COMPUTER GRAPHICS AND THE FASHION INDUSTRY

Extended Summary

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Abstract

This paper examines the role of computer graphics and new media technologies in the fashion industry. The three phases of computer graphics application are:

(1) *Design/Visualization*,
(2) *Pattern Creation/Manufacturing*, and
(3) *Presentation/Promotion*.

This paper focuses on the third application, illustrating some of the new directions in computer graphics and fashion with examples of the author's work in fashion videos and interactive systems.

KEYWORDS: fashion design, pattern CAD/CAM, stereoscopic, fashion video.

Introduction

Computer graphics has made its impact on most fields which entail design and imaging: movie and television special effects, computer-aided design and manufacturing, computer-aided engineering, molecular design, medical imaging, seismic analysis for oil prospecting, as well as on video-games and flight simulators. One design field for which the assimilation and creative use of computer graphics still poses a challenge is the fashion industry. Computer imaging systems are being applied in three areas: *Design*, *Manufacturing*, and *Presentation*.

The fashion industry is built around a process of producing a new look. The fashion business is an unending visual modification of the definition of society and its image. Ironically, its link to one of the newest image making media is not implicit. The motivation for using computer graphics systems is clearly defined only in the manufacturing phase: to obtain the advantages of an automated system. In the design and presentation phases, it is not yet evident that the computer medium can enhance production and creativity. In these areas, traditional methods are neither easily simulated nor improved. This paper gives an overview of some applications of new media technology in the fashion industry. An emphasis is given to the final phase; examples from the author's work are included to demonstrate how computer graphics animations can generate an immediacy and capture the imagination in a way which is true to fashion.

Design / Visualization

The computer is a natural medium for the mass production of perspective images; this makes it an effective tool for engineering and architectural design. Garments however are characterized by neither rigid surfaces nor simple geometrical construction.

To accurately model a garment requires a data format that can represent flexible materials and the effects of physical forces such as gravity and surface tension. Hierarchical solid modeling operations are one technique for simulating twisting, bending, tapering and other such transformations of objects. "Deformations" [1], a form developed by Alan Barr, can be used to simulate flexible geometric objects made of fabric. This technique obtains a normal vector of an arbitrarily deformed smooth surface that can be calculated directly from the surface normal vector of the undeformed surface and a transformation matrix. The deformations are combined in a hierarchical structure.

Furthermore, from the level of detail of fiber and fur to a pattern on a fabric, modeling a garment requires sophisticated techniques such as texture synthesis and stochastic modeling [2]. Patterns on flat fabric can be texture mapped onto the curved surface of the constructed garment [3]. Also, methods are being created to warp the surface of an analytically defined object [4].

The jacket design for a computer generated character, *User Abuser*, demonstrates a method developed at the Computer Graphics Lab, NYIT, for creating a realistic three-dimensional model of a garment. The jacket was modeled as a non-closed surface defined by polygons in a mesh format. This format consists of a list of 3d vertex coordinates, with normals and texture coordinates, topologically connected into a grid with a certain number of rows and columns [5].

One of its most important features is flexible joints at the shoulders and elbows, modeled with flex software by Richard Lundin [6]. These are necessary to correctly deform the surface when rotations are performed at a joint in a tree structure of a three-dimensional model. Each flexible joint is composed of a single polygonal surface in mesh format which changes shape as the joint is flexed; the joint begins at a particular body part in the model tree and ends at another body part. A bezier spline curve, which defines the centerline of the flexible joint, is created from control points which include the end points of the flexible joint and the coordinates of any joint nodes between the end points. The flex software determines the joint axis, calculates the two end coordinates of the joint, and finally distributes and orients the mesh rows, with respect to the centerline of the flexible joint. This allows the arms to be freely moved, while leaving the garment's seams intact!

The jacket can be rendered with any texture and color and displayed from any point of view [Figure 1]. The appearance of the jacket also depends on lighting which, in this case, creates the jacket's specular surface.

From the vantage of the computer graphics industry, the simulation of three-dimensional garments is a technical problem which will probably gain more attention. In part, this is because the efforts to model and animate the human figure are achieving more and more success. Obviously, this will converge upon the next challenge: designing and animating clothes for this figure.

Without a practical means for representing three-dimensional garments, computer graphics design systems in the industry have been geared towards manipulating two-dimensional designs. The thrust of these systems is to provide (1) an efficient means for visualization and (2) an optimal way to create a design to be readily used in a CAM system.

Textile design is an area related to the fashion industry where computer graphics are widely employed as a design tool. A separate activity from garment construction, textile design requires only two-dimensional representations. Weaving and textile design have long been familiar to computer graphics.

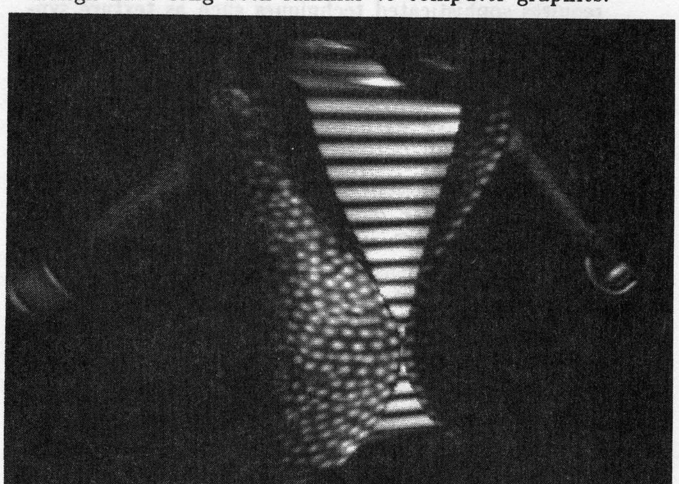

Figure 1 Suit jacket with texture map.

In the early 19th century, Joseph Jacquard developed punched cards as a means to control weaving machines in textile mills. Charles Babbage used these as a model for the cards he used to control the sequencing operations of his calculating machine [7]. Now, there are computer-interfaced looms which can control the pattern and handle complex designs as easily as simple ones. Computer imaging systems can analyze and visualize weave structures. Designs can quickly be scaled, repeated, recolored, and modified without having to laboriously redraw them by hand. The new design can then be produced using computer-interfaced looms.

For example, a textile designer can create textiles with a microcomputer by means of the AVL Loom. Textile designs can be generated in full color with the AVL software automatically calculating an accurate representation of the warp and weft. Via an RS232 connection, the AVL then can control the pattern as the loom is actually weaving it off, draw the pattern with a color plotter, or produce a black and white printout.

The direction of the industry has been to tighten the link between design and manufacturing phases. In part, this is because the most efficient way to give pattern data to a CAM system is to create the garment on a compatible design system. Thus, systems dedicated to the design phase have tended to evolve closely with those for manufacturing.

A system for designing textiles and previewing them on garments has been developed by Computer Design, Inc (CDI). Compatible with traditional design methods, this system is a tool for rapidly visualizing design variations without extensive sample and sketch making. The data describing designs can subsequently be manipulated with a variety of CAM systems. The menu driven system uses an Iris Workstation, from Silicon Graphics, Inc., which has a 68000-based processor, Geometry Engine, and raster subsystem; this system has 1024 x 1024 resolution and 24 bits of color. A more powerful version uses the Iris Turbo which has a 68020-based processor. Fabric designs can be created on the system with its paint program with an electronic tablet or mouse. The system can calculate the number of threads, warp and weft for a given weave (such as twill or oxford) and yarn size. Characteristics such as color, scale, and repeats can be readily manipulated. Fabrics can then be mapped onto garment patterns.

One of the system's features is that designs from other sources, such as samples and sketches, can be scanned in with a camera and then manipulated by the paint system with elaborate functions. Using the paint system and mapping functions, a design from any source can be viewed instantly in a repertoire of colors, patterns or textures.

Although the system works only with two-dimensional images, its functions preserve the dimensional effect created by textures or shadows in a drawn or photographic image of a garment. When the garment is specified in a new color, a transparency function preserves these visual cues which suggest folds and curves. The texture mapping also takes into account light intensities so that the fabric pattern is realistically mapped onto the garment.

In many respects, the role of computer graphics in the fashion industry's design and presentation phases is similar to its role in movies, television, and advertising. Its use in these areas is not always cost-effective. For lines of clothes which are not mass-produced or mass-marketed, using computer graphics for design alone may be too expensive. Furthermore, cost alone may not be an adequate motive for a designer to make use of the technique. Thus, the role of computer graphics in creating designs in many ways remains subject to the public's demands for aesthetic effects.

In many ways, haute couture has an image which is antithetical to automation and thus does not seem likely to embrace technology in any highly visible phase of its production. It is in ready-to-wear fashion, an industry directed to the "modern" woman, that computer graphics may prove to be in demand. There are some instances of designers who actually reflect the *image* of computer technology in their work rather than using it as a hidden process behind it. The designer, Jurgen Lehl has used computer chips and highly pixellated images as patterns in his individualistic and symbolic textile designs [8]. The fashion designer, Elisabeth de Senneville bases her line on the theme of new images. Dresses, sweat shirts, sweaters often have prints with computer and video images. She explains that when she designs a garment she always asks herself if it could be worn in the year 2001.

Pattern Creation / Manufacturing

In the fashion industry, the adaptation of computer imaging techniques in the area of manufacturing is more prevalent than in its other phases. The overall goal is to automate and manage quality control in all phases of design and production. Computer graphics appear in the form of CAD/CAM systems for digitizing, grading, marking, and sizing patterns in two dimensions. These are formulaic and mechanical operations which do not rely on creative decisions.

Systems are designed to depend on expertise in pattern marking or marker grading -- not computer knowledge. The Lectra System CAD/CAM systems give an example of a highly modular system in which each unit is dedicated to a particular subset of the traditional tasks. Each component has 68000-based processor and disc storage that can range from 256 to 1024 kbytes. Pattern pieces are input on a digitizing table. Next, the pieces can be manipulated -- graded, sized, and markers made -- in real time on a color vector graphic display workstation with a pen and tablet. The pieces can also be "dragged" around and magnified on the display in real time. The plotter unit is used for either single-ply laser cutting or drawing markers on spread fabric. A Winchester-based module with a networking controller provides extra storage. Modules can communicate between different locations over telephone lines by means of a modem.

The next step in manufacturing is a system which can model three-dimensional garments and then unfold them into two-dimensional patterns for subsequent manipulation on a CAM systems. GGT is developing a three-dimensional modeling system that can display rigid models of garments in high resolution (1280 x 1084), using z-buffer algorithms for hidden surfaces, and Gouraud shading. While it may be expensive -- in computer time alone -- to accurately model many of a garment's physical characteristics (such as draping), their impact on the geometric layout must be evaluated and accounted for in the pattern. GGT is currently researching how to reflect engineering concerns including the effects of gravity and warping of a flexible surface when translating the model from three dimensions to a two-dimensional pattern.

CDI is marketing a system for making shoe designs and patterns which is compatible with its design system described earlier. Shoes are characterized by having rigid forms which closely fit the model. Thus the problems posed by flexible surfaces are minimal. A shoe form which is input on a three-dimensional digitizer can be manipulated as a three-dimensional, smooth shaded image. The design is then unwrapped from which point it can go on to standard pattern engineering and CAM systems.

CDI's garment system, under development, also begins with a digitized mannequin. The image can be displayed from different points of view in four windows on the color monitor. The designer draws style lines which the system accurately maps to the surface; changes are updated in all windows simultaneously [Figure 2]. Mirroring functions can automatically reflect designs.

The problems are more complicated for the design of garments whose fabrics and construction do not adhere to the mannequin's shape. At present,

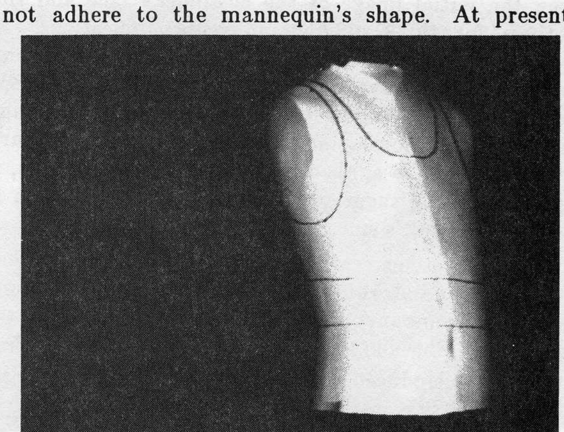

Figure 2 Smoothshaded three-dimensional image of digitized mannequin with pattern lines.

CDI is not attempting complete physical simulation of garments under the assumption that the level of detail may have applications in engineering but is not absolutely necessary in garment industry.

Presentation / Promotion

The technology for new ways of shopping overlaps with the technology for new ways of entertaining, promoting, educating, and informing. In many ways, much as it is in the design phase: it is a tool for visually exploring a database of images, editing and making final selections.

The cosmetics industry is one sector of the fashion industry which explores this. New technologies and cosmetics have a certain compatibility. "Science" is perceived as the means for attaining a variety of technological "miracles" that range from anti-aging products to long-lasting lipsticks. Most people welcome the association of technology with cosmetics because they perceive it as being particularly accurate and scientific. In the past year, "makeup computers" have been introduced by Elizabeth Arden and two Japanese companies, Shiseido and Intelligent Skincare (I.S.).

These systems offer two kinds of services: computerized techniques for (1) makeup application and (2) skin analysis. Basically, the makeup systems use a standard computer graphics technology -- a paint system -- as an innovative way to present the makeup.

All of these companies have systems which provide environments where a trained makeup artist can simulate the application of "electronic makeup" to the customer's face. For instance, Elizabeth Arden's Single Unit System called Sue (refined from its original 3-station system, Elizabeth) houses all of its components in a tall unit which is similar in appearance to a commercial video game. The customer's face is instantly scanned in, by means of a standard video camera, and digitized. The screen's 512 by 512 raster image is divided into four quadrants: one for displaying the initial image of the customer's face and the others for three different makeup applications. A menu provides palettes for blending suggested colors, selecting brush type and stroke firmness. Software can magnify the face to focus on details. A transparency function maintains the face's original texture while makeup is applied. At the end of the session, a print-out with suggested makeups scrolls out from a slot on the unit's side.

The systems cost each company about $1 million to develop and thus may not be offered by every cosmetic company. They have had an enthusiastic response. Shiseido, for instance, quintupled its sales, when it introduced its system at Bloomingdales in New York City, in the autumn of 1984 [9].

The appeal of these computer graphics systems is that they allow the customer to interact with the product by means of a simulation. Elizabeth Arden's marketing department has observed that potential customers are often reluctant to experiment or invest in a new product. With electronic makeup, a customer can experiment not only without being threatened, but without removing the makeup being worn.

The skin analysis system demonstrates the importance of having a human tending the interface between "science and beauty". Based on a personal computer, Arden's skin analyzer scans in the customer's skin with a black and white video camera. The computer constructs a three-dimensional image of the skin surface texture from light intensity information. The data is normalized with additional information such as the customer's age and skin type. Originally, the system assigned a numerical value to the skin type and recommended specific products using a logic system with a hierarchical database of 94 products and regimes. However, an uninterpreted numerical skin rating can alienate a potential customer. The computer thus works as an assistant to the consultant by performing the skin analysis and recommending an overall product line.

The notion of using simulations with which a customer can interact has been explored in the area of fashion as well. The Magic Mirror, designed in Paris by Jean-Claude Bourdier, is an interactive system which uses simulation to create the visual effect for a customer that he is "trying on" clothes. The system wittily updates the traditional interface between customer and garment: the mirror. Set in an environment that is like a darkened dressing room, the Magic Mirror optically combines the reflection of the customer's face with the reflection of a slide projection of an clothing outfit. In the L.S. Ayres store in Indianapolis and Galerie Lafayette in Paris, a trained operator uses a computerized focusing system with a pushbutton interface to project the slide at a scale that fits the customer's figure (size and height). In stores in Japan, the customer simply operates the Magic Mirror himself. Although the system is primarily based on "low" technology, it is easy to imagine the visual database updated so that it is accessed from a videodisc or computer generated.

The video image and fashion are not a novel combination. Often in the form of "news magazines," fashion reportage typically consists of interviews intercut with videotapes of fashion shows which concentrate on good photography of runway presentations. Basically, these presentations are documentaries which often have a canned look. Videotapes are frequently running in various departments of stores. And of course, television broadcasts a barrage of commercials for cosmetics, perfumes and blue jeans. By adding computer graphics and interaction, the customer can gain a fresh look at the product.

The Fizzazz store, designed by Music Video Productions, uses interactive computer graphics systems to present Murjani International's line of CocaCola clothes. The centerpiece of the store is a pair of television displays on which a customer can browse through images of the clothes. Each system appears to be simply a television, sheathed in a pared down chrome housing which is mounted on a slim column. Transparent touch sensitive plasma screens cover each of the screens. A computer generated graphical menu is composited with the video images; special hardware was designed by Sony to composite the videodisc (ntsc) and computer graphics menu (rgb). The interface is direct: no keyboards, cursors, mouses or computer languages. The hardware is placed behind the glass windows of CocaCola coolers, off near the dressing rooms.

Customers call up pictures of the clothes which are stored on videodisc by touching menu items on the screen. The images are drawings of the garments depicted in various colors and from different points of view (front and back) and at various level of detail (pocket, cuff, sleeve, etc.). They can be viewed by touching the appropriate selection on the screen. The presentation is geared for a young market which is already used to browsing television for visual stimuli and fashion ideas. Multiple video projection systems display computer graphics animations and stills from the videodiscs on a wall. Visible from the street, the video systems run twenty-four hours a day and the animations are changed weekly. Murjani is gearing the store towards twenty-four hour shopping where the customer electronically looks through the clothes, purchases by means of a credit card, and has the goods delivered the next day. The designers of the system note that it is important that the clothes are available in the store to be handled and tried on.

Like the makeup systems, fashion presentation systems introduce customers to a broader "database" of products than they might otherwise consider -- and give them a tool to manage it. These systems put to use the same shopping techniques exercised without technology: collecting and editing data with the goal of making a purchase.

Developing the notion that interactive computer graphics can provide a medium that can evoke the "presence" of the garment, the author designed a system (at the Architecture Machine Group, Massachusetts Institute of Technology) where a joystick can be used to interactively rotate a garment. This was accomplished by photographing a coat [10] from a series of points of view. The photographs were digitized and laid out in a grid as one picture. This was then displayed in an AED framebuffer which could pan to and zoom up the appropriate image in real time as the viewer moves a joystick to indicate the direction from which he wants to view the garment.

In another project, the same database of multiple images could be manipulated interactively in a stereoscopic computer graphics workstation [11, 12]. The workspace combines a stereoscopic video display with a real space by means of a semi-transparent mirror. Images were placed and moved in the space using an electromagnetic 6 degree of freedom digitizer

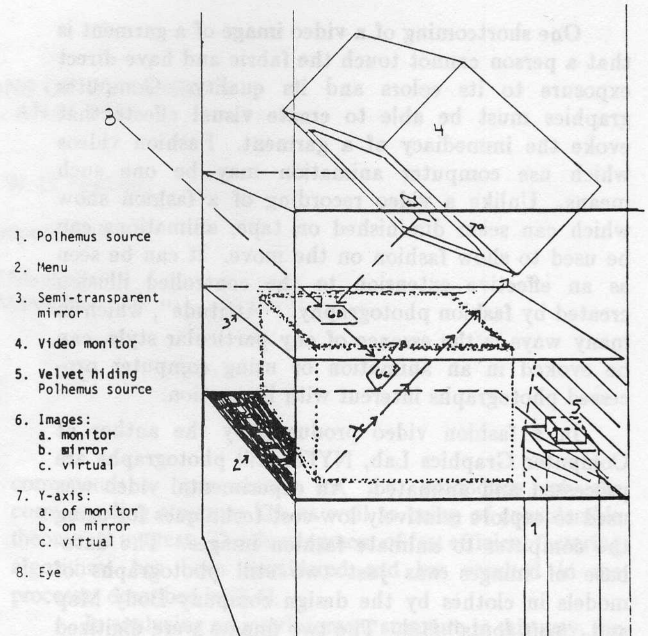

Figure 3 Diagram of stereoscopic computer graphics workstation.

mounted on a small "wand" with a pushbutton mounted in the handle [Figure 3]. The viewer could browse through different views of the garment which he had placed in the workspace [Figure 4].

When the modeling techniques and adequately powerful technology become available, such systems can also be imagined as a tool for the designer to preview a design. Rather that working with a database of digitized pictures, the designer creates a three-dimensional model of a garment which can then be displayed in the workspace from any point of view, at various levels of detail, and with colors and textures defined on the fly.

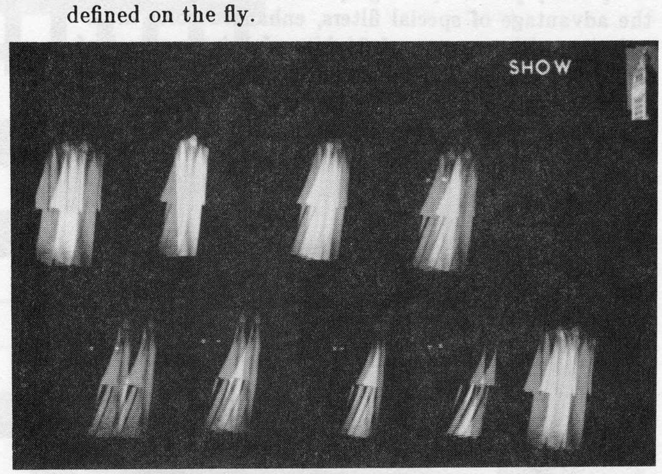

Figure 4 Coat displayed from different viewpoints in workspace. Both left and right images of stereoscopic pair are visible.

One shortcoming of a video image of a garment is that a person cannot touch the fabric and have direct exposure to its colors and its quality. Computer graphics must be able to create visual effects that evoke the immediacy of a garment. Fashion videos which use computer animation may be one such means. Unlike a video recording of a fashion show which can seem diminished on tape, animations can be used to show fashion on the move. It can be seen as an effective extension to the controlled illusion created by fashion photography. "Attitude", which in many ways is the essence of any particular style, can be evoked in an animation or using computer processed photographs intercut with live action.

In a fashion video produced by the author at Computer Graphics Lab, NYIT, still photographs are processed and animated. An experimental video was used to explore relatively low-cost techniques for using the computer to animate fashion images. The database of images was just two still photographs of models in clothes by the design company Body Map and "soft fonts" [13]. The two images were digitized and processed with Ikonas frame buffer software developed at the Computer Graphics Lab. Pictures were then zoomed up, sharpened and blurred with low and high pass filters, and recolored by merging different colormaps [see Figures 5-6]. Mattes were produced from the pictures and used for selectively using parts of images and putting the images against different backgrounds. The mattes were also used for animated shadows. The type was seven letters from an alphabet of two-bit Clarendon soft fonts which were zoomed up, blurred, recolored and warped.

UNIX shell scripts [14] were used to define the animation sequences. Each movement was specified as an interpolation between a beginning and end position over a given number of frames. Interpolation was determined by linear, ease in and ease out functions.

Many of the techniques are similar to those used to optically process photographs. The computer offers the advantage of special filters, enhanced color manipulation with a range of 24 bits of color, control of level of detail (such as magnifying accessories and fabric patterns), changing text, and most important, movement. Many standard computer special effects -- such as gleams and glitters, highly reflective surfaces, or wireframes -- are not necessarily appropriate to the style conscious subject matter. Other popular techniques such as fly-through camera moves, that rely on creating three-dimensional models, are not inherently the best way to present the subject matter and can be cost-prohibitive.

The control which the computer gives to the video image is suitable for making an emphatic statement. Rather than falling short of real life, the effect of a computer animation can be thought of as a caprice on real life -- much as fashion is.

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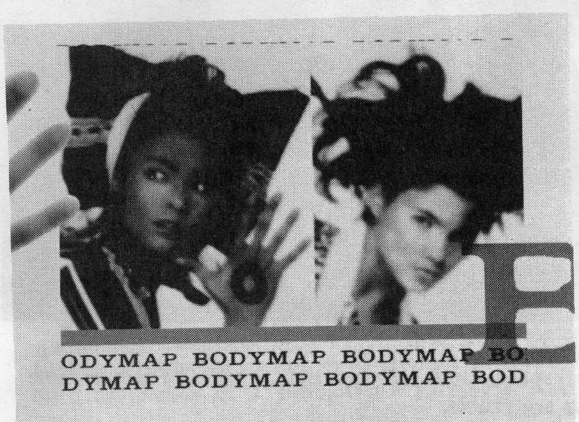

Figure 5-6 Frames from fashion animation.