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Images in Electronic Performance Support Systems (EPSS): An Eye Tracking Study

Niyati N. Bedekar

Images in Electronic Performance Support Systems (EPSS): An Eye Tracking Study

By

Niyati N. Bedekar

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Information Technology

Rochester Institute of Technology

B. Thomas Golisano College
of
Computing and Information Sciences

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Thesis Approval Form

Student Name: Niyati Bedekar

Thesis Title: Images in Electronic Performance Support Systems (EPSS): An Eye Tracking Study

Thesis Committee

Name	Signature	Date
Evelyn Rozanski Chair	Evelyn Rozanski	
Anne Haake Committee Member	Anne Haake	
Keith Karn Committee Member	Keith Karn	

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Abstract

Current forms of online help are increasingly making use of images (graphical illustrations or photographs), along with textual instructions to effectively assist users in performing a specific task. Users typically want to accomplish tasks quickly and devote limited attention to help systems. Hence, it is essential that these images facilitate efficient understanding of the task at hand and complement the instructions well. The first goal of the project was to create quick and inexpensive images that work better than or as well as existing graphical illustrations. The second goal was to conduct a usability test with eye tracking to compare guidance of visual attention by three types of images: graphic illustrations, digital photographs and modified digital photographs. During the test, other key measures like success rates and time on task were also measured. Subjective preferences for the three types of images were also evaluated.

Results indicated that the modified photographs performed better in guiding the visual attention of users to the relevant areas of the image than the other two image types. Though not statistically significant, the trend showed that task completion times for tasks with the modified photographs were shorter than those with the other image types (i.e., tasks with modified photographs were quicker than those with other image types). Subjective ratings indicated that participants preferred photographs and modified photographs to the existing graphical illustrations.

Acknowledgements

I would firstly like to thank my committee members, Dr. Evelyn Rozanski, Dr. Anne Haake and Dr. Keith Karn for their continued support and guidance during this project, and for providing me an opportunity to work in the exciting field of eye tracking.

I would also like to thank Dr. Robert Parody for his unending help in the statistical analysis done for the study.

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A special note of thanks goes to the faculty, staff and students of the CASCI Lab for letting me borrow the coffee maker (sometimes during peak hours) and the vacuum cleaner used in this study.

I am deeply grateful to my friends and family for their support and enthusiasm.

My greatest thanks to my parents for endlessly supporting me in what I did and always encouraging me to strive for the best. Aai-Baba, thank you for everything.

Last but not the least, I would like to thank my fiancé, Shrikant for his keen interest in the project and for standing by me through all the temperamental mood-swings I had during the course of the study.

Thank you all,

- Niyati Bedekar

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Chapter 1 – Introduction

Electronic Performance Support Systems (EPSS) are systems that provide training to improve performance. It is a kind of help referenced while performing a task. Examples include help accessed when assembling a new product, working with a new software application or troubleshooting a product. Earlier, performance support systems were paper-based and largely textual in nature. Over time, the medium changed from paper to the electronic format, however the systems remained text-based. Research has shown that such form of textual help is generally ineffective and tends to hinder rather than help the user's performance of tasks (Carroll & Mazur, 1986; Cohill & Willages, 1985; Dunsmore, 1980; Sellen & Nicol, 1990). Today, images are an essential part of any help system. Electronic forms of help systems (PDFs or HTML pages) are a mix of text and images. To consider an example of EPSS, Figure 1.1 shows a snapshot of an HTML-based EPSS for an HP inkjet multifunction office machine and Figure 1.2 shows an example of a PDF-based EPSS for the DirtDevil vacuum cleaner.

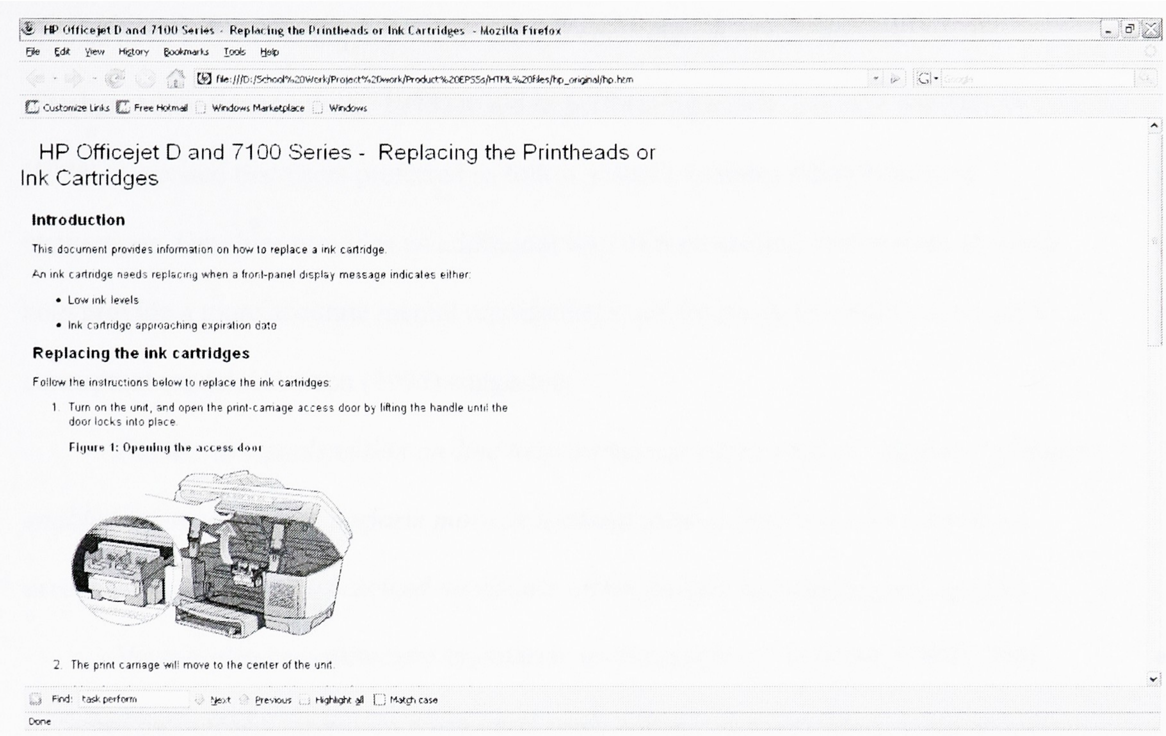


Figure 1.1 Snapshot of an HTML-based EPSS for an HP inkjet multifunction office machine

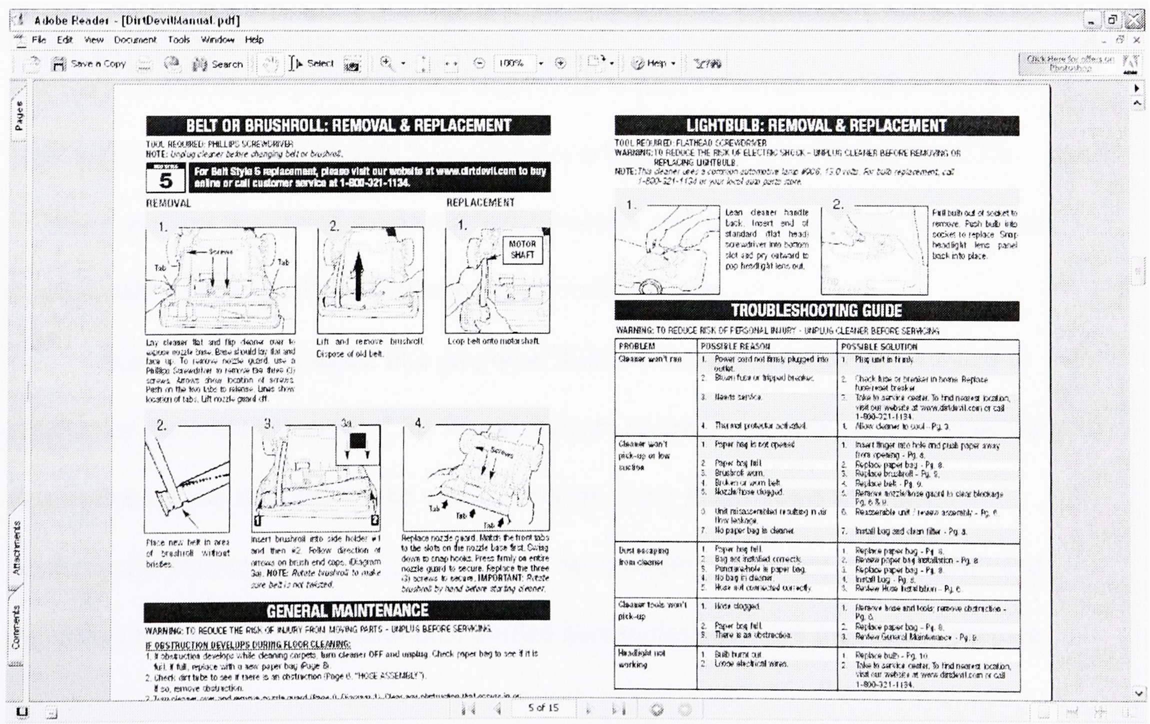


Figure 1.2 Snapshot of a PDF-based EPSS for a DirtDevil vacuum cleaner

Studies have shown the importance of using a combination of text and still image (Fischer, 1996; Spangenberg, 1973) to aid in performing a task. LeFevre and Dixon (1986) suggested that users preferred to follow visual examples rather than read instructions. Graphics provides an additional way of representing information and they help provide a more accurate mental representation of the procedure within the user's conceptual model. Harrison (1995) suggested:

The use of visuals within on-line help instructions for computer-based procedures enabled adult subjects to perform more procedural steps in less time and with fewer errors than subjects who received no visuals within on-line help instructions (p. 89).

Visuals also help eliminate orientation problems (Stone & Glock, 1981). This becomes particularly important when users work with physical products. Badgett and Sandler (1989) concluded that one remembers pictures more than words and thus, introducing graphics in any documentation may increase the likelihood of retention by the users. A still image provides great support for textual information. However, it is important to use images relevant to tasks under consideration. Faraday and Sutcliffe (1998) suggested the use of 'contact points,' features embedded in the text to help users easily locate relevant information in a corresponding image.

Some forms of images, like graphical illustrations, are specifically intended to emphasize the essential areas of the image relevant to the task at hand while suppressing details that should not distract the user's attention. Such illustrations are more aesthetically pleasing and may guide the user more clearly. However, it is difficult and expensive to design such illustrations. Skilled human designers are required to prepare

such illustrations and hence the process of making effective illustrations becomes extremely labor-intensive and time-consuming.

Since digital photographs are cheaper to produce than hand-drawn illustrations, some development teams use photographs rather than illustrations. The drawback of using photographs is that extraneous detail may distract the user from the most relevant parts of the image. For this study we considered another alternative: photographs, modified in some way to help focus the user's attention to the essential parts of the image. The aims of this project were to create such modified photographs, based on proven principles of human visual attention and compare the performance of these modified photographs to both existing graphical illustrations and unmodified photographs using eye tracking methods. More specifically, the objective focuses on learning whether modified photographs better direct visual attention to task-relevant parts of the image and lead to better task performance.

Chapter 2 – Background

Current theories of visual perception hold that two types of mechanisms guide the human visual attention: bottom-up and top-down. The bottom-up mechanism is stimulus driven – attention is involuntarily directed to the salient features of an image that pop out (e.g., a bright spot against a dark background or a spot of red against a background of green). The top-down mechanism is goal driven – attention is voluntarily directed to objects of importance to the observer based on a task (e.g., when looking for a set of car keys, a person looks in places he or she last remembers placing them). Both bottom-up and top-down processes are thought to influence eye movements simultaneously though some believe that top-down processes provide greater influence (Chen & Zelinsky, 2006). Visual attention helps us focus on relevant information quickly and efficiently. Eye movements play an important role in our understanding of human visual attention. At a higher level, eye movements can be described as a combination of *fixations* and *saccades*. Fixations occur when the eye rests on a spatial location in a scene, typically over a minimum duration of 100-200mS (Jacob & Karn, 2002). To re-orient to other locations of interest in the scene, the eye makes rapid movements called *saccades*. Monitoring eye movements during a task can give us a better insight into the cognitive processes taking place in the observer's mind. Though eye movements cannot completely explain the cognitive processes, they generally indicate where visual attention is directed.

2.1 Eye Movements and Images

Buswell (1935) provided the first detailed analysis of eye movements while viewing a picture. In the study consisting of 255 people, Buswell observed that people showed two types of eye movement behavior – a general survey of the image and a more detailed inspection of smaller regions in the image. He also observed that people tend to focus their attention on foreground objects like faces than the background objects. Babcock, Pelz and Fairchild (2003) also corroborated this when they observed that people focused attention towards faces and more semantic features of an image.

Yarbus (1967) concluded that eyes were directed to regions that were most "*useful or essential*" to perception. He also showed that eye movements greatly varied between free viewing of an image and when people were asked to perform tasks on the image.

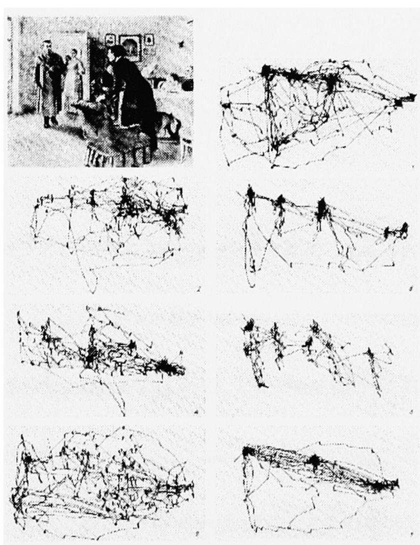


Figure 2.1 Eye Movements for the same subject viewing an image entitled "An Unexpected Visitor" by I.E. Repin. Note that the pattern of eye movement is task dependent.

Figure 2.1 illustrates the eye movements of the same subject viewing I.E. Repin's "The Unexpected Visitor." As indicated in Figure 2.1, eye movements for the subject greatly varied between free-viewing of the image and when he/she was given specific tasks with the image. In general, when the subjects were asked specific questions about the image, the eyes concentrated on areas of the image most relevant to the question (e.g., when asked to guess the ages of the people in the picture, the eyes focused on the faces of the people in the image).

Following this, Mackworth and Morandi (1967) showed that observers were likely to fixate on the most informative regions in an image within the first two seconds of viewing, implying that initial exposure from the periphery provides enough information to focus on the most informative regions of an image early on. Henderson and Hollingworth (1998) showed that fixations to a particular part of the image are guided due to *semantic informativeness* of that region rather than the structural information inhenrent in the image.

2.2 Images and EPSS

The aim of an Electronic Performance Support System (EPSS) is to aid users in performing their tasks easily and efficiently while also increasing productivity. Images become a very essential part of such a system. Booher (1975) concluded that images are appealing as they are relatively easy to process and large amounts of information can be conveyed in a small space. Thus, using images reduced cognitive load and improved retention. Stone and Glock (1981) studied assembly tasks and found that introducing images along with text greatly decreased errors among participants. When performing

tasks with products, it is essential that users who are new to the product orient themselves correctly while using the product and perform the task effectively as well as efficiently. Meij and Gellevij (2004) suggested that every task in a procedure should be broken into sub-tasks or goals and there should be a logical connectivity between images and the corresponding text. Faraday and Sutcliffe (1998) suggested the use of *contact points* between the text and images so as to direct the attention of the user to the part in the image most relevant to the current textual instruction.

Glenberg and Langston (1992) concluded that when appropriate graphics accompany text, users mentally represent the procedure by combining the two media. This study promoted the use of images with text in procedural instructions since images helped build mental models among users. Yoon and Narayanan (2004) performed an eye tracking study with 90 subjects solving two problems, one with a diagram associated with the text, the other with a blank display. The results showed that 42% of the subjects scanned the display to visually solve the problem thus showing that information displays that align themselves to the user's attention pattern are likely to result in better task performance.

Images are useful only when they are meaningful and relevant to the text and task being performed. Cater, Chalmers and Ward (2003) observed that users exhibit *inattentional blindness* (i.e., they focus on only task-related objects in an image and rarely direct their attention to other irrelevant semantic features in the image). They built a rendering method that reduces the quality of the image in parts unrelated to their assigned task so that the users are directed only to the relevant areas. Since the human eye processes detailed information from a relatively small part of the visual field, one can

exploit this to reduce the quality of the parts of the image that appear in the periphery without affecting the visual processing.

2.3 Motivation for the study

Graphic designers developing illustrations for product Electronic Performance Support Systems (EPSS) have the difficult task of abstracting images to emphasize or preserve some qualities while suppressing the irrelevant parts in such a way that users are directed to the most relevant and useful regions of the image. The process generally involves studying the product, working with the product, consulting with the design engineers and then developing the illustrations – hand-drawn or machine-generated, while also considering the orientation, size, etc. Since this process is not standardized, skilled designers are needed to develop illustrations and the process is extremely time-consuming and labor intensive. The motivation for this study was a desire to address a graphic design problem for the Xerox Industrial Design / Human Interface Department (Rochester, NY). The problem was to determine if images developed with a lower cost method could direct users to the most relevant areas of the image as well as hand-drawn illustrations.

Displaying computationally intensive graphics like flight simulators or scientific visualizations requires considerable rendering power. Baudisch (2003) discusses a number of rendering methods that address the demand for rendering power and display resolution by considering user's focus of attention. These displays also called *attentive displays* are designed to expend computational resources where its needed the most and focus only on the essential elements of any display. Since a user can attend to a relatively

small part of a display at a time, the display is rendered to enhance detail in that area while suppressing extraneous detail. Gaze-contingent displays (Reingold, Loschky, McConkie & Stampe, 2002) apply blurring to reduce the details in irrelevant parts of an image. We considered such a method of blurring to help reduce unrelated details in our modified photographs. After careful review, we decided against it since such an image is likely to cause confusion among users due to orientation problems when using products since that information will be lost due to blurring. Gooch, Sloan, Gooch, Shirley and Riesenfeld (1999) developed a computer-based non-photorealistic (NPR) system that produces interactive technical illustrations that build on established principles in traditional art as well as geometric modeling. This system takes into consideration shadows and lighting to emphasize specific regions in the image. Agrawala et al. (2003) developed a system that provides tools for building effective assembly instructions. The system consists of a *planner* that searches for assembly sequences and a *presenter* that renders a diagram for each step of the sequence. However, computer-generated renderings or automatic methods to create rendering affect an image globally. There is some manual intervention required to detail areas of potential importance to the observer. Santella and DeCarlo (2002) developed a non-photorealistic rendering (NPR) system based on human visual perception driven by eye tracking data. The subject is asked to look at a photograph for a given amount of time. The fixation data collected during eye tracking is fed to the system and a *painterly* rendering is developed emphasizing the areas that received more fixations while removing details from the areas that received little or no attention at all. Thus the resulting image best describes the regions of interest according to the observer. Another system (DeCarlo & Santella, 2002) creates a

rendering based on line drawing and uniform regions of color. However, such systems are not suitable for EPSS images since the resulting image is more like a painting with larger brush strokes resulting in the deletion of some vital product details in the image needed by users as references during tasks. In addition, computer generated rendering is still in a developing phase and such systems tend to require computationally intensive resources.

Artists have long used luminance and highlighting as a way to direct the viewer's attention towards the regions of interest. In this way, the artist reduces the scene to the most essential elements thus reducing cognitive demand while also aiding understanding of the image. This was supported in an eye tracking study by Wooding (2002). The study showed that the subjects directed their attention only on the two main characters in the image (see Figure 2.2) while the remainder of the image was left largely unnoticed (see the inset).

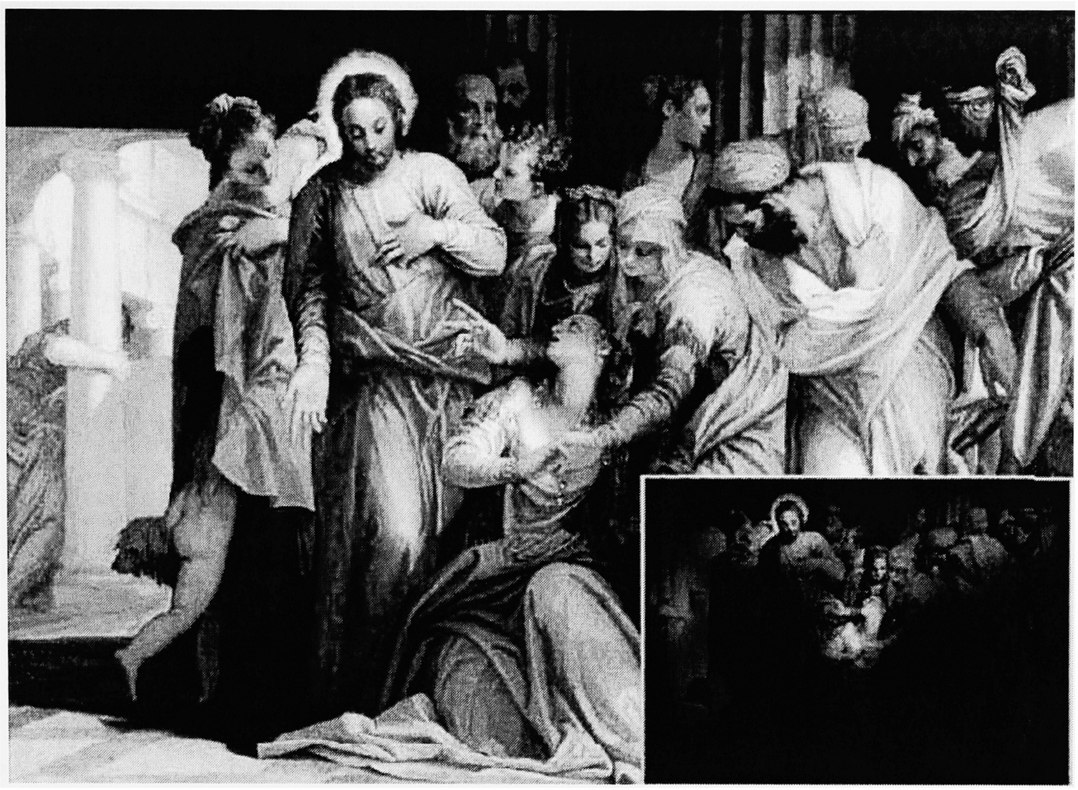


Figure 2.2 Aggregated eye fixations from 131 subjects viewing Paolo Veronese's Christ addressing a Kneeling Woman

2.4 Aim of the study

In previous studies, highlighting was used to emphasize the areas of interest for tasks involving image viewing alone. Our study takes this notion further to address the issues when tasks are involved, not directly with the image (e.g., count the number of red balls in the image) but tasks involving the interaction with products while using images for reference (e.g., product assembly, product maintenance, etc.). The aims of the study are twofold:

1) Create quick and inexpensive graphics such that they do the job (direct attention to relevant parts of the image) better than or as well as existing

graphical illustrations. Since digital images are cheaper to produce, it is natural to modify the digital photograph to enhance the task-relevant regions in the image while suppressing the irrelevant parts without negatively affecting the overall comprehension of the image.

2) Use eye tracking to compare user performance while using three types of images – the existing illustration in current EPSSs, a digital photograph (that will serve as a baseline), and the modified photograph created during the first phase.

The following chapters will discuss the methodology used in the study, the eye tracking instrument, the testing environment, observations, conclusions drawn from the study and future considerations.

Chapter 3 – Current Project Introduction

3.1 Problem Statement

Companies that produce Electronic Performance Support Systems (EPSS) are concerned with time and expenses required to create hand-drawn illustrations. To that effect, this study is tries to address this issue with the following goals:

1) Reduce the time required to create images such that the resulting images work as well as or better than existing graphical illustrations.
2) Utilize eye tracking to compare task performance while using three types of images: existing graphical illustration, original photograph and modified photograph.

3.2 Product and Image Types

3.2.1 Products

Six products were chosen that had existing EPSSs including both text and graphical illustrations . We chose products that would be novel enough that the user would likely need need to reference the EPSS to complete specific tasks with these products. The participants performed real tasks, interacting with each product while using the EPSS associated with the product. The six products used were:

1) HP OfficeJet D135 Inkjet Multifunction Office Machine - print, copy, scan and fax (see Figure 3.1)

Figure 3.1 HP Inkjet Multifunction Office Machine

2) DirtDevil Jaguar Vacuum Cleaner (see Figure 3.2)

Figure 3.2 DirtDevil Vacuum Cleaner

3) iRobot Roomba Discover Automatic Robotic Vacuum Cleaner (see Figure 3.3)

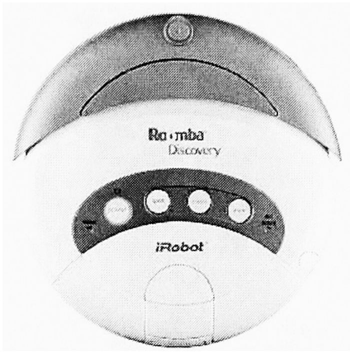


Figure 3.3 Roomba Robotic Vacuum Cleaner

4) Epson 82c Projector (see Figure 3.4)

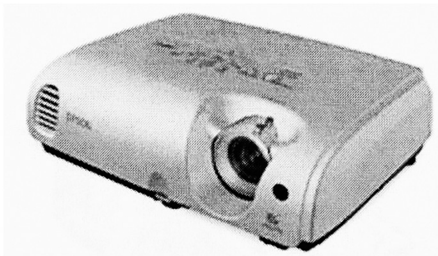


Figure 3.4 Epson 82c Projector

5) Braun Tassimo Coffee Maker (see Figure 3.5)

Figure 3.5 Braun Tassimo Coffee Maker

6) Xerox M750 Inkjet Printer (see Figure 3.6)

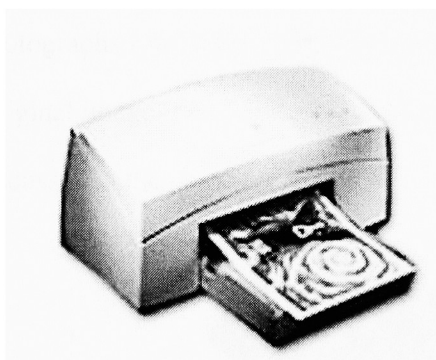


Figure 3.6 Xerox M750 Inkjet Printer

3.2.2 Types of Images

Three types of images were used in the study:

1) **Existing Illustration:** A hand-drawn or machine-generated graphical illustration with task-relevant parts of the image highlighted using color differences or arrows with or without labels (see Figure 3.7a).

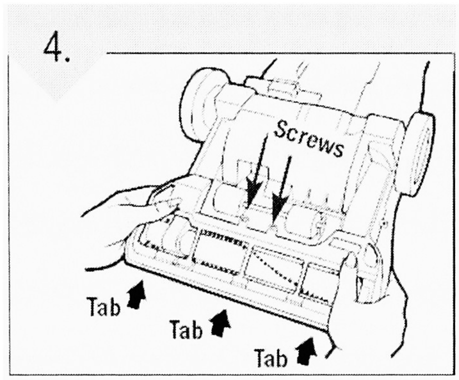


Figure 3.7a Example for Existing Illustration (DirtDevil vacuum)

2) **Photograph:** Digital photograph with no additional highlighting of relevant details. These photographs were taken from view point resembling as closely as possible to the original image (See Figure 3.7b). Some considerations for arrows and labels are discussed in the next section.

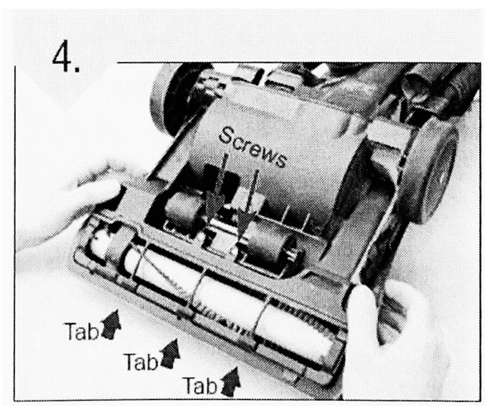


Figure 3.7b Example for Photograph (DirtDevil vacuum)

3) **Modified Photograph:** Modified digital photograph using a spotlighting effect to highlight the most relevant parts of the image (parts of the image most likely to help the user to perform the task) and darkening the areas irrelevant to the task. For example, in Figure 3.7c, the step requires replacing the screws, inserting the guard in the lower three tabs and then pressing the side tabs to secure it. Only these areas are highlighted as they are relevant to the user while darkening (but not completely eliminating) the irrelevant parts of the image, since they can be referenced by the users for product orientation. More recently, Holman, Vertegaal, Sohn and Cheng (2004) used such a technique for a concept called *attentive art*. They used a Gaussian luminance filter to highlight the areas of interest based on the observer's eye tracking data and darkening the irrelevant parts. The software continuously processes the image increasing the luminance over areas that receive more fixations while fading away parts that receive little or no attention.

All the images were created using Adobe Photoshop CS2 by overlaying partially transparent (Alpha=0.5) circular gradient (Gaussian filter) layers over the relevant parts of the unmodified digital photograph.

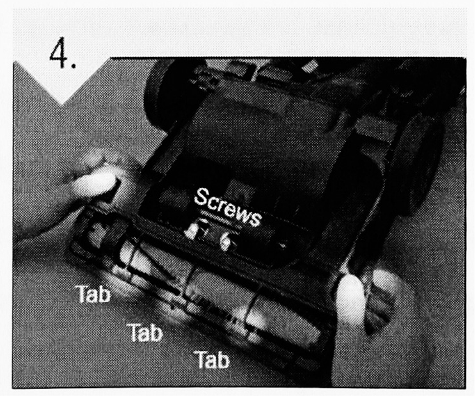


Figure 3.7c Example for Modified Photograph (DirtDevil vacuum)

Considerations:

The following points were taken into consideration when the photograph and modified photographs were developed:

1) The size and orientation would remain the same as in the original illustration.
2) Arrows were used in both photographs and modified photographs only if they were used in the existing illustration to indicate movement.
3) If arrows were used to highlight details in the existing illustration, such arrows were replicated in the photograph only if labels accompanied them. Arrows without labels and that did not show movement were not replicated in the photographs.

   For the modified photograph, the spotlighting technique was used to highlight relevant regions of the image if the original illustrations made use of color cues to highlight task-relevant details. In cases where the original illustration made use of arrows to detail relevant areas, the modified photograph replaced the arrows with the *spotlight* and replicated labels only if present in the original illustration. One reason to eliminate such detailing arrows in modified photographs was that this would reduce the overall noise in the image and reduce the cognitive burden to process the arrows and then direct attention to the object pointed to by the arrow.
4) If the original illustration consisted of a blow-out diagram to zoom into the details, this was not considered when developing the other image types. One reason was that the aim of the study was to examine if inexpensive graphics did

an equal or better job than the original illustration without expending too much time developing these images.

3.2.3 The Performance Support Systems

The existing Electronic Performance Support Systems (EPSS) help documentation consisted of a mix of text and images. Two of them were HTML pages (HP Printer and Braun Tassimo Coffee Maker) while others were PDF manuals (DirtDevil Vacuum, Roomba Vacuum, Epson Projector and Xerox Printer). For the existing HTML pages, original illustrations were replaced by photographs to create one version and by modified photographs to create the second.

For the PDF manuals, they were converted to HTML pages. The PDFs were first converted to a PNG image and this image was embedded in an HTML page. In this case too, two more versions were developed, one with photographs and the other with modified photographs. In all, for every product, three versions of EPSSs were developed. The only difference between the three versions was the type of images used (i.e., illustrations were replaced by the photograph or the modified photograph) as shown in Figure 3.8. Thus, the entire document structure as a whole remained consistent across all the three treatments and only the image types changed accordingly.

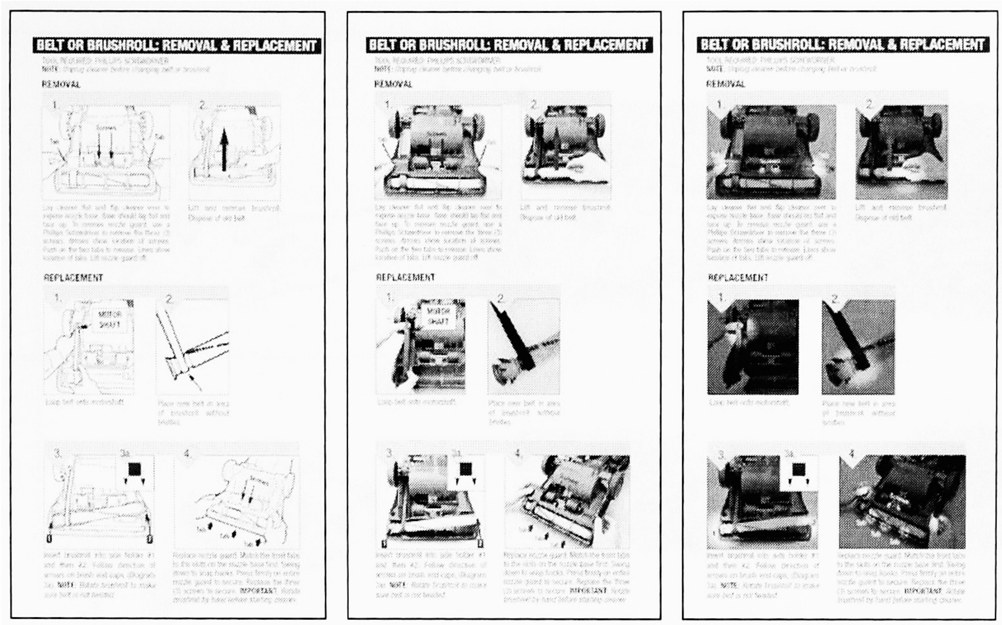
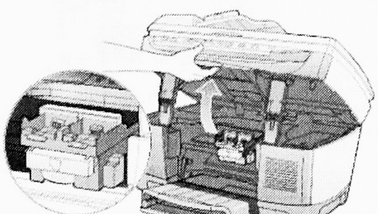
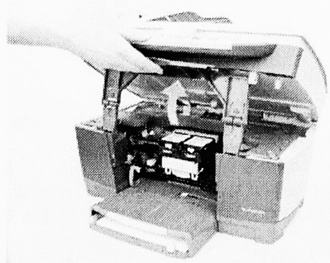
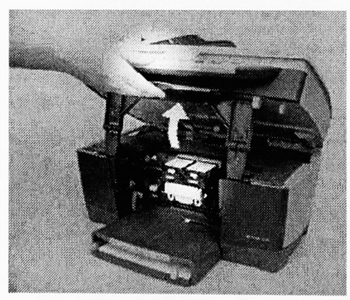
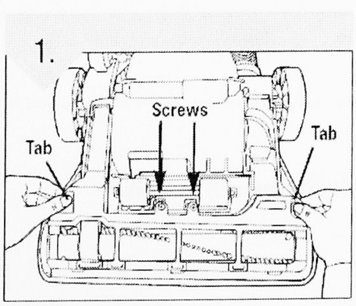
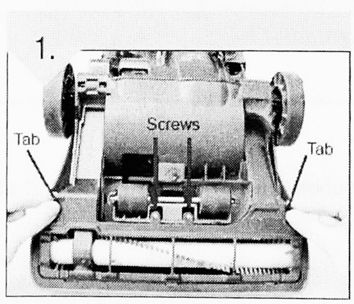
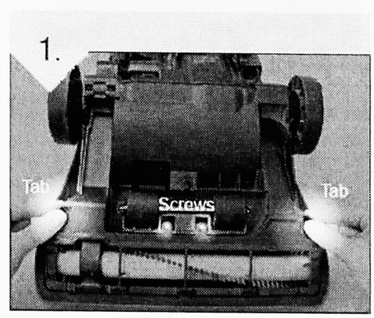


Figure 3.8 The three types of images in the context of a given product EPSS (DirtDevil vacuum)

Table 3.1 shows examples of the three types of images for all six products:

Product	**Existing Illustration**	**Photograph**	**Modified Photograph**
HP Inkjet Multifunction Office Machine			
DirtDevil Vacuum Cleaner			

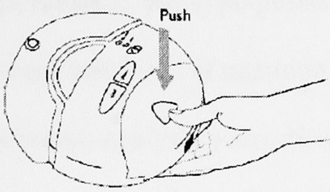
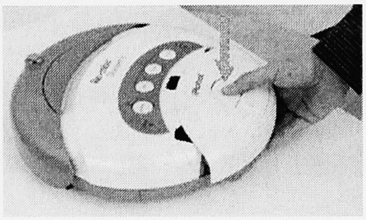
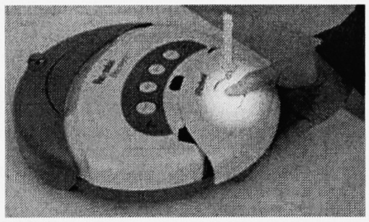
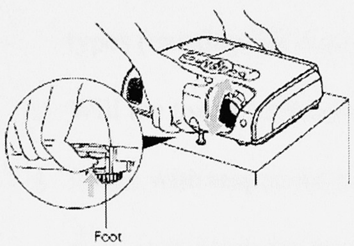
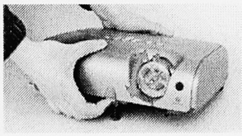
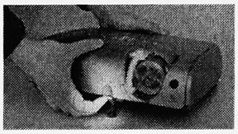
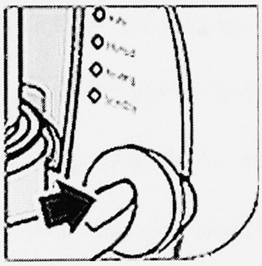
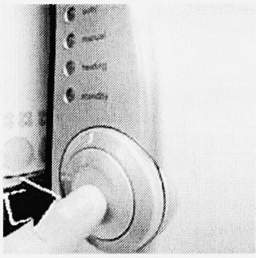
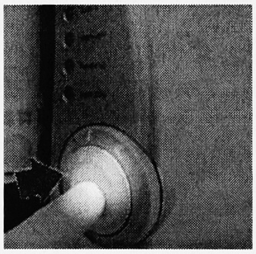
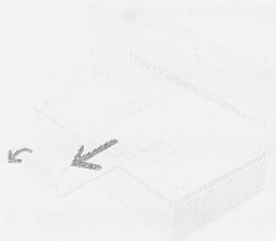
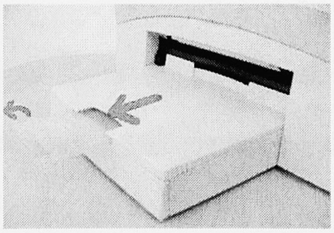
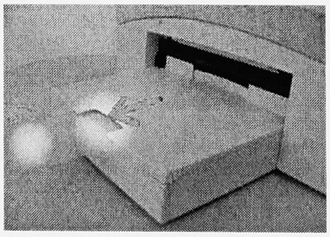
Roomba Vacuum			
Epson Projector			
Braun Coffee Maker			
Xerox Inkjet Printer			

Table 3.1 Example for the three types of images for all six products

3.3 Hypotheses

- **Hypothesis 1**: We hypothesize that with the modified photograph, there would be an improved focus of attention to the relevant parts of image. To help evaluate our hypothesis, analysis were planned to answer the following questions:
  - Will the user spend more time looking at the task-relevant regions of an image for the modified photograph as compared to the other two image types (existing illustration and original photograph)?
  - Will the user spend more time looking at the task-relevant regions of an image with respect to the time spent on instructions as a whole and total time on the task for the modified photograph as compared to the other two image types (existing illustration and original photograph)?
- **Hypothesis 2**: We also hypothesize that with the modified photograph, the task performance would be improved. To help evaluate our hypothesis, analysis were planned to answer the following questions:
  - Will users be more likely to succeed for tasks with the modified photograph as compared to the other two image types (existing illustration and original photograph)?
  - Will the time to complete the task successfully be less for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

3.4 Methods

3.4.1 Participants

Eighteen adults (aged 18-50; nine male, nine female) were recruited through a flyer advertisement posted at the Rochester Institute of Technology (RIT) campus. Through the advertisement, users were asked to fill out an online screener survey. Users were screened for normal vision. People with hard contact lenses and thick glasses were not considered due to the limitations of the eye tracker. None of these participants had any experience working with the products used in this study, though some had experience working with similar products. Out of the 18 participants, 16 were students from various departments of RIT; two were employees of RIT while one was a professional not directly affiliated to the school. Each participant was given a financial honorarium of $15 for participating in the study.

3.4.2 Apparatus and Testing Environment

The study was conducted in the Eye Tracking Laboratory of the Rochester Institute of Technology's Laboratory for Computer-Human Interaction and Performance Support (CHIPS). The testing room contained the administrator's computer and video monitors and recorder (Figure 3.9) and the participant computer with adjustable chairs. The Applied Science Laboratories Model 501 head mounted eye tracker (Figure 3.10) was used in this study. The main components include the head mounted optics that consists of the LED illuminator, a miniature video camera and a beam splitter. An external infrared reflective mirror is positioned in front of the participant's left eye and this reflects the eye image back to the camera. A second camera called the direct scene camera is situated in

front of the headband to record the scene from the user's perspective. The eye and scene video-out from the ASL control unit was piped through a picture-in-picture video mixer so that the eye image can be superimposed on the scene image. This resulting video was recorded on miniDV tapes that were later digitized and encoded manually using *RITCode*, an open source program written in Objective C by Scott Lawrence of RIT's Center for Imaging Science. Since the study did not investigate low-level dynamics of eye movements, the field averaging (number of 60 Hz video frames averaged when computing eye position) was set to 12 to reduce the influence of system noise in the computed eye position values.

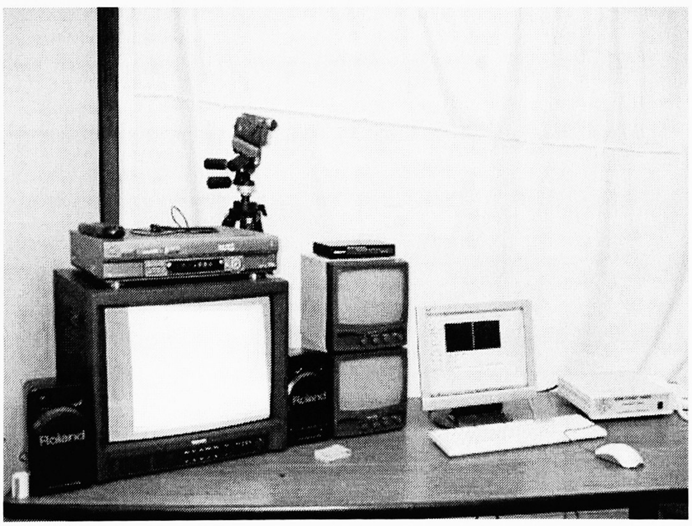


Figure 3.9 Administrator Table in the Eye Tracking Lab

Figure 3.10 ASL 501 Head Mounted Eye Tracker

3.5 Measures

3.5.1 Independent and Dependent Variables

Image type (existing illustration [EI], original photograph [P], modified photograph [MP]) was the independent variable. In each of the following measures, the areas of interest (AOI) mean the areas of the image most relevant to the textual instruction under consideration. For example, the circles in Figure 3.11 indicate the AOIs for the different image types. Since the decision to spotlight an area depended on the task as well as the regions highlighted in the existing illustration, the spotlight was applied to relevant regions of an untouched photograph first to create the modified photograph. Keeping this modified photograph as reference, the AOIs for the illustrations and photographs were marked based on this spotlighted area of the modified image. Since the spotlight had variable radii, the AOIs were marked accordingly. Thus, all three images for a particular task generally had identical areas of interest.

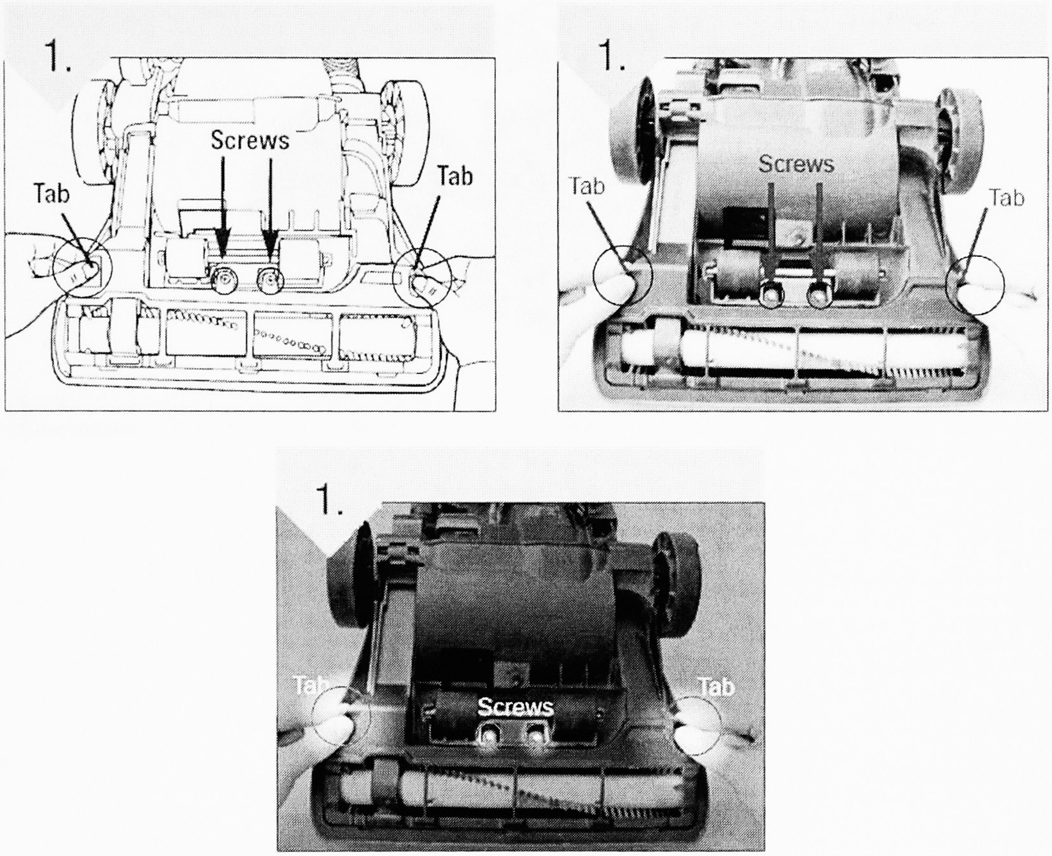


Figure 3.11 Circles indicating the Areas of interest (AOI) in all the three image types. The circles shown here are used only as a means to illustrate the definition of AOI and were not included in the actual study.

One exception to this definition of AOIs is blow-out diagrams (see Figure 3.12) in existing illustrations, which were also included as a part of the AOI. This resulted in a larger AOI for the existing illustration (see Figure 3.12) than the corresponding photograph (see figure 3.13) and modified photograph (see Figure 3.14) in 10% (3 out of 29 images) cases where blow-outs were included in the illustration. Please note that the red circles are used as a means to illustrate the difference in the AOI sizes and were not used in the actual study.

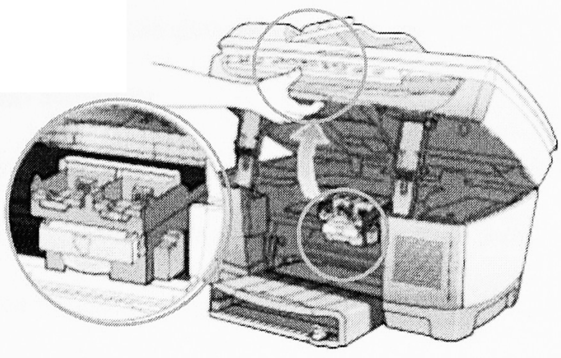


Figure 3.12 Example of a blow-out diagram in the existing illustration (EI) of the HP inkjet multifunction office machine. The red circles indicate the areas of interest

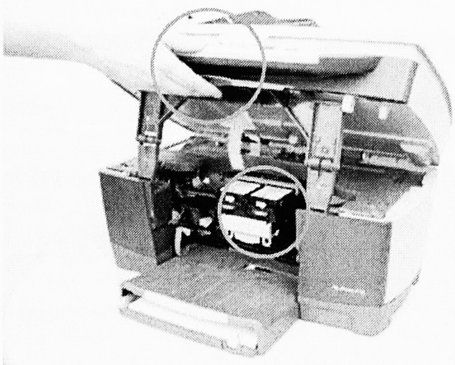


Figure 3.13 AOIs as indicated by the red circles in a photograph (P) of the HP inkjet multifunction office machine

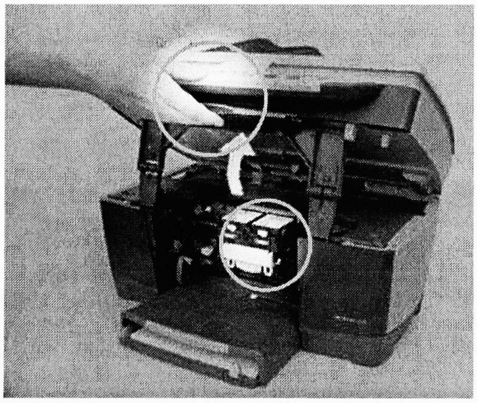


Figure 3.14 AOIs as indicated by the red circles in a modified photograph (MP) of the HP inkjet multifunction office machine

The dependent variables were categorized into three groups:

1) Measures of visual attention

To understand how eye tracking data is useful, it is important to know what the data looks like and how it is analyzed. Since eye movements are a mix of fixations and saccades, the common pattern to look at something is to scan a number of different features and then return to the ones that were most relevant or interesting. When the area of interest (AOI) is known in advance, the aggregated time spent in the AOI becomes a useful measure (Salvucci & Anderson, 1991). For the following measures, the time spent on any specific area is the aggregated time spent on that area over the entire task. For example, an image can contain multiple AOIs and a given EPSS can contain multiple images. Thus, the time spent on the AOIs for a task is the cumulative time spent on the AOIs of all the images in the EPSS. For example, in Figure 3.14, the time spent on the AOIs would equal the time spent by the user in both circles.

The following terms define what we mean by time spent in different areas of the screen or on the task as a whole:

Time spent in AOIs: This is the cumulative time spent on the AOIs of all the images for the given EPSS.

Time spent on the image: This is the cumulative time spent on all the images for the given EPSS (time spent in AOIs of images + time spent on areas of images other than AOIs).

Time spent on the task: Total time spent on the task. The task began when the HTML page for the EPSS was opened. It ended when the participant believed the task was completed and informed the administrator.

Time spent on instructions: Total time spent on the text as well as the images of a given EPSS.

The measures of visual attention were:

- Time spent in AOIs as a proportion of time spent on the image as a whole (AOI/Image)

This measure will be used to answer the question: Will the user spend more time looking at task-relevant regions of the image for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

- Time spent in AOIs as a proportion of total time spent on the task (AOI/Total Time on task)

This measure will be used to answer the question: Will the user spend more time looking at task-relevant regions of the image with respect to the total time on task for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

- Time spent in AOIs as a proportion of total time spent on instructions (AOI/Instructions)

This measure will be used to answer the question: Will the user spend more time looking at task-relevant regions of the image with respect to the total time on instructions for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

2) Measures of task performance

Measures of task performance were:

- Success rate across participants (percentage of participants succeeding on a task)

Will users be more likely to succeed for tasks with the modified photograph as compared to the other two image types (existing illustration and original photograph)?

- Time for successful task completion (total time spent on successfully completed tasks).

This measure will be used to answer the question: Will the time to complete the task successfully be less for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

3) Subjective ratings

The subjective ratings are based on the preference of the three image types as indicated by the participants based on their experience with them during the study. The participants were asked to rank order the three image types based on their preference and also provide a reason for their ranking. Though the study did not consider the correlation between the individuals' preference and performance when using a particular image type, the ratings are merely intended as an indicator of the type of the image most preferred by the participants and why.

3.5.2 Controlled Variables

The variables that we controlled were:

Learning effects

Each participant performed six tasks, one with each product. Participants were chosen based on their inexperience with the products, so learning due to prior experience was minimized. In addition, since each product along with the associated EPSSs was

significantly different from the others, learning across tasks was minimized. The task order was counter-balanced by a random assignment of tasks to the participants (Refer to Appendix A).

Style & Quality of Existing Illustration

The products were chosen such that their existing EPSS illustrations had similar styles and quality (i.e., line drawings with color highlights or labeled arrows).

3.6 Experimental Design

Each participant performed six tasks, one with each of the six products such that the participants received each of the three image types exactly twice (i.e., each participant performed 2 tasks with existing illustration, 2 tasks with original photograph and 2 tasks with modified photographs). The order in which they performed the tasks was assigned prior to the study in a random order (refer to the Appendix A for details regarding the task order and image type breakdown for each participant). Table 3.2 shows a consolidated table with the participant numbers for each product-image type cell.

	Task 1 **HP**	**Task 2** **DirtDevil**	**Task 3** **Roomba**	**Task 4** **Epson**	**Task 5** **Braun**	**Task 6** **Xerox**
Existing Graphical Illustration (EI)	7, 8, 10, 13, 15, 16	1, 6 11, 8, 14, 15	2, 3, 9, 10, 17, 18	2, 3, 4, 7,13, 16	1, 5, 12, 14, 17, 18	4 , 5, 6, 9, 11, 12
Original Photograph (P)	2, 4, 9, 11, 12, 17	2, 3, 4, 5, 10, 18	1, 6, 7, 8, 13, 15	5, 11, 12, 14, 17, 18	3, 6, 7, 8, 9, 16	1, 10, 13, 14, 15, 16
Modified Photograph (MP)	1, 3, 5, 6, 14, 18	7, 13, 9, 12, 16, 17	4, 5, 11, 12, 14, 16	1, 6, 9, 10, 8, 15	2, 4, 10, 11, 13, 15	2, 3, 7, 8, 17, 18

Table 3.2 Participant numbers distributed among product and image type cells

3.7 Procedure

Each participant completed an Informed Consent form (Appendix D-a) and then received a brief explanation of the equipment in the lab. This was followed by the eye tracking calibration procedure. The eye tracker was calibrated to a visual accuracy of 0.51 degree (arctan 0.4/45). The participant was made to sit 45 inches away from the monitor and asked to look at each of the nine different calibration targets when instructed. The targets were located in rows of three across the top, middle and bottom of the screen. Each calibration target measured 0.4 inches in radius when projected on the screen. For greater detail on the calibration screen points and layout, see Appendix D-e. The point of gaze was computed in real time and presented simultaneously on the screen along with the nine calibration checking circles. The point of gaze had to be within the 0.8 inch (1.01 degree) diameter circle when the participant fixated the center, to be considered accurate enough to move on to the next point for calibration. The participant was instructed to look at each target during calibration and if the crosshair marker (displayed as real-time feedback of the eye tracker's computation of the participants gaze) was within the 0.8 inch diameter circle on the screen, the calibration was determined to be accurate. Participant was then instructed to view the next calibration target. Once the calibration of all nine targets met the criteria, the participant was asked to look at points X and Y. Once these were confirmed for accuracy, the administrator started the recording process. The participants were free to move about after the calibration process, as needed, while interacting with the products. The six tasks were presented in a random order assigned to each participant prior to their arrival. For each task, the administrator read a short scenario (for details, refer to the Appendix D-d) and then provided the participant with an

index card with the task written on it. Participants were allowed to complete a task at their own pace and were asked to inform the administrator when they were done. The task time started when the HTML page with the given help documentation was opened and ended when the participant informed the administrator when he or she believed the task was complete. Following the last task, a post-test questionnaire was provided. At this time, the participants were also asked to rank order (1 – best, 3- worst) the three types of images preferentially based on their experience during the study.

Chapter 4 – Results and Data Analysis

4.1 Hypothesis 1

We hypothesized that with the modified photograph, there will be an improved focus of attention to the relevant parts of the image.

4.1.1 Hypothesis 1: Question 1

Will the user spend more time looking at the task-relevant regions of an image for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

Measure: *Time spent in areas of interest (AOI) as a proportion of time spent on the image as a whole (AOI/Image)*

Observation

We ran a General Linear Model ANOVA with three factors (subject: random, image type: fixed and product: fixed) and a 95 % confidence interval (alpha, $\alpha = 0.05$). There was a significant main effect of image type, $F(2,105) = 25.62, p < 0.001$. Using Tukey 95.0% Simultaneous Confidence Intervals, the pair wise comparisons indicate a statistically significant difference between existing illustration (EI) & modified photograph (MP) as well as photograph (P) & modified photograph (MP). The results indicated no statistically significant difference between the existing illustration and the unmodified photograph. Table 4.1 indicates the mean values for the three image types:

Image Type	Mean Values for AOI/Image	Standard Deviation
Existing Illustration (EI)	0.315	0.14
Original Photograph (P)	0.322	0.19
Modified Photograph (MP)	0.570	0.21

Table 4.1 Means and Standard Deviations for AOI/Image for all three image types

Figure 4.1 shows the mean proportion of time users spent looking at the areas of interest (AOIs) with respect to the entire time spent looking at the images for all the three image types.

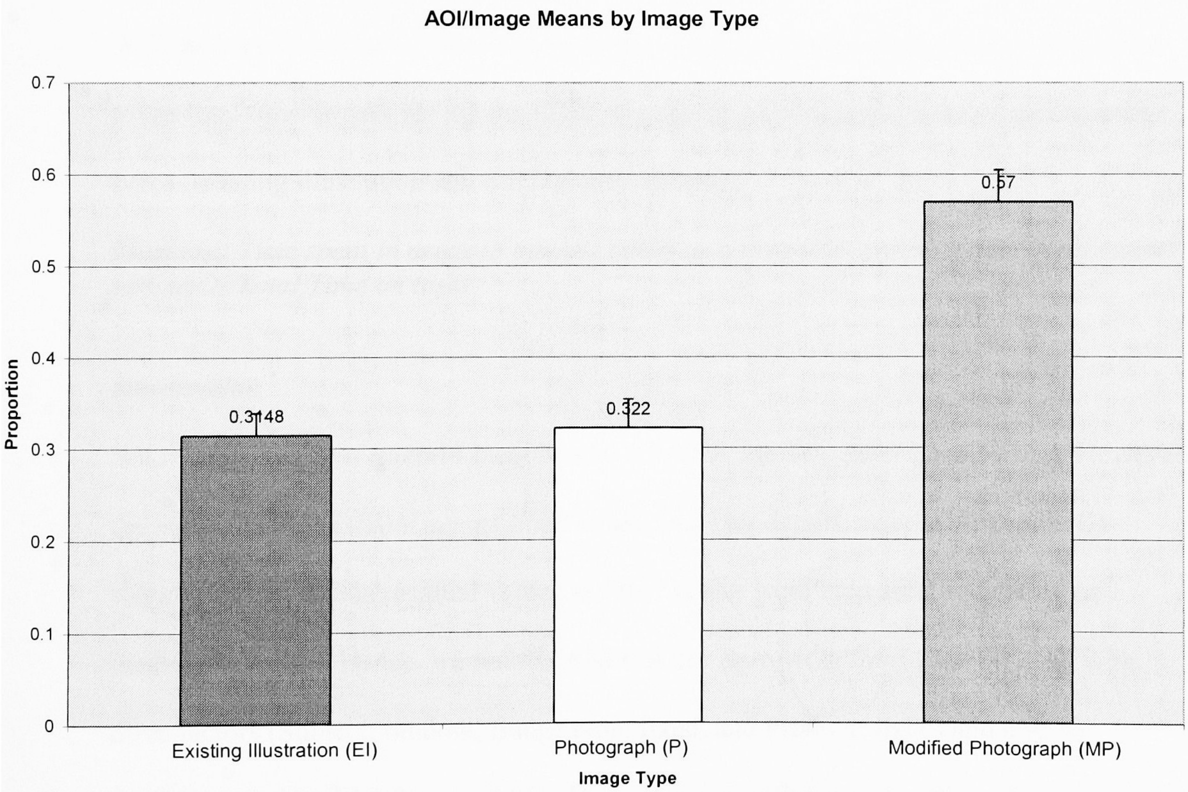


Figure 4.1 Graph showing the mean proportion of time users spent looking at the areas of interest (AOIs) with respect to the entire time spent looking at the images (AOI/Image) for all three image types

Analysis

The results indicate that participants spent almost 57% of their time on images on the relevant areas of the image in case of the modified photograph while spending only around 30% of their time on images on the relevant areas in case of the original photograph and the existing illustration (i.e. about 70% of the time on images was spent on irrelevant parts of the image in case of existing illustration and original photographs). This means that there was increased time spent on the relevant parts of an image with the modified photograph.

4.1.2 Hypothesis 1: Question 2

Will the user spend more time looking at task-relevant regions of the image with respect to the total time on task for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

Measure: *Time spent in areas of interest (AOI) as a proportion of total time spent on the task (AOI/Total Time on task)*

Observation

We initially ran the General Linear Model ANOVA for *AOI/Total Time on task.* However the *standardized residual versus fitted values plot* (for details, refer to Appendix C) showed an increase in residual values as fitted values were increased, indicating an inadequate model. Hence, we ran the ANOVA for *Sqrt (AOI/Total Time on task)* with three factors (Subject: random, Image type: fixed, and Product: fixed) and a 95 % confidence interval (alpha, $\alpha = 0.05$). There was a significant main effect of image type, $F(2,105) = 4.97$, $p = 0.009$. Using Tukey 95.0% Simultaneous Confidence Intervals, the

pair wise comparisons indicate a statistically significant difference between existing illustration (EI) & modified photograph (MP) as well as photograph (P) & modified photograph (MP). The results indicated no statistically significant difference between the existing illustration and the photograph. Table 4.2 shows the mean values for *AOI/Total Time on task* for the three image types were:

Image Type	**Mean Values for AOI/Image**	**Standard Deviation**
Existing Illustration (EI)	0.018	0.015
Original Photograph (P)	0.019	0.014
Modified Photograph (MP)	0.025	0.018

Table 4.2 Means and Standard Deviations for AOI/Total Time on task for all three image types

Figure 4.2 shows the mean time users spent looking at the areas of interest (AOIs) with respect to the total time spent on the task for all the three image types.

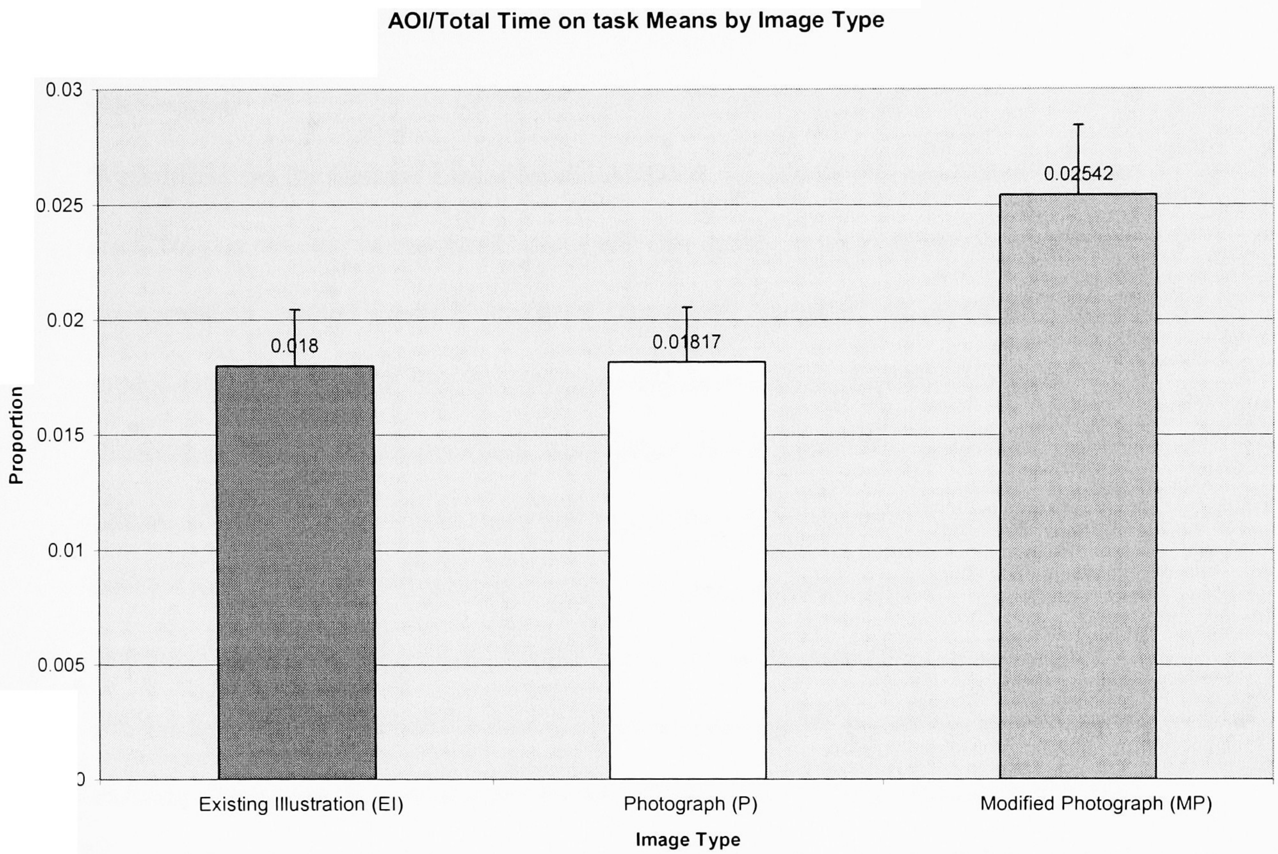


Figure 4.2 Graph showing the mean proportion of time users spent looking at the areas of interest (AOIs) with respect to the total time spent on the task (AOI/Total Time on task) for all three image types

Analysis

The results indicate that participants spent almost 2.5% of their time on the task on the relevant areas of the image in case of the modified photograph. This means that there was increased time spent on the relevant parts of an image due to the modified photograph.

4.1.3 Hypothesis 1: Question 3

Will the user spend more time looking at task-relevant regions of the image with respect to the total time on instructions for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

Measure: *Time spent in areas of interest (AOI) as a proportion of total time spent on the instructions (AOI/Instructions)*

Observation

We initially ran the General Linear Model ANOVA for *AOI/Instructions.* However the *standardized residual versus fitted values plot* (for details, refer to Appendix C) showed an increase in residual values as the fitted values were increased, indicating an inadequate model. Hence, we ran the ANOVA for *Sqrt (AOI/Instructions)* with three factors (Subject: random, Image type: fixed, and Product: fixed) and a 95 % confidence interval (alpha, $\alpha = 0.05$). There was a significant main effect of image type, $F(2,105) = 4.31$, $p = 0.017$. Using Tukey 95.0% Simultaneous Confidence Intervals, the pair wise comparisons indicate a statistically significant difference between photograph (P) & modified photograph (MP). The results indicated no statistically significant difference between the existing illustration (EI) and the photograph (P) as well as existing illustration (EI) and the modified photograph (MP). Table 4.3 indicates the mean values for *AOI/Instructions* for the three image types:

Image Type	**Mean Values for AOI/Image**	**Standard Deviation**
Existing Illustration (EI)	0.086	0.078
Original Photograph (P)	0.073	0.061
Modified Photograph (MP)	0.129	0.015

Table 4.3 Means and Standard Deviations for AOI/Instructions for all three image types

Figure 4.3 shows the mean time users spent looking at the areas of interest (AOIs) with respect to the total time spent on instructions for all the three image types.

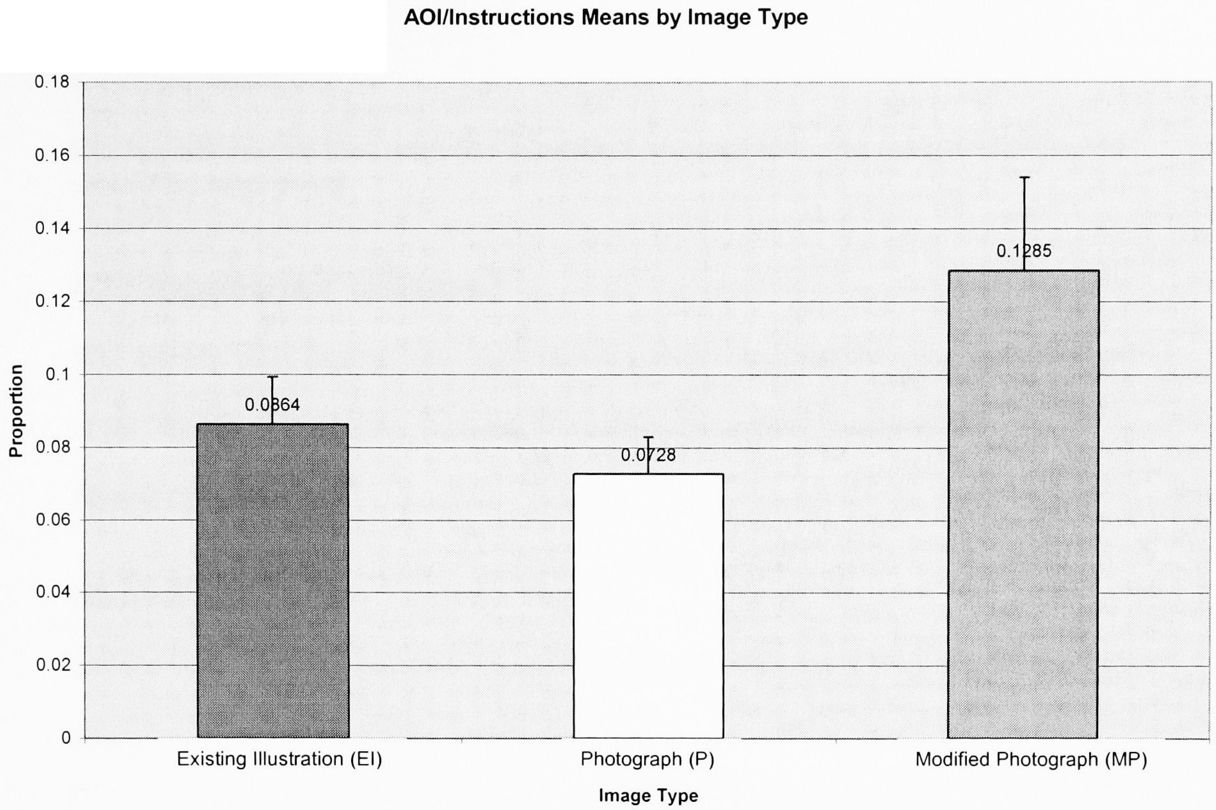


Figure 4.3 Graph showing the mean proportion of time users spent looking at the areas of interest (AOIs) with respect to the total time spent on instructions (AOI/Instructions) for all three image types

Analysis

The results indicate that participants spent almost 12.8% of their time on instructions on the relevant areas of the image in the case of the modified photograph. This means that there was increased time spent on the relevant parts of an image due to the modified photograph. Users are more likely to focus their attention on task-relevant parts of an image than other instructions in the case of modified photographs.

4.2 Hypothesis 2

We hypothesized that with the modified photograph, the task performance would be improved.

4.2.1 Hypothesis 2: Question 1

Will users be more likely to succeed for tasks with the modified photograph as compared to the other two image types (existing illustration and original photograph)?

Measure: *Success rate*

Observation

Table 4.4 indicates the success rate across participants. The rate is broken down for each product to show the variability between products.

	Task 1 **HP**	**Task 2** **DirtDevil**	**Task 3** **Roomba**	**Task 4** **Epson**	**Task 5** **Braun**	**Task 6** **Xerox**
Existing Graphical Illustration (EI)	6/6 = 1	6/6 = 1	2/6 = 0.33	4/6 = 0.66	6/6 = 1	5/6 = 0.83
Original Photograph (P)	6/6 = 1	6/6 = 1	0/6 = 0	6/6 = 1	6/6 = 1	5/6 = 0.83
Modified Photograph (MP)	6/6 = 1	6/6 = 1	1/6 = 0.16	6/6 = 1	6/6 = 1	6/6 = 1

Table 4.4 Success Rates

It is worthwhile to notice the lower success rates for the Roomba product. The problem was partly due to the feature of the product itself – the task involved the cleaning of the Roomba sensors, four of which were set in holes along the circumference of the vacuum. Most of the failures were due to the participants' inability to locate these sensors. All the six participants who worked with the unmodified photograph failed at the task since they did not find the sensors at all. This was due to the nature of the image –

arrows indicating the locations of sensors were used in the existing illustration without labels. These were not included in the photograph. The three successes for the Roomba product, two with existing illustration (EI) and one with modified photograph (MP) were apparently supported by the means to highlight relevant detail in these image treatments.

Since each of the 18 participants interacted with each image type twice, the total for the image type was 36 (18*2). Modified photographs had the most successes with 31 (success rate = 86.1%), while the existing illustrations (EI) and photographs (P) each had 29 successes out of 36 (success rate = 80.5%). There was no statistically significant difference among the image types.

4.2.2 Hypothesis 2: Question 2

Will the time to compete the task successfully be less for the modified photograph as compared to the other two image types (existing illustration and original photograph)?

Measure: *Mean times on task for the three image types across all six products*

Observation

For this metric, only time for successful tasks was considered since unsuccessful task times are not meaningful. In all of the measures of visual attention, success was not considered since the measures were a proportion and thus the numerator was relative to the denominator. Figure 4.4 indicates the mean times on successful tasks by product and image type.

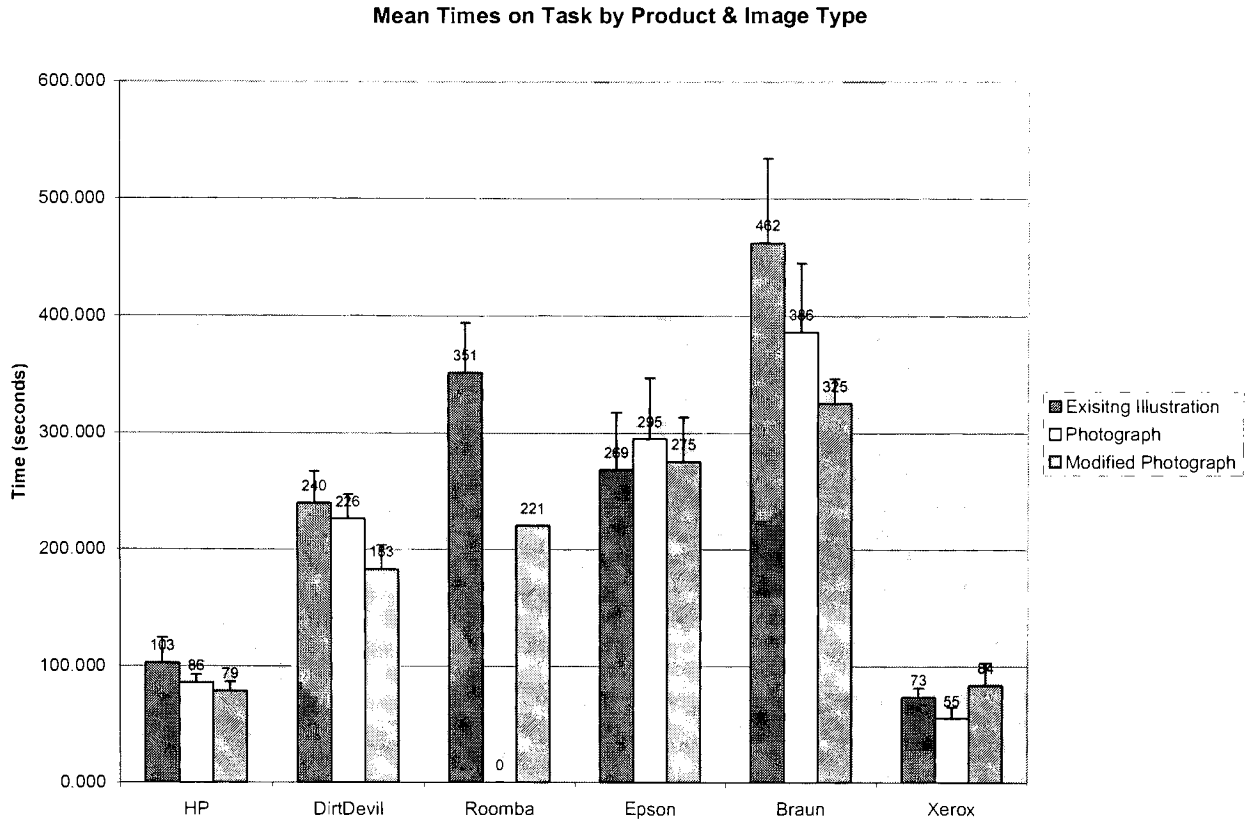


Figure 4.4 Graph showing the mean times with standard error bars for successful task completion by product and image type

Since the simple model *Total time on successful tasks* was not adequate, a transformed response variable (*1 / Sqrt (Total time on task -10)*) was used to run the General Linear Model ANOVA. The results indicated no statistically significant difference between the image types $F(2,105) = 1.99, p = 0.145$, the general trend shows that modified photographs had quicker completion times. In addition, there was less variability in the data for the modified photographs (MP) than for the existing illustrations (EI) and unmodified photographs (P) as indicated by the error bars (standard error). For four out of the six products participants using the modified photograph performed faster than participants using the other image types. For the Epson projector, participants performing with MP came in second while for the Xerox, they were slower than the other image types.

4.3 Subjective Rankings

The subjective rankings were gathered to get an idea of the user preferences for the image type. Figure 4.5 shows the subjective rankings while Figure 4.6 shows the subjective rankings by image type .

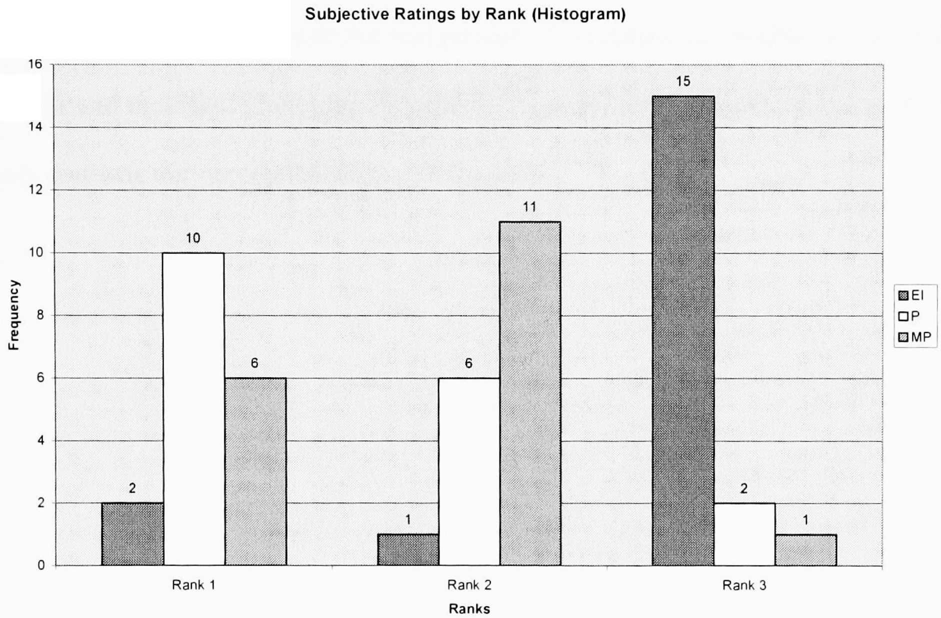


Figure 4.5 Histogram showing subjective rankings

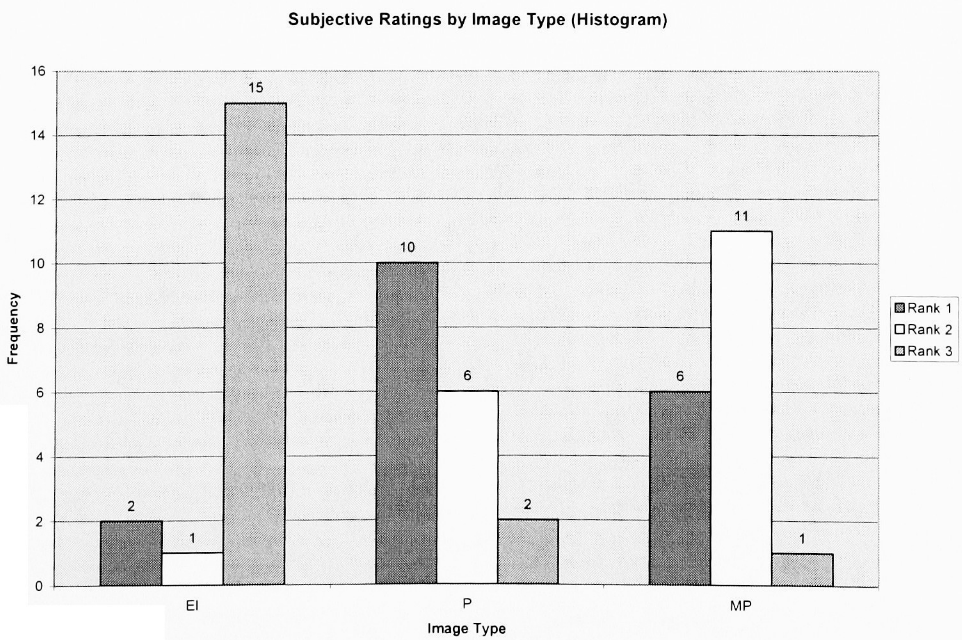


Figure 4.6 Histogram showing the rankings by image type

Overall, the participants preferred the photograph to the modified photograph and the existing illustrations. People in general preferred the realism of the photographs. They liked the 'spotlighting' effect of the modified photograph that directs their attention to the most significant parts of the image while maintaining the other parts too in case people needed that to orient themselves to the real product. Two participants also indicated that photographs and modified photographs helped comprehension of depth and proportion of the object that was not perceptible in the illustrations.

Chapter 5 – Conclusions & Future Considerations

5.1 Conclusions

Overall, the objectives of the study were met. The first goal of the project was to create images modified in such a way so as to highlight certain areas while suppressing the details in the other areas of the image in a quick and inexpensive manner. First, photographs were taken such that the orientation of the product resembled as closely as possible to that in the original illustration. These photographs were modified by overlaying a partially transparent gradient layer using Adobe Photoshop CS2. These images and the original photographs were substituted in the places where the existing illustration were situated in current EPSSs (for all six products) to create 18 treatments in total (6 product EPSSs * 3 image types).

The next step was to use eye tracking to verify whether the modified image indeed worked better than or at least as well as the existing illustration. Based on the results, we can say that the modified photograph did a better job at attracting the user's attention to the regions in the image that needed to be looked at in order to complete the given step of the task. Participants spent almost 60% their time on the relevant areas with respect to the image as a whole in the case of the modified photographs. It was hypothesized that if the participants spent more time on the areas of interest, they would be more likely to have faster task completion rates. Though there was no significant

difference among the three image types for the variable, *time for successful task completion*, there was a general trend that for a given product, participants that used modified photographs performed faster than participants receiving the other image type in their EPSSs (four out of the six products). For the Roomba, the success rate was generally low for all the three image types.

It is interesting to note that there was no significant difference between the photograph and the existing illustration. They performed the same on task performance measures as well in guiding the user's attention to relevant parts. People put in great effort to make illustrations though photographs work just as well and are also less expensive to produce. The photographs in the study were taken with a regular digital camera (Panasonic Lumix (6MP, 5 x Optical zoom) in the lab without the help of a professional photographer. Though the photographs borrowed the orientation of the existing illustration itself, it is clear that less time is needed to produce such photographs compared to creating illustrations. The time to develop the modified photograph was much lower too since an existing software application, Adobe Photoshop CS2 was used to create it. Though not statistically significant, it is also of great value to see that participants did prefer the photographs and modified photographs to the existing illustrations.

5.2 Future Considerations

In the current study, great variance was observed in the task completion rates across products as well as image types. In the future, it would help if all the products used needed about the same time to complete the tasks successfully. Though, some of the factors could be intrinsic to the individual participants as well, it would be worth seeing if

the image types performed in a similar fashion. One of the participants believed that the gradient overlaying used in the modified photographs was rather dark and was hindering the comprehension of the image. In the future, transparency of the layer could be varied depending on the underlying image itself, i.e., a lighter overlay (lower alpha) if the original image is darker and a darker overlay (higher alpha) if the underlying image is lighter. The study could also be further expanded using digital photographs including all details like arrows, labels, blow-outs etc.

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Appendices

A. Experimental Design Details

Key

Product		**Image Type**	
HP (HP)	1	Existing Illustration	E
Dirt Devil (DD)	2	Original Photograph	P
Roomba (Roo)	3	Modified Photograph	M
Epson (Ep)	4		
Tassimo (Br)	5		
Xerox (X)	6		

Participant Number	**Task Order**
1	P1, M3, M6, E2, E5, P4
2	P5, E6, M4, P3, M1, E2
3	E1, E4, M6, P3, M5, P2
4	M2, M1, E6, E4, P5, P3
5	M4, P1, E5, M2, P3, E6
6	E2, M5, E6, P1, P4, M3
7	M5, P2, P6, E4, E1, M3
8	E1, P4, P6, E2, M5, M3
9	E3, P2, M5, P4, M1, E6
10	E1, M2, E3, P5, M6, P4
11	P4, E2, M3, P5, M6, E1
12	E5, E6, M4, M1, P2, P3
13	M5, P6, E4, M2, P1, E3
14	M4, E2, M6, P1, E5, P3
15	M1, P5, P6, E3, E4, M2
16	P2, M3, M6, P5, E1, E4
17	M1, E3, E5, P6, M4, P2
18	P6, E3, P1, M4, E5, M2

Table A.1 Task order for the eighteen participants

B. Raw Data for Participants

Participant 1

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0001	**HP-Roo-X-DD-Br-Ep**								
	HP	**P**	**S**	1400	2700		37166	33966	100333
	DirtDevil	**EI**	**S**	1133	6001		18082	197700	256516
	Roomba	**MP**	F	9784	4366	36106	43434	300310	479584
	Epson	**P**	**S**	233	2932		61787	112432	195717
	Braun	**EI**	**S**	5098	6615		143253	167219	620800
	Xerox	**MP**	**S**	12417	3557		13848	83699	157783

Table B.1 Raw data for participant 1

Participant 2

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0002	**Br-X-Ep-Roo-HP-DD**								
	HP	**MP**	**S**	4033	1667		36268	37666	109950
	DirtDevil	**EI**	**S**	5683	19803		59648	155882	302000
	Roomba	**P**	F	35053	18969	38467	61200	611048	791316
	Epson	**MP**	**S**	7465	3699		66796	103487	229634
	Braun	**P**	**S**	6566	6250		119060	149585	336966
	Xerox	**EI**	**S**	5366	7266		12684	45799	101066

Table B.2 Raw data for participant 2

Participant 3

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0003	HP-Ep-X-Roo-Br-DD								
	HP	EI	S	3167	2950		46681	35449	113917
	DirtDevil	P	S	2499	9501		57917	100066	204750
	Roomba	P	F	233	3133	6037	15850	111633	192433
	Epson	EI	S	2599	7887		69749	130917	248383
	Braun	MP	S	5954	2149		123803	111006	289250
	Xerox	MP	S	1433	2167		22714	26183	76150

Table B.3 Raw data for participant 3

Participant 4

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0004	DD-HP-X-Ep-Br-Roo								
	HP	MP	S	5366	1433		26198	34634	89784
	DirtDevil	MP	S	3199	4516		6633	189733	218316
	Roomba	P	F	3868	8035	21068	34633	257335	374634
	Epson	EI	F	1533	1733		7550	87318	106733
	Braun	P	S	4233	2050		118069	157001	323333
	Xerox	EI	S	4534	3501		8666	54050	88250

Table B.4 Raw data for participant 4

Participant 5

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0005	**Ep-Hp-Br-DD-Roo-X**								
	HP	**P**	**S**	2565	3698		29716	12303	66333
	DirtDevil	**MP**	**S**	12369	7550		60530	111400	235133
	Roomba	**P**	F	3018	14266	17516	38332	160834	285150
	Epson	**MP**	**S**	816	634		47602	43602	126183
	Braun	**EI**	**S**	934	7269		126818	81666	268183
	Xerox	**EI**	**S**	1367	2750		10832	21366	57233

Table B.5 Raw data for participant 5

Participant 6

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0006	**DD-Br-X-HP-Ep-Roo**								
	HP	**P**	**S**	1900	2900		23383	63633	104950
	DirtDevil	**EI**	**S**	2300	5883		33901	261910	324716
	Roomba	**MP**	F	6832	5234	27399	34866	248705	384400
	Epson	**P**	**S**	5032	1834		100599	386437	526067
	Braun	**MP**	**S**	2098	1866		102263	227903	363834
	Xerox	**EI**	**S**	3899	7669		14450	62950	101833

Table B.6 Raw data for participant 6

Participant 7

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0007	**Br-DD-X-Ep-HP-Roo**								
	HP	**EI**	**S**	2617	2232		29300	47400	134867
	DirtDevil	**P**	**S**	2534	6666		25382	140983	211650
	Roomba	**MP**	F	1067	12335	49351	32698	184813	345534
	Epson	**EI**	**S**	1669	3700		59148	72896	159433
	Braun	**MP**	**S**	5433	1566		173254	147303	390350
	Xerox	**P**	**S**	1666	4482		7718	17382	48216

Table B.7 Raw data for participant 7

Participant 8

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0008	**Hp-Ep-X-DD-Br-Roo**								
	HP	**EI**	**S**	2501	3016		13501	15117	52283
	DirtDevil	**EI**	**S**	1501	3335		19866	172683	224417
	Roomba	**MP**	**S**	7799	7867	9284	11169	138216	220566
	Epson	**P**	**S**	2200	6135		56182	161001	261867
	Braun	**MP**	**S**	4618	2599		66700	140319	248084
	Xerox	**P**	**S**	1301	3200		3901	39850	63316

Table B.8 Raw data for participant 8

Participant 9

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0009	**Roo-DD-Br-Ep-HP-X**								
	HP	**MP**	**S**	1234	600		24416	26799	78583
	DirtDevil	**P**	**S**	600	6100		33249	124433	189316
	Roomba	**EI**	F	3665	9249	10400	26449	190347	287267
	Epson	**P**	**S**	1200	2283		22084	230233	269434
	Braun	**MP**	**S**	3434	200		116234	147554	316150
	Xerox	**EI**	F	6784	4865		21446	93351	174816

Table B.9 Raw data for participant 9

Participant 10

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0010	**HP-DD-Roo-Br-X-Ep**								
	HP	**EI**	**S**	567	1934		15532	27318	64000
	DirtDevil	**MP**	**S**	2132	0		434	100818	112450
	Roomba	**EI**	**S**	8917	11800	11134	14567	212715	309016
	Epson	**P**	**S**	2435	5615		15849	127032	172667
	Braun	**P**	**S**	1666	4518		94668	106334	238766
	Xerox	**MP**	**S**	2233	2467		4467	16767	35434

Table B.10 Raw data for participant 10

Participant 11

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0011	**Ep-DD-Roo-Br-X-HP**								
	HP	**EI**	**S**	800	3601		13650	36183	62966
	DirtDevil	**EI**	**S**	1667	10634		20517	120616	165866
	Roomba	**MP**	F	3466	3767	8367	27037	167566	236267
	Epson	**P**	**S**	2366	7602		66046	250867	342950
	Braun	**P**	**S**	6898	13717		68718	191717	371200
	Xerox	**MP**	**S**	2500	2533		2966	29701	47650

Table B.11 Raw data for participant 11

Participant 12

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0012	**Br-X-Ep-HP-DD-**Roo								
	HP	**MP**	**S**	1967	850		23998	28234	74583
	DirtDevil	**P**	**S**	5269	20069		34869	97283	202566
	Roomba	**P**	F	1901	13414	18581	34067	174936	296234
	Epson	**MP**	**S**	5583	8535		74851	120634	253534
	Braun	**EI**	**S**	5200	15147		162262	276176	519783
	Xerox	**EI**	**S**	4166	4767		7217	58516	91683

Table B.12 Raw data for participant 12

Participant 13

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0013	Br-X-Ep-DD-HP-Roo								
	HP	P	S	966	2767		26967	36251	81433
	DirtDevil	MP	S	2299	800		31001	76734	131100
	Roomba	EI	F	900	13532	17347	29083	233851	334567
	Epson	EI	S	2135	4967		112718	257532	398017
	Braun	MP	S	300	3866		171383	149051	344667
	Xerox	P	S	3051	1734		8001	23218	47350

Table B.13 Raw data for participant 13

Participant 14

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0014	Ep-DD-X-HP-Br-Roo								
	HP	P	S	2666	567		12733	38766	65866
	DirtDevil	EI	S	4400	4766		7050	140367	165867
	Roomba	P	F	899	15551	17117	41953	234986	348050
	Epson	MP	S	10918	6215		84135	208585	334100
	Braun	EI	S	8185	19719		284713	298720	679083
	Xerox	MP	S	1166	2201		18484	29368	66000

Table B.14 Raw data for participant 14

Participant 15

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0015	**HP-Br-X-Roo-Ep-DD**								
	HP	**MP**	**S**	2899	933		13666	26601	59650
	DirtDevil	**MP**	**S**	4284	3132		7982	128850	183783
	Roomba	**EI**	F	1934	29051	33735	45479	408975	596300
	Epson	**EI**	F	567	2866		600	100900	110900
	Braun	**P**	**S**	6567	36562		109353	410334	661217
	Xerox	**P**	F	7732	13438		27917	138917	222683

Table B.15 Raw data for participant 15

Participant 16

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0016	**DD-Roo-X-Br-HP-Ep**								
	HP	**EI**	**S**	4136	4901		89265	55201	187983
	DirtDevil	**P**	**S**	7318	15065		81319	159836	328917
	Roomba	**MP**	F	3268	20785	27952	34032	292051	448384
	Epson	**EI**	**S**	6382	9399		45547	184450	268333
	Braun	**P**	**S**	5186	12619		101974	202994	386296
	Xerox	**MP**	**S**	3451	2366		14299	65202	120367

Table B.16 Raw data for participant 16

Participant 17

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0017	**HP-Roo-Br-X-DD-Ep**								
	HP	**MP**	**S**	1367	1034		22967	12732	59100
	DirtDevil	**P**	**S**	1666	11952		50836	109984	220816
	Roomba	**EI**	**S**	1635	7467	20550	20782	20782	393934
	Epson	**MP**	**S**	2534	3719		80901	270082	391383
	Braun	**EI**	**S**	1632	5950		123336	93032	261617
	Xerox	**P**	**S**	2101	4865		12933	38685	75317

Table B.17 Raw data for participant 17

Participant 18

Participant ID		Image Type	Success / Failure	Time spent on the AOI of image (Msec)	Time spent on image with AOI (Msec)	Time spent on image without AOI (Msec)	Time spend on text instructions (Msec)	Time dpent working on the product (MseC)	Total Time on task (Msec)
P0018	**X-Roo-HP-Br-DD-Ep**								
	HP	**P**	**S**	2801	4266		33367	37685	94900
	DirtDevil	**MP**	**S**	5766	3701		54035	112835	217483
	Roomba	**EI**	F	5000	17246	19600	29800	171805	298700
	Epson	**MP**	**S**	5902	6983		54484	215365	316883
	Braun	**EI**	**S**	3734	14451		177968	181507	425000
	Xerox	**P**	**S**	3500	8800		5934	48568	98734

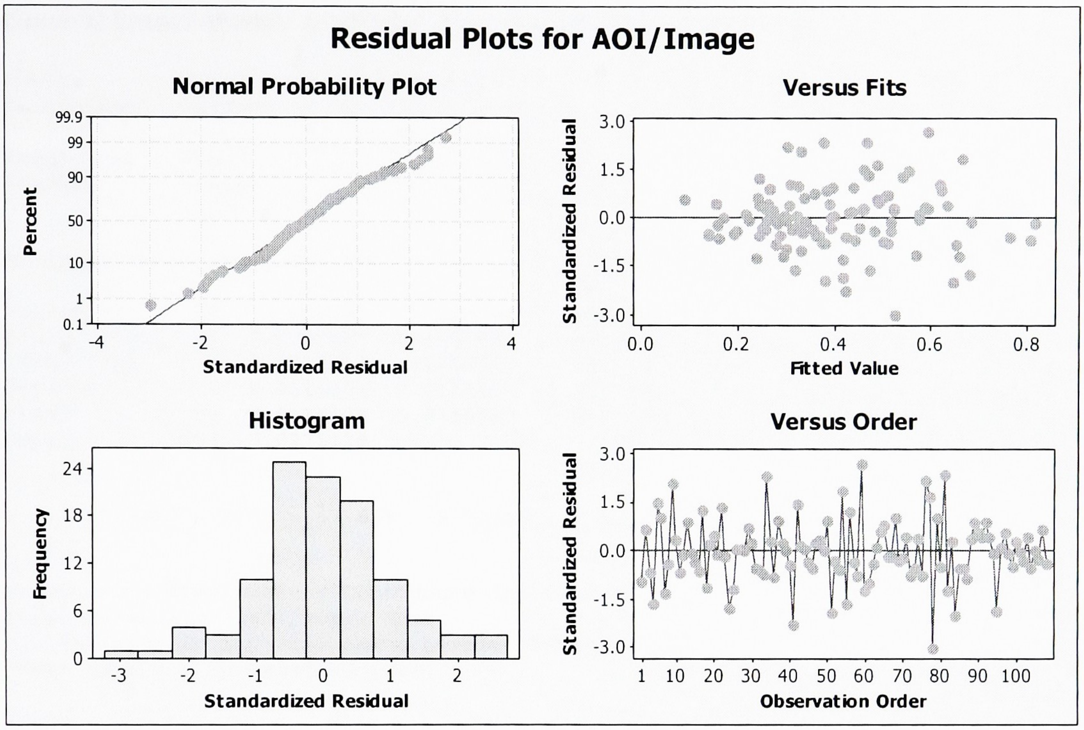
Table B.18 Raw data for participant 18

C. ANOVA Results & Descriptive Statistics

Key
Product 1:HP, 2:DirtDevil, 3:Roomba, 4:Epson, 5:Braun, 6: Xerox
Image Type 1:Existing Illustration, 2:Original Photograph, 3:Modified Photograph

General Linear Model: AOI/Image versus Participant, Image Type, Product

```
Factor        Type    Levels  Values
Participant   random      18  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                              16, 17, 18
Image Type    fixed        3  1, 2, 3
Product       fixed        6  1, 2, 3, 4, 5, 6


Analysis of Variance for AOI/Image, using Adjusted SS for Tests

Source        DF   Seq SS   Adj SS   Adj MS      F      P
Participant   17  0.50887  0.50887  0.02993   1.01  0.457
Image Type     2  1.52000  1.52000  0.76000  25.62  0.000
Product        5  0.51510  0.51510  0.10302   3.47  0.007
Error         83  2.46166  2.46166  0.02966
Total        107  5.00562


S = 0.172217   R-Sq = 50.82%   R-Sq(adj) = 36.60%


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable AOI/Image
All Pairwise Comparisons among Levels of Image Type
Image Type = 1  subtracted from:

Image
Type      Lower    Center   Upper  -------+---------+---------+---------
2      -0.08979  0.007222  0.1042  (-------*-------)
3       0.15818  0.255194  0.3522                    (-------*-------)
                                   -------+---------+---------+---------
                                        0.00      0.12      0.24


Image Type = 2  subtracted from:

Image
Type    Lower  Center   Upper  -------+---------+---------+---------
3      0.1510  0.2480  0.3450                     (-------*-------)
                               -------+---------+---------+---------
                                    0.00      0.12      0.24
```


Residual Plots for AOI/Image
Normal Probability Plot
Percent
Standardized Residual
Versus Fits
Standardized Residual
Fitted Value
Histogram
Frequency
Standardized Residual
Versus Order
Standardized Residual
Observation Order

General Linear Model: AOI/Total Time versus Participant, Image Type, ...

Factor	Type	Levels	Values
Participant	random	18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
Image Type	fixed	3	1, 2, 3
Product	fixed	6	1, 2, 3, 4, 5, 6

Analysis of Variance for AOI/Total Time, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Participant	17	0.0027087	0.0027087	0.0001593	1.13	0.337
Image Type	2	0.0012912	0.0012912	0.0006456	4.60	0.013
Product	5	0.0118601	0.0118601	0.0023720	16.90	0.000
Error	83	0.0116529	0.0116529	0.0001404		
Total	107	0.0275129				

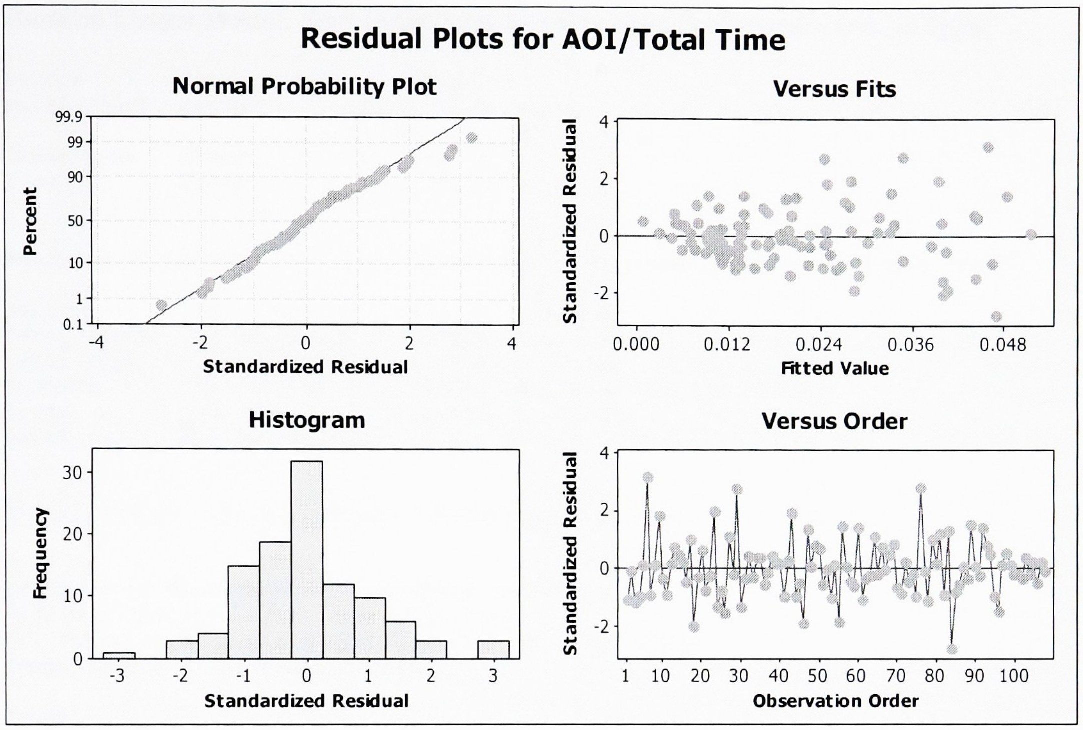
S = 0.0118489   R-Sq = 57.65%   R-Sq(adj) = 45.40%

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable AOI/Total Time
All Pairwise Comparisons among Levels of Image Type
Image Type = 1 subtracted from:

```
Image
Type      Lower    Center     Upper   -+---------+---------+---------+-----
2     -0.006508  0.000167  0.006842   (----------*----------)
3      0.000742  0.007417  0.014092             (----------*----------)
                                      -+---------+---------+---------+-----
                                    -0.0060    0.0000    0.0060    0.0120
```

Image Type = 2 subtracted from:

```
Image
Type     Lower    Center    Upper   -+---------+---------+---------+-----
3     0.000575  0.007250  0.01392             (----------*----------)
                                    -+---------+---------+---------+-----
                                  -0.0060    0.0000    0.0060    0.0120
```


Residual Plots for AOI/Total Time
Normal Probability Plot
Percent
99.9
99
90
50
10
1
0.1
-4
-2
0
2
4
Standardized Residual
Versus Fits
Standardized Residual
4
2
0
-2
0.000
0.012
0.024
0.036
0.048
Fitted Value
Histogram
Frequency
30
20
10
0
-3
-2
-1
0
1
2
3
Standardized Residual
Versus Order
Standardized Residual
4
2
0
-2
1
10
20
30
40
50
60
70
80
90
100
Observation Order

General Linear Model: Sqrt (AOI/Total Time) versus Participant, Image Type, ...

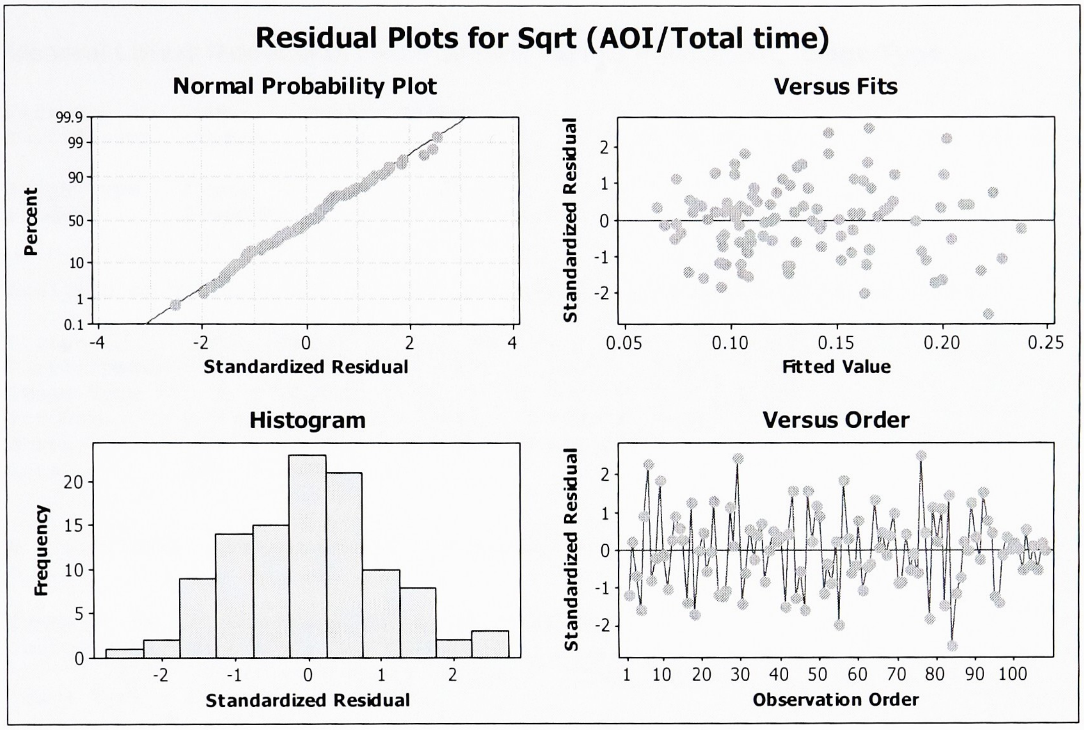
Factor	Type	Levels	Values
Participant	random	18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
Image Type	fixed	3	1, 2, 3
Product	fixed	6	1, 2, 3, 4, 5, 6

Analysis of Variance for Sqrt (AOI/Total time), using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Participant	17	0.037224	0.037224	0.002190	1.41	0.154
Image Type	2	0.015448	0.015448	0.007724	4.97	0.009
Product	5	0.134810	0.134810	0.026962	17.33	0.000
Error	83	0.129105	0.129105	0.001555		
Total	107	0.316587				

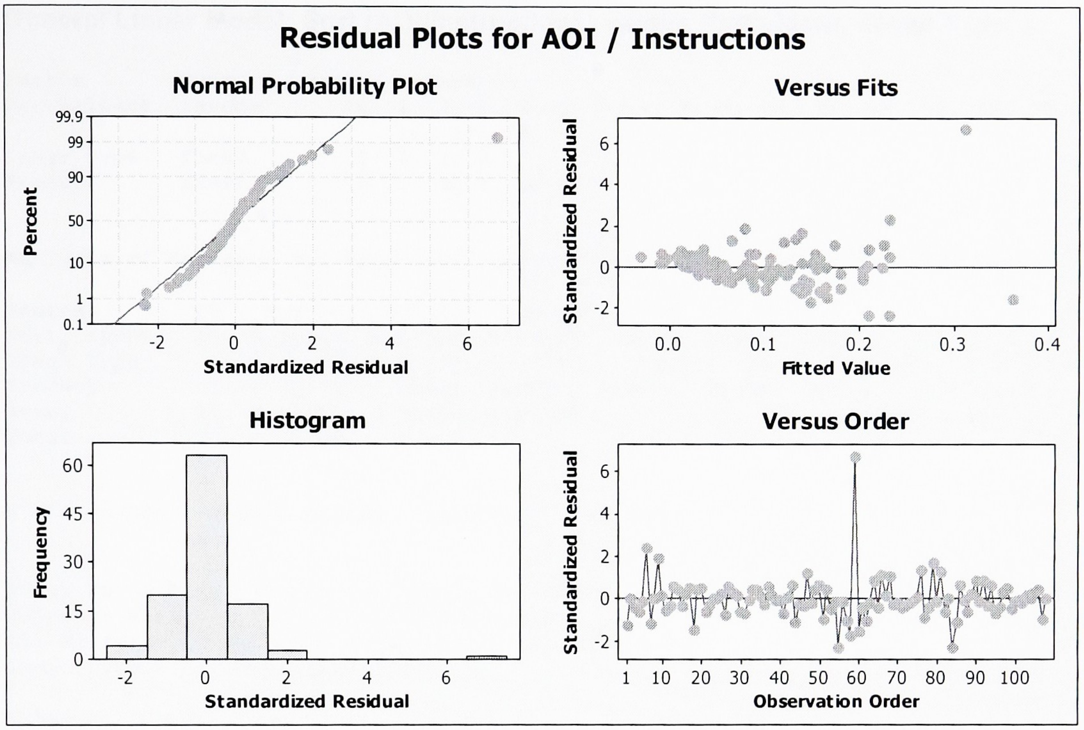
S = 0.0394397   R-Sq = 59.22%   R-Sq(adj) = 47.43%

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Sqrt (AOI/Total time)
All Pairwise Comparisons among Levels of Image Type
Image Type = 1  subtracted from:

Image
Type      Lower    Center    Upper    -+---------+---------+---------+-----
2      -0.02149  0.000730  0.02295    (----------*----------)
3       0.00351  0.025727  0.04795                (----------*----------)
                                      -+---------+---------+---------+-----
                                   -0.020     0.000     0.020     0.040


Image Type = 2  subtracted from:

Image
Type      Lower   Center    Upper    -+---------+---------+---------+-----
3      0.002780  0.02500  0.04721               (----------*-----------)
                                     -+---------+---------+---------+-----
                                  -0.020     0.000     0.020     0.040
```


Residual Plots for Sqrt (AOI/Total time)
Normal Probability Plot
Percent
Standardized Residual
Versus Fits
Standardized Residual
Fitted Value
Histogram
Frequency
Standardized Residual
Versus Order
Standardized Residual
Observation Order

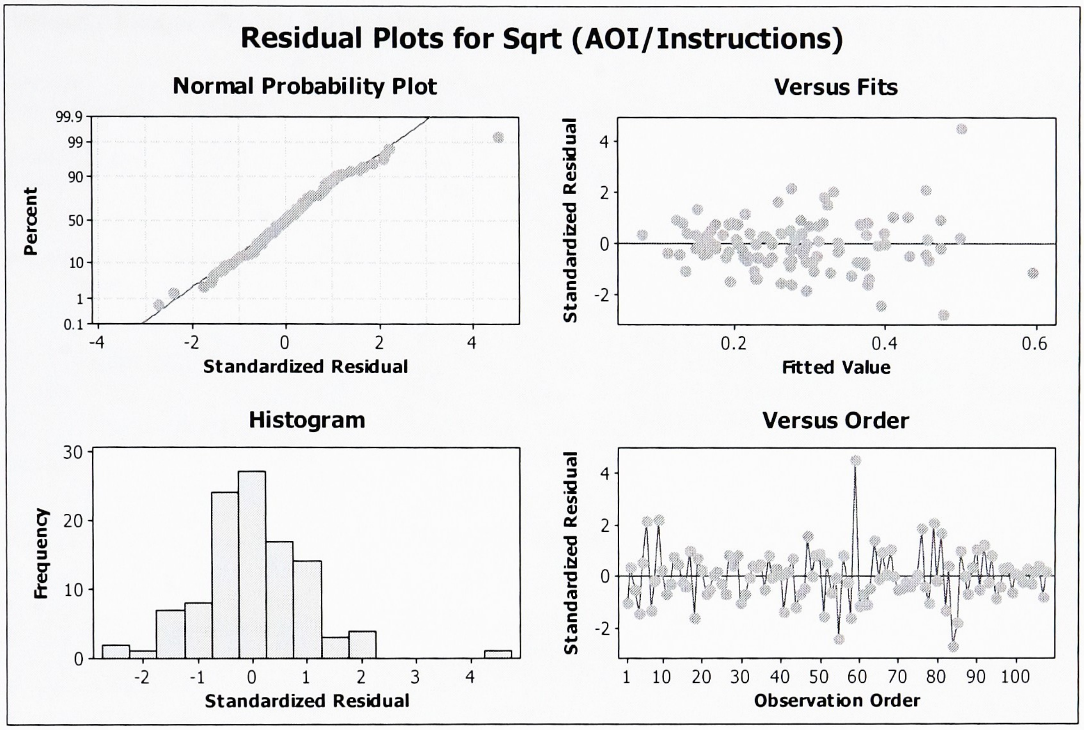
General Linear Model: AOI / Instructions versus Participant, Image Type, ...

```
Factor       Type    Levels  Values
Participant  random      18  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                             16, 17, 18
Image Type   fixed        3  1, 2, 3
Product      fixed        6  1, 2, 3, 4, 5, 6


Analysis of Variance for AOI / Instructions, using Adjusted SS for Tests

Source        DF    Seq SS    Adj SS    Adj MS     F      P
Participant   17  0.219442  0.219442  0.012908  1.67  0.066
Image Type     2  0.060633  0.060633  0.030316  3.92  0.024
Product        5  0.298361  0.298361  0.059672  7.71  0.000
Error         83  0.642436  0.642436  0.007740
Total        107  1.220871


S = 0.0879784   R-Sq = 47.38%   R-Sq(adj) = 32.16%


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable AOI / Instructions
All Pairwise Comparisons among Levels of Image Type
Image Type = 1  subtracted from:

Image
Type      Lower    Center    Upper  ---+---------+---------+---------+---
2      -0.06317  -0.01361  0.03595  (---------*---------)
3      -0.00751   0.04206  0.09162            (---------*---------)
                                    ---+---------+---------+---------+---
                                    -0.050     0.000     0.050     0.100


Image Type = 2  subtracted from:

Image
Type      Lower   Center   Upper  ---+---------+---------+---------+---
3      0.006106  0.05567  0.1052              (---------*---------)
                                  ---+---------+---------+---------+---
                                  -0.050     0.000     0.050     0.100
```


Residual Plots for AOI / Instructions
Normal Probability Plot
Percent
99.9
99
90
50
10
1
0.1
-2
0
2
4
6
Standardized Residual
Versus Fits
Standardized Residual
6
4
2
0
-2
0.0
0.1
0.2
0.3
0.4
Fitted Value
Histogram
Frequency
60
45
30
15
0
-2
0
2
4
6
Standardized Residual
Versus Order
Standardized Residual
6
4
2
0
-2
1
10
20
30
40
50
60
70
80
90
100
Observation Order

General Linear Model: Sqrt (AOI/Instructions) versus Participant, Image Type, ...

```
Factor       Type    Levels  Values
Participant  random      18  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                             16, 17, 18
Image Type   fixed        3  1, 2, 3
Product      fixed        6  1, 2, 3, 4, 5, 6


Analysis of Variance for Sqrt (AOI/Instructions), using Adjusted SS for Tests

Source        DF   Seq SS   Adj SS   Adj MS      F      P
Participant   17  0.37363  0.37363  0.02198   2.06  0.016
Image Type     2  0.09183  0.09183  0.04591   4.31  0.017
Product        5  0.68210  0.68210  0.13642  12.81  0.000
Error         83  0.88396  0.88396  0.01065
Total        107  2.03152


S = 0.103200   R-Sq = 56.49%   R-Sq(adj) = 43.91%


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Sqrt (AOI/Instructions)
All Pairwise Comparisons among Levels of Image Type
Image Type = 1  subtracted from:

Image
Type      Lower    Center    Upper  ---+---------+---------+---------+---
2      -0.07633  -0.01819  0.03994  (---------*---------)
3      -0.00742   0.05072  0.10885             (--------*---------)
                                    ---+---------+---------+---------+---
                                    -0.060     0.000     0.060     0.120


Image Type = 2  subtracted from:

Image
Type     Lower   Center   Upper  ---+---------+---------+---------+---
3      0.01078  0.06891  0.1270                (--------*---------)
                                 ---+---------+---------+---------+---
                                 -0.060     0.000     0.060     0.120
```



Residual Plots for Sqrt (AOI/Instructions)
Normal Probability Plot
Versus Fits
Histogram
Versus Order
Percent
Standardized Residual
Fitted Value
Frequency
Observation Order
99.9
99
90
50
10
1
0.1
-4
-2
0
2
4
0.2
0.4
0.6
30
20
10
-1
3
1 10 20 30 40 50 60 70 80 90 100

General Linear Model: Total time on task versus Participant, Image Type, ...

Factor	Type	Levels	Values
Participant	random	18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
Image Type	fixed	3	1, 2, 3
Product	fixed	6	1, 2, 3, 4, 5, 6

Analysis of Variance for Total time on task (seconds), using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Participant	17	289254	289254	17015	1.85	0.035
Image Type	2	19298	19298	9649	1.05	0.355
Product	5	1456703	1456703	291341	31.67	0.000
Error	83	763656	763656	9201		
Total	107	2528910				

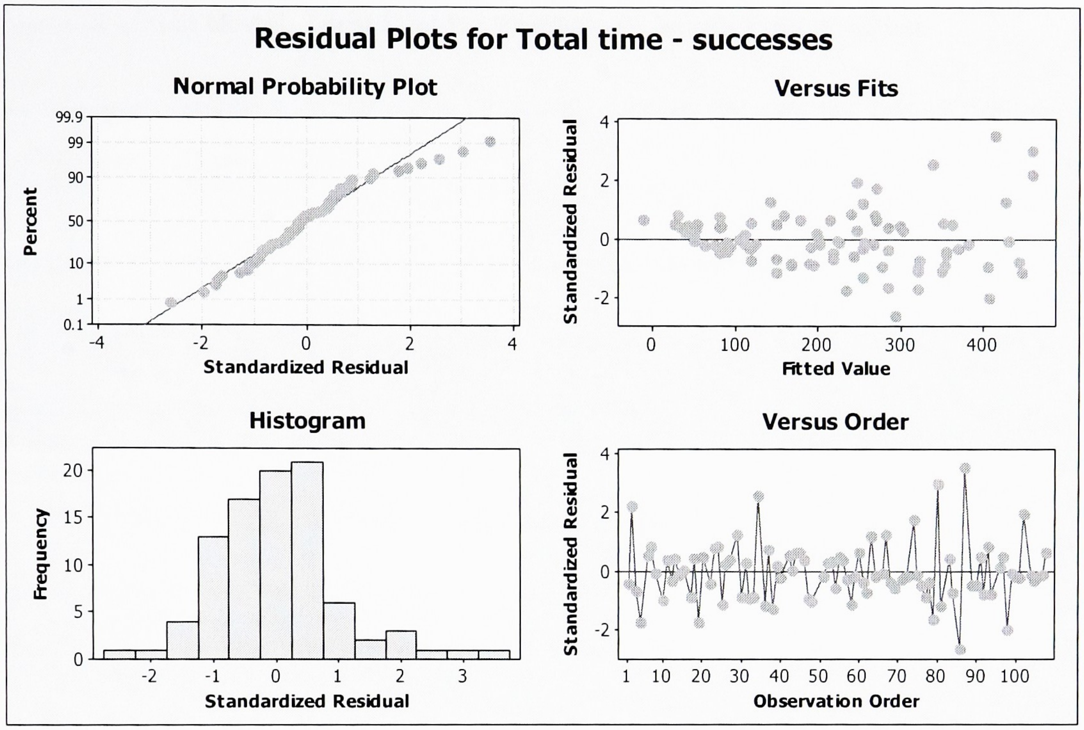
S = 95.9201   R-Sq = 69.80%   R-Sq(adj) = 61.07%

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total time on task (seconds)
All Pairwise Comparisons among Levels of Image Type
Image Type = 1 subtracted from:

```
Image
Type     Lower  Center   Upper  -----+---------+---------+---------+-
2       -65.77  -11.74   42.30        (---------------*--------------)
3       -86.38  -32.34   21.69  (---------------*--------------)
                                -----+---------+---------+---------+-
                                   -70       -35         0        35
```

Image Type = 2 subtracted from:

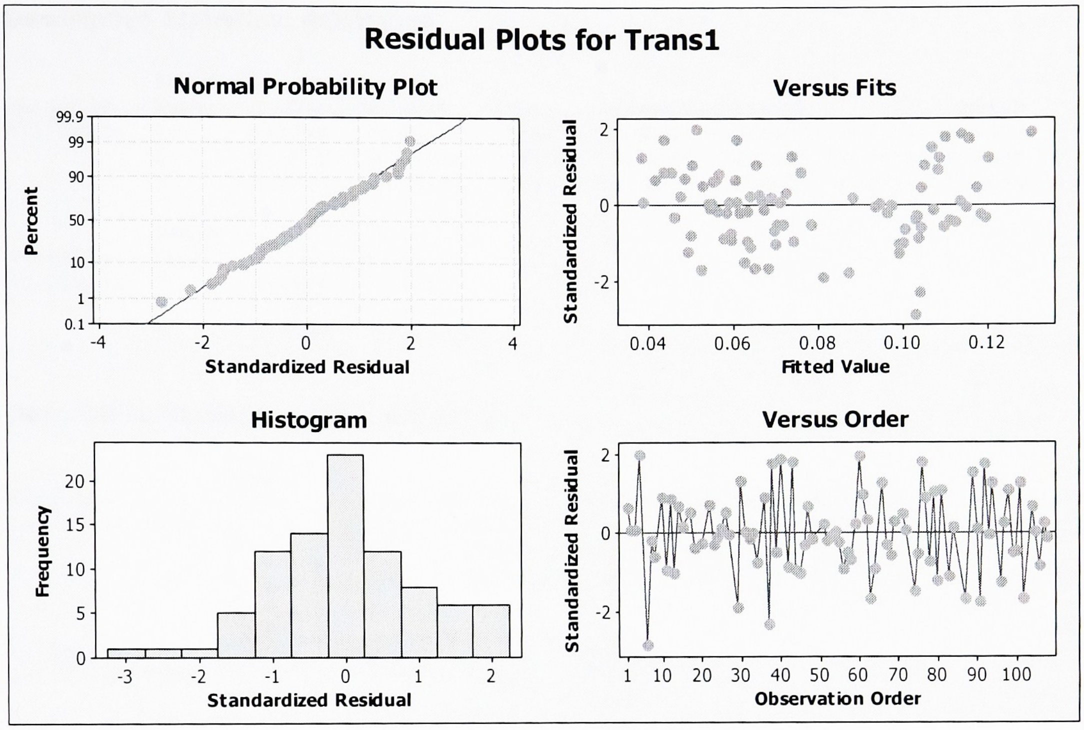
```
Image
Type     Lower  Center   Upper  -----+---------+---------+---------+-
3       -74.64  -20.60   33.43      (--------------*---------------)
                                -----+---------+---------+---------+-
                                   -70       -35         0        35
```



Residual Plots for Total time - successes
Normal Probability Plot
Percent
99.9
99
90
50
10
1
0.1
-4
-2
0
2
4
Standardized Residual
Versus Fits
Standardized Residual
4
2
0
-2
0
100
200
300
400
Fitted Value
Histogram
Frequency
20
15
10
5
0
-2
-1
0
1
2
3
Standardized Residual
Versus Order
Standardized Residual
4
2
0
-2
1
10
20
30
40
50
60
70
80
90
100
Observation Order

General Linear Model: Trans1 versus Participant, Image Type, Product

```
Factor       Type    Levels  Values
Participant  random      18  1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,
                             16, 17, 18
Image Type   fixed        3  1, 2, 3
Product      fixed        6  1, 2, 3, 4, 5, 6


Analysis of Variance for Trans1, using Adjusted SS for Tests

Source       DF     Seq SS     Adj SS     Adj MS      F      P
Participant  17  0.0048156  0.0056220  0.0003307   2.84  0.001
Image Type    2  0.0007923  0.0004642  0.0002321   1.99  0.145
Product       5  0.0492607  0.0492607  0.0098521  84.56  0.000
Error        64  0.0074566  0.0074566  0.0001165
Total        88  0.0623252


S = 0.0107940   R-Sq = 88.04%   R-Sq(adj) = 83.55%


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Trans1
All Pairwise Comparisons among Levels of Image Type
Image Type = 1  subtracted from:

Image
Type       Lower    Center    Upper  ---------+---------+---------+-------
2      -0.003616  0.003466  0.01055    (-------------*-------------)
3      -0.001184  0.005791  0.01277         (-------------*-------------)
                                     ---------+---------+---------+-------
                                           0.0000    0.0050    0.0100


Image Type = 2  subtracted from:

Image
Type       Lower    Center     Upper  ---------+---------+---------+-------
3      -0.004535  0.002325  0.009184  (------------*------------)
                                      ---------+---------+---------+-------
                                            0.0000    0.0050    0.0100
```


Residual Plots for Trans1
Normal Probability Plot
Percent
Standardized Residual
Versus Fits
Standardized Residual
Fitted Value
Histogram
Frequency
Standardized Residual
Versus Order
Standardized Residual
Observation Order

Descriptive Statistics: AOI/Image

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1	Median
AOI/Image	1	0.3148	0.0240	0.1441	0.0208	0.0620	0.2075	0.2970
	2	0.3220	0.0314	0.1885	0.0355	0.0550	0.2080	0.2900
	3	0.5700	0.0347	0.2081	0.0433	0.0720	0.4623	0.5855

Variable	Image Type	Q3	Maximum
AOI/Image	1	0.4485	0.5820
	2	0.3883	0.8250
	3	0.7055	1.0000

Descriptive Statistics: AOI/Total Time

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
AOI/Total Time	1	0.01800	0.00245	0.01472	0.00022	0.00300	0.00700
	2	0.01817	0.00238	0.01430	0.00020	0.00100	0.00800
	3	0.02542	0.00302	0.01811	0.00033	0.00100	0.01500

Variable	Image Type	Median	Q3	Maximum
AOI/Total Time	1	0.01250	0.02625	0.05300
	2	0.01300	0.02750	0.06400
	3	0.01950	0.03300	0.07900

Descriptive Statistics: AOI / Instructions

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
AOI / Instructions	1	0.0864	0.0130	0.0783	0.0061	0.0070	0.0288
	2	0.0728	0.0102	0.0611	0.0037	0.0040	0.0318
	3	0.1285	0.0254	0.1526	0.0233	0.0020	0.0455

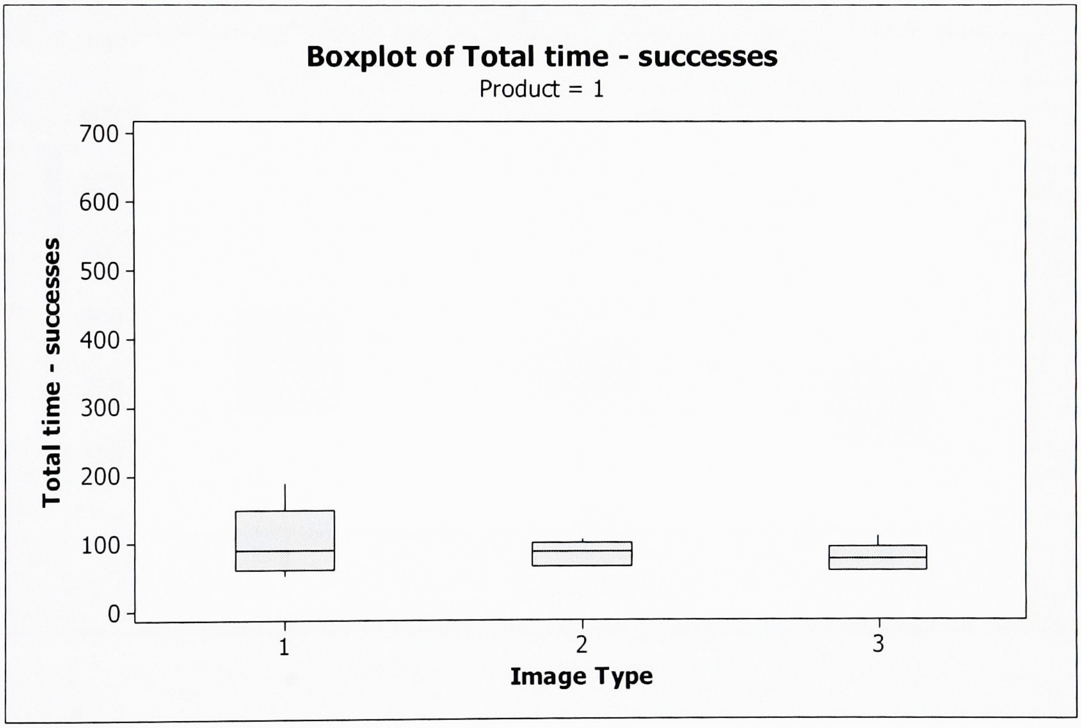
Variable	Image Type	Median	Q3	Maximum
AOI / Instructions	1	0.0575	0.1387	0.2710
	2	0.0485	0.0985	0.2390
	3	0.0845	0.1653	0.8310

Descriptive Statistics: Total time - successes

Results for Product = 1

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	102.7	21.6	53.0	2810.4	52.3	60.3
	2	85.64	6.97	17.06	291.20	65.87	66.22
	3	78.61	7.88	19.30	372.68	59.10	59.51

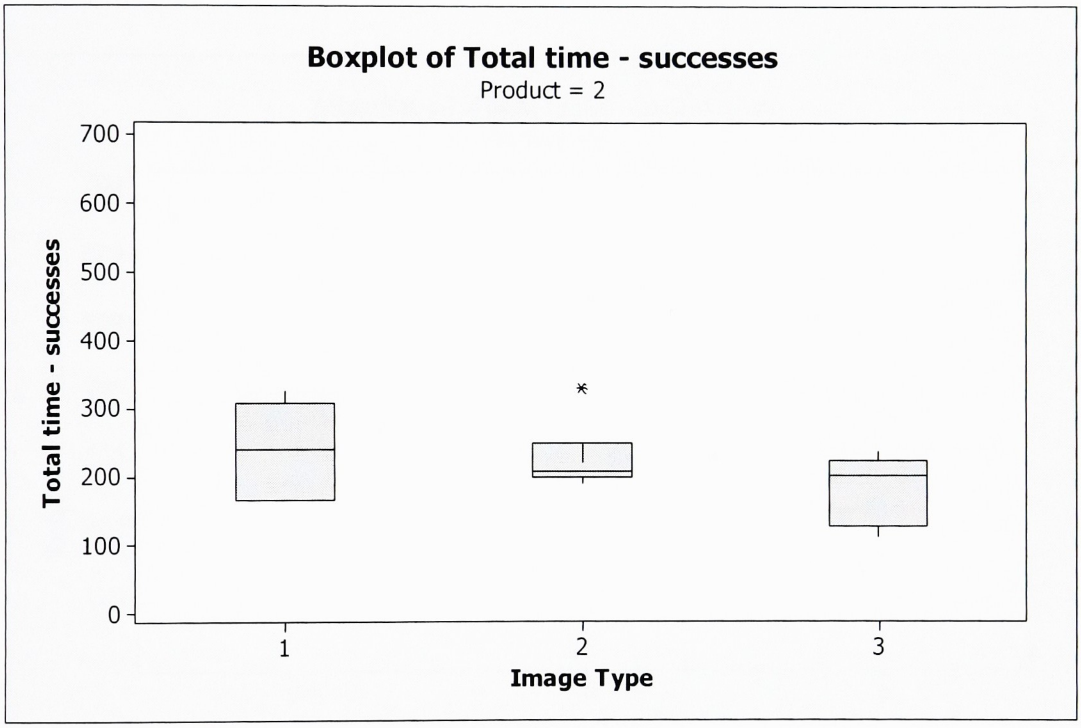
Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	89.0	148.1	188.0
	2	88.17	101.49	104.95
	3	76.58	94.83	109.95



Results for Product = 2

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	239.9	27.4	67.1	4505.6	165.9	165.9
	2	226.3	21.0	51.3	2634.1	189.3	199.3
	3	183.0	20.7	50.6	2565.1	112.5	126.4

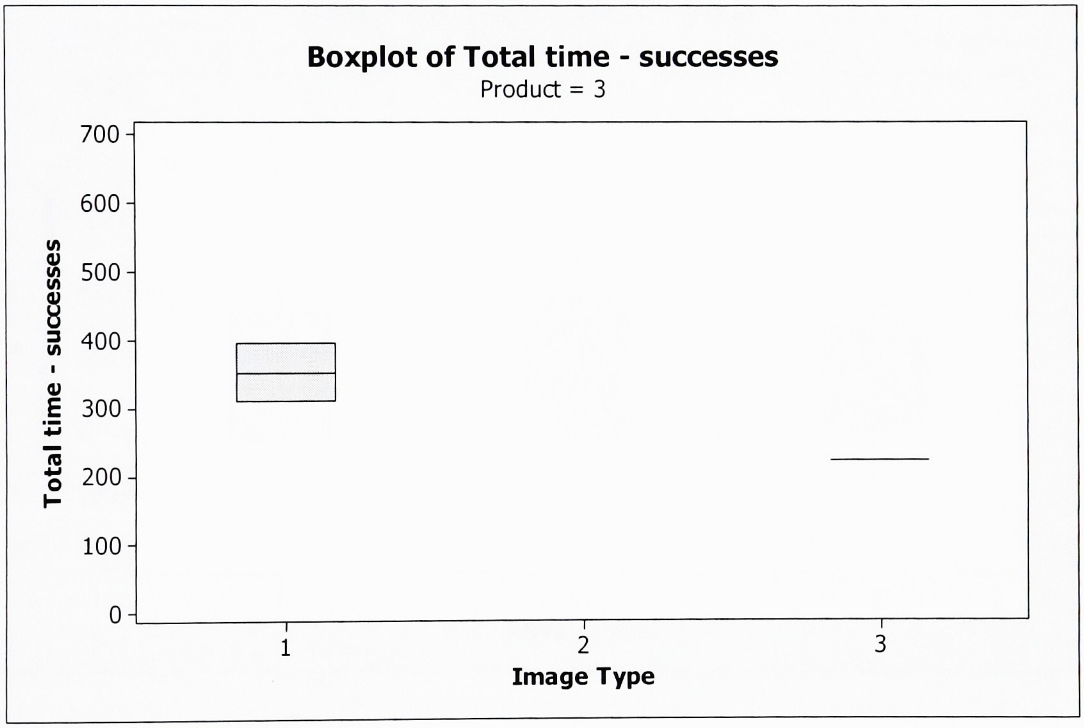
Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	240.5	307.7	324.7
	2	208.2	247.8	328.9
	3	200.6	222.5	235.1



Results for Product = 3

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	351.5	42.5	60.0	3605.5	309.0	*
	2	*	*	*	*	*	*
	3	220.57	*	*	*	220.57	*

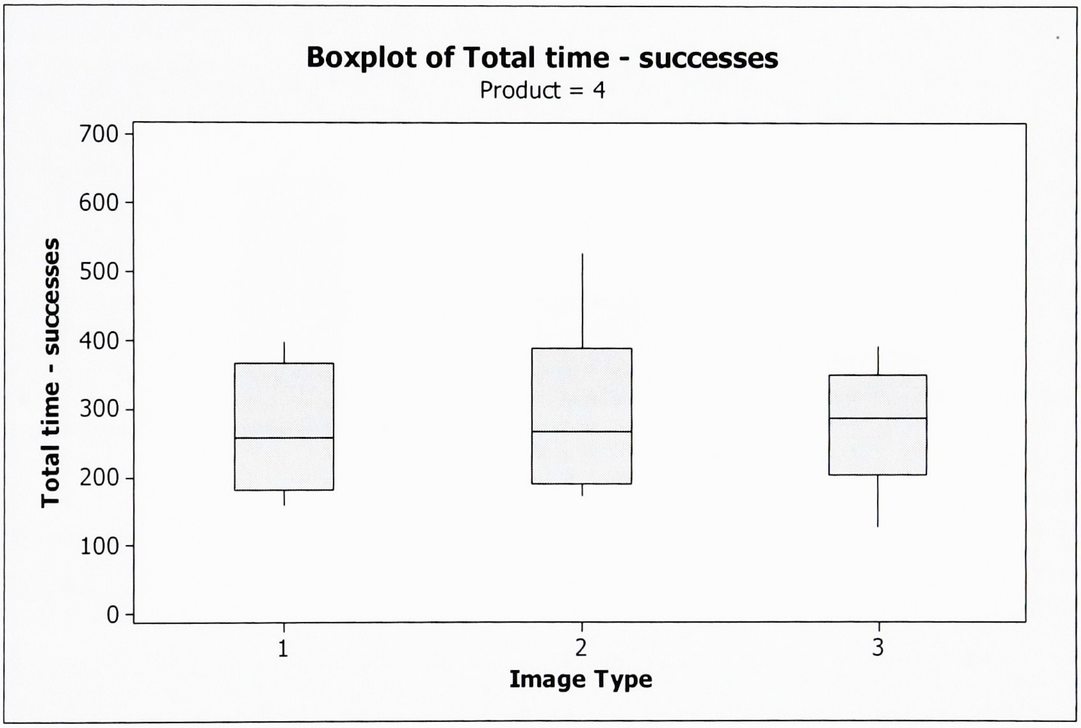
Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	351.5	*	393.9
	2	*	*	*
	3	220.57	*	220.57



Results for Product = 4

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	268.5	49.2	98.4	9691.7	159.4	181.7
	2	294.8	52.4	128.3	16453.0	172.7	190.0
	3	275.3	38.1	93.2	8691.4	126.2	203.8

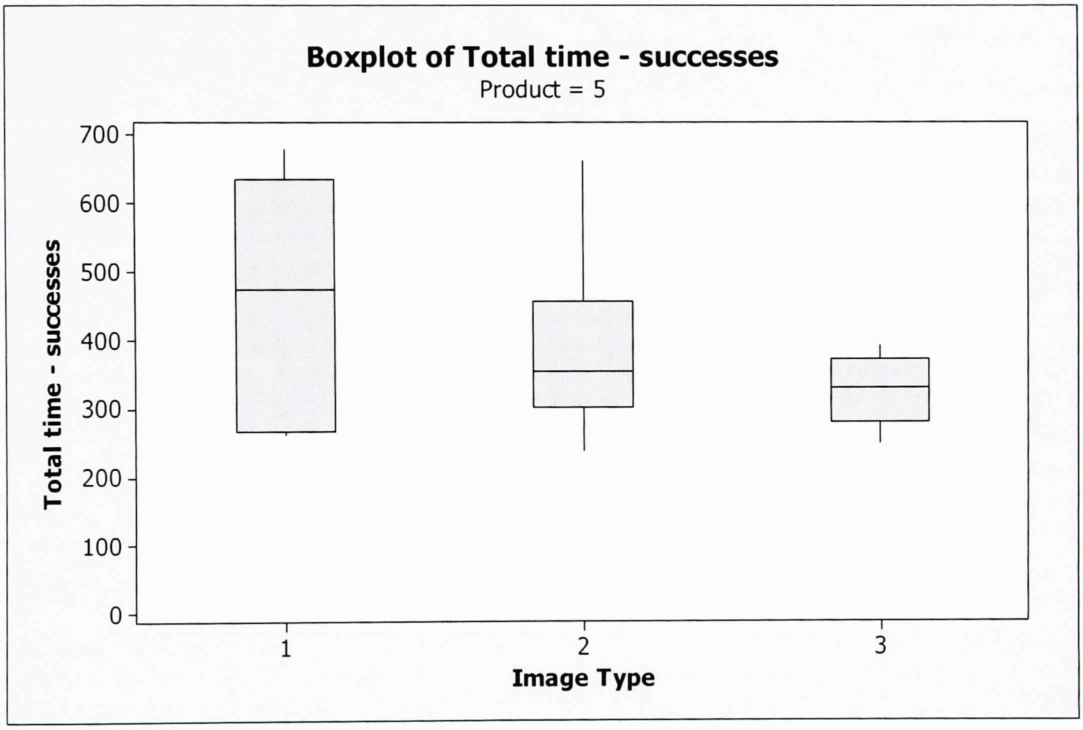
Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	258.4	365.6	398.0
	2	265.7	388.7	526.1
	3	285.2	348.4	391.4



Results for Product = 5

Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	462.4	71.8	175.9	30953.5	261.6	266.5
	2	386.3	58.9	144.2	20794.5	238.8	302.2
	3	325.4	21.2	51.8	2687.4	248.1	279.0

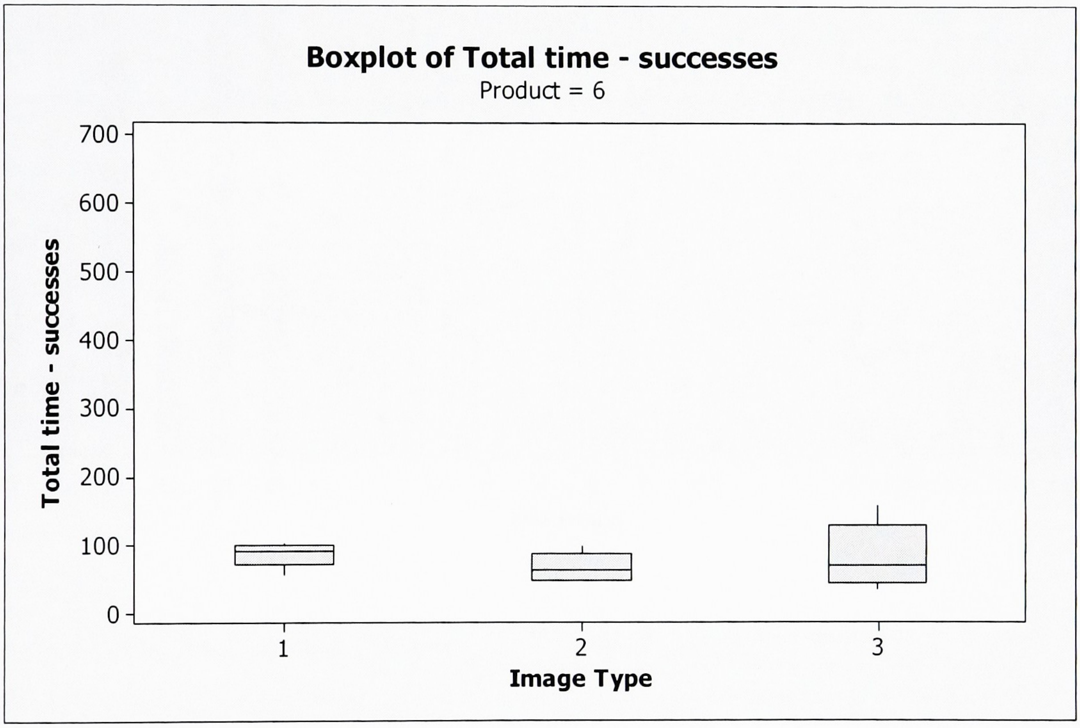
Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	472.4	635.4	679.1
	2	354.1	455.0	661.2
	3	330.4	370.5	390.4

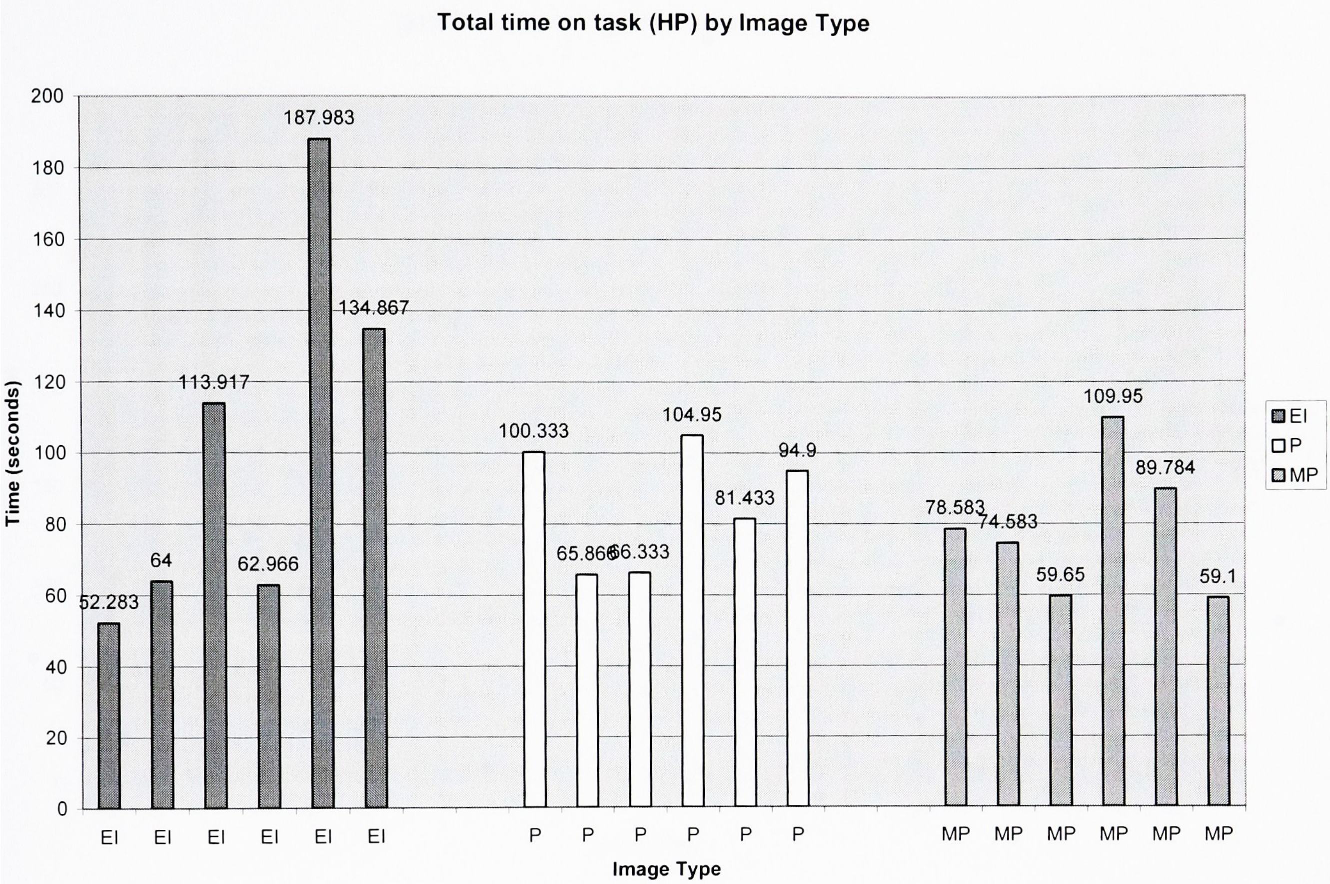


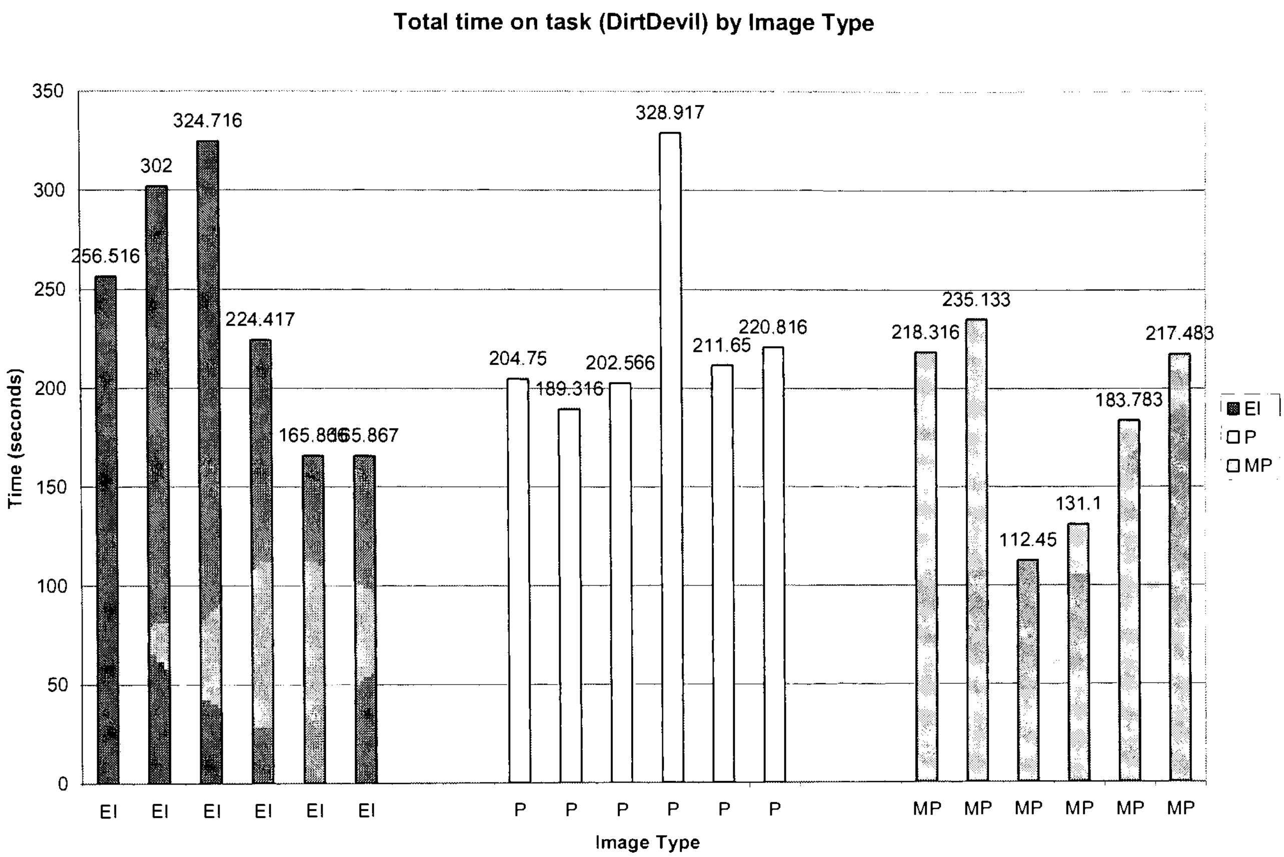
Results for Product = 6

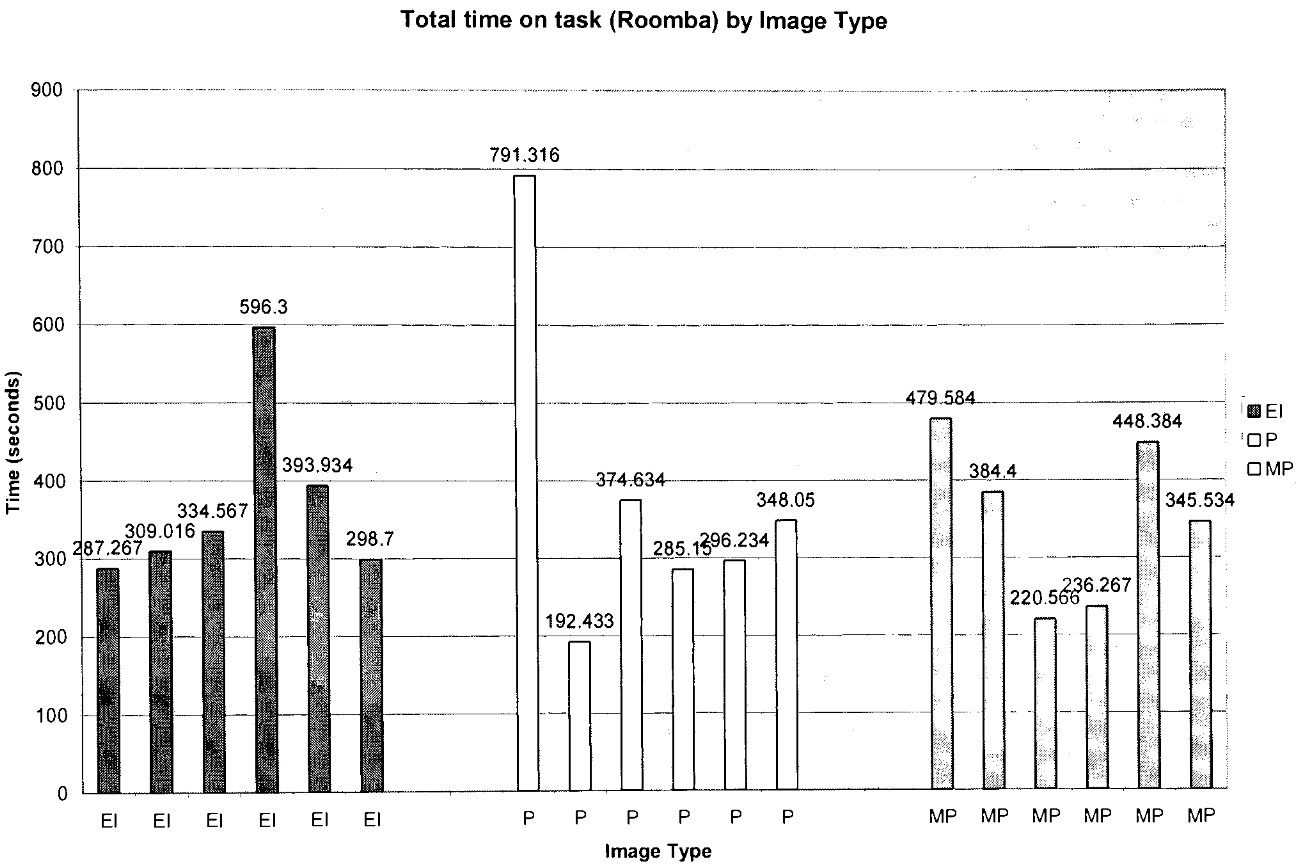
Variable	Image Type	Mean	SE Mean	StDev	Variance	Minimum	Q1
Total time - successes	1	88.01	8.13	18.18	330.58	57.23	72.74
	2	66.59	9.56	21.38	456.97	47.35	47.78
	3	83.9	19.0	46.5	2166.4	35.4	44.6

Variable	Image Type	Median	Q3	Maximum
Total time - successes	1	91.68	101.45	101.83
	2	63.32	87.03	98.73
	3	71.1	129.7	157.8

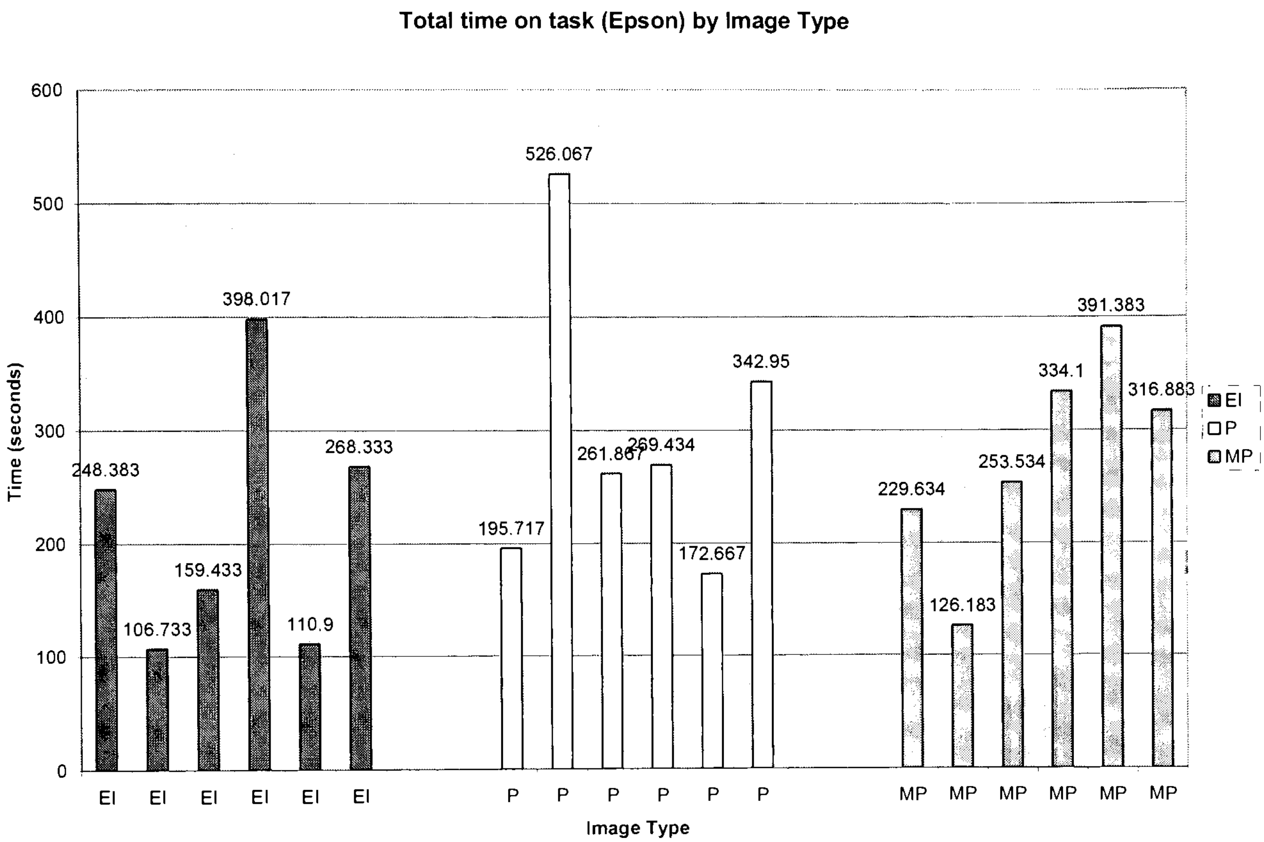


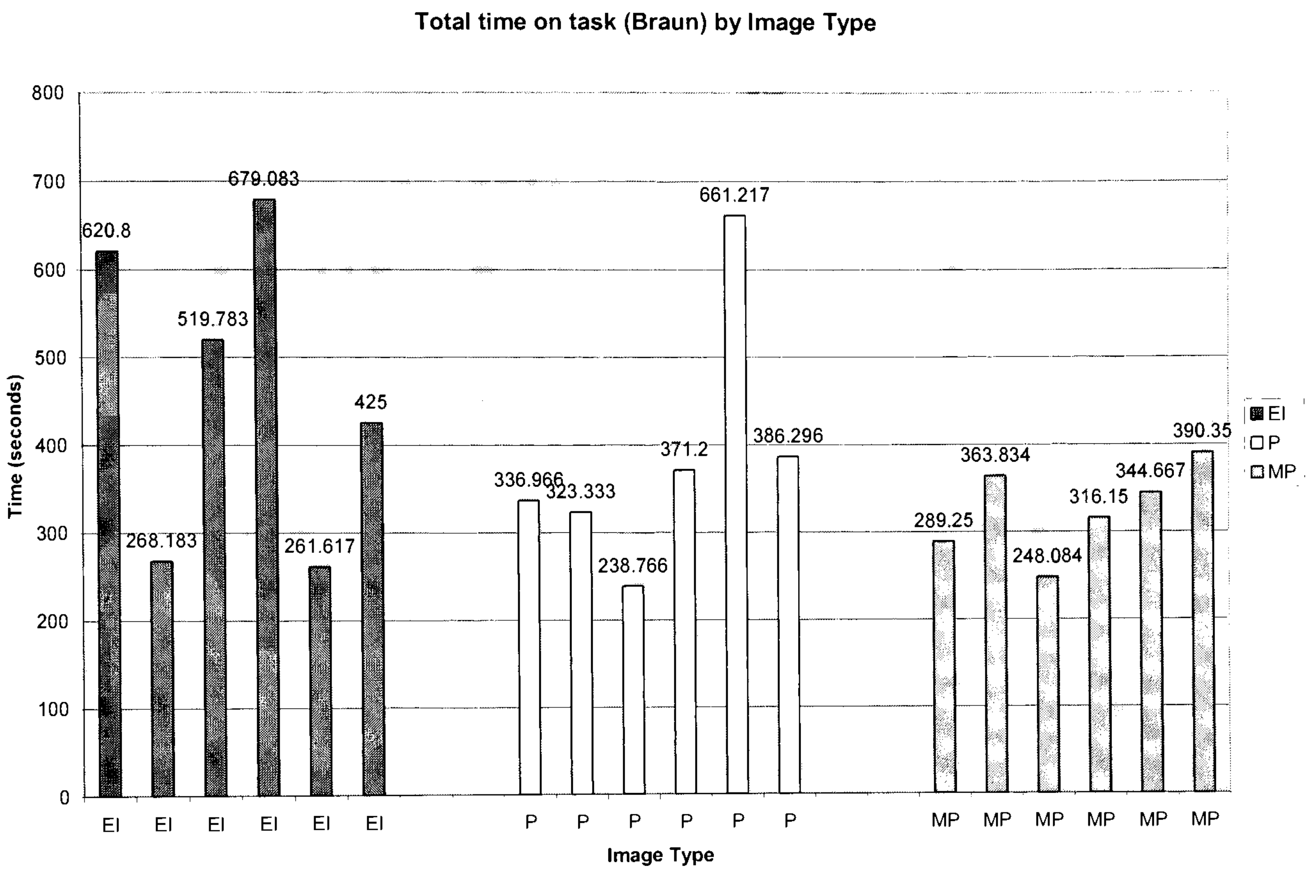

Total time on task (HP) by Image Type
Time (seconds)
200
180
160
140
120
100
80
60
40
20
0
52.283
64
113.917
62.966
187.983
134.867
100.333
65.866
66.333
104.95
81.433
94.9
78.583
74.583
59.65
109.95
89.784
59.1
EI EI EI EI EI EI
P P P P P P
MP MP MP MP MP MP
Image Type
EI
P
MP

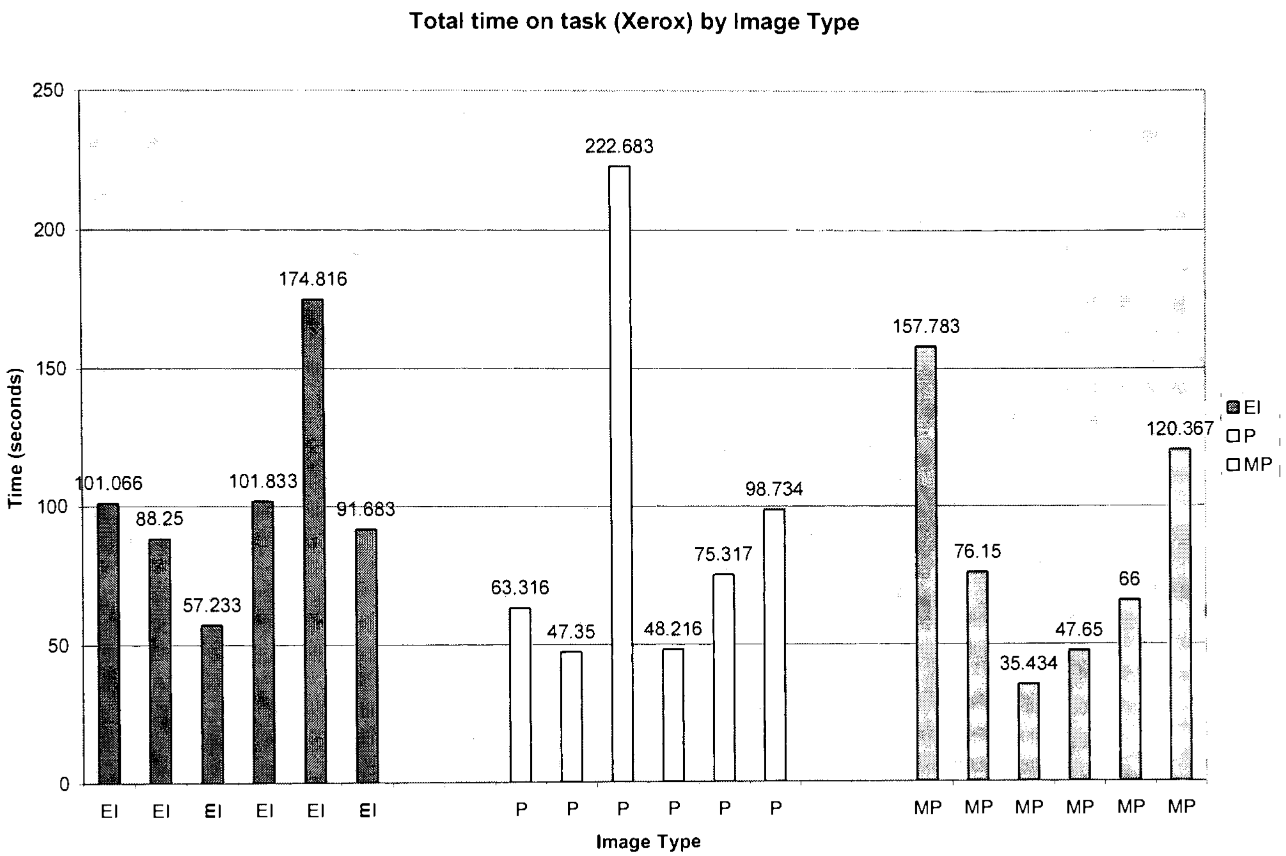

Total time on task (DirtDevil) by Image Type
Time (seconds)
350
300
250
200
150
100
50
0
256.516
302
324.716
224.417
165.866
165.867
204.75
189.316
202.566
328.917
211.65
220.816
218.316
235.133
112.45
131.1
183.783
217.483
EI
P
MP
Image Type



Total time on task (Roomba) by Image Type
Time (seconds)
900
800
700
600
500
400
300
200
100
0
287.267
309.016
334.567
596.3
393.934
298.7
791.316
192.433
374.634
285.15
296.234
348.05
479.584
384.4
220.566
236.267
448.384
345.534
EI EI EI EI EI EI
P P P P P P
MP MP MP MP MP MP
Image Type
EI
P
MP


Total time on task (Epson) by Image Type
Time (seconds)
600
500
400
300
200
100
0
248.383
106.733
159.433
398.017
110.9
268.333
195.717
526.067
261.867
269.434
172.667
342.95
229.634
126.183
253.534
334.1
391.383
316.883
EI
P
MP
EI EI EI EI EI EI
P P P P P P
MP MP MP MP MP MP
Image Type


Total time on task (Braun) by Image Type
800
700
600
500
400
300
200
100
0
Time (seconds)
620.8
268.183
519.783
679.083
261.617
425
336.966
323.333
238.766
371.2
661.217
386.296
289.25
363.834
248.084
316.15
344.667
390.35
EI EI EI EI EI EI
P P P P P P
MP MP MP MP MP MP
Image Type
EI
P
MP


Total time on task (Xerox) by Image Type
250
200
150
100
50
0
Time (seconds)
101.066
88.25
57.233
101.833
174.816
91.683
63.316
47.35
222.683
48.216
75.317
98.734
157.783
76.15
35.434
47.65
66
120.367
EI
P
MP
EI EI EI EI EI EI
P P P P P P
MP MP MP MP MP MP
Image Type

D. Project Documents

a. Informed Consent Form

Rochester Institute of Technology

INFORMED CONSENT FORM

Project: Eye Tracking Usability Study, 2007

Principal Investigators: Evelyn Rozanski, Niyati Bedekar, Anne Haake, Keith Karn, Brian Ashbaugh

The usability test you have volunteered to participate in will help us to better understand problem solving, decision-making, and perception in individuals as they complete a variety of tasks with different products. We do not anticipate taking more than 60 - 90 minutes of your time.

RISKS

As part of this research study, you will be required to use a head-mounted eye tracker. The eye tracker used in the study monitors your eye movements by monitoring one eye with a video camera while you are performing a task. A special computer uses the video image to determine the direction that your eye is pointing. Your eye will be illuminated with an infrared LED (like that used in TV remote controls). The amount of infrared illumination at your eye is less than the amount outside on a sunny day, and is well within the safe limits. If the eye tracker headband is too tight, it may become uncomfortable and cause a headache. Please let us know immediately if you experience any discomfort so that we can re-adjust the headband and/or terminate the experiment. There are no other known risks associated with the eye tracker.

BENEFITS

This project is intended to contribute to new knowledge in the area of design and usability. In addition, you will gain the experience of being involved in a "real" usability test along with receiving compensation of $15.00 to be paid to you at the completion of the test.

CONFIDENTIALITY

Data will be compiled and analyzed in an anonymous manner. The summary may include discussion of the demographics of the subjects. The session may be recorded on video and / or audio tape, and notes will be taken to record your opinions and actions. This document states that you agree to be video / audio taped while participating in this study. This information may be shared with others for educational or promotional purposes. We will hold as confidential your personal information (such as name and phone number) and use the data only for research purposes.

CONTACT

If you have questions at any time about the study or the procedures, you may contact the researcher, Evelyn Rozanski, Department of Information Technology 475-6147 or e-mail epr@it.rit.edu or Niyati Bedekar, Graduate Research Assistant in the Department of Information Technology 412-551-3483 or email nnb1095@rit.edu.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate at any time. If you decide to participate, you may withdraw from the study at any time; request a break or direct questions to the administrator.

CONSENT

I have read and understand the above information. I have received a copy of this form. I agree to participate in this study.

Participant's signature ______________________________________ **Date** ________________

Participant's name (printed) ______________________________________

Investigator's signature ______________________________________ **Date** ________________

Parent's signature ______________________________________ **Date** ________________

(if participant is under 18yrs. of age)

b. Script

Greetings / Introductions

Welcome to the RIT usability session. I want to thank you for agreeing to participate in our study.

Participated in usability evaluation?.

Have you ever participated in a usability evaluation here at RIT before?

As you know, during today's session, we will make use of an eye tracker to help us understand how difficult or easy online help systems are to use. If you have any questions about the equipment, feel free to ask us and we will gladly explain.

During the session, you will be asked to perform certain tasks. These tasks are prepared to test the product/help system and **not you**. We will be gather comments and suggestions from participants, like you, to improve the help system. We will gather notes as well as record the session for later review.

Tasks / Instructions / Questions

I will present the tasks to you, one at a time. If you don't understand the task, please ask and I will explain it further. You may also have questions once you get started on a task and I encourage you to ask questions as you go along. Sometimes I may not answer them directly, because it's important for me to be able to record when people have problems and how they solve them.

Head Movements

Please **do not** make sudden head or body movements during the tasks. Any significant movements may cause the eye tracker to lose track of where your eye is. If this happens, I will ask you to pause on the current task to make adjustments.

Between every one or two tasks, we shall recalibrate the eye tracker in order to acquire the most accurate data.

Swiveling Chair

The chair swivels. So I ask you not swivel it too much during the actual study as that might throw off the eye tracker.

Stopping

There is **no time limit** on any of the tasks, but if you ever get to a point where you are lost or don't think you can continue, don't want to continue, or just need a break please let

me know. Likewise, when you believe you have completed the task successfully let me know that.

Videotaping

Before we begin I want to point out the video camera in the room. They allow us to review a portion of the evaluation that we may have missed, and also allows us to better understand peoples' interactions with the system. That is why we had you sign such an agreement on the ICF.

Relax

Finally, if is important to keep in mind that we are evaluating this product, not you. So, you can relax and hopefully have some fun doing this.

Duration / Any Questions?

I estimate that the study will take about an hour. Do you have any questions about the testing process before we start?

Calibration Process:

This is trickiest part of the process. I ask that you be absolutely still during this process since I might take us longer to calibrate otherwise. Once, the calibration is done, you will have some leeway to move about.

c. Post-test questions

Based on your experience, how important is text in help systems?

Based on your experience, how important are images in help systems?

Rank Order these image types based on your preference:
(1: best, 3:worst)

Graphical illustration
Photograph
Modified Photograph

Basis for the ranking?

Prior Experience

HP Printer ___ Yes ___ No
Last Used:
How often:

Dirt Devil ___ Yes ___ No
Last Used:
How often:

Roomba ___ Yes ___ No
Last Used:
How often:

Epson ___ Yes ___ No
Last Used:
How often:

Braun Coffee Maker ___ Yes ___ No
Last Used:
How often:

Xerox Printer ___ Yes ___ No
Last Used:
How often:

d. Scenarios

HP Printer – "Imagine that your HP printer just flashed a message on the front panel indicating "Low ink levels". Resolving this issue might require cartridge replacement. Please use the documentation provided to check the ink cartridge."

DirtDevil Vacuum – "Imagine that your DirtDevil Jaguar vacuum cleaner has recently started making weird noises. You believe it is a problem with the brush rolls. Please use the provided help to check the brush roll and belt."

Roomba Vacuum – "Imagine that you recently bought a Roomba robotic vacuum cleaner. It's been a while since you've cleaned it. To keep it in working condition, you need to make sure it is dirt free. Tasks involved are cleaning the brushes and changing the filters. Please use the given documentation to perform these tasks."

Epson Projector – "Please use the provided documentation to project a clear, crisp image in the rectangle indicated."

Braun Coffee Maker – "Imagine that your office recently bought a Braun Tassimo coffee maker. You wish to make coffee with this machine, in the auto mode. Please use the provided documentation to make yourself a cup of coffee."

Xerox – "Imagine that you want to assemble the paper and output trays for your recently purchased XEROX printer. Please use the documentation to perform this function."

e. Calibration Image