

Student Reaction to an Interactive Compact Disk on Engineering Graphics

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ABSTRACT

In the Fall semester of 1996, the freshman engineering graphics class, with an enrollment of 170, was introduced to the Beta version of an interactive multimedia computer compact disk (CD) entitled "Graphics Interactive." It was assigned, in addition to a conventional textbook, as required review material for the class. The CD assisted in visualizing the principles of orthogonal projection and sectioning in engineering drawing, geometric dimensioning and tolerancing, the geometric relationships involved in descriptive geometry, and other engineering graphics topics. The CD presented classical engineering graphics topics using a combination of animation, audio description, and interactive exercises. At the end of this first semester, a student survey was taken to assess student reaction to the CD. Results of the survey indicate that the new presentation media was extremely well received and helped with the understanding of the course material.

Introduction

Interactive multimedia computer presentation has started to appear as a delivery vehicle for education. Initially used for computer games, this technology brings audio, video, and interactive user interfaces to the personal computer. Engineering education is now realizing the potential of multimedia as a learning and teaching tool. Engineering educators that have experimented with various multimedia instructional aids include Rais-Rohani and Young (1996), Lipman and Lieu (1994), and Agogino and Hsi (1994). One of the clearest advantages of multimedia in engineering education, particularly in engineering graphics, is the use of new media types to present topics that are difficult to understand, visualize, and/or illustrate. For building students' understanding of orthogonal projections or how a 2D representation correlates to a 3D object, 3D animation of objects, scanned pictures and sketches, and other media, have a significant

advantage over the inanimate graphics of traditional text books (Wilson, 1996). An additional benefit is that more than one type of media can be used to simultaneously present information.

At the University of California at Berkeley (U.C. Berkeley), a multimedia tutorial has been developed by Krueger and Lieu (1996) that focuses on engineering graphics. The tutorial, entitled *Graphics Interactive* (1997), was intended to be a learning aid that supplements the textbook and lectures in a freshmen engineering graphics course. Much of the effort in developing the tutorial was focused on using the tools provided by multimedia to aid 3-dimensional (3D) visualization through animation, focus the user on graphics rather than text through audio narration, and promote learning by association through interactive user interfaces. The tutorials were authored using *Assymmetrix ToolBook™*. The animations were created

using *Autodesk 3-D Studio™*. The audio development was done with standard *Microsoft Windows™* development tools. The entire tutorial development effort took place mainly during the summers over a span of approximately three years.

In the Fall semester of 1996, the freshman engineering graphics class, with an enrollment of 170, was introduced to the Beta version of *Graphics Interactive*. It was assigned, in addition to a conventional textbook, as required review material for the class. At the end of the semester, a survey, specific to the *Graphics Interactive CD*, was taken. The survey presented questions about the organization of the CD, its clarity, and its ease of use.

Tutorial Organization

The tutorials were offered to students in the form of Beta version compact disks (CD's) that the students could run on their own personal computers or on the personal computers provided by the UC Berkeley in the engineering graphics laboratory. The topics covered by the CD were those found in a typical college entry level engineering graphics courses. The table of contents is shown in *Table 1*.

The typical layout of a tutorial presentation page is shown in *Figure 1*. A typical problem solution page is shown in *Figure 2*. In both page types, the user can initiate a response from the computer by selecting buttons or regions with the pointing device. The contents of the central region change from page to page, but the border is constant; namely, the menubar is always present, as are the page forward/backward arrows on the lower right-hand cor-

ner of the page. Most pages also contain a "repeat" and a "pause" button, located in the lower right-hand corner of the page, that allow an audio narration to be replayed or paused when selected. Additionally, whenever an animation appears on the page, a "repeat animation" button is present so users can replay the animation. Many of the pages also contain "hot regions" which present different animations when selected. Control of the user environment is implemented through the menubar. The "Options" submenu allows the audio narration to be turned on or off and its volume adjusted.

Navigation in *Graphics Interactive* is managed with the menubar and the page forward/backward arrows. The "Navigate" submenu allows users to navigate directly to any chapter or subsection listed in *Table 1*, or to simply move one page ahead or back in the current section. The page forward/backward arrows also allow the users to page through a section of the tutorial or to go directly to any page within the current section by entry on the keyboard.

Using a combination of 3-dimensional images, animation, and audio narration, the tutorials explained many of the basic principles of engineering graphics which would be difficult with text and 2-dimensional draw-

Introduction and History	Orthogonal Projection	Geometric Dimensioning
Sketching	Pictorials	Tolerancing
Engineering Drawing	Sections	Descriptive Geometry

Table 1 - Graphics Interactive CD table of contents.

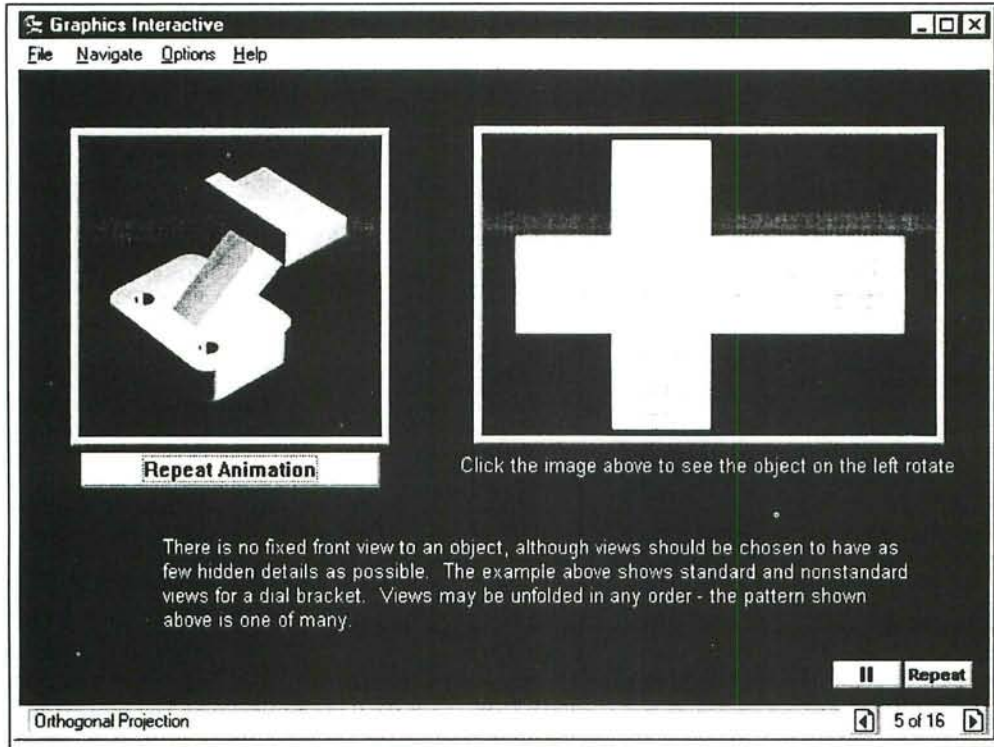


Figure 1 - Example of a typical presentation page. Selecting a view on the right causes the 3D image on the left to rotate to show the corresponding side of the part.

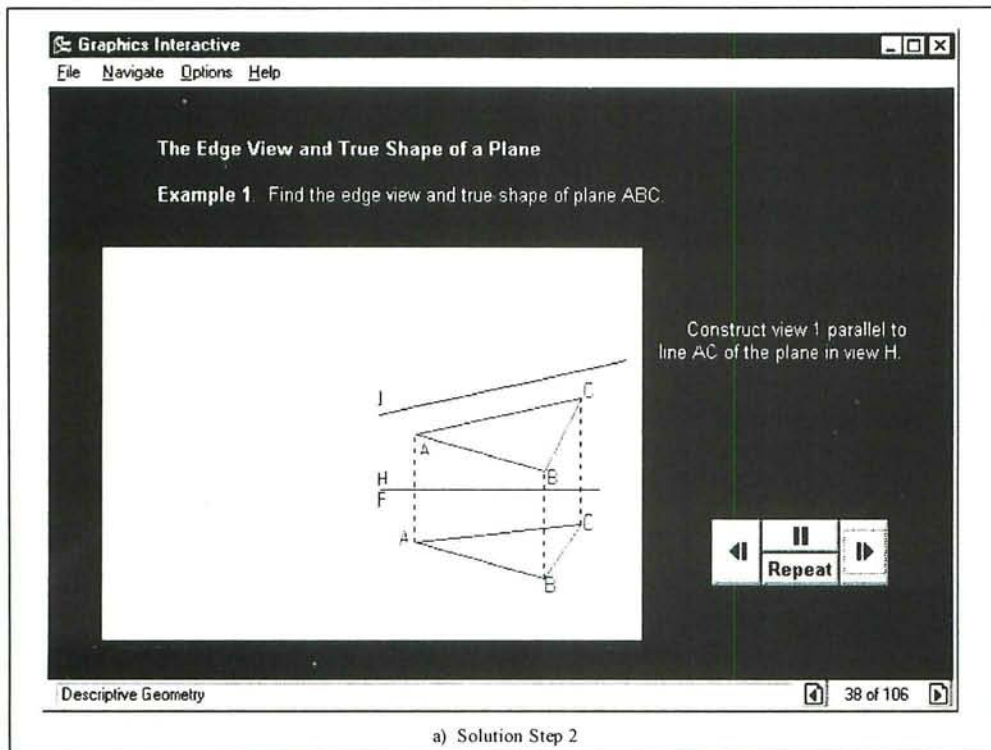


Figure 2 - A typical problem solution page. The forward and backward buttons allow the user to step through the construction of the solution, with an explanation at each step.

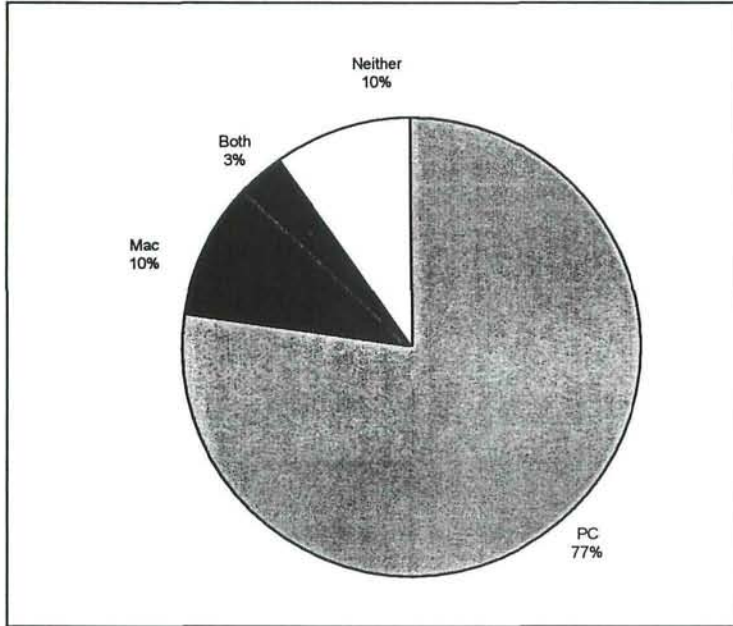


Figure 3 - Type of computer accessible to students outside of the laboratory.

ings, as with conventional textbooks or lecture notes alone. A series of interactive example problems, with solutions, that parallel the course lectures and assignments were part of the CD. These examples provided step-by-step solutions to traditional graphics problems, explaining at each step the proper procedure to reach the solution.

Course Organization

The engineering graphics course at UC Berkeley is a single semester, 3 unit course. There are 3 one-hour lectures and one 3-hour lab per week. The lectures are conducted with the entire enrollment in a large lecture hall. Laboratory sections are divided into 6 groups of 30 students each. Attendance at the laboratory sections is highly recommended, but not required. This

“open” laboratory policy permitted students to use their home computers for the required assignments, as well as the computers in the graphics laboratory. Homework is assigned weekly. Additionally, there is a semester long group design project. The course is required for all mechanical engineering, civil engineering, manufacturing engineering, and naval architecture students.

Laboratory Resources

Computer ownership was not required for the class, and students had 24-hour access to a computer lab which could run the CD.

For a class of 170 students, there were two computer laboratories with 30 90 MHz Pentium class computers in each lab. Each machine was equipped with a 16 Mb of RAM, video accelerator, sound card, and a

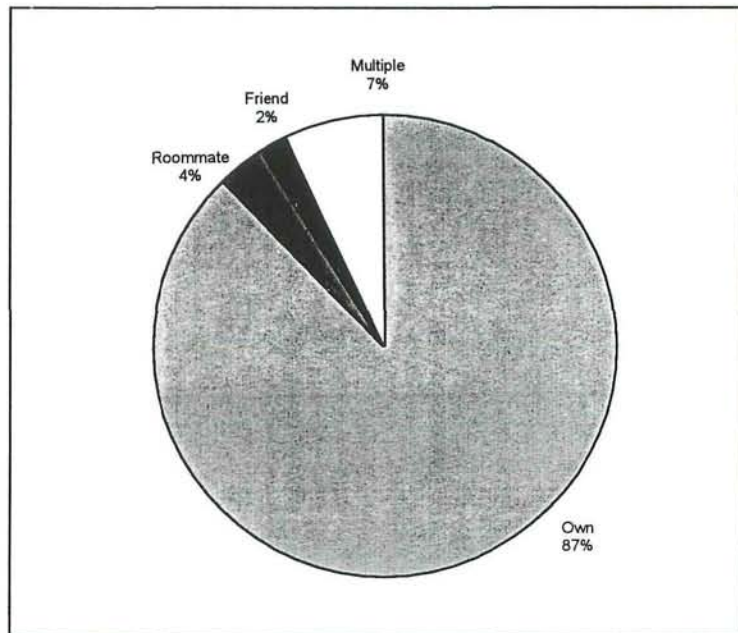


Figure 4 - Method of access to computers outside of the laboratory.

2x CD player. The computers were configured to *Autodesk AutoCAD™* from the hard disk drive and the tutorial CD from the CD player. Students were required to bring their own earphones if they wanted to hear the audio output of the CD. Even though it was possible to switch between two programs on the same computer, it was noted that many students found it convenient to simultaneously use two computers that were side-by-side: one running *AutoCAD* and the other running the tutorial CD.

Student resources

The large “virtual laboratory” provided by students who had access to computers outside of the University lab provided a very valuable resource. The ability to view the tutorial outside of the laboratory, at the students’ homes, was considered an important factor for the success of the CD. The extent of the virtual laboratory was unknown until the survey at the end of the course. The result of the accessibility survey question, shown in *Figure 3*, indicated that of the students who responded to the survey, 90% had access to a computer outside of class. 77% of the total test group had access to a PC. Also, as shown in *Figure 4*, 87% of those with access to computers outside of the University lab owned their own machines. The high percentage of students with home computers, as at UC Berkeley, would almost certainly have a positive effect on the success of the tutorial CD.

The student computer ownership survey also showed that of the computers outside the lab, 82% were Pentium class machines, 95% had CD players, 86% had sound cards, 95% had internet access, and 79% had all four of the previous options.

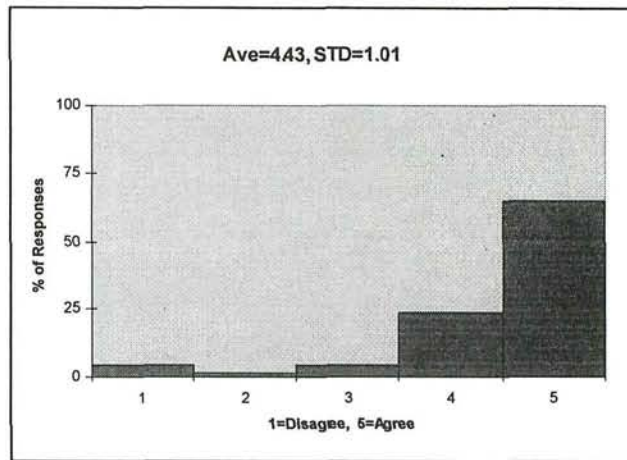


Figure 5 - Understood functions of buttons and how to navigate the first time used.

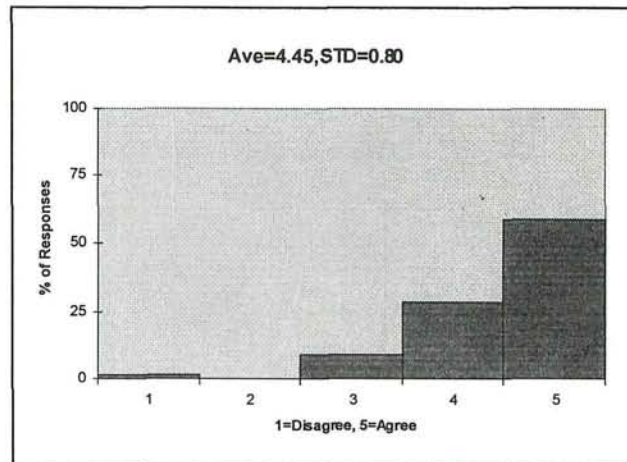


Figure 6 - Understood which words or buttons could be selected to prompt a response from tutorial.

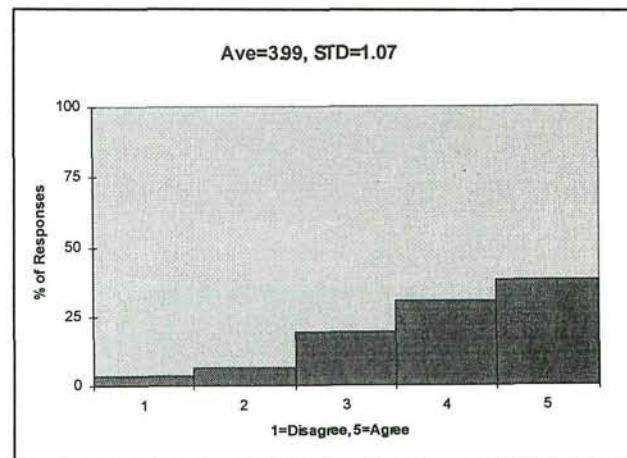


Figure 7 - Able to easily navigate to find desired examples, quizzes and/or explanations.

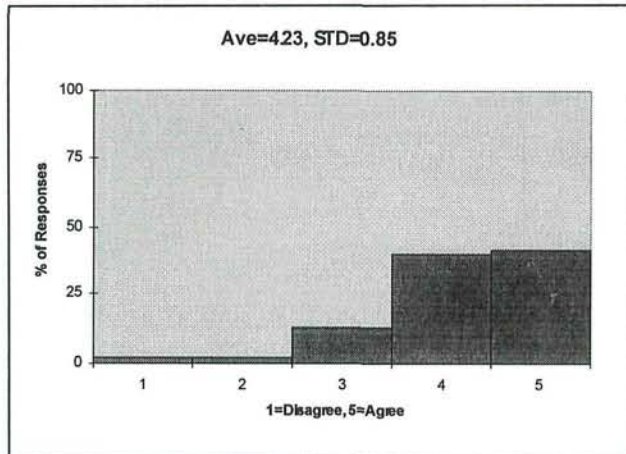


Figure 8 - Useful in explaining lecture material.

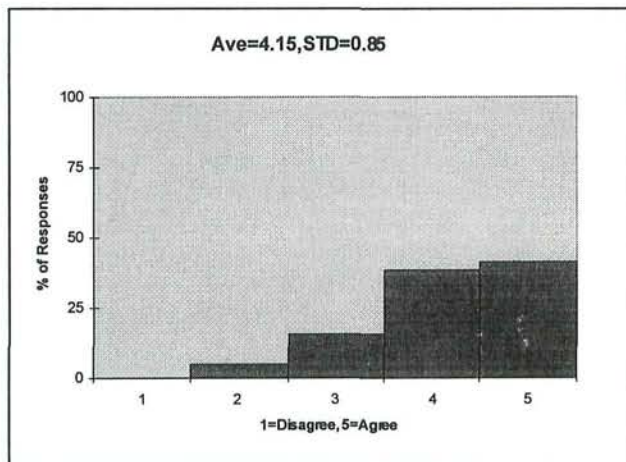


Figure 9 - Helpful for homework assignments.

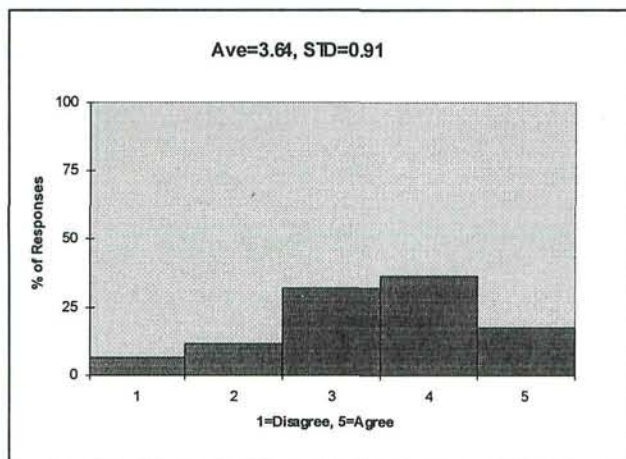


Figure 10 - Useful in preparing for exams.

Survey Questions and Responses

More interesting, however, were the responses to the survey questions about the usefulness of the CD in the class, and how students used the new media. The first questions on the survey asked about the ease of use of the tutorial. Figure 5 and 6 shows that the vast majority of students understood how to use the tutorials the very first time. These questions related more to the organization of the CD and the layout of the screens rather than to the use of multimedia itself. Later questions related more to the use of multimedia itself.

Figure 7 shows that the means of navigation through the CD to find specific examples or explanations could have been improved, although the results were already rather favorable. The final version of the tutorial uses an improved indexing system, as a result of this survey. In the final version, a separate, movable toolbar allowed the user to conveniently page forward, page backward, go to the contents page, or exit the program.

The usefulness in helping to understand the lectures and completion of homework assignments is shown in Figures 8 and 9. It appears that vast majority of the students found the CD tutorials to be very helpful, in terms of conventional measurements, for the understanding of the course material.

In particular, student written comments indicated that the tutorials were especially helpful for descriptive geometry. Descriptive geometry is considered the most difficult part of the course, and, as such, received a more extensive treatment on the tutorials. Many students also

indicated that the use of animations on the CD made many topics clearer than was explained in the lectures.

As would be expected, the ratings were not as strong when the students were asked if the tutorials were helpful for the preparation for exams (*Figure 10*). The course at UC Berkeley is graded according the guidelines recommended by the University. The average GPA for the course is 2.5/4.0. The exams in the course account for 60% of the final grade.

The inclusion of audio descriptions on the CD received somewhat mixed reviews, as shown in *Figure 11*. Some students found it quite helpful, while a similar number of students did not use the audio portions at all. The audio portion followed the screen text almost exactly, and many of the written survey responses included comments such as, "Audio unnecessary, we can read." Still it seemed that the audio portion was able to perform its intended purpose, which was to permit the student to concentrate on the graphics, rather than try to read text from the screen. For future versions of the tutorial, it may be possible to include a feature to remove the screen text when the audio is active. Removal of the text altogether would not be possible, as this would not be accommodating to hearing impaired students.

The overall usefulness of the CD was rated at 4.09, which represents a significant increase over conventional textbooks in past years (*Figure 12*). In past years, when asked to rate the textbook for usefulness in the class on a scale from one to five (five is most useful, one is least useful), a conventional textbook would rate an average

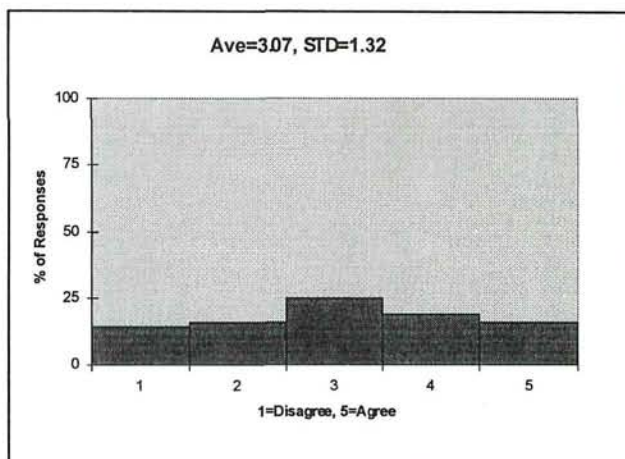


Figure 11 - Audio narration useful.

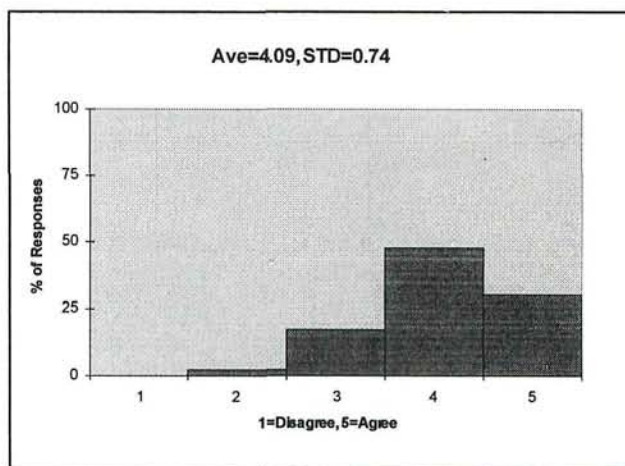


Figure 12 - CD tutorial useful overall.

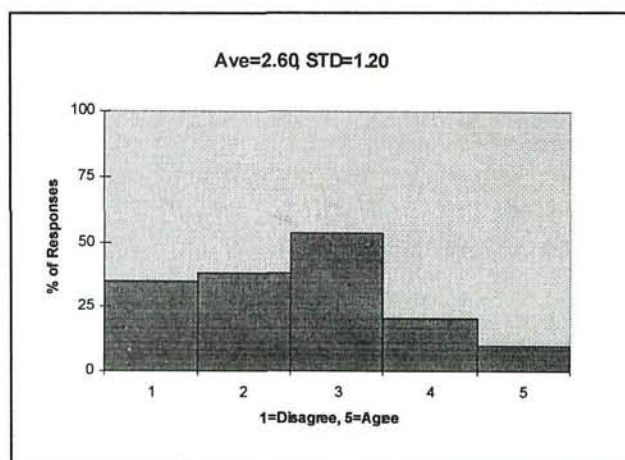


Figure 13 - Typical response for usefulness of conventional textbook (1995).

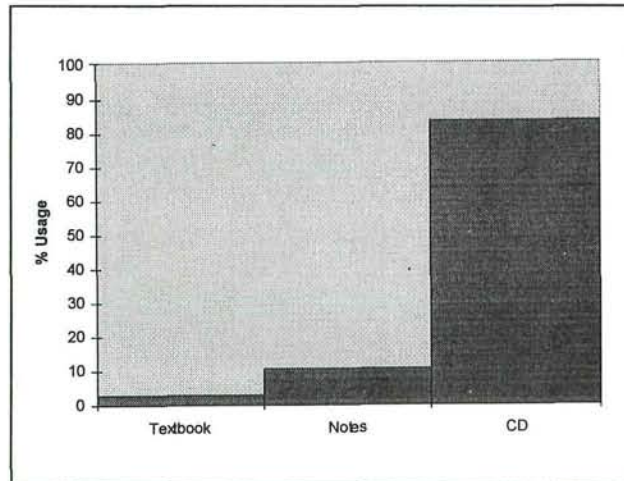


Figure 14 - Distribution of study time.

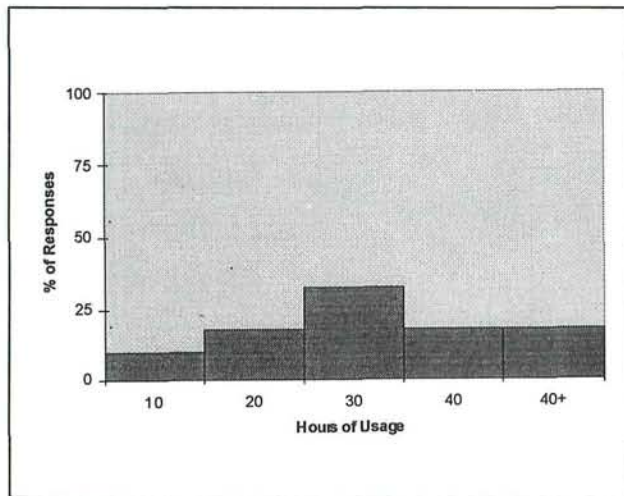


Figure 15 - Hours of CD tutorial usage.

of between 2.50 to 3.00. Figure 13 shows the student response to the usefulness of the (conventional) textbook in a 1995 survey. The distribution shown is typical for any textbook previously assigned in this course.

Students were asked which of the study aids they used for the course. The results are shown in Figure 14. On average, while studying, students claimed to use the CD 83% of the time, their own notes 10% of the time, and the conventional textbook only 3% of the time. However, since the CD tutorial

was designed to follow the course as taught at UC Berkeley, it is not likely that similar responses would be expected if the tutorials were used elsewhere.

The average time of usage for the CD was 20 hours during the class, although the range was quite wide (Figure 15). 10% of the respondents never used the CD, while 30% used it exclusively. An average of 20 hours use for the entire course appears to be shorter than would be expected for any textbook. Thus, it appears likely that the CD was a more efficient means of delivery for the course material.

Concluding remarks

The description of the contents of the tutorial reveals that it gives a thorough discussion of engineering graphics, but the material is rather standard. The novelty of this application is that the material is presented in an interactive multimedia format. Nearly all of the topics encountered in an engineering graphics course deal with 3D objects or concepts, which are often difficult to visualize. This is especially true in the cases of orthographic projection and descriptive geometry. In both cases, 3D representations and animation of these representations can benefit students trying to relate 2D drawings to the 3D objects they represent. The most useful contribution of the CD was in assistance in explaining the lecture material, especially with the sections on descriptive geometry.

References

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