	53.4660	LOCK ST	DART BACKS 1 PC BACK JACKET
2060-0201-00-W-OMC	86-01-21	0.0000	PFAFF483	DART FRONT LINING
0502-0502-00-A-OWP	85-09-19	25.6000		DART SEW
0301-0101-00-E-OWP	85-09-23	19.7000	39-500	DE FLY FRONT
0406-0101-00-L-OMJ	85-06-25	18.8400	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-OWJ	85-07-03	18.8400	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-OWP	85-06-21	18.8400	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-OYJ	85-06-24	18.8400	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-AMJ	85-06-25	18.4260	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-AWJ	85-07-03	18.4260	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
0406-0101-00-L-AYJ	85-06-27	18.4260	LOCK ST	DECORATIVE STITCH SPADE HIP POCKETS
2008-0204-00-W-OMC	86-01-22	49.0000	HOFFMAN	DIE CUT FRONTS AND BOTTOMS
2008-0204-0A-W-OMC	86-01-23	27.0000	HOFFMAN	DIE CUT FRONTS AND BOTTOMS
0103-0202-00-L-OWP	85-06-17	0.0600	LOCK ST	DOUBLEFACE FRONT POCKETS
1807-0101-00-L-OMJ	85-06-24	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-OWJ	85-07-03	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-OYJ	85-07-02	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-AMJ	85-06-25	16.7220		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-AYJ	85-07-01	16.7220		DOUBLEFOLD GARMENT AND BAG
2100-0102-00-W-OMC	86-01-21	36.0000	US51300-Z	DRAW BACK ARMHOLE
2060-0203-00-W-OMC	86-01-21	4.0000	EAGLECOMPO	EAGLE LINING FACING
2060-0203-0A-W-OMC	86-01-23	21.0000	EAGLECOMPO	EAGLE LINING FACING
0114-0104-00-B-OMC	85-09-20	22.1000	LH515	EDGESTITCH AND PLEAT BREAST POCKET
0117-0104-00-B-OMC	85-09-20	58.9000	251-11	EDGESTITCH AND PLEAT LOWER POCKET
1901-0207-00-R-WRS	85-10-16	12.0000	251-2	EDGESTITCH COLLAR
1903-0205-00-W-OMC	86-01-23	22.0000	PFAFF[illegible]	EDGESTITCH COLL[illegible]
[illegible]	[illegible]	[illegible]	LOCK ST	EDGESTITCH FRONT - REDUCED RPM
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX VI

1807-0101-00-L-OMJ	85-06-24	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-OWJ	85-07-03	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-OYJ	85-07-02	16.9380		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-AMJ	85-06-25	16.7220		DOUBLEFOLD GARMENT AND BAG
1807-0101-00-L-AYJ	85-07-01	16.7220		DOUBLEFOLD GARMENT AND BAG
2100-0102-00-W-OMC	86-01-21	36.0000	US51300-Z	DRAW BACK ARMHOLE
2060-0203-00-W-OMC	86-01-21	4.0000	EAGLECOMPO	EAGLE LINING FACING
2060-0203-0A-W-OMC	86-01-23	21.0000	EAGLECOMPO	EAGLE LINING FACING
0114-0104-00-B-OMC	85-09-20	22.1000	LH515	EDGESTITCH AND PLEAT BREAST POCKET
0117-0104-00-B-OMC	85-09-20	58.9000	251-11	EDGESTITCH AND PLEAT LOWER POCKET
1901-0207-00-R-WRS	85-10-16	12.0000	251-2	EDGESTITCH COLLAR
1903-0205-00-W-OMC	86-01-23	32.0000	PFAFF483	EDGESTITCH COLLAR
0311-1102-00-L-OMC	85-08-07	47.0340	LOCK ST	EDGESTITCH FRONT - REDUCED RPM
0311-1101-00-L-OMC	85-08-06	42.6360	LOCK ST	EDGESTITCH FRONTS
0311-1101-00-L-OWC	85-07-31	42.6360	LOCK ST	EDGESTITCH FRONTS
0311-1101-00-L-OYC	85-08-07	42.6360	LOCK ST	EDGESTITCH FRONTS
0311-6001-00-L-OMC	85-08-03	47.7720	LOCK ST	EDGESTITCH FRONTS (EXTRA POINTING OUT)
0311-6001-00-L-OWC	85-08-01	47.7720	LOCK ST	EDGESTITCH FRONTS (EXTRA POINTING OUT)
0311-6001-00-L-OYC	85-08-06	47.7720	LOCK ST	EDGESTITCH FRONTS (EXTRA POINTING OUT)
0311-6001-00-L-AMC	85-08-06	47.9520	LOCK ST	EDGESTITCH FRONTS (EXTRA POINTING OUT)
0311-6001-00-L-AYC	85-08-06	47.9520	LOCK ST	EDGESTITCH FRONTS (EXTRA POINTING OUT)
0201-0601-00-P-OMJ	85-09-19	20.9000	61900	EDGESTITCH LEFT FLY
1803-0503-00-T-MRS	85-10-22	20.0000		EXAMINE
1803-0903-00-R-WRS	85-10-15	52.2000		EXAMINE & BRICK
1803-0903-00-W-MRS	86-01-14	13.8000	HAND	EXAMINE AND BRICK
1803-0903-0A-W-MRS	86-01-15	3.0000	HAND	EXAMINE AND BRICK
1803-0903-0A-W-MSS	86-01-15	3.0000	HAND	EXAMINE AND BRICK
1803-0503-00-D-MRS	85-09-20	0.5466	FORMASTER	EXAMINE FOLDED SHIRT
1803-0503-0A-D-MRS	85-09-20	0.5016	FORMASTER	EXAMINE FOLDED SHIRT
0114-0101-00-B-OMC	85-09-20	16.4000	REECE 101	EYELET BREAST POCKET
0117-0101-00-B-OMC	85-09-20	31.2000	REECE 101	EYELET LOWER POCKET
0106-0102-00-G-OCP	85-09-27	36.4000	281-3	FACE AND CLOSE FRONT POCKET
0403-0701-00-L-OWP	85-06-17	53.2740	LOCK ST	FACE AND WELT HIP POCKET W/FOLDER
0401-0200-00-G-OCP	85-09-27	24.4000	281-3	FACE BACK POCKET
0402-0701-00-G-OCS	85-09-19	28.5000	6800 2 MD3	FACE BACK POCKETS
0402-0701-00-X-OCP	86-01-08	25.0000	PFAFF 463	FACE BACK POCKETS
0402-0701-00-X-OCS	86-01-07	25.0000	PFAFF 463	FACE BACK POCKETS
1212-0712-00-X-OCP	86-01-08	37.0000	PFAFF463	FACE EXTENSION END
1212-0712-00-X-OCS	86-01-08	37.0000	PFAFF463	FACE EXTENSION END
0103-0202-00-I-OCS	85-09-19	5.3000	241-12	FACE FONT POCKET
0103-0202-00-W-OCP	86-01-24	8.0000	PFAFF463	FACE FONT POCKET
0103-0202-00-X-OCP	86-01-08	8.0000	PFAFF463	FACE FONT POCKET
0103-0202-00-X-OCS	86-01-07	8.0000	PFAFF463	FACE FONT POCKET
0103-0201-00-C-OWP	85-09-18	30.0600		FACE FRONT POCKET
0103-0201-00-C-OYS	85-09-19	30.0600		FACE FRONT POCKET 1/4 TOP SINGLE
0103-0203-00-E-OWP	85-09-23	52.8000	281	FACE FRONT POCKETS
0103-0201-00-G-OCS	85-09-19	11.1000	RIMOLDI680	FACE FRONT POCKETS
0301-0113-00-Y-WSS	86-06-16	39.3000	SNGER251-6	FACE FRONT POCKETS
0402-0701-00-C-OWP	85-09-18	19.6800		FACE HIP POCKET
0403-0701-[illegible]	[illegible]	[illegible]		FACE HIP POCKET

0402-0701-00-I-OCS	85-09-19	24.4000	241-12	HIP POCKET
2060-0101-00-W-OMC	86-01-21	48.0000	SNGR281-1	FACE LINING POCKET
2060-0101-0A-W-OMC	86-01-23	37.0000	SNGR281-14	FACE LINING POCKET
2040-0201-00-W-OMC	86-01-21	28.0000	PFAFF 463	FACE LOWER POCKET AND MAKE CASH POCKET
2001-0304-00-U-MRS	86-01-30	32.2998	SINGR281	FACE SLEEVE
0413-0904-00-I-OCS	85-09-19	23.1000	61900	FAKE STITCH HIP POCKET
0402-0202-00-P-OMJ	85-09-18	38.4000	61900	FALSE STITCH BACK POCKET
1803-3006-00-V-CBD	86-02-04	0.0000		FANFOLD LENGTHWISE AND STAMP
1803-3004-00-V-CBD	86-02-04	0.0000		FANFOLD REMAINING DRAPE CROSSWISE
1803-3002-00-V-CBD	86-02-04	0.0000		FANFOLD TOP OF DRAPE CROSSWISE
0503-0401-00-L-OMC	85-08-05	3.4380	CHAIN ST	FELL BACK GORES - CURVED GORES
0503-0301-00-L-OMC	85-07-30	57.6720	CHAIN ST	FELL BACK GORES - STRAIGHT GORES
0503-0301-00-L-OWC	85-07-31	57.6720	CHAIN ST	FELL BACK GORES - STRAIGHT GORES
0503-0301-00-L-OYC	85-07-30	57.6720	CHAIN ST	FELL BACK GORES - STRAIGHT GORES
0503-0301-00-L-AWC	85-07-31	0.5700	CHAIN ST	FELL BACK GORES - STRAIGHT GORES
0503-0601-00-L-OMC	85-08-03	35.1720	CHAIN ST	FELL BACK GORES AND BACK YOKE
0503-0601-00-L-OWC	85-07-31	35.1720	CHAIN ST	FELL BACK GORES AND BACK YOKE
0503-0601-00-L-OYC	85-08-06	35.1720	CHAIN ST	FELL BACK GORES AND BACK YOKE
0503-0601-00-L-AMC	85-08-06	35.4180	CHAIN ST	FELL BACK GORES AND BACK YOKE
0503-0601-00-L-AYC	85-08-06	35.4180	CHAIN ST	FELL BACK GORES AND BACK YOKE
0503-0602-00-L-OMC	85-08-07	40.9980	CHAIN ST	FELL BACK GORES AND YOKE - REDUCED RPM
0503-0201-00-M-OYS	85-09-23	40.0000	56-500	FELL BACK YOKE
0503-0201-00-O-OWJ	85-09-19	36.0000	56500	FELL BACK YOKE
0503-0302-00-L-OMC	85-07-30	19.3140	CHAIN ST	FELL BACK YOKE AND JOIN SHOULDERS
0503-0302-00-L-OWC	85-07-31	19.3140	CHAIN ST	FELL BACK YOKE AND JOIN SHOULDERS
0503-0302-00-L-OYC	85-07-30	19.3140	CHAIN ST	FELL BACK YOKE AND JOIN SHOULDERS
0503-0302-00-L-AMC	85-08-05	20.9220	CHAIN ST	FELL BACK YOKE AND JOIN SHOULDERS
0503-5001-00-L-OMC	85-08-07	34.2600	CHAIN ST	FELL BACK YOKE TO BACK
1001-0102-00-Y-WSS	86-05-28	45.3000		FELL BACKS
0503-0403-00-L-OMC	85-08-06	34.4880	CHAIN ST	FELL BACKS - 2 PC. BACK
1503-0101-00-W-OCP	86-01-08	0.0000	DEARBORN	FELL BOTTOMS
2008-0213-00-W-OMC	86-01-22	53.0000	LEWI630-23	FELL BOTTOMS
2008-0213-0A-W-OMC	86-01-23	58.0000	LEWI630-23	FELL BOTTOMS
0309-0701-00-L-OMC	85-07-30	55.6320	CHAIN ST	FELL FRONT YOKES - FF - JKTS
0309-0701-00-L-OWC	85-07-31	55.6320	CHAIN ST	FELL FRONT YOKES - FF - JKTS
0309-0701-00-L-OYC	85-07-30	55.6320	CHAIN ST	FELL FRONT YOKES - FF - JKTS
0309-0701-00-L-AMC	85-08-05	51.0180	CHAIN ST	FELL FRONT YOKES - FF - JKTS
0309-1101-00-L-OMC	85-08-03	49.4100	CHAIN ST	FELL FRONT YOKES-FF-DIFF SIZE YOKES-JKT
0309-1101-00-L-OWC	85-07-31	49.4100	CHAIN ST	FELL FRONT YOKES-FF-DIFF SIZE YOKES-JKT
0309-1101-00-L-OYC	85-08-06	49.4100	CHAIN ST	FELL FRONT YOKES-FF-DIFF SIZE YOKES-JKT
0309-1101-00-L-AMC	85-08-06	49.6440	CHAIN ST	FELL FRONT YOKES-FF-DIFF SIZE YOKES-JKT
0309-1101-00-L-AYC	85-08-06	49.6440	CHAIN ST	FELL FRONT YOKES-FF-DIFF SIZE YOKES-JKT
0901-0301-00-E-OCO	85-09-19	3.9000	231-7	FELL INSEAM - 2 NEEDLE
2001-0305-00-W-OMC	86-01-22	20.0000	LEWIS30210	FELL LINING
2001-0305-0A-W-OMC	86-01-24	10.0000	LEWIS30210	FELL LINING
2007-0403-00-W-OMC	86-01-21	32.0000	LEWS240-16	FELL LINING TO CUFF
1001-0106-00-A-OWP	85-09-19	38.1000		FELL SEAT SEAM
2009-0206-00-T-MRS	85-10-22	4.5000	CONVNL EQP	FELL SIDES
0801-0101-00-Y-WSS	86-05-28	22.0000		FELL SIDESEAMS
2001-0301-00-B-OMC	85-09-20	5.7000	ST6-8926-5	FELL SLEEVE
2007-0502-00-L-OMC	85-08-03	34.8660	CHST	FELL SLEEVE OUTSEAM - HANDLE ASSEMBLED JACKET
2007-0502-00-L-OWC	85-08-01	34.8660	CHST	FELL SLEEVE OUTSEAM - HANDLE ASSEMBLED JACKET
2007-0502-00-L-OYC	85-08-07	34.8660	CHST	FELL SLEEVE OUTSEAM - HANDLE ASSEMBLED JACKET
2007-0502-00-L-AMC	85-08-06	35.0760	CHST	FELL SLEEVE OUTSEAM - HANDLE ASSEMBLED JACKET
2007-0502-00-L-AYC	85-08-06	35.0760	CHST	FELL SLEEVE OUTSEAM - HANDLE ASSEMBLED JACKET
2007-0501-00-L-OMC	85-08-03	28.6380	CHAIN ST	FELL STRIP TO FRONT SLEEVES
2007-0501-00-L-OWC	85-08-01	28.6380	CHAIN ST	FELL STRIP TO FRONT SLEEVES
2007-0501-00-L-OYC	85-08-07	28.6380	CHAIN ST	FELL STRIP TO FRONT SLEEVES
2007-0501-00-L-AMC	85-08-06	28.8060	CHAIN ST	FELL STRIP TO FRONT SLEEVES
2007-0501-00-L-AYC	85-08-06	28.8060	CHAIN ST	FELL STRIP TO FRONT SLEEVES
2001-0307-00-W-OMC	86-01-22	1.0000	STROK13254	FELL TOP OF ARMHOLE
1903-0204-00-W-OMC	86-01-22	10.0000	AMF 84-5	FELL UNDERCOLLAR
[illegible]3-0[illegible]0-W	86[illegible]	[illegible].000		FI[illegible] EXAM
1803-0302-00-A-OWP	85-08-29	0.0000		FINAL INSPECT

STYLES IN EACH OPERATION
SAM = SAM FOR THAT OPERATION

OPERATION: 0000-0001-00-D-MRS DESCRIPTION: CUTTING

STYLE NUMBER	SAM	STYLE DESCRIPTION
AC1-2000	0.00000	MENS
AC2-2000	0.00000	MENS

DATE 06/17/87
OPERATION: 0000-0001-00-H-MSS DESCRIPTION: CUTTING

STYLE NUMBER	SAM	STYLE DESCRIPTION
KSE-4000	0.00000	MEN
KSE-4001	0.00000	MEN

DATE 06/17/87
OPERATION: 0000-0001-00-L-OMJ DESCRIPTION: CUTTING

STYLE NUMBER	SAM /100	STYLE DESCRIPTION
200-0041	89.14200	MENS [redacted] - ZIPPER FLY
200-0141	89.14200	MENS [redacted] SLIM - ZIPPER FLY
200-0241	89.14200	MENS JEAN - BUTTON FLY
200-0341	89.14200	MENS BOOT CUT RIDER
200-20XX	89.14200	STRAIGHT LEG RIDER - TWILL
200-7041	89.14200	MENS BOOT CUT RIDER - WASHED
200-7241	89.14200	MENS [redacted] - WASHED
200-7341	89.14200	MENS SLIM [redacted] - WASHED
201-0541	89.14200	LP BOOT CUT [redacted]
201-0941	89.14200	MENS BOOT CUT FLARE
202-0341	89.14200	WIDE [redacted] FLARE
202-0441	89.14200	WIDE [redacted] FLARE
202-0449	89.14200	WIDE [redacted] FLARE
309-0241	89.14200	[redacted] MENS CUT JEAN [redacted]
309-1109	89.14200	[redacted] FLARE [redacted]
400-0041	89.14200	[redacted] JEAN
400-0341	89.14200	[redacted] STRAIGHT LEG - WASHED
411-0241	89.14200	[redacted] FLARE
411-1044	89.14200	WIDE STRIDER - CHAMBRAY
411-2041	89.14200	[redacted] FLARE - WASHED
411-3141	89.14200	[redacted] SUPER BELL

DATE 06/17/87
OPERATION: 0000-0001-00-D-MRS DESCRIPTION: CUTTING

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
AC1-2000	0.00000	MENS'S REGULAR DRESS SHIRT
AC2-2000	0.00000	MENS'S REGULAR DRESS SHIRT

DATE: 06/17/87
OPERATION: 0000-0001-00-H-MSS DESCRIPTION: CUTTING

STYLE NUMBER	SAM /100	STYLE DESCRIPTION
KSE-4000	0.00000	MEN'S SPORT SHIRT
KSE-4001	0.00000	MEN'S SPORT SHIRT

DATE 06/17/87
OPERATION: 0000-0001-00-L-OMJ DESCRIPTION: CUTTING

STYLE NUMBER	SAM /100	STYLE DESCRIPTION
200-0041	89.14200	MENS [redacted] - ZIPPER FLY
200-0141	89.14200	MENS [redacted] SLIM - ZIPPER FLY
200-0241	89.14200	MENS JEAN - BUTTON FLY
200-0341	89.14200	MENS BOOT CUT [redacted]
200-20XX	89.14200	STRAIGHT LEG [redacted] - TWILL
200-7041	89.14200	MENS BOOT CUT [redacted] - WASHED
200-7241	89.14200	MENS [redacted] - WASHED
200-7341	89.14200	MENS SLIM [redacted] - WASHED
201-0541	89.14200	[redacted] BOOT CUT [redacted]
201-0941	89.14200	MENS BOOT CUT FLARE
202-0341	89.14200	WIDE [redacted] FLARE
202-0441	89.14200	WIDE [redacted] FLARE/WASHED [redacted]
202-0449	89.14200	WIDE [redacted] FLARE
309-0241	89.14200	[redacted] MENS CUT JEAN LOT [redacted]
309-1109	89.14200	[redacted] FLARE LOT [redacted]
400-0041	89.14200	[redacted] JEAN
400-0341	89.14200	[redacted] STRAIGHT LEG - WASHED
411-0241	89.14200	[redacted] FLARE
411-1044	89.14200	WIDE [redacted] - CHAMBRAY
411-2041	89.14200	[redacted] FLARE - WASHED
411-3141	89.14200	[redacted] SUPER BELL
411-3941	89.14200	WIDE [redacted] - WASHED DENIM
411-4041	89.14200	CANADIAN BIG BELL 14 OZ DENIM
411-4049	89.14200	WIDE [redacted] WASHED [redacted]
411-4941	89.14200	[redacted] [redacted] JEAN CANADA DENIM
411-4949	89.14200	[redacted] [redacted] JEAN WASHED DENIM
411-5841	89.14200	[redacted] SUPER BELL - WASHED
413-5049	89.14200	MENS [redacted] - WASHED [redacted]

APPENDIX XVII

DATE 06/17/87
OPERATION 0000-0001-00-L-OWJ DESCRIPTION: CUTTING

STYLE NUMBER SAM /100 STYLE DESCRIPTION

DATE: 06/17/87
OPERATION: 0000-0003-00-L-OWJ DESCRIPTION: CUTTING MENS DIREC

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
260-25XX	103.66200	LADIES WESTERN [redacted] JEAN CORD
300-19XX	103.66200	[redacted] JEAN LADIES

DATE: 06/17/87
OPERATION: 0000-0004-00-L-OWJ DESCRIPTION: CUTTING MENS/DIREC

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
200-10XX	90.57000	[redacted] BOOT CUT [redacted] mens
200-21XX	90.57000	[redacted] BOOT CUT FLARE
201-23XX	90.57000	BOOT CUT [redacted]

DATE: 06/17/87
OPERATION: 0000-0005-00-L-OYJ DESCRIPTION: CUTTING BOYSNONDIR

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
205-10XX	73.01400	BOYS BOOT CUT [redacted]
205-12XX	73.01400	BOYS [redacted] BOOT CUT [redacted]
242-0029	73.01400	BOYS BOOT CUT [redacted]
242-0109	73.01400	BOYS BOOT CUT [redacted]
242-0249	73.01400	BOYS BOOT CUT [redacted]
242-0441	73.01400	BOYS [redacted] BOOT CUT [redacted]
242-0829	73.01400	BOYS BOOT CUT [redacted]-SUITING
242-0940	73.01400	BOYS BOOT CUT [redacted]-SUITING
242-1010	73.01400	BOYS BOOT CUT [redacted]-SUITING [redacted]
242-1620	73.01400	BOYS BOOT CUT [redacted]-SUITING [redacted]
242-21XX	73.01400	BOYS BOOT CUT PUERTO RICO SUIT
242-7341	73.01400	BOYS BOOT CUT [redacted] WASHED
242-97XX	73.01400	BOYS BOOT CUT PUERTO RICO
420-0841	73.01400	BOYS 4-PKT BELL-BUTTON FLY
420-1241	73.01400	BOYS 4-PKT BELL-WASHED [redacted]
420-26XX	73.01400	BOYS [redacted] FLARE - SUITING

DATE: 06/17/87
OPERATION: 0000-0006-00-L-OYJ DESCRIPTION: CUTTING BOYS DENIM

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
205-0341	78.21600	BOYS BOOT CUT [redacted] BOYCONST
240-0041	78.21600	BOYS [redacted]
240-7041	78.21600	BOYS [redacted] WASHED [redacted]
242-0541	78.21600	BOYS BOOT CUT [redacted]
242-5041	*78.21600*	*BOYS HUSKY BOOT CUT* [redacted]
420-0041	78.21600	BOYS [redacted] STRAIGHT LEG [redacted]WAS
420-02XX	78.21600	BOYS [redacted] FLARE
420-0341	78.21600	BOYS [redacted] STRAIG LEG WASH MENS
420-2041	78.21600	BOYS [redacted] FLARE WASH MENSCONST
420-4041	78.21600	WIDE [redacted] BOYS 14OZ DEN MEN
420-4049	78.21600	WIDE [redacted]BOYS WASH[redacted]MEN

DATE: 06/17/87
OPERATION: 0000-0007-00-L-OYJ DESCRIPTION: CUTTING BOYS DIREC

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
203-14XX	85.62600	BOOT CUT [redacted] (BOYS CONST.)
205-14XX	85.62600	BOYS CORDUROY BOOT CUT[redacted]
242-0629	85.62600	BOYS BOOT CUT [redacted]-NAPSUITING
242-15XX	85.62600	BOYS BOOT CUT FLARE -CORDUROY
420-16XX	85.62600	BOYS [redacted] STRAIGHT LEG CORDURO
420-25XX	85.62600	BOYS[redacted]FLARE-CORD-MENSCONST
420-35XX	85.62600	BOYS WIDE [redacted] CANADA CORD

DATE: 06/17/87
OPERATION: 0000-0008-00-L-OYJ DESCRIPTION: CUTTING YOUTHS

STYLE NUMBER	SAM/100	STYLE DESCRIPTION
203-10XX	75.94200	YOUTHS BOOT CUT [redacted]
203-12XX	75.94200	YOUTHS BOOT CUT [redacted]
243-0029	75.94200	YOUTHS BOOT CUT [redacted]
243-0109	75.94200	YOUTHS BOOT CUT [redacted]
243-0249	75.94200	YOUTHS BOOT CUT [redacted]
243-0441	75.94200	YOUTHS [redacted] BOOTCUT [redacted]
243-0549	75.94200	YOUTHS BOOT CUT [redacted]-SUITING
243-0829	75.94200	YOUTHS BOOT CUT [redacted]-SUITING
243-0940	75.94200	YOUTHS BOOT CUT [redacted]-SUITING
243-1010	75.94200	YOUTHS BOOT CUT [redacted]-SUIT- [redacted]
243-1620	75.94200	YOUTH BOOTCUT [redacted]SUITING [redacted]
243-21XX	75.94200	YOUTH BOOTCUT PUERTO RICO SUIT
243-97XX	75.94200	YOUTH BOOTCUT [redacted]UERTO RICO
423-0841	75.94200	STUDENT 4-PKT BELL-BUTTON FLY

SAM = SAM PER 100

4

% CONTRIBUTION OF AN OPERATION TO A STYLE BASED ON: $\frac{SAM\ OP}{SAM\ TL} \times 100$

DATE: 07/09/87 SAM: 96.4000
OPERATION: 0106-0102-00-Q-OCP DESCRIPTION: FACE/CLOSEFRT POCKET

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
T-7200	2550.70000	53	3.779	[redacted] DRESS PANT
T-7201	2511.21000	54	3.839	[redacted] DRESS PANT
T-7202UPS	2400.30000	55	4.016	[redacted] DRESS PANT

DATE: 07/09/87 SAM: 136.2000
OPERATION: 0106-0102-00-W-OWP DESCRIPTION: SET BEARER& FACING

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
W7548	5488.20000	49	2.482	TROUSER WOODLAND CAMOUFLAGE
W7548R1	5283.00000	49	2.578	TROUSER WOODLAND CAMOUFLAGE

DATE: 07/09/87 SAM: 11.3000
OPERATION: 0106-0103-00-Q-OCP DESCRIPTION: TURN FRONTPOCKET

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
T-7200	2550.70000	53	0.443	[redacted] DRESS PANT
T-7201	2511.21000	54	0.450	[redacted] DRESS PANT
T-7202UPS	2400.30000	55	0.471	[redacted] DRESS PANT

DATE: 07/09/87 SAM: 20.7000
OPERATION: 0106-0201-00-G-OCS DESCRIPTION: CLOSE FRT POCKET

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
WJ-7200	2163.40000	48	0.957	TROUSERS

DATE: 07/09/87 SAM: 29.9040
OPERATION: 0106-0202-00-L-OWP DESCRIPTION: CLOSE FRT POCKETS

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
110-50XX	2193.04800	50	1.364	[redacted] PANTS
110-56XX	2115.95400	48	1.413	[redacted] WORK PANTS
118-2041	2095.95000	49	1.427	LAUNDRY PANT--[redacted]
118-37XX	2092.75800	49	1.429	BEDFORD CORD PANT - COMMERCIAL
118-70XX	2152.43400	50	1.389	WORK PANT
118-95XX	2144.02800	50	1.395	[redacted] UNIFORM PANT

DATE: 07/09/87 SAM: 22.9000
OPERATION: 0106-0203-00-P-OMJ DESCRIPTION: CLOSE FRT PKT FACING

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
BS-7500	1074.20000	37	2.132	BASIC 5-PKT WESTERN JEAN

DATE: 07/09/87 SAM: 33.4020
OPERATION: 0106-55XX-00-L-OMJ DESCRIPTION: CLOSE SCP FRT PKTS

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
410-55XX	1961.07000	46	1.703	KNIT JEAN OPEN CONSTRUCTION

APPENDIX XVIII

DATE: 07/09/87 SAM: 62.4000
OPERATION: 0107-0502-00-W-OWP DESCRIPTION: BUTTONHOLEFA FLAP2PC

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
W7548	5488.20000	49	1.137	TROUSER WOODLAND CAMOUFLAGE
W7548R1	5283.00000	49	1.181	TROUSER WOODLAND CAMOUFLAGE

DATE: 07/09/87 SAM: 54.0000
OPERATION: 0107-0503-00-W-OWP DESCRIPTION: JOIN EH TAB/FLAP

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION

411-4041	1614.33600	42	3.207	CANADIAN BIG BELL 14 OZ DENIM
411-4049	1631.04000	42	3.174	WIDE [redacted] WASHED 411-4041
411-4941	1547.18400	40	3.346	[redacted] JEAN CANADA DENIM
411-4949	1749.78600	43	2.959	[redacted] JEAN WASHED DENIM
411-5841	1644.57000	42	3.148	[redacted] SUPER BELL - WASHED
413-5049	1656.29800	44	3.126	MENS [redacted] - WASHED [redacted]
418-3941	1694.23200	41	3.056	[redacted] STRIP JEAN-WASHED 14OZDEN
418-6041	1654.22400	41	3.130	[redacted] STRIP JEAN-REVERSE14OZDEN
418-6541	1684.63800	41	3.073	[redacted] STRIP JEAN-WASHED REV DEN
418-7441	1654.22400	41	3.130	[redacted] STRIP JEAN - 14 OZ DENIM

DATE: 07/09/87 SAM: 51.7740
OPERATION: 0108-0101-00 L-OWJ DESCRIPTION: SET SCOOP FRT PKT

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
260-2541	1631.17200	42	3.174	LADIES WESTERN STRETCH DENIM
261-0541	1668.61800	43	3.103	LADIES WESTERN SCOOP PKT JEAN
300-1141	1425.04800	37	3.633	[redacted] SCOOP POCKET JEAN LADIES
310-19XX	1662.73800	40	3.114	[redacted] JEAN LADIES

DATE: 07/09/87 SAM: 51.4260
OPERATION: 0108-0101-00-L-OWP DESCRIPTION: SET SCOOP FRT PKT

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
118-9603	1611.11400	44	3.192	PHILLIPS [redacted] FLARE

DATE: 07/09/87 SAM: 51.7740
OPERATION: 0108-0101-00-L-OYJ DESCRIPTION: SET SCOOP FRT PKT

STYLE NUMBER	SAM TOTAL	OPS	% OF STYLE	STYLE DESCRIPTION
203-0341	1403.54200	42	3.637	YOUTHS BOOT CUT [redacted] BOYCONST
205-0341	1418.54400	42	3.650	BOYS BOOT CUT [redacted] BOYCONST
240-0041	1335.67800	40	3.876	BOYS [redacted]
240-7041	1498.24800	43	3.456	BOYS [redacted] WASHED [redacted]
241-0041	1302.58800	40	3.975	YOUTHS [redacted]
241-7041	1503.24600	43	3.444	YOUTH [redacted] WASHED [redacted]
242-0541	1547.05200	44	3.347	BOYS BOOT CUT [redacted]
242-0629	1662.71400	49	3.114	BOYS BOOT CUT [redacted]-NAPSUITING
242-0749	1592.78400	49	3.251	BOYS BOOT CUT [redacted] NAPSUITING
242-5041	1395.41000	41	3.708	BOYS HUSKY BOOT CUT [redacted]
242-7341	1519.11000	43	3.408	BOYS BOOT CUT [redacted] WASHED
243-0541	1737.24600	47	2.980	YOUTH BOOT CUT [redacted] FLARE [redacted]
243-0629	1622.34400	47	3.190	YOUTH BOOT CUT [redacted]-NAP SUIT
243-0749	1622.84400	47	3.190	YOUTH BOOT CUT [redacted]-NAP SUIT
243-5041	1401.40800	41	3.694	YOUTH HUSKY BOOT CUT [redacted]
243-7341	1503.24600	43	3.444	YOUTHS BOOT CUT [redacted] WASHED
244-0041	1234.27200	40	4.195	HUSKY [redacted]
420-0041	1576.09200	42	3.285	BOYS [redacted] STRAIGHT LEG [redacted] WAS
420-02XX	1420.77600	39	3.644	BOYS [redacted] FLARE
420-0341	1607.70000	42	3.220	BOYS [redacted] STRAIG LEG WASH MENS
420-2041	1592.38800	42	3.251	BOYS [redacted] FLARE WASH MENSCONST
420-4041	1429.04400	40	3.623	WIDE [redacted] BOYS 14OZ DEN MEN
420-4049	1602.69600	43	3.230	WIDE [redacted] BOYS WASH [redacted] MEN
421-6041	1611.82800	41	3.212	BOYS [redacted] STRIP JEAN REVERSE DEN
421-8041	1632.52800	42	3.171	BOYS [redacted] STRIP JEAN-BRUSHED DEN
421-8049	1662.94200	42	3.113	BOYS [redacted] STRIP JEAN-WASHBRSHDEN
423-0041	1584.87000	42	3.267	STUDENT [redacted] STRAITLEG [redacted] WAS
423-02XX	1420.01400	39	3.646	STUDENTS [redacted] FLARE
423-0341	1616.47800	42	3.203	YOUTH [redacted] STRAIT LEG WASH MEN
423-2041	1570.79200	42	3.255	STUDENT [redacted] FLRE WASMENSCONST
423-4041	1440.69600	40	3.594	WIDE [redacted] STUDENT 14OZDENMEN
423-4049	1611.47400	43	3.213	WIDE [redacted] STUDENT WASH [redacted]
424-6041	1631.17200	41	3.174	STUDENTS [redacted] STRIP REVERSE DEN
319-12XX	1619.70000	43	3.197	[redacted] YOUTHS STRAIGHT LEG

DATE: 07/09/87 SAM: 51.4260
OPERATION: 0108-0101-00-L-AMJ DESCRIPTION: SET SCOOP FRT PKT

END
DATED
FILM
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