Technical Data Presentation: A New Course Offering for Engineering Graphics Programs

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Abstract

During the spring semesters of 1999 and 2000, a new engineering design graphics course was introduced to the university course offerings at NC State University through the Graphic Communications Program. The author developed this course titled “Technical Data Presentation” to meet future needs of the university, especially for areas in science, business, education, and technology. The course was designed to attract students other than the traditional engineering students that already have, as a part of their education requirements, a traditional engineering graphics course. This paper will describe the development process for the implementation of a course of this type, as well as explaining the topics associated with the course and how they are alike, and different, from traditional engineering graphics. Information gathered from the instrument titled Motivated Strategies for Learning Profile (MSLP) about student perceptions of the course will be discussed as well.

Introduction

During the past 20 years, the profession of engineering graphics has seen major changes in the content and curriculum taught in our classrooms. With the advent of the personal computer and new technologies, major changes have taken place in what we teach and to whom we serve. Although these major shifts in pedagogical strategies and content exist, the profession still needs to continue to grow and develop new avenues to reach a broader range of students whom all need visual literacy in a information-based world (Wiebe, 1992). Given these changes, the Graphic Communications Program at NC State University developed a new course offering that was targeted to students that were not engineering majors, but to students from other disciplines that wanted to learn how to visualize and use graphics in their chosen professions. Students from business, marketing, communications, education, and science were participants in this new course called Technical Data Presentation. In this new course, students learn the same basic visual techniques taught to engineering students in a traditional engineering graphics course, but with different media. Examples used in this graphics class did not surround the common areas of architectural, civil, or mechanical engineering, but laboratory assignments came from areas in meteorology, physics, environmental science, business, education, medical, and art. The rationale for offering a course of this type was to provide a vehicle for the development of a new paradigm in graphics at NC State University, in which students from technical and scientific disciplines are exposed to a wide variety of graphics-based tools to develop their visual abilities, and to have future success in their chosen professions (1992).

Visualization

The main focus of a course of this type is to teach people how to visualize. To visualize is the ability to recall or form mental images associated with spatial abilities, creative thinking, and problem solving (Roth, 1993). Imagery is the foundation for the ability to understand and recognize the ability for visualization and to think in a visual way. Linked to imagery is perception, that is the main focus for imagery and is the heart of the creative process associated with visualization and visual thinking. The development of visual thinking is directly related to intelligence and the quality of thinking to the fullness of seeing (Martinello & Mammen, 1982). Considering this broad definition of visualization and the ability to think visually, engineering curricula throughout the United States of America have often tried to meet these skills and abilities for students in their programs by offering a course in engineering graphics with the emphasis on teaching theoretical concepts and their practical applications (Leach & Rajai, 1995). Although this process of teaching visualization to engineers has a long history, still we see students coming to and
from our classes having difficulty visualizing both two and three-dimensional drawings while trying to find a solution to a graphics problem (Wiley, 1990). With engineering professions and others becoming more three-dimensional-based, the need for students to understand and use spatial abilities to become visual thinkers is a must for success in current engineering practices and other related professions (Barr, Juricic, and Barr, 1991).

Spatial abilities are defined by many researchers as the innate ability we all have before any formal training in visualization takes place. Once we are trained to manipulate our visual abilities and can use these controls to improve or enhance our ability to communicate, then one can assume to have spatial skills (Sorby, 1999). Although everyone can have spatial skills, there is a direct correlation between students with high spatial abilities and those with good spatial skills. Research has shown that early influences on life lead to the development of spatial abilities. Boys usually have better abilities than girls, but this may explain to some people as to why boys may seek out careers with a high need for visual ability (i.e. engineering and science), it is import that everyone be given a chance to develop their visual skills and learn to apply these skills in real-world situations (Stanic & Owens, 1990). Therefore, the need to understand and use spatial abilities and skills to visualize information has been important to educators for many years, but little effort towards training students in these areas has been given at both the secondary and post-secondary levels. Because of this lack of infusion into our educational system, students have vast differences in their ability to visualize, especially in three dimensions (Anand, Aziz, and Agrawal, 1987). But, in the last decade, a trend has started and a resurgence of interest in visualization and spatial abilities/skills has emerged and professionals in the field of education are starting to see the need for this type of training for all students at both secondary and post-secondary levels no matter what a student’s interest or discipline (Greeson & Zigarmi, 1985). This ability to visualize opens many doors for communication between people, professionals, and especially for individuals in the fields of science, mathematics, technology, business, education and engineering (DeFanti & Brown, 1989). Therefore, more course offerings that would attract students in both secondary and post-secondary education to visual skill development need to exist to accommodate this need and diversity of capabilities among students (Clark & Matthews, 2000).

History of Technical Data Presentation in North Carolina

During the 1995-96 academic year, the Graphic Communications Program at NC State University began the development of a secondary curriculum titled Scientific and Technical Visualization(SciVis). This curriculum was developed in conjunction with the North Carolina State Department of Public Instruction and Wake Technical Community College with the rationale that creating a curriculum of this type would attract students into the course that would not normally take a technical visualization course. Currently, most secondary and technical school course offerings that teach any type of technical visualization are in drafting programs primarily focusing on mechanical and architectural drawing (Wiebe & Clark, 1998). This course was designed to complement rather than replace these mainstream courses with the outcome of greatly enhancing students’ abilities to visualize all forms and types of data from a multitude of disciplines and fields of study.

The SciVis curriculum focuses on six primary areas of instruction. The first is basic design principles and how they relate to different data types. Second, the graphing and plotting of different types of data are explored. Third, students learn to manipulate images and process these images to enhance understanding of information. Fourth, developing both two-dimensional and three-dimensional models for all types of conceptual and data-related information. Next, students explore the use of animation and simulation as it can be related to areas of science, technology and engineering. Finally, students learn how to prepare a presentation and the types of final presentations that can be given (Clark & Wiebe, 2000). After two years of development and piloting the curriculum, the course became a part of the course offerings to students in public secondary education throughout North Carolina. Seeing the success of this initiative, and having students coming to the university system with good visual skills, the authors of the curriculum felt that a course of this type would appeal to post-secondary students majoring in sciences, education, humanities, and business at NC State. Once the college level course was developed in the fall of 1998, the course was offered in the spring of 1999 and 2000 with the hope that some day it would become a part of the general education offerings.
Technical Data Presentation

Technical data presentation, or scientific visualization in some communities, requires the presenter to make decisions about the type of data, manipulation of variables, targeted audience, and computing needs (Wiebe, 1992). Technical data can be classified as one of the following three types. First, conceptual-driven modeling is the process of taking information, most likely not empirical data, and generating a concept or theory in either two or three dimensions. Typically, the types of data shown as a concept would be something that is not normal seen in a visual form and by making it visual, the targeted audience can develop an understanding of the information. An example of a conceptual-driven model would be the drawing of a virus. No one has ever seen a virus, but we know they exist; therefore, the model can be used to conceptualize what the presenter has in mind as to its characteristics. These models can be either static or dynamic, sometimes movement or animation is needed for clarity. The second classification for technical data is data-driven modeling. These models use empirical or mathematically derived values to formulate a visualization. Most commonly seen as data-driven models are data with a numeric value that can be placed into a spreadsheet and developed into a chart or graph. These models can also be either two-dimensional, when the graph or chart is to show one independent and one dependent variable, or three dimensional, for one independent and two dependent variables. Also, the type of data used with data-driven models can be further broken down into sub-categories of either quantitative or qualitative data type (Wiebe & Clark, 1998). The third type of technical data classification is theoretical modeling. The modeling classification is sometimes called predictive modeling were the data is generated to predict an event. Linear regression is considered a basic form of theoretical modeling derived from data, but concept-based models do exist. Examples would be profiling a gene sequence or developing a model or illustration of a serial killer for law enforcement agencies. Given the complexity that exists with predictive or theoretical modeling, the Technical Data Presentation course developed for undergraduate students at NC State did not include this classification of modeling (Clark & Matthews, 2000).

Technical data presentations are for a variety of audiences. The intended audience and their backgrounds allow the presenter to decide how the information is to be presented and in what format. Related elements to the presentation are the use of color, media type, and layout. Presentation media can be the traditional lecture with overhead transparencies, or electronic. Typically, formats for presentations are either electronic using a computer projector; the use of Smartboard and related distance technology; video output for both computer and VHS tape; or in web-based formats. Color is used to enhance these presentations by showing relationships to variables in a visualization (i.e. blue for cold, red for hot). Given the nature of the presentation, some will use basic color schemes while others will include renderings or photo-imaging processing. Overall, all technical data presentations, no matter the media type, will fall within one of the four following categories; two-dimensional data driven, three-dimensional data driven, two-dimensional conceptual (static or dynamic), and three-dimensional conceptual model(s) (static or dynamic) (Clark & Wiebe, 2000).

Course Description

This course was designed to introduced students to appropriate methods for analyzing, visualizing, and representing technical data and information. Students studied basic visual science concepts and applied this knowledge in developing technical data presentations that were both data and conceptually driven. Students learned software (e.g. PowerPoint, Excel, Corel Draw, and TrueSpace) that allowed them to create professional presentations, illustrations, and 3-D animations. The major focus of this class was to have students become visually literate and understand the role that technical graphics has in the workplace and everyday life. Listed below are major course goals:

1. Students are to become familiar with different ways to present technical data.
2. Students are to understand the appropriate techniques used in presenting different types of data.
3. Students will be able to manipulate different types of data using a variety of software packages.
4. Students will learn how to manipulate data with one and two independent variables.
5. Students will be able to develop and produce both conceptual and data-driven visualizations.
6. Students will understand the history related to traditions within the field, data visualization, and computing technology.

ASEE Southeast Section Conference
Students will understand and develop visualizations based on the use of color and shape.

Students will understand and develop visualizations for communicating using different visualization theories.

Students will demonstrate proper ways to present different types of data.

Students will learn alternative ways to communicate different types of technical data.

Students will learn and demonstrate an understanding of various ways to present data in different professions.

Students will learn basic modeling theory and be able to apply this knowledge in developing both 2-D and 3-D static models and animations.

The course was three credit hours, two hours lecture and two hours laboratory. Given the specialized software used throughout the duration of the course, most laboratory assignments were done in class. In addition to the allotted time for classroom activities, outside reading assignments were given for each topic discussed in class and required research activities were required using the Internet as a data harvesting tool (Clark & Matthews, 2000).

**Outline of Content and Activities**

The course was developed to include five major areas to be taught within a 15-week semester. The first area of instruction introduced students to technical data presentation, the use of software in general presentations (i.e. PowerPoint) and the history of graphics, technical graphics, and general computing. Students were given a chance to practice their skills over the two-week period by developing a presentation about themselves in a resume form. After students received the basics for the course, the next topic dealt with data-driven models. In this topic, students learned how to use Excel to develop different types of charts and graphs and when one type of graph is more appropriate than another. Students had the opportunity to develop both one independent variable graph, as well as a two independent variable graph over a period of three weeks (See figure 1). Next, students studied how image processing can be used to enhance the understanding of pictorial information. Students were introduced to the topic with special attention given to the areas of business graphics, academic/research, and scientific visualization.

Software used in this part of the course included Scion, Corel Draw, and Photo Shop. Activities included the over-drawing of a cell and image manipulation (See figure 2). This part of the course lasted for three weeks. The major area that followed image manipulation was conceptual-driven modeling. In this part, students learned the basics of visual theory and how it applies to technical data presentation, as well as storyboarding, two-dimensional and three-dimensional modeling, and the use of design briefs. Software and activities used in this section of the course included Corel Draw for two-dimensional animation by making a cell split; three-dimensional modeling of a virus in TrueSpace; and a simple two-dimensional animation of a topic of choice by the student (See figure 3). This conceptual part of the course was done over a four-week period. The fifth and final major area of the course included advanced visual techniques for the last three weeks of class. During this section of the course, students studied advanced rendering techniques, issues related to presentation graphics (i.e. copyright and trademark), and portfolio development. Students were also assigned a final presentation to be given at the end of the semester. The final presentation consisted of at least two data-driven models and one conceptual-driven model, all presented in a
electronic format. This activity was comprehensive and included information students had learned during the course of the semester.

Figure 2. Student example of color and image manipulation.

Figure 3. Student example of a conceptual-driven model in two dimensions.

**Students Perceptions**

The impact of the course on students was determined by having them fill out a survey at the end of the spring 2000 semester. The instrument asked demographic information as well as questions related to student understanding of course topics and materials. These questions came from a standardized test called the Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ is a self-report instrument designed to assess college student’s motivation and learning strategies used for post-secondary courses. The test identifies students as active processors of information; whose belief, attitudes and cognitions are important mediators for instructional material development (Pinterich, Smith, & McKeachie, 1993). Although students were asked to take the entire test, certain questions were of importance to the author of this study and are listed in Table 2.

The demographic information and MSLQ test was given the last week of class during the spring semester of 2000. A total of 19 students answered the demographic part of the questionnaire and 20 students took the test and gave feedback as to how they felt about the course. As for the demographic information, 19 students, or 100% indicated that they learn best by viewing pictures. Eighteen (94.7%) had taken a CAD course prior to this course and 17
(89.4%) had at least one geometry course in high school. Table 1 shows the demographic makeup of the students that were in the technical data presentation course.

Table 1
Demographic Information about Students in the Technical Data Presentation Course Spring 2000

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency*</th>
<th>Percentage**</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 20</td>
<td>2</td>
<td>10.5</td>
</tr>
<tr>
<td>19-20</td>
<td>7</td>
<td>36.8</td>
</tr>
<tr>
<td>21-22</td>
<td>7</td>
<td>36.8</td>
</tr>
<tr>
<td>23-24</td>
<td>3</td>
<td>15.7</td>
</tr>
<tr>
<td>GENDER:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>73.6</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>29.4</td>
</tr>
<tr>
<td>ACAD. LEVEL:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>3</td>
<td>15.7</td>
</tr>
<tr>
<td>Sophomore</td>
<td>6</td>
<td>31.5</td>
</tr>
<tr>
<td>Junior</td>
<td>8</td>
<td>42.1</td>
</tr>
<tr>
<td>Senior</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>WORK EXPERIENCE:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>42.1</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>57.8</td>
</tr>
</tbody>
</table>

*Note: Maximum number for each category is 19.
**Note: Total percentage for each category is 100%.

Other questions asked in the demographic section of the study include the following. First, 19 (100%) students indicated that the content within the course seemed interesting. Eighteen (94.7%) said that the information learned within the course would be useful in other courses. Seventeen (89.4%) indicated that the information learned from this course would help improve their academic skills and 18 (94.7%) said that the knowledge gains from the course would improve their career prospects.

The MSLQ questionnaire had a total of 81 questions asking 20 participating students about learning course content and what motivated them to do the required work within the course. All questions used the same scale with seven indicators for rating/answering each question. Students could choose from the following indicators for each question: (NT) Not True at all of me; (NNT) Nearly Not True at all of me; (SNT) Somewhat Not True of me; (NO) No Opinion either way of me; (SVT) Somewhat Very True of me; (MVT) Moderately Very True of me; and (VT) Very True of me. Overall, students found the course useful and met their expectations. Most students seemed to enjoy learning the content and tried to apply each concept in a way that would be beneficial to their career goals. Table 2 shows the responses given to selected questions from the MSLQ questionnaire asked to each participate.

Conclusions and Recommendations

Conclusions made from the author’s previous experiences and the piloting of this course can basically be discussed looking into three rationales for a course of this type. First, professionals in engineering graphics have a long history of serving engineering and technology students needs in visualization, but with more new
Table 2
Selected MSLQ Questions from Participating Students in the Spring 2000 Technical Data Presentation Class

<table>
<thead>
<tr>
<th>Questions</th>
<th>NT</th>
<th>NNT</th>
<th>SNT</th>
<th>NO</th>
<th>SVT</th>
<th>MVT</th>
<th>VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think I will be able to use what I learn in this class in other courses.</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>It is important for me to learn the course material in this class.</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>I am interested in the content area of this course.</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>I like the subject matter of this course.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>I’m certain I can master the skills being taught in this class.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>I attend this class regularly.</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>I try to apply ideas from course readings in other class activities such as lecture and discussion.</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: Maximum frequency for each question is 20.

and better technologies, other professions are using these same visual tools and need training on how to properly show visual information. Second, students from different majors can benefit from a course like this one in helping to develop visual skills and go more in-depth into their major area of study through the study of visualization. But, changes in the way graphic educators teach will need to happen first and foremost. A paradigm shift will need to take place where course content will no longer focus on standards and conventional practices, but in new areas of design, conceptual and theoretical ideas, color, image processing, rendering, animation, and data manipulation. These new areas are vast, and the instructor will no longer have the expertise in each area, so a new philosophical change needs to happen with a focus on the constructivist theory of learning. In this new philosophical change, the teacher will no longer be the expert in every aspect of what is happening in the classroom but will guide students through their own individual learning experiences. This can benefit the student by having the ability to further study their area or specialty and learn to apply their new knowledge in a visual way. The third and final rationale is that a course of this type is now affordable for most engineering graphics programs. Over the past 10 years, software and hardware has come down in price and most computers used for computer aided design (CAD) can support the software used in a course like Technical Data Presentation. Instructors can start with a simple CAD program and spreadsheet and offer a course of this type. As indicated by the students that took this course last spring, it is beneficial and useful.

In conclusion, it is the goal of professionals in engineering graphics to seek new endeavors in the pedagogy and understanding of visualization. New courses, such as this course in Technical Data Presentation, help us reach more students and aid their overall understanding of visual science. As our society, industries, and culture become more dependent on visual information, our profession should strive to help guide students into the 21st century, which many say will be the “visual-age.”
References


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