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MasqueArray
Automatic Makeup Selector/Applicator
by
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Nowadays, makeup is becoming more and more important because one's appearance can affect one's success in business, professionally, and socially. Women generally feel more self-confident when they are wearing makeup. Few are born with an ideal face. In light of the fact that there are more women in the workplace, and the realization that one's appearance can affect one's career, there is increased interest in effective cosmetic makeup that can be applied quickly.

Problems

Putting on makeup is a time-consuming process. Each day, many women spend almost an hour to make up and maintain their faces. They will spend almost 3 years of their lives making up. Not only do they have to spend time, but they also have to rely on their skill. If the colors do not go together, their faces will look strange and fake. If they do not like the results, they will need to redo them.

One can become bored with two or three styles of makeup that are applied day after day. However, trying new styles will cost a lot of time and money because women have to apply cosmetics to their face in each style until they are satisfied. Some people hesitate to try new styles of makeup because they don't have much knowledge about the making up process. Furthermore, some styles of makeup are not suitable in daytime but are only appropriate at night because of the effect of different light sources.

Some women do not like to make up because of the complexity of choosing cosmetics. There are a number of kinds of cosmetics that are used for making up. The user has to choose each cosmetic for compatibility of color with skin, face, personality, fashion choices, and daily wardrobe.

The most important thing is to avoid facial damage. The process of applying cosmetics is very important for the health of facial skin. If too much makeup is applied, the face cannot breathe. Consequently, it will cause pimples and wrinkles will develop that one absolutely does not want.

Issues

In order to create an Automatic Makeup Selector/Applicator (AMS/A), several issues such as technology, anthropometrics, ergonomics, safety, appearance, speed, skill of making up, permanence, variety, symmetry, and color have to be considered.

Some technologies for supporting this product still are in the process of research and development.

Anthropometrics of the face is a factor that affects the precision of applying makeup to the face. Accordingly, this product should be adjustable to accommodate anyone's face in the appropriate position.

Safety is one of the most significant issues for this product, especially regarding the application of makeup to the eye area. All technologies that could be utilized have to be harmless.

The product should be user-friendly, approachable, comfortable, and stylish in order to attract customers.

The speed issue is divided between the preview process and the application process. The time of the preview process depends on how long the customer spends choosing the styles. The speed of the application process should be only a few minutes.

Skill in using this product should not be demanding. The AMS/A should be comprehensible and easy to use.

The makeup that can be applied by this product should be long lasting. The makeup should only be changed or erased when the users want to clean the makeup from their skin by utilizing a special cleaner.

The AMS/A should include a variety of styles, colors, shapes, and textures for the customers to combine by themselves.

Process of Design

The first step to create this product was to establish goals. They are to provide the following:

- Nearly instant makeup choice recommendation
- Color and style preference recording
- User friendly tools and processes
- Choices and creation of colors
- Choices and creation of styles
- Time reducing process
- Preview function
- Product safety
- Adjustability
- Hygiene

The second step was to define the problems and clarify each issue. To solve the problems, research was done in three categories. The first was the process of applying foundation, blush, lipstick, and eye shadow. Each application has its own technique to make it appropriate for each individual face. Trends, colors, and styles also were researched because they constantly change. The second category of research was facial anthropometrics. Anthropometrics of the face is an issue that affects the precision of applying makeup to the face. Lastly, technologies such as the 3D scanning, display technologies, virtual reality, voice recognition, and 3 dimensional printing needed to be researched for the plausible development of the design.

Establishing criteria to achieve the goals was the third step of the design process. This product would include the function of scanning the user's face, previewing styles on the user's face, and providing shades of foundation, shading, contouring, eyeshadow, blush, and lipstick. It would not include applying hair styles, mascara, and removing hair such as eyebrows.

Generating concepts by sketching was the next step. Not only do all concepts were delivered through users' needs and functions, but were embodied with semantic metaphors of beauties.

In the fifth step, the sketch concepts were evaluated as to how well they met the criteria. One of the design concepts was chosen for development.

The sixth step was the development of the design. The development was accomplished with Alias Wavefront software.

Finally, There was an exhibition of my design using multimedia presentation techniques. I gathered feedback and suggestions from the exhibition, and then drew conclusions and speculated on its potential for use in the future.

User Behavior

In order to design a product to facilitate the makeup process, understanding user behavior is important.

Complexity of choosing cosmetics

There are over 100 brands of cosmetics on the market. Prices are varied from affordable to exorbitant. In many brands, there may be over 50 products. Furthermore, each product may have at least 10 different colors or special properties. One would have over 50,000 choices of cosmetics.¹ Beginners would not be able to fathom what products are suitable for their skin and faces. The beginner user may counsel with makeup sellers, makeup artists in beauty shops, relatives and friends. Nevertheless, choosing cosmetics is a difficult matter. The user may need to experiment in selecting suitable cosmetics in order to find those that work with their own skin conditions and complexion.

¹ Cosmetic Connection, "Product Finder Resource", accessed 19 september 1997, available from <http://www.kleinman.com/cosmetic/shopper.html>, Internet.

Complexity of the makeup process

A comparison between a professional makeup artist's process and a nonprofessional's makeup process is interesting.

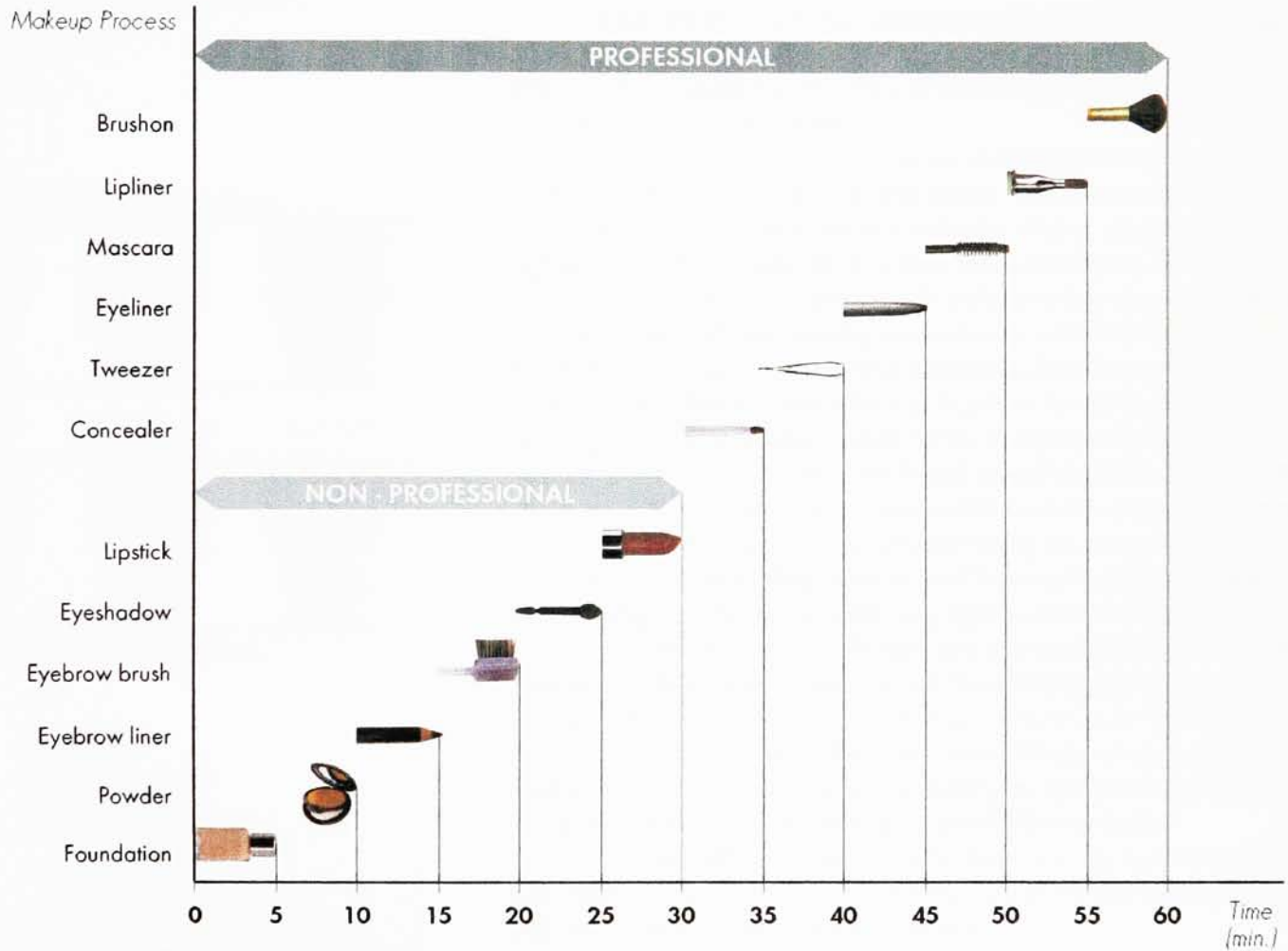


Figure 1. Makeup Process
 (Leonard Engelman, *Your Beautiful Secret*, [Dallas, TX., Equiknox Partners, Inc., 1996], Video.)

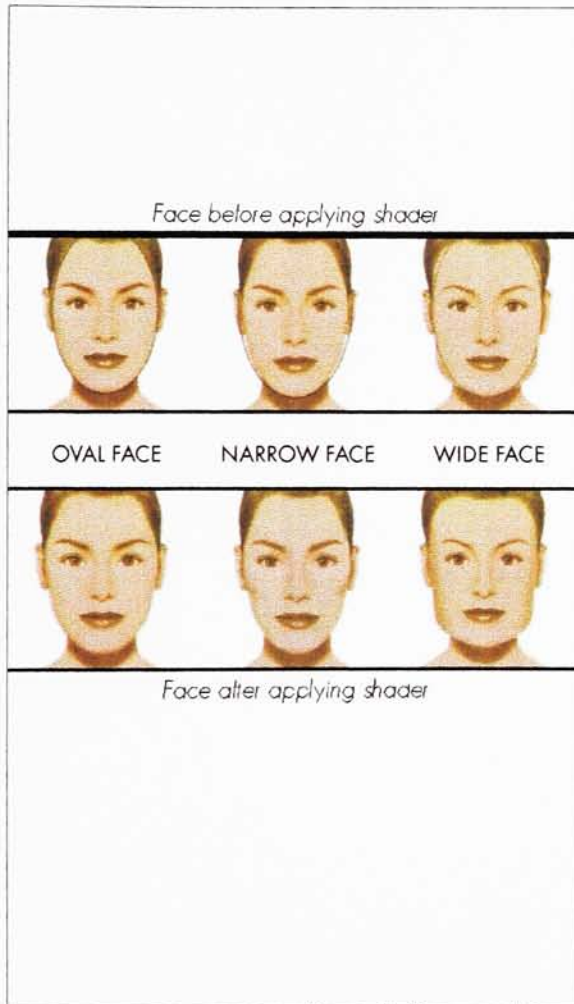


Figure 2. Structure of Faces

It can be seen from the comparison in Figure 1 that a professional makeup artist's process is dramatically more complicated than a nonprofessional's makeup process. Every application must be well mixed together. This requires time, personal experience, skill and knowledge.

In general, structures of faces are divided into three categories: oval face, wide face, and narrow face. The oval face is considered to be an ideal face.² The wide face and narrow face can be shaded by utilizing darker shaders and brighter highlight in order to achieve the oval face shape (see Figure 2).

The making up process normally includes a face preparation procedure. The face preparation includes applying foundation for smooth skin, concealer for covering blemishes, and highlight and shader for contouring. These three processes are determined to be the most substantial and laborious to put on. For professional makeup artists, applying these three cosmetics would not be a major problem. They would be able to blend cosmetics on the face naturally and beautifully. On the other hand, beginners, who have no special skills, may make unmatched color selections. Furthermore, applying excessive amounts of makeup may bring up more wrinkles, especially in the eye areas. Powder is another cosmetic used for smoothing the face, drying up grease, and blending foundation, concealer, highlight and shader together.

The eyebrow process is the next step after completion of the face preparation. Eyebrows could be shaped and painted. The process of doing brows is demanding in order to even and balance both eyebrows. This is due to the different abilities of using the left and right hand. This also causes difficulty when using eyeliner and eyeshadow. Only professional makeup artists can apply and blend eyeshadow gracefully, particularly when employing especially dark colors.

Blusher is utilized to accentuate the structure of the face and bring up a radiant look. Blusher colors are not merely limited to coral or red, and they should be compatible with other cosmetic tones applied to the face.

The lips can be tinted to provide the illusion of thicker lip size by using lipstick

² Leonard Engelman, *Your Beautiful Secret*, [Dallas, TX., Equinox Partners, Inc., 1996], Video.

and lipliner. Thinner lips can be accomplished by using concealer, lipstick, and lipliner. For a person who does not have symmetrical lips, balancing the lip shape is a painstaking process because of the precision required.

Mascara is the last process of makeup. Mascara can enhance the eyelashes by lengthening, curling, thickening, and darkening them.

The process of applying makeup is complex. A makeup machine could assist users in every procedure. A makeup applicator machine could provide ease of use, precision, skin analysis, color complexion analysis, face structure analysis, cosmetics recommendation, and preview function. A preview function would allow users to experiment with styles, colors, and shapes before applying them to their faces.

Selection of styles

Make up trends are constantly changing. There are some other circumstances such as occasions, moods, or the color and style of attire that may influence women to change makeup styles. In order to get new styles, cosmetic users need to experiment with different styles until they find something suitable. Applying makeup by using personal skills may not guarantee that a user can obtain the same result every time. Experimenting may cost both time and cosmetics.

A makeup application device would allow a user to experiment, create, choose, mix, and match for different results. The user would be able to decide which style would be appropriate before applying makeup to the face. Moreover, the user may save preferred styles as a personal record.

Time Consuming Process

The more processes and details, the more time-consuming the procedure. A person could spend over an hour with the entire makeup process. In general, most people have inadequate time to do so. This seems to be another trade-off between beauty and time.

Time is one of the critical factors that may affect the application. Everybody wants to gain a perfect face within a short period of time. In order to solve the problem, the makeup applicator machine should be able to apply makeup on the user's face automatically and quickly.

Marketing Strategies

A customer may need assistance or encouragement when using a new technological product. For this reason, the Automatic Makeup Selector/Applicator should be placed in a beauty salon. In addition, the price may not be suitable for personal use.

Technologies

An automatic makeup machine is proposed to shorten a time-consuming makeup process. Moreover, it should provide an instant recommendation, a variety of styles and colors, and a process of applying makeup. In order to achieve these objectives, relevant technologies were considered, such as personal data analysis and storing technology, makeup selector technology (display and interactive), and makeup applicator technology.

Personal data analysis and storing technology

Personal data analysis and personal data storage are primarily utilized for identifying and recording a customer's face structure and skin characteristics.

Identifying customer function

Personal data which includes name, face structure, complexion condition, preferred styles, preferred colors, and personal preference, could be recorded electronically. All data could be recalled in order to accelerate the makeup process. The user would be able to select makeup styles on file and apply makeup instantly.

Existing identifying technologies that may be suitable for an automatic makeup selector and applicator consist of face recognition, voice recognition, retina reader, fingerprint reader, and password recognition.

- **Face recognition**

Face recognition is a technology that utilizes a Central Processing Unit (CPU), a video camera, and face recognition software. The identification process is mainly composed of two different processes. The first process is the enrollment process. The user's face is captured from a video camera. The image can be stored in a storage medium, a plastic card, a computer chip, or a database. In the access process, the user's face is captured one more time. Then, the CPU searches for a matched image

from the database. If the image is matched, the user has accessibility.

- **Voice recognition**

Voice recognition uses speech as input. This technology does not require any massive physical input device, such as a keyboard or mouse. This is considered as a “hands-free device.” Voice recognition would require a microphone, CPU, and voice recognition software. This technology also matches the user’s pre-recorded voice and the user’s live voice. When the user’s voice is matched, the command could be activated and executed.

- **Retina Reader**

The retina reader is a device normally used for identifying applications. This technology requires the user to look through the machine, which directs light to the back of the user’s retina. The light allows the machine to capture and identify the user’s vein pattern.

- **Fingerprint Reader**

The fingerprint reader identifies fingerprints by making a comparison between pre-recorded fingerprint images and live-scanned fingerprint images. This technology combines a fingerprint reader, CPU, and fingerprint verifying software.

- **Password Recognition**

Password recognition requires some extra input device, such as a keyboard or mouse. Password recognition can be integrated with voice recognition technology. The CPU can verify the identification by matching the entered password with the one in the database.

A comparison of technologies identifies face recognition as the most suitable technology for the identifying function of the AMS/A (see Table 1). Face recognition is a rapid and precise process. Moreover, equipment required by this technology could be used in the 3D scanning process as well.

Identifying Means Issues	evaluation Face Recognition	evaluation Voice Recognition	evaluation Retina Recognition	evaluation Fingerprint Recognition	evaluation Password Recognition
Low false accept	4 low	4 low	5 very low	5 low	5 low
Low false rejects	5 < 2 %	3 5% on telephone 20% on microphones	5 1 %	4 5 %	5 1%
Ease of use	5 very good	4 good	2 poor	4 good	4 good
User process speed	5 2 seconds	3 3-9 seconds	2 15-30 seconds	4 2-5 seconds	3 6-10 seconds
Comments	cannot be fooled by a picture of a correct person because it requires 2 views of live picture.	can be made fraudulent with a voice recorder.	people will resist anything being measured inside their eyes.	restricted for law enforcement use.	can not work when password is forgotten.
total	19	14	14	17	17

5 = very good 4 = good 3 = fair 2 = poor 1 = very poor

Face structure and skin analysis /record

Face structure analysis and complexion analysis can be provided by 3D or 2D technology. The 3D-analysis procedure, using a 3D scanner, could capture three dimensional geometry, color mapping, and texture mapping simultaneously. On the other hand, the 2D-analysis procedure, employing a video camera, could capture exclusively the flat image with colors.

• 3D Scanning

The 3D scanner allows the user to quickly scan one's face in 3 dimensions with texture mapping. Components of the 3D scanner are a triangulation-based laser, a position mirror, an ultra-fast galvanometric motor, a black and white video camera, and a color video camera. A triangulation-based laser is reflected from a positioning mirror to the surface in order to obtain the profile of the face. An ultra-fast galvanometric motor positions the laser strip to several locations within a single frame of the video camera. A black and white video camera collects reflected light from the face. A color video camera captures the texture map or complexion of the scanned face. This texture map would be applied onto the surface of the reconstructed facial topography.

• 2D Scanning

Video camera or digital camera technology is used for capturing a 2D image of the user's face. However, editing colors and shapes on a 2D image for makeup preview may not be an effective method. Painting color on a 2D image may not provide a realistic look, especially for lighting, shadow, shade, and dimension. This may create an unwanted result when previewing and applying makeup. Moreover, 2D may provide adequate information about width and height, but not contours of the user's face.

From the comparison of using 3D and 2D scanning, 3D scanning could simulate a better preview. The simulated images are constructed under the circumstances of light directions, shadows, reflections, color mappings, and texture mappings. In as much as a 3D scanner structures a face in three dimensions, a computer generated

face could be divided into parts such as eyebrows, eyes, nose, cheeks, forehead, chin, hair, and lips. Applying a color onto those surfaces should give a realistic look by displaying accurate shades and shadows. In contrast to 2D application, 3D application could restore more information about the user's face contours. The 3D application would provide substantial accuracy when the user is previewing and applying the makeup.

Makeup selector Technology

In order to allow the user to preview makeup in different styles, a display and interactive technology is required in this Automatic Makeup Selector/Applicator.

Display Technology

The preview function and instructions would be included and shown through a display. Display technology would play an important role in the design, particularly for shapes and forms of the product. In addition, the display technology also influences the choice of interactive technology that can be used. The three options of displays are as follows:

- **Flat panel display**

Nowadays we have the flat panel display, a thinner display with anti-reflection and anti-glare. This technology produces a shared information medium. Several persons can view images at the same time.

- **Head Mounted Display (HMD)**

HMD is a comparatively small virtual output. The advantage of HMD is portability and hands-free operating. The display is close to the eye. Although the display is small, the user can perceive it as a large size display. HMD is essentially restricted by weight, comfort, and safety aspects.

- **Digital Light Processing (DLP) Projector**

DLP projector consists of three digital technologies: digital light processing, computer, and video decoding. Keyboard and remote control are input devices. This machine functions the same as a computer, but images are projected. The size and resolution of the display may vary depending on the distance between the screen and the projector. The bigger the display, the less the privacy.

Issues \ Method	Flate Panel Display		HMD		DLP Projector	
	evaluation	Comment	evaluation	Comment	evaluation	Comment
Ease of use	5	users are familiar with the display.	2	user may not be familiar with the technology.	3	product is used in dark environment.
Safety	4	radiation and static are emitted.	3	radiation and static are emitted.	5	product is used in dark environment.
Comfort	5		2	user may feel claustrophobia.	5	
Privacy	5	high resolution	3	low resolution	3	color distortion
Precise color and image	3		5		1	
Minimum size	3	varied	5	small	3	large
Minimum operating space	3		5		1	
Non glare display	3	light sources and display angles are main factors.	4	bright light source may interfere with the perception.	5	none on a projector screen.
Durability and ease of maintenance	5		3		4	
total	36		32		30	

5 = very good 4 = good 3 = fair 2 = poor 1 = very poor

From the comparison in table 2, the flat panel display has the best benefit. Because of the need for color accuracy, the image quality rather than the size of the machine seems to be the first priority of this product. The user requires certain privacy, but not a closed environment, since she may need assistance. People may have concern about personal belongings or purses carried into the beauty shop. In the case of two-display (full-peripheral vision) HMD, the user would not perceive the outer environment when donning the apparatus. Furthermore, the user may not feel comfortable when secluded from reality by the simulated environment. In the case of one-display HMD, images on display could be adversely affected by the surrounding ambience. Therefore, the flat panel display is the best choice for an AMS/A in a beauty salon environment.

Table 2 . Display Technology Comparison

Interactive Technology

The user may spend most of the time on an AMS/A choosing colors and styles of makeup while using interactive multimedia. For this reason, the selected interactive technologies should be user-friendly. Interactive technologies may consist of touchscreen, voice recognition, mouse, keyboard, pen-based screen, or eye tracker.

- **Touchscreen**

A touchscreen is an input device which can communicate with the CPU. The computer could respond to the user by direct touch on the screen. Touchscreen technology is considered to be one of the most simple and effective technologies.

- **Voice recognition**

A microphone and CPU are components of voice recognition technology. Voice recognition could be facilitated by means of voice recognition software. This software translates voice commands into computer language or text that can be understood by the computer. Then the command would be activated and executed. Voice recognition is a fast and hands-free process, but could not be utilized in a noisy environment. This technology needs more development of pronunciation recognition and incorrect grammar recognition.

- **Mouse and Keyboard**

There are 2 kinds of mouse: wired mouse and wireless mouse. The user may need skill and familiarity to use a mouse. Mostly, a mouse is used to make a selection. The keyboard is used for input information or data.

- **Pen-based interface**

Pen based interface is an input device that could integrate the function of touchscreen, mouse, and keyboard. One makes a selection by using a pen in lieu of a mouse. The user would be able to input information by the use of handwriting. Pen based interface may not work well because of the limitations of handwriting recognition. Moreover, a pen may be easily lost.

- **Eye tracker**

A computer, video camera, high-speed infrared sensitive camera and lens, and eye-image monitor are used in eye tracker technology. In order to operate or activate the machine, the user needs to look at a specific area for a specific time. The eye tracker will determine the location on the computer screen where the user is looking. Then the machine executes what the user chooses. Outdoor usage is a limitation of an eye tracker machine because the machine is sensitive to infrared light. Also for this reason, fluorescent light is more compatible with the machine than incandescent light.

Table 3 shows the pros and cons of each interactive technology. Each technology is given a subjective value relative to six issues. The issues are weighted according to their relative importance. The products of the two provide a useful comparison.

Issues	Method		Touchscreen		Voice Recognition		Mouse & Keyboard		Pen-based Interface		Eye Tracker					
	value	evaluation product	evaluation product	Comment	evaluation product	Comment	evaluation product	Comment	evaluation product	Comment	evaluation product	Comment				
Ease of use	5	5	25	no skill required	2	10	hand-free device requires precise accent or pronunciation	3	15	requires skill for mouse control	4	20	requires extra equipment (pen) as an input	4	20	hand-free device
Interactive response confirmation	5	3	15	command executed when finger touches the screen	4	20	command executed when user speaks	5	25	command may be highlighted before executing	3	15	command executed when pen touches the screen	1	5	the user does not know when the machine will activate
Speed	5	4	20		3	15		2	10		3	15		5	25	
Accuracy of activating and executing	5	4	20	less accuracy in small area	2	10	sometime voice may not be recognized	5	25		5	25		2	10	user may activate command accidentally
Environment compatibility	4	5	20		1	4	may not be efficient in noisy ambience	5	20		5	20		2	8	could not perform well outdoors and in incandescent ambient light
Less components and processes	3	5	15		2	6	microphone, speaker, software	3	9	mouse, keyboard	4	12	pen	1	3	video infrared camera eye detector monitor software
total			115			74			104			107			71	

5 = very good 4 = good 3 = fair 2 = poor 1 = very poor

Table 3. Interactive Technology Comparison

Makeup Applicator Technology

At present, there is no existing technology for applying makeup automatically. A study of promising processes and technologies would be advantageous. This study can be considered as a projection.

Printing technology offers a way of changing color on the surface. To be compatible with the rest of the system, digital printing processes should be considered. Digital printing processes can be divided into the silver halide process, thermal printing process, ink jet printing process, and electrostatic process. The feasibility of using the thermal printing process or the electrostatic process is limited. Thermal printing would require a significant amount of heat for transferring colors. This could cause discomfort or injury to the face. The electrostatic process is a color transfer process which requires full contact between two surfaces. This may not work very well with three-dimensional objects. The practicable technologies would be the silver halide process and the ink jet process.

- **Silver halide process**

The silver halide process could provide photographic quality by utilizing photographic film or paper wrapped around a drum. An image would be created by projecting narrow beams of light through tiny electronic light valves that modulate the intensity of the light. Because photographic film and paper are light sensitive, an image can be developed on them line by line.

- **Ink jet process**

The ink jet process is a process of creating images onto a surface by controlled deposition of tiny drops of ink. The image can be represented by tiny dots of colors. In transferring colors onto the surface, the ink chamber should be located close to the surface, but not in contact with it. Ink jet technology could be used strictly with plane surfaces rather than with 3D objects according to the controlling distance between the ink nozzle and the surface. In using the AMS/A, one may not feel safe with the ink jet process because ink would have to be applied very close to eye, nose, and mouth

openings. Furthermore, the ink jet process may take sufficient time to risk movement during application.

The most desirable application would be the silver halide process. Instead of using photographic paper, special photosensitive cream, would be applied to the user's face. The light would project on the user's face, activating the cream to produce a result as seen in the preview.

- **MasqueArray cream**

MasqueArray cream is a speculative technology based on chemistry yet to be invented. The cream would have a wide range of color changing capabilities activated by different frequencies of laser lights. MasqueArray cream would be:

- inert to natural light, fluorescent light, and incandescent light.
- only activated by the MasqueArray laser.
- permanent until the user cleans the cream by using MasqueArray cleanser.
- visible when applied to the face.

Material

The AMS/A is composed of several electronic units: a monitor, CPU, 3D scanner, camera and laser unit. Some components produce a consequential amount of heat. Material that may suitable for the AMS/A should provide exceptional thermal and electrical insulation. A variety of colors of materials should be also considered. ABS is one good material for the housing because it provides an excellent, continuous resistance to heat, electrical resistance, and impact strength. Moreover, ABS can be colored as desired.

MasqueArray

MasqueArray is derived from Masque (or Mask) and Array. MasqueArray could be a play on the word "masquerade." This would allow people to remember it easily. MasqueArray would be a suitable name for this Automatic Makeup Selector/Applicator.

Process of design

Designing MasqueArray would include a behavioral/ergonomic design process, product design process, and interactive interface design process. Each step of the process is related to another as seen in figure 3.

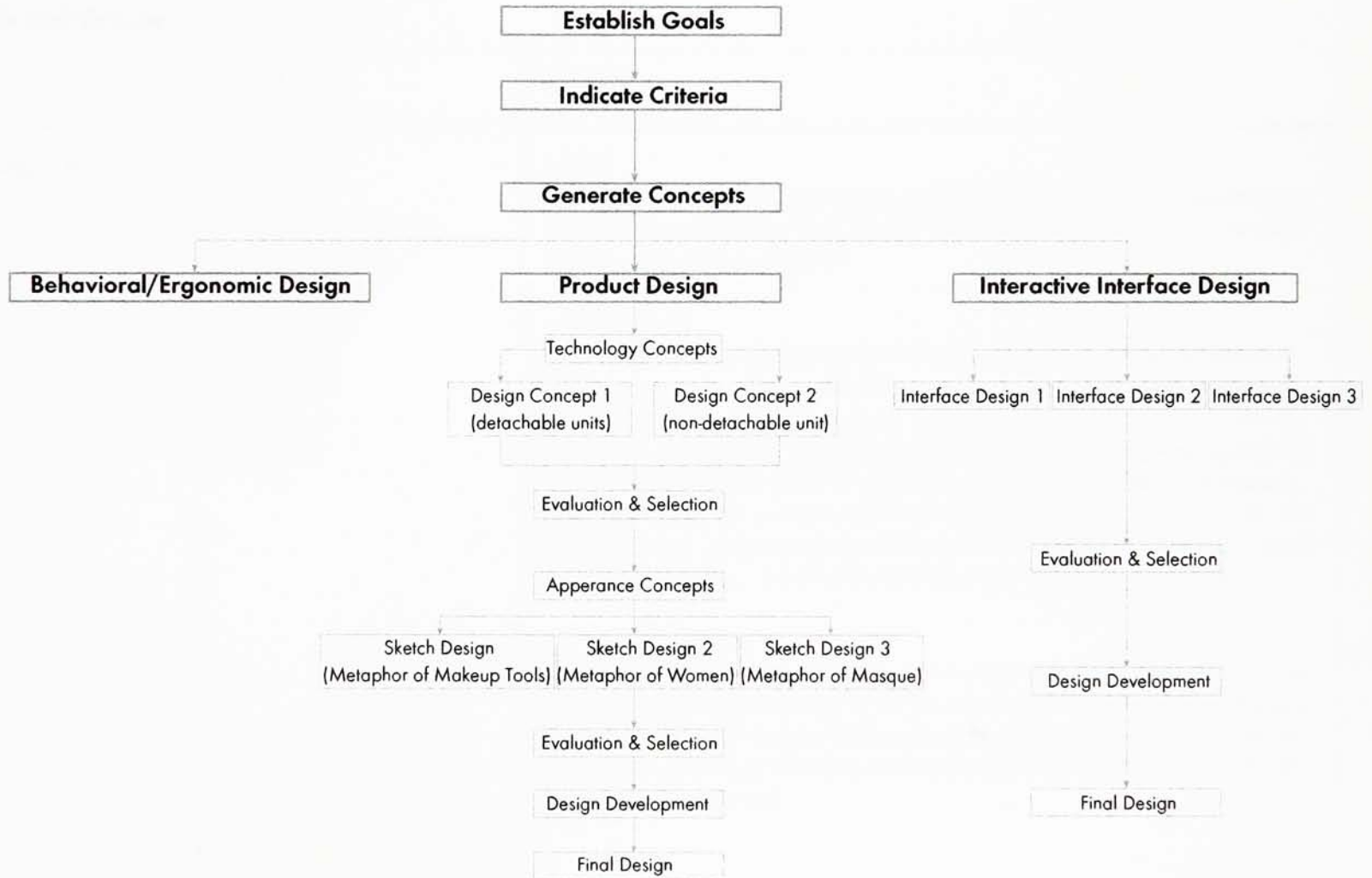


Figure 3. Process of Design

Goals and Criteria

	Goals	Criteria
Product Design	<ul style="list-style-type: none"> • ease of use • simplicity • userfriendly operation • approachability • safety • adjustability • ergonomic • foolproof • hygienic • automatic 	<ul style="list-style-type: none"> • CPU The CPU is a central communicating, memorizing, analyzing, and executing unit. With existing technology, the CPU could be as small as 4" x 2" x 6". The CPU could be placed in any location. • 3D Scanner The 3D scanner is a unit that could create a simulation of a three-dimensional face in a computer. This would allow the user to apply colors onto the surface and preview one's face with makeup. 3D surface information also provides an accurate face profile in 3 axes (x,y,z). For this reason, applying makeup digitally should be more precise. A color video camera, black and white video camera, and an eye-safe laser scanner would be components of the 3D scanner unit. The 3D scanner size would be approximately 6.5" x 7.25" x 3.25". The weight would be around 4 pounds. The location of this scanner should be at eye level. • Flat Panel Display The flat Panel Display is used to communicate with the user both operation instruction and preview. The display size should be at least 15". This would allow the user to select choices effortlessly. The display angle should be about 15 degrees to the vertical. In order to eliminate connections, the CPU and the display should be combined in one unit.

Table 4 . Goals and Criteria

Goals and Criteria

	Goals	Criteria
Product Design		<ul style="list-style-type: none"> • Face Positioning Equipment The face positioning equipment controls the distance between face and scanner, face and laser applicator, and face and display. A decent distance for viewing and touching the screen is in the neighborhood of 16" to 18". To accommodate different heights of users, face positioning equipment should be adjustable. In addition, this equipment should not obstruct any parts of the face so as to interfere with the scanning and application process. • Laser Applicator The laser applicator is a tool for creating colors and styles on the user's face. The laser works as a catalyst or developer for the MasqueArray cream. The MasqueArray cream changes color by responding to different wavelengths and frequencies of applying laser. The position of the laser unit should be level with the middle of the face so the laser can project onto the face evenly.
Interactive Interface Design	<ul style="list-style-type: none"> • ease of use • clear navigation • user-friendly interface • quick results 	<ul style="list-style-type: none"> • preview function • face structure and skin analysis/record • instant makeup choice recommendation • styles and colors of choices and creation • colors and styles preference record • reasonable size and location of icons and images

Table 4 . Goals and Criteria continued

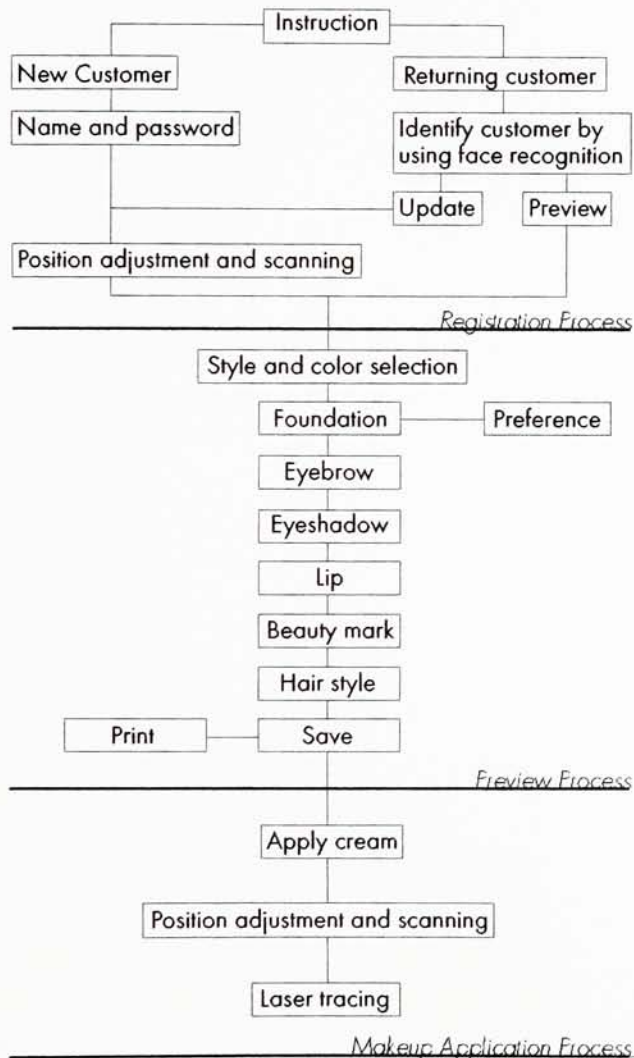


Figure 4 . Behavioral/Ergonomic Design Process

Behavioral/Ergonomic Design Process

In order to design a user-friendly product, the procedure of using the product step by step should be considered. There are chiefly three processes: registration procedure, preview procedure, and application procedure (Figure 4, left).

All customers are required to register by using a registration unit. MasqueArray should provide ample instructions to the customer. A customer could be identified as either a new member or a returning member. For a new member, one's personal information, name or password, is required to input as a personal database. Then, a 3D face scanning process is introduced to the customer. The user's facial topography could be employed for the style and color selection process. In the case of a returning member, a machine could retrieve personal data by using face recognition technology. This process requires the customer to face the display for approximately two seconds. All of one's recorded personal information could be displayed when the user's face has been recognized from the database. In addition, MasqueArray allows the returning customer to update both name and face scan as needed.

A new user could select styles and colors as provided sequentially in the software. A returning member could acquire saved preferences in the personal database and use them instantaneously. Saved styles also could be printed for customers. All preferences could be named and dated.

After selecting a desired style, the user is required to apply MasqueArray cream onto her face. Then face position adjustment should precede the rescanning process. Rescanning is to ensure the position of the user's face before applying color onto the face. After MasqueArray has rescanned one's face, it would ask for a confirmation before applying makeup. Thus, MasqueArray could provide more accuracy and precision in applying makeup.

Product Design Process

MasqueArray requires a CPU, 3D scanner, Flat Panel Display, face positioning equipment, and laser applicator. Each unit requires special space and position.

The positioning all of these components could be with either a detachable unit or a non-detachable unit.

Design Concept 1 (Detachable Unit)

The detachable unit could be separated into 2 components. One is composed of a CPU and a flat panel display. Both are used at the same time. The CPU and flat panel display are utilized to process data, analyze data, and display results from the various processes. The display plays an important part in previewing and selecting colors and styles. The other component is composed of a 3D scanner, face positioning equipment and a laser applicator. These components should be combined in the same unit because this would enhance accuracy and efficiency when applying makeup onto the face automatically.

Design Concept 2 (non-detachable unit)

The non-detachable unit is a unit which includes a CPU, flat panel display, 3D scanner, laser applicator, and face positioning equipment. Non of the components could be removed.

The following are the pros and cons of detachable and non-detachable units:

- The advantage of the detachable unit for a beauty shop is that it would reduce the investment budget. For instance, the 3D scanner, face positioning equipment, and laser applicator set would be used for only a short period of time (approximately one minute). The users would spend the most time on previewing and selecting styles, which may require only a CPU and a display set. Therefore, a beauty shop would need to purchase only one complete set for scanning and application.
- The benefit of the non-detachable unit concept is in its easy setup and easy operation. However, when one component malfunctions, the rest would not work under any circumstances.
- From a marketing aspect, a detachable unit could attract the target group: beauty salon entrepreneurs. Therefore detachability is another requirement of the design.

The MasqueArray form concepts used metaphors of makeup tools (Figure 5.1-5.2 : A, B, C, D), woman (Figure 6.1-6.2 : E, F, G, H), and Masque (see figure 7.1-7.2 : I, J, K, L). Makeup tools could remind the user that MasqueArray is a kind of makeup equipment. The shape of a woman could also be considered because the target customer would be female. The Masque is another choice of metaphor suggested by the name of the product itself. In order to make MasqueArray recognizable, the shape, the logo, and the name should be related.

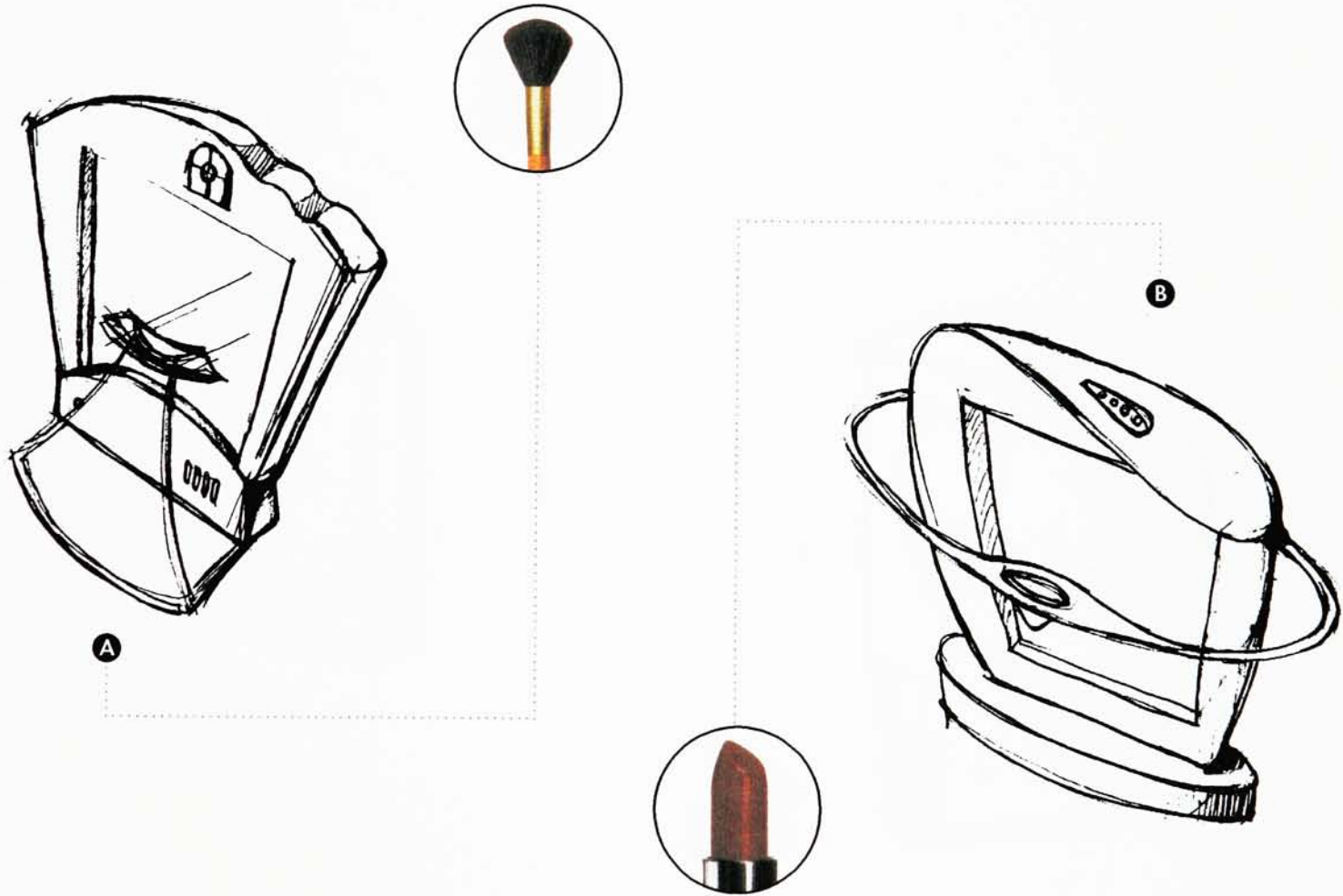


Figure 5.1 . Metaphor of Makeup Tools

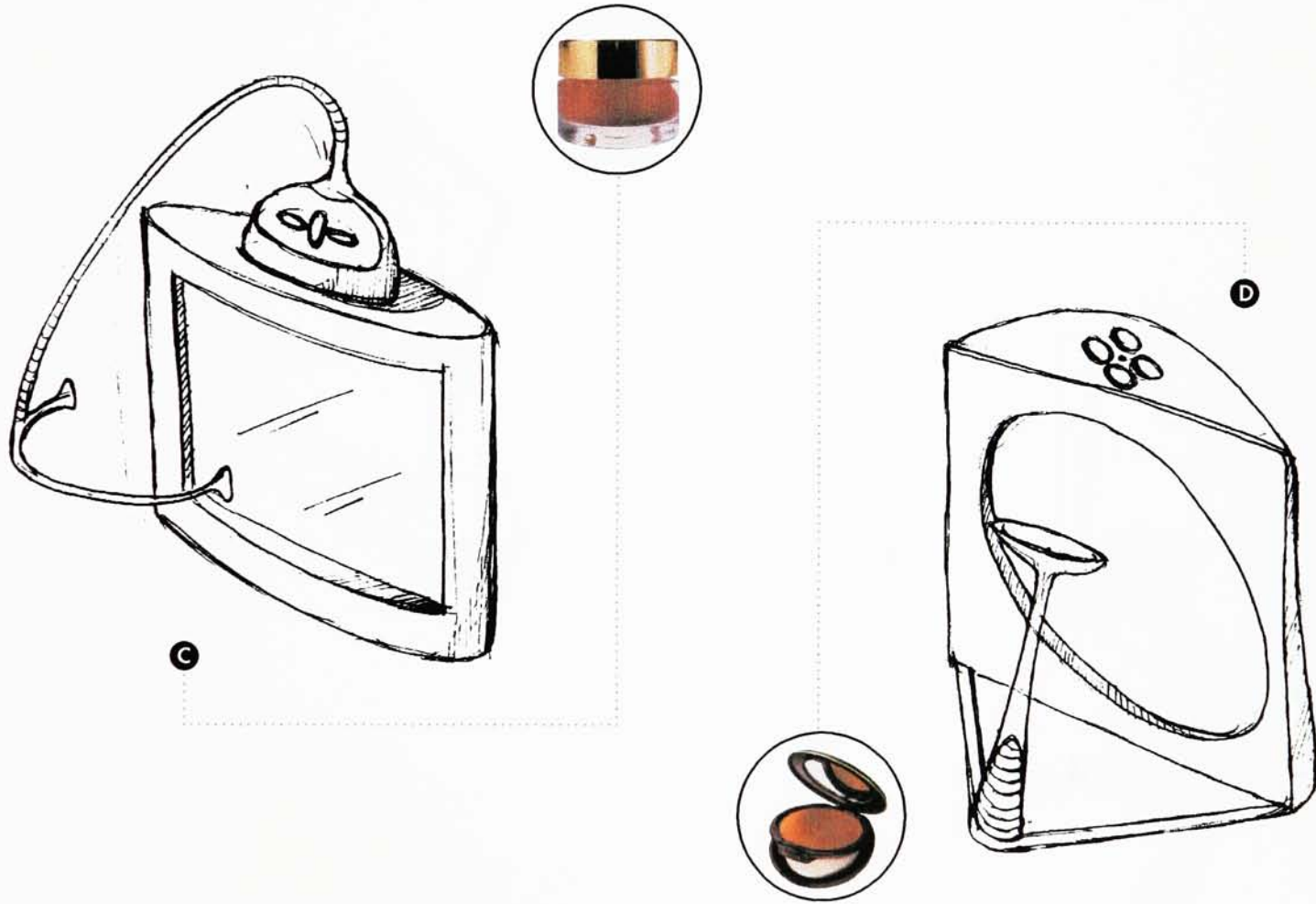


Figure 5.2 . Metaphor of Makeup Tools

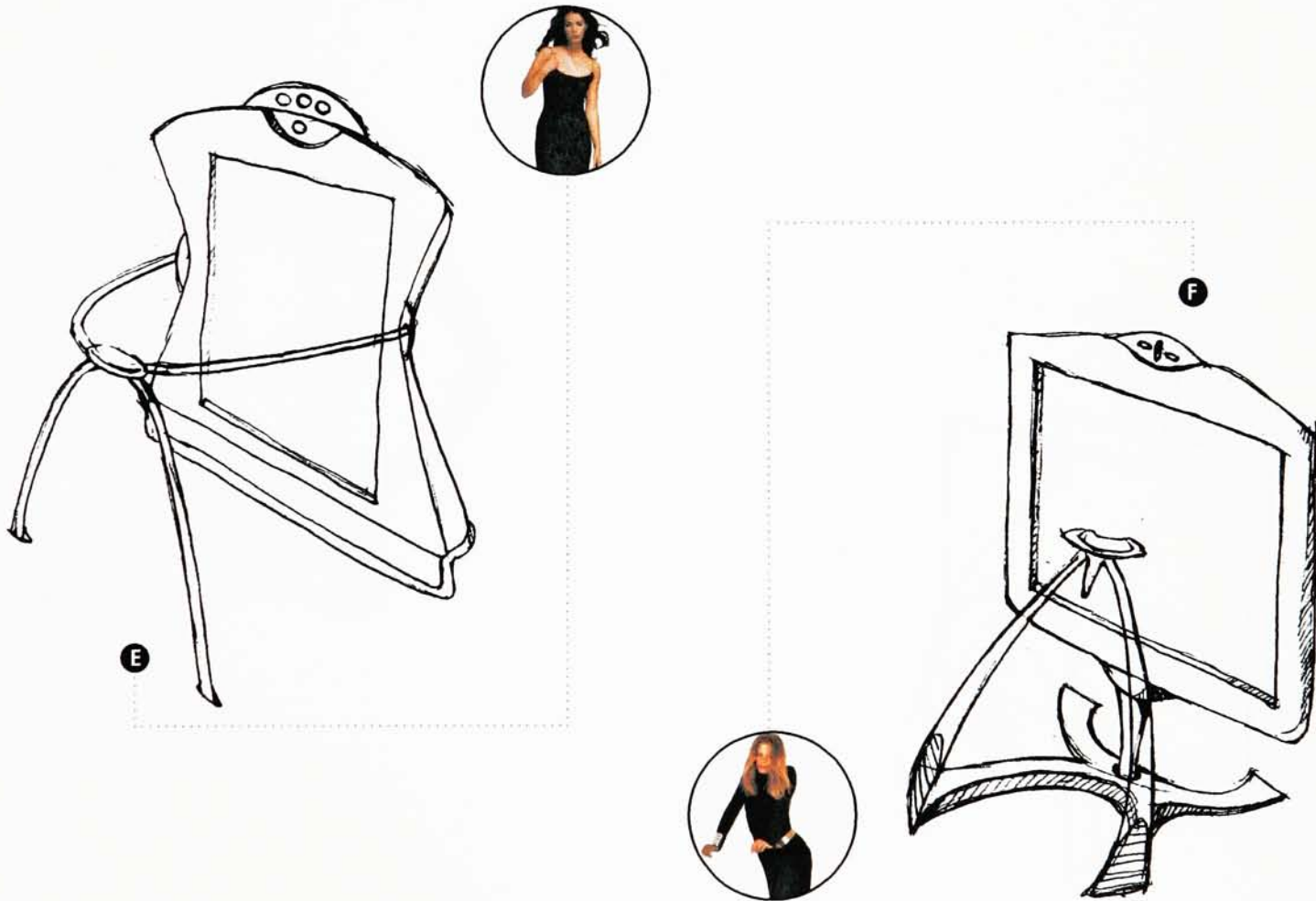


Figure 6.1 . Metaphor of Woman

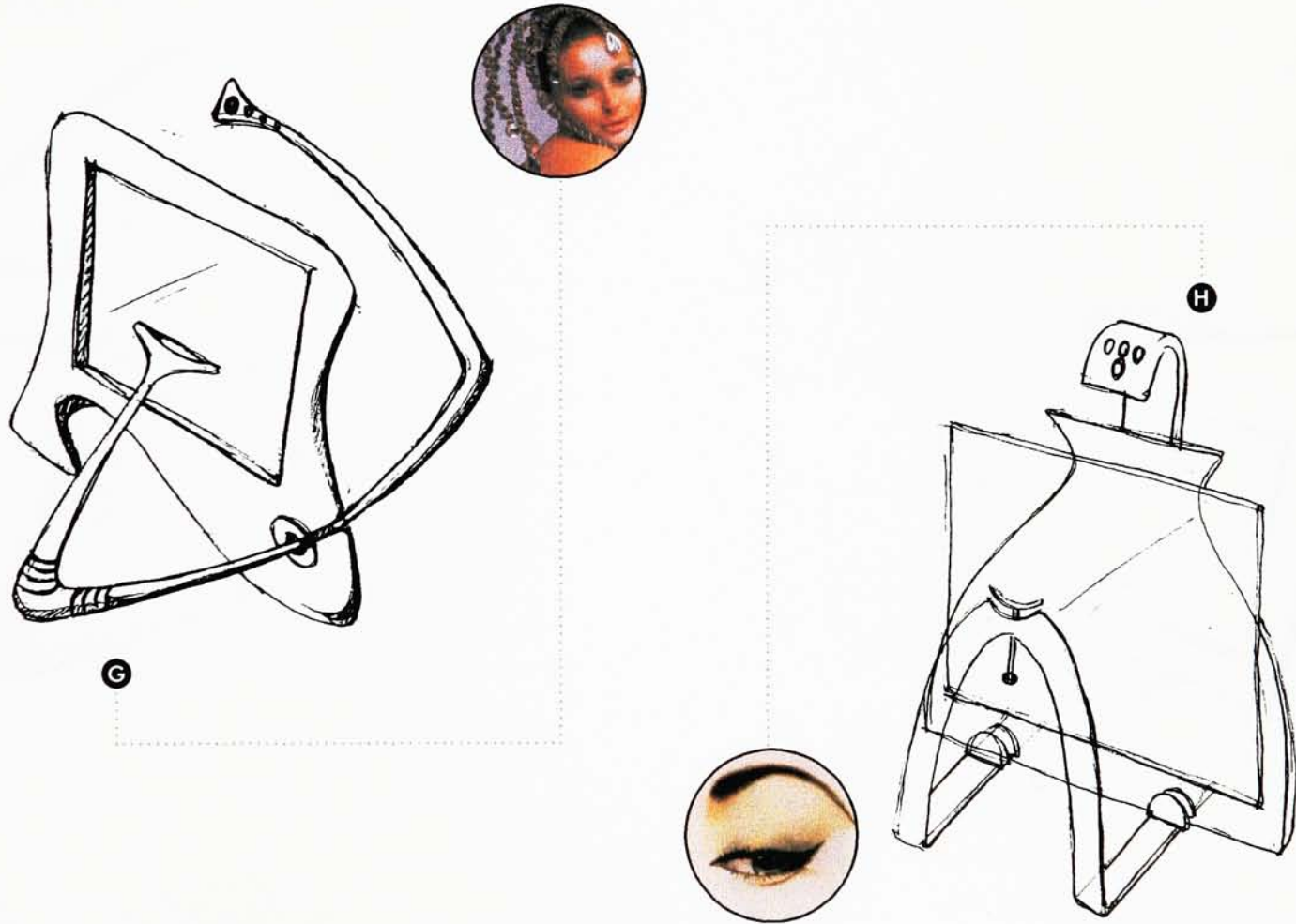


Figure 6.2 . Metaphor of Woman

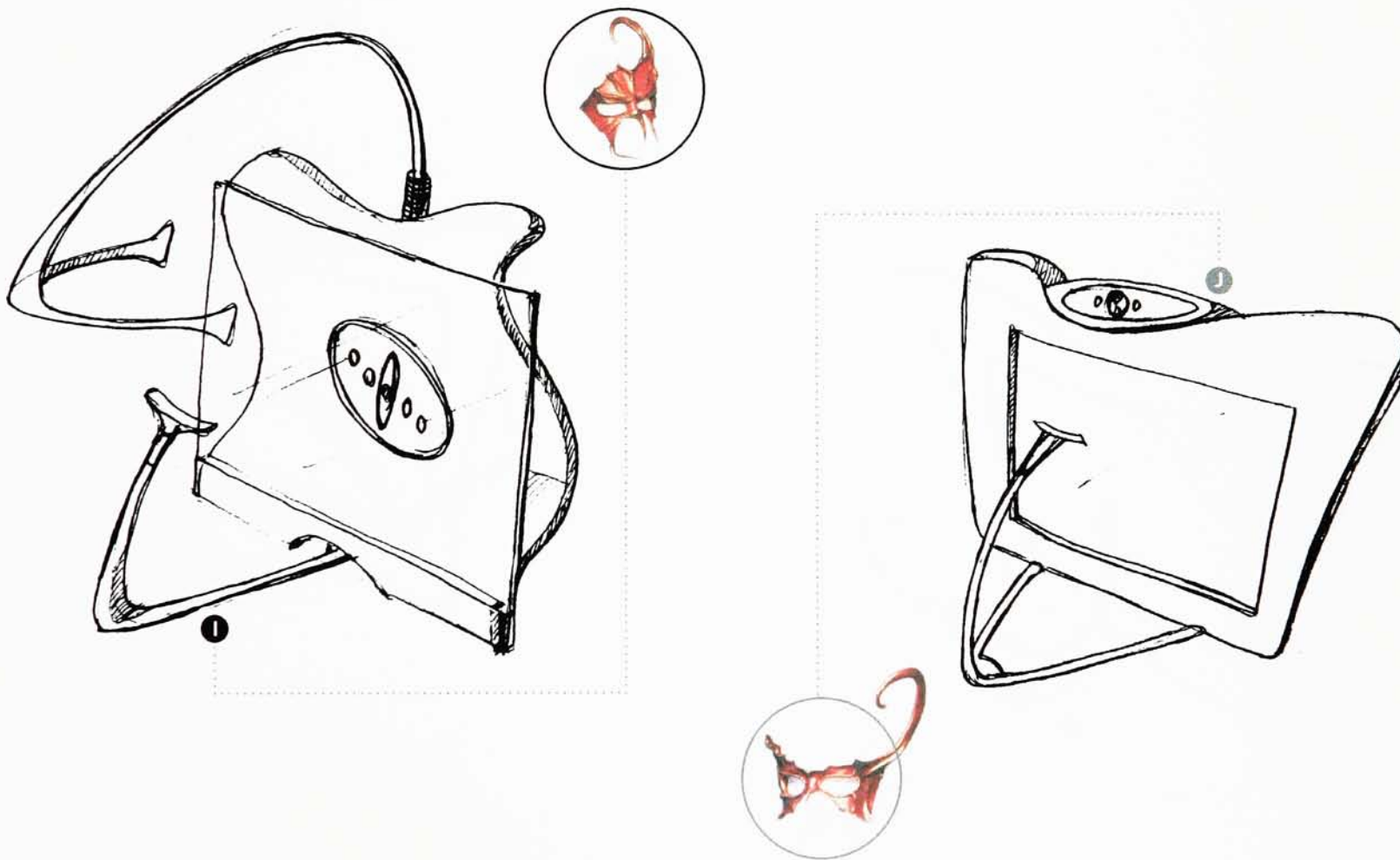


Figure 7.1 . Metaphor of Masque

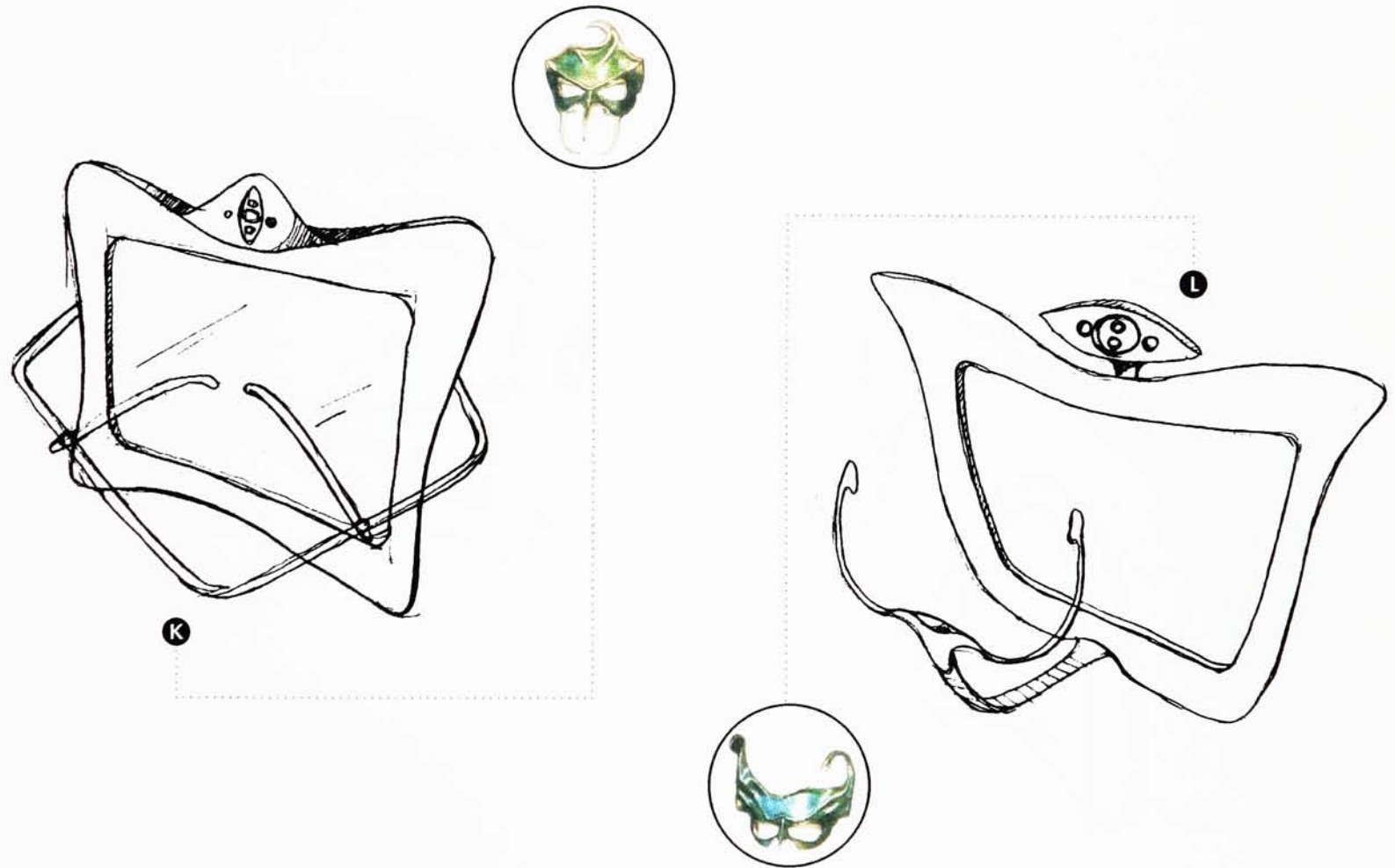


Figure 7.2 . Metaphor of Masque

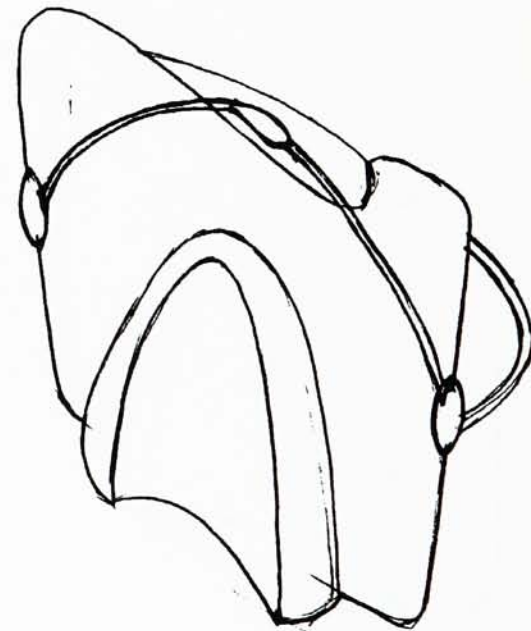
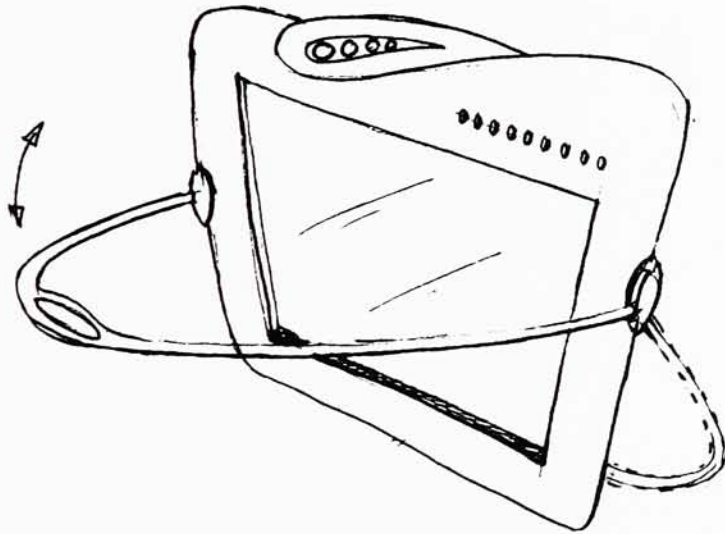


Figure 8.1. Design Development 1

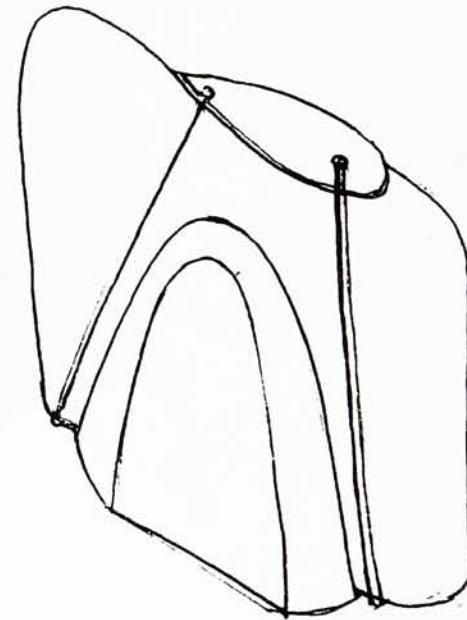
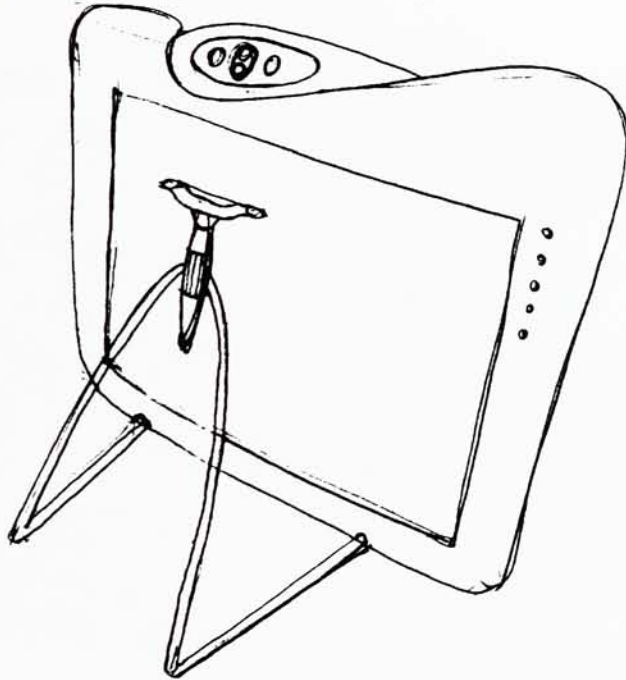


Figure 8.2 . Design Development 2

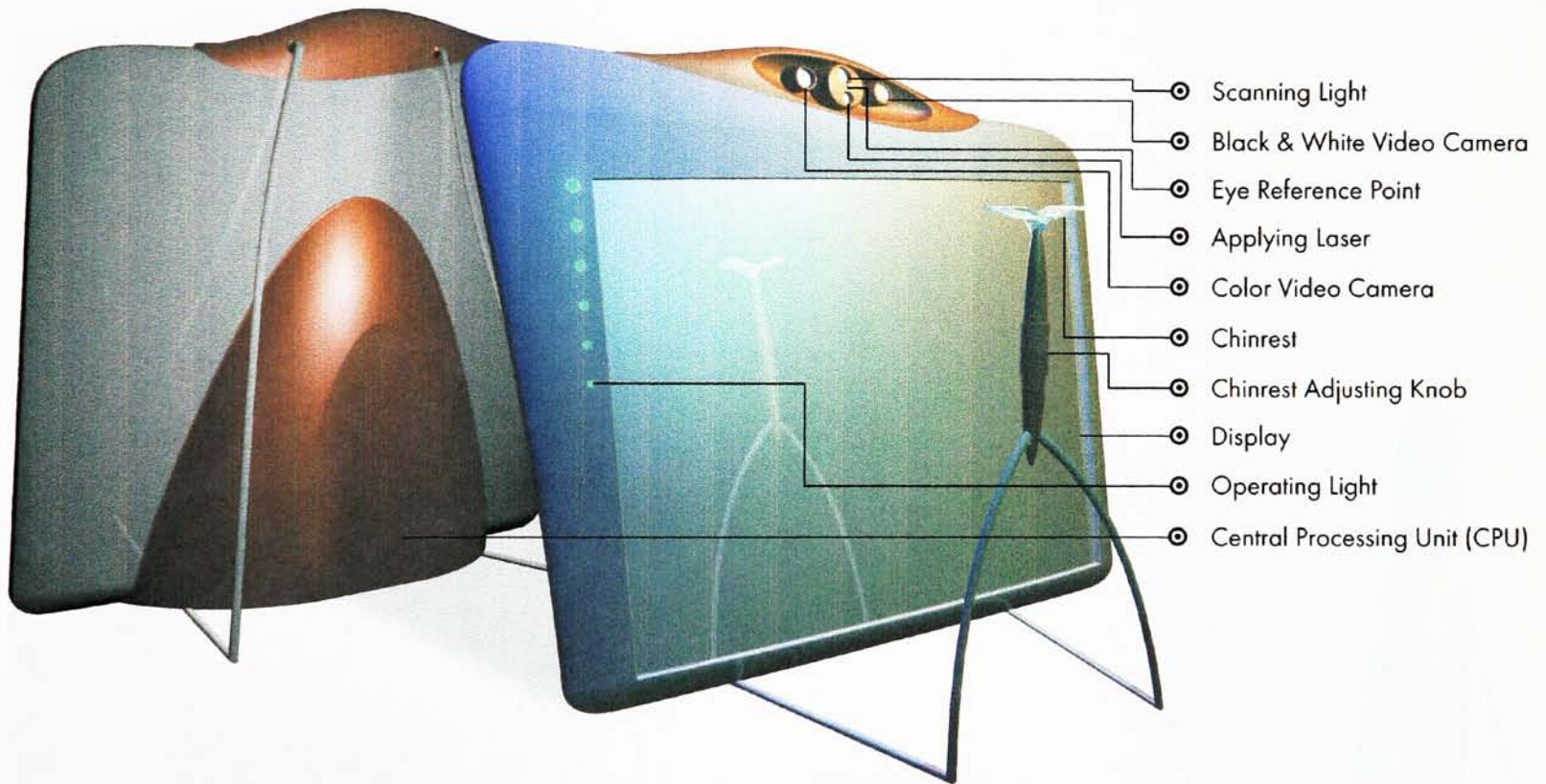
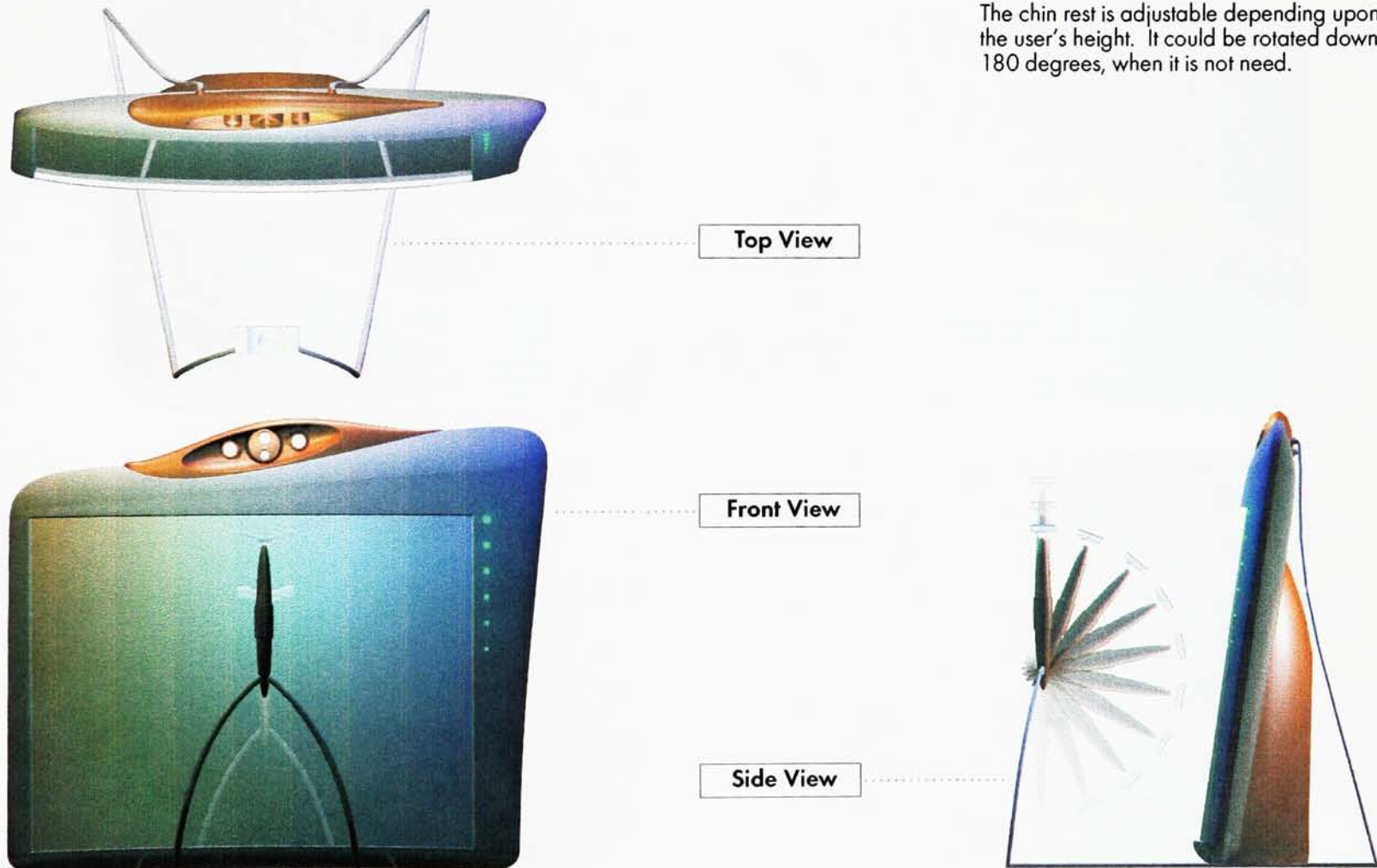


Figure 9 . Final Design : MasqueArray Components



The chin rest is adjustable depending upon the user's height. It could be rotated down 180 degrees, when it is not need.

Figure 10 . Final Design . MasqueArray Orthographic Views

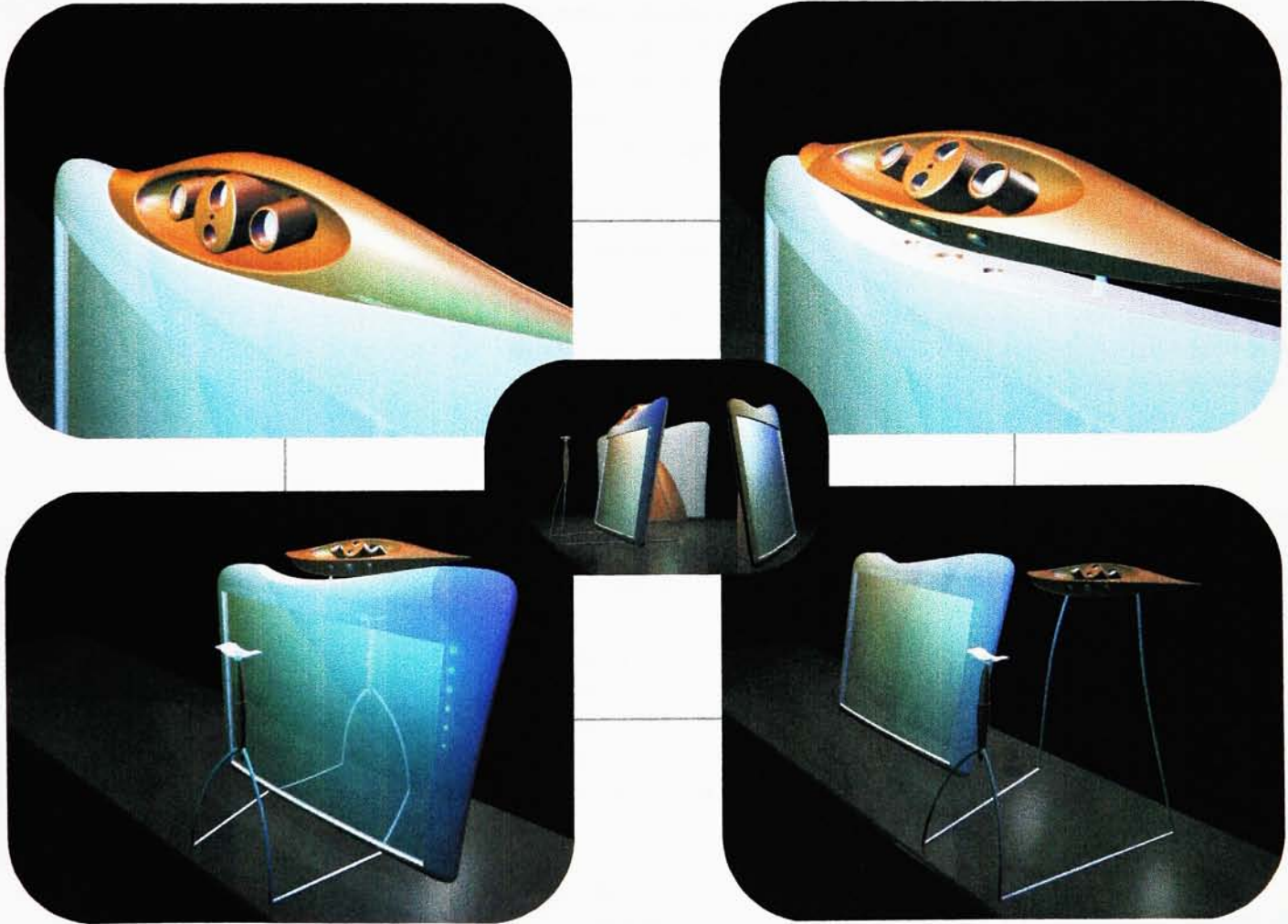


Figure 11 : Final Design : Detachable Unit

Interactive Interface Design Process

Good interactive application design provides the user clear navigation and congruity of design between each section of interactive software. This application can be categorized into 3 different parts: the registration process, the preview process, and the makeup application process.

Registration Process

Instruction

Instruction should consist of a video and an audio format. This would broaden the range of users to include hearing-impaired persons and vision-impaired persons. Animations and sounds also provide both entertainment and information to the user. The introduction at the beginning is intended to be short and understandable. In addition, both verbal and written instructions would assist the user.

Customer Identification

For returning customers, a face recognition process would be employed to pull up the existing information such as colors, styles, and shape from the database. The face recognition unit would share the same equipment with the scanning component. A video camera could be used to capture images of the user for identification. For confirming the identification, the display would indicate the user's face and user's name when the customer has access to her account. Moreover, the machine would be able to record the date and time when styles and colors were saved to the database. In the case of a new customer, name and password are required to be entered by using an on-screen pad (or touch screen). Afterwards, the scanning process would proceed.

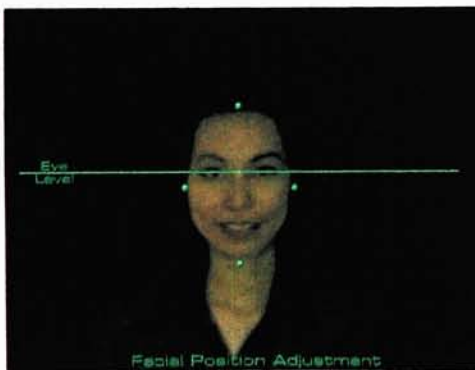


Figure 12. Position Adjustment

Position Adjustment and Face Scanning

In order to adjust the face position precisely for scanning, the user should be

able to see her face on the monitor and adjust by aligning with the guidelines and registration point on the screen. MasqueArray could automatically detect the correct position of the user's face. MasqueArray computes distances from the center point to both sides of the face. The distances should be approximately equivalent. MasqueArray would respond by changing the color of the guidelines and indicating "Prepare for Scanning." Accordingly, the user should be in a fixed, eyes-open and mouth-closed position. Then MasqueArray begins scanning with the text "Scanning" message taking about 1 second. The scanning information could be analyzed and stored in a personal database in order to be used in the select and preview processes.

Preview Process

MasqueArray changes the way people wear makeup from the traditional way to a digital way. In order for the user to become acquainted with MasqueArray easier, a step by step process of applying makeup is used. The process includes foundation, eyebrow, eyeshadow, lip, beautymark, and hairstyle selection respectively. In addition, MasqueArray allows the user to save preferences.

In the marketplace, there is makeup selecting software called Cosmopolitan Virtual Makeover from Segasoft Networks, Inc., introduced in October 1997. This software can be used with a regular personal computer. With this software, the user can experiment with preview only. The users are not able to actually apply a previewed makeup style to their face automatically. Cosmopolitan Virtual Makeover allows the user to import face images into the program and to apply makeup virtually onto the image on the monitor. The restriction of using this program is that the user requires considerable skill in controlling the mouse in order to select painting areas. The user may find it difficult to achieve an even color. Painting onto the image may take considerably more time than actually applying make up. Besides, the user may not find makeup colors in the marketplace as found in the program. To color the face exactly the same way as it appears in preview is relatively unattainable. The best

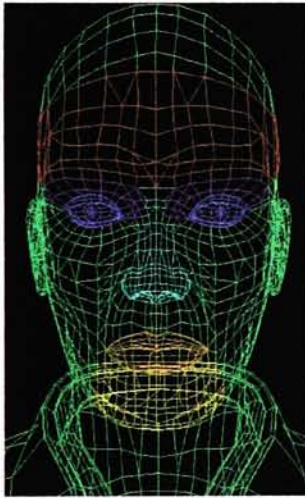


Figure 13 : Mosaic of The Customer's Face

feature of this software is help in selecting hairstyles.

The use of MasqueArray does not require computer skills. MasqueArray scans the customer's face in parts: forehead, nose, chin, eyes, eyebrows, cheeks, lips, and hair. When selecting areas of the virtual face, the customer does not need to define the selection edges. On one hand, 2D painting would be considered to be a laborious effort. The user needs to render on the image to achieve the natural appearance of colors and shadows. On the other hand, 3D painting allows the user to select the desired area and desired color. A computer will calculate and render shades and shadows automatically without requiring any rendering skill.

MasqueArray also provides instant styles and instant makeup color recommendations. Styles refer to shapes or patterns of makeup such as eyebrow shapes, eyeshadow shapes, lip shapes, and beauty mark patterns. Styles and patterns are also provided with color choices. MasqueArray provides a color recommendation by analyzing colors taken from the camera. This would make the makeup look natural on one's face, particularly for foundation. In traditional application, for eyeshadows and lips, matching colors together is a tiresome task. In the colors recommendation mode, MasqueArray could harmonize the tone colors on the face. A customer could select colors from the color bar-gradient colors mixed from cyan, magenta, yellow, and black. The user has choices for saving colors and styles of personal preferences from the instant color recommendation menu, color bar menu, instant style menu, and personal preference menu.

Interactive graphics navigation guides the user in following each makeup process. The user is required to select foundation, eyebrow, eyeshadow, lip, beauty mark, and hairstyle consecutively in order to prevent confusion. The customer would be able to reselect any of them when all processes are done. Different color graphics (or buttons) should indicate the current process and visited processes. This would help the user to have a correct orientation. The user could save the final colors and styles in the preference mode. This preference mode could shorten the time for reselecting

foundation, eyebrow, eyeshadow, lip, beauty mark, and hairstyle.

Makeup Application Process

The makeup application process is a major concern because the laser would be projected to the face and would alter color of MasqueArray cream. In order to prevent inaccuracy in application, MasqueArray should provide comprehensive instructions. Both video and audio instruction are used to describe the current process and the upcoming process. Confirmation is required in every step. For example, the user has the alternative to choose or cancel before applying each selected makeup and style.

There are three concepts for interface layout (see Figure 14, 15, and 16). These three concepts lead to effective interface solutions, especially for visual communication. Graphics would help the user to understand the process easier. 3D graphics and simulated button icons are providing a clickable or interactive area. The makeup process buttons are visually connected together in order to indicate the direction to the user. A pop-up menu would be convenient when the user would like to display only her face.



Figure 14 . Interface Layout, Concept 1

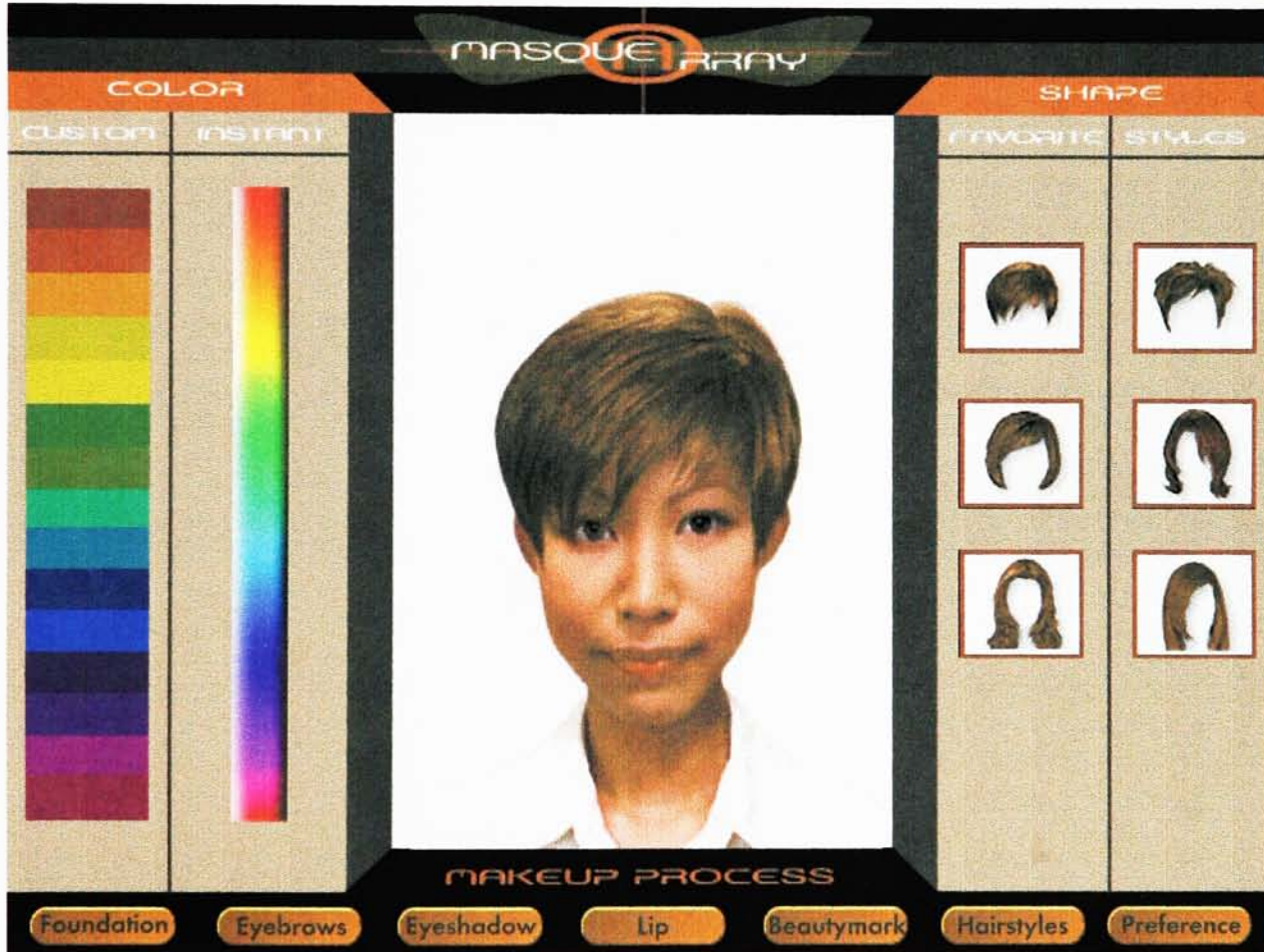


Figure 15. Interlace Layout, Concept 2



Figure 16 . Interlace Layout, Concept 3

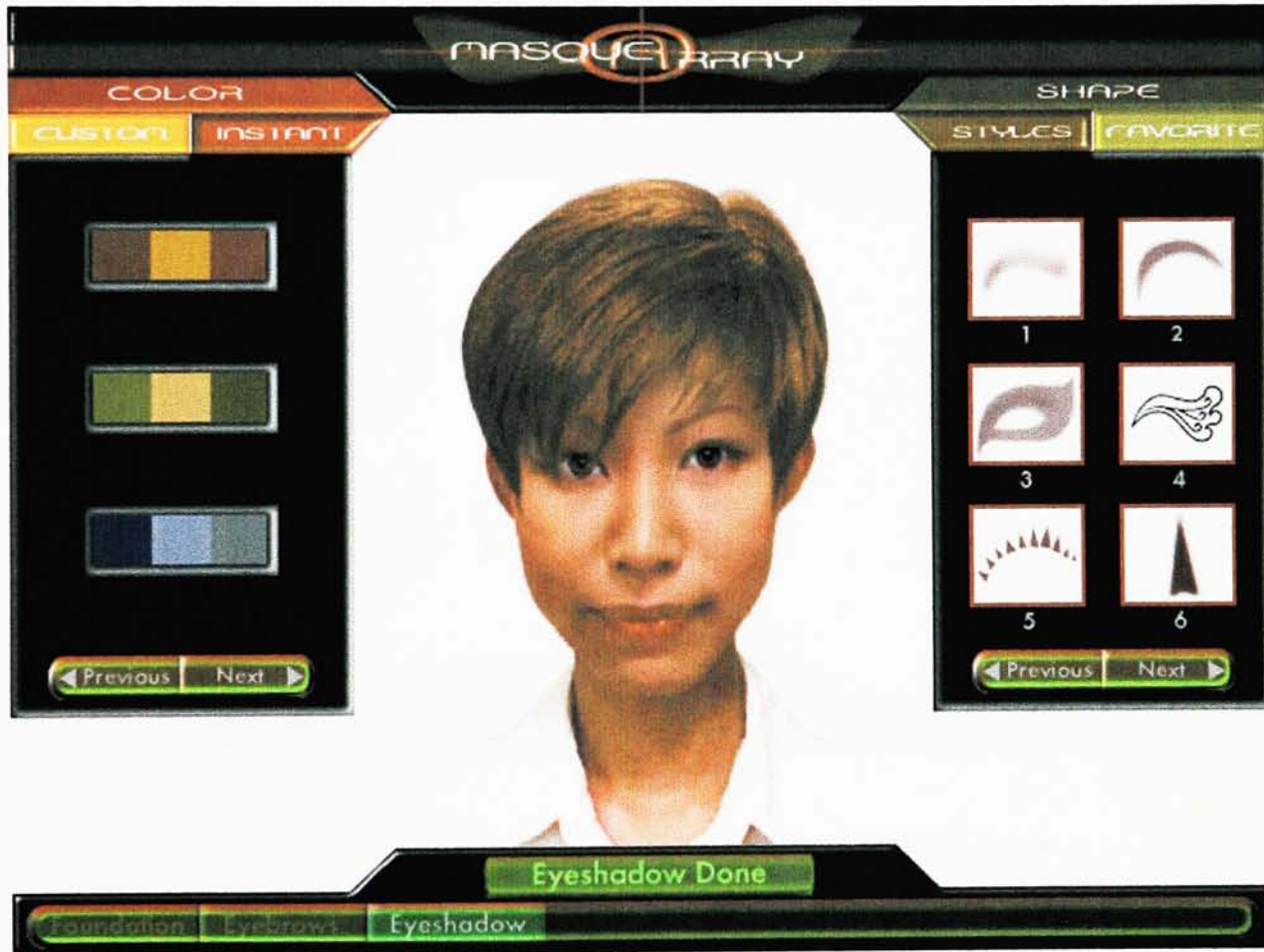


Figure 17. Interface Design Development

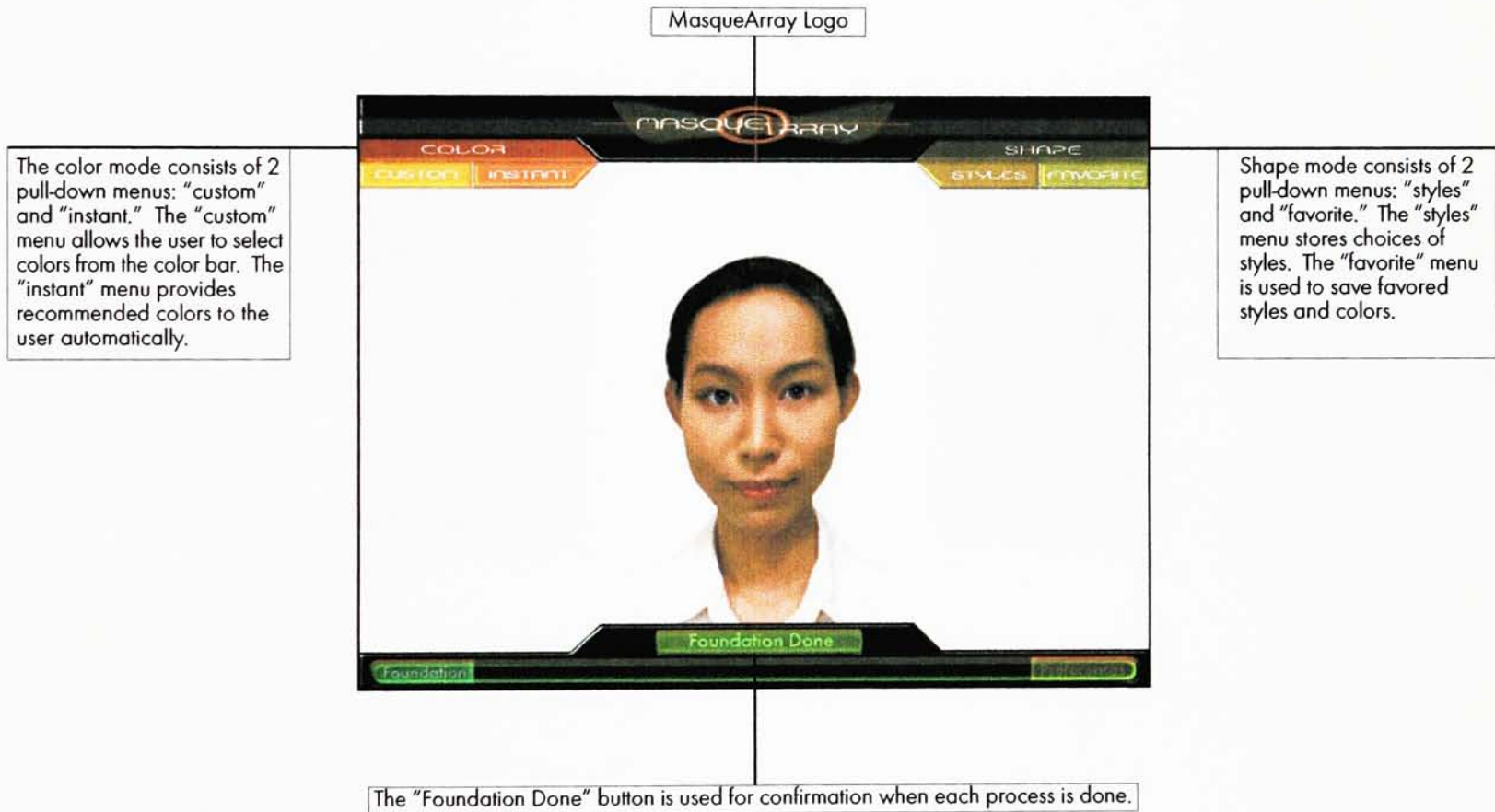


Figure 18. Interface Final Design

3D simulated buttons suggest they are to be pressed.



The user is able to proceed to preference mode without going through makeup selection process.

Figure 19. Interlace Final Design : Foundation



Pop-up menu allows the user to display or conceal the menu arbitrarily. One menu can be displayed at a time from each side in order to enlarge the icon or image on the menu. To display one menu at a time would not be a problem for the user. Under the color mode, "custom" and "instant" are not to be used simultaneously. For the shape mode, "styles" and "favorite" also should not be used at the same time.

Figure 20 . Interface Final Design : Eyebrow



Clicking on the "style" button shows the selected mode to the user.

The current process is indicated by a highlight icon. Also the visited process is shown in different color.

Figure 21 . Interlace Final Design : Eyeshadow



A pull-down menu is shown when button is clicked. To conceal the pull down menu, the user can click on the same button.

Figure 22 . Interlace Final Design . Lip

The user can select colors from the color bars and select values from the color square. The selected color would be shown along with the with lighter and darker values.



Beautymarks can be chosen from the style menu. Beautymarks are moveable. The user can locate the position of the beauty mark by dragging it to the desired location on the face image.

When the cursor is rolled over the button, it is changed to a finger icon, and the icon is highlighted.



As seen, the "next" and "previous" buttons are provided, when the button is grayed out, there are no more choices available.

Figure 24 . Interface Final Design : Hairstyle

In order to facilitate the user, preference is divided into 2 categories; natural and special. For natural mode consist of Day time and Night time menu. Users could name each preference as they desire.



Figure 25 : Interlace Final Design : Preference

In order to design MasqueArray, I utilized the Silicon Graphics computer platform, as a tool to create a 3D model with Alias Wavefront 8.5. The reasons why I selected computer 3D modeling are as follows :

1. to modify shapes or forms.
2. to demonstrate details in small area.
3. to display the product in many different angles.
4. to show the product in various materials, textures and colors.
5. to present photo quality in visually realistic environments.
6. to animate the product in order to explain usage, assembly, and details.

3D renderings of MasqueArray in different formats, images and animation were presented through three media: video, interactive CD-ROM, and posters.

Demonstration

Video was significantly beneficial to the presentation in simulating the product in operation. This permitted the audience to "experience" the product.

The processes and technologies of creating this video are based upon computer generated design. Originally, 3D models and images were constructed. Then, storyboards established each image of the entire story to depict the usage of the product. These storyboards led to the animation of images such as a rotated model, close-up details, and a simulated beauty shop. All of the 3D computer-generated atmosphere was created in Alias Wavefront software. In order to narrate the story or usage, presentation movies are overlaid on top of the MasqueArray movie by using the blue screen technique. Blue screen is a video technique which utilizes a blue screen in the background. Extracting blue pixels from the movie could expunge this blue background, therefore the blue area is transparent (see figure 26). Blue screen technique was accomplished by using Adobe Premiere video-editing software. Sound and music were edited and recorded from SoundEdit 16 software. Adobe AfterEffect

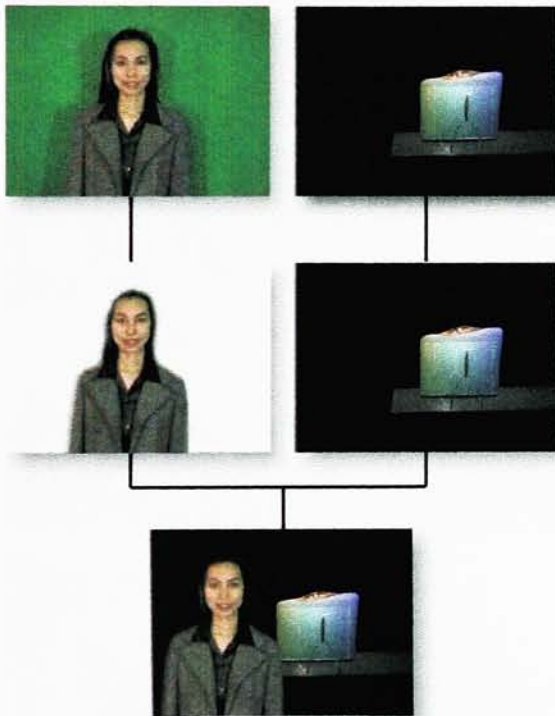


Figure 26 . Blue Screen Technique

was used for text, graphic, and video composing. Entire movies and sound were combined in Adobe Premiere. Ultimately, a final movie was exported to videocassette tape.

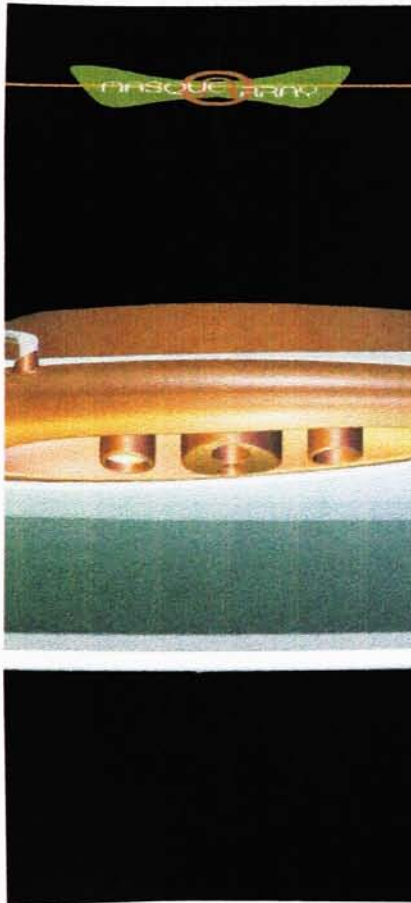
Interactive CD-ROM

Macromedia Director Software was the tool for creating interactive multimedia for MasqueArray. All graphics were made in Adobe Photoshop and Adobe Illustrator.

MasqueArray software or application is currently in the prototype stage. This application still needs more development. Testing the application with target users and observing their reactions would lead to better interactivity. The focus of testing and observing would be on the preview functions, clear instructions, obvious navigation, and esthetic aspects. This information could be collected and used to improve the next generation application.

Poster

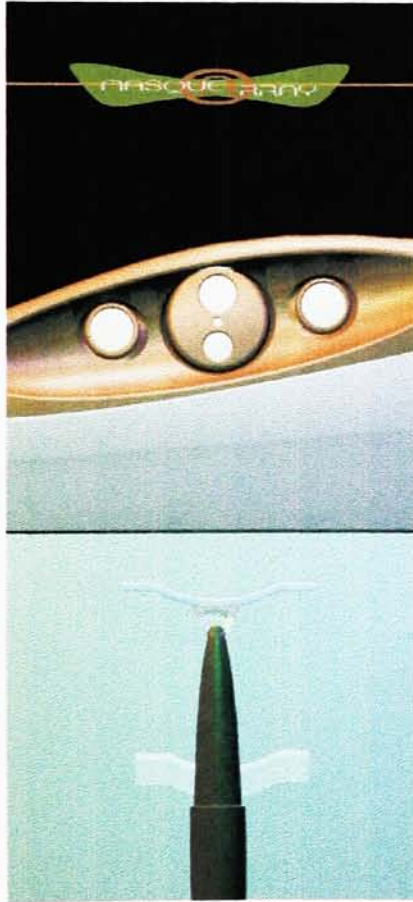
Posters were designed to provide textual information of MasqueArray to the audience comprehensively. Elements such as concept ideas, technologies, and process, are included (see Figures 27-32). Moreover, the process is described chronologically (see Figure 33).



Nowadays, makeup becomes more and more important because the first impression in appearance affects life in the case of business, profession, and society. Some people feel more self-confident when they are wearing makeup. Actually, all makeup changes people's looks to some degree. Nobody is born with an ideal face structure. It all depends on what degree you want to bring your own face into perfection.

What is MasqueArray

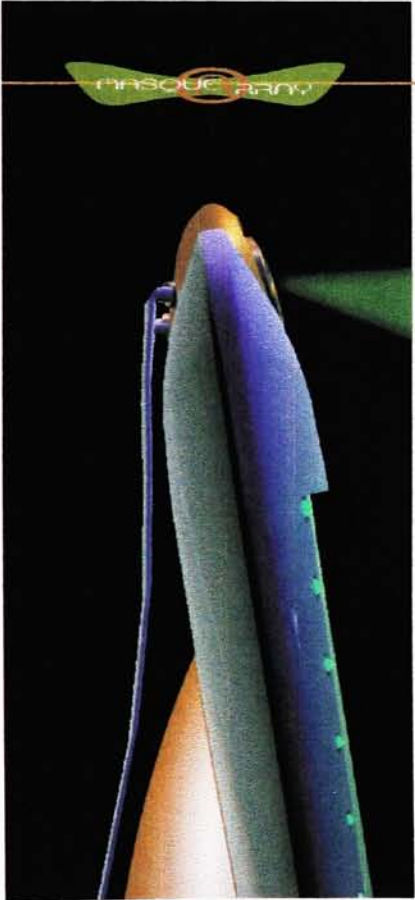
Applying makeup is a painstaking process. MasqueArray is an automatic makeup selector/applier proposed for solving these problems. The first benefit is saving time because it will apply cosmetics automatically and does not require complex cosmetics or any professional skills. The second benefit is this product can scan your face in 3 dimensions and then preview several kinds of makeup and hair styles on your own face, or you can mix styles by yourself and save them as the preferences. Then you can see your own face in a new style before application. If you choose to apply that style, it will apply makeup automatically exactly the same way that you see in preview on your face (except hair styles). In addition, MasqueArray will remember the colors and styles that you have used for specific occasions.



Why is MasqueArray

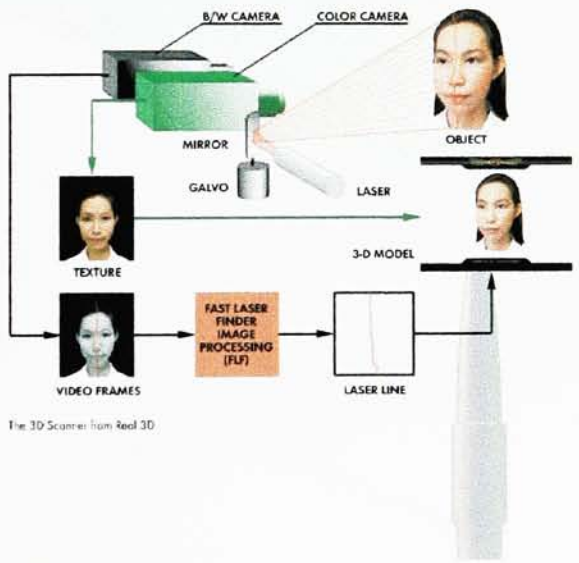
- Fast Fast Fast Fast
- Stylish
- Easy

Figure 28 . Foster 2 : **Why** is MasqueArray ?



How does MasqueArray work

Technology



The 3D Scanner from Real 3D

3D Scanner

The 3D scanner allows users to quickly scan the face in 3 dimensions with texture-mapping. Components of the 3D scanner are a Triangulation-based laser, a position mirror, an ultra-fast galvanometric motor, a black & white video camera and a color video camera.

Triangulation-based laser

The Triangulation-based laser is reflected from a positioning mirror to the surface in order to obtain the profile of the face.

Ultra-fast galvanometric motor

The Ultra-fast galvanometric motor positions the laser strip to several locations within a single frame of the video camera.

Black & White video camera

The Black & White video camera collects reflected light from the face.

Color video camera

The Color video camera captures a texture-map of the scanned face. This texture-map would be applied onto the surface of the reconstructed geometry.

MasqueArray Cream

The MasqueArray Cream changes colors by responding to the different wavelengths and frequencies of applying laser.

Applying Laser

The Applying Laser projects various wavelengths and frequencies of light to the face.

Figure 29. Foster 3. How does MasqueArray work?

How does MasqueArray work

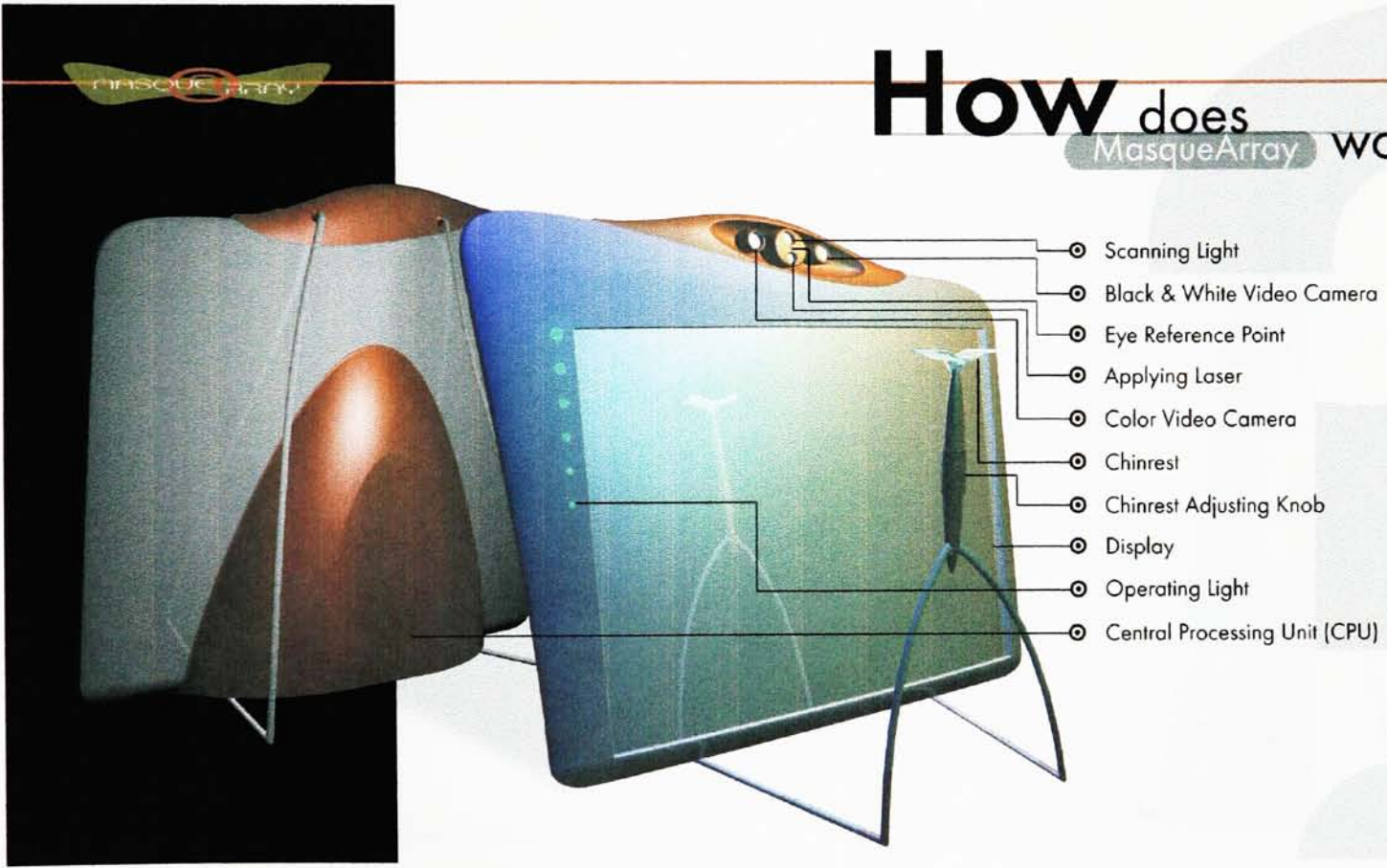
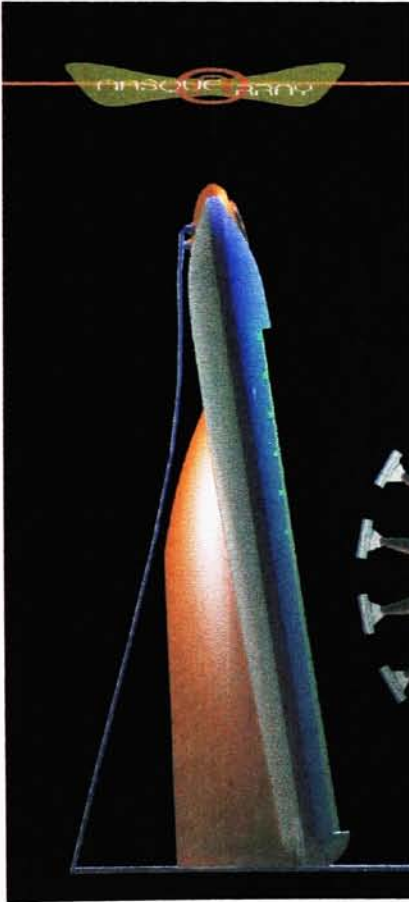


Figure 30 . Foster 4 . **How** does MasqueArray work ?



How does MasqueArray work

Adjustable chinrest is for positioning and repositioning the user's face.

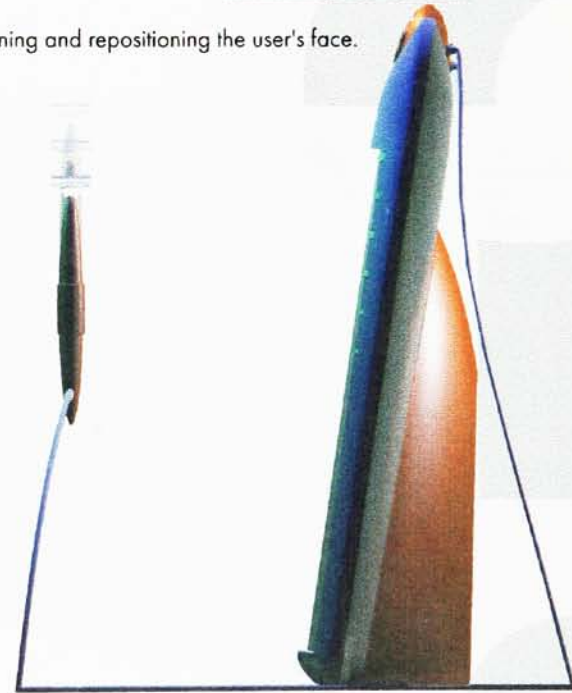
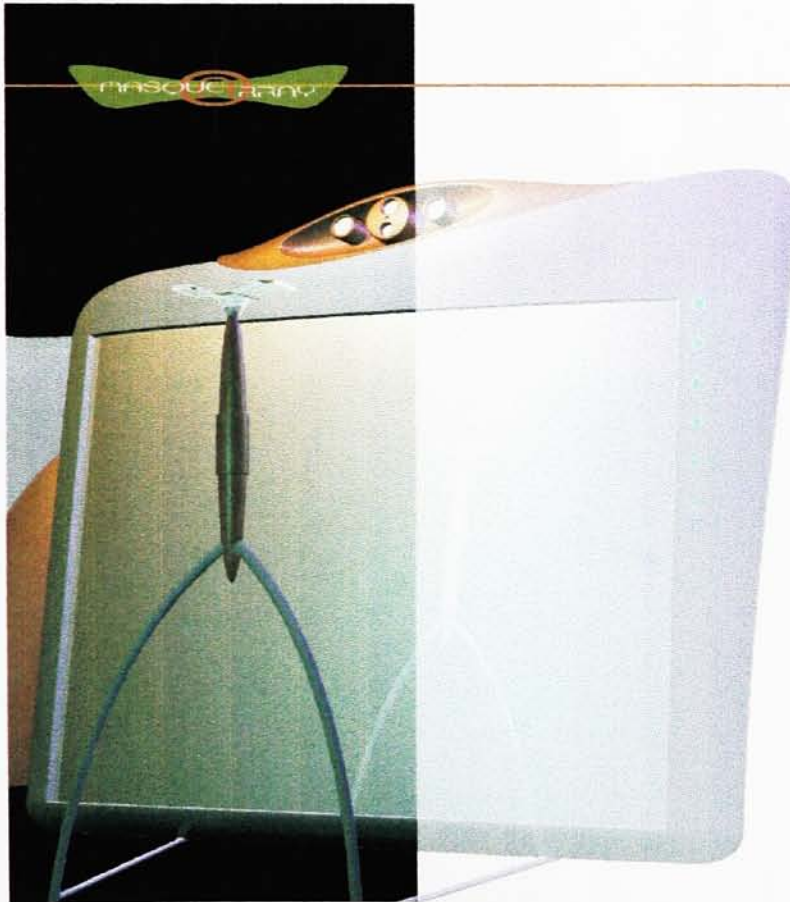


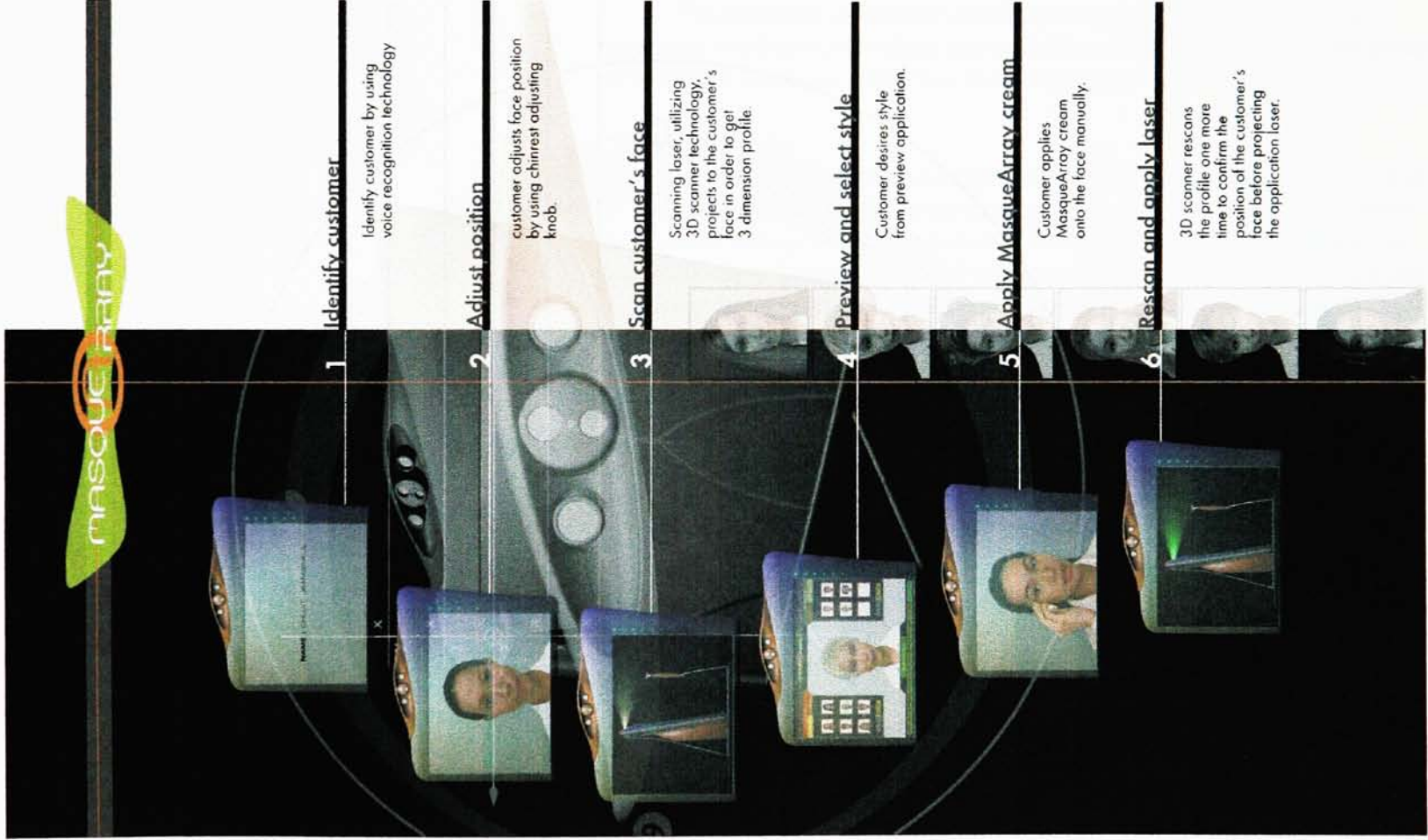
Figure 31 . Poster 5 . **How** does MasqueArray work ?



How does MasqueArray work

Detachable Selector and Applicator Unit

This machine is designed to separate into two parts, one of which is the selector and the other is the applicator. Beauty salon shops can have fewer applicators and more selectors to save on costs while accommodating more customers.



1 Identify customer

Identify customer by using voice recognition technology

2 Adjust position

customer adjusts face position by using chinrest adjusting knob.

3 Scan customer's face

Scanning laser, utilizing 3D scanner technology, projects to the customer's face in order to get 3 dimension profile.

4 Preview and select style

Customer desires style from preview application.

5 Apply MasqueArray cream

Customer applies MasqueArray cream onto the face manually.

6 Rescan and apply laser

3D scanner rescans the profile one more time to confirm the position of the customer's face before projecting the application laser.

Figure 33. Poster 7: Usage of MasqueArray

The evaluation of MasqueArray design is derived from comments and suggestions of advisors, committee, and exhibition audience. There are 3 categories for evaluation: hardware, interaction, and presentation.

Hardware

In general, most audiences appreciated the concept and the appearance of the MasqueArray design. Comments and suggestions are essential to the product's development. MasqueArray is considered as a hygienic product. The chinrest (or face positioning equipment) and touch screen monitor should be cleansed before use. The beauty shop should provide a disposable chinrest pad to the customer. The user needs to apply MasqueArray cream manually. Ideally, MasqueArray would apply the cream onto the user's face automatically. A MasqueArray cream sprayer could be attached to the unit. The sprayer could spray the cream on the user's face thoroughly and with adequate precision. To cleanse the makeup, the customer could use a special cleanser.

Interactive Software

Interactive software still needs development of instructions. The user should be able to approach "Help" instructions easily. Users may prefer to import some different styles of beautymarks to the software. This process would be feasible, but may require an assistant to convert images into digital format. Employing a password, a customer could access her account through the Internet. This would also permit the user to preview and save styles and colors at home.

Presentation

In the exhibition, MasqueArray drew the attention of viewers because of the variety of media video, interactive software, and poster that were presented. Most of the audience could comprehend the concept and operation of MasqueArray by

watching the 7 minute video presentation. The design experience was presented through the video. This video allowed the audience to view or experience simulated-real-life usage. After audiences viewed the video presentation, they tried the interactive preview software provided in the exhibition. The viewers were satisfied with the software. Textual information appeared on the poster.

Generally, the viewers were fascinated with MasqueArray, especially the women. MasqueArray has the potential to be a successful product in the future.

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