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DSCP sends out diskettes of Micromark pattern files to its Micromark-compatible contractors. These files as received by CAR require substantial preparation before the files are ready for production markermaking. This preparation translates to additional production time and cost, which can translate to higher manufacturing costs per item of clothing and longer lead times for new items.

The purpose of this report is to document the preparation activities, time, and cost to CAR before markers can be produced. This information will contribute to DSCP's ability to evaluate its pattern delivery procedures and to assess the potential system-wide costs of delivering patterns in this format to other Micromark-compatible contractors.

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For
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At
Clemson Apparel Research

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I. Background

As a part of the Defense Logistics Agency's Apparel Research Network, Clemson Apparel Research (CAR) maintains a fully functioning manufacturing plant in which primarily shirts, military and commercial, are produced. This manufacturing facility, with its compliment of modern equipment consigned by numerous vendors, acts as a laboratory for the demonstration and testing of contemporary sewn-products manufacturing and management practices. Two projects undertaken by CAR as a contractor for the military have been "quick response" and "special measurement" manufacturing of various military clothing items. Both of these projects require that the time between receipt and shipping of an order be considerably shorter than has previously been customary in the sewn products industry.

Before any sewn product can be produced, it is necessary to cut out of cloth the "puzzle pieces" which, when assembled, become the finished product. The "puzzle piece" shapes are called patterns and may be created manually or on a computer-aided design (CAD) system. Patterns are "graded" (exploded or imploded) to accommodate all sizes needed. Grading is accomplished by moving the key points on the perimeter of each pattern by specified amounts in X and Y and then connecting the moved points to create the new (larger or smaller) pattern shape. Prior to cutting, patterns (in specified sizes) for the product to be produced are laid out on a simulation of the cloth to be cut. This simulation may be produced manually on paper or with the aid of a CAD system on a computer and is called a marker. CAR's pre-production CAD facility currently displays, demonstrates, and uses four industry-specific CAD systems for patternmaking and markermaking: Micromark and Accumark (by Gerber Technology), Modaris/Diamino (by Lectra Systemes), and Optitex (by Scanvec). Any of these competitive systems can aid the user in more-easily and more-quickly performing patternmaking and markermaking tasks. Although the latest version of each system may be operated on Microsoft Windows, and although conversion from one system to another is possible, file formats are NOT fully compatible. Until file formats ARE fully compatible, it is much faster to process patterns and markers for production in their native environment.

The Defense Supply Center—Philadelphia (DSCP) procures clothing and other commodities for the military. As a part of this process, DSCP contracts with manufacturers to produce military uniform items. DSCP supplies the patterns for these military uniforms to the contractors. Depending upon the capability of each contractor, DSCP sends either paper patterns or computer pattern files. In 1993 the DSCP computerized its pattern department. Micromark's CAD system was selected. An important issue today is that the industry is in transition between manual patternmaking and automated CAD systems. This leaves DSCP with the problem of determining the best way to deliver pattern files to contractors on a variety of systems. Since Micromark is among the CAD systems at CAR, DSCP's and CAR's

CAD systems are fully compatible. This compatibility makes it possible for DSCP to send Micromark pattern files to CAR on diskette or as an e-mail attachment. At this time DSCP typically sends pattern files on diskette.

II. Problem Statement
DSCP sends out diskettes of Micromark pattern files to its Micromark-compatible contractors. These files as received by CAR require substantial preparation before the files are ready for production markermaking. This preparation translates to additional production time and cost, which can translate to higher manufacturing costs per item of clothing and longer lead times for new items.

III. Purpose
The purpose of this report is to document the preparation activities, time, and cost to CAR before markers can be produced. This information will contribute to DSCP's ability to evaluate its pattern delivery procedures and to assess the potential system-wide costs of delivering patterns in this format to other Micromark-compatible contractors.

IV. Micromark Format
Micromark is a style-oriented CAD system. As such, all patterns for a garment are stored in a style and cannot be individually identified without first being associated with that style. When a marker is requested in Micromark, the user must tell the computer the Style Name from which the pattern pieces should be collected, the Size(s) of the pattern pieces needed, and the type of fabric (Material Group) from which the pattern will be cut. This function assumes that each pattern piece needed resides in the style in such a way that Piece Name, Material Group, and Size alone can identify it. For this reason, there cannot be, for example, two pocket patterns intended for sizes 6 through 12 and 14 through 20, respectively. There needs to be one pocket pattern graded in such a way that it accommodates all sizes.

Within the style there is a page called Style Description where the user defines all of the desired characteristics of individual pattern pieces by name. The parameters to be defined include:

Piece message	Information to be printed on each pattern at the time of plotting in addition to the standard annotation
Unflipped	The quantity needed of this pattern as it appears on the screen
Opposites	The actual quantity needed of a symmetrical copy of the pattern as it appears on the screen (flipped on the x-axis)
Material group	The fabric type (by group name) from which the pattern will be cut

Die allowance	The offset allowed beyond the perimeter of the pattern, thus creating a space between plotted patterns equal to the sum of the die allowances around each
Seam allowance table	The reference table that defines the primary seam allowance applied to the style lines of the pattern

V. CAR Procedures—DSCP Pattern Files

Before CAR can make a production marker, it is necessary to define the appropriate Style Description parameters and to modify the patterns to conform to any special machine setups required by CAR's production facility. Typical pattern modifications are to change the width of a seam allowance on a pocket (for automatic pocket setting) or centerplait (for the folder used to apply the centerplait) or assembly seams (so that the shirt can be assembled on the same production line with commercial shirts). If the pattern pieces have not been set up in such a way that Style Name, Size, and Material Group can uniquely identify them for markermaking, then new grade rules may need to be written and applied.

Piece message	None
Unflipped	The actual quantity needed of this pattern as it appears on the screen
Opposites	The actual quantity needed of a symmetrical copy of the pattern as it appears on the screen (flipped on the x-axis)
Material group	Following a pre-established coding scheme (such as default A for shell, I for interlining, L for lining, P for pocketing), the actual material group in which the pattern will need to be cut
Die allowance	None
Seam allowance table	A seam allowance table whose default (SY) line type seam allowance amount is that specified in the spec for the majority of seams.

The cost of preparing the pattern files for production markermaking depends on several variables. Among these are:

- the number of pattern pieces in the file
- the state of readiness of the patterns
- the expertise/availability of the CAD system operator

The number of pattern pieces in the file varies widely. For the military shirts CAR has prepared for production markermaking, the number of pattern pieces has ranged from 12 to 63 (see Appendix B, Table 2). In CAR's experience, the Style

Description parameters outlined above must always be changed. The format typically provided by DSCP is as follows:

Piece message	"cut two"
Unflipped	1
Opposites	0
Material group	A (on all pieces or multiple group names that are unrelated to fabric type)
Die allowance	.5"
Seam allowance table	None

This format is excellent for plotting/cutting patterns on tagboard when a full set of hard patterns is needed in all sizes. For a manufacturer like CAR, however, with a compatible CAD system and numerically controlled cutters, this format creates extra work.

Pattern files received at CAR from DSCP also often contain multiple, individually sized patterns for the same styling feature, instead of fully-graded patterns. For example, if two pocket sizes satisfy all shirt sizes, then two pocket patterns are contained in the Style File, instead of one pocket with grade rules attached to accomplish the appropriate size for each shirt size. An extreme example of this scenario is the Navy shirt detailed in Appendix B, which contained all five neck sizes and all four sleeve lengths as separate patterns in the same file. The graded sizes provided are by bust size. If a markermaker were to attempt to make a production marker from this file, it would be necessary to select the correct neck size front and the correct sleeve length sleeve from among the many icons displayed for each requested bust size. This is impractical for one-size markers and impossible for multiple-size markers.

In CAR's experience, the cost of preparing the Style Descriptions, patterns, and grade rule tables has ranged from $23.71 to $1,030.44. Although some tasks can be performed by a markermaker alone, many tasks have required the expertise of a patternmaker (see Appendix A for Training/Skills/ Capability comparison). Costs are based on salaries ranging from $10.58 to $28.85 per hour (unburdened), as detailed in Appendix B.

VI. CAR Procedures—Commercial Pattern Files
The majority of CAR's <u>commercial</u> shirt production is for a large career apparel manufacturer that uses the Micromark CAD system. Pattern files are received by CAR from this manufacturer as e-mail attachments, not diskettes. Pattern files are received in a format ready to "plug and play" for production markermaking. Patterns must be modified for CAR's tooling needs, but all other parameters are already prepared for production markermaking (including the definition of seam

allowances and all patterns graded in such a way that they can be uniquely identified by Piece Name, Material Group, and Size). Such markings as buttonhole and pocket placements are provided on a separate template pattern piece in Material Group X (not intended to be cut). The user can copy the locations of the markings to the appropriate Material Group A (shell) pattern using Copy Lines, if desired (for drill holes, for example), or can plot the template on paper for setting up automated equipment (for pocket setting and buttonhole/button sew, for example). With this file format, CAR's markermaker is capable of making all necessary file modifications without assistance.

CAR would like to receive DSCP Micromark files in a similar ready to "plug-and-play" for production markermaking format. Although CAR will continue to have special manufacturing requirements that will necessitate making modifications to ANY basic pattern files, this "generic" format, in which these pattern files could be provided by DSCP to CAR, would decrease the time and effort needed to get production up and running. This format would also simplify making the additional modifications necessary for CAR's manufacturing requirements.

If DSCP is sending out files to multiple contractors working in Micromark, who all incur labor costs for pattern file preparation, then the costs incurred are multiplied by the number of contractors receiving the same pattern files. Although these costs are not incurred to DSCP, they are additional system-wide costs in time and money that could be eliminated.

VII. Conclusion and recommendation
Electronic patternmaking for military patterns is in a state of transition. Although DSCP has CAD capability (Micromark), not all defense apparel manufacturers have CAD capability. Among the defense apparel manufacturers with CAD capability, not all have Micromark software. In addition, although all the services have CAD capability, not all have the Micromark product. Until all apparel CAD software products are totally compatible with all others, there will be issues of conversion among vendors' products. However, for those defense apparel manufacturers who use Micromark software, the receipt of pattern files ready to "plug and play" for markermaking:

- would decrease the time necessary for the manufacturer to get up and running on a contract
- would decrease the costs associated with beginning a contract
- would make the changing of seam allowances due to equipment needs more precise while preserving DSCP's intended garment size and shape (minimal training of the contractor may be needed)
- would speed implementation of DSCP- or service-directed pattern modifications during a contract (by the receipt of a new "plug-and-play" diskette)

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The implementation of this recommendation could be accomplished by the personnel at DSCP, the services, or by an independent patternmaking contractor, depending upon human resources available.

Appendix A

Training/Skills/Capability Comparison

Table 1

Training/Skills/Capability Comparison

Job Descriptor Salary Range	Source of Training	Likely Teacher(s)	Pattern Adjustment Skills	Understanding of Fit (the Relationship of the Pattern to a 3D body)	Computer Skills	Computer Training	PDS/GMS Capability	PDS/GMS Training
Markermaker $22,000-30,000	On the job	Supervisor	Minimal, how to do only what has been demonstrated, otherwise "winging it"	Little or none	Enough to get by, may have some office but job-specific only CAD	Supervisor or self-taught	Enough to get by, has difficulty with documentation	Supervisor or self-taught
Patternmaker $40,000-60,000	College and/or Technical School	Professor Internship Supervisor	Capable of drafting a pattern from body measurements	Excellent, based on patternmaking and draping coursework	Excellent, experienced in using office and CAD software	Formal coursework	Proficiency dependent on experience, but sufficiently knowledgeable to find answers	Vendor training or college/technical school training

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The following description is applicable to the personnel at Clemson Apparel Research and has been found to be applicable to government shirt contractors with whom CAR has worked.

The markermaker has been taught on the job and may have previously made markers manually or may have been a sewing machine operator. This person may have some training in pattern adjustment, such as lengthening a shirt pattern, but has little or no understanding of fit or the relationship between the pattern and a three-dimensional body. Computer skills were most likely self-taught. The markermaker may initially have used the computer to plot markers made by someone else, somewhere else, received by modem for plotting at the sewing plant. Pattern Design System and Grading/Marking System instruction may have been provided by a user of the systems in another division of the same company. The training was not received by attending the vendor's training school. Occasionally a supervisor will have attended vendor training school and then attempted to transfer that training to the subordinate on the job site.

The following description is applicable to the personnel at Clemson Apparel Research and has been found to be applicable to manufacturers of men's and women's tailored clothing with whom CAR has worked.

The patternmaker, who usually also has some experience in markermaking, typically has a college and/or technical school degree and has learned the principles behind the relationship between a two-dimensional, irregularly shaped pattern and the three-dimensional body it is intended to fit. Supportive coursework usually includes pattern drafting (from measurements), flat pattern techniques (from blocks), draping, grading (manual and/or computerized), markermaking, CAD, apparel production, textiles, and word processing/spreadsheet. These courses likely have been supplemented/enhanced by one or more internship experiences in the industry, prior to graduation. This individual has learned how to solve problems and where to go to find answers. Industry experience during full-time employment following graduation provides practical application of principles learned in school.

Appendix B

Cost of Pattern Preparation for Preferred Format

Cost of Pattern Preparation for Preferred Format

The cost of getting DSCP pattern files prepared for Micromark "plug-and-play" markermaking depends on several variables. Among these are:

- **the number of pattern pieces in the file**
- **the state of readiness of the patterns**
- **the expertise/availability of the CAD system operator**

The number of pattern pieces in the file varies widely. Using available files, the following file sizes (based on number of pattern pieces) were calculated:

Table 2
Pattern Count for Military Patterns at CAR

All Military Patterns at CAR

Type	# Pieces Range
Shirts	12-63
Slacks/trousers	14-18
Coats	43-68

All Dress Uniform Shirt Patterns at CAR

Style	M/F	Service	Sleeve	# Pieces
A_A_52112	Men's	Army	Long/Short Sleeve	17
S_17618	Men's	Navy	Short Sleeve	13
A_A_55091	Men's	Navy	Long Sleeve	15
S_87214	Men's	Air Force	Long/Short Sleeve	18
S_3649	Men's	Marine Corps	Long Sleeve	18
S_19984	Men's	Marine Corps	Short Sleeve	13

Style	M/F	Service	Sleeve	# Pieces
A_A_55283	Women's	Army	Short Sleeve	17
A_A_55218	Women's	Navy	Short Sleeve	50
S_87056	Women's	Navy	Long Sleeve	60
A_A_55263	Women's	Air Force	Long/Short Sleeve	17
S_29368	Women's	Marine Corps	Long/Short Sleeve	15

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In tests with a stop watch, it was determined that the time it took to change 6 elements per pattern on the Style Description page was approximately 20-30 seconds per pattern. The elements were:

- **eliminating the piece message**
  (requires extra plotting time, not necessary for computer-generated markers)
- **indicating the correct number of unflippeds and opposites**
  (tells the computer how many of each symmetrical lefts and rights are needed)
- **indicating the correct material group**
  (groups pattern pieces to be cut out of the same cloth)
- **removing the die allowance**
  (allows patterns to be bumped against each other for efficient cloth utilization)
- **adding a seam allowance table name**
  (indicates the seam allowance value of the majority of seams in the style, permits modifications to seam allowance values without altering the intended sew lines)

For the military pattern files on hand at CAR, the time necessary to change the above elements resulted in a range of 4 minutes to 34 minutes, assuming no interruption and no time spent contemplating the correct inputs.

The process of selecting one cut line to adjust its seam allowance value also required approximately 20 seconds per seam. The process of indicating a corner type required 15 seconds (corner types modify seam allowances at corners to provide for such things as accurately mirrored turnbacks of hems and guides for manufacturing to place pieces together properly on princess seams). The indication of a seam allowance table correctly identifies the seam allowance value for the majority of seams. All seam allowances and hem allowances (which, as far as the computer is concerned, are treated as wide seam allowances) whose width varies from the majority seam allowance must be manually changed. On the women's Army short-sleeved shirt, with the seam allowance table for the majority of seams set to 1/4", there was a need to change 7 seam/hem allowances and to make 5 mirrored corners.

This represents 4 additional minutes for this example only (see Table 3).

In some special cases, such as the Navy women's long-sleeved shirts, the preparations are even more complex. For each bust size, this shirt is available in five neck sizes and four long sleeve lengths. The MicroMark file for the shirt contains separate pattern pieces for the Center Front and Back in each neck size and contains separate pattern pieces for each sleeve length. In order to prepare this file for markermaking, in addition to the tasks outlined above, it was necessary to do one of two things:

1) Create separate style files for each possible neck and sleeve length combination (20 files)

2) Create a synonym table and add variations to appropriate rule numbers to tell the computer how to make all possible neck and sleeve length combinations in one file

Option 1 takes less time to accomplish (see Table 4), but Option 2 is preferred because the result is one file in which all sizes reside and the size names match those in the spec (ex., 38B14N30 for a 38 bust with a 14 neck and a 30 sleeve length).

To make all of the above basic modifications plus Option 2 on the Navy A_A_55218 required approximately one week of professional time (see Table 5).

It would only require someone at the services, DSCP, or a pattern contractor to perform these functions ONCE to provide a file ready for markermaking, in addition to the primary file which is ready to cut tagboard. If a ready-to-cut-tagboard file is sent to multiple MicroMark compatible manufacturers, the time and costs for these modifications are multiplied by the number of manufacturers who have to perform these same functions. And that is the best case scenario.

Based on the above activities, given all the variables to be considered, the cost for preparing a Style File for making a marker ranges from **$15 to over $1000**. The range represents the shortest time for the least expensive personnel and the longest time for the most expensive personnel.

Often a manufacturer has the personnel to make markers, given prepared pattern files, but the markermaking person knows NOTHING about patternmaking and therefore would not have the understanding necessary to prepare the files.

Table 5
Navy Women's S_87056 Shirt Pattern Preparations
60 pattern pieces

Option 2:   Create One Master File with Synonyms for Size Names to Match Spec

Operation	Markermaker	Cost Range @ $10.58-14.42 per hour	Patternmaker	Cost Range @ $19.23-28.85 per hour
Set up/preparation/ evaluation	Load diskettes Consult spec for material group	30 minutes $5.29-7.21	Load diskettes Consult spec for material group, seam allowance values (includes details in manufacturing requirements table)	60 minutes $19.23-28.85
Prepare file for extraneous pattern piece elimination			Chart grade rule locations, create clean rule table, determine differences between neck sizes, create synonym table for sleeve lengths and neck sizes	16 hours $307.68-461.60
Create new Style File with 21 pattern pieces			Copy file to new name, delete 39 unneeded patterns	30 minutes $9.62-14.43
Change piece message, unflipped/opposite, material group, die allowance	Select items and change/delete listing 21 pattern pieces @ 20 seconds each	7 minutes $1.24-1.69	Select items and change/delete listing pattern pieces @ 20 seconds each	7 minutes $2.25-3.37
Determine primary seam allowance and indicate table name in Style Description			Add seam allowance table name	Negligible
Manually change non-conforming seam allowances and add corner types			8 seam/hem allowances @ 20 seconds prepare seam for corner, 2 @ 1 minute 4 corners @ 15 seconds	6 minutes $1.92-2.89

Table 5
(continued)
Navy Women's S_87056 Shirt Pattern Preparations
60 pattern pieces

Option 2: Create One Master File with Synonyms for Size Names to Match Spec

Operation	Markermaker	Cost Range @ $10.58-14.42 per hour	Patternmaker	Cost Range @ $19.23-28.85 per hour
Add new grade rule table with synonyms			Indicate table name, revise rule numbers on pattern pieces, grade to check movements, revise rules as necessary	up to 8 hours $153.84-230.80
Check new grade rules			Plot old and new patterns to assure correct sizes, revise rules as necessary	up to 8 hours $153.84-230.80
Clarify pocket placement			Create pocket template for pocket placement, add synonym for non-conforming pocket movement	2 hours $38.46-57.70
Total Cost		$6.53-8.90		$686.84-1,030.44