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ROCHESTER INSTITUTE OF TECHNOLOGY

A Thesis Submitted to the Faculty of
The College of Fine and Applied Arts
in Candidacy for the Degree of
MASTER OF FINE ARTS

POINTS OF HUE

By

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April 15, 1989

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INTRODUCTION

My intent in this thesis is to display the visual capabilities of the computer as a tool to assist fabric designers, interior designers and consumers in a growing and demanding market. These ideas evolved out of my own personal interest in two seemingly different yet historically related fields, computers and textiles, and my feeling that there might be an obvious solution to the somewhat complex problem of visualizing surface pattern, texture and color in relation to the environment.

The invention of the Jacquard loom in the early 1800's provided a powerful, time-saving mechanism for weaving fabrics which contained complex designs. The Jacquard, with its system of punched cards as a means of processing data, is said to have inspired Charles Babbage and Herman Hollerith, two pioneers in computer engineering. Both the loom and the computer solved the problem of processing large amounts of data quickly and accurately, through mechanical and mathematical means. The development of computer looms and computer weaving software programs has renewed the relationship between these technologies.

Since I was learning about computers and weaving at the same time, these developments were of particular interest to me. In the weaving studio, I learned how a pattern could be created on a computer and viewed in repeat on the monitor before any thread ever touched the loom. The speed and accuracy of the computer to display patterns and to change them instantly if necessary was impressive; moving from conception to reality, from a digitized pattern to an actual fabric, seemed to offer limitless possibilities. I was frustrated, however, by the limitations in color selection and screen resolution.

The computer studio also allowed me to create a pattern and view it in repeat with ease and accuracy. Although I lacked the expertise to translate this pattern into a weaving set-up, I knew that it could be done. And with the computer, my frustrations with color and screen resolution were eliminated.

Computer displays are made up of a matrix of dots known as "pixels" (picture elements). The number of pixels that can be displayed at

one time corresponds to the screen resolution. The system I used in the computer studio, the Artronics (now the Genigraphics PGP Paint System), has a resolution of 512 x 480 ---it can display 512 pixels horizontally and 480 vertically. It can also display a palette consisting of 256 colors with the option to create 16 million. In comparison, the Apple II that I used to create patterns in the weaving studio displayed a much coarser image. Its highest resolution was 280 x 192 and can only display up to 16 colors.

Although I was not actually able to weave the Artronics pattern, this software allowed me to treat it as if it were a piece of fabric, bending it, folding it, viewing it in perspective. The potential of this tool to display fabric not just as a bolt of cloth but as applied to a chair, a wall, or a floor, with the computer's enormous color selection and ability to make instant changes, provided huge possibilities. This system could be used by a designer to create, by a salesperson to sell, by a consumer to make choices. I chose to assume the role of all three of these specialists and to create a tool which would be of benefit in any of these positions.

TOOLS

Artronics Computer and PC Paint software
Number Nine REVOLUTION Board
LENCO Sync Generator
LENCO Color Encoder
SONY VO5850 3/4" Tape Recorder
CONVERGENCE ECS-90 3/4" Editing Station
Genigraphics 100 Series V and D+

Faced with the choices of the Artronics PC Paint system or the Genigraphics object-based paint and animation system, I chose the Artronics PC Paint system because of its patternmaking and color-shifting abilities, two necessary functions that the Genigraphics system did not offer. This paint system was run on a Leading Edge computer, an IBM PC-compatible.

I chose video as the best method of presentation and tape-recorded my images on the SONY VO5850 3/4" tape recorder. I also needed the Number Nine REVOLUTION board installed in my PC, as well as the LENCO Sync Generator and Color encoder to provide NTSC composite video output (Plate #1). After the still and color-cycled images were recorded, I used the CONVERGENCE 3/4" editing station to synchronize them to music. Titles and credits were created, animated and videotaped on the GENIGRAPHICS 100 series V and D+.

PROCESS

Considering time and equipment constraints, my goal for final presentation was that it be informative as well as visually appealing. Since I wanted to show as wide a variety as possible of textures and patterns, the decision to "redo" the basic four rooms of a single house was obvious; the application would be more diverse and would encourage the viewer to tap a greater potential of the system.

Research & Development

Research centered upon a large number and variety of books and magazines pertaining to interior design. Drawings rather than photographs from these sources seemed to allow for a more attractive finished print which could be used as a marketing tool or given to a client, much as a realtor supplies an artist's rendition of a recently purchased home. The line drawings were adapted from fairly conservative rooms which offered a variety of patterns and textures.

Grabbing

Images were digitized into the computer through the "grab" function. Using a video camera connected to the computer, a digital representation of each drawing was created. This image was interpreted by the computer as "bits" of information. Each bit corresponded to a pixel on the computer screen, allowing for manipulation of the image. Under normal circumstances, this would have been an uncomplicated process. However, the high contrast of the line drawings together with the limitations of the video camera presented difficulties. In order to grab a sharp image, the Artronics system was interfaced with the Genigraphics system including the Ikegami video camera, Lenco sync generator and color encoder, which were of higher quality.

Object & Palette Control

The Artronics paint system is raster-based; that is, images are created as blocks of color composed of individual pixels. They are not objects that are created by vectors or lines which connect x and y coordinates. The movement of a vector-based object is merely a repositioning, on the x and y axes, on which any number of objects can occupy the same position. Movement of a raster-based "object" involves the reinterpretation of pixels, of which there can only be one per position on the screen.

Images may be copied and positioned about the x and y axes, but they may not overlap one another and still remain intact, as in an object-based system. For example, if a chair which is positioned in the foreground of a scene is removed from that scene, it is done by duplicating it within a bounding rectangle. This action duplicates not only the chair, but any pixels occupying the space within that rectangle, such as the floor and the wall. These extra pixels cannot be removed, but they can be made transparent, so that although one is working with a rectangular shape, the only picture elements visible are those of the chair.

Since I wanted to create an illusion of depth in my rooms, some furnishings were needed to occupy background space, some for foreground space. I also wanted these furnishings to "pop into" the empty room starting from the background and moving to the foreground. To achieve this effect, each piece was taken from the original drawing, rendered and saved separately with a transparent background, so that they could be layered on top of one another. Registration was not a problem since these pieces could be restored to the exact position from which they were saved.

Through the process of "color-shifting", each object was then assigned its own position on the palette, allowing for independent color manipulation of each object. Palette control and organization became crucial at this point. Fortunately, each of the 256 displayable colors is assigned a number which, when selected, appears on the instruction monitor. I kept a record of which pieces corresponded to which color palette numbers. This palette set-up also became a factor in the final presentation.

Cycle paint vs. Hue change

In the Artronics system, colors appearing on an image correspond directly to colors on the color palette: if a color is changed in the palette, it will also change on the image. This function allows the user to change, in a single, simple operation, a blue chair to red, a green wall to yellow, etc., while retaining its shading and pattern. This simplicity is one of the most important visualization functions this system possesses and cannot be over-emphasized. Two processes that demonstrate

this function are "color cycle" and "hue change": both appear as limited animation, as colors cycle through the palette and consequently through the images. The difference between these functions is the specific range of colors each displays. I chose "hue change", because it offers the viewer more choices than does "cycle paint".

Cycle paint will only cycle through the existing 256 displayable palette colors. Hue change will create different available hues for the existing palette colors, allowing for a much greater color variety. (An unexpected but pleasant surprise occurred during this cycle of color: since the colors of each object were located in 16 space increments on the palette, objects changed color as the colors cycled, one at a time instead of all at once. Thus, it was possible to see the effect, on the entire room, of a color change in any single object in the room, as well as to see the effect of a total color change in all objects.)

Pattern making

Research and development of patterns evolved in much the same way as did the room designs. Constant searching through books, magazines, and stores which specialize in fabrics for the home provided endless inspiration and ideas. I discovered a wide variety of colors and patterns ranging in diversity from small, simple pastels to large, bold, exotic statements. I found nature and angularity to be recurring themes in pattern design, along with ethnic influences from South America and the Orient.

Predictions from the Color Association of the United States (CAUS) provided important assistance to me in patternmaking. This association is composed of professionals in the fields of color styling, color use, color research, marketing and merchandising. They predicted reds, pinks and corals to continue as a major direction into 1988. The traditional neutral, ivory, bisque, white, tan and oyster would all retain their importance. Recommended accents in hot yellows, oranges, reds, pinks, tourquoises and yellowed greens, being tropical in feeling, were said to satisfy the American appetite for color in smaller living and working spaces which call for non-light-absorbing colors.

My goal in designing patterns was to have maximum appeal by giving as many choices as possible, based upon what I had seen. All patterns were created within the Artronics paint system instead of through the grabbing process. Since patternmaking is a simple function of the computer (a mathematical repeating process), it was easy to be creative with colors and styles. Some of these patterns were made very deliberately, while others were purely experimental.

Admittedly, my personal preference for earth tones did become apparent as I was making color selections. The bedroom, living room, and kitchen took on a warm and golden atmosphere. The richness of the blues and greens in the bath, with tan and gold accents gave it a cozy feeling as well.

While the creation of flat patterns was relatively easy, fitting them to the dimensions of a room or a piece of furniture were a little more complex. Although I was working in two dimensions, I wanted the illusion of three dimensions, to give the viewer a more accurate picture from which to make choices. This illusion was created in four steps. First, a flat, rectangular "swatch" is created: the pattern. Then, a template is created to conform to the shape of an object: the mask. Next, the pattern is forced to conform to the shape of the object by moving end points. Finally, the mask is placed on top of the reformed pattern. Finishing details were blended and painted in free hand.

Title

The title "Points of Hue" was chosen because it seemed to encompass the whole project. Literally, because a computer image is made up of pixels of color; points of hue. The play on words "points of view" deals with the interactive aspect. Had this system reached its full potential, a viewer would be able to make choices based on personal preferences, using information given on the computer screen. As the viewer's selections were refined, the computer would continually interpret and reinterpret point of view.

The animated title sequence, consisting of four rectangles passing through one another to create four squares of their combined color,

as well as the embossed type, was created on the Genigraphics system. The rectangles and subsequent squares represent the four illustrated rooms and symbolize the pixel or point of color on a computer-generated image.

PRESENTATION

My choices of display were a series of prints, a slide show or a videotape. I chose video because it is more informative than prints, less cumbersome than slides and offers easier manipulation for editing. Planning was of critical importance; the actual recording was just a matter of pushing buttons. The first step was the creation of a storyboard, with the basic script I would follow. Since I was not working with an animation system, I had a few challenges to deal with. One was the timing of fade-ins and fade-outs as well as zoom-ins and zoom-outs. Another was the smoothness of transition from black and white to color.

Recording

Fade-in and fade-out timings were determined by the motion of the pen on the tablet. Smoothness and consistency became a matter of practice. Thanks to the versatility of video, I was able to record a great many fades and chose the best of them later on in the editing process.

Zooming was a bit more abrupt, since it is a keypad function instead of a pen and tablet function. The best way to make it work was to be quick, deliberate and consistent.

Transition from black and white to color was achieved by combining a technique commonly referred to as a "wipe", with the zoom function. Once the black and white scene was set, blocks of patterns appeared on top of the image, eventually covering the entire scene (Plate #2). I was able to zoom in on one pattern, change the scene and zoom in to the same pattern, now in perspective. I zoomed out to reveal the previous black and white scene, but with one piece in color, immediately followed by the rest of the room turning to full color (Plate #3).

This entire step-by-step recording process consisted of:

1. Setting the tape player to record
2. Recalling an image
3. Recording for five to ten seconds
4. Cutting out the tape player
5. Recalling another image
6. Repeating sequence

Changing of hue was the most difficult to control and therefore took more time to record. In total, I recorded approximately 40 minutes of tape which was edited down to five minutes for the final presentation.

Editing

I listened to a lot of music before deciding on "The Velocity of Love". The final decision was based on the fact that I could hear four distinct sections and I could visualize each of the rooms in those sections. I also noticed a background beat which would help to provide points for editing. Again, at this stage, planning became the most important part of the actual manipulation.

First, the music was recorded on a videotape with time code. This became the record tape. Time code is a time reference recorded frame-by-frame on the spare track of a videotape, providing an hour, minute, second and frame count. It is a very high frequency, invisible pulse that can be read by computer-assisted editing equipment such as the one that I used. This identification allows for more accurate editing, since it can be done numerically as well as visually. The source tape consisted of the previously recorded scenes and time code.

Time code was absolutely essential since editing had to be so tight. Using the Convergence ECS-90 3/4" editing station, I first listened to the music and noted my time code for the four sections, so I would be sure not to run out of music. Then, I listened for the exact beat where I wanted an image to appear, marked that as an "in" point, found the image on the source tape, marked that "in" point, and edited.

PRESENT
LIMITATIONS

While the Artronics Paint system had a lot to offer in terms of color and design, it fell short in terms of creating a realistic environment. One of the greatest limitations was the creation of a 3D image on a 2D system. This system could provide only an illusion of 3D space not much different than a rendering on paper.

Another limiting factor was the time involved in creating "objects" within a raster-based system (see OBJECT & PALETTE CONTROL). This was an extremely tedious process and can be related to creating paper cut-outs of an interior drawing.

The fact that the colors and patterns used were fictitious can be considered a limiting factor as well. These were not actual fabric swatches. The colors were not created in the same manner as actual dyes or paints. They were only suggestions of what could be done when an artist creates them with colored pencils on paper.

One might ask, "Why bother with the cost, maintenance and training required of a computer and a computer designer, when I can produce the same results with an illustrator and a few pieces of paper?" The answer is: imaging power.

A computer is a visualization tool just as paper and pencils are visualization tools. The advantage of the computer lies in its speed, storage capacity and ability to create immediate changes.

Let me offer a brief scenario to illustrate this point: A client walks into a fabric shop intending to give his bedroom a new look. The room has just been painted and he's interested in bedspreads, draperies, and matching accessories. As he will be spending a good deal of money, he wants to feel sure about the finished product, but such certainty is difficult to reach by looking at swatches or bolts of cloth.

Provided with proper software, a computer artist could produce twice as many variations, in probably half the time, as an illustrator rendering the project on paper. More importantly, changes can be made visually and immediately while the shopper looks at the computer screen. A bedspread, for example, could be changed in a matter of seconds, as would the look of the entire room. This is much more exciting for a customer than waiting hours for a new sketch to be made, and potentially more reassuring.

FUTURE POSSIBILITIES

EPICAD

EPICAD, a unique pattern design system, was displayed at the 1987 SIGGRAPH convention in Anaheim, California. It is a division of LEEDYE, Inc., a Quebec textile dyeing and finishing company which is wholly owned by Burlington, Canada, Inc.

The division was formed in 1986 as an in-house system, when careful search failed to turn up a computer graphics system suitable for textile print design. So much outside interest was generated by this development project that LEEDYE, Inc. decided to market it to the textile community, as well as to other industries in which repeat patterns are the norm (wallpaper, gift wrapping paper, etc.).

This design system is based on a powerful raster-based computer paint system with the extremely high internal resolution of 2800 by 2800 pixels. The software allows the designer to create with ease a new pattern or to edit an existing one, to put a pattern into repeat with a touch of a pen, to change the type or size of repeat, change the colors, or perform symmetry operations, all with a continuous view of what the final repeat pattern will look like.

In addition, the system is customized by a wide range of input and output devices, ranging from a video camera and ink jet printer for small patterns or conceptual work, to full featured ultra high resolution scanners and large format laser output devices for large pattern CAD/CAM.

Fabricated Rhythm

A 15-minute animation entitled Fabricated Rhythm was accepted into the 1987 SIGGRAPH Film and Video Show.

Produced at AT&T Bell Laboratories, it illustrates research being done in the area of cloth animation. Pieces of cloth with varying stiffness and elasticity are blown in the wind, draped over furniture and formed into clothing to the rhythm of the music.

Roomer 2

Designed by Hufnagel Software, Roomer 2 is a low cost 3D system that runs on an IBM PC/XT/AT or compatible. It can build an accurate three-dimensional model of an area, complete with furnishings, that can then be displayed and manipulated.

This system includes four integrated program modules: Make Room is used to construct room or floor plans; Furnish is for adding furniture, drapes, curtains, stairs, electric components and decorations, such as mirrors and paintings; View creates 3D views and Layout Page is used to print or plot the finished drawing.

It is being used by facility designers, remodeling firms, realtors, space consultants, developers, and interior decorators as a highly satisfactory answer to the problem of creating and presenting their plans and proposals. It is also being used in education as a means to teach design principles.

ModaCAD

ModaCAD is a tool which combines design creativity with business productivity. Developed by the company of the same name, it runs on the Macintosh II and is used for computer-aided fashion design and manufacturing. Designers and manufacturers can automate design sketching, pattern generation, grading and marking, project management and manufacturing.

CONCLUSION

Major developments of systems that integrate computer graphics with textile design and interior design illustrate a constantly increasing market demand. It seems that no sooner does one system appear on the market than another one is right behind it, with better features and greater cost effectiveness. New ideas are feeding off of old ideas, causing constant improvement and change.

My presentation merely scratched the surface of what could be done, given the proper technology. I envision a true interactive system complete with 3D real-time display. I would incorporate a touch screen and perhaps a videodisc to store a vast library of images consisting of rooms, furniture, fabrics and patterns. This could be used for all types of interior designs ranging from homes to corporate offices. It could overflow into environmental design, fashion design and product design as well. The possibilities are endless.

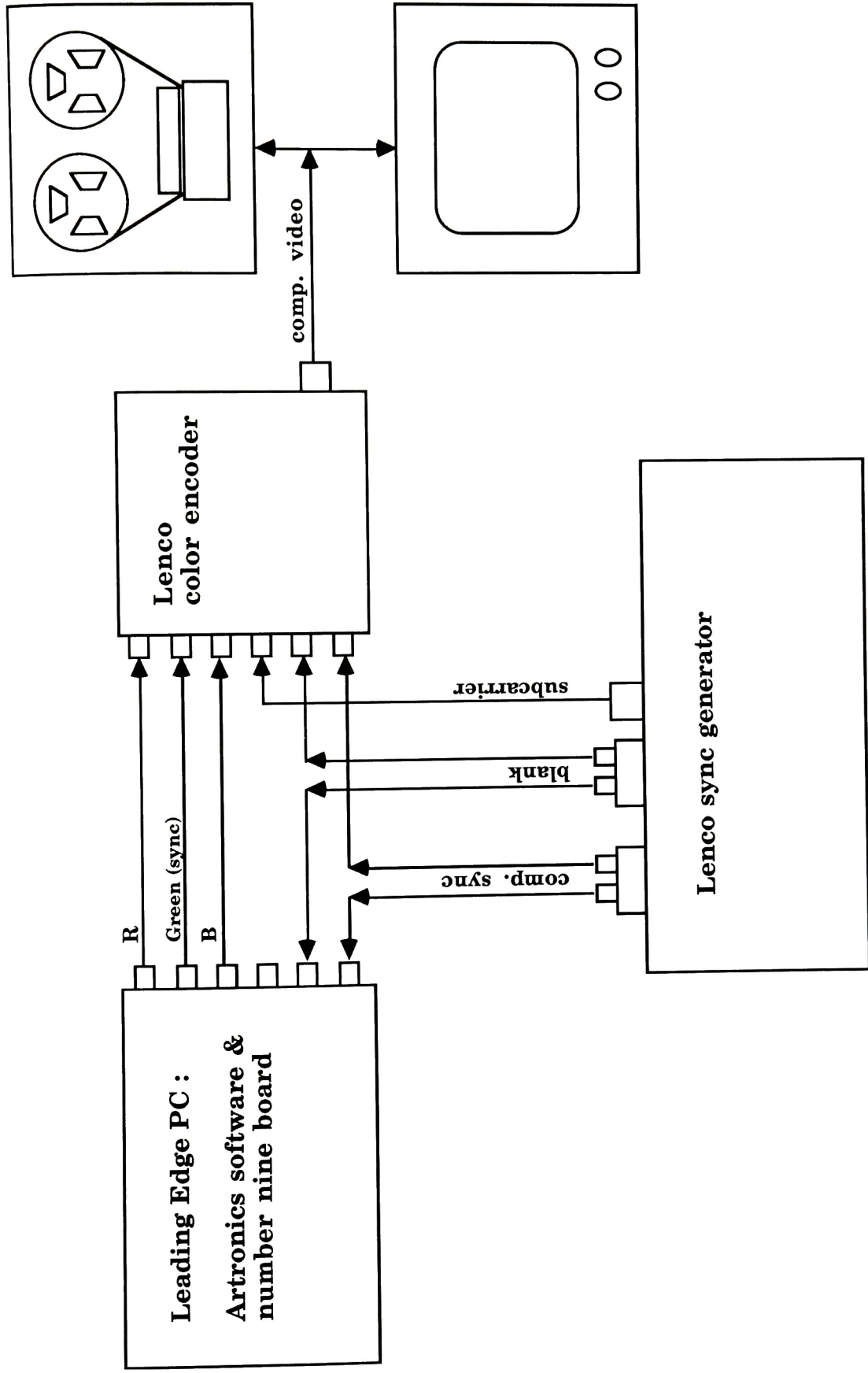


PLATE #1

Recording set-up

PLATE #2

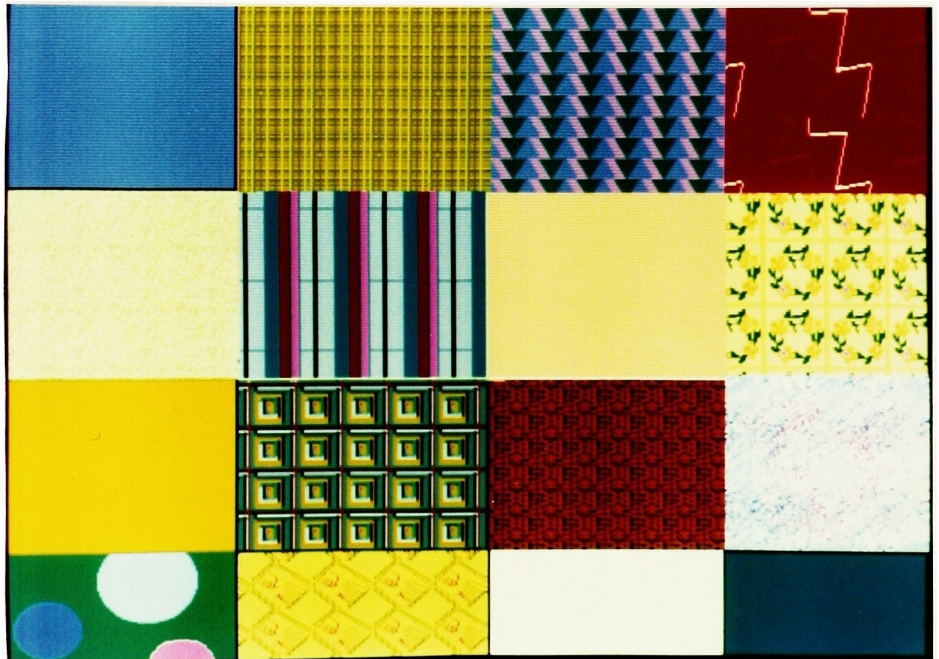
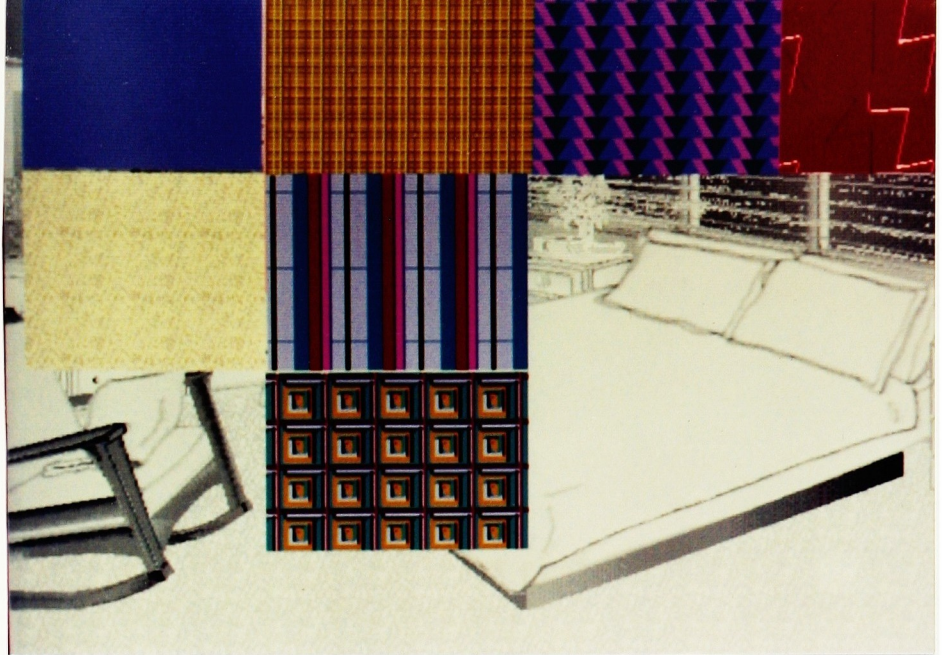
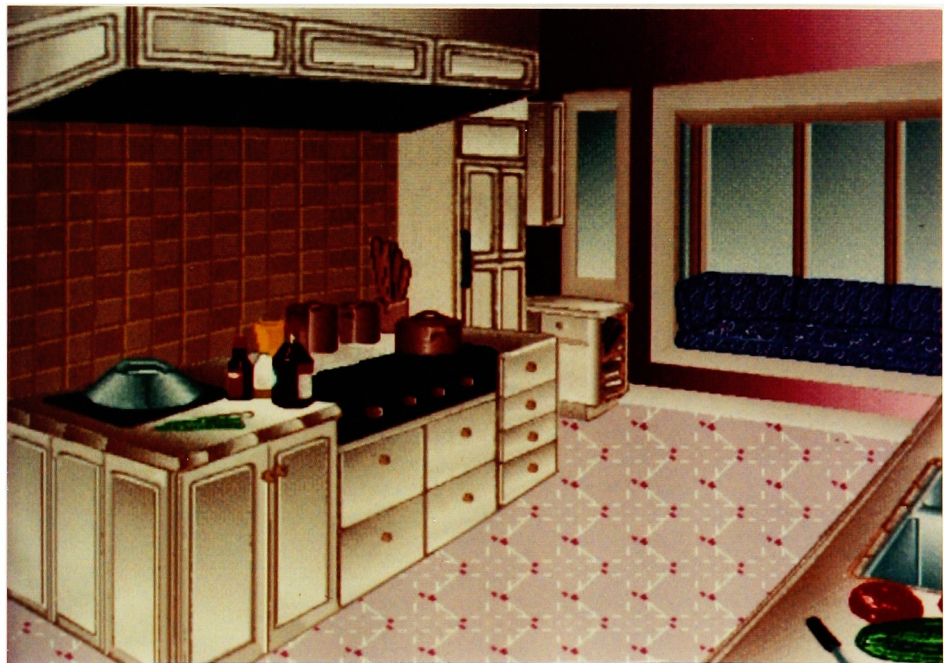


PLATE #3



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