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Science Museum: Creating the Morphing Image Database

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by

Darren McCormick

Carl Messina

Brian Wozniak

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Approved:

Professor Holly K. Ault, Major Advisor

1. museum
2. volunteer
3. morph

Professor Joel J. Brattin, Co-Advisor

Abstract

The London Science Museum is developing two interactives that combine the latest biomedical research with cutting edge face morphing software. The morphing software requires a database of facial images to execute the morphing process. Our project involved developing a strategy to create this image database. To insure that the database was compatible with the interactives, we developed a prototype of the interactives that simulated lighting, backdrop, and camera position. We then implemented strategies to advertise, recruit volunteers, and build the database. The result was a complete database diverse in age, race, and gender. The database will be fully compatible with the interactives, thus creating realistic impressive morphed images. We analysed our methods and made recommendations for people interested in reproducing our work in the future.

Acknowledgements

We would like to express our deepest thanks to all the employees of the Science Museum in London who helped us in our tireless journey to complete this project. We had a wonderful time working with all of you.

We would like to especially thank Heather Mayfield, Aisling Byrne, and Nick Smith for their patience in dealing with us for seven weeks, and being able to answer our seemingly endless supply of questions.

We wish you luck in opening the Wellcome Wing. We hope our contribution has made its marvellous exhibits even more impressive.

Good luck with all future endeavours!

We would to also thank Holly Ault, Joel Brattin, and Jennie Hawks for their support and guidance with this project.

Executive Summary

The National Museum of Science in London strives to keep visitors informed of the history and future of science. In keeping up to date, the museum will be opening a new section of the museum in June of 2000 entitled the Wellcome Wing. There will be a section within this wing dedicated to contemporary biomedical science. One exhibit, the *Who Am I?* exhibit, will explore the intricacies of human life and what it means to be human using new advances in genetic analysis, imaging technology, and psychological profiling.

Two interactive exhibits known as bloids, will be used by visitors to help answer the questions *What makes people attractive?* and *Can science slow the process of ageing?* These exhibits will be enhanced by the incorporation of current morphing technology that will provide an innovative and informative way for people to experiment with these questions.

The Science Museum in South Kensington, London will be the first science museum to open exhibits of this type. The morphing interactives will allow museum visitors to have their pictures taken and then morphed to either a different age or a different gender. This will all be possible with the help of cutting edge morphing software. The software uses a database of facial images to perform the morphing process. Our project goal was to develop and implement a strategy to create an image database that would be compatible with the morphing interactives.

Preparations

The creation of the morphing image database began with research in the areas of morphing technology, marketing strategy, and key concepts of volunteerism. Our research gave us a strong foundation of knowledge, which allowed us to work effectively with the exhibit developers.

Upon arrival at the Science Museum, we undertook a three-week period of further training, research, and preparation for the construction of the morphing image database. We began this period with a brief trip to St. Andrew's University in Scotland where we met with two of the creators of the morphing software, Bernard Tiddeman and David Perrett. At this meeting, we learned how to use the morphing software. We also learned how to create image templates. The templates are a series of points that locate key features of the face. The templates are used by the software to perform the morphing process. The research team at St. Andrew's also stressed the strengths and limitations of the morphing software and discussed the requirements of the image database. We noted specific elements such as image quality, facial expression, head position, lighting and background types so they could be considered later during the construction of our image capture station.

Our next step in creating the morphing image database was the construction of an image capture station. The image capture station was the place where we brought volunteers to have their picture taken. We determined that the images in the morphing database needed to be of similar image quality to those that the actual exhibit will take in order to produce the most impressive morphs. Therefore, we needed to simulate the conditions of the final exhibit in the image capture station. Research was done to determine what the conditions of the Wellcome Wing where predicted to be while the morphing interactives are on gallery. We worked closely with the Science Museum and their exhibit design team at IDEO to determine these conditions. We collected information regarding the lighting conditions in and around the bloid, the position of the user, and the general location of the monitor and camera. We used this information along with prototype specifications designed at IDEO to construct our image capture station. After completion of our image capture station, we produced a set of test images. We evaluated these images based on the requirements of the software and our discussions at St. Andrew's.

Before we gathered volunteers, we created methods to organise all the information we collected. We realized that we would be collecting a large number of images and demographic information. To keep everything organised, we created a Volunteer Information Sheet, and system of photo ids, and a database in Microsoft Access®. The Volunteer Information Sheet was used to gather information about the volunteers that could later be recorded into our Volunteer Information Database. It contained questions regarding the age, sex, gender, and ethnic origin of the volunteer. There was also a question that indicated which volunteer gathering method was used to attract each volunteer; information gathered from this question was used in the analysis of the effectiveness of our volunteer gathering methods. We also created a photo id system. The photo was used as the filename for collected images, and also written on an images corresponding volunteer information sheet. This allowed us to keep a link between images and their corresponding information. This volunteer information database was used to display the current breakdown of the morphing image database so that we could better target the individuals needed. The database was also used extensively during the analysis phase of our project.

Gathering Volunteers

Once we had completed our preparations, our primary concerns became gathering volunteers, collecting images, and creating templates. Two advertisements were distributed inside the museum building to create awareness of the volunteer opportunity.

We gathered volunteers from the Science Museum until it became apparent that certain groups were not being represented in sufficient quantities. These groups were primarily the elderly in all racial groups except Caucasians, and 8-18 year old East Asian, West Asian, and Afro-Caribbean groups. To reach these specific groups, we gathered information about local organisations in the Kensington, Chelsea, and Westminster areas. We then called these groups and scheduled times to meet. After we delivered a presentation to the group that detailed the new exhibit and the need for images, we asked if anyone would like to volunteer. Our most successful location types for targeting groups were day centres, schools, and community centres.

Finally, we evaluated the methods used to contact people as well as the specific locations targeted. We hoped that by showing the areas of the database that were difficult to fill and how we attempted to fill them, future development teams might have an easier time creating the database.

We found during the course of the project that gathering volunteers directly from the Science Museum was very successful. People were helpful and in most cases volunteered gladly. The groups we gathered from the Science Museum, however, were primarily Caucasian. This meant that the other ethnicities of the morphing image database were being filled too slowly given our three-week time frame for image capture. A collection of target groups were therefore selected and met with in order to fill these groups. We selected the PepperPot Day Centre to provide Afro-Caribbean elderly. We selected the Leanora Day Centre to provide West Asian elderly. We selected the Chinese Community Centre for East Asian volunteers of all ages. We selected the Holland Park School to gather 11-18 year old ethnic volunteers. We selected the Imperial College Library to provide young adult ethnic volunteers. We selected a Science

Museum kiosk in the South Kensington subway tunnel for the gathering of ethnic groups in all ages.

The day centres were a good source of volunteers over the age of fifty-five. The PepperPot Day Centre was targeted for Afro-Caribbean volunteers. We were able to recruit many volunteers of the ethnic background from this group. The Leanora Day Centre was targeted for West Asian volunteers over the age of fifty-five. Unfortunately, due to poor attendance on the days we visited, we were unable to recruit the number of volunteers we had anticipated. Nevertheless, the volunteers from these centres were very helpful; we received a high response rate our visits. Both the Imperial College Library and the Holland Park School were successful target groups. We were able to recruit many young non-Caucasian volunteers. The Imperial College Library had a positive response rate of 68%, which is much lower than the average response rate for the target groups—85%. Holland Park School was our best source of young volunteers and had a high response rate of 94 percent.

Recruiting at the Science Museum Kiosk was our only unsuccessful attempt to gather volunteers. People from this area were not interested in the volunteering opportunity. A low response rate of 13 supports this supposition.

Our method of combining in museum recruiting with target group recruiting allowed us to reach all the demographic groups we needed for the image database. We were able to reach the suggested minimum goal of eight volunteers in each age/race/sex group, for 28 of the 32 demographic groups. Even in the groups with less than eight images, we were able to create strong average images that produced impressive morphs during testing. We feel the database is fully capable of being integrated into the morphing interactives in its current state.

After we completed our part in the creation of the morphing exhibit, we felt it would be worthwhile to offer recommendations for the future development of morphing exhibits such as ours. We felt that any increase in the number of images gathered could significantly improve the quality of the morphing experience by strengthening the average images. The average image has the ability to represent a wider range of people if more images are used to create it. Future teams should also consider including new image sets to support added facial types. Image sets that would include facial hair, expression, or more specific ethnic groupings could greatly increase the effectiveness of the morphing experience.

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* The report was reviewed and edited by all team members.

1 INTRODUCTION

The Science Museum in London will be opening a new wing of the museum entitled the Wellcome Wing in June 2000. There will be a section within this wing dedicated to contemporary biomedical science. It will contain the *Who Am I?* exhibit. This exhibit will explore human life using new advances in genetic analysis, imaging technology, and psychological profiling. The creation of the *Who Am I?* exhibit will provide a new and exciting way to explore the details of human life, with particular focus in the areas of facial attractiveness and the study of ageing. Visitors will use interactive displays in an attempt to answer questions such as *What makes someone attractive?* and *Can science slow the process of ageing?* These displays will provide an entertaining and informative way for people to experiment with these questions.

Two bloids, or interactive stations, in the *Who Am I?* exhibit will use image-morphing software to provide an interactive experience for museum visitors. The Agetron bloid will simulate the ageing process while addressing issues of ageing; the Gender Morphing bloid will vary the feminine and masculine facial characteristics to support claims regarding the direct correlation between sexual attractiveness and the presence of feminine facial characteristics. Both bloids will contain image-capturing equipment that will allow museum guests to morph their own facial images.

The cutting edge morphing software behind the interactives was developed at St. Andrew's University in Scotland. The software is heavily rooted in psychological research, and was originally used by the university's psychology department. The software uses a database of previously captured facial images to create realistic morphs. Additionally, a template must accompany every image in the database. The templates are a series of points that locate features on the images such as the eyes and nose. By accurately locating points on the captured images, the templates allow the morphing software to function optimally and generate realistic morphed images.

The completion of these interactives is eagerly anticipated by the staff of NMSI, who understand the impact they will have on the museum visitors. The Science Museum in London will be the first science museum to open interactives of this type. If done successfully and with positive results, the museum's implementation strategy may be used as a model for other museums in their efforts to create similar interactives.

There were two important goals of this project. The first goal was to create a database of images and templates that would be compatible with the morphing software. The database needed to be populated with a diverse selection of images representative of all ages and ethnicities. This would allow the exhibit to produce realistic morphed images for any museum visitor who may interact with it, regardless of their age or ethnic background. These images also needed to be captured in conditions similar to those that will be experienced in the Wellcome Wing to ensure full compatibility between the image database and the morphing software.

The second goal of our project was to create a document that provided a general implementation strategy for people interested in reproducing our work to create an image/template database of their own. We have included this document as well as details on how we implemented it and an analysis of its effectiveness.

The image/template database is an essential part of the morphing interactives. Since images in the database must reflect the conditions in which the software will be used, the database cannot be shared between museum unless exhibit conditions are very similar. Since this is not likely, there will be substantial curiosity regarding the process used to create the database. Other museums will benefit from studying our implementation strategy, methods, results and analysis.

The success of this project will be measured by the completion of the database that will be compatible with the *Who Am I?* exhibit, and completion of the report and analysis of our implementation strategy.

2 LITERATURE REVIEW

2.1 National Museum of Science and Industry (NMSI)

The London Science Museum, part of the National Museum of Science and Industry, is one of the world's leading scientific museums. Its dedication to excellence is demonstrated, in part, by the constant expansion and refinement of housed exhibits to interest and inform over one million visitors per year. The museum maintains a fine balance between education and entertainment through interactive exhibits and valid connections between the past, present, and future of science. It is the museum's practice to encourage learning, not merely display information. The NMSI charter summarises the museum's purpose and its attention to visitors; "The Science Museum helps the public understand and enjoy the history and contemporary practice of science, medicine, technology and industry. We aim to inspire, enlighten, and educate" (NMSI 1999).

NMSI has set high goals for the millennium. Continuing its tradition of creativity and inspiration, the museum will be opening a new wing. The Wellcome Wing, as it is called, will focus on the future of science and people's relationship with it. Exhibits will range from explorations of new technology and human perceptions, to an almost science-fiction-like journey through the future possibilities of science.

One portion of the new wing, the *Who Am I?* exhibit, will primarily focus on what it means to be human and what makes us different from animals and robots. Museum guests will explore topics such as ageing and attraction using interactive stations in certain exhibits. These stations will allow people to transform their facial images to different genders and different ages. The museum exhibit briefs (NMSI 1999a,c) give an in depth description of the two interactive stations. See Appendices E and F for more detailed information.

The Gender Morphing station will focus on the differences between men and women, and how we make judgements about faces. The purpose of these interactives is to entertain people by allowing them to alter their appearance, point out predominant features that are seen as male or female, and present questions that lead people to think about how they see other faces. The software that makes this possible has been used in real psychology experiments such as the work done by David Perrett (1998). Visitors will be able to morph their appearances to the opposite sex to explore these questions.

The Agetron interactive will present information on theories concerning ageing. The goal of the interactive is to demonstrate the changes people undergo as they grow older. Computer software will simulate these changes. Visitors will have access to the cutting-edge software that is currently used by today's psychology researchers in order to see what they might look like when older or younger. The use of morphing stations stimulates interest and offers better insight into questions such as "Can science make us live longer?" (*NMSI* 1999a).

A firm understanding of the importance of both the Agetron and Gender Morphing interactives was crucial when we begin to gather volunteers. Being able to stress the museum's long-standing goal of making science interesting and fun; to describe the reasons why we need volunteers to come in and have their images captured; and to emphasising the exciting and entertaining new interactives increased the likelihood of people to volunteer.

2.2 St. Andrews University and Morphing

2.2.1 Morphing Technology

With the recent technological advances in computer-generated graphics, it is now possible to morph, or change the appearance of, faces by gradually altering specific facial features. Morphing is derived from the Greek word "morph" which means form or shape. Morphing is an image processing technique typically used as an animation tool for the metamorphosis from one image to another.

The morphing process consists of warping two images so that they have the same "shape" and then cross dissolving the resulting images. Cross dissolving is simple; the major problem is how to warp an image. The idea is to specify a warp that alters the shape of the first image into the second. The inverse will distort the second image into the first. As the metamorphosis proceeds, the first image becomes gradually distorted and fades out, while the second image starts out totally distorted toward the first and is faded in. Thus, the early images in the sequence are much like the first source image. The middle image of the sequence is the average of the first source image and the second source image. The last images in the sequence are similar to the second source image. For morphs between faces, the middle images often looks strikingly life-like, but is clearly neither of the source images. Figure 1 below shows an example of a three-frame morph.

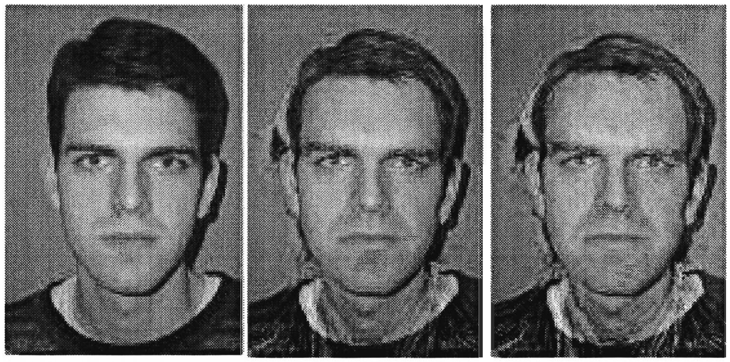

Figure 1: Three-Frame Morph

There are two general methods to implement the morphing process. The first utilises three-dimensional computer graphic techniques, and the other uses two-dimensional computer graphic techniques. The first approach involves the representation of a pair of three-dimensional objects as a collection of polygons. The vertices of the first are displaced over time to coincide with the corresponding vertices of the second object. Colour and other attributes are similarly interpolated. The problem with this technique is the difficulty in establishing a desirable relationship between vertices on the two objects. This often imposes inconvenient constraints on the geometric representation of the objects, such as requiring the same number of polygons in each model. Even when these conditions are met, problems still arise when the topologies, configuration, or arrangement of the two objects differ (Beier 1992).

While three-dimensional object morphing is usually a simple process when both objects are modelled for the computer, the complexity of some subjects can make the approach impractical (Beier 1992). Many applications of the effect require transformation between complex objects such as animal or human faces. Beier, in this case, writes it is easier to manipulate scanned photographs of the faces using two-dimensional image processing techniques rather than attempt to model and render a three-dimensional representation.

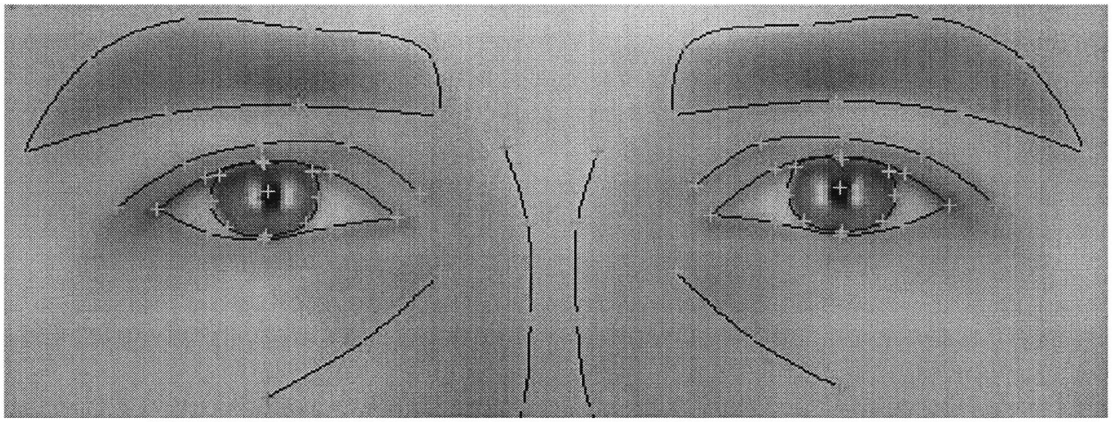

Figure 2: Fiducial Points of the Eye Area

In order to morph images of two faces together, one must first locate a set of corresponding points on each face. These points are the fiducial points. Fiducial points locate key features of an image. Figure 2 shows a series of fiducial points around the eyes of an average face. The fiducial points are displayed as dots along the line. In standard two-dimensional morphing software, the human operator locates and marks these points on each face before applying the morphing procedure (O'Toole 1999). After all the points are located, computer software connects the points forming a mesh configuration. For each transitional frame, the software uses interpolation to approximate the intermediate lines based on the source and destination images. The software distorts the images towards the position of the lines in the intermediate frame. These two resulting images dissolve throughout the metamorphosis. At the start of the process, the first frame is identical to the source image. Halfway through the metamorphosis it is an average of the two images. At the end of the morphing, the final frame is identical to the second, or destination image.

Another issue of morphing is how to change the colour for the intermediate frames. The simplest method entails proportionally averaging the colour taken from source and destination images (Beier 1992). For example if we need 10 frames to complete the morph (frames numbered from 0 to 9), then the colour of frame 0 will be 9/9 of the source image and 0/9 of destination image. For frame 1, its colour is 8/9 from the source image and 1/9 from the destination image. This trend is continued for each frame, until finally frame 9 has a colour, that is 0/9 of the source image, and 9/9 of the destination image. By gradually warping each image, one can change the appearance of an image to look like another.

2.2.2 St. Andrew's University Research

The sex of a person can be determined from his/her face (Enquist 1998). Although there are only two sexes, people exhibit many different degrees of masculinity and femininity. Studies at St Andrew's University have been done using these new morphing techniques to test the effects of sexual dimorphism on facial attractiveness.

A study conducted by Perrett and colleagues at St. Andrew's University probed for answers to what the differences in masculinity and femininity mean in terms of attractiveness (1998). In the study, the research team photographed Japanese faces under standard lighting conditions with neutral facial expressions. Similar photographs were prepared for Caucasian faces. They converted the photographs to digital format and defined 174 feature points on prominent facial landmarks manually for each face (Perrett 1998). The average face shapes of male and female Japanese and Caucasian face subsets were calculated from the feature points. The research team standardised the positions of eye centres for corresponding average male and female face shapes. Then, the computer software warped the original face image to the shape of the corresponding average face and then averaged colour and intensity values of pixels at corresponding image locations. The software increased or decreased the average vector difference between corresponding feature points on the male and female averages by 50% to create masculinised or feminised shapes. Then, the software warped the image of the composite face into these new face shapes to create image pairs with identical texture but enhanced or diminished sexual dimorphic differences in face shape. Then, the software matched the sizes of all male and female face images by standardising the inter-pupil distance. Lastly, the software cropped the resulting composite images around the face and faded them into the background. Cropping removed the hair, ears, and neck that were not consistent in the shape or visibility in component images in order to minimise the negative effects of different hairstyles and clothing on the morphing process.

After defining the reference points on all the faces, the computer could begin the task of changing the shape of the faces. The positions of these points differ in male and female faces. The computer software manipulates these points to accentuate or normalise male and female features. For instance, males have bigger jaw-lines than females. So, by increasing the size of the jaw, one can create a more extreme male face. In this study, images were produced where faces varied from feminine to masculine based on the scanned faces from Scotland and Japan. Researchers asked men and women from Japan and Scotland their opinions about the attractiveness of the generated images. The results were used to test two different hypotheses.

The first hypothesis is the Average Hypothesis. It states that people consider the generated average of male and female features more attractive than either feminine or male characteristics alone (Langioia 1990). According to Langioia, the Average Hypothesis would account for the low uniqueness of attractive faces. If the Average Hypothesis is valid then attractiveness is an indication of having average features, and a composite with a shape derived from highly attractive faces should not differ from a composite derived from average faces. This basically states that as a face is changed from average it should become less attractive. Perrett conducted research to explore this conclusion and found evidence to the contrary.

The second hypothesis, as studied by the researchers at St. Andrew's, is that a more feminised average face is often considered more attractive. In Perrett's experiment, researchers displayed a number of faces to the subjects. The subjects were shown masculinised, feminised, and average faces from male and female Caucasian and Japanese people. When both the men and women from Japan and Scotland were asked to pick which faces they found most attractive, the results contradicted the Average Hypothesis (Perrett 1994). In almost all cases, the Japanese and Caucasian male faces that subjects considered the most attractive were significantly feminised. The same applies to the attractiveness of the female face. Subjects preferred an average value of 20% feminisation (Perrett 1998). Caucasian and Japanese subjects demonstrated the same pattern of preferences with the same face stimuli. This suggests that aesthetic judgements of face shape are similar across different cultural backgrounds. Thus, these results show that highly attractive faces are systematically different in shape from average faces.

The new addition to the museum entitled the Wellcome Wing will include an interactive to demonstrate the results of these studies and present visitors with questions of attractiveness. Visitors will enter the interactive and have their faces scanned into a computer where they can graphically alter their appearance. By changing the amount of male or female stimuli added to their face they can judge what they find to be the most attractive face and then compare it to the results of the studies by Perrett. This interactive and ones to follow could greatly help people understand how facial features influence interaction and perception.

2.3 Marketing and Advertising

A major portion of the project work we performed in London involved gathering volunteers. We needed to be efficient in our advertising methods to reduce the amount of time it required to create awareness, and to initiate the flow of volunteers into the museum for image capturing. We gathered some information describing how to create effective advertisements, and how to market a product or idea to consumers, who in this case will be the volunteers.

Advertisers must design adverts with target audiences in mind. In order to market a product or idea to consumers effectively, it is important to define the consumers (Gray 1984). A defined target audience allows advertisers to tailor their marketing strategy to maximise the impact an advert has on consumers. An effective advert cannot be created without a good sense of the target audience.

We divided volunteers into groups based on common activities, beliefs, or needs. Examples of these are age, sex, education, occupation, and ethnic background (Gray 1984). These examples all represent different characteristics of people's lives. It is important to remember that a single person can be in several groups. By considering different aspects of the consumers, it was possible to simplify the marketing process by reducing the number of groups.

According to Gray (1984) and Holtz (1988), there are three key parts to every printed advertisement. They are the layout of the advert, the headline, and the illustration. These three parts can create a powerful advertisement, capable of attracting the reader's attention, and turning a glance into a chance to sell a product or idea (Gray 1984). Each part could have had a positive or negative affect on the effectiveness of an advertisement, so it is important that they were designed properly.

The headline is a crucial part of an advertisement. People are exposed to an average of two hundred and fifty advertisements a day, and are becoming increasingly desensitised to them (Gray 1984). Therefore, the headline must be clear and visible, in order to attract the reader. The headline also needs to create enough curiosity and interest in the reader so that he or she reads the rest of the advertisement. Otherwise, the reader's attention will be lost—a symptom of a poorly constructed headline.

A relevant, well-placed illustration can greatly enhance an advert by reinforcing the message it is relaying. Holtz (1988) writes that "one of the most serious errors some writers make is basing their efforts on the supposition that writing is primarily the use of language—words—to organise appropriate structures to communicate information, ideas, arguments, emotions and whatever else a writer wishes to express." The addition of graphics can make an ineffective advert effective (Holtz 1988). It is important that the illustration complements the headline and strengthens the advert by reinforcing the message it contains (Gray 1984).

The layout of the advert organises the advert in a manner that allows the reader to extract the key points in the advert, while minimising distraction. A simple layout is often most efficient. Reducing the number of graphics and letter styles will reduce distraction from the key points of the advertisement (Gray 1984).

2.4 Volunteerism And Motivation

Our task of locating roughly 500 select volunteers who were willing to have their image captured required additional research to find possible methods for recruiting and motivation. We briefly explored the social and psychological elements that stimulate the need to volunteer. The Total Design Method, as discussed in detail by Ally and Bacon (1994), described the basic technique for getting people to respond. The principle behind this theory is that in order to get an effective response from a volunteer, recruiting methods must be created in such a way that the benefits to the volunteer outweigh the costs. Therefore, our research looked into ways to increase the benefits to the volunteer while minimising the disadvantages.

Some positive influences that appeared to be directly applicable to our project are the use of incentives. Rosenthal and Rosnow (1975) document scenarios where a simple offer of an insignificant amount of money would significantly increase the percentage of volunteers for research experiments. Also, using a slight combination of altruism and ego by making the act of volunteering more public seemed to increase the number of participants. As people saw others volunteering, their interest was increased and doing something for free appeared a bit more enticing. Stressing the importance of the volunteer work and generating genuine interest were also strong tactics for getting more participants. If people feel that the work is of greater value to society, it is worth more of their time. By making sure the potential volunteers understand the importance of the work, the act of altruism will have more meaning (Rosenthal & Rosnow 1975).

Knowing what keeps people from volunteering was as important as understanding what motivates them. According to Rosenthal and Rosnow (1975), three of the most popular reasons why people refuse to volunteer involve lack of time, lack of interest, and fear of what the experiment requires. Lack of time seemed to be related to lack of interest. If potential volunteers are not interested in the work, they might feel it is not worth their time to volunteer. Stimulating interest and emphasising a short timeframe decreases the number of people who do not volunteer for these reasons. Fear of the volunteer work is usually caused by the person's lack of understanding of his or her exact role. Fear of the activity will dissipate if the role of the volunteer is defined and questions are answered clearly.

Considering the motivations for volunteerism was essential in our development of volunteer gathering methods for the image database. Having an idea of what motivates people to participate, as well as what deters people, allowed us to create our methods to account for them.

3 METHODOLOGY

Other museums may be interested in the morphing interactives and the methods that were used to create them, and possibly even model their own interactives after the ones at the Science Museum. Therefore, it was important for the Science Museum to have a comprehensive record of all the work that was done in the process of creating these new interactives. Since our work helped get the new interactives online, we also needed to have comprehensive documentation of our methods.

Part of our project goal was to create a document that provided a general implementation strategy to create a morphing software image database. We wrote the methodology section of this report to serve as an instruction manual for persons interested in reproducing our work to create an image database of their own. This section develops a general strategy that will allow exhibit designers to replicate our work, and/or tailor it to their operating environment.

3.1 Preparation and Training

Before any work can be done, the database development team needs to make a number of preparations. In order to develop an image database, it is important for the development team to gather relevant background information and train in the use of any hardware, software, and equipment that they will use in the development of the database.

One of the first bits of information that they should determine is the type of software that exhibit designers plan to use in the morphing interactives. Before any development work can be done, it is important for the team to know several things about the software. They should know such things as how the software performs the morphing process, if this process has any image quality requirements, and what the software's capabilities and limitations are. All these things greatly influence the preparations that the team will need to make before they can capture database images. It is also important for them to learn how to use the morphing software so they can test the image database to ensure the images and the software are compatible.

Next, the database development team should research the various conditions of the final exhibit. This information will include the location, type, and intensity of exhibit lighting fixtures, method of exhibit/user interface, image capture equipment, image capture technique, distance of user from camera, angle of camera to user's face, and the environment of image capturing in the exhibit including background lighting and colouring. Exhibit designers and developers should have access to this information. Database developers must use all this information when creating an image capture station. The image capture station is the location where the development team will gather the database images. It is crucial that the environment at the image capture station simulates the environment of the final exhibit so that the images captured at the station are similar to those that will be gathered in the final exhibit. This will result in better quality morphed images. The variation allowance between the conditions at the image capture station and the final exhibit will be governed by the tolerance of the morphing software. This is another reason why it is essential for the development team to have a full understanding of the morphing software.

Another key component required to create the image database is the image capture equipment. It is vital that the camera has the ability to capture images with a quality level that meets or exceeds the needs of the morphing software. In addition, the camera needs to be able to capture images in the lighting conditions of the exhibit—the light requirements of the camera should be noted.

The last consideration that the development team will need to make before the image capture station can be created, is where the station is going to be located. The ideal location will have light conditions that will not interfere with image capture; the station will be in an area easily accessible to volunteers who are essential to the completion of the image database.

Once all of information collection and training are complete, the database development team can create the image capture station.

3.2 Method of Record and Organisation

Regardless of the size of the image database that is required for the morphing software, it will be important for the development team to keep all the images organised. They should employ a method to keep track of image files (i.e. a system of directories and a filename convention), and their corresponding demographic information. The different types of information (age, sex, ethnic origin, date of image capture, etc.) that need to be recorded are specific to the exhibit being developed. Depending on the needs of the exhibit, it may be useful for the team to have the ability to sort images by these types of information. They can create a database to perform this function.

3.3 Recruiting Volunteers

Once the database development team has completed all the preparations, training, and created the image capture station, attention should turn to recruiting volunteers. The database development team should devise some sort of advertising campaign. Proper advertising can greatly simplify the task of recruiting volunteers. There are many methods of advertising. The team should establish which method(s) are the most practical, and the most effective for their circumstances. The informational flyer and pinup advert are two easy methods of advertising.

The museum that is developing the morphing exhibit may have its own design staff who specialises in designing printed advertisements. The development team could delegate the responsibility of designing the advertisements to the design staff, which could prove beneficial to the development of an effective advertising campaign.

If the development team plans to design advertisements themselves, they should follow design rules that have been proven successful. An eye-catching headline, an interesting relevant illustration, and simple layout are the key elements in an effective advertisement. See section 2.3 for more details on creating an effective advertisement.

The development team also will need to consider where they are going to find volunteers. The museum that is developing the exhibit should be a good source of volunteers, but it may be necessary to search elsewhere if a large diversity of volunteers is required. To reach diverse groups, it is worth contacting social groups and organisations such as day centres, nearby schools, and foreign embassies.

3.4 Scanning and Template Creation

Before scanning and template creation can begin, it will be important for the database development team to create a standardised set of rules that dictates how to capture images and create templates. Once these rules are established, it is crucial that they remain consistent during the course of the image/template database construction. Consistent images and fiducial point placement during the template creation process will greatly improve the quality of the images produced by the final exhibit. The database development team will need to tailor both the image capture and template creation standards to the morphing software they will be using. It will be essential that the points that make up the template represent the same facial features in each image. Special attention should be given to the spacing of individual points and the placement of points in the more ambiguous areas of the cheekbone, hairline, and nostril regions.

The database development team needs to gather relevant demographic information from the volunteers as they have their image captured.

3.5 Report Results and Integration

An important part in the completion of the morphing database is the documentation and analysis of the methods used during its creation. The final task of the database development team will be to gather and organise the information recorded during the creation of the database. The development team should pay particular attention to the response rate of each gathering location, the locations responsible for specific groups, and how volunteers became aware of the opportunity. By presenting and evaluating the contact methods and gathering locations, future development teams will be able to refine previously used methods and create a potentially stronger morphing exhibit.

4 IMPLEMENTATION

4.1 Development of the Bloid / Image Capture Station

It was essential for us to create a controlled environment where we could capture consistent images for the morphing database. This led to the creation of an image capture station. We raised many questions when considering the design of the image capture station. Our goal was to replicate the Wellcome Wing environment in an area inside the museum in order to capture images of the same picture quality as those that will be taken when the exhibit is opened in June 2000. Considering the restrictions on money, time, and construction materials, coupled with the desire for the image capture station to be mobile, we developed the best design under the given circumstances.

During the process of designing the image capture station, we considered many factors, as discussed in the methodology. The following sections contain information on the various aspects of our final design for the station, support for the decisions we made, and also a hindsight analysis of our design.

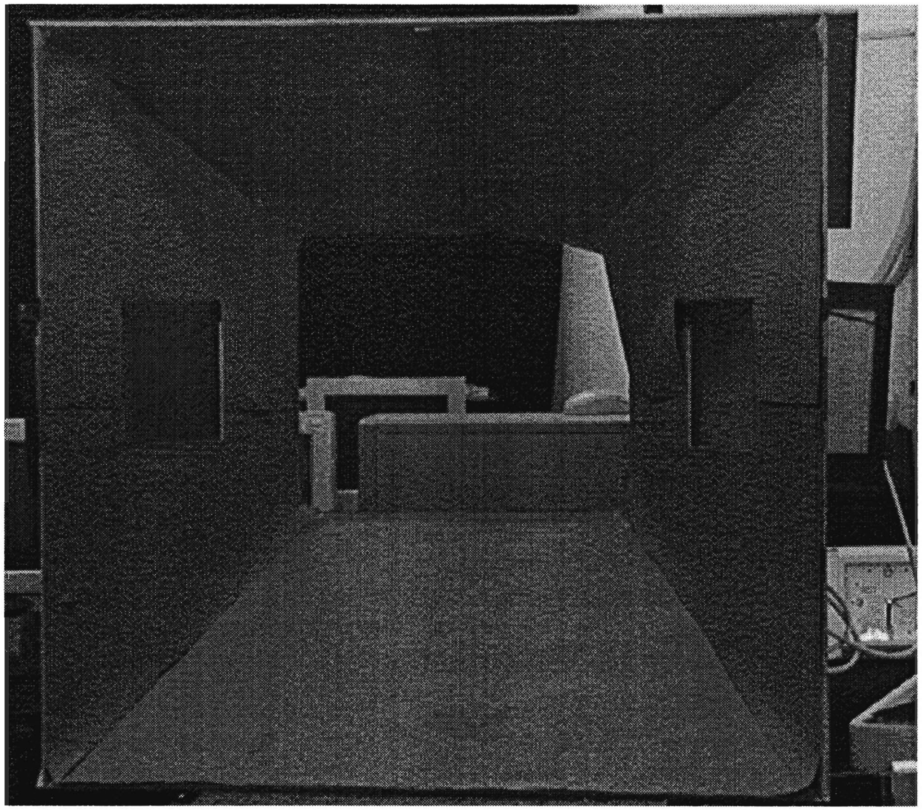

Figure 3: Image capture station

4.1.1 Location

The available locations in the museum for setting up the image capture station were limited. None of the locations were ideal for setting up our station, so we compared the locations by focusing on their positive and negative attributes. Ultimately, we determined that being in a popular area of the museum would be invaluable to us. All other conditions, such as lighting, could be altered well enough for us to capture valid pictures.

We set up our station on the third floor of the Science Museum across from *Flight Lab*. The primary reasons we chose this location were its popularity and diversity of visitors. "*Flight Lab* is a hands-on exhibition with demonstrations and experiments designed to show how aircraft are built, how they fly, how they are controlled, and how their engines work." (NMSI 1999)

This exhibition schedules various school groups daily, and is home to the museum's popular Motionride Simulator. To one side of *Flight Lab* is a gallery named *Flight*. This gallery tells the story of the birth of flight and contains more than twenty aircraft. On the other side of *Flight Lab* are *Science in the 18th Century* and *Heat and Temperature*, two galleries which contain historical scientific objects and target older museum visitors. Also adjacent to *Flight Lab* is the replica radio station, *On Air*. These exhibitions draw a diverse group of visitors from all age groups to the area. A further advantage of this location was a nearby storage area, in which we were able to store our equipment, as well as do related project work such as template creation.

There were a few drawbacks to this location. One problem was that it contained many large windows that made the area bright. Since the Wellcome Wing was designed to have a dim interior, we needed to dim our image capture area. The set up of the lighting fixtures, and the use of a dark backdrop helped us solve this problem.

4.1.2 Computer Software

During our visit to St. Andrew's University in Scotland, we were introduced to morphing software similar to the software that will be used in the interactive bloids. Both software packages have the same designer. The only difference between the two software packages were improvements in the section of the software that powers the feature location function during automatic template creation. In order for this automatic identification process to function optimally, it was important to ensure that the images have certain consistent qualities. While at St. Andrew's University we learned which qualities of the captured image are used by the software to map the features of the face. By keeping these qualities consistent, clear and accentuated, we were able to create a database of images that will work effectively with the morphing software.

The first quality requirement of the software is contrast in colour. The morphing software uses contrast in colour to determine the location of important features of the face. For example, the red colour of people's lips contrasts with the peach colour of their skin. For this reason, it was important that shadows were minimised on the face. The presence of a shadow might result in faulty facial feature recognition. Because of this, it was important that light of a sufficient intensity was cast evenly over the face to illuminate the features of the face completely, without washing out the colour in the picture. It was also important for us to create contrast in colour and focus between the faces and the background of the picture. This contrast allows the software to correctly identify which parts of the digital image belong to the volunteer and which parts can be ignored as background. To strengthen the contrast in colour of the image and diminish the impact of the background we used frontal lighting along with a flat dark background.

The second quality required by the morphing software is a database of high-resolution images with deep colour depth. This requirement is closely related to the software's need for colour contrast. It was important that the quality of the captured images is high enough for the software to recognise small differences in colour and shape. In order for these small differences to be represented well enough to create a quality morph, an image of 640x480 resolution or greater with a colour depth of at least 24 bits must be used. We used these specifications to determine if the camera was able to produce images of a sufficiently high quality.

4.1.3 Camera

In order for the morphing software to function optimally, the captured images needed to meet certain quality standards. Since the camera can limit the quality of the captured images, we conducted preliminary tests using a small set of cameras to determine which would produce the best results. Dave Patten, the museum's Interactive Media Exhibits Manager, selected a few cameras prior to testing. He selected the cameras based on certain criteria such as cost, image quality, and availability. Ultimately, we chose the Sony DCR-TRV900E for use with the interactives. Our main reasons for selecting this camera were its abilities to produce a high resolution still image, and to function at low light levels.

It was essential for the camera to be able to capture high-resolution images in low light levels since the same camera was going be used in the dimly lit Wellcome Wing. Image precision under low light levels greatly aided the software's ability to automatically identify features.

The resolution of the captured images also had a significant impact on the effectiveness of the morphing software. The Sony DCR-TRV900E was a mid-range digital camcorder that had the ability to produce still images that are 640x480 with 24 bit colour. This was the size and colour depth that was suggested by the researchers at St. Andrew's University. Even though these values met their suggested minimum values, we felt it was necessary to test some captured images with the software before continuing. We captured three facial images and used the software to attempt to identify the features of the face automatically and then perform a morph on the captured image. The automatic template creation worked fairly well, and the morphs of these images were of a similar quality to those done at St. Andrew's University. Images were also sent to St. Andrew's and IDEO for further review. It was determined by all people involved that the picture quality produced by the camera was sufficient, and therefore the camera would work well in the morphing exhibits.

4.1.4 Lighting

To create a functional database for the morphing exhibits, we needed to populate it with images of equal quality to those taken by the bloid in the Wellcome Wing. Because of the quality issues, lighting was a big concern. We wanted the lighting arrangement in the image capture station to be the same as the lighting arrangement in the bloid. This would ensure consistency between the images in the database, and the images taken at the bloid. A team from IDEO assembled a prototype of the bloid liner during the first three weeks of our project. The finished prototype was similar in shape to that of the final exhibit liner and contained openings for the camera, monitor, and areas where lighting fixtures could be mounted. The lighting fixtures consisted of two halogen light bulbs attached in boxes mounted to the backside of the bloid liner. A sheet of prismatic plastic was placed over the light to diffuse the beam. Then a sheet of blue acetate was layered over the prismatic plastic to reduce the amount of orange light that was transmitted. The light produced by this configuration worked to counteract the effects of the magenta colour of the bloid liner, and produced a primarily white light. In addition, the lights were angled to direct the light at the face of the user. This frontal lighting set-up served to illuminate the face, while diminishing shadows and interference caused by the background.

The dimensions of the prototype liner, including openings for the monitor, camera, and lights, were given to the Science Museum's workshop team. The workshops team created an identical bloid liner, which we used in the image capture station.

Another issue that we dealt with was the construction of the lighting fixtures for the bloid liner. In order to avoid delays involving workshops, we purchased materials we could manipulate ourselves without the use of many tools. We purchased corrugated plastic sheets to use in the construction of the housing for the lights. We assembled the lighting unit using the dimensions of the bloid liner and the wiring diagram provided for us. We then tested the prototype to confirm that the light quality and intensity were sufficient to produce high quality pictures.

4.1.5 Backdrop

As designed, the ambient lighting of the Wellcome Wing will be quite dim. Also, there will be no objects close to the location of the user interface in the morphing bloids. This will ensure that lighting from the bloids will not illuminate any objects in the background that may 'confuse' the morphing software's automatic feature recognition. The pictures taken in the Wellcome Wing will consist of an illuminated face with a nearly solid dark background. In order to simulate this environment we used front angled lighting and a black sheet as a backdrop. The use of a black sheet did two important things. The sheet eliminated the presence of any background objects in the images that could have reduced the effectiveness of the software's automatic template feature. It lowered the light level of the scanning area and provided a consistent background that was completely mobile.

One problem we had with our backdrop was that the sheet had a low fibre density and allowed some light to pass through. Windows located across *Flight Lab* allowed direct sunlight to shine through our backdrop and affect our images. When we were capturing test images, we noticed these windows affecting the effectiveness of the morphing software. Luckily, these windows were equipped with metal shades. These shades were lowered before the collection of images commenced.

4.2 Organisation

With all the image and template files that we generated, and the demographic information that we gathered on the volunteers, it was essential for us to develop a method of orgainsation.

4.2.1 Volunteer Information Sheet

The Volunteer Information Sheet was created to facilitate the organisation of volunteer demographic information. A copy of the Volunteer Information Sheet was included in Appendix B. The sheet was designed to contain information on the volunteers in four categories: age, sex, ethnic origin, and method of attraction to volunteering. The question regarding age was located at the top of the Volunteer Information Sheet as question one. This allowed us to point to question one and ask the volunteers which age group they belonged to, while simultaneously covering up the remaining questions. Placing this question at the top of the page was a recommendation made by Sarah Hunt of the museum's Evaluation Group who regularly interacts with museum volunteers to test out new museum exhibits. She claimed it would streamline operations if the age question was at the top of the page and the volunteers could not see the remaining questions.

A line labelled 'ID' was included at the top of the Volunteer Information Sheet. On this line we wrote the filename given to the image and template that correspond to the volunteer whose information was on the Volunteer Information Sheet. This allowed us to keep a link between images and their corresponding information.

4.2.2 Filename Convention

To keep track of image and template files, we created a file naming convention. This allowed us to determine the demographic content of image files without loading them into a image viewing program.

The first letter represented the gender of the volunteer: m = male, f = female. The second letter represented the volunteer's ethnic origin: c = Caucasian, a = Afro-Caribbean, e = East Asian, w = West Asian. The final letter represented the age group the volunteer fit into: a = 8-12, b = 13-18, c = 19-24, d = 25-35, e = 35-54, f = 55+. Finally, a number was appended to each filename to denote the sequential order in which the images were captured. For example, the file "mcc010" would be tenth image captured. The volunteer would have been a Caucasian male between the ages of nineteen and twenty-four. Since the morphing software created image files with the file extension .ppm, and template files with the extension .dat, both the captured images and their templates were able to have the same filename prefix. The filename prefix was written in the space provided on each Volunteer Information Sheet. This naming convention allowed for the captured images, the corresponding templates, and the information gathered on the volunteers to share the same name, and therefore allow for easier information retrieval.

4.2.3 Volunteer Information Database

We constructed a database in Microsoft Access® to help us organise and analyse the information gathered from our Volunteer Information Sheets. We entered all the information from the volunteer information sheets into the database in order to keep track of the current composition of the morphing database. This allowed us to easily identify the groups in the image database that were filling slowly, and then develop a plan to target these groups specifically. The Volunteer Information Database was also used to analyse the effectiveness of our gathering methods and the usefulness of each gathering location.

We stored the information in a series of interconnected tables that could then be queried for specific information. We entered data into the database using a simple input form that was constructed from a set of sub-forms. We created queries to gather information about specific subsets of volunteer information (i.e. sex, ethnic origin, etc.). Then we organised the queried information into graphs, spreadsheets, and reports. The ability to quickly determine the current composition of the morphing database, as well as analyse the collected data, proved to be very valuable during the course of our project. See Appendix I for addition information on the construction of the database.

4.3 Recruiting Volunteers

More important than the considerations involved in the creation of the image capture station, were the considerations that we made when developing a plan for gathering volunteers. The morphing software was robust enough to 'work' even with images of poor quality, but it still needed the images. Therefore, gathering volunteers was an essential part of the project. Described below are the measures we took to create awareness of the volunteering opportunity and to attract people to volunteer.

4.3.1 Creating Awareness

Once the image capture station had been created, we initiated plans for creating awareness in potential volunteers. Several measures were taken to do this. Initially, we focused primarily on museum visitors and staff as sources of volunteers because they were the most convenient. We were able to gather a large quantity of people in a limited amount of time. In addition, we were not required to transport the image capture station to various locations. Also, we felt people already in the museum would have a greater interest in helping us develop a new exhibit, and therefore would require less persuading.

There were two ways in which we attempted to create awareness in the museum. First, we sent out an email (see Appendix D) to all museum staff with email addresses. Since the majority of the employees already knew about the Wellcome Wing, it was not necessary to include much background information about the wing or the morphing interactives. Instead, the focus of the email was on our need for volunteers. The email contained information regarding times, and location of the image capturing. We created a draft of the email and submitted it to Aisling Byrne for approval. We then submitted the email to the Network Administrator for distribution. The email was a simple means of reaching many of the employees in the museum. Unfortunately, not all the employees have access to computers or email. We contacted these types of employees (Warders, Explainers, security, and cleaning staff) through other means.

To reach these groups, as well as general museum visitors, we created an informational flyer (Appendix C-2) and a one-sided advert (Appendix C-1). These contained similar content to the email but also offered a visual example of what the finished exhibit could do (i.e. a morphed image). They contained more background information than the email since it was also targeting museum visitors. Due to the strict regulations surrounding any museum publications, we had limited input in the design of these flyers. The design staff at the Science Museum designed the information flyer and one-sided advert. We supplied the headline, the informational text, and the photo.

The informational flyers were distributed at various locations in the museum. Stacks of flyers were deposited with the Warders at the information stand by the main entrance of the museum, and with the Explainers at various interactive exhibits in the museum. We also attended a weekly Explainers meeting in the museum on 11 February 2000 to introduce ourselves, and ask for their help in gathering volunteers. By letting the Explainers know what type of people we were trying to gather and where we were located, they could then direct potential volunteers. The one-sided advert was used when gathering volunteers in the museum.

4.3.2 Volunteer Gathering from the Museum

Once awareness and interest in the volunteer opportunity was created, the specific methods for approaching and gathering people became important. We contacted the Science Museum's Evaluation Group, which routinely draws volunteers from the museum to test upcoming museum exhibits. Sarah Hunt and Ben Gammon, members of the Evaluation Group, explained the methods and systems the museum uses for gathering volunteers. Their suggestions appear were included in Appendix A.

We quickly found that the majority of people visiting the museum were more than happy to help out with the development of new exhibits. Because of this, the methods of gathering were simple and direct. Though most contacts were direct, the actual presentation varied slightly depending on the perceived attitude of the intended target or questions asked during the gathering process.

When a potential volunteer was identified, contact was initiated by greeting him or her, and followed by a self introduction. We approached all people while wearing a museum photo ID badge and carrying a clipboard of one-sided adverts. We felt this style assured people that we were a part of the museum staff and that the volunteer opportunity was legitimate and important. We kept contact informal and friendly by introducing our need for volunteers in a relaxed manor. Since the area in which we were gathering volunteers was in sight of the image capture station, the time people required to volunteer was kept to a minimum. On average, volunteers spent less than a minute to walk over and be photographed. This point was stressed to the visitors. Upon any initial rejection we emphasised the short time commitment, the large need for volunteers and the 'good cause'. This proved, in most cases, to be enough to convince people to participate.

Styles of presentation and gathering were adapted over time to answer anticipated questions. We found that providing all necessary information and offering a visual explanation with the advert helped create interest and convince people to volunteer. Using the advert, we were able to show an example of a person being aged by the morphing software, which proved to be invaluable for stimulating interest and explaining the exhibits.

4.3.3 Volunteer Gathering Outside the Museum

Gathering volunteers outside of the museum was crucial for completing the sections of the database that were not being filled adequately by visitors in the museum. After the first week of scanning, 216 images were gathered from visitors to the museum. From these images we were able to determine which groups were not be sufficiently represented in the museum. All ethnic groups except Caucasian needed volunteers of the ages 8-12, and 55 and older. The database composition also proved that all of the East Asian age groups were poorly represented in the museum.

Science museum staff provided good insight toward determining and locating target groups. Since our primary target groups were elderly, East Asian, and 8-12 year old students, we focused on day centres, East Asian social groups, and schools.

Day centres are places where elderly can go during the day for meals, company, and entertainment. By locating these day centres in areas that are known to be ethnically diverse, we were able to pinpoint a large number of elderly in all of the ethnic groups. The centres were selected primarily by looking in the phonebook for services provided by local boroughs. The boroughs of Kensington and Chelsea, and the city of Westminster were our starting locations based on the suggestions of the Science Museum staff. We then called the day centres in these areas and scheduled times to meet.

For the most part, day centres were very receptive to the volunteer opportunity. In a few cases, a copy of our informational flyer was faxed to illustrate further the purpose of our need for volunteers. A wish of the day centres was to make the volunteer process as interesting as possible. To do this we presented a detailed explanation of the final exhibits to the people at the day centres. We used our informational flyers as handouts. Also, we loaded a previously captured image into the software with its associated template. We used this image/template pair to describe the workings of the software for waiting volunteers. The locations we visited are listed below, in the order in which we visited them. Refer to chapter 6 ANALYSIS to see the results of gathering volunteers at each of these locations.

4.3.3.1 Museum Kiosk, South Kensington Underground

The Science Museum had a kiosk in the subway that connects the South Kensington Underground station to the Science Museum. A wide variety of people traveled through that subway each day. When we realised that the database needed images of non-Caucasian people in all four age groups, we considered moving the image capture station to the kiosk. We made arrangements with Andy Fenwick, the museum's Front of House Manager, to set up the image capture station in the kiosk.

The same technique was used to gather volunteers in the subway as was used in the Science Museum; we approached people with our one-sided advert. In the kiosk, a more purposive selection process was used. Since the database already had a sufficient number of Caucasians, they were not asked to volunteer.

4.3.3.2 Imperial College Library

The Science Museum is located directly next to Imperial College, and our office was in the Imperial College Library. Therefore, we were exposed to the school's students and staff daily. We noticed that the school had a very diverse student body. When we realised that the database was still lacking images of Afro-Caribbean, East Asian, and West Asian volunteers aged 13-18, we deduced that the Imperial College Library would be an ideal location to find them. We contacted Pauline Dingley, Head of the Library, and received permission to set up the image capture station in the library's main lobby.

The same technique was used to gather volunteers in the library as was used in the Science Museum and the kiosk; we approached people with our one-sided advert. Since the database already had a sufficient number of Caucasians aged 13-18, they were not asked to volunteer.

4.3.3.3 Holland Park School

We noticed that the diversity of the visitors in the museum aged 8-18 was still low for some groups. We considered the option of contacting local schools. Museum staff informed us that the museum has a rapport with two nearby schools, and that the museum occasionally involves these schools in new exhibit development. We contacted these schools, but were only able to schedule a day to visit one, the Holland Park School. Holland Park School has an ethnically diverse student body aged 11-18.

We chose this location to target people between the ages of 11 and 18 of all non-Caucasian ethnic groups. The method that was used to gather these volunteers was quite different than the gathering method used up to this point. Mr. McKenna, our contact at the school and head of the science department, gathered volunteers for us. He inquired as to which races we were looking for, and moved between classrooms gathering volunteers.

4.3.3.4 Leanora Day Centre

The Leanora Day Centre was initially chosen as a target group because of its location in London. The day centre is located in the city of Westminster, which was one of the boroughs mentioned by Science Museum staff as being ethnically diverse. In our initial contact with the day centre, the manager mentioned that the day centre was diverse and contained males and females of Caucasian and West Asian descent. We used this location to target West Asian volunteers aged 55 and older.

The method used to gather volunteers at Leanora was similar to the one used at Holland Park School. The manager of the day centre approached people individually and brought them over to the image capture station. The manager offered to approach the members of the centre for us. We felt this would be beneficial to us. The members trusted the manager, and that most likely contributed to the high response rate.

4.3.3.5 Chinese Community Centre

After almost two weeks of capturing images, there still were not any images of East Asian volunteers aged 55 and older. We contacted various groups to reach these volunteers. We received a list of Anglo-Japanese societies in London from the Japanese embassy, and found many Chinese and Japanese groups listed in the phone directory. Unfortunately, many of the groups congregated to learn English and learn about England. Very few were interested in having us visit and gather volunteers. Eventually, we contacted the Chinese Community Centre. The centre provides many services to Chinese people in the area, including fun and educational activities. The Chinese Community Centre was used to target East Asian volunteers aged 55 and older.

The method we used to gather volunteers at the Chinese Community Centre was similar to the method used at Holland Park School and Leanora Day Centre. The manager of the centre approached people and asked them to volunteer. There were two reasons why this method was used. The primary reason was that many of the people in the centre did not speak English well, or at all. Therefore, we had no means of communicating with them. The manager was fluent in English and Chinese and acted as our interpreter. The second reason was so the manager could dispel any superstitions the volunteers might have about having their picture taken. The manager informed us that some Chinese people, mostly older ones, believe that having their picture taken may cause them to lose part of their soul, or that by us having their picture, we have some power over their soul.

4.3.3.6 PepperPot Day Centre

The PepperPot Day Centre is a centre that plans activities and events for elderly Afro-Caribbean people. We had not been able to gather many Afro-Caribbean volunteers from the Science Museum, or any of the other locations we set up the image capture station. PepperPot was chosen due to the fact that it contained almost exclusively Afro-Caribbean males and females over the age of fifty-five.

The method used to gather volunteers at the PepperPot day centre was slightly different than the method used at the other day centres. Since the people were located in a small meeting room we were able to present the information to all the people at once. The manager of the day centre introduced us to the group. Then we presented the information on the exhibits, and asked if anyone was interested in volunteering. One of us went around the group while the other captured images and answered any questions people had.

4.4 Image Capturing

Once people decided to volunteer, we were able to capture their images. We used our discretion when deciding how to position the volunteers; this pose was kept consistent for all volunteers. We asked the volunteers to sit facing forward and look directly at the camera. We wanted their face to be square with the camera so that their face was symmetric across a vertical axis. This eliminated any inconsistency between face-to-camera angles. Volunteers were also requested to hold a relaxed facial expression while the image was captured. If we had requested that volunteers smile, this would have introduced substantial variation between images due to the different types of smiles. When dealing with some volunteers, such as young children or people with poor English skills, it was hard to get them to maintain the proper pose. If after several attempts, an image of adequate quality was not captured, we led the volunteer to believe the photos had been taken successfully, thanked them for participating, and worked with the next volunteer. Later the bad images were deleted.

The zoom lens of the camera was used to zoom in on the volunteers until their head reached the limits of the image field. This resulted in more detailed images with less background area to interfere with the morphing software.

4.5 Template Creation

Before an image could be stored in the database, a template was created for it. A template is a series of points and lines that were used by the morphing software to locate key features of the face, such as the eyes and nose. We were able to create the templates immediately after the images or at a later time.

4.5.1 Template Creation Process

Once a facial image was captured, template creation began by identifying the centre of each eye. After we located these two points, the software automatically placed an average template around these points. When the template was centred on the eyes, we then selected a menu option that manipulated the average template to fit the current face based on software image analysis. Though the software's auto template creation function did well at locating the facial features, it was still necessary for us to relocate some of the fiducial points to represent the image more accurately. This fiducial point relocation process was done by clicking on a fiducial point or line, then dragging it to the desired location. Each template consisted of 174 fiducial points. The points of the template were placed in identical locations on all the faces. This consistency resulted in more realistic looking morphed images. In order to be consistent in fiducial point placement, a standard method of template creation was created.

4.5.2 Standard Method of Template Creation

The image in Figure 3 is an average face created by combining a group of images of males aged twenty to fifty. The image was created by researchers at St. Andrew's University. This image will be used as a model to demonstrate the standardised systematic method we used to create the templates for the captured images.

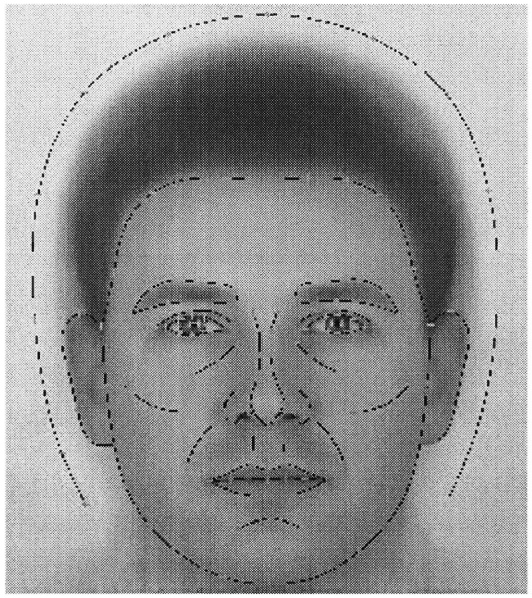

Figure 4: Average Male Image and Template

Creating a template was a very complicated process. Since the morphing software worked by comparing the location of the same points on two different images, each point needed to be located on an image in the same order every time. Luckily, researchers at St. Andrew's University in Scotland created 'average templates' based on the templates they created for images from their research. These average templates eliminated the concern of placing the points on the image individually, and in the same order. Instead, the average template was superimposed onto the image, and the points were moved into proper location.

The process of creating a template for an image first involved loading up an average template. We used two average templates—one for images of male volunteers, and one for images of female volunteers. Next, we moved the fiducial points into proper location. Our systematic method of point placement is described below for each feature of the face.

- Hair and Face Outline

The points that identify the jaw-line, forehead area, and the inside line of the ear were easily located by following the outline of the face. First, a few key points were moved into place. These included a point at the middle of the chin, at the middle of the ear, at the two places each ear connects to the head, and the top of the forehead. The points that get moved to the middle of the chin and the top of the forehead were selected so they formed a line of symmetry between the number of fiducial points on the left and rights sides of the template. Once these points were moved into place, the remaining points were spaced evenly around the perimeter of the face.

Some of the captured images had hair that partially or completely obscured the forehead line. In these cases, the line of the forehead was estimated with a smooth curve similar to the one in Figure 3. The outside of the hair was not followed closely like the chin and forehead. Instead, it was loosely contained within a series of points. These points were arranged in a smooth curve around the head by placing them a small distance from the hair, ears, and jaw. This shape stayed basically the same from image to image regardless of hairstyle. For this set of points, their exact location was insignificant, as long as they contained all the hair in the image. However, the size of the curve varied with the size of the head and hairstyle.

- Eye Region

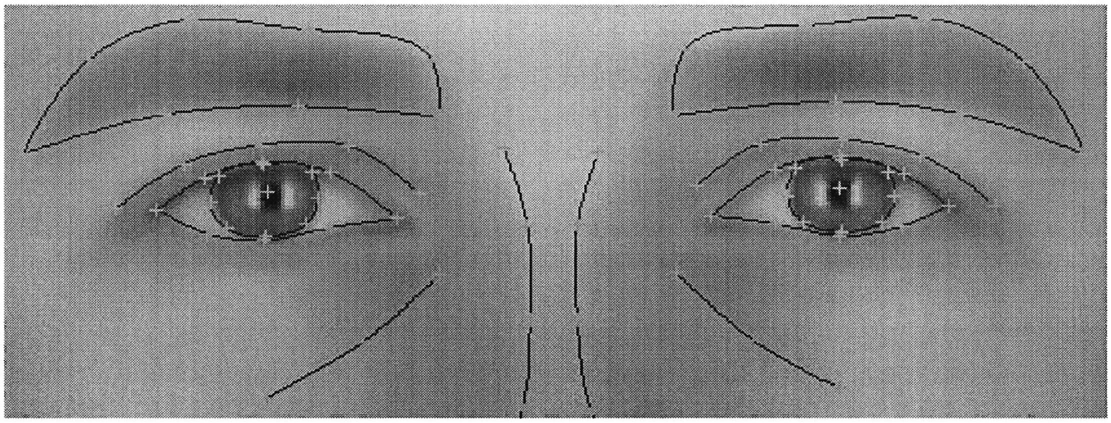

Figure 5: Eye Region

Defining the eye region started by first placing a single point in the centre of each pupil. Visualise a Polar co-ordinate system such that the origin is placed on the fiducial point in the centre of the pupil. The points around the iris were placed at every forty-five degrees around the iris, starting at zero degrees. In many cases, the iris was not completely visible due to a low eyelid. In these cases, the points around the iris were still placed using the same geometric system, except the result was not a perfect circle of points—the circle became 'flattened' where the eyelid hung low.

Next, points were placed around the inside of the eyelid. Points were placed directly above and below the fiducial point that identified the centre of the pupil, and also at the corners of the eye. The remaining points were spaced evenly around the eye. Finally, a series of points were placed at the top of the eyelid. These points were located where the top of the eyelid visibly started and ended.

While creating templates for images of certain ages and ethnic groups, we noticed that the top of the iris, the inside of the eyelid, and the top of the eyelid became very close. In these cases, it was very important to always maintain the proper order between the lines: iris below inside of eyelid, which in turn is below the top of the eyelid. For the best accuracy, it was best to do this at 300% zoom.

To properly locate the eyebrows, fiducial points were placed in such a way that they contained most of the eyebrow. In many cases, the edges of the eyebrows were well defined making this location process simple. For poorly defined eyebrows, they were positioned in an approximate area. In the case of non-existent or barely visible eyebrows, their location was estimated and a classic eyebrow shape was used.

- Mouth Region

The mouth region includes the lips, the two ridges that connect the nostrils and the tops of the lip, and the edges of the cheeks (also known as the 'laugh lines').

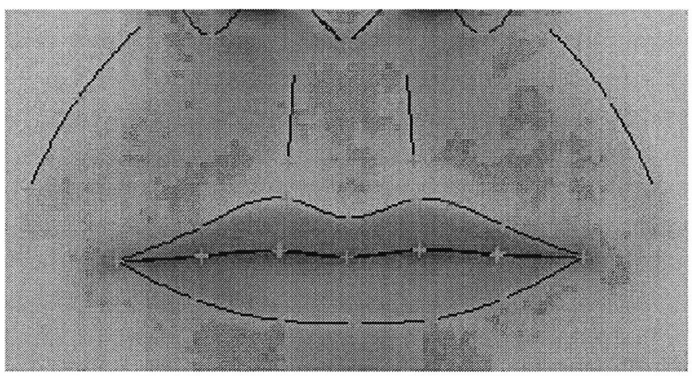

Figure 6: Mouth Region

Locating the points on the lips was usually quite simple since there is such a high contrast in colour at the edge of the lips. A total of twelve points were used to outline the lips. First, two points were placed at the corners of the mouth. The remaining ten points were divided evenly between the top and bottom lips. Looking at the mouth region in Figure 5, it is noticeable that the top edge of the lip forms sort of an "M" shape. A point was placed at the two high points of the lips, and another at the low point in between. The remaining two points on the top lip were placed half way between the high points of the lip and the corner. A similar system was used to locate points on the upward curve of the bottom lip.

To locate points on the two ridges that connect the nostrils to the top lip, one point was placed directly beneath the nostril and another directly above the high point of the lip. The line created between these two points should lie along the ridge.

Determining the edges of the cheeks was relatively difficult. These lines are noticeable when people smile, but for our pictures we requested that people did not smile. Therefore these lines were quite ambiguous. In older volunteers, there were permanent wrinkles at these locations that were used as guides. Otherwise, an estimate was made for placement of these points. In order to estimate the location of these lines, a point was placed by the outside edge of the nostril. The remaining points were spaced evenly to make a gentle curve around the mouth.

- Nose Region

The nose region was one of the most difficult regions to position points on, primarily because everyone's nose is quite unique. The point location process starts by locating two points at the bridge of the nose between the eyes. From here, a series of points was placed along the bridge of the nose such that the points created lines that contained the flattish top part of the nose. Toward the end of the nose, a ball starts to form. Points were placed to cause the two lines to flare out around this ball. The two lines converged at a point placed midway between the nostrils.

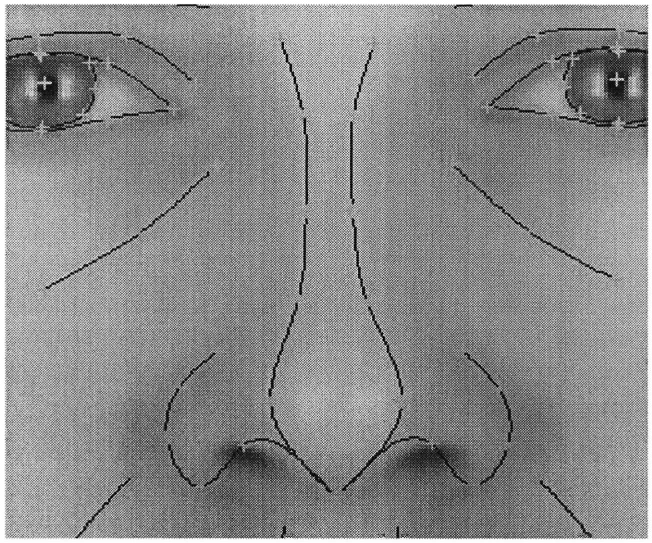

Figure 7: Nose Region

Four points were used to locate the nostrils. They were placed around the outside edge of the nostrils. Three fiducial points indicated the shape of the inner part of the nostril. The three points were the point at the contact point of nose and upper lip, the last point on the outside of the nostril, and one point that was placed above the inner nostril. The morphing software connects these three points with a curved line that accurately traces the inner edge of the nostril.

Also contained within the nose region are lines on either side of the nose which trace the under eye area. These lines are created by locating fiducial points shaping the contour slope of the nose.

- Ear Region

The ear region is comprised of the ears on both sides of the head, and also the cheekbones. The locations where the top and bottom of the ear contact the face have already been defined during the facial outline. There should also be a point located on the side of the face equidistant between the top and bottom points. The remaining points are located around the outer edge of the ear at positions such that the curve that connects these points accurately represents the outside edge of the ear. When the ears were not visible, because of long hair for example, their location and shape was estimated.

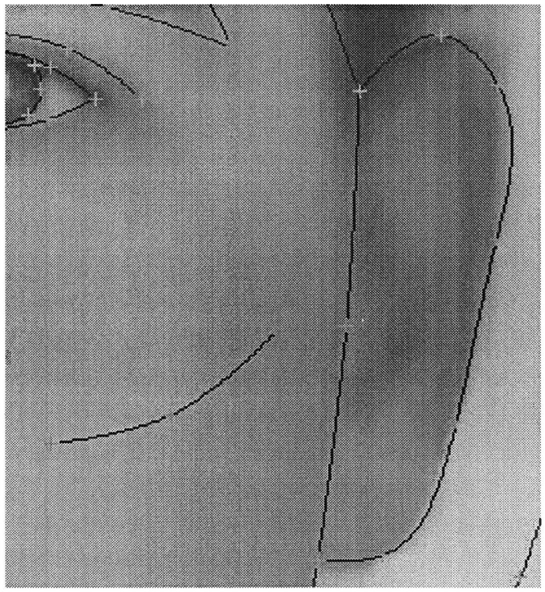

Figure 8: Ear Region

Locating the points that define the cheekbones was a difficult task. Often, it is hard to determine where someone's cheekbones are due to lack of contrast. Best estimates were made. Three points define each cheekbone. Figure 7 shows an example of where the points that locate the cheekbone were placed. The St. Andrew's University researchers explained to us that these three points play a very small role in the morphing process, and therefore their exact placement need not be a huge concern. Usually, the software's automatic template creation function located the cheekbones well. Therefore, little modification was necessary.

- Chin Region

Locating the points for the chin was always a quick process. From the process of defining the shape of the face, the outside contour of the chin has already been established. Two more aspects of the chin need to be defined.

The first aspect is the dimple in the chin. This feature is most prominent in men. Two points create a short line, which is placed over the dimple. If the location of the dimple was not apparent, it was estimated.

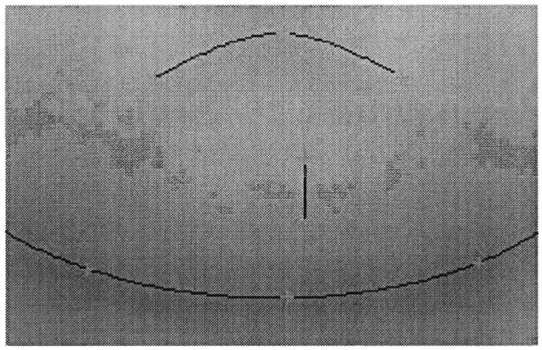

Figure 9: Chin Region

The second aspect of the chin that needs to be defined is the top of the chin. There are three points that define this. There was usually a visible crease at the top of the chin. A fiducial point is placed at either end of the crease. The third point is placed equidistant between the two. See Figure 8. Once we created a template, the image was ready to become part of the database that the morphing software used.

4.6 Integration Requirements

Once all the images have been captured and their templates created, additional work was performed to make the database compatible with the morphing exhibits. The morphing exhibits did not use the database of images directly. The exhibits used average images, average templates, and .pca files made by combining all the images in certain age/ethnicity/sex subsets.

4.6.1 Average Images

The morphing software used average images to perform the morphing process. The software had a built in function to make average images and average templates. The software accessed a text file that contained the names of all the images that were going to be averaged together. We made text files for all the averages. Average images and templates were made for each age/race/sex group. This resulted in the creation of thirty-two average images and templates. The exhibit user inputted information that allowed the software to determine which average image is most like the user. Then, the user inputted a destination group, i.e. different age group or different sex. The software determined what the differences were between the average images and templates in the two selected groups, and then applied these to the image of the user.

4.6.2 The .pca File

The final interactives also required .pca files. The morphing software used the .pca files to adjust the average template to fit an image. The .pca files creates relationships between the features of the face by gathering information from all the images in the database. The interactives use the .pca files to automatically recognise the exhibit user's features during automatic template creation. Ten .pca files were created: one for each race/sex group, and one for each sex group regardless of race. Since .pca files worked better when they were created with a large number of images, it was recommended by software developers that we not make a .pca file for each age/sex/race group. The process of creating the .pca files was similar to the process described above for the creation of the average image files. It involves creating a text file that lists the images to be combined. A function in the morphing software package then automatically created the .pca file.

4.7 Results

The final phase of our project work at the Science Museum was the creation of a document detailing the results of our work, a presentation of the completed database and an analysis of gathering methods. The document containing the results of our work included two main sections. Section one showed the breakdown of the database in terms of race, age, and sex. Section two explained the effectiveness of our methods in gathering volunteers in the museum as well as from target groups. We used information in the Volunteer Information Database to form conclusions. By separating groups based on certain traits, we were able to compare response rates between groups. This allowed us to see the effectiveness of our methods on specific subsets of volunteers in the database.

Soon after the morphing database was complete, IDEO integrated the morphing database into a prototype version of the museum exhibit, which the Evaluation Group then tested.

5 DATA

At the onset of this project, researchers at St. Andrew's University recommended that we collect fifteen images to create each average image for the demographic groups. NMSI later lowered that number and established the suggested minimum number of images per demographic group to be eight. Due to the areas and target groups selected, we exceeded fifteen images in several of the demographic groups. These excess images simply allowed for the creation of a more realistic "average image".

A total of 16 days were spent recruiting volunteers. Volunteers came from many sources: the Science Museum, day centres, local schools and universities, the South Kensington Underground tunnel, and ethnic community centres. The following sections contain information on the specific breakdown of the database, the correlation between scanning location and ethnicity of volunteers, which methods for creating awareness were used most often and were most effective, and the response rates of areas visited and individual groups.

5.1 Demographics of the Image Database

Tables 1 contains figures regarding the number of volunteers recruited for each age and ethnic group.

Number of Volunteers in each Age Range*				
Age Range	**Afro-Caribbean**	**Caucasian**	**East Asian**	**West Asian**
8-12	42	36	7	29
13-18	35	39	30	41
25-35	34	48	15	24
55 and Older	18	49	32	10
* Male and female volunteers were represented equally				

Table 1: Number of volunteers in each age range.

5.2 Gathering Locations

We moved the image capture station to several different locations in order to facilitate gathering volunteers of various ages, and ethnic origins. Table 2 shows the number of volunteers we recruited at each location.

Volunteers Gathered at Each Image Capture Location	
Image Capture Location	**Number of Volunteers**
Science Museum	321
Subway Kiosk	7
Imperial College Library	69
Holland Park School	97
Leanora Day Centre	26
Chinese Community Centre	45
PepperPot Day Centre	22

Table 2: Number of volunteers recruited at each image capture location.

5.3 Ethnic Diversity of Gathering Locations

The museum did not provide a diverse enough group of visitors for us to meet our database requirements. Therefore, it was necessary for us to move the image capturing station to locations outside the museum. Tables 3 contains data regarding the number of volunteers we recruited at each location in terms of ethnic origin.

Number of Volunteers per Location				
Location	**Afro-Caribbean**	**Caucasian**	**East Asian**	**West Asian**
Museum	39	153	14	40
Kiosk	1	1	0	4
Library	11	8	30	15
Holland Park School	24	4	2	13
Leanora Day Centre	0	19	0	7
Chinese Community Centre	0	0	21	0
PepperPot Day Centre	22	0	0	0

Table 3: Number of volunteers per location.

5.4 Initial Contact Methods

We employed several different methods to create awareness in potential volunteers and recruit them into volunteering. For each volunteer, we recorded which method successfully attracted him or her to volunteering. Table 10 contains data that relates the methods we used to gather volunteers to the number of volunteers it successfully recruited.

Initial Contact Methods	
Recruiting Method	**Number of Volunteers**
Personal Contact in Museum	301
Other	17
Target Group Presentation	208
Advertisement	4

Table 4: Number of volunteers gathered by each contact method.

5.5 Time Spent at Each Location

We used many locations to gather volunteers. Some locations we only visited for a day, while others were used repeatedly. Tables 5 and 6 show the number of days spent at each location, and the average number of volunteers gathered per day respectively.

Number of Days Spent at Each Location	
Location	**Number of Days**
Science Museum	10
Subway Kiosk	1
Imperial College Library	2
Holland Park School	1
Leanora Day Centre	2
Chinese Community Centre	2
PepperPot Day Centre	1

Table 5: Number of days spent at each location.

Volunteers Gathered per Day	
Location	**Volunteers per Day**
Science Museum	30
Subway Kiosk	6
Imperial College Library	32
Holland Park School	44
Leanora Day Centre	11
Chinese Community Centre	23
PepperPot Day Centre	22

Table 6: Volunteers gathered per day.

5.6 Response Rate

While recruiting volunteers at various locations, we recorded the number of volunteers we recruited, as well as the number of people that refused to volunteer. These data are included in Table 11.

Response Rate Per Location	
Location	**Response Rate (%)**
Holland Park School	94.2
Museum	87.8
Imperial College Library	68.3
Kiosk	13.0
Pepperpot Day Centre	88.0
Leanora Day Centre	90.0
Chinese Community Centre	84.5

Table 7: Percentage of people who offered to volunteer after our initial contact.

6 ANALYSIS

6.1 Demographics of the Image Database

The Science Museum recommended that we use a minimum of eight images in each age/sex/ethnicity group to create the average images and templates that the morphing software will use in the final exhibit. From analysis of the final demographics of the database we saw that we were able to collect the minimum number of volunteers in 28 of the 32 age/sex/race groups. There were only four groups that we were unable to sufficiently represent in the database: 8-12 East Asian males and females, 55 and older West Asian males and females. We felt, along with museum staff, that the East Asian group would have been easily filled during the half term break in the final week of the project. Once we realised that this group was not being filled, the remaining time for the project had already been scheduled for other target groups.

We targeted 55 year old West Asian volunteers with the Leanora Day Centre target group. Unfortunately, we were not able to gather enough volunteers at that location.

Despite the low number of volunteers in these groups, we still were able to create average images of good quality.

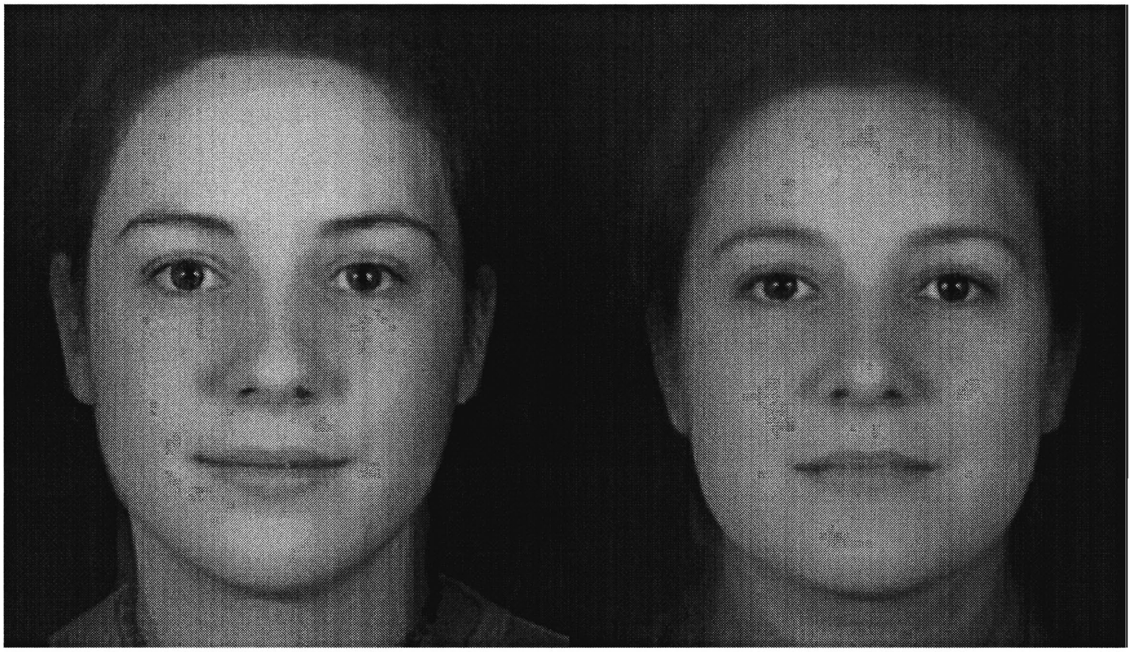

Figure 10: The average image on the left was created from 5 images; the one on the right from 15.

Notice the images in figure 10. These images represent Caucasian females age 18-25. Both images are of good quality. Although the image on the left looks different than the one on the right, impressive morphs can still be generated with the average image create from only 5 images. For this reason we feel the database is fully capable of being integrated into the morphing interactives in its current state. It will be compatible with the software and will produce impressive results.

6.2 Contact Methods

We recruited a total of 532 volunteers using several different methods. We analysed each of these methods to determine if they were effective means of recruiting volunteers. We based success of each method on the number of volunteers recruited by each method, as well as the comparison of how much time was invested in each method, and how successful they were. Figure 11 shows a comparison in the number of volunteers recruited by each contact method.

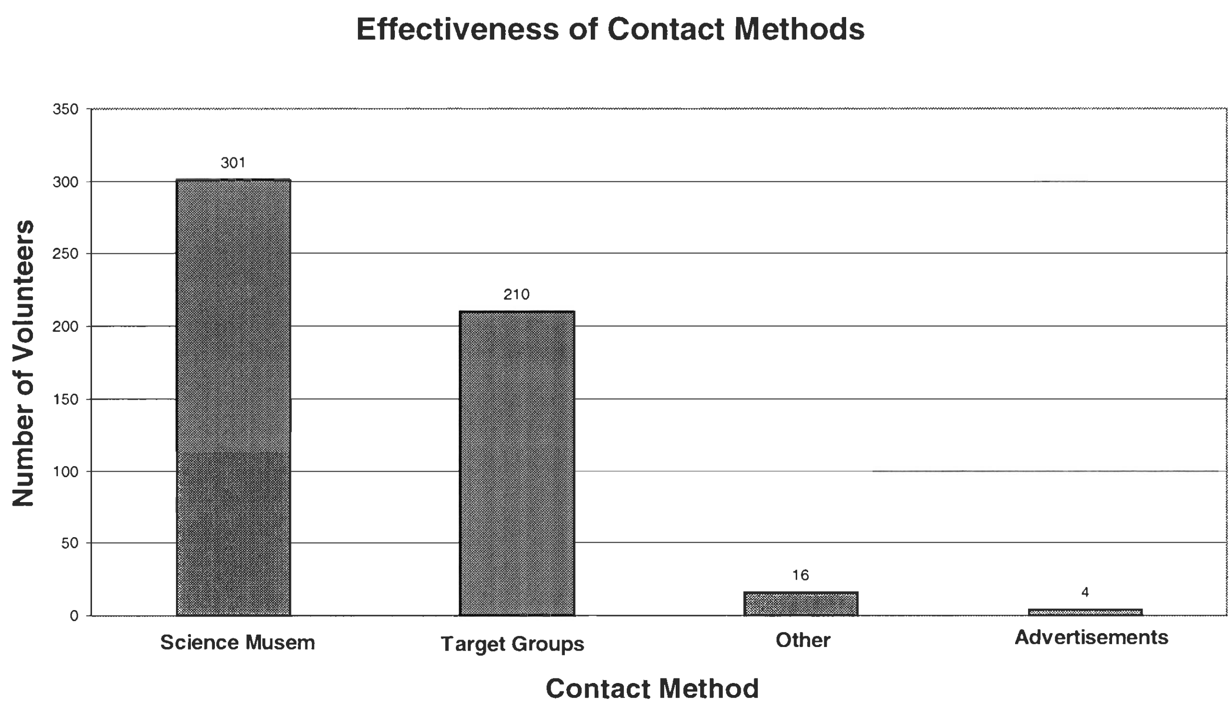

Figure 11: Comparison of methods used to recruit volunteers.

6.2.1 The Science Museum

The Science Museum was our initial source of volunteers. Every day, hundreds of potential volunteers passed by the image capture station. These people were mostly Caucasian youngsters. The museum provided us with the majority of our volunteers: 55 percent of the total volunteers gathered. Since the museum was the first location where we recruited volunteers, all database groups were empty so every person in the museum was a potential volunteer. Also, in the museum there was always a new supply of people to recruit for volunteering. Furthermore, people in the museum are there because of an interest in science. This interest made them more apt to volunteer. We received an 88% response rate while recruiting volunteers in the Science Museum.

Another reason why the museum was such a successful source of volunteers was the fact that it was so convenient for us to set the image capture station up there. Once the image capture station was created, the station was set up every day in the museum, except on the days when we visited target groups. Even though the number of volunteers we got each day steadily declined due to increasing volunteer selectiveness, we still managed to recruit volunteers from database groups that were not yet filled. We carefully monitored the average number of volunteers gathered each day in the museum to ensure that the progress we were making justified setting up the image capture station. We collected an average of 30 images per day in the Science Museum. This average is better than that of some of the target groups.

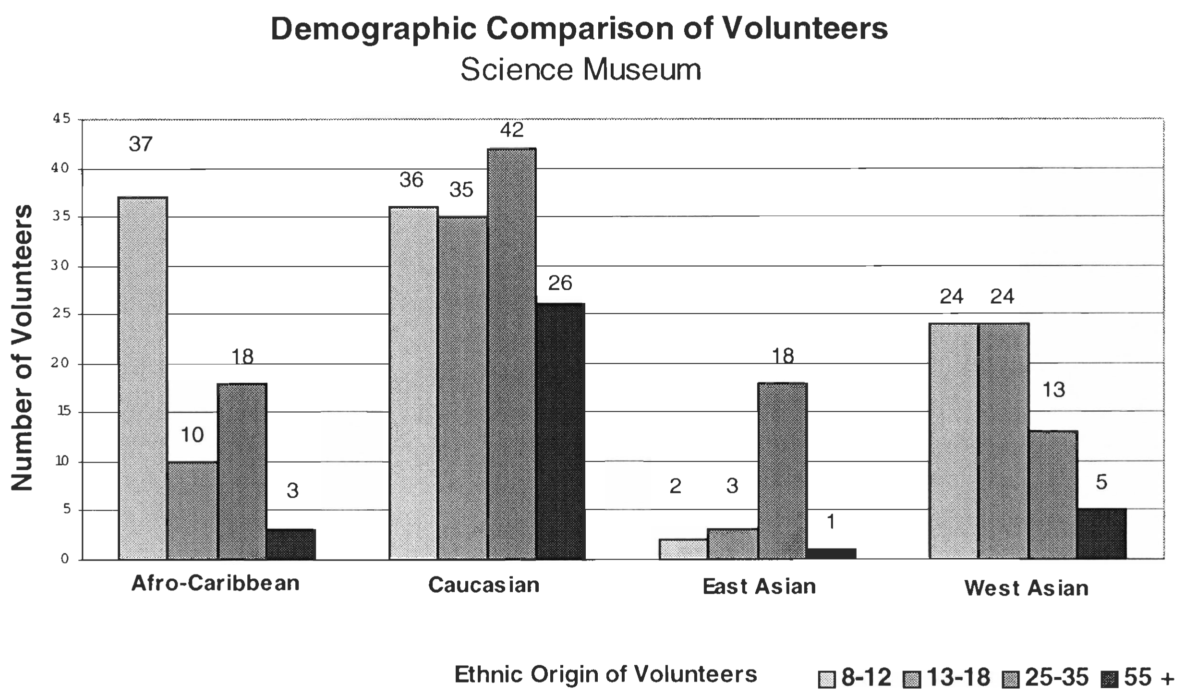

Figure 12: Number of volunteers gathered at the Science Museum separated by ethnic origin.

As far as ethnic diversity was concerned, the Science Museum provided good diversity for the younger age groups due to its daily infusion of new school groups. The older two age groups however, were mostly Caucasian. Figure 12 shows the substantial number of Caucasian volunteers gathered at the museum.

It appeared from preliminary analysis after a few days of scanning that we would be able to meet our image database requirements for young and middle aged West Asian volunteers. We felt it was only necessary for us to determine target groups for West Asian volunteers aged 55 and older. Therefore, no target groups were located which contained young and middle-aged West Asians.

6.2.2 Target Groups

To recruit volunteers of age and ethnic groups that were not available in the Science Museum, we located groups in London that contained these types of people. We measured the success of the target groups by comparing which ethnic and age groups we were targeting, and whether or not we were able to collect images of them. We also examined the response rate for each of the target groups.

6.2.2.1 Museum Kiosk, South Kensington Underground

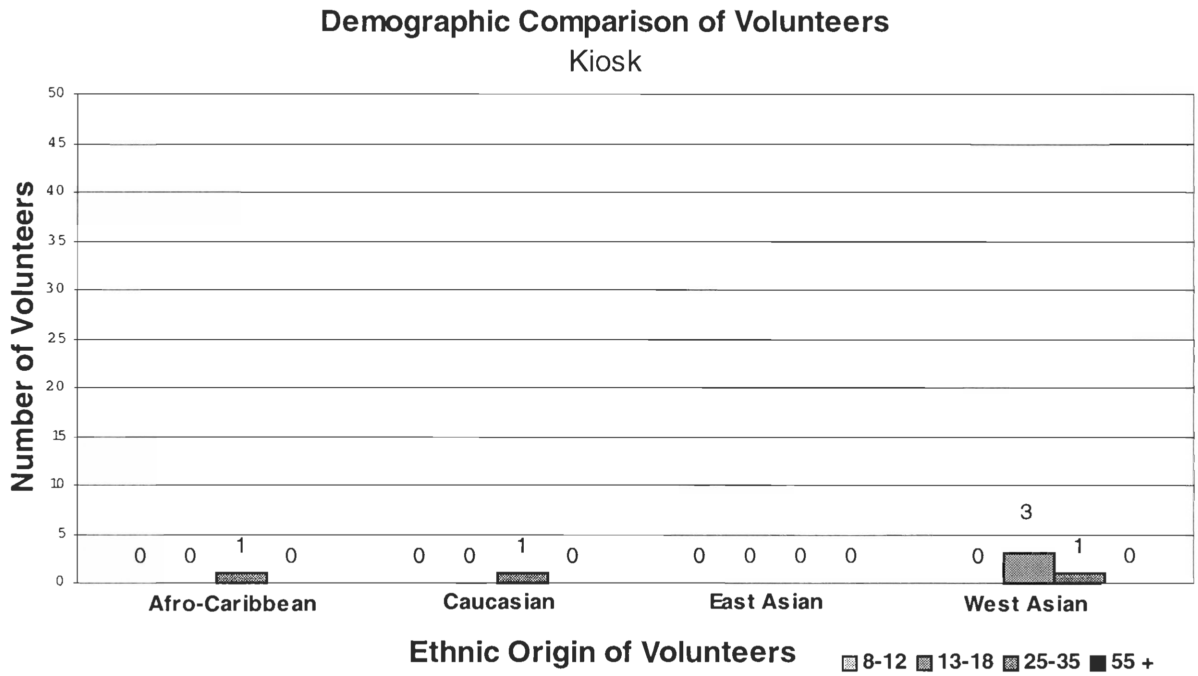

Figure 13: Number of volunteers gathered at the Science Museum Kiosk separated by ethnic origin.

The Museum had a kiosk in the subway that connects the museum with the South Kensington Underground station. We moved the image capture station to the kiosk one day. Initially, we thought the kiosk would be an ideal location to set up the station. With a constant flow of people past the kiosk, we thought we would have exposure to various ages and ethnicities. Unfortunately, many people in the subway claimed they were too busy to volunteer. This resulted in an extremely low response rate. The kiosk was our most unsuccessful attempt at gathering volunteers. Notice from Figure 13, that only six volunteers were recruited from the half day spent in the Kiosk. An alarmingly low response rate was received from people in the subway (13%).

6.2.2.2 Imperial College Library

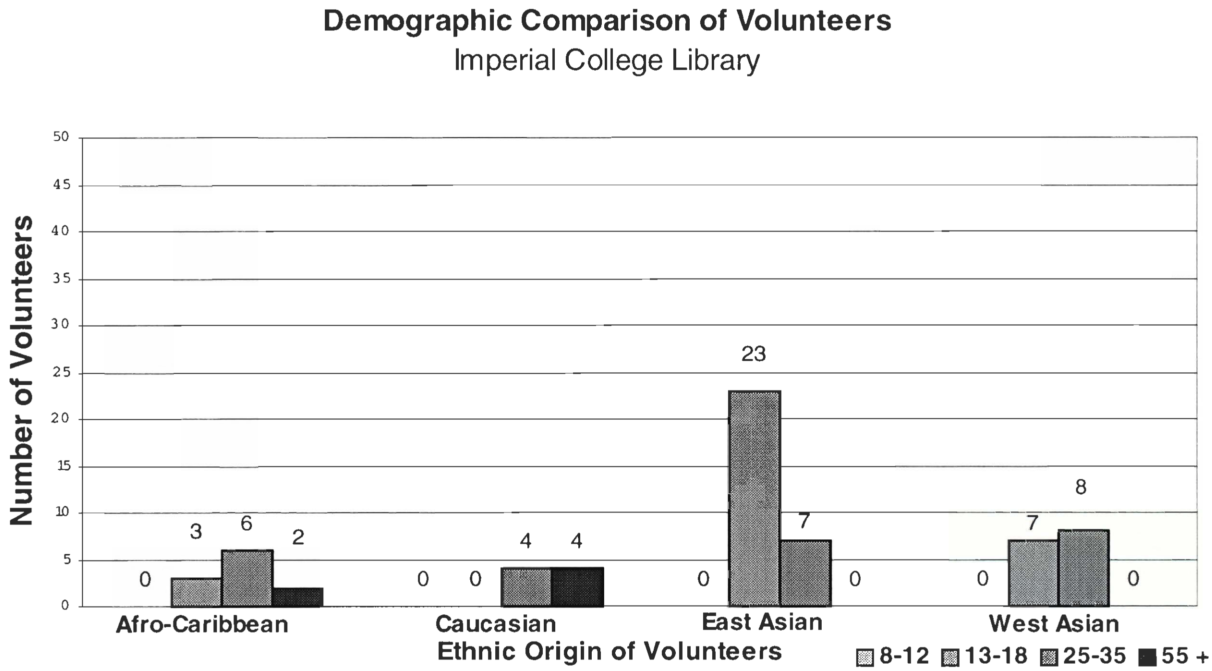

Figure 14: Number of volunteers gathered at Imperial College Library separated by ethnic origin.

We set up the image capture station in the Imperial College Library to target volunteers aged 13-18 of all non-Caucasian ethnic groups. Figure 14 shows the demographic breakdown of the volunteers that we recruited in the library. Primarily, we focused on gathering East Asian volunteers from this location because they were so poorly represented elsewhere. Notice the relatively large number of East Asian volunteers we gathered in this location. We also took advantage of the presence of West Asian people in the library, and recruited a few of them for volunteering. At this stage of image capturing, the database still required the addition of male and female Caucasians aged 55 and older, and also Afro-Caribbean volunteers of various ages. We were also able to recruit volunteers to fill these groups at the Imperial College Library.

The Imperial College Library was a successful venue for recruiting East Asian volunteers. We also managed to recruit volunteers of all the other ethnic groups. The volunteer positive response rate for this location was 68%. We attribute our high response rate to the interest and curiosity shown by many of the students in the library. Setting up in the library moved us closer to satisfying the database requirements for East Asian males and females aged 13-18.

6.2.2.3 Holland Park School

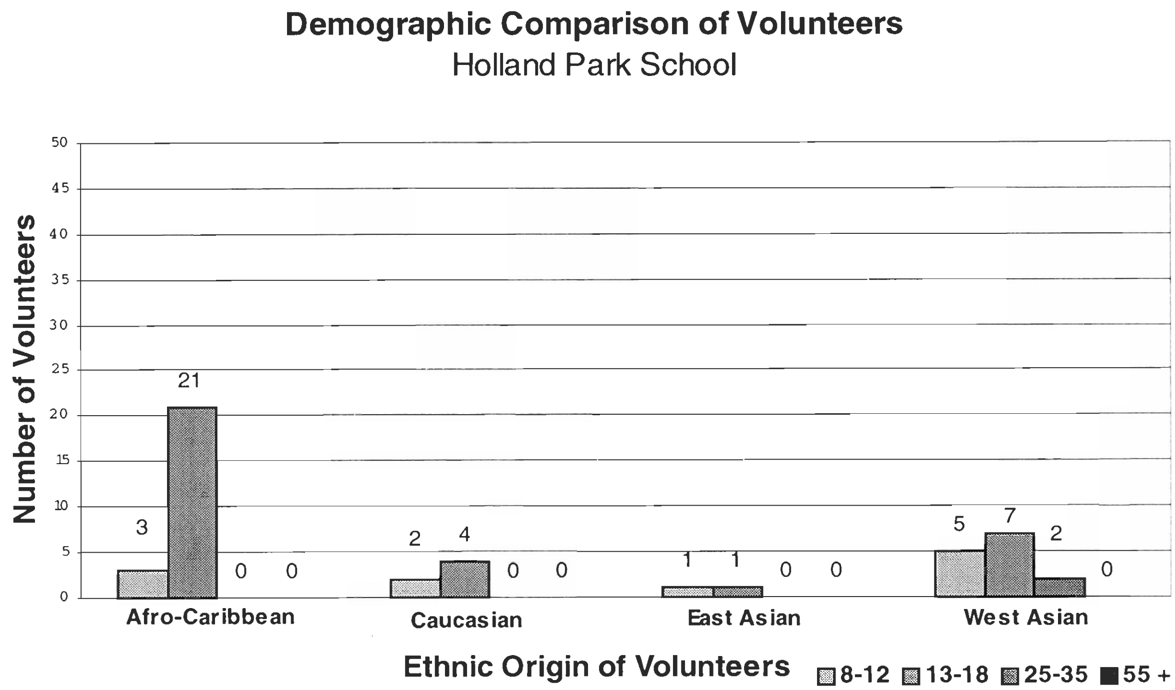

Figure 15: Number of volunteers gathered at Holland Park School separated by ethnic origin.

Our contact, Mr. McKenna was very helpful in our recruiting process. He allowed us to be very candid about our needs and gathered volunteers accordingly. At Holland Park, we targeted all non-Caucasian people aged 12-18. Even though we gathered many East and West Asian volunteers from the Imperial College Library, we still need volunteers from these ethnic groups. We also needed many Afro-Caribbean volunteers.

The Holland Park School was a successful target group. We were able to recruit close to fifty volunteers. The volunteers were mostly Afro-Caribbean, which was poorly represented group in the image database for the 13-18 age group. Further, we were able to capture images of a few West Asian faculty members. We received an extremely high 94% response rate. We attribute this to the fact that most of the children knew Mr. McKenna and trusted him; they were willing to volunteer based on his request. Furthermore, many children of this age are eager to be released from class. We think this may have added to their willingness to volunteer.

6.2.2.4 Leanora Day Centre

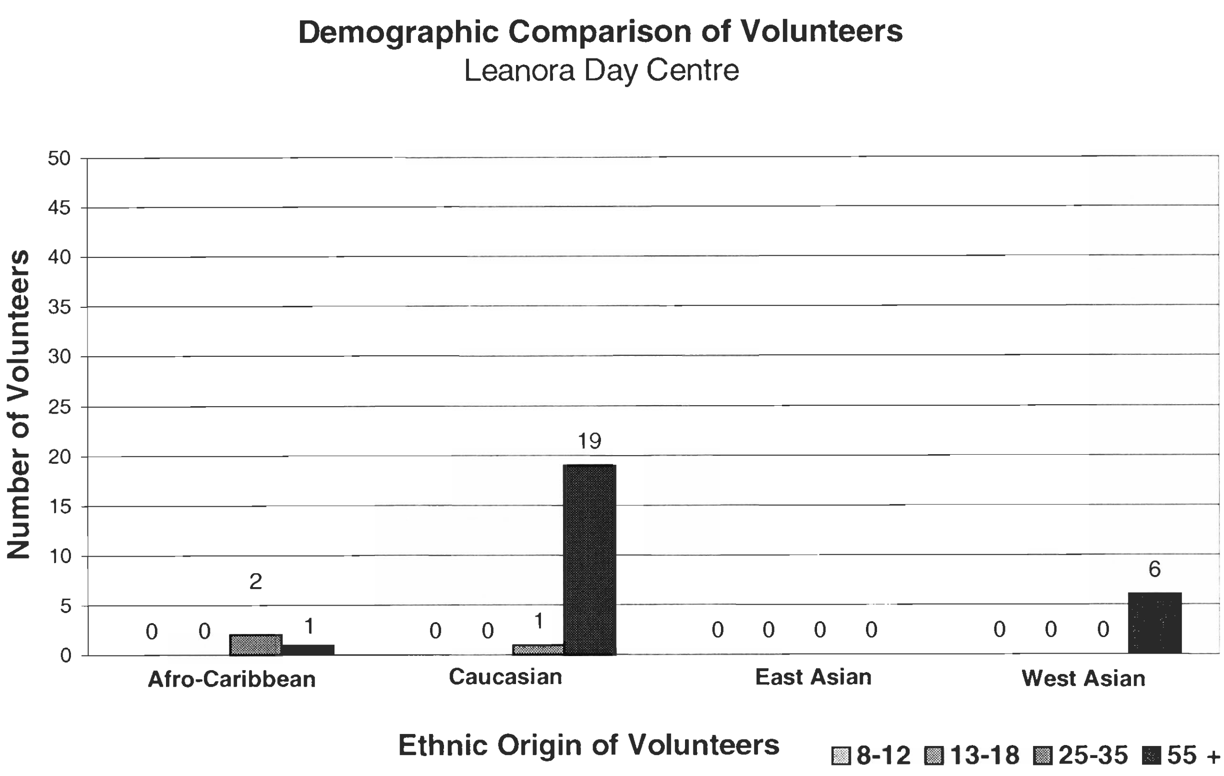

Figure 16: Number of volunteers gathered at Leanora Day Centre separated by ethnic origin.

The Leanora Day Centre was used to target West Asian people aged 55 and older. The manager of the centre had informed us during our initial contact that there were many West Asian people that visited the day centre regularly. Upon our arrival at the centre, we noticed that the people at the centre were predominately Caucasian, and that there were no West Asian people present at all. Apparently, a group of West Asian people visit the centre on every other Tuesday; this was not mentioned to us during our initial contact with the day centre. Unfortunately, we scheduled on a Tuesday when the group was not visiting. Once we became aware of the West Asian group's alternating schedule, we offered to return again the following Tuesday.

Our initial visit yielded close to twenty pictures of mostly Caucasian women aged 55 and older. Unfortunately, we did not need many volunteers in this group; we continued to capture images in order not to disappoint any willing participants who may have missed their chance to volunteer. The response rate of our first day at Leanora Day Centre was 100%. Most of the people at the day centre were very interested in the work we were doing and about having their picture taken.

The second day we visited Leanora, the group of West Asians visited the centre. Unfortunately, there was inclement weather that day so the entire group did not make the trip. We were still able to recruit several volunteers, but not as many as we had hoped. Due to time constraints, we were unable to return the next time the group visited Leanora.

6.2.2.5 Chinese Community Centre

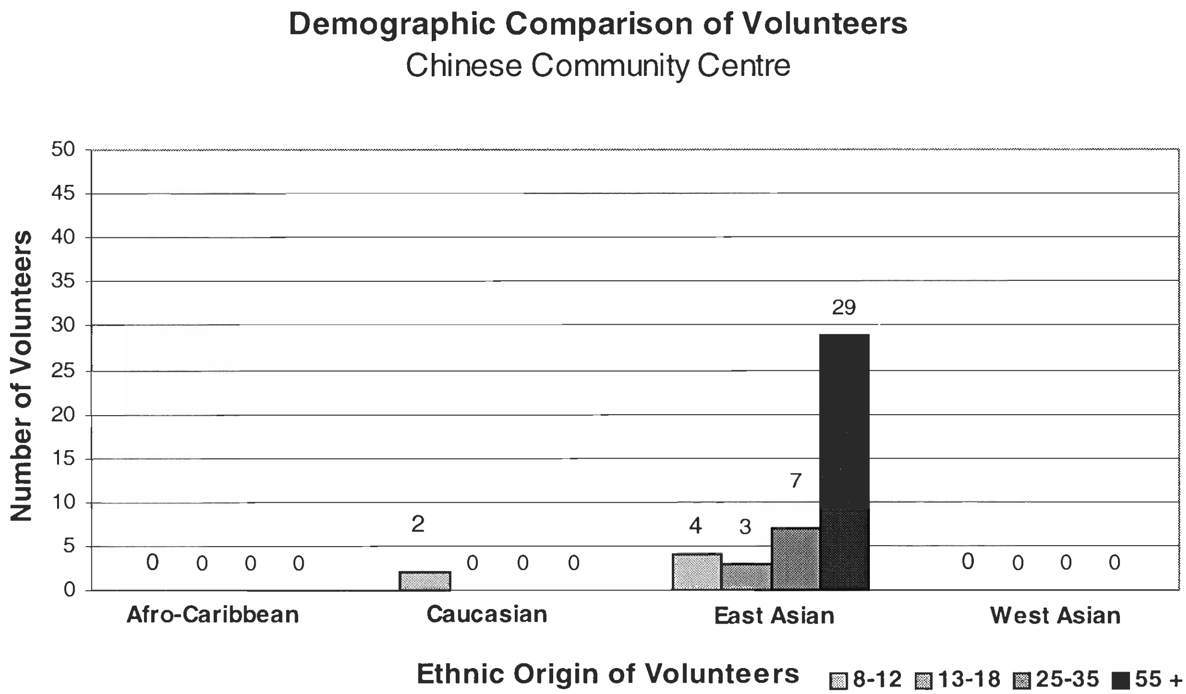

Figure 17: Number of volunteers gathered at the Chinese Community Centre separated by ethnic origin.

We used the Chinese Community Centre to target East Asian people aged 55 and older. We visited the community centre on two different days. The first day we visited was not very busy at the centre, so we were not able to recruit enough volunteers. The manager of the centre recommended that we return on the following Sunday, which would be substantially more busy. We returned on Sunday and were able to recruit many more volunteers. On Sunday, we were able to get volunteers that were over the age of 55, as well as some East Asian children aged 8-12.

The Chinese Community Centre was a successfully target group. We were able to obtain many images of East Asian volunteers aged 55 and older, as well as East Asians of various other ages. The response rate at the centre was 84.9%. This response rate is low when compared to the response rates of the other target groups. This is most likely due to the difficulty we had communicating with the people at the centre. The only communication we had with the people in the centre was through the centre's manager who translated for us. He also tried to quell the suspicions many of people in the centre had about us taking their picture. In many cases, he was unable to do this. Still, the target groups was successful in targeting East Asian people 55 and older.

6.2.2.6 PepperPot Day Centre

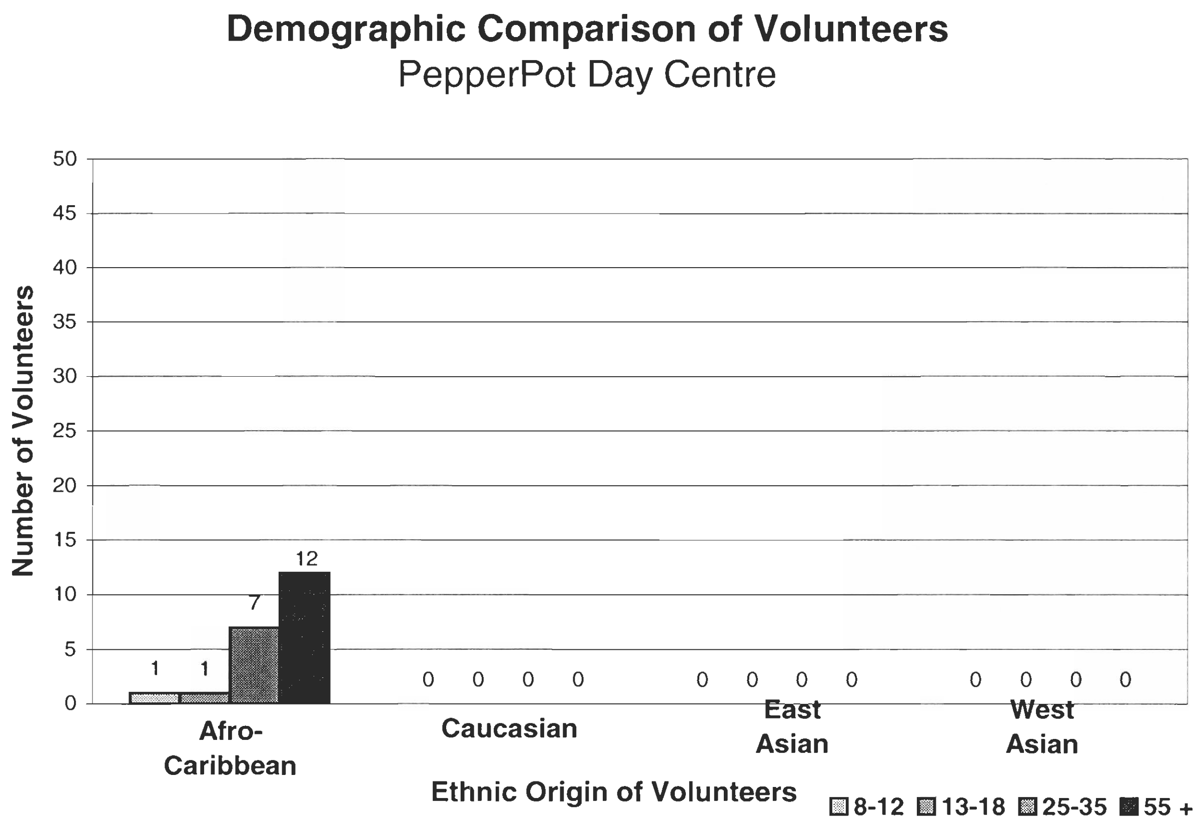

Figure 18: Number of volunteers gathered at PepperPot Day Centre separated by ethnic origin.

The PepperPot Day Centre was our target group to isolate Afro-Caribbean people aged 55 and older. Unfortunately, PepperPot had very few members. Of the members that were present, 88% of them volunteered.

We were not able to recruit as many volunteers as we had hoped because there were so few members at the PepperPot. Time limitations kept us from returning at a later date to gather more people. Despite the high response rate, we considered this target group to be only mildly successful because we were not able to reach our goal of satisfying the Afro-Caribbean requirement in the image database.

6.2.3 Advertisements

We used three types of advertisements to attract volunteers to the image capture station: informational flyer, one-sided advert, and an email to all the employees of the Science Museum. With the co-operation of the Design Staff at the Science Museum, we created two printed advertisements. One was a two-sided informational flyer that was distributed at different information booths about the museum. The other was a one-sided advertisement with similar content, which was attached to a clipboard and was shown to potential volunteers when they were contacted in the Science Museum. The third type of advertisement we made was done electronically through email. We created an email that was sent to all employees with computer access, which requested that they volunteer.

Even though the one-sided advert was shown to every person we approached in the museum, we only marked the advertisements as responsible for recruiting volunteers if people approached us with a copy of the informational flyer in their hand, or if they mentioned the flyer or global email when they came to the image capture station.

Initially, we anticipated that the advertisements would significantly help us to gather volunteers. As figure 10 shows, only a very small number of people were attracted to volunteering by one of our advertisements. We feel it was the passive nature of the advertisements that caused them to be so unsuccessful. The active methods of attracting volunteers (approaching them directly in the museum, and target groups) were significantly more successful due to their more aggressive nature. Furthermore, the advertisements were in locations of the museum away from the image scanning station. The requirement of having to travel some distance through the museum to volunteer might have been enough of a deterrent to keep some people from volunteering. Fortunately, we invested very little time creating the advertisements since the Design Staff were required to make them.

6.2.4 Other

Some people's motivation for volunteering did not come from interacting with one of the team members at the museum or at a target group, or from seeing an advertisement. These people were categorised as being recruited through "Other" means. These means included fellow WPI students who stopped by the museum to volunteer, co-workers at the museum who volunteered before the global email was sent out, as well as people who were curious about what was hidden behind the black backdrop we hung in the museum.

7 Conclusions

We had two goals for this project. The first goal was to create an implementation strategy to create an image database that will be compatible with the morphing interactives that will be part of the *Who Am I?* exhibit. We then used this implementation strategy to create an image database. By documenting our process and evaluating its effectiveness we were able to prove that it was a successful plan for the creation of a morphing image database.

The second goal was to complete a diverse morphing database. We were successful in reaching the suggested minimum of eight images, as established by the Science Museum. This success is attributed to successful volunteer recruiting methods. Our method of combining in museum recruiting with target group recruiting allowed us to reach the many diverse groups that were not present in the Science Museum.

The first portion of our implementation involved the creation of an image capture station. The success of this initial task was measured by the quality of the images produced and the degree to which the image capture station simulated the conditions of the final exhibit. We were able to capture images with consistent lighting, background, and facial position with our image capture station. The station also produced images that accurately simulated the conditions of the *Who Am I?* exhibit.

The second portion of our implementation involved the gathering of volunteers. Our analyses of the contact methods employed and target groups chosen show a successful implementation strategy. With the exception of the Science Museum kiosk, all target groups were successful; we were able to reach the ethnic and age groups we targeted. The high response rates of the selected areas, and large number of diverse volunteers gathered also indicated the successful selection of target groups. Groups in the database were not filled primarily due to time constraints and the initial anticipation of their availability among the museum visitors. When it was observed that these groups were not being filled we had already scheduled the remainder of our time for other target groups. Given the time allocated for image capture, a large and diverse group of people was reached.

The images we collected of volunteers created a database that met the suggested minimum value established by the Science Museum in 28 of the 32 groups. Though 4 groups are below the suggested minimum, we were still able to create high quality average images for these groups. Therefore, we felt that the database could be used in its current state, as part of the morphing interactives. This was based on information we received from St. Andrew's University, input from museum staff, and from test images produced during our work with the morphing software. Although the addition of more images could improve the quality of morphs produced by the interactives, we felt that the current image database would still provide an extraordinary and memorable experience.

8 Recommendations

After the completion and analysis of our methods, we felt it would be beneficial to offer recommendations for future work on similar exhibits. The following points can be used to strengthen both the implementation process and the effectiveness of future exhibits.

- Establish a method for capturing consistent images. Since some volunteers are difficult to recruit, it is important that each captured image is of good quality such that it can be used in the image database.
- Allocate a large portion of time for the gathering of volunteers. Unforeseen problems can easily arise. Because of this, it is important to start the gathering process early. This includes the contacting and scheduling of target groups as well.
- Gather as many images for the database as time allows. The greater the number of images that are used to create an average, the more accurate the average will be.
- Add additional image sets if possible. The number of people who enjoy the exhibit could be increased by adding support for things such as: facial hair, various hair and eye colours, or more specific ethnic groups.

Glossary of Terms

Bloid – A Science Museum term for the housing of the interactive exhibits in the *Who am I?* Gallery. Bloids are hollow aluminium structures of organic form, supported on three or five legs. Each houses four to six interactive exhibits.

Cross-Dissolve – A technique used to blend two images together.

Dropdown box – A dropdown box is an element of a form that is used to display a list of options from which the user can make a selection from. For example, a user needs to enter a colour into the database. Instead of typing in the colour, a dropdown box can be used to display a list of colours.

Fiducial Points - Special geometrical points placed on the features of the face, which are recognised by the morphing software.

Field – A field is an element of information that is part of a record. For example, a first name is a field in a record that might identify a person.

Form – A form is an element of a database that is used for the entering and display of data from a database.

Macro – A macro is a Microsoft Access® tool for automating a series of actions, such as a series of queries.

Morphing - Derived from the Greek word morphe, which means form or shape, it is an image processing technique typically used as an animation tool for the "metamorphosis" from one image to another.

Morphing Database/Morphing Image Database – The collection of images and templates are used for the morphing exhibit.

Query – A query is a tool for assembling and organising data from tables.

Record – A record is one set of information contained in a table. A table can contain many records. Each record can contain many fields.

Relationship – A relationship is a connection between tables that defines how the data is related.

Sexual dimorphism - The difference in the appearance and morphology of males and females. For example, males may be either larger (as in primates) or smaller (as in hawks) than females.

Sub-Form – This is a form imbedded in another form.

Table – A table is a collection of data about a specific topic.

Template – A series of points and lines that define the features on a digital image of a face.

Topologies - The features of geometry that remain unchanged after twisting, stretching or other deformations of a geometrical space.

Volunteer Information Database – The database we created in Microsoft Access® to record and analyse the composition of the morphing database.

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Appendix A – Volunteer Gathering Procedure

This appendix was received in the form of an email from an Evaluation team member, Sarah Hunt on Wednesday Jan. 20th. It provides suggestions for how to approach and gather volunteers from the visitors of the museum.

- Always wear a name badge / museum ID pass.
- Approach people close to (within sight of) where you will be taking them and point it out.
- Introduce yourself, say you work for the Museum and explain very briefly what you would like them for and how long it will take (they won't be interested in details at this point)
- If they are leaving a group (e.g. a school group) make sure they will be back in time, always check with their teacher, don't rely on the pupils!
- Recruit children with a carer / adult
- Once you are at your testing area, explain briefly what will happen, e.g. 'we'll take your photo, you just need to sit there and try not to move. Then we'll ask you some questions just as part of our college project' or whatever.
- During the photographing you can explain more about the project / exhibit
- You may find that people are worried about being identified so you may need to reassure that their names, etc. are not necessary.
- You could give them an information sheet to take away telling them more about: the Wellcome Wing, the Who Am I? exhibition, the exhibits and your college project (we never hand out info but I tend to tell people on their way out more about the exhibit we've tested and the Wing itself. I make a big thing about how they've helped shape a Science Museum exhibit which they will be able to come back and see)
- Give them a silver VIP sticker and a big thank-you afterwards. Explain that the sticker will stop them getting recruited by other evaluators in the Museum.

Appendix B – Volunteer Information Sheet

I.D. ____

Morphing Database Volunteer Information Sheet

Hello my name is … and I work for the Science Museum. We are creating a database of facial images for use in an upcoming museum exhibit. Would you and your child(ren) be interested in spending about 5 minutes helping us out? *{If yes take into image capturing area}.*

1. *{Ask the volunteer to point out the answer}* What of the following groups includes your age?

a. 8 to 12   b. 13 to 18   c. *19 to 24*   d. 25 to 35   e. *36 to 54*   f. 55 or older

* Italics indicate ages between two age groups required by the database. Indicate which adjacent age group the volunteer appears to fit in best by filling in the space with a letter.

____

2. *{Ask the volunteer if answer is not known}* How was the visitor contacted?

   a. From contact with a museum representative inside the museum.

   b. From a target group presentation. Which group? ______________________________

   c. Through an advertisement

   d. Other.

3. What is the gender of the volunteer?

   Male   Female

4. Which racial group does the volunteer appear to be

   a. Caucasian

   b. Afro-Caribbean

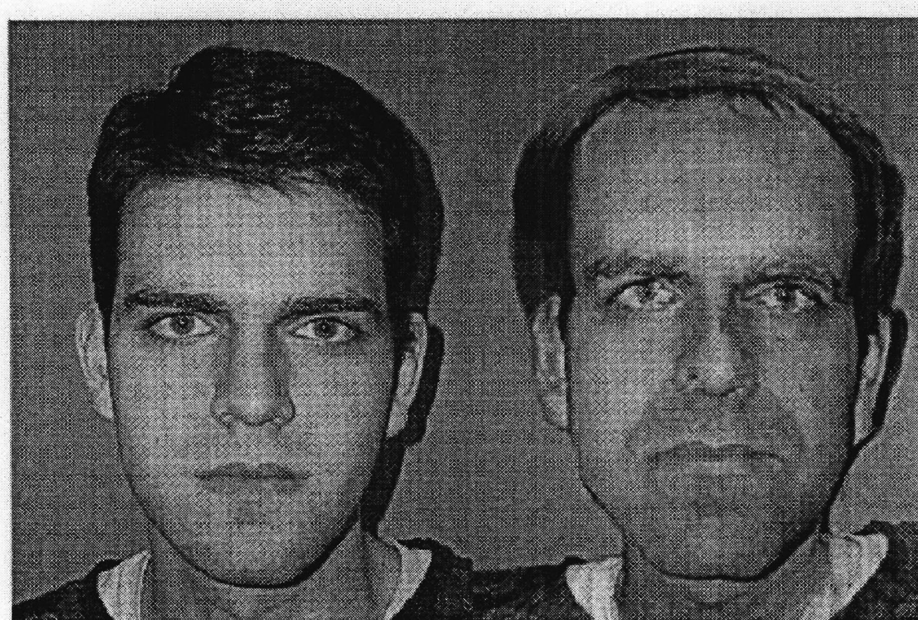
   c. East Asian (Chinese, Japanese, Korean, etc.)

   d. West Asian (Indian, Pakistani, etc.)

Appendix C-1 – Hanging Advert

SCIENCE MUSEUM

Ever wondered what you might look like as a different age or sex?



The Science Museum is developing an exciting new exhibit that seeks to answer this question. We would like your help to develop the exhibit during February and March 2000.

The exhibit will take an image of your face, then change it to make you look older and even change your sex. This 'morphing' process uses cutting-edge computer technology and the results of modern psychological research.

500 volunteers of all ages and origins will have their faces scanned. This will take only 5 minutes, and your face will not appear as part of the finished exhibit so privacy is guaranteed.

Sci m
SCIENCE MUSEUM

Interested in helping?

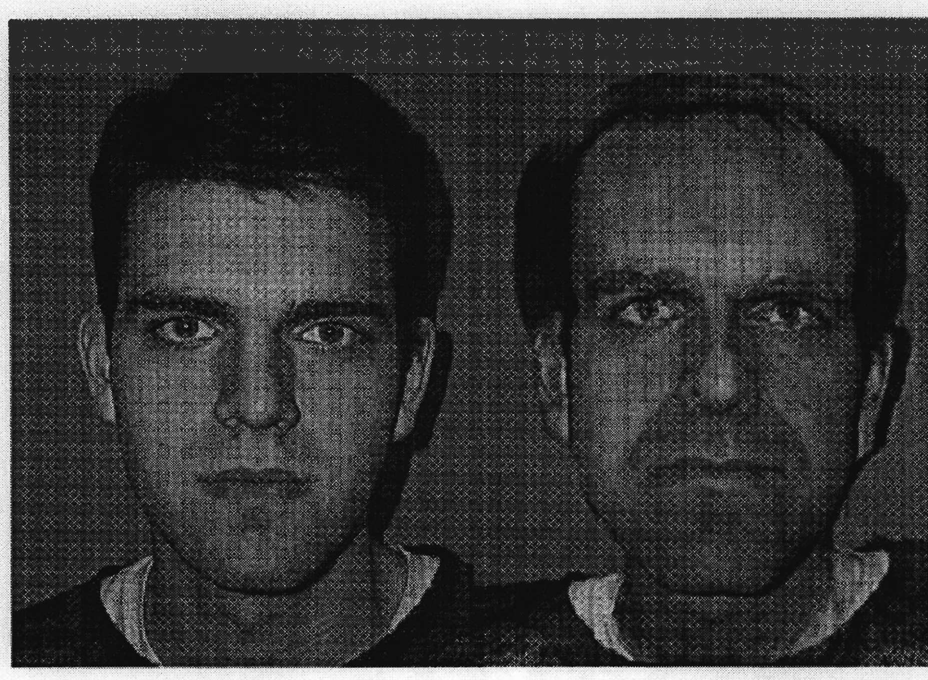
Contact Darren, Carl or Brian on 020 7942 4834 to arrange a time

Appendix C-2 – Informational Flyer

SCIENCE MUSEUM

Interested in helping?

Ever wondered what you might look like as a different age or sex? The Science Museum is developing an exciting new exhibit that seeks to answer this question.



We would like your help to develop the exhibit during February and March 2000.

SCIENCE MUSEUM

Science Museum Digital Morphing Exhibit

Details
The exhibit will take an image of your face, then change it to make you look older and even change your sex. This 'morphing' process uses cutting-edge computer technology and the results of modern psychological research.

Volunteers
500 volunteers of all ages and origins will have their faces scanned. This will take only 5 minutes, and your face will not appear as part of the finished exhibit so privacy is guaranteed.

Information
Come in to have your face scanned at Flight Lab on the Third Foor next to the Motion Ride Simulator Monday–Friday 11.00 am–2.00 pm.

Or contact Darren, Carl or Brian
on **020 7942 4834** to arrange a time.

The Science Museum,
Exhibition Road,
South Kensington
London SW7 2DD.
tel: 0207 942 4454/4455/4000
http://www.sciencemuseum.org.uk

The National
Museum of
Science & Industry

Appendix D – Email

X-Sender: ajbrooke@mail-server.nmsi.ac.uk
Date: Fri, 11 Feb 2000 11:51:26 +0000
To: a.poynter
From: Angela Poynter <a.poynter@nmsi.ac.uk>
Subject: VOLUNTEERS NEEDED TO HELP DEVELOP NEW WELLCOME WING INTERACTIVES
Mime-Version: 1.0
X-MDaemon-Deliver-To: h.mayfield@nmsi.ac.uk
X-Return-Path: a.poynter@nmsi.ac.uk

To all staff

We need your help to develop some exciting new exhibits that will feature as part of the new WHO AM I? and DIGITOPOLIS galleries in the Wellcome Wing.

These exhibits will use morphing software based on the latest psychology and computer science research to change the age or sex of your face.

We need to photograph 500 people over the next 3 weeks to provide the database these exhibits are based on. All ages and origins will need to be photographed, so we would encourage you to bring along friends and family to help us out if they are in the Museum.

An image capture station has been set up next to the MotionRide simulator on the Third Floor until the end of February. We will be there most days between 11.00 and 2.00. It takes less than a minute to have your image captured and your face will not appear as part of the final exhibits.

We would be grateful if all line managers could pass this onto any staff without access to email.

If you have any further queries please call Aisling Byrne on ext 4842, or Brian, Darren and Carl on ext 4834.

Appendix E – Information Brief – Agetron Exhibit

Exhibit Agetron
CREATIVE BRIEF
Draft 2 25/6/99

The WELLCOME WING

1.0 INTRODUCTION

The Wellcome Wing aims to be unlike any science museum or "experience". We are aiming for a perfect synthesis of screen-based interaction, novel forms of input, hands-on mechanical interactives, audio-visual pieces, graphics and three-dimensional design. Our task is to avoid the traditional, bomb-proof solution of plastic laminate, stainless steel and metal treadplate; avoid screen-based interactives that can be bettered at home by a kid with a Pentium or Nintendo; avoid earnest didactics and classroom graphics. We want to be hip in the nicest way, cool, a bit off the wall, iconoclastic and brave.

The CREATIVE BRIEF

1.0 INTRODUCTION

This document outlines the content for a computer interactive that will be placed in the biomedical gallery, '*Who Am I?*' of the Wellcome Wing at The Science Museum. This exhibit will be in an area called Identity Parade, which deals with our physical identity - where it comes from, and how it changes as we age.

The main messages of the ageing exhibits are that ageing is a process of wear and tear: we are continually repairing the damage which occurs to our bodies but the repair processes cannot keep up with this damage. How long we live is influenced by our genes and our lifestyle and although we can take action to improve our health in later life we cannot prevent ageing. Other exhibits in this bloid include an amusing video discussing the question "can science make us live longer ?" and a children's exhibit which allows visitors to compare models of body parts from old and young people.

2.0 EXHIBIT AIMS

- to amuse people by showing what they might look like aged to certain ages or showing them rejuvenated
- to allow people to see the different changes that are likely to happen to their face as they age (see section 4 for details)
- to show that once these changes are understood they can be mimicked with morphing software
- to allow visitors to use morphing software similar to that used in real psychology experiments

3.0 TARGET AUDIENCE

Depends on software used - may have problems with very old/young people. Waiting for more info on different software packages.

4.0 SCIENTIFIC BACKGROUND

Our faces change in different ways as we age. There are some characteristic changes which are the same for everyone. Some of these are obvious - e.g. our skin wrinkles - but others, like changes in the shape of our faces are not.
Examples of characteristic changes are:

- eyes and foreheads relatively smaller in adults than children
- chins relatively larger in adults than children
- skin colour becomes darker
- skin becomes more wrinkly
- hair becomes lighter
- receding hairline leads to higher forehead in older men
- face becomes fatter
- lips become thinner

Researchers have been studying these characteristic changes. Understanding these changes allows us to mimic them.
This software, developed by Dave Perrett in the School of Psychology ,St Andrews University, Scotland, simply applies these changes to your face to show you how you may look when you are older.

References

Examples of age-progression on-line at:

- www.ncmec.org
- www.face.com

See also “In the Eye of the Beholder” by Bruce and Young, pages 95-96

5.0 BASIC DESCRIPTION

This exhibit will attract people with an animated sequence showing a person ageing in the manner possible using this software. On engaging with the exhibit a digital camera will take their picture and they will then see their image aged, either to one specific age which they can choose or in gradual steps.

Visitors will be able to find out what researchers know about the specific ways we age and how this information has been made use of and applied in creating this program. This will give them a sense of how accurate the morph may be!

Other components to the exhibit that we can envisage include:

- The users image will be captured by a digital camera - they will have the option to re-capture if it is not satisfactory
- Visitors will be able to choose from a selection of choices the number of years they wish to be aged - or made younger – by: we suspect the options will be in the region of 15, 25, 45 & 70
- Having chosen the age they will be required to input their current age and also to indicate on the screen the position of specific points of the face – eg end of nose, between eyes, bottom of ears etc. This is so the computer will be able to work with each person’s individual face shape and size.

- It may require up to a minute for the morphing process to complete. If this is the case there will be other points of interest available to be explored to occupy visitors, which can of course also be referenced at other times too:
  - explaining how the details that scientists have discovered about how we age have been incorporated into this software
  - playing simple games - e.g. show images of age progressed people and ask user to guess who the person is
  - showing animation of famous person being age progressed
  - show images from successful use of age progression software in recovering missing children
  - compare 'before and after' images with those of last 10 users and/or famous people

The choice of input device to be used for this exhibit will very much depend on what the actual software will be able to do, what it requires the visitor to do and how easy it will be to 'play' with the morphed images produced. The Museum is currently evaluating a number of input devices, including touchscreen, trackball and button, and joy stick, so software concepts that demand a different input device can be considered.

BIOMETRIC TRAIL

A number of computer-based exhibits throughout the Wellcome Wing will be linked together via the "*Biometric Trail*". This will be an additional feature on the exhibits, and will comprise a fingerprint scanner with dedicated software. This addition will enable visitors to keep a record of their progress around the Wellcome Wing and information they discover during their visit. A fingerprint scanner will enable the system to identify individual visitors and a network database will record their information for retrieval at a later date via the internet. The Biometric Trail software will run from a central server and will respond to calls from the local software at specific points in the activity. The registration, identification and data entry functions will be controlled by the central server, which will take over the local machine while these functions are carried out.

It is anticipated that the Agetron exhibit will be connected to the Trail to allow visitors to save the face they generate. Further details are available from the Museum on request.

In response to this brief a prospective contractor is requested to describe:

_ Details of how the existing software can be supported by an interactive front end to provide an exhibit that will work in the gallery;
- Details of the recommended input devices, including the camera and means to adjust it;

_ Ideas for the manner in which the explanatory and interpretive information will be displayed;
- How any required details about the images will successfully link to the biometric trail software;
- How the design considerations will be accommodated;
- Details of how it will be achieved in the given budget and in what timeframe.

6.0 CREATIVE INPUT

This design brief is not a fully resolved specification. We look forward to the contractor's creative input while developing the exhibit along the general lines indicated here. We also expect the contractor to highlight and help resolve any issues that become apparent in the process. We encourage contact with the Science Museum to discuss or clarify any issues regarding the development of the exhibit. Design detail development and suggested modifications can be submitted to the Science Museum during the approval process.

SPECIFICATION REQUIREMENTS

1.0 EXHIBIT DETAILS

1.1 Scope of work.

This brief is for the development and implementation of a screen-based interactive exhibit that will be housed in a structure called a "bloid" (see 7.1). The scope of work includes the design and production of a user friendly interface as a front end for the morphing software developed by St Andrews, which will also incorporate the pictures taken by the camera. The camera will be sourced and provided by the Science Museum in collaboration with St Andrews and the contractor; the computer hardware and monitor will be provided by the Science Museum and the bloid manufacturer will provide the bloid itself. The contractor will also need to propose a means to house the carmera in conjunction with the bloid liner; this will be reviewed by Hollington and Casson Mann. It is expected that the contractor will liase with both the Science Museum and the Dave Perrett at St Andrews as necessary during all phases of development.

1.2 Basic information

The following is a basic description of the exhibit and the information flow. The exhibit contractor will be required to present a full interaction sequence diagram as part of the exhibit design development. The content script will be developed by the Science Museum. The exhibit consists of a screenbased interactive in a structure that houses the monitor and camera.

Camera

- The camera should be placed at an appropriate height and position such that it captures a users face without too much gallery background. It may therefore need to be adjustable for visitors of different heights.
- Exact placement of this apparatus in the bloid will depend on how the particular model chosen will work best. Positioning of the camera must enable the images to be of the appropriate size.
- It should be easy for the user to capture their image – or recapture it if they are not happy with it.
- The method by which the images will be captured also needs to be decided once the camera is chosen. Eg. will the camera film in real time and allow a user to select the frame; will it act like a camera self timer/photo booth?

The following is a suggested sequence for the activity though alternative suggestions are welcome:

- The standby attractor screen mode for the exhibit is what will draw people to the exhibit. This could feature an animation of famous person being age progressed. The exhibit will return to this state after a time-out and at the end of the users sequence. It should not contain any text other than something equivalent to "Touch screen to start".
- Initial instructions should be as brief as possible.
- It must be easy for visitors to have their image captured and clear to them where they should stand.
- Once their image is captured, they will be able to select one of a few options about what they would like to see happen to it. This could include age progressing it to a certain age – older or younger (current suggestions are 15, 25, 45, 70), with the opportunity to redo it to a different age.
- There is other information to get across within this exhibit, as briefly described in section 5.0 above. When this is done could depend on how long the system takes to morph the images - while it is being done the visitor can scroll through some of the following; however, the information should be available at any time:
    - explanation or details and interesting facts about what we know about the ageing process ;
    - explanation about what parts of the face are being changed and why, and how our knowledge of this has enabled the technology to develop;
    - simple games - e.g. paired images of 'original' then age progressed people which the user is asked to match up (could be child to adult), or the chance to guess which celebrity an age progressed image is;
    - an animation of a famous person/people being age progressed;
    - images / stories from successful use of age progression software in recovering missing children;
    - comparison of 'before and after' images of last 10 users and/or well recognised people.
- The visitor will be offered the opportunity to save an image to their personal web page. Space considerations will probably allow them to save only one so they will be given the chance to select which one. If they answer yes, the exhibit will export the image to the Biometric Trail server.
- The final section of the activity could, for example, ask visitors if they wish to have their face added to a collage of overlapped 'before and after' images of previous users. It could then show a collage with or without their face.

1.3 Further design considerations

- If it is likely the technology will progress over the next 5 years it would be nice if the software could be written to incorporate any potential improvements at a later date.
- It should be clearly explained to visitors any likely instances where it may be difficult to use this exhibit – for example on very young children. It is possible that images will simply appear a little odd if too young a child tries to rejuvenate or an old person tries to get older!
- It is likely that visitors will want to compare any morphed images with their current one, thus one suggestion is to keep the current image on the screen.

- It is likely there will be a limit to the morphing age within the software.
- This exhibit is intended for a single user, with up to four onlookers. The size of the images and type needs to afford onlookers a reasonable appreciation of what is happening.
- While the exhibit presents a fairly linear sequence of events it should not appear too didactic or inflexible to the user. It should also be simple, intuitive and enjoyable for all of the target audience to use.

1.4 Look and feel

1.4.1 Attitude and colour

As stated in section 1.1, this exhibit will be housed in a structure called a bloid. Further information on bloids is included in section 2.

The monitor will be set into a liner inside the bloid. Each bloid has a keyed colour for its liner. The colour for the Ageing bloid liner is Pantone 473. This will need to be considered in:
a) developing the colour palette of the exhibit, as the liner will be the colour surround for the monitor;
b) designing the screen saver, so that it both indicates a sense of movement and activity when the exhibit is not in use and uses enough of the bloid liner colour that the monitor blends seamlessly with the liner. The on-screen colour may need to be fine-tuned to match colour material samples, which will be provided.

An aspect of the gallery character is that each bloid has its own personality and attitude. That particular personality should help to inform the design development of each exhibit. The Ageing bloid is cool and futuristic as you age into the future. This personality must be developed in the context of appealing to the target audience and will probably be most obviously manifest in the design elements of the interface as well as the way the accompanying information is presented.

1.4.2 Typography

There is a typographic specification for the gallery (see Appendix___). This should be used for any type included in the screen saver, and any direct instructions to the user. Designers may make alternative typography proposals for other aspects of the exhibit, although, in a design sense, these must successfully co-exist with the standard gallery typography.

1.4.3 Imagery

The contractor will develop any imagery, graphics or animations used in the software.

1.5 General hardware and software information

The monitor size will be 17", and the screen resolution we are asking contractors to work to is 1024 x 768. However, as the monitor is set behind and revealed by the liner (housing), it is important to assume that there will be some overlap on the outer edge of the screen. Therefore, we suggest that you do not place anything important at the outermost 20mm of all edges of the screen. The Science Museum will provide a pixel count for this dimension once the brand of monitor has been specified.

Delivery of the final interactive must be in a self-running (projector) format most likely for Windows NT.

Please refer to the Technical Specification appendix for full hardware and software requirements.

1.6 Interface and input.
The exhibit could use a touchscreen, trackball or joystick interface. The final choice is likely to depend on the capabilities and requirements of the morphing software. The Science Museum is developing a variety of potential devices.

The camera which will be used is yet to be decided. This will be discussed in collaboration with the contractor should they have certain recommendations.

2.0 BLOIDS.
2.1 Overall structure. BLOID is the name given to the interactive exhibit housings in the Who Am I? Gallery. They are hollow, aluminium frame and skin structures, of organic form, supported on three or five legs, each housing on average 4-6 interactive exhibits.

2.2 Exhibit aperture.
The skin panels of the bloid will be formed from aluminium sheet. Each interactive will be contained within the volume of the bloid (i.e. will not extend outside the bloid) within its own dedicated aperture. The placement and mounting of the monitor will be within a dedicated liner provided by the Science Museum. The exhibit contractor is welcome to come and see the structures as they are developed.

Appendix F – Information Brief – Gender Morphing Exhibit

Exhibit Gender Morphing
CREATIVE BRIEF
Draft 2 16/6/99

The WELLCOME WING
1.0 INTRODUCTION
The Wellcome Wing aims to be unlike any science museum or "experience". We are aiming for a perfect synthesis of screen-based interaction, novel forms of input, hands-on mechanical interactives, audio-visual pieces, graphics and three-dimensional design. Our task is to avoid the traditional, bomb-proof solution of plastic laminate, stainless steel and metal treadplate; avoid screen-based interactives that can be bettered at home by a kid with a Pentium or Nintendo; avoid earnest didactics and classroom graphics. We want to be hip in the nicest way, cool, a bit off the wall, iconoclastic and brave.

The CREATIVE BRIEF
1.0 INTRODUCTION
This document outlines the content for a computer interactive that will be placed in the biomedical gallery, '*Who Am I?*' of the Wellcome Wing at The Science Museum. Gender Morphing will be in the Faces area of Identity Parade. This area will concentrate on how research into faces has changed over the last century and what contemporary work is telling us about how we store, recall and make judgements about faces. Other interactives include computer systems which enable you to create a photo-fit image of your own face and to explore what it is you find attractive in a face.

Visitors will have an image of their face captured by digital camera. Morphing software will then change the sex of their image to suggest what they could look like as the opposite sex.

2.0 AIMS
- To amuse visitors by showing them what they would look like if they were of the opposite sex.
- To demonstrate the typical structural differences between male of female faces (see section 4 for details).
- To allow visitors to use software used in real pyschology experiments.

3.0 TARGET AUDIENCE
Depends on software used - may have problems with very young / old people. Waiting for more info on different software packages.

4.0 SCIENTIFIC BACKGROUND
Scientists working on face recognition have quantified the differences between male and female faces. They did this by taking 3D scans of a large number of male and female faces. They averaged the scans for the different sexes and then looked at the how these average scans compared.

They found a number of areas of the face where male and female faces tended to be different:

- male nose and brow more protuberant
- male chin and jaw-line broader
- female cheeks and eyes more protuberant
- female chin fleshier

Quantifying these differences helps scientists to understand how we judge people's sex from their faces. Once we understand the differences between male and female faces we can mimic them using computer morphing software. This software, developed by Dave Perrett in the School of Psychology ,St Andrews University, Scotland, simply applies these changes to your face to show you how you could look as the opposite sex.

References

See "In the Eye of the Beholder" by Bruce and Young, pages 95-96

5.0 BASIC DESCRIPTION

This exhibit will attract people with an animated sequence showing selections of 'sex-changed' images, possibly of recognisable people, done using this software. As visitors engage with this exhibit a digital camera will take their picture and after the morphing process they will see an image of their face, altered to have more of the opposite sex characteristics.

Visitors will be able to find out what researchers know about how we recognise people's sex from their face and how this information has been made use of and applied in creating this program.

Other components to the exhibit that we can envisage include:

- The users image will be captured by a digital camera - they will have the option to re-capture if it is not satisfactory.
- Visitors will need to input their sex and also to indicate on the screen the position of specific points of the face – eg end of nose, between eyes, bottom of ears etc. This is so the computer will be able to work with each person's individual face shape and size.
- It may require up to a minute for the morphing process to complete. If this is the case there will be other points of interest available to be explored to occupy visitors, which can of course also be referenced at other times too:
    - explanation of differences between male and female faces as outlined in scientific background section 4.0 above;
    - explanation about what the software does;
    - simple games - e.g. images of 'sex-changed' people where the user guesses who the person is;
    - animations of a famous person 'sex-changed';
    - compare 'before and after' images with those of last 10 users and/or famous people.

The choice of input device to be used for this exhibit will very much depend on what the actual software will be able to do and what it will require the visitor to do. The Museum is currently evaluating a number of input devices, including touchscreen, trackball and button, and joy stick, so if the software concepts demand a different input device it can be considered.

BIOMETRIC TRAIL

A number of computer-based exhibits throughout the Wellcome Wing will be linked together via the "*Biometric Trail*". This will be an additional feature on the exhibits, and will comprise a fingerprint scanner with dedicated software. This addition will enable visitors to keep a record of their progress around the Wellcome Wing and information they discover during their visit. A fingerprint scanner will enable the system to identify individual visitors and a network database will record their information for retrieval at a later date via the internet. The Biometric Trail software will run from a central server and will respond to calls from the local software at specific points in the activity. The registration, identification and data entry functions will be controlled by the central server, which will take over the local machine while these functions are carried out.

It is anticipated that the Gender Morphing exhibit will be connected to the Trail to allow visitors to save the face they generate. Further details are available from the Museum on request.

In response to this brief a prospective contractor is requested to describe:

- Details of how the existing software can be supported by an interactive front end to provide an exhibit that will work in the gallery;
- Details of the recommended input devices, camera and image focusing control;
- Ideas for the manner in which the explanatory and interpretive information will be displayed;
- How any required details about the images will successfully link to the biometric trail software;
- How the design considerations will be accommodated;
- Details of how it will be achieved in the given budget and in what timeframe.

6.0 CREATIVE INPUT

This design brief is not a fully resolved specification. We look forward to the contractor's creative input while developing the exhibit along the general lines indicated here. We also expect the contractor to highlight and help resolve any issues that become apparent in the process. We encourage contact with the Science Museum to discuss or clarify any issues regarding the development of the exhibit. Design detail development and suggested modifications can be submitted to the Science Museum during the approval process.

SPECIFICATION REQUIREMENTS

1.0 EXHIBIT DETAILS

1.1 Scope of work.

This brief is for the development and implementation of a screen-based interactive exhibit that will be housed in a structure called a "bloid" (see 7.1). The scope of work includes the design and production of the software for this exhibit as well as a user friendly interface that also incorporates the pictures taken by the camera. The computer hardware and monitor will be provided by the Science Museum and the bloid manufacturer will provide the bloid itself. The contractor will also need to propose a means to house the carmera in conjunction with the bloid liner; this will be reviewed by Hollington and Casson Mann. It is expected that the contractor will liase with both the Science Museum and the Dave Perrett at St Andrews as necessary during all phases of development.

1.2 Basic information

The following is a basic description of the exhibit and the information flow. The exhibit contractor will be required to present a full interaction sequence diagram as part of the exhibit design development. The content script will be developed by the Science Museum. The exhibit consists of a screenbased interactive in a structure that houses the interface and camera.

Camera:

- The camera should be placed at an appropriate height and position such that it captures a users face without too much gallery background. It may therefore need to be adjustable for visitors of different heights.
- Exact placement of this apparatus in the bloid will depend on how the particular model chosen will work best. Positioning of the camera must enable the images to be of the appropriate size.
- It should be easy for the user to capture their image – or recapture it if they are not happy with it.
- The method by which the images will be captured also needs to be decided once the camera is chosen. Eg. will the camera film in real time and allow a user to select the frame; will it act like a camera self timer/photo booth?

The following is a suggested sequence for the activity though alternative suggestions are welcome:

- The standby screensaver mode for the exhibit is the attractor sequence that will draw people to the exhibit. This could feature an animation of famous person being 'sex-changed'. The exhibit will return to this state after a time-out and at the end of the users sequence. It should not contain any text other than something equivalent to "Touch screen to start".
- Initial instructions should be as brief as possible.
- Visitors will need to enter their sex before or after their image is captured.
- It must be easy for visitors to have their image captured and clear to them where they should stand.
- Once their image is captured, they will be able to select one of a few options about what they would like to see happen to it
- The image will take between 20 secs and a minute to morph.

- While it is being done the visitor can scroll through some of the other information there is within this exhibit (as briefly described in section 5.0); however, this information should be available at any time:
  - explanation about what parts of the face are being changed and why, and how our knowledge of this has enabled the technology to develop;
  - explanation or details and interesting facts about what we know about facial sex differences;
  - simple games - e.g. paired images of 'original' then altered faces which the user is asked to match up, or the chance to guess which celebrity a sex changed image is;
  - an animation of a famous persons face with the changes applied;
  - comparison of 'before and after' images of last 10 users (if they have added their face to the collage - see last point below).
- The visitor will be offered the opportunity to save their image to their personal web page. If they choose to do so, the exhibit will export the image to the Biometric Trail server.
- The final section of the activity could, for example, ask visitors if they wish to have their face added to a collage of overlapped 'before and after' images of previous users. It could then show a collage with or without their face.

1.3 Further design considerations

- If it is likely the technology will progress over the next 5 years it would be nice if the software could be written to incorporate any potential improvements at a later date.
- It should be clearly explained to visitors any likely instances where it may be difficult to use this exhibit – for example on very young children or much older visitors
- It is likely that visitors will want to compare any morphed images with their current one, thus one suggestion is to keep the current image on the screen.
- This exhibit is intended for a single user, with up to four onlookers. The size of the images and type needs to afford onlookers a reasonable appreciation of what is happening.
- While the exhibit presents a fairly linear sequence of events it should not appear too didactic or inflexible to the user. It should also be simple, intuitive and enjoyable for all of the target audience to use.

1.4 Look and feel

1.4.1 Attitude and colour

As stated in section 1.1, this exhibit will be housed in a structure called a bloid. Further information on bloids is included in section 2.

The monitor will be set into a liner inside the bloid. Each bloid has a keyed colour for its liner. The colour for the Faces bloid liner is Pantone 174 (brown). This will need to be considered in:

a) developing the colour palette of the exhibit, as the liner will be the colour surround for the monitor;

b) designing the screen saver, so that it both indicates a sense of movement and activity when the exhibit is not in use and uses enough of the bloid liner colour that the monitor blends seamlessly with the liner. The on-screen colour may need to be fine-tuned to match colour material samples, which will be provided.

An aspect of the gallery character is that each bloid has its own personality and attitude. That particular personality should help to inform the design development of each exhibit. The faces bloid is personable and friendly. This personality must be developed in the context of appealing to the target audience and will probably be most obviously manifest in the design elements of the interface as well as the way the accompanying information is presented.

1.4.2 Typography

There is a typographic specification for the gallery (see Appendix___). This should be used for any type included in the screen saver, and any direct instructions to the user. Designers may make alternative typography proposals for other aspects of the exhibit, although, in a design sense, these must successfully co-exist with the standard gallery typography.

1.4.3 Imagery

The contractor will develop any imagery, graphics or animations used in the software.

1.5 General hardware and software information

The monitor size will be 17", and the screen resolution we are asking contractors to work to is 1024 x 768. However, as the monitor is set behind and revealed by the liner (housing), it is important to assume that there will be some overlap on the outer edge of the screen. Therefore, we suggest that you do not place anything important at the outermost 20mm of all edges of the screen. The Science Museum will provide a pixel count for this dimension once the brand of monitor has been specified.

Delivery of the final interactive must be in a self-running (projector) format most likely for Windows NT.
Please refer to the Technical Specification appendix for full hardware and software requirements.

1.6 Interface and input.

The exhibit could use a touchscreen, trackball or joystick interface. The final choice is likely to depend on the capabilities and requirements of the morphing software. The Science Museum is developing a variety of potential devices.

The camera which will be used is yet to be decided. This can be discussed in collaboration with the contractor should they have certain recommendations.

2.0 BLOIDS.

2.1 Overall structure.

BLOID is the name given to the interactive exhibit housings in the Who Am I? Gallery. They are hollow, aluminium frame and skin structures, of organic form, supported on three or five legs, each housing on average 4-6 interactive exhibits.

2.2 Exhibit aperture.

The skin panels of the bloid will be formed from aluminium sheet. Each interactive will be contained within the volume of the bloid (i.e. will not extend outside the bloid) within its own dedicated aperture. The placement and mounting of the monitor will be within a dedicated liner provided by the Science Museum. The exhibit contractor is welcome to come and see the structures as they are developed.

Appendix G – IDEO Study – Morphing Software Background

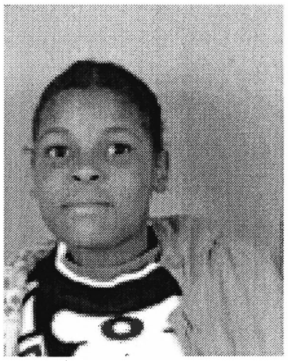
"Agetron" and "Gender-Morph" Face Image Changing Software

By the University of St. Andrews

A DRAFT Feasibility Analysis Document vO.9 NOT FOR RELEASE

For Barbara Keating of the Science Museum, London

By Colin Burns of IDEO Europe 0171 485 1170 colin@ideo.com



source image

target image aged

Introduction

The School of Psychology at the University of St. Andrews has created a software application that they have been using to study ***human perception of the ageing and gender of people's faces***. The application takes a picture of a face and transforms, or "morphs", the picture to make the face appear older, younger, more or less masculine or feminine, as required

The Science Museum is considering the potential for this software to form the basis of an interactive exhibit for the new Wellcome Wing at the museum. The Science Museum has commissioned IDEO to carry out a SWOT analysis with a view to assessing the suitability of this work for museum use and outlining the potential work required to create a successful interactive exhibit.

The morphs work by performing three key processes. Images of faces are transformed by:

- ***distortion*** to reposition and re-proportion key features (e.g. eyes, nose, mouth, forehead, chin)
- ***colourization*** to lighten hair and darken skin
- ***texture mapping*** of images to mimic skin visual attributes

The software works by comparing a new ***source image*** of a (visitors) face to a stored ***composite target template*** that has been pre-built from a small ***set*** (some 20) of ***target images*** that exemplify the intended physical facial change desired. The composite template has two components, a features position vector map and a composite image bitmap of carefully overlaid target images.

It should be noted that the demonstrations witnessed were conducted in the controlled, stable computing and physical environment of the University Lab. All demos were carried out using image files drawn from existing departmental resources.

IDEO were able to witness first-hand and discuss the morph process and transformation techniques employed. We were only able to discuss (without witnessing) the process of creating the composite templates, the capture of sample images and the hardware issues. The dialogue during the visit was conducted in an open, highly collegial manner. We have no reasons to assume that the St. Andrews researchers would continue to make anything less than excellent collaborators.

Strengths

The software produces excellent visual results. Face images do indeed look older, younger, more or less masculine or feminine. The synthesized images look ***extremely engaging and authentic***. The software very much delivers results "as advertised"

The software system ***degrades gracefully***. During the demonstration at St. Andrews, the researchers repeatedly attempted to make the system "fall over" - e.g. by taking a sample image of a juvenile black female morphed by the system as a middle-aged caucasian male to a target image of elderly caucasians. The images on the front page of this report show the results of this "worst case" scenario. IDEO believe that these would be deemed by the museum to be to be more than "good enough" for exhibit purposes.

IDEO believe that acceptable results could be obtained from a reasonably manageable ***number of composite target templates***. The minimum requirement would be for 8 composite templates from 8 sets of around 20 images each. One set each for juvenile, teen/twenties, middle-agers and elderly, for both male and female. This translates to taking portraits of some 160 people.

St. Andrews know that there are, indeed, some differences between the ***facial characteristics of different ethnic groups***, but have done limited work in quantifying or qualifying this. Again in terms of creating a "good enough" exhibit experience, a single ethnic sampling would potentially fit the bill. The decision to build a wide range of ethnic sets would be based on trading off considerations of "good politics" and /or "better science" for manageable logistics. The cost/benefit analysis on this would need to be carefully carried out by the Museum.

The St. Andrews team has in-depth experience in the ***efficient building of the composite target templates***. They reported work rates (typically automated initial image processing followed by some manual hand tweaking) of around 25 images a day. This would translate to around 1 complete template set processed in a single daily session.

Morph ***transformations execute reasonably quickly*** (something in the order 10-15secs - note that these are the times experienced by IDEO first-hand at the St. Andrews Lab and are somewhat quicker than the 20 secs to 1min. previously assumed by the museum - this may be due to a recent processor upgrade to a 400MHz Intel PIII). This process can be ran as a background process, but is very processor intensive. Any wait time or explanation multimedia graphics being concurrently displayed would be somewhat limited by what could easily run out of RAM - with the well specified computers available this should not be a significant limitation.

Users are able to "dial-in" the desired ***proportion of the effect*** they wish to see. This will work best when presented at the user interface as rough guidelines like "older" or "much older" than precise target instructions like "make me look 56"

St. Andrews or IDEO are currently not aware of any reasons that the software would not run comfortably on the ***hardware platform*** available to the Museum.

Weaknesses

The ***capture of suitable sample images*** in the "live" Museum environment is potentially problematic. The images have to quite closely conform to those that make up the composite templates in terms of facial expression, composition, background, and subject positioning in the frame. Key requirements include:

- only a single subject at a time
- the eye position has to be within a reasonably small bounding box to allow the automatic feature recognition to work. This box is roughly 10% to 20% of the area of the whole of the image map, positioned about 3/5ths up from the lower edge of the image map.
- lighting on the subject's face has to be consistent
- the background features need to stay consistent
- facial expressions like smiles, frowns, closed eyes, etc. will produce poor results if they don't match the expressions in the composite template

The ***target images need to be acquired in the same conditions as the installed exhibit***. This has implications for the development schedule. The exhibit either needs to be completed and in-situ before the data processing work can be carried out, or the developers will need to re-create with some certainty the conditions to be encountered on the museum floor, to allow parallel hardware and software development efforts.

The ***system needs to be "trained"*** with a large number of the actual target images. Within the University's current experience this is currently thought to be something in the order of 150 images to achieve satisfactory results. However, the University are currently of the opinion that this training meta-set could be potentially created from the 160 images intended for creating the composite target templates. The training requirement number is therefore effectively the minimum number of portraits that would need to be acquired during development.

The ***user interface*** cannot be simply "snap and go". Visitors will be required to enter a minimal level of data about themselves to get a morphed result. For "Agetron" the miminimum entry requirements will be age and a target age range (much younger, younger, older, much older...) For "Gender-Morph" the minimum requirements will be age, sex and a target sex change range (much more feminine, more feminine, more masculine, much more masculine...)

Visitors with unusual or strongly aged or gendered ***hairstyles*** might find it harder to get the best exhibit experience. Hairstyles can be a very significant perceptual cue for ageing or gender recognition - which can overwhelm the effect of the other perceptual cues.

It is not possible to show a progression or ***range of morphs*** between the sample and target images. The current software implementation does not allow this.

A ***high specification digital camera*** is required to create images of the required fidelity for the software. The researchers at St. Andrews reported poor results from previous experiments with video camera sources.

Opportunities

The University has created a number of multi-face morph movies showing rapid transitions backwards and forwards between source images and morphed images. These are readily ***available multimedia assets*** that could be employed for development to help create, for example, an eye-catching and explanatory "idle attract" screen design.

The University is able and willing to work with the Museum and the exhibit developer in the ***exhibit development*** phase. They could provide resources to both "wrap" the current software as a discrete software object with function documentation and provide image processing capabilities to create composite templates from target image sets. Their depth of expertise and familiarity with the system would be a highly valuable contribution to the development of the exhibit.

The ***"wrong" morphs*** produce results that are at least as engaging (if not more so...) than the "right" ones. For example a female visitor being able to see herself become more feminine is as potentially engaging as seeing herself appearing to change gender.

Threats

The ***physical capture environment*** will require non-standard design approaches. The somewhat constrained requirements for the source (visitor's face) image will require a more controlled interaction style than currently anticipated in the architecture of the "bloid". To ensure a good result we might imagine more of a single person "open booth" environment - at least a raised dias with a background wall - providing much better results than the current "open floor" plan. The physical design of this "protected" interaction environment would require extra resourcing to realise this "non-standard" architectural feature as well as be potentially difficult to integrate with the current design.

Both physical and virtual ***user interface mechanisms*** to shape the visitors behaviour appropriately during capture will also be a potentially great challenge - the "put your head here, like this" imperative. Getting visitors to compose their expressions and positions within the frame will require very careful interaction design. We might imagine pursuing the design through elements like: telling visitors to "click on" or touch their eye positions on the captured image; employ an eye position "target" graphic overlaid on the video mirror preview of the captured image; use "seaside photography" head holes or show example images that are "right" or "wrong" to inform visitors how to capture images properly.

The ***image capture hardware*** may require an expensive non-standard specification. With St. Andrews's current camera set-up, the time currently required to capture the source image (20-30secs) is currently two to three times that required to make the "morph" (10-15secs.) The appropriate hardware strategy to maintain or reduce this time period may require additional resources and a "non-standard" hardware approach - specifically, "clean through" SCSI capture to a SCSI (RAID) drive. A USB camera solution would provide a high bandwidth solution, but USB is not supported by Windows NT4. A serial or parallel based solution would result in unacceptably long capture times (> I min.) Depending on the strategy chosen, capture may not be able to be undertaken as a background process - thus "locking-up" the computer in terms of providing a dynamic multimedia wait time presentation.

The ***logistics of recruiting candidate subjects*** whose images could be used to build the composite template sets should not be under-estimated. At best, this will mean finding some 160 subjects - the limitation here is the required minimum for system training. To comprehensively represent a cross section of visitor ethnicities would require 160 additional subjects for each ethnic group.

There is an outside possibility that the ***system training sample set*** may need to be much larger than the combined images sets acquired for the composite target templates. This would have an effect on the logistics of the development - requiring more subjects to be recruited, portrait imaged and processed.

Conclusions

IDEO believe that the St. Andrews University face morphing software provides a good basis for a compelling Science Museum exhibit. Perhaps based on measures of a "good visitor experience" rather than those of "best practice science", the current application could be economically developed to provide a successful exhibit requiring a single data set of 160 subjects. The most critical part of the process of developing it from a lab demonstration into a fully functional exhibit will be around the image capture issues. There are significant challenges involved in creating the physical and virtual environments that both encourage visitors to behave appropriately to successfully make an image of themselves suitable for morphing by the software, as well as integrating the required physical environment into the current architectural scheme for the gallery. The logistics of gathering suitable image data are manageable, although must be regarded as non-trivial.

Additional Technical Details

Current ***image capture*** is through a FUJI DS300 digital camera. This was chosen due to the availability of a SCSI connectivity solution. The application software currently requires TWAIN compatibility. St. Andrews's use a 3rd party application (bundled with the FUJI camera) called MicroGraphics Picture Publisher to capture and process images for target image banks. They are currently unhappy with the color definition and stability of this application. The likely cost of the necessary camera and computer interface should be budgeted at between £1,500 and £3,000.

St. Andrews's staff currently capture at a number of different ***pixel map*** dimensions, but report good results at around 500 x 700 pixels. The optimum capture size for best morphing speed performance and image resolution would keep both pixel dimensions at or below 512 pixels (e.g. 512 x 512 or 512 x 384 pixels).

Larger dimensions than this result in the software processing the image as a 1024 x 1024 pixels map - with a resulting non-linear increase in processing time required to morph.

Image storage needs will be somewhat significant, depending on the visitor flow anticipated and length of time desired to archive visitor's images - 1 week, 1 month, etc. The images generated from each visitor session will be two image map files and a template. At 512 x 512 pixels, 24 bit colour depth, each image file will require storage resources of around 1MB per image - i.e. 2MB per visitor session. Template files are trivial in size (<10KB). Long term archiving needs should be anticipated from this figure.

Each exhibit would be able to ***run on a single computer***, to the Museum's current spec (except for capture as described above...) - i.e. one machine per "Agetron" and "Age-Morph" exhibit.

As the ***Biometric Trail*** software has been currently described, the University researchers currently do not anticipate difficulties in interfacing their software to it.

Appendix H – Contact List

Author Contact Information:

Darren McCormick
dmlupus@wpi.edu
(508) 831-6543
Carl Messina
cmessina@wpi.edu
(978) 597-8036
Brian Wozniak
bwozniak@wpi.edu

Museum Affiliated Contacts:

Colin Burns: 0207 713 2600
Contact at IDEO for bloid conditions and prototype.

Andy Finch: 0171 942 4515
Science Museum contact for giving our lighting set-up approval.

Sarah Leonard: 0207 924 4750
Science Museum Education Coordinator. Contacted for information regarding school groups that were scheduled to visit the museum.

Andy Lloyd: 0207 924 4377
Contact for bloid set-up and material gathering.

Jean McConachie: 0171 942 4775
Contacted for school group schedules.

Katrin Wegener: 0171 924 4775
Contact at IDEO for bloid conditions and prototype.

Nick Smith: 0171 942 4856
Science Museum contact for general help.

ReproGraphics: 0171 942 4262
Science Museum contact for the printing of adverts.

Successful Target Group Contacts:

Age Concern England: 0181 765 7200 Contacted for information on elderly groups in the Kensington and Chelsea, and Westminster areas. Provided numbers for local Day Centres.

Chinese Community Centre: 0171 439 3822 Meeting centre for Chinese People of different ages. Contacted and images gathered on 23/2/2000 at 2:00.

Holland Park Secondary School: 0171 727 5631 Mr. McKenna was contacted and images gathered with on 18/2/2000.

Japanese Embassy: 0171 465 6500 Contacted. Information on Japanese groups in the area was sent back.

Kensington Day Centre: 0171 727 7337 Contacted, with good response. Primarily Caucasian so no meeting was scheduled.

Leanora Day Centre: 0171 286 0836 Day Centre with West Asian elderly. Contacted and gathered images from on 23/2/2000.

PepperPot Day Centre: 0207 942 4856
Afro-Caribbean Day Centre. Contacted and images gathered from on 24/2/2000.

Westminster Social Service: 0171 641 3678 Area contacted for groups in the Westminster and Soho areas. Phone numbers provided.

Unsuccessful Target Group Contacts:

Covent Garden Day Centre: 0171 240 5733
Large Chinese groups on Mondays – Not interested.

Edenham Day Centre: 0181 969 7182
Contacted, no response.

EPICS, Westway Centre: 0171 598 4600
Contacted, no response.

Japanese Conversation Club: 0171 352 7716
Contacted, not applicable.

Marlborough Primary School: 0171 589 8553
Contacted but images from the group were no longer needed.

Appendix I – Volunteer Information Database

1 Volunteer Information Database

1.1 Tables

Tables are the elements in which the raw information of the database is stored. The organisation of these tables is crucial in the design of an efficient and flexible database. We chose a main information table, "Volunteer_Information", to store the majority of the information we had gathered. This table stored references to records from other small lookup tables instead of the actual values themselves. This approach allows values for individual fields and dropdown menus to be changed or added globally. This approach will be described in more detail below.

1.1.1 Volunteer_Information

We used this table simply to store the information gathered from the Volunteer Information Sheets. This table is connected with the Ages, Genders, Races, and Contact_Methods tables through relationships. These relationships are described in further detail in Section 1.2 – Relationships of this appendix. Each record in this table represented a single volunteer. The fields of this record are described below.

ID: Contained a number which automatically incremented with each new record in order to ensure that each record was unique.

Gender: Contained a number that was used to represent either *Male* or *Female*. This field was linked to the *Gender* table where the genders were stored.

Age_Range: Contained a number that was used to represent one of the four age ranges we needed to fill in order to complete the database. This field was linked to the *Ages* table where the age groups were stored.

Race: Contained a number that was used to represent one of the four race groups. This field was linked to the *Races* table where the ethnic groups were stored.

Contact_Method: Contained a number that was used to represent one of the four contact methods. This field was linked to the *Contact_Methods* table where the contact methods were stored.

Date: Contained a date in the form of dd/mm/yy that represented the date that the volunteer was gathered.

Photo_ID: Contained text that was used to represent the id of the digital photo taken. This field contained the filename of the photo associated with it, without the three-letter file extension.

In_Between_Ages: Contained a *Yes/No* value that was used to denote whether the volunteer's age fell into one of the groups that we did not specifically need.

Rejected: Contained a *Yes/No* value that was used to denote whether we had rejected the image due to poor quality.

Location: This field held text that denoted the location describing where the volunteer was gathered.

1.1.2 Ages

The *Ages* table was used as a lookup table for the four age ranges. Indices into this table were stored in the Volunteer_Information table. By keeping the age ranges in this separate table, we were able to alter the age ranges more easily, and use this table as a source for dropdown boxes. Each record represented a single age range.

Age_ID: Contained a number that is used as an index to the age range stored in the current record.

Ages: Contained text that denoted an age range. For example, '8 to 12'.

1.1.3 Contact_Methods

The *Contact_Methods* table was used as a lookup table for the four methods of initial contact. Indices into this table were stored in the *Volunteer_Information* table. By keeping these values separate, we were able to alter the contact methods and use this table as a source for dropdown boxes. Each record represents a single contact method.

Contact_ID: Contained a number that was used as an index to the contact method stored in the current record.

Contact_Methods: Contained text that denoted a contact method. For example, 'Target Group Presentation'.

1.1.4 Genders

The Genders table was used as a lookup table for the two genders. Indices into this table were stored in the *Volunteer_Information* table.

Gender_ID: Contained a number that was used as an index to the gender stored in the current record.

Gender: Contained text that denoted a gender.

1.1.5 Races

The *Races* table was used as a lookup table for *Volunteer_Information* and a source for dropdown boxes. By keeping these values separate we were again able to alter these values without impacting the data stored in the rest of the Volunteer Information Database.

Race_ID: Contained a number that was used as an index to the race stored in the current record.

Races: Contained text that denoted an ethnic group. For example, 'Caucasian'.

1.1.6 Current Breakdown

The *Current Breakdown* table was created by a *Make Table* query and was used to construct the *Database Composition* table. This table contained information for each of the 32 age/race/gender for which we had gathered volunteers. The information in this table was then used to update the *Database Composition* table that held information for all 32 groups. This table was only used as in intermediate data source because of a subtlety in query construction in Microsoft Access®. This table displayed each group along with the number of images we had and the number of images we needed. An example record from this table is displayed as Figure 17.

Races	Ages	Gender	Have	Need
Afro-Caribbean	13 to 18	Female	12	3

Figure 19: Current Breakdown/Database Composition Record

1.1.7 Database Composition

The *Database Composition* table was almost identical to the *Current Breakdown* table described in the preceding section. The only difference was that this table was created from a different query that used the *Current Breakdown* table to create this table. This table contained information for all of the 32 age/race/gender groups instead of only those with volunteers gathered. See Figure 17 for an example record.

1.1.8 Rejections_Volunteers

The *Rejections_Volunteers* table was used to keep track of the number of rejections and volunteers for each gathering location. Each record denoted a gathering location.

ID: Index field to ensure the uniqueness of each record.

Location: Text field that denoted the location where the rejections and volunteers were received.

Rejections: This field counted the rejections we received at the designated gathering site.

Volunteers: This field counted the volunteers we received at the designated gathering site.

1.2 Relationships

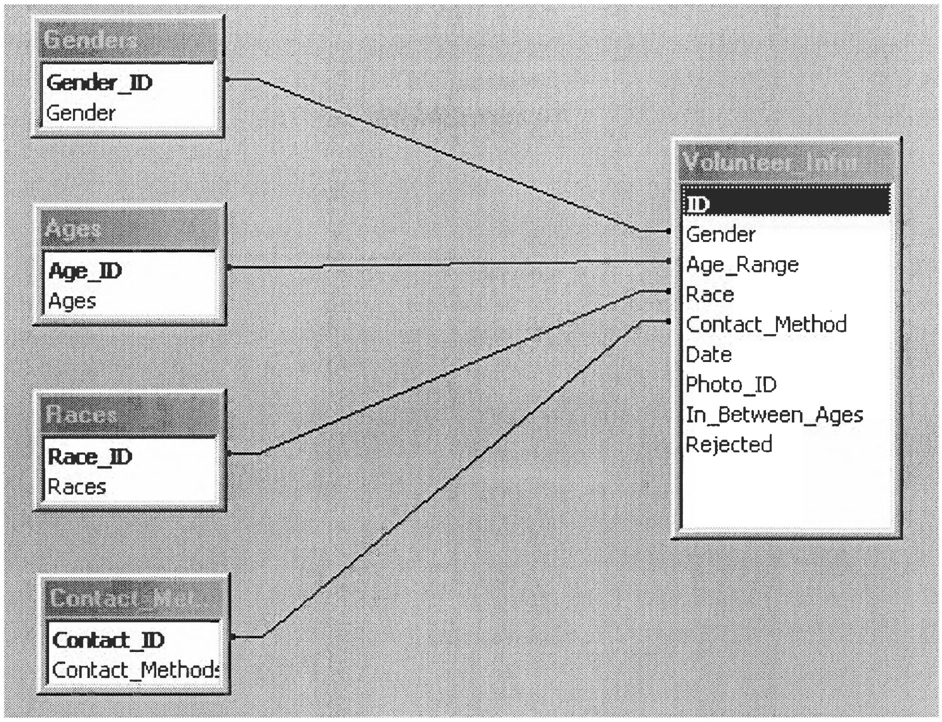


Figure 20: Database Relationships

Figure 18 shows the connections between the *Volunteer_Information* table and the *Gender, Ages, Races, and Contact_Methods* tables. The index fields in the *Volunteer_Information* table were linked to their associated lookup tables. For example, the *Age* field from *Volunteer_Information* was linked to the *Age_ID* field of the *Ages* table. This association allowed the *Volunteer_Information* table to store a number that represented one of the age ranges stored in the *Ages* table. By using this technique, we were able to alter/add age ranges, races, etcetera, without having to alter any queries or forms that were run using the *Volunteer_Information* table.

1.3 Queries

We also created a series of queries to assemble subsets of the data and to keep track of the current composition of the morphing database. The specific purpose of each query is described below.

1.3.1 Database Breakdown

This query created totals of the number of volunteers gathered for each of the 32 age/race/gender groups. The number of volunteers gathered was subtracted from the number of volunteers needed which gave us another way to view the information. The totals and group breakdown information was then used to create the *Current Breakdown* table.

1.3.2 Composition Builder

The *Composition Builder* query used the table created by the Database Composition query to update the *Database Composition* table with the current morphing database breakdown.

1.3.3 Ethnicity_by_Site

This query totalled the number of volunteers gathered in each ethnicity from each location. The main purpose of this query was to display the best location we had found for the gathering of certain groups. An example of the Afro-Caribbean group's breakdown by location is showed as Figure 19.

Races	Location	Count
Afro-Caribbean	Holland Park Sc	24
Afro-Caribbean	Kiosk	1
Afro-Caribbean	Library	11
Afro-Caribbean	Museum	39

Figure 21: Ethnicity_by_Site query records

1.3.4 Gathered_v_Time

In order to keep track of when volunteers for each ethnic groups were primarily being gathered, we created the *Gathered_v_Time* query. This query separated the number of volunteers gathered for each ethnicity into the days in which they were gathered. Some sample records are displayed as Figure 20.

Races	Date	Volunteers
Afro-Caribbean	2/7/00	3
Afro-Caribbean	2/9/00	14
Afro-Caribbean	2/10/00	1

Figure 22: Gathered_v_Time

1.3.5 Rejected_v_Kept

The *Rejected_v_Kept* query was used to display the total of images that we chose to reject due to imperfections in the image capture. Images were rejected for such things as lighting problems, head position, and facial expressions. We chose to keep track of our rejected images because it allowed us to see how many "bad" images we captured, therefore possibly inferring something about our capture methods.

1.3.6 Volunteer_Information Query

The *Volunteer_Information* query was used to display the information from the *Volunteer_Information* table in a more readable way. Since the *Volunteer_Information* table contained mostly indices into other lookup tables, we created this query to gather the values associated with each index and display them. This query was also used as a source for some of the queries mentioned above.

1.4 Macros

The purpose of a macro is to automate a series of tasks that are performed repeatedly. Only one macro was created for the *Volunteer Information Database*.

1.4.1 Build Current Composition Macro

This macro was used to update the *Database Composition* table with the current data about the morphing database. The macro runs the *Database Breakdown* query to gather information about the current breakdown. It then runs the *Composition Builder* query to update the *Database Composition* table.

1.5 Forms

We created four forms to display and enter data. We created three of these forms as sub-forms, which means they were only accessed through another form. These forms were useful as easy methods for entering information into the database as well as displaying the current composition of the morphing database.

1.5.1 Volunteer Information

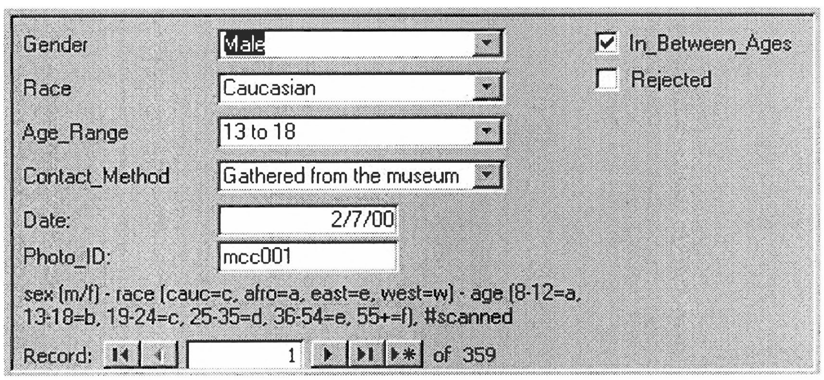
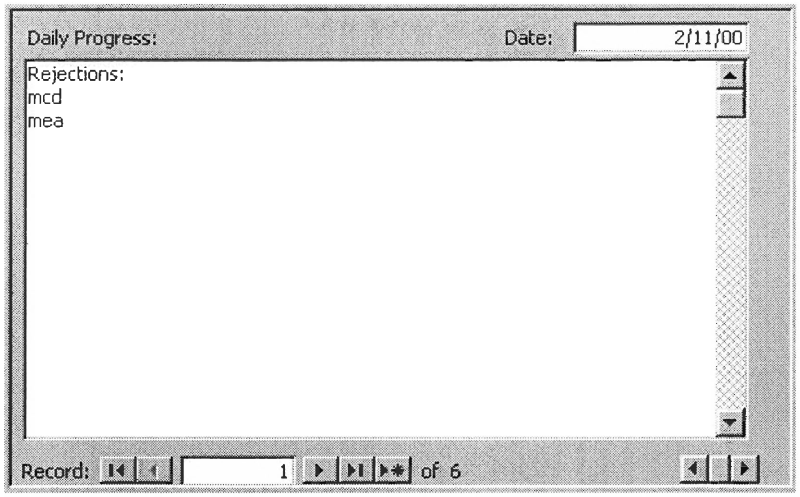


Figure 23: Volunteer Information sub-form

The *Volunteer Information* sub-form was used to enter in the information for each volunteer. Dropdown boxes were used to enter in information for the *Gender, Race, Age_Range* and *Contact_Method* fields. The *Date* field was filled automatically with the current date to save time. We entered in the text for the *Photo_ID* field manually. We used two checkboxes to show whether the volunteer fell between our desired age ranges and to denote if the volunteer's photo had been rejected. The information entered into this form is stored directly in the *Volunteer_Information* table.

1.5.2 Daily Progress Form


Daily Progress: Date: 2/11/00

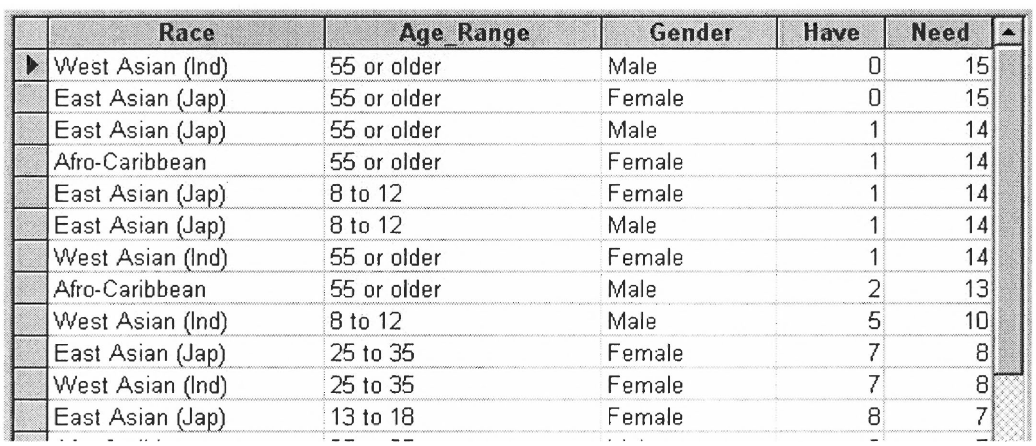
Rejections:
mcd
mea

Record: 1 of 6

Figure 24: Daily Progress Form

The *Daily Progress* form has only two input fields. The Daily Progress field was used to keep track of rejections per day. The *Date* field was automatically filled with the current date.

1.5.3 Database Composition



Race	Age_Range	Gender	Have	Need
West Asian (Ind)	55 or older	Male	0	15
East Asian (Jap)	55 or older	Female	0	15
East Asian (Jap)	55 or older	Male	1	14
Afro-Caribbean	55 or older	Female	1	14
East Asian (Jap)	8 to 12	Female	1	14
East Asian (Jap)	8 to 12	Male	1	14
West Asian (Ind)	55 or older	Female	1	14
Afro-Caribbean	55 or older	Male	2	13
West Asian (Ind)	8 to 12	Male	5	10
East Asian (Jap)	25 to 35	Female	7	8
West Asian (Ind)	25 to 35	Female	7	8
East Asian (Jap)	13 to 18	Female	8	7

Figure 25: Database Composition Form

The *Database Composition* form was a simple spreadsheet view for the information contained in the *Database Composition* table. The information from the table could be organised easily by sorting the information in one of the fields. For example, the *Need* column could be sorted so the groups that we needed the most would be displayed at the top of the list. This proved to be very useful in determining which groups we needed to target for more volunteers.

1.6 Main Form

The *Main Form* arranged each of the above three forms in one window. A picture of the form was not included because of the size of the image. The *Main Form* allowed us to view all pertinent information at one time. A single button was also included on the *Main Form* that, when clicked, would run the *Build Current Composition* macro and update the *Database Composition* sub-form.