Addressing Design Problems of the Textile Industry through
Computer Aided Design

by

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ACKNOWLEDGEMENTS

1. Introduction

In the textile industry, the problem often arises of presenting, on very short notice, the new designs for the upcoming season. The fabric market shows a high demand for new designs under the variable fashion trend at each preseason. Because of this, textile manufacturers must show their samples as soon as possible so as not to lose the market.

The manual procedure is tedious and time consuming. Having gathered all the information and taking into account the tides of the fashion in the relevant centers, the designer must prepare a set of designs in the hope that they will show the desired effects. The specification for each design goes then to the factory, where a loom has to be set up with the yarn configuration, a few feet of cloth must be woven and then everything must be discharged for other trials. Obviously, the number of possible trials is limited, both by time and cost, and therefore the designer cannot try out many proofs and must get the right design at the first try.

This design process can be computerized. If this is done, a very fast generation of samples can be achieved, together with flexibility in their variation. Changes are straightforward and imply no substantial increases in time. The cost is also reduced because the maintenence of the loom plus the specialized labor must be compared against the computer maintenence.

2. The Textile Design Process

2.1 Asthetic design

Textile products depend for their success in the market place on the right combination of asthetic and engineering quality with cost. Meeting this need is the responsibility of the textile design engineer. Asthetic design starts with a creative idea, and then goes through a period of detailed development of the total design using a medium acceptable to the designer. There follows conversion to the explicit features of textile material, and so to the instructions for machine control and the production of samples. It is here that the computer can play a liberating role.

Computer facilities offer a number of freedoms to the textile designer. (See Figure 2.1)

1. There is freedom from chores. Operations such as putting a pattern into repeat, completing the multiple sectors of a symmetrical pattern, and carrying out the detail of conversion to machine instructions become automatic.

2. There is freedom from visualization. The computer can easily and rapidly display the design in a variety of scales and colors, and could also display it in an environment such as the drape of a skirt.

3. There is freedom of additional sources, since it becomes easy to introduce different inputs: geometrical shape, letter and number typefaces, and so on can be available in the computer store; random number generators can

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THE SEVEN FREEDOMS OF CAD

FREEDOM FROM VISUALIZATION

FREEDOM OF EASE & SPEED IN SAMPLING

FREEDOM FROM CHORES

FREEDOM OF NEW DESIGN POSSIBILITIES

FREEDOM OF GEOGRAPHY

FREEDOM OF ADDITIONAL SOURCES

FREEDOM OF INFORMATION FLOW
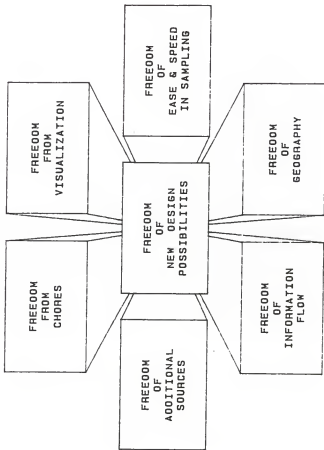
Figure 2.1 The 7 freedoms of CAD

provide irregular regions; scanners can incorporate photographic material; and so on.

4. There is freedom of new design possibilities. There is no real limit to the size of a design, with computer control of machines. A floral design, with an underlying regularity of form, could be modified by a random number generator so that no two elements were identical, just as no two flowers are identical. Creative designers will find other new possibilities.

5. There is freedom of ease and speed in sampling. The links from the design computer to the the sample machine enable production to be rapid. Cost and time can be saved in the dialogue between designer and customer.

6. There is freedom of information flow to and from the rest of the organization. Technical and market information can be fed into the design office, and the information needed for the purchase of materials, for machine control, and production planning fed out.

7. There is freedom of geography. The design studio can be located where it is best situated – in a stimulating design environment close to the market – and the information needed for production can be sent by radio satellite to a manufacturing operation on the other side of the world.

Finally one can summarise the freedoms in the statement that

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computer design is a dynamic operation. In traditional designing once a line has been put on paper it cannot be moved or easily removed. But the essence of the computer is to move and manipulate information in its store, and the changes are reflected in the image on the screen.

2.2 Engineering Design

Traditionally textile materials have been designed by trial and error. Long experience enables a textile designer to make a good guess at a likely specification, then make a sample and test it. If it fails, it is not a disaster (unlike building bridges or aeroplanes) and the construction can be revised and tried again. Consequently there is no background of calculation or draughtsmanship in the industry, except at a trivial level of costing; and there are no engineering design offices ready for CAD.

But the situation is changing for several reasons. Firstly, the range of choices has increased enormously. A fabric manufacturer estimates that, with the range of available fibres and range of new fabric constructions, he has to choose from a million possibilities. Optimization is only possible with computational assistance. Secondly, there are now a large number of demanding industrial uses and civil engineering end uses for textiles where a large and effective product has to function effectively, possibly for many years, so that design calculations and an evaluation of

performance are essential. Thirdly, there are social fac-
tors, such as mobility in employment, education, and compu-
ting in the home, that both make the old ways more difficult
and the new ways expected.

3. The integrating role of a computer system

The major advantage of the adoption of a computer system is the way in which it can liberate the flow of information in a circuit around a company.

3.1 The industrial and commercial network

The creative concepts in the design studio may be justifiably be regarded as the start of the process, although the designers will need to be fed through the network with information on the market, on raw material prices, on availability of stocks and machinery, and other factors which influence a successful commercial design choice. As the design develops, iterative calculation will generate more specific feedback on cost and performance; iterative sample production will show the reality of the material.

Of course, the design department does not operate in isolation, and there will be contacts with marketing and other members of the managerial team, and with customers, before the decisions are taken to manufacture. A computer system can contribute particularly to this interaction by providing information both as a starting package for discussion and interactively during meetings.

With the final design selected and details held in the computer, the necessarry information can flow around the company. Hardly seen by human operatives will be items such as: machine control instructions; purchase orders;

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production planning; and the handling of repeat orders. Other parts will feed into the system through the provosion of samples and specifications to the sales office, cash flow information to the finance director, and so on. On a longer time scale, there will be links to Research & Development on the needs for better computer packages, and on the opportunities generated by technical innovation.

3.2 The links to machinery

The potential for linking the design information in a computer to control information for machines is clear. An important area is sample production, which is an essential part of the design process but is also part of the selling process, with samples being made for distribution to customers. This indicates the need for computer-controlled sample machines as part of a CAD system, with the high probability that the requirements will be of the same order (less demanding in speed, more demanding in versitality) as the machine control for production machines.

An example of this type of machine currently available is the Millitron carpet printing machine, which may be used for production or sampling. This machine is computer controlled with an instantaneous change-over from one design to an other during full speed production with no reduction in the rate of production and only a six inch gap between carpets of different designs.

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3.3 The Links to Fashion Design

Except perhaps for decorative hangings, the textile fabric is not an end in itself. It is a raw material for the fashion designer to cut and sew into garment or the interior decorator to fit into a room.

Already there are systems which can take a carpet design and impose this, with the appropriate perspective transformation, on a video picture of a furnished room. As a somewhat more difficult problem, it would be possible to take a video-picture of a standard print cloth, printed with a standard grid, and make up into curtains or a dress, and then, by digital manipulation, replace the grid by information from a print design.

At a more advanced level it is possible to simulate the actual folds and drapes of a woven or knitted fabric of a new design. Another possibility through the use of CAD-CAM is in making the design fit the cutting pattern of the final garment. For example, a panelled skirt could have a complete, enclosed and bordered figure in each panel - with automatic adjustment of the pattern to fit different sizes. At the top end of the market, this sort of technique would be liberating to the fashion designer; at the lower end it could lead to economy in cutting and the saving of costs.

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4. CAD Applications in the Apparel Industry

Figure 4.0 shows a general breakdown of the processes involved in apparel manufacturing; the CAD functions conduct the study and creation of "style/design images," and create patterns during the "pattern making" "grading" and "marking" processes.

Design image creation (Sketching):

Through CAD systems, style, coloring and inspections can be easily and efficiently performed on color displays with capabilities up to 16.8 million colors. The processes of determination of basic style and basic design, and the creation of the design image, permit the maximum expression of the the designer's imagination and sensibilities and allows for limitless expansion of creativity and makes possible the timely creation of the design image.

The design procedure begins by digitizing a mannequin, which may or may not be used as a point of reference. Once the image of the mannequin appears on the computer screen, the stylist or designer can design the actual garment over the mannequin. Through a camera, the designer can shoot the image of a piece of fabric, which can be stored into files and called up when needed. With a mouse or pencil fabric designs, textures, patterns - anything that a designer would do on paper, could be drawn. Fabrics, seam lines, and notions can be superimposed on the image to create a complete look (see Figure 4.01a). After having made a 3-D

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APPAREL MANUFACTURING PROCESSES

Clothing Design/Trial Manufacturing Processes

- Product Design
- Create Designer Sketch
- Create First Pattern
- Create Sample Garment
- Get Approval
- Sample Pattern
- Sample
- Industrial Pattern

Sewing Preparatory Processes

- Grading
- Marking
- Stretch & Inspection
- Cutting

Final Processes

- Handling
- Sewing
- Finishing
- Inspection
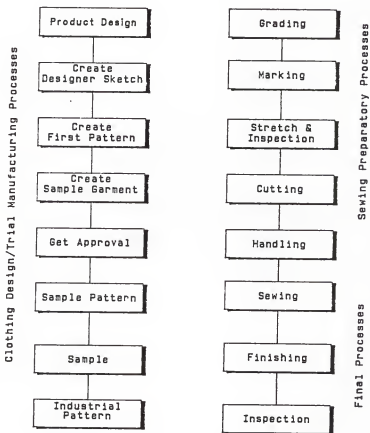
Figure 4.0 Apparel Manufacturing Processes

(a) Sketching

(b) Pattern Design
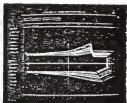
(c) Grading

(d) Marking

Figure 4.01 CAD Applications in Apparel Manufacture

illustration of a garment the way the designer visualized it, the next step involves the conversion of that illustration into a series of 2-D pieces to outline the actual manufacturing process.

Pattern Making:

Once a style has been approved the next step is the making of patterns. A pattern is defined in the apparel industry as an outline of a garment on paper. It embodies usually all the pieces necessarry to cut a complete garment from material (see Figure 4.01b). With a CAD system the designer can point at different parts on a 3-D illustration and the computer automatically flattens them out to a pattern piece on the screen.

Grading:

Grading is defined as the drafting process of diminishing or enlarging a style pattern into patterns for other sizes. Its function is to give proper fit without changing the style sense of the original (see Figure 4.01c). The procedure involves interpreting the design; determining the grading measurements, anthropometric data, and the sizing designations of the particular manufacturer.

A computer aided system, using the manufacturer's grading rules can conduct size deployments from the master pattern quickly, easily and accurately. In addition the computer

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stores the grading pattern as data, so storage is easy and grading information and technology can be accumulated. Each graded part also can be plotted and cut out.

Marker-Making:

Marking is the transfer of patterns to a piece of fabric or paper. This is the development of the jig-saw like diagram (see Figure 4.01d) as a guide for cutting the piles of fabric into the required component parts. Various methods are used in the marking operations depending upon the grade of garment produced.

Computer aided systems conduct marking operations effeciently with as little loss of cloth as possible, conserves cloth and directs cutting, all based on cloth width, size combination, direction of weave and other conditions of the graded pattern. Marking is conducted through the input of mark requests for information about cloth width/efficiency, defective finished products (%), direction of weave, striped/checked and other conditions of appearence and variety of sizes. In addition, since marking of the parts is conducted on the color display with an interactive system, mistakes are reduced, fatigue is lessened and operability is increased. The results of marking can also be plotted out at any time as miniature markers or as actual-size marker sheet.

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Cutting:

The major categories of cutting production processing are spreading, "chopping", position marking, shading, sloping, and bundling. They usually follow each other in this sequence. Spreading is the process of superposing piles of materials on a table in a manner which permits these piles to be cut simultaneously into product components acceptable for further processing. Chopping is the process which actually cuts raw material into product components. Position marking is the process of placing guide marks on the surface and/or perimeter of cut components. These guide marks are followed by the assembly operators in order to make precise alignment in assemblies. Shading is the process process of marking cut components for shade matching, precision, and sequence identification with respect to cut components sequence in the spread. Sloping is the process of respreading a stack of cut components for pattern chopping. Bundling is sorting and stacking (with or without ties) cut components for further processing.

4.1 Benefits of Apparel CAD systems:

1. Material Utilization:

There are several systems on the market that allow an experienced operator to take a standard pattern piece, generate other pieces from it on a graded basis and then pack all of the necessary pieces on a piece of fabric so as to give maximun fabric utilization. Maximizing fabric

utilization is probably one of the greatest driving forces for this technology. It is estimated that, for plain fabric, fabric wastage can be reduced to about 3 percent compared with 5-6 percent when human beings do the same job unaided. On the other hand if instead of plain fabrics, one uses patterned fabrics, then fabric wastage can be as high as 25 percent, and there is clearly room for improvement here. The increased speed of computer aided marking and grading systems allows the marker maker to test several different layouts. This process lets the operator select the most efficient marker, resulting in better material utilization. When a marker produced on a marking and grading system is fed to a computer controlled cutting system, material utilization can increase further. Buffer zones, for example, are eliminated, die cut and seam allowances are substantially reduced. These factors can increase fabric usage efficiencies by additional percentage points. Computer-aided systems also help handle marker imperfections better. The system allows the spreader, using a hand held device, to enter a description of the flaw into the computer. The computer calculates the position of the flaw in the marker, then tells the spreader how to remove the imperfection from critical areas with the least fabric waste. If the flaw falls within the noncritical area of the marker, the spreader will be instructed to leave the imperfection in place.

2. Worker Productivity and Operations Productivity:

Users of computer-aided systems generally find that skilled designers can increase their output fivefold. New styles can be processed many times faster through automation systems, resulting in improved turnaround time. In addition, the designer no longer has to rely upon subjective judgement to determine costing since utilization information is automatically provided. This eliminates the bottleneck in the earlier costing systems, which involved putting the pattern pieces in pattern bags and sending them to the costing department where they have to manually measure out each of the pieces and start from there to calculate. By flattening the design on the screen, the designer has the area measurements of each of the pieces and knows where the cuts will be made and approximately what material usage will be.

Figure 4.1 shows a comparision chart of the savings in time brought about by the usage of CAD systems. It compares the total time involved in the actual design process for conventional vs CAD systems. What takes about 4 days in the conventional method is reduced to less than 2 hours when designing using a CAD system. For a large company with marketing offices in major cities getting approval for a particular design could take weeks. Cad systems provide the advantage of instant communication between design and marketing centers. Using a modem, a design center located in California could show a buyer located in New York 15

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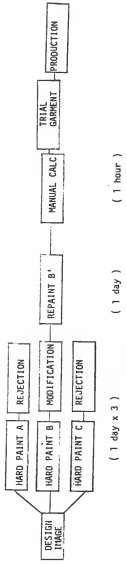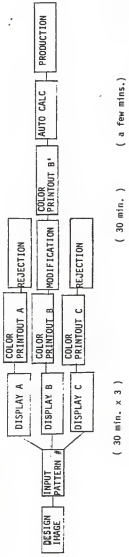
Figure 4.1 Comparison Chart

different fabrics on 15 different sketches. It affords the opportunity to merchandise products instantly - without incurring the cost of making samples. From the merchandising viewpoint, the buyer can readily select garment types to reflect a specific design theme. This results in a faster sale and a more satisfied buyer.

Automated pattern design systems can also significantly improve pattern development. A pattern maker can quadruple his or her output of new styles and considerably reduce pattern turnaround time. Stored patterns can be readily recalled and reused without losing shape or becoming distorted. This also reduces storage requirements within the factory.

3. Quality Control:

Many manufacturers have found that CAD systems help control and improve garment quality. Computer-based marking and grading controls fabric constraints. Equipment of this type also ensures consistent grading which guarantees accurate fit of the garments. Grading libraries, which are sets of grade rules entered into the computer, permit the application of different specifications to patterns. In addition to imposing tighter controls on the production process, CAD systems help reduce human error.

4.2 CAD and "Quick Response" in the Apparel Industry

Faced with a rising tide of textile imports, the U.S Textile industry is relying on what is known in the textile circles as "Quick Response". Quick Response is quick, and accurate response to customer demands. It requires a managerial process and an organization of production characterised by:

- understanding of customer demands
- command of appropriate resources
- tuning these resources to the demand

Many U.S manufacturers have placed a great deal of emphasis on Quick Response and have been successful in reducing sewing cycle time. They have streamlined designing, marking and cutting operations as well as reduced planning time. At the Bobbin Show 1987 (an international exposition of textile machinery for the sewing products industry, held at Atlanta, September 15-18) Milliken Industries, a leading textile products manufacturer, announced that it is possible for the apparel industry to reduce its response time from the traditional 14 week period to as little as 3 weeks (see Figure 4.2, using Quick Response.

Milliken proposed a three phase implementation program of Quick Response wherein the total time in weeks could be reduced from 6.6 weeks to 4 weeks and finally to 3 weeks. It also noted that the largest time savings occurred in the "Dye and Finish Fabric" and the "Cut & Sew" operations, two areas where Computer Aided Design plays an increasing role.

In the traditional response time of 14 weeks these two operations account for 9 weeks or 64 percent of total time. In phase three of Quick Response, which the industry is expected to achieve in the coming years, these two operations are expected to take a week each, contributing roughly 78 percent to the total savings in time from 14 weeks to 3 weeks. Although other factors such as increased automation (robotics, flexible manufacturing systems, etc.), growth in information systems technology, and strategic management contribute to make Quick Response successful, Computer Aided Design is cited to be the driving force behind it.

CAD &
QUICK RESPONSE
IN THE
APPAREL INDUSTRY

	TRADITIONAL	QUICK RESPONSE	
	I	II	III
FABRIC ORDER PROCESSING	1.0	0.5	-	-
DYE & FINISH FABRIC	4.0	2.0	2.0	1.0
SHIP FABRIC	0.5	0.5	0.2	0.2
RECEIVE FABRIC	0.5	0.1	0.1	0.1
QUALITY CHECK	1.0	-	-	-
GARMENT ORDER PROCESSING	1.0	0.5	0.1	0.1
CUT & SEW	5.0	2.0	1.0	1.0
SHIPPING	0.5	0.5	0.5	0.5
RECEIVING GARMENTS	0.5	0.5	0.1	0.1
TOTAL TIME IN WEEKS	14.0	6.6	4.0	3.0

Figure 4.2 CAD and Quick Response

5. CAD Applications in the Carpet Industry:

Figure 5.0 gives the general breakdown of the process involved in the manufacture of tufted carpets. CAD systems play a vital role in product design. It is now possible to move from the product design to the industrial pattern stage without having to go through the intermediate stages as shown in the figure.

Product design deals with identifying factors that determine what type of carpet is designed and for what specific applications. High traffic areas generally require higher density and are mostly of the loop pile construction. Carpets for living rooms and bed rooms that impart a luxurious outlook generally have the cut pile construction. Tufting can be described as a wide, multiple machine needle process that sews pile yarns into a broad backing fabric of woven propylene, spun bonded polypropylene or jute. Yarn is fed to each individual needle via tubes from the creel - a spool rack on which yarn cones are held. A tuft may be either loop or cut pile and sometimes combinations of both are applied for design effect. Figures 5.01a and 5.01b show the sequence of loop pile and cut pile tufting methods. Note that the essential difference in the cut pile machine is the cutting knife which cuts the loop to give the cut pile construction. Other important factors which can effect the design and texture of the carpet are (1) gauge (2) pile height and (3) stitch length.

CARPET MANUFACTURING PROCESSES

```
Product Design              Soft Carpet
                            Inspection

Set up                      Backing/
Yarn Creel                  Latexing

Tuft                        Shearing/
Sample Carpet               Finishing

Get Approval                Final
                            Inspection

Industrial                  Cut
Pattern                     to Order

Tufting                     Packaging
Process
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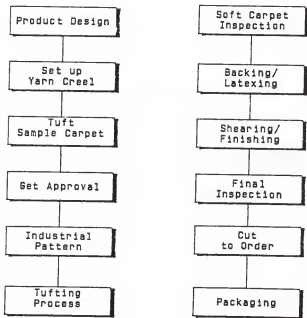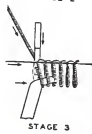
Figure 5.0 Carpet Manufacturing Processes
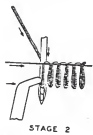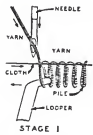
Figure 5.01 a Loop Pile Tufting process
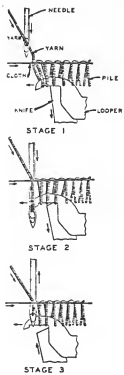
Figure 5.01 b: Cut pile Tufting process

The gauge of a tufting machine is the distance between adjacent needles, in inches, on the needle bar. This distance determines the distance between rows of stitches in the tufted fabric. Machines come in standard gauges of 5/64, 1/10, 1/8, 5/32, and 3/16. Note that as the gauge size increases, the distance between adjacent needles increases and therefore higher density yarns are used for the higher gauge machines. The gauge will also determine the number of needles across the width of the 5 yard wide standard tufted carpet. As a direct consequence the creel of a larger gauge machine is smaller as fewer needle ends are fed. Finer gauge machines such as 1/10 or 5/64 therefore have larger creels.

Pile height and stitch length produce variations in quality, weight and appearence of the tufted carpet. Pile height is determined by (1) the distance between the point at which the backing cloth passes beneath the tufting needles and the position of the loopers below the fabric and (2) the amount of yarn fed to the needle. Stitch length is controlled by the speed at which the backing fabric is fed through the tufting machine. If the backing cloth is fed at a faster rate the distance between two consequtive stitches or tufts is higher and the resulting density of the carpet is lower. The reverse is the case when the backing cloth is fed at a slower rate.

A bulk of the tufting production process is employed for producing plain/solid color carpets. The reason being that

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each individual needle on the tufting machine is fed from an individual yarn cone and that each stitch is along a straight row. The usual practice is to tuft undyed yarn and then dye it to specific colors, or to tuft pre dyed yarn of the same color. Design effect if any was created by threading up the creel in a combination of colored yarn sequences and the resulting carpet would have a stripe effect.

Design effects were further enhanced by the introduction of scroll machines which by means of an electro-mechanical device increased or decreased the amount of yarn being fed to the machine and thus varied the pile height of the carpet. This imparted a "sculptured effect" to the resulting carpet.

With the introduction of the sliding needle bar on the tufting machine it was possible for individual needles/yarn to switch rows and thereby create design effects. The restrictions of being able to obtain only small geometric configurations was overcome by introducing the concept of twin needle bars moving in opposite directions (i.e, the Graphics machine). Newer machines combine the capabilities of scroll and graphics machines to produce a whole gamut of design effects.

Other methods of producing design carpets from tufted carpet involve printing and dyeing techniques. Some of these are (1) Heat transfer printing (2) Flat/Rotary screen printing,

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and (3) Computer injection dyeing method. Of these the computer injection dyeing technique is considerd to be a major breakthrough in the succesful application of color and designs to carpets. The machine can best be described as a computer controlled micro-jet, color injection dyeing technique with total flexibility of reproducing any color or any printed pattern appearence, beginning with solid color applications and concluding with the most complicated Oriental designs imaginable. Equally important is that the machine does this without the aid of screens or pattern rollers, and it can change from the solid color to a pattern, or change to patterns, in literally a two to five minute time span. Basic equipment consists of a computer and a complex series of micro-jets which force the dye into the pile surface of the carpet. The process operations are as follows.

The design to be duplicated is carefully photographed and this is then placed into a computerized, high resolution scanner which is capable of taking millions of readings per square inch. The digitized image is then viewed on a color video monitor. At this point the designer can check his work on the screen and make modifications if necessary. Once the design is approved the computer converts the image to magnetic tape which can communicate the designs to the machine.

5.1 Benefits of CAD systems for Carpets

The role of CAD becomes increasingly important with these innovations in the tufting industry. Currently available CAD systems in the market are capable of simulating how the different tufting machines work and thereby produce the resulting designs that could be obtained. The most significant effect of CAD systems is that it gives a designer a more direct relationship with the manufacturing process. The designer now can think in "real" terms. For example, a pixel on the CRT can equal one firing impulse on a jet-printer and thus equal one dot on the carpets surface. CAD helps eliminate processes, involving setting up of the creel and machine, that are required in confirming an industrial pattern. It has been estimated that upfront design time has been slashed by as much as 70 percent in the carpet and rug industry. Samples of new designs previously actually had to be tufted, backed and finished before they could be shown to potential dealers. This is a comparatively slow and costly process. Presently a high-speed color ink-jet plotter reproduces hard copy samples in minutes at only a fraction of the old cost. Cad systems give the carpet manufacturer an opportunity to go to the field with a photo or plot, and pre-sell a number of products prior to manufacturing. The system thereby helps control inventory and reduce material waste.

CAD systems also have the capability for automatic calculation of yarn requirements for a new carpet design.

Avoiding overestimates reduces inventory costs; sidestepping underestimates eliminates production delays. The imaging capabilities of CAD systems could also be used for other applications, such as research to detect wear and tear on carpets and their quality control.

6. Survey of Textile -CAD Systems

Product features of a dozen companies were surveyed for the purposes of comparision. Figure 6.0 lists the functions offered by the industry suppliers.

The following is a breakdown of the different functions available in the market:

1. Garment product design
2. Patternmaking
3. Production Cutting
4. Fabric design
5. Costing
6. Silkscreen designing
7. Cut order planning
8. Advertising art and set-up
9. Retail display design
10. Embroidery design
11. Sample fabric cutting
12. Costing markers

CAD FUNCTIONS
OFFERED BY INDUSTRY
SUPPLIERS

	APPAREL VISION	COMPUTER DESIGN SYSTEMS INC.	EASTMAN MACHINERY	GERBER GARMENT TECH.	INVESTRONICA	LECTRA SYSTEMS INC.	MICRODYNAMICS INC.	SCIENTIFIC APPAREL	SHIMA SEIKI
ADVERTISING ART	*						*		
RETAIL MERCHANDISING	*						*		
FABRIC DESIGNING	*				*		*		*
SILKSCREEN DESIGNING	*			*	*		*		*
EMBROIDERY DESIGNING	*			*	*		*		*
GARMENT DESIGNING	*		*	*	*		*		*
PATTERNMAKING	*		*	*	*	*	*	*	
COSTING MARKERS			*	*	*	*		*	
PATTERN CUTTING		*	*	*	*	*		*	
COSTING		*	*	*	*	*		*	
SAMPLE FABRIC CUTTING			*	*		*			
GRADING		*	*	*	*	*	*		
PRODUCTION MARKING		*	*	*	*	*	*		
PRODUCTION CUTTING			*	*	*	*	*		
CUT ORDER PLANNING				*	*	*	*		

Figure 6.1 CAD Functions offered by Industry Suppliers

6.1 CAD Systems Purchasing Considerations

There are a number of CAD systems available in the market today. Depending on a company's direction and budget, one can purchase a CAD "turn-key" system such as:

(1) "Dedicated" systems – generally the least expensive type CAD system, designed for only one major task; and depending on the hardware quality and software flexibility, it might perform that task very well. An example would be a system for designing "graphics" for tufting with a sliding needle bar. This system allows color flexibility, as well as gauge and stitch inputs through a simple menu driven program.

(2) "Multi-Functional" systems – with greatly expanded memory capability and speed, you can have 16.7 million colors to select from and can represent up to 256 on the screen at one time. Also, each pixel represents something, i.e.,a needle or valve on one axis and stitch or firing impulse on the other. Grid size and design functions such as zoom, mirror, rotate, expand, trim, place, overlay, etc., are available with such programs. One computer function can function as a starting "concept point" for several machine applications.

(3) "Custom Multi-Functional Systems" – Corporations with inhouse electronic engineers and software programmers have the advantage of being able to link, or interface, the computer design system with their manufacturing equipment.

The manner of inputting design data can be by a variety of means for example: (1) a light pen, (2) digitizer pad and puck (3) a mouse, (4) optical scanner, or (5) a photo digitizer in black and white or color. The best method of data input is still a debatable issue and is basically a question of speed and accuracy.

Computer memory, resolution, and speed are important factors to consider in a system. Hard disk storage is becoming very affordable and screen resolution of upto 1024 pixels is available with even higher resolution coming on higher priced systems.

Some of the design systems offer 16.8 million colors in the design library. If you are considering such a system for exact color matching, you might consider current arguements on the accuracy of color that have divided color experts into two opinions - (1) inks do not reproduce dye effects and (2) visual effects on CRT screens are not correctly reproduced to color standards established on textured fabrics.

Output from the computer (hardcopy) is available in a wide variety of choices such as: (1) dot matrix (2) thermal printers (3) pen plotters (4) ink jet printers (5) laser printers, and (6) electrostatic printers. The electrostatic printer can print on film and paper in widths of up to a full 42 inches of any length and in 256 colors. In addition to standard colors, it can also print 256 customer defined

colors in a resolution of 40,000 points per square inch.

Based on the above discussion the following criteria for standards is being recommended, for purchasing considerations:

(1) Meeting a design need.

(2) Compatibility with:

- existing departmental equipment

- existing processing equipment

(3) Long-range compatibility / impact on long range planning

(4) Product support:

- maintenence

- trouble analysis

- consulting

(5) Training availability, both internal and external

(6) Vendor considerations:

- pricing

- support

- reputation and future potential

(7) Ease of use, installation, reliability and performance.

7. Analysis of CARPET-CAD

CARPET-CAD is a versatile computer aided design system designed by Vertical Technologies Corporation . It provides the carpet designer or colorist, with a simple-to-use, expandable design system to fully explore the potential of every piece of production equipment at his disposal. Utilizing the latest microprocessor technology available, CARPET-CAD gives the designer the tools he needs to let his creativity flow, without having to depend on time consuming and expensive sample production for every design he creates.

7.1 Introduction

CARPET-CAD is a simple system. In most instances the computer can be directed using a mouse or four-button tracer to point at the function desired. There is very little interaction with the keyboard. The system contains four main menus:

1. Coloring
2. Patterns
3. Simulations
4. Utilities

Each main menu contains the functions needed to work in that area. Each function also has a help screen. The real advantage of the system lies in the ability to view color

and pattern over texture. Texture being defined as the appearence, composition or character of the carpet surface. Using video equipment, pictures of the carpet textures that the designer wishes to use in his design can be captured. These textures can then be stored in the computer's memory, and can be retrieved, colored and patterned to create new styles. The results of this new design can be seen in a few minutes. This capability takes the guesswork out of design, and puts the designer in total control. Video capabilities also gives the designer an important advantage in the marketplace. The system can be used to create a video tape presentation of company products for potential buyers. A client can view the tape and make preliminary choices of styles, color combinations and patterns, saving time and money for both the client and the company.

CARPET-CAD is a flexible and powerful tool that lets you get the most out of your time, and out of your production equipment. With the CARPET-CAD system, results can be achieved immediately. The system can be modified to keep pace with the carpet industry.

7.11 System Description and Terminology

CARPET-CAD's power as a design tool comes from the disk drive unit. Its 40 megabyte hard disk is divided into two logical drives: C and D. Logical drive C is 32 megabytes and contains Carpet-CAD and the various patters, textures,

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etc.; Drive D contains the MS-DOS operating system and other
utilities. The 1.2 megabyte floppy disk drive is used to
copy design files from the hard disk.

CARPET-CAD's design system is divided into three areas
of concentration: the monitor and keyboard, the color
graphic monitor and digitizer pad, and the video
camera/video screen unit.

Monitor and Keyboard:

This is where housekeeping functions are performed. When the
system is turned on, you move into the design functions of
CARPET-CAD. The system uses a 13 inch monochrome monitor
and AT style keyboard. A mouse is attached to the
monitor and keyboard. This is the designers tool for moving
around CARPET-CAD screens. The mouse has two buttons that
can be used to make decisions in the system. Generally,
one of the four main menus of the system are accessed by
moving the mouse until the cursor is in the required area
and pressing both buttons. The left button is used to
perform a command. The right button will access the help
screen for a command, and in some cases, will act like a
negative response. In general, the left button is positive,
the right button is negative.

Color Graphic Monitor and Digitizer Pad:

This is where patterns are designed. The system uses a
Mitshubshi 19 inch high resolution analog RGB color monitor

with a color capability of 256 colors. The color monitor shows what is being designed. The digitizer pad is the design surface. Attached to this unit is a four-button tracer that permits drawing, erasing, placing elements on the screen and choosing pattern design functions.

Video Camera and Screen Unit:

The video capabilities of CARPET-CAD distinguish it from all other design systems. This provides the capability to capture actual carpet textures on camera, store them in the computer, and call them up to design patterns and colorations to create styles. The simulation mode of CARPET-CAD permits combining of textures to create new styles. Level loop and cut pile textures can be mixed together for a variety of exciting new designs. The system utilizes a 512 x 480 graphics resolution Sony Trinitron video monitor with a color capability of 16 million plus.

7.12 Using the Screens:

CARPET-CAD is a user-friendly system. Instructions are given on the monitor screen to guide the designer through the design process. Move the cursor to any of the four areas (Coloring, Patterns, Simulations, Utilities) and press both buttons. The menu screen for that area will appear. Messages on the screens direct the designer through most of the functions of CARPET-CAD. An instruction area at the bottom of the screen informs what the system

expects to be done. A prompt area contains the question
expected to be answered. An error area tells the designer
what is wrong. The status area displays specific info-
rmation about the pattern or style one is working on. The
help area is where the help screen information will appear.

Help Screens:

Help screens to explain each function of the system are
provided to make the system as user friendly as possible.
The help screen is accessed by pointing to a function with
the cursor, and pressing the right button on the mouse. The
information appears in the central area of the screen,
immediately below the screen title.

7.13 Setting Up Naming and Numbering Systems:

With CARPET-CAD a large number of styles can be colored
and designed. Before beginning, it's a good idea to think
about a naming and numbering system. Some of the
restrictions the system has are that colors, greiges,
patterns, and styles have to be labelled and labels cannot
exceed six characters.

Colors:

Colors must be numbered. They cannot be named. With CARPET
CAD, colors can be created for each style and the color can
be given a number not exceeding six digits. A variety of
standard colors can be created and stored in the color

library. Due to the configuration of the color library, it
is recommended that color numbers be kept under 4 digits, to
avoid using too much disk space.

Patterns, Greiges and Styles:

A pattern is the decorative element in the fabric. This
could either be a single repeat of the weave formation or
the decoration of the fabric through techniques such as
dyeing or printing. A greige is essentially unprocessed
fabric or carpet. A carpet that has been woven or tufted
but has undergone no dry or wet finishing operations. A
style is a finished sample approved for industrial produc-
tion. Patterns, greiges and styles can be named using
letters, numbers or symbols to a maximum of six characters.
The design process of CARPET-CAD starts with the creation of
a color or pattern, or capturing a greige image first.
To keep any color, pattern or greige, it has to be given
a name or number. Later, when colors and patterns on
greiges are combined, or new patterns created, the finished
product is named as a style.

7.14 Printing Styles, Patterns and Colors:

Printouts can be obtained by accessing the UTILITIES menu,
and by placing the cursor in the appropriate print box and
pressing the left button on the mouse. When styles are
printed, the style name, the date, and the time it was last
modified, is also printed. When patterns are to be printed,

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the left button of the mouse represents scroll patterns and the right button multicolor patterns. (These are described later). The printout gives the pattern number, the date and the time. A color printout gives you the style number, the greige number, the color file and the pattern number. It also lists color number and the RGB values for each color component. Styles, patterns or colors can also be deleted by accessing the DELETE function from the appropriate section of the menu. Backup files could be obtained by accessing UTILITIES from the CARPET-CAD main menu. One floppy disk can hold approximately four styles. When a style is being copied, color, greige or texture files associated with that style is also copied.

7.2 Coloring

The first function from the main menu is the coloring
area of CARPET-CAD. Within this menu, greige styles
could be called up or captured and solid shades or
multicolors designed to create one color or an entire color
line. Figure 7.2 shows the Coloring menu.

Carpet Coloration

Date: Time:

1. Take Picture

2. Keep   Picture   Choose Colors

3. Store Image   Save Colors

4. Get Image   Display Colors

5. Display Style   Change a Color

6. Delete Color

7. Delete Style

8. Clear Screen

9. Exit Function

Figure 7.2 - CARPET-CAD Coloring Menu

Color **Numbers:** Colors can only have numbers, not names.
Colors that are assigned to the color library for frequent
use, should not be given numbers that exceed four digits. To
create colors with CARPET-CAD, a greige is required on the

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video screen. A new greige can be captured with a camera or can be called up from a previously captured greige. CARPET CAD utilizes a JVC color video camera with a zoom lens of 1 : 1.2, 8.5 - 51 mm macro and auto focus capabilities.

Capturing a Greige: A sample piece of carpet is placed under the camera and camera lights and switch activated.

Take Picture: This mode is chosen to obtain a live image on the video screen. The camera can be adjusted using the zoom feature to get a clear image on the screen.

Keep Picture: The image can be locked in using this function and by giving the greige a name or number.

Image: The image is saved into the computer memory by calling up this function. A six digit name or number has to be specified. The texture information could also be written to the hard disk by using the **Store** function.

Display Style: This function displays a style with all its color choices. When this function is accessed, the computer asks for a style number. The style with the first color designed is displayed on the video screen. Successive colors can be seen by pressing the left button of the mouse.

Delete Color: Deletes a color from an existing style based on the style and color number.

Delete Style: Deletes a style from the computer's memory.

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Clear Screen: Clears the screen and returns to the Coloring menu.

Exit Function: Exits to the main menu.

Choose Colors: To a particular style or greige colors can be added or recolored. Colors can be either solid or multicolor. The left button of the mouse represents solid colors and the right button multicolors. Colors are created by adding values of red, green and blue together. Boxes labeled RED, GREEN, and BLUE appear on the screen. The color intensity can be changed by moving the mouse through the boxes. After an appropriate color combination has been arrived at, through the SHOW function on the screen, this color can be applied over the texture on the video screen. Note that the video treats colors as additive. As the RGB values get larger, the colors get lighter. If all RGB values are set at 255, the resulting color will be white. If all RGB values are 0, black will appear.

Shade: This gives the option to change the shade of the color by + or − 20 percent. The left button selects the percentage, by moving the mouse.

Keep: saves the color temporarily. The color could be added to a style by accessing SAVE COLORS from the COLORING menu.

Multicolors:

The only difference between multicolor and solid color design is the selection of the pattern sequence. When a multicolor pattern is called up the information displayed below the CHOOSE COLOR screen gives the style number, color number, RGB value, the pattern sequence and the pattern number. The 0 pattern sequence is the background color. When designing multicolors, a small color chip appears on the video screen for each color in the pattern. The colors can be seen on texture by accessing the SHOW function. If you like the combination, access KEEP to store the colors temporarily. Then access SAVE COLORS to add them to a style. Multicolors are stored as one color. Colors could also be called from the library, rather than creating them from scratch.

7.3 Patterns

This is the second function of the main menu and is used to design scroll and multicolor patterns. A scroll pattern is one where the textural design involves different surface configurations. (e.g: cut-loop, level cut-loop, loop-loop, etc;). Patterns, such as logo designs, could be captured on the video screen, in this menu. The PATTERNS menu appears as shown in Figure 7.3.

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Carpet Pattern Design

Date: Time:

1. Capture Pattern   Scroll

2. Keep Pattern   Multicolor

3. Store Pattern

4. Display Pattern

5. Print Patterrn

6. Plot Pattern

7. Clear Screen

8. Delete Pattern   Overlay Patterns

9. Exit Function   (Coordinates on digitizer pad)

Figure 7.3 - CARPET-CAD Patterns Menu

Capture Patterrn: This function is designed to reproduce logos or patterns without manual drawing. The image under the camera is captured on the video screen

and now the designer has a live image to work with, to make any adjustments to position or focussing.

Keep Pattern: This function freezes the image into the computer's memory. A menu prompt line appears on the computer screen requesting a threshold value between 1 and 255. The threshold value helps the computer 'clean up' the image saving time. Simply put, the threshold value tells the computer what to perceive as white and what to perceive as black. A good value to start with is 150. The computer shows the image on the graphic monitor screen and the designer can try different values and decide which one is best for his needs. In many cases, this function can save him as much as a 1/2 hour's worth of manual cleanup work. The computer then asks to choose between scroll and multicolor pattern type. The left button represents the scroll pattern and the right for multicolor.

Store Pattern: Once a pattern has been designed on the graphic monitor it can be stored using this function. When through with the pattern, access END on the graphic monitor then move to the monitor and access STORE PATTERN.

Display Pattern: A pattern that has been previously stored could be looked up by accessing this function.

Print Pattern: This function lets you print patterns based on pattern numbers.

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Plot Pattern: This function lets you plot out patterns on paper or mylar film. The computer will request a pattern number.

Delete Pattern: Deletes patterns based on pattern numbers.

Clear Screen: Clears the graphic monitor screen.

Exit Function: Returns to the main menu.

7.31 Designing Patterns:

Patterns are designed with the SCROLL and MULTICOLOR functions of CARPET-CAD. The designer now moves away from the monitor, keyboard and mouse, to the color monitor, digitizer pad and four-button tracer. While designing patterns on the graphic monitor, a service area on the right-hand side of the monitor is available. These functions allow the designer to draw, place geometric shapes, check matches, save patterns, etc. There are differences between the SCROLL and MULTICOLOR functions. These are described below.

7.32 Scroll Patterns:

Scroll carpet machines are capable of producing carpets of different pile (high and low pile; cut and loop pile) configurations. This difference in pile gives the carpet its design characteristics. The difference in pile being brought about by special yarn feed attachments. Most yarn

feed mechanisms are electro-mechanical - an electrical
impulse causes a mechanical change which alters the feed
rate of the yarn. A higher rate of feed results in a high
cut-pile/loop-pile and a lower rate of feed results in a low
cut-pile/loop-pile. Rollers feeding yarn into the tufting
machine have electro-mechanical clutches, which when ener-
gised, locks the rollers on to their shafts. The scroll
patterns designed determine which clutch is to be energised
at what point in time. Most scroll machines have a standard
number of clutches, depending on the gauge of the tufting
machine, which determine amount of yarn fed to the machine.
The design process starts with either a pre-designed
pattern or by designing a new pattern. The number of
clutches used in the carpet machine has to be specified at
this point. By entering the number of clutches, you are
giving the computer information to simulate the clutch
configuration on the design screen, assuring that your
pattern will be designed realistically for your equipment.

Patterns can be designed either in half pattern or full
pattern mode. In half-pattern mode, the computer automati-
cally generates the other half of the pattern. The actual
design process takes place at the color graphic monitor.
Each function on the service area of the graphic monitor is
described below.

End: This function is used to get out of the design mode
and return to the monitor and keyboard to store a pattern

after completion.

Pen: Gives a drawing tool of variable size. A size is selected by first accessing PEN and pressing the first button on the tracer. Moving into the field and pressing the button again determines the left boundary of the pen. The cursor is then moved horizontally to the right till the desired pen width is achieved.

M-1: Mode 1. This mode is intended for cut/loop patterns. In Mode 1, the background of the screen is white, the drawing black. When simulating these patterns with textures, white areas appear high, black areas appear low. When mode 1 is accessed, the cursor is moved out into the design area for the background to appear. In mode 1, only the tracer buttons are used for drawing. Button 1, under the light, places a 1X1 stitch in the southeast quadrant of the cross hairs. The second button places a 2X2 stitch. The third button places a 3X3 stitch. The fourth button acts as an eraser, eliminating the last stitch size selected.

M-2: Mode 2. In this mode, the background is black, other areas are white. In simulation mode, black areas are low, white areas are high. The tracer buttons have the same meanings as for mode 1.

Era: Erase. Gives a variable size eraser. Activated by selecting erase, pressing the first button, moving the cursor into the design field, and pressing the first button again. The cursor is moved until a suitable sized eraser

box is obtained, which is then placed over the region to be erased.

Ddl: Doodle. This function permits drawing with the pen size selected.

Lin: Creates variable size straight lines. Activated by selecting LIN, pressing the first button, moving the cursor into the design field, and pressing the first button again.

Cir: Circle. Creates various sized circles. Activated by selecting CIR pressing the first button, moving the cursor into the design field, and pressing the first button again. The tracer can be moved until the circle is the correct size.

Arc: This function creates variable size arcs. Activated by selecting ARC pressing the first button, moving the cursor into the design field, and pressing the first button again. An arc requires three points. Each point is placed by moving in a clockwise direction and by pressing the first button.

Box: Draws variable size boxes. Activated by selecting BOX, pressing the first button, moving the cursor into the design field, and pressing the first button again.

Bar: Draws variable size solid bars. Activated as above.

Cpy: This function permits copying portions of a design,

to place in other areas of the screen. After having accessed the function, move the tracer to the area to be copied and press the first button. Move the tracer to outline the area. Then move to the area to place the design and press the first button again to place the copy. Designs can be duplicated as many times as required, by moving the tracer and pressing the button.

Fil: Fills an area with solids or zebra stripes. Activated by moving cursor to the area required to be filled and pressing the first button. Note that this function will not work with a grid . Also the area to be filled has to be completely closed.

Zdn: Zoom down. This function reduces the design four times. The grid mode has to be removed before the zoom mode will function. To zoom, access the function and press the first button. To undo zoom, reaccess the function.

E/M: End Match. Brings the ends of a pattern together.

S/M: Side Match. Brings the sides of the pattern together.

C/M: Corner Match. Brings the corners of the pattern together.

GRD: Grid. Places a grid on the screen for precise drawing, or removes it to access the match functions. The grid has got to be removed before filling, zooming, or matching ends, sides or corners. The grid is removed by

accessing the function and pressing the first button on the tracer.

PDN: Pattern Down. This function scrolls the screen down to see the lower half of your pattern.

PUP: Pattern Up. Also for full patterns. Moves the screen up to see the upper half of the pattern.

PLN: Plain. Used to fill a plain area. Access PLN, then move the cursor to access FIL. Place the tracer in the area to be filled and press the first button again.

VZR: Fills a closed area with vertical, right-handed zebra stripes. First access VZR, then FIL.

VZL: Fills a closed area with vertical, left-handed zebra stripes. First access VZL, then FIL.

SIZ: Size. This function permits copying the size of a piece of paper or fabric, different from the screen size, and translate it into the proportions of the screen, so it can be copied from it with the tracer. The upper left corner of material be copied is lined up with the upper left corner of the digitizer pad. The mouse is positioned over the lower right corner of the image, and the first button of the tracer is activated. The size of the image is now mapped onto the screen.

SIM: Simulation. This function simulates the pattern with texture on the video screen. After accessing this

function, return to the monitor to choose from one of the
four carpet texture choices:

1. CUT/LOOP where the carpet pile structure is composed
of both cut and loop. Generally the cut-pile areas are kept
high and the loop-pile areas low.

2. LOOP/LOOP where the pile structure is composed of both
high and low loops.

3. CUT/CUT where the pile structure is composed of both
high and low cut-pile.

4. LCL which stands for level cut and loop, where cut and
loop piles are tufted to the same height. The same effect
could also be produced by shearing a cut-loop carpet till
the two pile heights are the same.

Depending upon the pile structure required the relevant
number is input. The simulation will appear on the screen.
The computer then requests that the simulation be given
a greige name. Another texture combination could be chosen
by reaccessing SIM.

ZUP: Enlarges the image for precise design work.

ROM: Roam. Scrolls and/or pans the screen. Intended for
use in the ZUP mode.

RST: Reset. Resets the screen in the proper position
after scrolling with ROM.

7.33 Multicolor Patterns

Multicolor mode is used to design patterns that require multiple layers of color, such as screen designs. In this design mode patterns are designed in subsequent layers. Each layer will be represented with a different color on the color graphic monitor. As with scroll pattern designs, there are a list of functions that appear on the right side of the graphic monitor screen. Many of these functions work the same way as they do in scroll. There are some different ones, however, and these are described in detail below.

END: Takes you get out of the design mode and store your pattern.

PEN: Pen size selection. See Scroll Pattern.

NPT: Next Pattern Level. Since the designing process is in layers, this function permits movement from one pattern level to the next, clearing the screen each time.

PPT: Previous pattern level. This function returns to the previous pattern level.

ERA: Erase. Gives a variable size eraser. See Scroll.

DDL: Doodle. Draws with the selected pen size.

LIN: Gives a variable size line. The first button places the line, the second button on the tracer undoes the line. This

works for all the geometric functions including CIR, ARC, BOX and BAR.

CIR: Gives a variable size circle.

ARC: Gives a variable size arc. The three points are to be placed clockwise.

BOX: Gives a variable size box.

BAR: Gives a variable size bar.

CPY: Permits copying from one area to another. You are restricted to copying an area about 1/4 the size of the screen.

FIL: Fills a closed area. If the area is not completely closed, the entire screen will be filled. As in the scroll mode, FIL cannot be used with the grid on.

ZDN: Zoom down. Reduces the design by four times. The grid has to be removed before zooming, and must get out of ZDN before ending.

E/M: End match. Will not function with a grid on the screen. Must get out of this function before ending.

S/M: Side Match. Will not function with a grid on the screen. Must get out of this function before ending.

C/M: Corner Match. Will not function with a grid on the screen. Must get out of this function before ending.

GRD: Gives a grid on the screen for precise drawing. Grid to be removed before using the match functions, zooming, filling or ending.

MIR: Mirror. Mirrors the top half of the screen to the bottom half.

FUZ: Fuzz. The designs placed on the screen simulate actual stitch placement, and so have sharp edges. In multicolor applications, the edges will appear softened in reality. This function simulates softened edges on the graphic monitor.

COL: Color pen selection. In the multicolor mode, colors for the graphic monitor can be created to simulate the ones required for use in coloring. This is done from a color selection screen on the graphic monitor. Values of red, blue and green have to be selected to create the color that is required for each level of the pattern.

SIZ: Size. See Scroll.

SAV: Save. This function temporarily saves the pattern, to avoid losing any of it in case of an electrical interruption, or some other accident. This function also permits saving a pattern in a zoom mode for later coloration and simulation.

ZUP: Zoom Up. See Scroll.

ROM: Roam. Scrolls and/or pans the screen. Intended for

use in ZUP mode.

RST: Reset the screen after scrolling with ROM.

OVERLAY PATTERN: This is the last function of the PATTERN menu. Through this function two or more patterns can be put on top of one another to create different effects. The first is displayed by accessing DISPLAY PATTERN and typing in the pattern number. Both patterns will be displayed on the graphic monitor, one over the other.

7.4 Simulations

This area of CARPET-CAD permits designing of patterns to simulate specific production equipment such as space dyeing, tak machines, graphic tufting machines, etc. The simulations menu appears, as shown in Figure 7.4. The different functions on the menu are very much similar to the ones described earlier.

Simulations

1. Space-Dye

2. Graphic Tufter

3. Velva-Loop/ Velva-Weave

Figure 7.4 - CARPET-CAD Simulations Menu

7.41 Space-Dye

This mode simulates using space-dyed or co-mingled yarns, and TAK machines. Space dyed yarns are randomly colored yarns which when tufted on a carpet machine impart a random color distribution to the design surface. Space dyed effect can also be produced by co-mingling yarns of different colors. TAK machines enable a random but controlled pattern to be produced on either dyed or undyed carpet. It is essentially a dyeing process where a series of thin continuous streams of color dye are broken up into

droplets to fall randomly on the carpet passing beneath. The different parameters such as line speed, flow rate can be adjusted to produce multi-colored effects.

In the SPACE-DYE mode Carpet-CAD the different parameters have to be specified to determine the placement and density of color. Some of the parameters to be specified are LINE SPEED (8 - 24 YPM) FLOW RATE (1 - 5) and DROP CUTTER SPEED (1 - 3). Depending on the parameters selected, random dots of color show up on the graphics monitor. The combination of line speed and flow rate determines the density of the drops. The drop cutter speed determines the size of the drops. Another layer of color can be overlayed by reaccessing the Space-Dye function.

Once finished, the pattern can be stored by accessing STORE PATTERN .Color can be simulated over the texture by accessing the Coloring menu.

7.42 Graphic Tufter

This function creates patterns for graphic tufting machines, by designing cams and choosing threadups. The computer then "threads" the machine and "tufts" the carpet, on both the graphic monitor screen, and the video screen. Designs are made on tufting machines by utilising cams to move the needle bar of a conventional tufting machine, and by having a threading sequence of different

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colors. The earlier graphic tufting machines utilised only one sliding needle bar. This limited the design configurations to small squares, zig-zags, etc;. Presently in the industry the "graphics machine" is synonymous with dual needle bars sliding in opposite directions. This increased the size of the geometric design configurations for tufting machines. Movement of the needle bars can be controlled either using cams or hydrostatic pressure.

The design process on carpet-cad starts with specifying the machine gauge (1 = 5/64; 2 = 1/10; and 3 = 1/8). The gauge is the distance between to successive needles in inches. The gauge of a machine plays an important role in the texture and look of a carpet. For example plush saxony carpets are made on larger gauge machines. Fine velvet like carpets are made on smaller gauge machines.

The next parameter to be specified is the type of cam being used. This can be done on the graphic monitor. The screen highlights cam diagrams for both needlebars. Also available on the screen below these diagrams, is the area for threadup sequence. The top row is for the back needlebar; the bottom row for the front. The functions and color bars are placed on the right side of the screen. The functions are described below.

The tracer buttons have special functions in this mode. The first button is used to access a function, to place stitch steps for the cam sequence and threads in the

threadup bar. The second button serves as an eraser.
The third button on the tracer restores the screen, in
case something is erased. The fourth button on the tracer
draws out a color from the color bar.

GCM: Get Cam. If cam designs for the available tufting
machinery have already been input then this function can be
used to call up a cam. A particular cam design could then
be made available by inputting the cam pattern number.

SCM: Save Cam. This function saves cams for frequent
threadup diagram. TRD : Threadup. This function deals
with threading of the machine. Colors for the threading
sequence are selected from the color bar visible at the
side of the screen. The fourth button on the tracer is used
to select colors. The selected colors are then placed in
the threadup diagram by moving the tracer into the threadup
box and pressing the first button. On the color bar, the
top color is one, the second one is two, and so on.

CAM: Used to design cams. After accessing this function
the tracer is moved into the cam diagram and stitch
sequences are placed using the first button on the tracer.
The back needlebar cam is critical. The computer
assumes that the front needlebar cam mirrors the back
needlebar, if nothing is put in the front needlebar cam
diagram.

SEE: This function "tufts" the pattern on the design

screen and on the video screen. In the SEE mode the functions on the design screen change. They are described below:

TCL: This function takes you back to the choose color mode, and allows modification of colors.

ZDN: Zoom down. Reproduces the pattern four times smaller than the original. The zoomed image is 240 by 240 stitches.

PRT: Prints out the pattern on a color ink jet printer.

MOD: Modify. This function is accesssed to go back to the cam/threadup screen and modify the pattern.

SAV: This function saves the threadup sequence and cam design as a pattern.

END: Clears the screen, and gets back to the monitor. Once a graphic pattern has been designed COLORING is accessed to design colors and create styles.

7.43 Velva-weave/ Velva-loop

Velva-Weave and Velva-Loop machines combine the principles of scroll patterns with shifting needlebars. The total pattern is then a combination of (1) the Velva-Scroll and (2) the Velva-Shift. First the scroll component is designed by accessing Velva-Scroll. Once this is finished it is stored and the next step involves designing

the Velva-Shift component. If a shift pattern already exists, it could be called up by entering the pattern name. The full pattern is simulated from VELVA-SHIFT.

Velva-Scroll

Essentially there are two types of design modes - (1) the Velva-weave (2) the Velva-Loop. With the velva-weave design mode high cut pile, high loop pile, and high cut and high loop together can be placed. The computer assumes the background is low cut and low loop pile. With the Velva-loop design, due to the nature of the machine, only the loop pile placement can be varied. After having chosen the type of design mode, the number of clutches on the machine have to be indicated. Once this information has been input the designer then moves to the graphic monitor to design his pattern. Basically a scroll pattern is being designed and most of the graphic functions, as seen on the right side of the graphic monitor, work as they do in the scroll pattern mode of CARPET-CAD. Only those functions not available in the scroll pattern mode are described here:

BHI: This function is used to fill areas in the pattern where both cut and loop are high. The area that represents BHI on the screen appears as beige. The black background represents low loop and low cut.

CUT: This function is used to fill areas in the pattern where only the cut pile is high. This area appears as dark

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rust. If a pattern is being designed with large areas of high cut pile, it is quicker to design the loop pile areas first, and then flooding the screen with cut pile by accessing CUT.

LUP: This function is used to fill areas in the pattern where only the Loop pile is high. This area will appear orange on the screen.

Velva-Shift:

Designing for Velva-shift, is just like designing for the graphic tufter. You will design cams and choose threadups, and then see the pattern on the design screen. The graphic monitor screen exhibits cam diagrams for both needlebars. The left one is for the back needlebar; the right one for the front. Below these diagrams is the area for threadup sequence. The top row is for the back needlebar; the bottom row for the front. The functions and color bars are placed on the right side of the screen. The functions are similar to the ones described in the Graphic Tufter menu.

7.5 Utilities

The Utilities area of CARPET-CAD performs housekeeping
functions, such as printing out styles patterns and colors,
and backing up styles on floppy disks. The utilities menu
appears as shown in Figure 7.4

Utilities Menu

1. Print styles

2. Print Colors

3. Print patterns

4. Backup Style

5. Burn Eprom

6. Exit to DOS

7. Exit Function

Figure 7.5 - CARPET-CAD Utilities Menu

PRINT STYLES: This function gives a printout of all that
have been created.

PRINT COLORS: Gives a printout of all the colors that have
been created.

PRINT PATTERNS: Prints a listing of all patterns stored in
memory.

BACKUP STYLE: Lets you copy a style on to a floppy disk.
On accessing this function, the computer directs you to

insert a formatted floppy disk into the disk drive. The computer will copy the style, including the greige style, colors, and patterns, onto the diskette.

BURN EPROM: If EPROMs are being used to run production equipment, the system has the capability to prepare EPROMs. On selecting BURN EPROM the computer asks for the number of the pattern to be copied, and pattern repeat in stitches. The computer then directs you to turn on the EPROM programmer and hit any key to proceed. The computer tells you how many EPROMs you will need to copy the pattern. Scroll patterns take 1 to 4; Velva-Weave patterns take 2 to 8.

EXIT TO DOS: This function gets you out of CARPET-CAD, and into the operating system. When you access EXIT TO DOS, you will see the prompt: C:\CCAD>. To reaccess CARPET-CAD, type CCAD, and press ENTER; or hit the CTRL, ALT, and DEL keys simultaneously.

EXIT FUNCTION: Takes you back to the main menu.

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ADDRESSING DESIGN PROBLEMS OF THE TEXTILE INDUSTRY THROUGH COMPUTER AIDED DESIGN

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AN ABSTRACT OF A MASTER'S REPORT

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ABSTRACT

In the textile industry, the design of new fabrics or apparel requires interactive facilities for the specification of the various weaving/tufting/sewing parameters, their modification and the simulation of the results. One of the problems faced by the industry has been the presentation of new designs for upcoming seasons, on very short notices. Computer aided design (CAD) has been used to address this problem by eliminating manual procedures which are tedious and time consuming. This report reviews CAD applications in the apparel and carpet industries and the resulting benefits of CAD systems to these industries. This report also analyzes in detail an interactive package called Carpet-Cad, to explain the CAD design process currently evolving in the carpet industry.