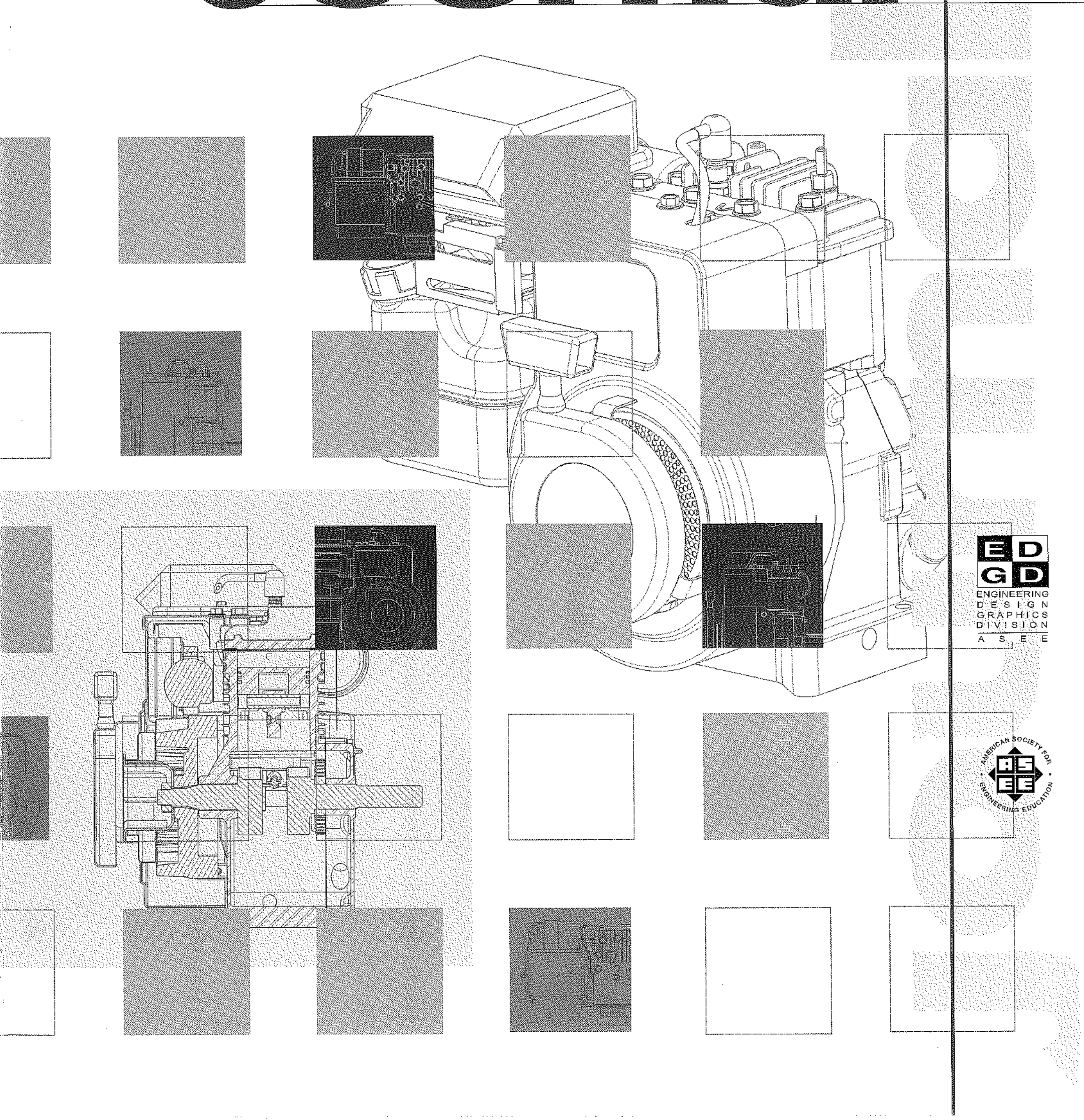
AUTUMN 2001

volume 65 number 3

THE ENGINEERING DESIGN GRAPHICS Journal



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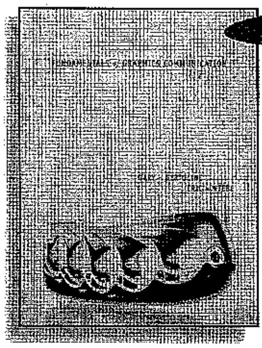

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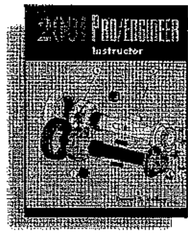

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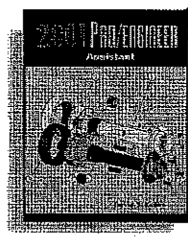

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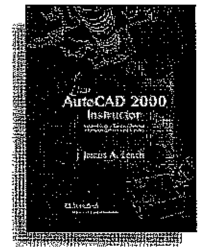

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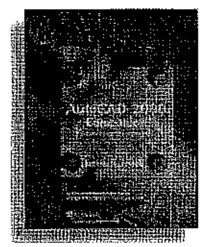

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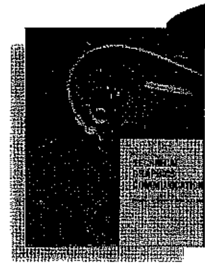

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THE ENGINEERING DESIGN GRAPHICS
Journal

AUTUMN 2001

volume 65 number 3

The Engineering Design Graphics Journal is the official publication of the Engineering Design Graphics Division of ASEE. The scope of the Journal is devoted to the advancement of engineering design graphics, computer graphics, and subjects related to engineering design graphics in an effort to 1) encourage research, development, and refinement of theory and applications of engineering design graphics for understanding and practice, 2) encourage teachers of engineering design graphics to experiment with and test appropriate teaching techniques and topics to further improve the quality and modernization of instruction and courses, and 3) stimulate the preparation of articles and papers on topics of interest to the membership. Acceptance of submitted papers will depend upon the results of a review process and upon the judgement of the editors as to the importance of the papers to the membership. Papers must be written in a style appropriate for archival purposes.

Cover graphics created by graduate students Travis Fuerst, Josh Richard, and Isaac Chang for Purdue University, Digital Enterprise Center.

ISSN 0046 - 2012

[From the Editor]

Dear Members:

This issue contains a variety of very interesting papers. Important concepts such as group design problems and assessment practices in engineering graphics are discussed. Use of the Web for the delivery of course materials is presented through examples on practical applications of this technology. Finally, the advancement of spatial abilities and there impact on the performance and retention of engineering graphics concepts is presented.

The membership directory has been emailed to all EDGD members who received the Spring 2001 issue of the *Engineering Design Graphics Journal*, and for whom the *Journal* had in its circulation files an email address from the ASEE Membership Department. The directory will no longer be printed so if you did not receive the directory by email, please supply your email to the ASEE Membership and also to Clyde Kearns at kearns.1@osu.edu. See page 5 for additional details. Everyone can thank Clyde for sending this directory out electronically and saving the Division the expense of having it printed.

As we begin a new year please support Mike Stewart as Chair and the other officers with the goal of increasing membership in the Division and with the planning of events for 2002. Many times it is too easy to forget how much time goes into the success of these activities.

Susan G. Miller

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Message from the Chair

Mike Stewart
Georgia Institute of Technology

Welcome to the fall issue of the Journal. As your Chair for this year, I want to tell you about the exciting year's events that we hope you will begin planning for. But first a little news about this past summer.

If you were unlucky and were not able to attend the annual ASEE conference in Albuquerque, NM, you missed a great event. Our Division hosted four technical sessions, the National Design Competition, a new member's breakfast, our business luncheon and awards banquet. It filled up the four-day conference but still allowed us to visit the exhibitions and sit in on other paper and poster sessions. The time was also spent visiting with old friends and making new friends with new members of our Division as well as other members of the ASEE. I hope you will be able to plan early to attend the next Division conference with us.

> **Our Division is only as strong as the members make it. We need all of you members to continue to invite your colleagues and acquaintances to join our Division, and invite them to attend our meeting and conferences, especially by submitting papers for our technical sessions and our Journal.**

Next summer the Annual ASEE Conference will be in Montreal, Quebec, Canada, June 16-19, 2002. You will definitely want to start planning for this trip. Our Division will have a full venue of technical, social and fun events for you, I promise.

Following in the steps of past chairs, as I am, I will be working hard to fulfill some needed changes in the Division's Committee structure. Pat Devens, Director of Liaison has been directed to modify the sub committees structure to make them current with the needs of our Division as we communicate with other ASEE divisions as well as other organizations that are in the same sphere of graphics, CAD, and education that we are. Pat will be looking for members to head these new committees and take the responsibility of contacting and carrying on dialogue and communication with them regarding what our Division is doing and how our groups might work together.

Membership has been a major thrust of our Division especially with our past Chair, Jim Leach. Through Jim's efforts and those of countless others we have over 30 new members. We welcome all of you new members and want to invite you especially to help us make this a better Division with your ideas, input and participation. We would love to see you contact us to volunteer in your area of expertise or interest. Our Division is only as strong as the members make it. We need all of you members to continue to invite your colleagues and acquaintances to join our

Division, and invite them to attend our meeting and conferences, especially by submitting papers for our technical sessions and our Journal.

Another goal of mine is to see the Engineering Design Graphics Division as a link from every conceivable web page there is on every web site there is. We know how great an organization this is and its rich history, but many people even within our educational community do not even know of its existence. The Internet is such a powerful knowledge portal; we need to make known the existence of the EDGD wherever we can. This is a challenge I put out to each and every one of you. As you peruse the Web, contact those webmasters and ask them to place our web-site as a link on their site. Most of the time they will be happy to add it and we will have just that much more visibility. If you do get links added, please send me an email letting me know of your success. Better yet, tell everyone on our EDGD listserve. If you don't have the time or do not want to do this, just send me the web site and I will be happy to ask them to add our link to theirs.

Our Division also has a new 2001 Membership Directory and this should help you contact each other. We would especially like to thank Clyde Kearns for all of his efforts in doing this.

Our executive committee consists of Sheryl Sorby, Vice Chair, Tim Sexton, Secretary-Treasurer, Pat Devens, Director of Liaison, Ron Pare', Director of Programs, Craig Miller, Director of Professional and Technical, John Freeman, Zone Activities and Susan Miller, Publications. Please contact any of us with your ideas, suggestions, and to volunteer. Our hopes are to leave this Division better and stronger than it was when we came. To that end you all can help. Have a great year.

Respectively,

Michael D. Stewart

Michael D. Stewart
EDGD Chair

ASEE EDGD Division Member Directory

Dear EDGD Members:

The June 2001 ASEE Engineering Design Graphics Division Member Directory has been E-mailed on August 14, 2001 to all EDGD members who received the Spring 2001 issue of Engineering Design Graphics Journal and for whom the Journal had in its circulation files an E-Mail address from the ASEE Membership Department in Washington DC. Listed below please find the names of Division members for whom we have no E-mail address, or for whom ASEE has supplied an invalid E-mail address (**). The Journal plans to supply future Division directories to members in this manner. The directory can be updated each time we receive a new Division member roster from ASEE Membership, just prior to the publication of each issue of the Journal. If your name appears below and you have a valid E-mail address, please supply ASEE Membership at 202-331-3520, and also our Journal Circulation Manager, Clyde Kearns at kearns.1@osu.edu, with the correct address.

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Group Design Problems in Engineering Design Graphics

David Kelley
Purdue University

Abstract

Engineering and design philosophies, such as concurrent engineering, place an emphasis on group collaboration for the solving of design problems. This paper describes group design techniques used within the engineering design graphics sequence at Western Washington University.

Introduction

Modern management and engineering philosophies and techniques place an emphasis on the solving of design problems through collaborative efforts. Principles of concurrent engineering have been stressed in companies for well over a decade. Within concurrent engineering, the design process is shifted from a linear model to a model where everyone with an interest in the design solution is involved, including customers. With the advent of Internet collaboration tools, engineering teams are not limited by geographic boundaries. Due partly to the benefits of concurrent engineering principles, companies competing in a global market can no longer expect design solutions to be found by single individuals or by small, isolated teams. Successful engineers, designers, and technicians have to function well in a team environment. They have to have the understanding, management, and communication skills to meet the needs of their customers.

Employers expect new college graduates to have strong technical skills along with strong communication and interpersonal skills. Increasingly, employers are expecting graduates to be able to function in a team environment. According to Bursic (1992), well functioning teams can improve innovation, increase knowledge sharing, reduce levels of management, and enhance competitiveness. One technique used by engineering and technology programs to develop team skills is the requirement of group design projects. The focus of this paper will be how the Engineering Technology Department at Western Washington University approaches group projects within its Engineering Design Graphics sequence. Related topics to be discussed in this paper will include group development and forming and project management techniques. This paper will detail how students approach the design process within their groups, how students use project management principles to produce a successful design, and student opinions on the group project.

Group Fundamentals

According to Bragg (1999), groups must have certain attributes that lead to success. One attribute is a reason to work together. Often, groups (or teams) are formed for the sake of change. Without a reason to work together, teams are doomed from the beginning. Accordingly, a group should work toward a specific, clear objective. As identified by Pagell and LePine (1999), groups that work on novel problems were more likely to be successful than groups that worked on mundane issues. Additionally, when individuals believe that group activities are better that working alone, team production will improve.

Bragg (1999) stresses that the composition of a team should be carefully considered. A common approach is to form teams with members that share common skill sets. Since this provides a group with a narrow range of expertise, this type of group naturally fails. When teams are formed, team members should have complementary skills. It is senseless to form a concurrent engineering team composed of nothing but engineers. This principle is echoed by Katzenbach and Smith (1993) when they define a team as a "small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (p. 45). Concurrent engineering teams are formed of individuals from all avenues of an organization. This provides a broad range of expertise and timely input to critical design information. When a group is formed, the group, not individuals in the group, should be held accountable for success or failure.

A common problem with group problem solving is allowing strong members of the group to do a majority of the work, with weaker students not performing their share. Groups should be structured to allow for equal participation from all members. According to Johnson and Johnson (1994), five essential elements are necessary to allow for true cooperative efforts: (a) positive interdependence, (b) individual accountability, (c) face-to-face interaction, (d) social skills, and (e) group processing.

While common educational methodologies either require students to compete for grades, or to work alone to accomplish an educational goal, successful groups should have a positive interdependence, where the successful outcome of one group member is dependent upon the successful outcome of each group member. In addition, well functioning groups require every group member to be held individually accountable for handling their share of the load. Through design or through neglect, these two elements of cooperative learning are not incorporated into most group exercises. While neglecting these two elements can still lead to successful group outcomes, there is no assurance that all members of the group benefited equally.

Johnson, Johnson, and Holubec (1993) describe three steps for structuring positive interdependence. First, groups should be presented with clear objectives and goals to accomplish. Assignments with absolute right or wrong answers, such as in mathematics and physics, make ideal opportunities for cooperative groups, but design problems can also be integrated successfully too. The key to cooperative groups is the setting of clear and measurable objectives. Second, groups should have positive goal interdependence. This requires individual member objectives and goals to complement the objectives and goals of the group, and the goals of individuals should lead to the accomplishment of the group's goals. Finally, groups should focus on the accomplishment of individual objectives and make a point to reward or compliment members for accomplishing a task. Johnson et al. (1993) also describe several ways to structure individual accountability. First, groups should be small enough to allow individuals to contribute, and each group member should, at times, be individually examined. Additionally, individuals in a group should be required to share learning outcomes with other members of the group.

Group Design Problem

Students taking the engineering design graphics two-course sequence at Western Washington University have the opportunity to solve multiple design problems. The first course, ETec 110, is a conceptual design and modeling course where students are presented with design problems and follow a formal design process to find a solution. Ideation sketching and Rhinoceros™, an intuitive conceptual modeling computer-aided design application, are used to develop design solutions. The final project within this course requires students to individually design a flashlight. This project is further developed in the second course in the sequence, ETec 111, where students work in teams to develop a more defined solution.

Within a design problem, students must follow a formal design process (see Kelley, Newcomer, & McKell, 2000). The process used is the same for both courses in the sequence, and for all sections and instructors. Students are first presented with a design problem (e.g.

a Flashlight). Depending upon the course's instructor, extra specifications, limitations, and requirements may be provided. Students develop the problem by defining a problem statement and problem specifications. Specifications are ranked and categorized in order of importance. Students must develop possible solutions through the use of ideation sketching and conceptual three-dimensional (3D) modeling. For most design problems, three conceivable solutions are required. A final solution is selected through the use of a weighted scoring table (see Table 1). In most cases, documentation drawings are created of this final solution.

While ETec 110 is a course conceived to develop a student's problem solving and conceptual model skills, ETec 111 is focused on the incorporation of high-end computer-aided design applications (e.g. Pro/ENGINEER™ and I-DEAS™) and concurrent engineering principles into the design process. In ETec 110, students are allowed to be creative with their designs, but in ETec 111 students must develop designs that they can actually model in a package such as Pro/ENGINEER. The primary group design problem in ETec 111 is a spin-off of the flashlight design in ETec 110, with additional limitations and specifications provided by the instructor. As an example, one group's problem was the design of a light for a mountain bike. Students could utilize any previously defined material from ETec 110.

Group Formation and Project Management

Students taking ETec 111 come from a variety of majors to include Industrial Design (ID), Industrial Technology-Graphics(IT-G), Manufacturing Engineering Technology (MET), Manufacturing Management (ManMgt), and Plastics Engineering Technology (PET). Two criteria are considered when assigning students to groups: populating a group with a variety of student skills and providing each group with at least one "power" CAD user. Groups are formed around the third or fourth week of the academic quarter. This provides time for the course's instructor to determine which members of the class are stronger at Pro/ENGINEER. The course's instructor first forms groups by distributing majors into each group. The objective is to get a least one ID, IT-G, MET, and ManMgt major into each group. The purpose of this approach is to simulate a concurrent engineering philosophy. The instructor then determines that each group has one member apparently strong at computer-aided design. If not, the instructor reconfigures each group to meet this requirement.

Example of a Weighted Scoring Table

Specification	Weight	Concept 1		Concept 2		Concept 3	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Weight	2	4	8	5	10	2	4
Color	2	3	6	4	8	4	8
Cost	3	4	12	4	12	3	9
Functionality	5	1	5	3	15	3	15
Total			31		45		36

Table 1

Group development and organization are important considerations within each design project. When groups are formed and the design problem presented, the instructor provides a list of required tasks along with approximate times necessary to complete each task (see Table 2). From this list, each group must assign tasks for specific group members to perform (see Table 3). Additionally, each group must develop a group mission statement and a set of group rules and polices. Examples of issues addressed within a set of rules include: (a) meeting attendance, (b) communication methodologies, (c) personal problem solving, and (d) member task requirements.

Using backwards planning techniques, groups are responsible for setting their own task due dates. Once set, each group is held responsible for completing each task according to schedule. As a reference for setting their due dates, groups are provided approximate completion times for each required task (see Table 2). The instructor also provides prerequisite tasks. Using this information and working backwards from the project's final due date, a Gantt chart (Figure 1) and a PERT chart (Figure 2) are created to help manage the project.

The emphasis on formally managing the course's design projects serves two purposes within the goals of the course. First, students are introduced to real-world project management techniques that they can use throughout their programs of study. Since most students in the course have already completed or will take a course in production control, this provides a good balance between theory study and practical examination. Second, since the course's design project can at first seem overwhelming, task-scheduling techniques help to keep students on track toward producing a high-quality final design.

Manufacturing Management majors play an important role in managing their group projects. Often, they are either selected or emerge as their group's leader. Unlike most students taking ETec 111, ManMgt students are typi-

Required Project Tasks

Task Number	Required Tasks	Prerequisite Task(s)	Recommended Time to Complete Task
1	Task due dates to instructor	NA	1-2 days
2	Group member duties	1	1-2 days
3	Group mission and rules	1	2-3 days
4	Problem identification statement	3	1-3 days
5	Ideation sketches	4	5-10 days
6	Concept Models (Rhino)	5	5-10 days
7	Weighted scoring table	5,6	1-2 days
8	Pro/E part models	7	5-10 days
9	Pro/E assembly drawing	8	2-3 days
10	Pro/E detail drawings	7	5-8 days
11	Abstract sheet/Notebook	9,10	2-3 days

Table 2

Team Member Responsibilities (Example)	
Task	**Assigned Persons**
Setup Group Rules and Develop Mission Statement	Jill, Jane, Jack, and Joe
Assign Member Duties	Jill, Jane, Jack, and Joe
Develop Problem Statement	Jill, Jane, Jack, and Joe
Develop Ideation Sketches	Jill, Jane, and Jack (one concept each)
Develop Concept Models	Jill, Jane, and Jack (one concept model each)
Produce Weighted Scoring Table	Joe
Model Parts in Pro/ENGINEER	Jill, Jane, and Joe
Develop Detail Drawings of Parts Modeled	Jack and Joe
Develop Assembly Model in Pro/ENGINEER	Jack
Produce Assembly Model in Pro/ENGINEER	Jane
Design Format for Notebook	Jill

Table 3

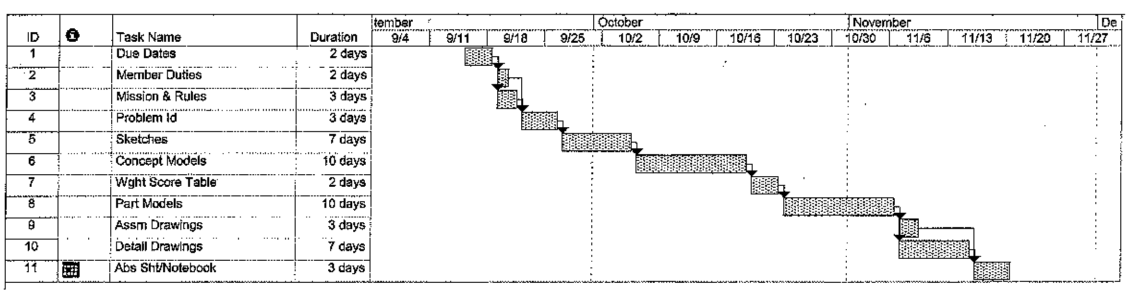

Figure 1 *Gantt Chart*

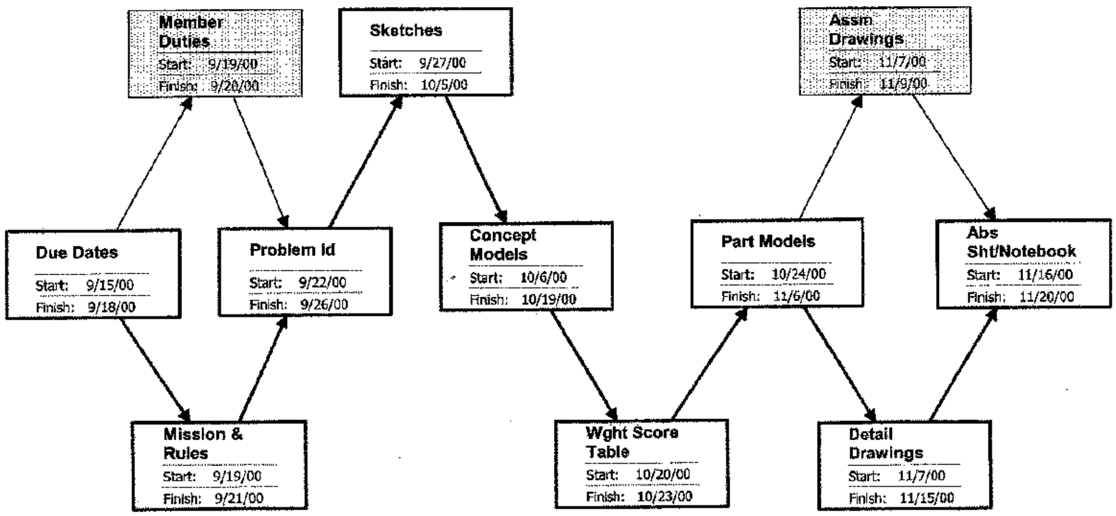

Figure 2 *PERT Chart*

cally juniors or seniors. At this point in their curriculum, they have a background in production management including project scheduling fundamentals. To benefit students with no previous experience in project management, one lecture is devoted to the management principles behind Gantt and PERT charts.

Student Feedback and Evaluation

A survey instrument was developed to measure student opinions on the effectiveness and value of the group project. One section of ETec 111 (N = 15) was randomly selected for implementation of this instrument. The seven-question survey utilized a Likert scale with the categories and weights shown in Table 4. Each question provided a section for student comments.

One of the goals of the survey was to determine how well members of each group worked together. Feedback from the survey revealed that student design groups functioned adequately as a team. Of the participates that were surveyed, 13 agreed or strongly agreed that their group functioned well together (M = 1.93). Also, in response to a question focusing on member duties, 14 students agreed that all members of their group performed their assigned duties (M = 1.8). Despite positive feedback on group performance, there was some indication that formal team training would have been beneficial. Referring to the findings of one question, members of the class agreed that team training would have positively influenced the final results of their projects (M = 2.5, mode = 3). In addition, nine members of the class agreed that team-building exercises would have positively influenced their project (M = 2.26). One student commented that training might have helped communication difficulties between group members.

Likert Scale Categories

Category	Weight
Strongly Agree	1
Agree	2
Neutral	3
Disagree	4
Strongly Disagree	5

Table 4

Feedback on the benefits of the group project was also positive. Of the 15 students in the class, four felt that the exercise would benefit them later in their programs of study (M = 1.8), while all the students in the class agreed that the project would help them after they graduate. When asked how well they enjoyed the group exercise, most students agreed that the project was enjoyable (M = 2.26, mode = 2).

Conclusion

One of the goals of the Western Washington University's engineering design graphics sequence is to develop in students the ability to visualize and solve design problems using a formal design process. This goal is accomplished through multiple design projects and modeling exercises. Another goal is to develop in students the ability to implement basic principles of concurrent engineering. This goal is accomplished through the utilization of a group design project. Within this goal is the ability to manage multiple team tasks through formal project management tools. This sub-goal is met through the utilization of management tools such as PERT and Gantt charts.

During the development of the group design project concept, two concerns were addressed: group member participation and task completion. It is common within group exercises for some members of a group to not do their fair share of the work. This concern was addressed through the requirement of each group to officially assign project tasks to specific individuals. This technique was established to hold each group member individually accountable for doing his or her fair share of the exercise. Based on student feedback and instructor observation, lack of member participation was not an issue. Before the implementation of formal project management tools, groups had a tendency to procrastinate on the group design exercise. This issue was addressed through the requirement for the setting of task due dates and for the management of task completion through the use of project management tools, such as Gantt charts.

References

Bragg, T. (1999, May). Turn around and ineffective team. *IIE Solutions, 31*(5), 49-51.

Bursic, K. M. (1992). Strategies and benefits of the successful used of teams in manufacturing organizations. *IEEE Transactions on Engineering Management, 39*(3), 277-289.

Johnson, D. W. & Johnson, R. T. (1994). *Learning together and alone: Cooperation, competition, and individualization* (4th ed.). Heedham Heights, NH: Allyn and Bacon.

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1993). *Cooperation in the classroom* (6th ed.). Edina, MN: Interaction Book Company.

Katzenbach, J. R. & Smith, D. K. (1993). *The Wisdom of Teams: Creating the High-Performance Organization.* Boston: Harvard Business School Press.

Kelley, D., Newcomer, J., & McKell, E. (2000). The design process, ideation, and computer-aided design. *The Proceedings of the Annual Conference of the American Society for Engineering Education.* St. Louis, MO.

Pagell, M. & LePine, J. A. (1999). Characteristics of the manufacturing environment that influence team success. *Production and Inventory Management Journal, 40*(3), 21-25.

Assessment Practices in Engineering/Technical Graphics

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Abstract

Assessment in engineering/technical graphics is a subject very few professionals in education have studied over the years. Many professionals in the field of education assess (grade) students the way they were assessed and have never thought about how they evaluate student work. Another compelling component of assessment is its subjective nature, knowing that no two graphics educators will grade the same drawing the same way. Given these dilemmas, in the Fall of 2000, a survey was conducted looking at the different ways professionals in engineering/ technical graphics assess student work. The population selected for this study was all the members of the Engineering Design Graphics Division of the American Society for Engineering Education for the 1998-1999 academic year. The survey focused on questions related to evaluating traditional two-dimensional drawings (both manual and CAD), three-dimensional models, and animations. The survey asked participants about methods and taxonomies used in evaluating drawings required in classes they teach and approaches used to assign grades. The survey collected information on the focus areas instructors feel are important when grading different types of drawings and why. Major conclusions drawn from the information found in the survey center on the lack of uniformity in grading practices and limited training in evaluation techniques.

Introduction

Many individuals have noted that assessment is crucial and has been the neglected area of quality learning. Imrie (1995) quotes Biggs as stating that "some of the most profoundly depressing research on learning in higher education has demonstrated that successful performance in examinations does not even indicate that students have a good grasp of the very concepts which staff members believe the examinations to be testing" (p. 176).

For those of us in the field of technical graphics education, this dismal picture of the quality of assessment in higher education is further compounded by the changes that have taken place in our field in the last few years. Our field has moved from teaching students primarily on drafting boards with manual instruments to the use of new tools and methods of representing objects through computer-aided drawing (CAD). Advances in the field of computer graphics have also taken us from two-dimensional (2D) representations of objects to three-dimensional (3D) constraint and non-constraint models. With these changes, we have found ourselves with a dilemma. How do we appropriately assess this type of student work? Still another aspect of this necessity to review and define our assessment methodologies is the need to be able to create assessment instruments (tests, projects, and assignments) that truly measure those aspects of a course's content. Over the years, our profession has seen very little research in subjects related to assessment, only one article was found that could be directly tied to assessment in graphics and it dealt with using an overhead for grading drawings and was written over three decades ago (Schroeder, 1973). However, for years educators have identified assessment and the development of a taxonomy as crucial for the growth within a discipline and to provide quality assurance and quality control as both processes and outcomes (Imrie, 1995). Given the information found in a review of literature and current trends of accountability in education, the authors felt it was time to look into how professionals within our field assess student work and begin the early stages of development of a taxonomy that could be used to assess graphic related areas.

This study reflects the need to redefine assessment procedures by first examining current practice in the field. It is hoped that it will be the starting point for the creation of a classification system (taxonomy) for teaching practices in Graphics Education. Taxonomies are used as a base to structure teaching activities, and to design assessment that is appropriate to the goals of the instruction (Imrie, 1995; Orlick & Murphy, 1979). The uniqueness of our field, which centers on visual science, makes adopting previously designed taxonomies inappropriate. In an age where accountability is being stressed (Darlin, et al., 1996; Jacobi, et al., 1987), creating a taxonomy for our field allows us to establish a base for our assessment processes and to define the areas and levels of achievement we consider appropriate for our course offerings. A taxonomy for our field would also provide a starting point for research on assessment and student outcomes in our current teaching environments. By establishing the assessment procedures currently used in our field, the authors wish to determine if there is a need for a review of our assessment practices and to begin a discussion of appropriate assessment methods and the development of a taxonomy for our field.

Taxonomies

The creation of educational taxonomies had their origins in a meeting of the American Psychological Association in Boston in 1948. There it was suggested that a taxonomy of the goals of education could help classify examination questions commonly used by examiners and facilitate communication among them (De Landsheere, 1977). A taxonomy is a classification system. However, in education, the term taxonomy is also hierarchical and defines those elements or aspects that we wish students to learn in a class or discipline (De Landsheere, 1977; Orlick & Murphy, 1979). Imrie (1995) uses the definition for taxonomy defined by Woods as "a fancy name for a structured set of levels for development of a subject" (p. 176). Although educational objectives are now usually written as outcomes, without a clearly defined systematic framework (taxonomy) quality assurance is not evident or verifiable and there could be a mismatch between the stated outcomes and the actual understanding and behavior of students. A "thorough" rather than a "superficial" understanding of concepts should be achieved, which we hope our assessment methods measure (Imrie, 1995). Attached to the development of outcomes through a taxonomy are ways educators link learning styles to student assessment. Several learning styles exist and have been defined by educational psychologists and curriculum developers, and many, if not all, are linked to taxonomies of learning (McNeil & Bellamy, 1994). But, while completing the review of literature for this study, no taxonomy was found that was directly related to the spatial learner. Although mentioned as a learning style in many articles, none had this essential way of learning as a major focus for the development of a taxonomy, only as a process for learning.

Educational taxonomies are written for specific areas of learning that have been subdivided into the cognitive, affective, and psychomotor domains (McNeil & Bellamy, 1994). The cognitive domain is concerned with knowledge and information and is subdivided into the levels of cognitive ability (lower to higher), knowledge, comprehension, analysis, synthesis, and evaluation. The affective domain deals with areas of learning that include such concepts as receiving, responding, valuing, characterizing, organizing, and conceptualizing. The psychomotor domain is concerned with the performance of skills and includes readiness, guided response, mechanism, complex response, adaptation, and origination (Imrie, 1995).

Taxonomies are also created for specific fields of instruction in order to model the content and goals of that field (Thomas, 1972). Probably the best known taxonomy in use is

Bloom's taxonomy for the cognitive domain (Imrie, 1995; De Landsheere, 1977; Orlick & Murphy, 1979). Constructed in the 1950s, Bloom and his associates sought to create a set of verbal descriptions for a behavioral category and then list the objectives belonging to this category. Finally, they proposed concrete behavioral examples, consisting of tasks, as exemplified in examination questions or test items. Bloom's Taxonomy is divided into areas or goals that are based on educational objectives (Thomas, 1972). These goals are knowledge, comprehension, application, analysis, synthesis, and evaluation. These goals span learning tasks and the instruction is designed to meet these goals. A similar taxonomy to Bloom's is that of Buhl. Buhl's Taxonomy is based on the concept of problem solving, much like that of Dewey (Thomas, 1972). The steps in his taxonomy include recognition, definition, preparation, analysis, synthesis, evaluation, and presentation. Many other educational taxonomies exist, which are designed for specific domains. Although the basis of these domains are most notably found in Bloom's Taxonomy (Tittle, Hecht, & Moore, 1993), other taxonomies do exist. Among the other common taxonomies used today in educational domains is the Secondary Schools Taxonomy (SST), which focuses on vocational education (Brown, 1989). Taxonomies that address the problem solving process include the S.A.C.K Alignment model, that focuses on skills, attitudes, concepts, and knowledge (Sappier, 1996). Dewey's taxonomy emphasizes difficulties in learning and Cruthfield's looks at ways student's process information. For assessment in creativity, Binet, in 1909, developed a structure of learning that identified comprehension, invention, and criticism, which later became the foundation for most early taxonomies (Thomas, 1972). Again, of all of these taxonomies for learning and assessment, including 14 others reviewed by the researchers of this study, no one particular taxonomy was exclusively for the visual learner (Thomas, 1985). This led the researchers to ask why and to begin the process of creating a scope and sequence related to assessment that can lead to the development of a taxonomy for teaching spatial concepts and skills. However, before a taxonomy can be crafted, research in current assessment practices need to be conducted to establish a foundation for developing such a taxonomy.

Research Methodology

In the Fall of 2000, a survey was sent to the members of the Engineering Design Graphics Division of the American Society for Engineering Education that asked about assessment practices conducted in courses of engineering/technical graphics. A total of 333 surveys were sent. Ninety-three (27.9%) were returned and are included in the data analysis presented in this paper.

The survey was divided into several sections. Section one (General Questions and Course Assessment) asked about the content in graphics related areas at the institutions where the respondents taught, grading practices used, exam formats, attendance policies, project requirements, and taxonomy usage. Section two (Instrument Drawings, Sketching, and CAD Drawing) solicited information on the content covered in introductory and advanced classes, and the areas of greatest difficulty that students have in subject areas including manual instrument drawing, sketching, 2D CAD drawing, 3D CAD modeling, and animation. In this section, respondents were also allowed to add areas they felt should be included under each category. Section three (Introductory Class Assessment) asked about course projects (their format and submission procedures), grade distribution, and the number of graded and practice assignments in introductory courses. Section four (Instructor Information) asked for the level and type of assessment training the respondents had and general demographic information.

Findings

The responses to the questions in the first section of the survey revealed several trends. Among the subject areas offered at institutions, 3D and 2D CAD dominates, and over 50 percent of the respondents indicate that CAD/CAM is being taught at their institutions. Also, animation is now being taught at over 25 percent of those institutions represented by the respondents to this study (See Table 1).

Section one of the survey asked about the methods used to submit student work. Of the 92 respondents who answered these questions, 29 (31.2%) have their students submit their work on paper, 8 (8.6%) have students submit work electronically, and 54 (58.1%) submit work on paper and electronically. The respondents also indicated that the majority of instructors use letter grades (see Table 2).

Questions related to exam formats found that 37 or 39.8% of the respondents use common exams in their courses, 69 or 74.2% use written exams, 61 or 65.6% use electronic exams, and 18 or 19.4% use take-home exams. Forty-four (47.3%) out of 93 respondents include instrument drawings on their exams, and 66 (71.0%) out of 90 respondents who answered this question use hands-on exams. Thirty-two (34.4%) of the respondents use teaching assistants for grading.

Questions related to attendance policies found that 42 (45.7%) of the respondents' institu-

Subject Areas Offered: (n=93)

Subject Areas	Frequency	Percentage*
Intro. Engineering Graphics	86	92.5
3D CAD	80	86.0
2D CAD	79	84.9
CAD/CAM	51	54.6
GD&T	43	46.2
Animation	26	28.0
Descriptive Geometry	34	36.6
Illustration	23	24.7
Web Design	20	21.5

*Note: *Maximum percentage for each subject area is 100%.*
Table 1

Types of Grades Assigned to Student Work: (n=92)

Subject Areas	Frequency	Percentage*
Letter Grades	66	71.0
Letter and Numerical Grades	19	20.4
Numerical Grades	8	8.6
Pass/Fail Grades	4	4.3

*Note: *Maximum percentage for each subject area is 100%.*
Table 2

tions have some form of course attendance policy, but 61 (65.6%) of the respondents have an attendance policy for their classes. Of the respondents that had an attendance policy for their introductory courses, 50 (53.8%) indicated that it is used as part of their students' grades. However, in examining the data on attendance policies in advanced courses, the researchers only found 33 (35.5%) of the 54 individuals who responded to the question have an attendance policy that affects their students' final grades.

In examining the data related to areas that students find difficult when creating projects with manual instruments, 2D CAD, and 3D modeling, dimensions were identified as the most problematic. Other areas noted as the most difficult varied some with the media used to create the projects. It was observed that students had difficulty in similar areas for manual and 2D CAD drawn projects (See Table 3).

Areas of Manually Drawn Project(s) that Students Find Difficult: (n=72)

Topic	Frequency	Percentage*
Dimensions	21	29.2
Line Work	19	26.4
Accuracy	17	23.6
Solutions	17	23.6
Standards	16	22.3
Scaling	8	11.1
Design	7	9.7

Areas of 2D CAD Project(s) that Students Find difficult: (n=87)

Topic	Frequency	Percentage*
Dimensions	48	55.2
Standards	31	35.6
Scaling	26	29.9
Solution	24	27.6
Accuracy	18	20.7
Design	9	10.3
Line Work	2	2.3

Table 3

Areas of 3D Modeling Project(s) that Students Difficult: (n=86)		
Topic	**Frequency**	**Percentage***
Dimensions	21	24.4
Design	19	22.1
Datum Alignment	12	14.0
Accuracy	9	10.5

Note: *Maximum percentage for each subject area is 100%.
Table 3 continued

Several questions in the first section of the survey related to final projects. The majority of the respondents, 68 or 73.1% (n=91), indicated that they require some form of final project in their introductory and advanced courses. Twenty-two or 23.7% require some form of strategy drawing or outline submitted by students as part of their final project in introductory courses, and 42 or 45.2% indicated that they require this in advanced courses (n=93). Table 4 provides a summary of the methods used to submit projects and the format of projects.

A final area of questions in section one of the survey related to the use of a model/taxonomy of assessment by the respondents and objectives when grading. Only 15 (16.1%) of the 93 respondents indicated that they used a model or taxonomy for assessment. When respondents were asked to indicate their major emphasis when grading, the largest single emphasis given was to meet industry standards and requirements. Table 5 provides a list of the most common indicated emphases in response to this question.

Types and Methods of Submitting Introductory Course Final Projects: (n=93)		
Submission Type	**Frequency**	**Percentage***
Submitted as Hardcopies	64	68.8
Submitted on Disk	25	26.9
Submitted Via On-line access	12	12.9
Project Formats: (n=93)		
Project Format	**Frequency**	**Percentage***
2D CAD Drawings	38	40.9
Solid Models Converted to 2D Drawings	28	30.1
Instrument Drawn Multiviews	12	12.9
Sketches	16	17.2
Solid Models	15	16.1

*Note: *Maximum percentage for each subject area is 100%.*
Table 4

Main objective when grading: (n=93)		
Grading Emphasis	**Frequency**	**Percentage***
Meeting Industry Standards/Requirements	14	15.1
Feedback	12	12.9
Measure Student Ability	6	6.4
Problem Solving	5	5.4
Motivation	4	4.3
Being Fair/Consistent/Objective	4	4.3

Note: **Maximum percentage for each subject area is 100%.*

Table 5

Instruction of Tool Use in Introductory and Advanced Course			
Tool	**Frequency**	**Percentage***	**n**
Manual Equipment:			
Introductory Courses	43	46.2	88
Advanced Courses	12	12.9	69
Sketches:			
Introductory Courses	84	90.3	88
Advanced Courses	49	52.7	70
2D CAD:			
Introductory Courses	71	76.3	85
Advanced Courses	57	61.3	67
3D CAD:			
Introductory Courses	51	54.8	85
Advanced Courses	67	72.0	70

Note: **Maximum percentage for each subject area is 100%.*

Table 6

Section two of the survey asked respondents to indicate the types of drawing "tools" that they use in teaching their introductory and advanced courses. The responses to these questions found a clear trend towards the use of 2D and 3D CAD and away from manual equipment. However, manual equipment is still used by a large percentage of individuals in introductory courses, and over 50% of the respondents are now including 3D CAD in their introductory courses as well as their advanced courses. See Table 6.

In the third section of the survey, questions related specifically to teaching and assessment in introductory courses. Table 7 displays the data related to the topics covered in introductory courses. Only topics that were taught by 50% or more of the respondents are included.

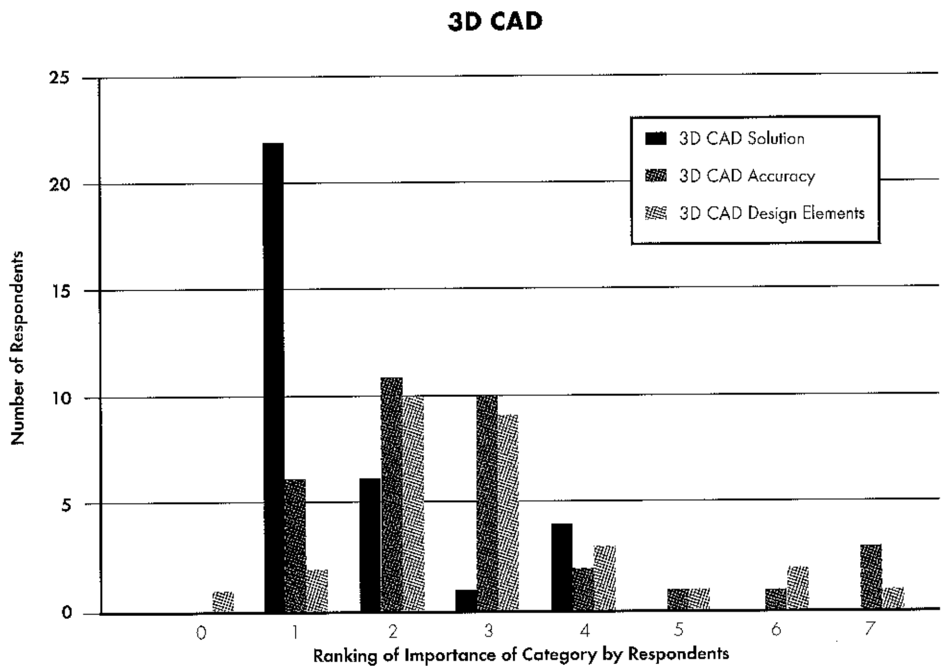

Figure 3 *Top Three Areas Stressed when Assessing 3D CAD Models.*

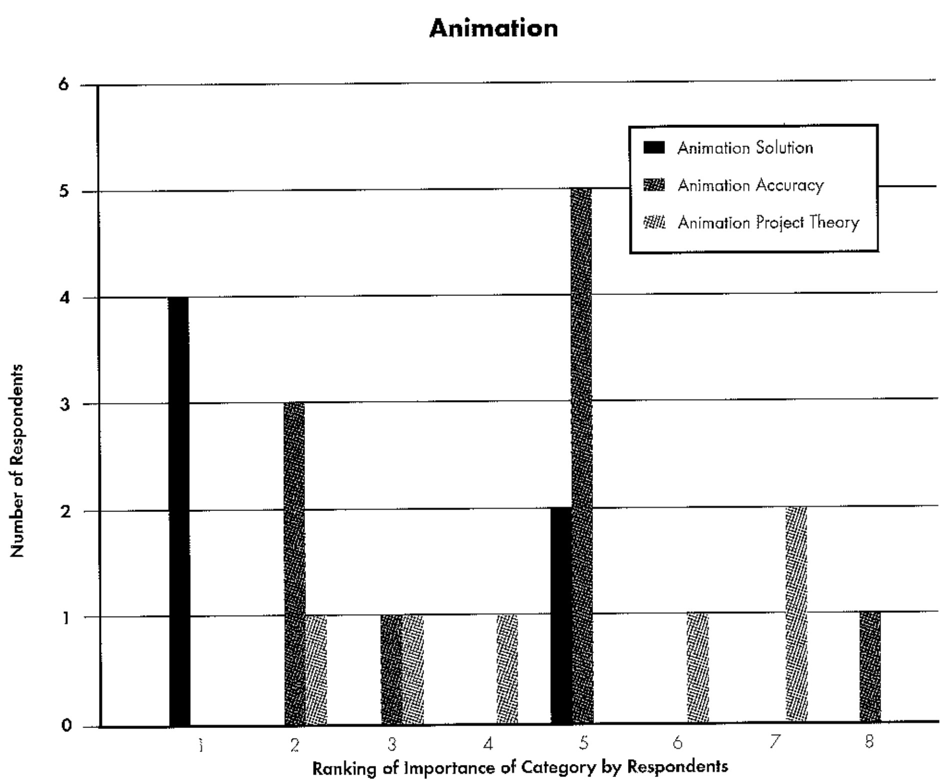

Figure 4 *Top Three Areas Stressed when Assessing Animation Projects.*

Instructor Information

The researchers wanted to know the backgrounds of respondents and the training they had received related to assessment. The responses in section four of the survey related to the respondents' backgrounds. The data from this section found that the respondents to the survey had an average of 18.6 years of teaching (SD = 10.7) n=92. The highest degree obtained by the respondents were 4 (4.3%) with undergraduate degrees, 54 (58.1%) with master degrees, and 35 (37.6%) with doctorate degrees. The majority of the individuals, 45 (48.5%), had degrees in some form of engineering and the second largest field represented by the respondents was 12 (12.9%) who had degrees in some form of education (higher and adult). The average number of students taught by the respondents in an academic year was 159.1 (SD=123.5), the average number of different courses taught per academic year was 4.6 (SD=2.69), and the average of the number of classes taught per academic year was 7.5 (SD=3.6), n=91. Only thirty-six (38.7%) out of 90 respondents had some type of training in assessment and evaluation. Ninety (96.8%) of the respondents indicated that their introductory course was required, 16 (17.2%) were teaching on the semester system, and 75 (80.6%) were teaching on the quarter system (n=93).

Conclusions

Certain points worth noting can be gleamed from the responses to the questions and the issues it raises for the profession concerning how to improve assessment strategies. First, the majority of technical graphics instruction has shifted towards the use of CAD and modeling. As noted in sections one and four of the survey, respondents are now using 2D CAD in most introductory courses and 3D CAD is also being taught in introductory courses. Second, that assessment procedures are fairly consistent between institutions, instructors, and drawing formats (manual drawing, 2D CAD, and 3D CAD). This consistency in grading may indicate that instructors are struggling with appropriate methods for assessing student work, and we should question whether the consistency in grading across different methods of drawing and modeling is appropriate. As a profession, we should be active in devising assessment practices that are better suited to the new methods of representing objects. Third, there is a need to develop a taxonomy for our field that can be used as a basis of instruction with the current tools in use and as a basis for assessment procedures. This is evident by the wide range of major objectives that respondents use when grading work. Likewise, as a unique field of study with unique content, the taxonomies currently in use are not always appropriate to our subject matter. Fourth, assessment of student work should be measured against a taxonomy that is appropriate for our subject area in order to provide direction and assessment uniformity. Finally, if a taxonomy is to be developed it should be disseminated throughout the field so that instructors have a solid basis for their instruction and assessment.

This survey was designed to begin an exploration of assessment practices in our field. According to Imrie (1995), "From a professional point of view, levels of learning need to be identified (as well as domains of knowledge) so that the rationale for assessment is accessible to students for effective learning, to peers (for effective teaching, moderation, and continuity) and for external requirements of quality assurance" (p. 180). Additional research must be conducted to determine how we should assess student achievement in our courses so that we have a clear basis for our assessment practices. Once these practices are known, the process to develop a taxonomy for the visual learner can begin. It is the hope of the researchers of this study that once a foundational area like a taxonomy is in place, both experienced and novice educators can use this tool in the development of assessment strategies to be used in graphic communications related areas. If the study of graphics is truly a discipline to be studied, we must first develop a foundation both for content and the way we assess learning in our classrooms.

References

Brown, C. L. (1989). *The Secondary School's Taxonomy (SST).* National Assessment of Vocational Education, Berkeley, CA.

Darlin, R., et al. (Feb. 1996). An academic department's response to outcomes assessment. *Paper Presented at the New Mexico Higher Education Assessment Conference.* Albuquerque, NM.

Imrie, B. W. (August 1995). Assessment for learning: Quality and taxonomies. *Assessment & Higher Education, 20* (2), 175-190.

Jacobi, M; et al (1987). College student outcomes assessment: A talent development perspective. *ASHE-ERIC Higher Education Report No. 7*, 18-51.

De Landsheere, V. (1977). *On Defining Educational Objectives.* Elmsford, NY: Pergamon Press.

McNeil, B. M., & Bellamy, L. (1994). *Curriculum Development, Design, Specification and Assessment and Supplemental Materials.* Arizona State University; College of Engineering and Applied Sciences.

Orlick, D. C. & Murphy, R. R. (1979). *Selected Models and Elements of Evaluation for Vocational Educators.* Olympia: Washington State Commission for Vocational Education.

Sappier, T. A. (1996). Integrating Curriculum, Instruction and Assessment. Paper presented at the Annual Meeting of the National Indian Education Association, Rapid City, SD.

Schroeder, A. M. (1973). Grading Drawings with the Overhead Projector. *School Shop, 32* (5), 42-43.

Thomas, J. W. (August, 1972). *Varieties of Cognitive Skills: Taxonomies and Models of the Intellect.* Philadelphia: Research for Better Schools, Inc.

Thomas, R. S. (1985). *Strategies for Differentiating Curricula.* Baltimore County Public Schools, Towson, MD.

Tittle, C. K., Hecht, D., & Moore, P. (1993). Assessment Theory and Research for Classrooms: From Taxonomies to Constructing Meaning in Context. *Educational Measurement: Issues and Practices, 12* (4), 13-19.

Preparing Class Materials for the Web Using PDF Format

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Abstract

Faculty and students are quickly becoming accustomed to the convenience of online class resources. Electronic documents are easily updated, transmitted and stored. In addition, they offer enhancement features such as searches, hypertext links and security to control access to materials. The Portable Document Format (PDF) offers faculty an alternative to HTML documents. PDF is a cross-platform file format that represents documents independent of the software, hardware and the operating system used to create the file. Documents created in applications such as Word, Excel and AutoCAD can be converted to PDF format. Documents are compressed for use on the Internet while retaining their original appearance. PDF's are particularly advantageous in situations where documents already exist and need to be repurposed for the Internet. Using Acrobat software, value-added features can easily be added to enhance the online document. This paper will focus on preparing, enhancing and publishing PDF documents on the Internet. Topics will include a comparison of HTML and PDF documents, the advantages of PDF format, and features that can be added to make document more interactive and user friendly.

Introduction

Providing resources online is becoming more prevalent in today's teaching environment. Both faculty and students have come to rely on the convenience of storing class materials online. There are several good reasons to make materials available to students online. First, it requires less paper shuffling for the faculty member. Once class handouts are posted, the professor can refer students to the web site if they miss class or lose their class materials. Second, printing and copying costs can be transferred out of the department. Students will either print at home or in the computer lab. In our case, the paper cost in the lab does not come out of the department budget. Third, files will be accessible to students at times convenient to them outside of open lab hours or the professor's office hours. This is especially important to students who work or have other obligations that may hinder their access to labs and course materials apart from regularly scheduled class meetings. This format will also allow professors to post resource materials for students that will help them prepare for class without printing out the material and handing it out the session before. This makes less work for the professor and fewer papers to keep track of for the student. For instance, lab preparatory information can be posted on the web for students to access before their scheduled lab time, instead of handed out in lecture. Finally, security measures may be used to control who has access to materials by the use of passwords. Files may also be limited to read-only so that selected documents cannot be copied or printed.

Online publishing or electronic document delivery (EDD) technology is concerned with how documents are produced, distributed, managed, revised and maintained electronically. (Bielawski, 1996) For an individual faculty member, getting documents online can sometimes be a challenging task. Many faculty are experimenting with HTML (Hypertext Mark-up Language) editors as the primary means of preparing documents for online distribution. Another alternative to consider is Portable Document File Format (PDF).

Universal File Format

Since the Internet provides a means for easily disseminating documents, it is necessary to establish a universal format (McKinley, 1997). McKinley points out several strategies for "universal" file access. 1. Native File Formats, 2. Convert to HTML on-the-fly, 3. Viewer to Display Document, and 4. Format that is Native to the "Universe" (McKinley, 1997). The underlying concept of document portability is that of printing to a file & distributing that file. It is like Faxing something, but instead of converting the document to dots & sending it to a printer, it is instead sent to the screen (Romano, 1999).

The first option, native file format, requires the user to have the creator application installed on their computer. For example, many faculty pass Word documents to each other via email. This works because almost everyone has Word installed on their machine. This option offers a completely editable document.

The second option, HTML "on-the-fly", converts documents to ASCII equivalent in HTML. This works well for simple text documents but documents with columns or tables often lose their formatting. Saving documents out of Word as an HTML file is an example of this option.

The third option, viewer to display, simply reproduces the appearance of the document. It cannot be edited and it often results in a file size which is larger than the original document in native format. A scanned document would fall into this category.

The fourth option, format native to the "universe", are files that are designed from the start to be "universal". HTML and PDF documents both fall under this category. Both HTML and PDF documents offer a variety of features, which are associated with online digital documents in general such as interactive features, hypertext links, video and audio capabilities and search engines.

PDF files compete well with HTML documents and offer many of the same features. Unlike print documents which are static and offer a "stream of text", online documents can be connected elements of information with a flexible navigation system. Hypertext links can lead to other pages, documents or URL's (Uniform Resource Locator) expanding beyond the limitations of the printed page. Online resources are more user-centered and adaptive. Users can explore a variety of resources such as articles, sketches, case studies, tutorials, video clips and they control the pace and sequence of their exploration according to their specific learning needs. The main advantage of PDF's is their ease of creation and revision.

PDF Files

History

PDF is an acronym for Portable Document Format. PDF files can be described as —"An open, cross-platform file format that represents documents independent of the software, hardware & the operating system used to create the file." (Kent, 1996). Developers first introduced portable document software in 1990 (Romano, 1999). It was called "Common Ground" and was an attempt to create a Cuniversal" file format that could be used on any computer without the native application being installed. In 1993 Adobe Systems introduced "Carousel" (later to be called Acrobat), a page-definition language based on PostScript. It was an output file type used to represent a document (Romano, 1999).

Advantages

Advantages of PDF files include ease of creation, predictability, portability and value-added features. Although HTML editors are relatively easy to use, document integrity is sometimes lost or time must be spent repurposing documents for online use. Documents created in almost any applications can be converted to PDF files. PDF documents are portable and can be viewed on most platforms — DOS, Windows, Mac, Unix — with the Acrobat Reader which is a free plug-in available for use with most browsers. Predictability of document appearance is another positive associated with PDF files. PDF's offer more font and formatting capabilities than HTML.

CG 110 Technical Graphics Communication

OA 9 — Precision Fits and Limits

Using the nominal diameters and standard precision fits given, calculate the required sizes as shown in the example, and PRINT neatly in the space provided.

Name:____________________Section:___Date:________

	RC8	RC1	LC10	LT6	LN3	FN2
Nominal Size	1	$\frac{1}{8}$	12	$2\frac{1}{4}$	$2\frac{5}{8}$	$\frac{3}{8}$
Basic Size	1.0000					
Limit Dimensions Shaft	.9955					

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Basic Size	1.0000					
Limit Dimensions Shaft	.9955					

Figure 1 *Example of a table converted to an HTML file (left) and a PDF file (right).*

Fonts, columns, diagrams, tables and charts retain both their appearance and positioning on the page (Romano, 1999). Figure 1 shows a comparison of an HTML and PDF of the same document.

Content Sources

PDF format can be used to convert both electronic documents and pre-existing, print-only documents, for online display. Documents created in word processing, spreadsheet and presentation applications are easily converted to PDF files. It is almost easier than creating an HTML file because it's just like printing a page except the page is printed to a file. Electronic documents created in Word, Excel, AutoCAD or any other application can easily be converted. This means that all your existing class files such as syllabus, class notes, assignments can quickly be converted and organized into a series of pages similar to what you would see in a printed document. In addition to using PDF files for new documents you create, it also works well for pre-existing pages including those available only in print form. Documents can also be "captured" using a scanner. This is particularly useful for documents existing in print-only format such as sketches or even excerpts from texts or journals.

Creating PDF's

PDF's can be created and enhanced using Acrobat's suite of electronic publishing tools. Depending on the type of document you are converting to PDF, there are two options available — PDFWriter and Acrobat Distiller.

PDFWriter is a print driver, selected in the print dialog box that converts creator application's files to PDF. Instead of sending the file to the printer it gets written to a PDF file. It is most suitable for documents that contain mainly text and to convert simple business documents, like those created with Word or Excel.

Acrobat Distiller is an application used to convert PostScript & Encapsulated PostScript (EPS) files into PDF files. It is used for documents created in page layout and illustration applications like PageMaker and Illustrator. It can also be used for documents with extensive graphics since it offers more control over downsampling and compression, which are used to control the file size. Since it is important to reduce the file size for online distribution, Distiller offers a variety of compression options that can be tweaked to attain the smallest file size, as well as the best looking images. File size, can be 10 to 20 times smaller than the original file depending on number of images and the compression and resolution selected. There are also several preset options to make these choices easier for the novice.

Another option is to use a scanner to import a scanned image directly into Acrobat. This will create an 'image only' view of the scanned page, meaning the text is uneditable. However, once the document is a PDF, a second step can be applied which "captures" previously scanned pages and converts them using Acrobat's built-in OCR (Optical Character

Recognition) capabilities to transform it to editable text. This technique works well for documents unavailable electronically, which you would like to edit. There is a built-in capture feature for capturing single-page documents or those with only a few pages. For larger documents, Acrobat Capture, a separate piece of software can be purchased to automate page capture.

Value-added Features

In addition to simply transforming documents for use on the Web, Acrobat allows you to add a variety of useful features to your documents. Value-added documents contain the original content and then add navigational, organizational, retrieval and presentational elements to the online version (Bielawski, 1996).

Navigation

Bookmarks and thumbnails are two options that can be used to navigate and add structure to the document. Based on a traditional table of contents, bookmarks show the pages included in the document as well as serving as a link to each of the pages. Bookmarks can be nested to create an outline which links to sections of the document or to particular pages. Figure 2 shows an example that organizes weekly lecture notes created by converting the PowerPoint slides to a PDF file. Each bookmark is linked to a particular slide in the lecture sequence for easy reference.

Thumbnails, miniature views of each page, can also be used as a visual guide to the document. They are also links to the pages they identify for easy movement through the document. In addition, Acrobat Reader also has built-in navigation tools for moving through documents that include forward and back arrows, a place to type in an exact page number, and scrolling through pages in a filmstrip manner. These features and the thumbnail view can be seen in Figure 3.

Links

Hypertext links are easily created in Acrobat and can be used for a variety of purposes. Links can go to other locations in the same PDF document, to a location in another PDF file, to a URL (Uniform Resource Locator) on the World Wide Web or to another file in a different application. Internal Links can be made within a document such as linking a reference notation to the page which lists all the references or to a figure that goes with the example which is separate from the text. Links to other PDF files can be used to link to files from a class syllabus which serves as the base document. Materials like class assignment specifications, reading excerpts and tutorials can be

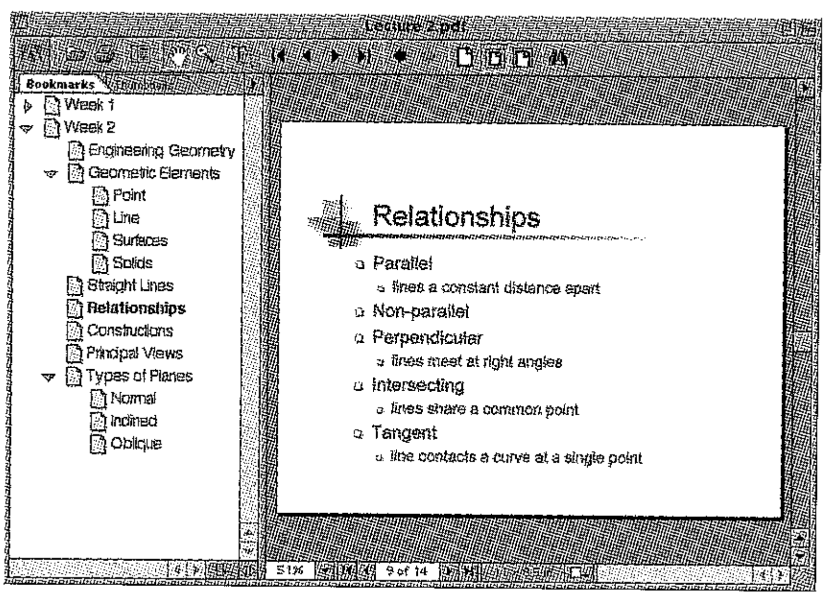

Figure 2 *Bookmarks used to organize lecture slides.*

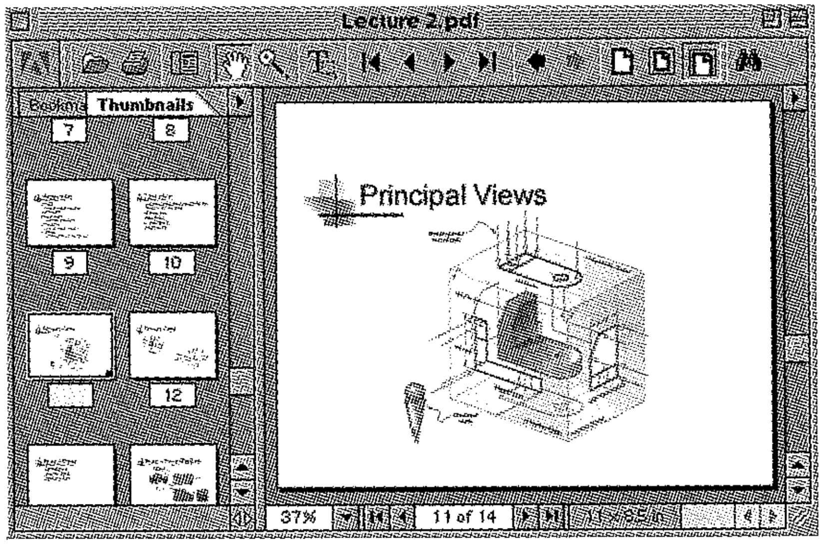

Figure 3 Navigation tools are show at the top and bottom of the window and thumbnails at the left.

linked from items on the syllabus. Files created in other applications such as Word or AutoCAD can be launched from a link if the creator application resides on the user's machine. This means that students could download an AutoCAD file for use in lab simply by launching it from the syllabus. URL links make it easy to directly link students to external resources available on the World Wide Web.

Annotations

There are a variety of tools that can be used to edit and markup existing PDF documents. Some of these tools include notes, stamps, text, audio annotations, and a set of markup tools. For example, sticky reminders and instructions can be added to assignments to draw attention to a particular reading passage or remind students of a due date (Figure 4). Stamps can be used to add images or grades to student projects and although there are existing galleries of stamps and graphical markup annotations, you can create your own if you have custom marking needs. Annotations can be filtered so only certain markups will appear and a summary of reviewers comments can be generated on a marked up document. Annotations can also be set so they do not print with the document. There is also a document compare feature to view pre and post-review versions of a document.

Multimedia Elements

Media elements such as sound and video may also be added to documents. QuickTime or AVI movies can be incorporated into a lecture presentation to show movie clips of simulations, live-action sequences or interviews. Sounds and music can be added for narration or to simulate a multimedia presentation. Hypertext links and multimedia elements can be used in combination to develop an interactive learning environment.

Security

There are several options available to protect documents if they contain confidential, proprietary, or copyrighted materials or have other needs for preserving document validity. These options include password protection and specific restrictions such as preventing the viewer of the document from printing or modifying the document, selecting text and images, or creating and modifying electronic notes and form fields. It is also possible to authenticate content using digital signatures. Acrobat supports digital signatures, which can be used to authenticate authorship, track alterations, and verify approvals of documents.

Viewing PDF's in a Browser

Web browsers can be configured to handle PDF files in several ways. First, a PDF file can be embedded in a Web page so it looks just like

PSVT:R Pre-/Post-Test Results (Scores in Percent Correct)					
Year	**n**	**Average Pre-Test**	**Average Post-Test**	**Average Gain**	**Level of Significance of Gain**
1993	24	51.7	82.0	30.6	p<0.0001
1994	16	47.0	79.3	32.3	p<0.0005
1995	47	54.7	75.0	22.2	p<0.005
1996	26	50.0	81.7	31.4	p<0.0005
1997	27	48.3	78.0	29.6	p<0.0005
1998	36	50.7	72.7	21.8	p<0.0005

Table 1

course, students were administered the Purdue Spatial Visualization Test: Rotations (PSVT:R) (Guay, 1977) as both a pre- and post-test. (The pre-test was administered during freshman orientation and the post-test was administered during final exam week.) Table 1 presents the pre-/post-test results from 1993 through 1998. As it can be seen from this table, significant short-term improvements in spatial skills were obtained for each of these six years. The focus of this paper is on long-term analysis of the results obtained through offering this course over several years.

The Analysis

Improvements in spatial skills through participation in this course have been continually assessed primarily by means of standardized testing since 1993. Long-term data was recently gathered and analyzed. In this analysis, the transcripts of all of the students who initially failed the PSVT:R during freshman orientation (n=536) were obtained for each of the years 1993-98. Transcripts were obtained in January of 2000 for all 536 students. For each year, the student transcripts were sorted into those who had failed the PSVT:R and enrolled in GN102 (the experimental group) and those who failed the spatial test and did not enroll in GN102 (the comparison group). The results from this long-term assessment are presented in the following sections.

Grades in Subsequent Graphics Courses

At Michigan Tech under the time period of consideration, there were several graphics courses that engineering students might take, depending on their major (MTU recently adopted a common first year for engineering freshmen). In addition, several students in the comparison and experimental groups may have taken graphics courses outside of the College of Engineering, particularly if they changed majors to engineering technology. In each case, the first grade that students received in a particular course was the grade that was used in this analysis. The transcripts of a number of students showed that they had repeated graphics courses, however, the grades received the second (or third!) time they enrolled in a course were not included in this analysis. Michigan Tech utilizes a 4-point grading scale with grade points assigned according to the following scheme: A=4.0, AB=3.5, B=3.0, BC=2.5, etc. (please note that a grade of AB is equivalent to a grade of B+, a grade of BC is equivalent to a grade of C+, and so on). In addition, if a student enrolled in a particular course and dropped it after the third week in the quarter, a "W" would appear on his/her transcript. The W grade does not affect a person's overall GPA, but it typically is an indication that a student "struggled" with the given course and did not wish to receive a final grade in the course (there are other reasons as well).

Table 2 presents the average GPAs for the students in the comparison and experimental groups for the various graphics courses offered at Michigan Tech as well as an overall GPA computed from all graphics courses taken by each group. (Note that grades of "W" were not included in this analysis since there are no grade points associated with this designation.) It should also be noted that not all of the students in each group took any graphics courses and some students took more than one graphics course. Sample sizes for this analysis were computed based on the number of courses attempted as shown on student transcripts. As it can be seen from this data, students who had participated in the spatial skills course received better grades on average than those who did not. The difference between average GPAs for the two groups were tested for statistical significance with the results from this analysis also presented in the table. Although most differences in mean GPAs for the two groups for individual graphics courses did not show statistical significance due to relatively small sample sizes, the difference in overall mean graphics GPA for the two groups was highly significant with students in the experimental group outperforming students in the comparison group by nearly a half letter grade in their subsequent graphics courses.

In addition to looking at mean GPAs in graphics courses for the students in the two groups, we also looked at the distribution of those grades for each group. In particular, the percentage of students who performed poorly as well as those who were not successful in graphics was of particular interest. At Michigan Tech, a student can repeat a course if s/he receives a CD (corresponds to a grade of D+)

Average GPAs in Subsequent Graphics Courses

	Comparison Group (Failed PSVT:R did not enroll in GN102)	Experimental Group (Failed PSVT:R enroll in GN102)	Significance of the Difference in Means
ME104-Engineering Spatial Analysis	2.30 (n=126)	2.79 (n=74)	$p<0.0005$
ME105-Graphical Communication in Engineering Design	2.55 (n=102)	2.65 (n=57)	N.S.
GN131-Introduction to Engineering Graphics	2.80 (n=23)	2.86 (n=28)	N.S.
GN135-Introduction to Computer Aided Design	3.02 (n=26)	3.31 (n=24)	N.S.
GN201-Introduction to Computer Aided Drafting and Design	3.07 (n=42)	3.32 (n=25)	N.S.
CET103-Engineering Graphics Using CAD	3.57 (n=29)	3.36 (n=14)	N.S.
Other MTU graphics courses offered through the School of Technology	2.33 (n=58)	3.13 (n=15)	$0.01<p<0.005$
Overall Graphics GPA (sum total of all graphics courses attempted)	2.61 (n=406)	2.93 (n=237)	$p>0.0001$

Table 2

Poor Performance in Subsequent Graphics Courses		
Grade	**Comparison Group (n=422)**	**Experimental Group (n=244)**
CD	27 (6.4%)	12 (4.9%)
D	20 (4.7%)	8 (3.3%)
F	26 (6.2%)	6 (2.5%)
W	16 (3.8%)	7 (2.9%)

Table 3

or lower as a final grade. Table 3 presents the overall graphics performance for these two groups in these "lower" grade categories.

From the data presented in this table, it seems that the students in the comparison group were more likely to perform poorly in their subsequent graphics courses when compared to the students in the experimental group. For the students in the comparison group for all graphics courses attempted, 21.1% performed poorly compared to only 13.6% for the experimental group. Statistical analysis was performed on these results and it was determined that these differences were significant ($p=0.015$). The students in the comparison group were also twice as likely to be unsuccessful (F or W) in their subsequent graphics courses (10.0%) compared to their counterparts in the experimental group (5.3%). This difference was also statistically significant ($p=0.037$).

Attrition from Michigan Tech and/or the College of Engineering

The attrition rate of the students in the comparison and experimental groups was also examined. In this case, students were considered to be "retained" if they were still enrolled in or had graduated from Michigan Tech. Determining the impact of this project on the retention of women in engineering was of special interest. Figures 1 and 2 show the retention rates for men and women respectively. In these figures, students who remained at Michigan Tech but who transferred out of the College of Engineering into another program are shown as "Retained at MTU," whereas students who remained in or graduated from the College of Engineering are shown as "Retained in Engineering" (also retained at MTU).

The overall retention rates for this group of students for the entire time period under consideration were also computed and are presented in Table 4. The retention data shows that men in the experimental group were retained at the university at a higher rate (75.3%) than were men in the comparison group (69.0%). Similarly, men in the experimental group were retained in the College of Engineering at a higher rate (61.2%) than were their counterparts in the comparison group (52.0%). Statistical analysis reveals that the differences between retention rates for male students at MTU and within engineering, although encouraging, were not statistically significant. Women in the experimental group were likewise retained at the university at a higher rate (88.9%) than were women in the comparison group (68.3%), and the women in the experimental group were also retained within Engineering at a higher rate (76.7%) than were women in the comparison group (47.8%). The difference in retention rates

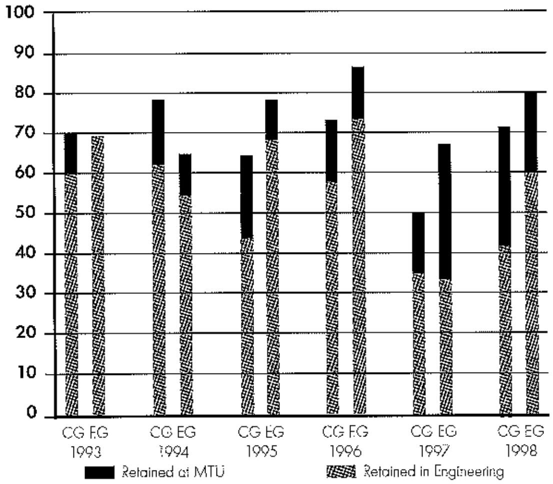

Figure 1 *Retention of Male Students*

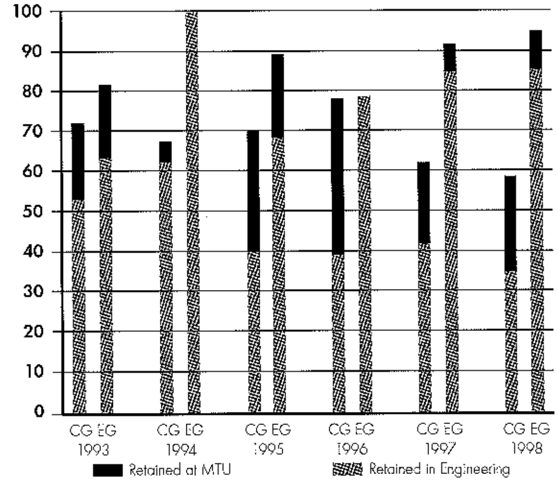

Figure 2 *Retention of Female Students*

between the women in the comparison and experimental groups at Michigan Tech and within the College of Engineering were highly significant ($p<0.0002$ for each).

Conclusions

Through this study, results from the development of a course designed to improve the spatial visualization skills of first-year engineering students were analyzed. Statistically significant improvements in spatial skills were measured by means of a standardized testing instrument in each of the six years under consideration. This improvement in spatial skills resulted in improved performance in subsequent graphics courses as measured by final grades in the courses for the students who enrolled in GN102. In addition, it was found that students who enrolled in GN102 were retained at the university and within the College of Engineering at a higher rate when compared to the group of students who initially failed the PSVT:R and did not enroll in GN102. These differences in retention rates were significant for female students but not for male students.

Engineering has many "gateway" courses. Typically, these are thought to be Calculus, Chemistry, and/or Physics. From the results of this study, it seems that for women, Engineering Graphics may also be a significant gateway course. By developing and implementing a course to help students improve their ability to visualize in three dimensions, improvements in graphics performance and in retention rates (particularly for women students) were obtained.

Retention Rates for Men and Women

Comparison Group			Experimental Group	
Male	**Female**		**Male**	**Female**
n=200	n=161		n=85	n=90
62 (31.0%)	51 (31.7%)	Not Retained	21 (24.7%)	10 (11.1%)
34 (17.0%)	33 (20.5%)	Retained at Michigan Tech but not in Engineering	12 (14.1%)	11 (12.2%)
104 (52.0%)	77 (47.8%)	Retained in Engineering at Michigan Tech	52 (61.2%)	69 (76.7%)

Table 4

Acknowledgement

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References

Barke, H.-D. (1993). Chemical education and spatial ability. *Journal of Chemical Engineering, 70* (12), 968-971.

Bowers, D. H. & Evans, D. L. (1990). The role of visualization in engineering design. *Proceedings of the NSF Symposium on Modernization of the Engineering Design Graphics Curriculum.* Austin, TX. 89-94.

Deno, J. A. (1995). The relationship of previous experiences to spatial visualization ability. *Engineering Design Graphics Journal, 59* (3), 5-17.

Field, B. W. (1994). A course in spatial visualization. *Proceedings of the 6th International Conference on Engineering Design Graphics and Descriptive Geometry.* Tokyo, Japan. 257-261.

Guay, R. B. (1977). Purdue spatial visualization test: Rotations. West Lafayette, IN, Purdue Research Foundation.

Leopold C., Sorby, S. & Gorska, R. (1996). Gender differences in 3-D visualization skills of engineering students. *Proceedings of the 7th International Conference on Engineering Computer Graphics and Descriptive Geometry.* Andrzej Wyzykowski, et. al., Editors, Cracow, Poland, 560-564.

Maier, P. H. (1994). Raeumliches vorstellungsvermoegen. Frankfurt a.M., Berlin, Bern, New York, Paris, Wien: Lang.

Mc Kim, R. H. (1980). Experiences in visual thinking. PWS Publishers, Boston Massachusetts.

Medina, A. C., Gerson, H. B. P., & Sorby, S. A. (1998). Identifying gender differences in the 3-D visualization skills of engineering students in Brazil and in the United States. *Proceedings of the International Conference for Engineering Education.* Rio de Janeiro, Brazil.

Norman, K.L. (1994). Spatial visualization-A gateway to computer-based technology. *Journal of Special Educational Technology, XII* (3), 195-206.

Smith, I. M. (1964). *Spatial ability-Its educational and social significance.* London: University of London.

Sorby, S. A. & Baartmans, B. J. (1996). A course for the development of 3-D spatial visualization skills. *Engineering Design Graphics Journal, 60* (1), 13-20.

Sorby, S. A. & Gorska, R. A. (1998). The effect of various courses and teaching methods on the improvement of spatial ability. *Proceedings of the 8th International Conference on Engineering Design Graphics and Descriptive Geometry.* Austin, TX. 252-256.

Sorby, S. A. (2000). Spatial abilities and their relationship to effective learning of 3-D solid modeling software. *Engineering Design Graphics Journal, 64* (3), 30-35.

[Distinguished Service Award]

EDGD
2001 Distinguished Service Award
Presented to
Jack C. Brown

ASEE Annual Conference
June, 2001
Albuquerque, New Mexico

Presented by Frank M. Croft, Jr.

This year, the Engineering Design Graphics Division's Distinguished Service Award is presented to a "southern gentleman" who is a "Jack of all Trades" and a friend to all. When I heard the name of this year's recipient, I was delighted to know that the Division's choice for its highest award was none other than Jack C. Brown from the University of Alabama. His selection delighted me because often, dedicated people like Jack can be forgotten as time goes by after they retire; however, this Division did not forget and we honor Jack this evening.

As I think back to when I first met Jack, my first recollection was several years ago at the First International Conference on Descriptive Geometry, which was held in Vancouver, British Columbia in 1978. This conference was planned as a celebration of the 50th anniversary of the Engineering Design Graphics Division of ASEE; however, it was only the beginning-for there have been many international conferences after Vancouver in places like Japan, China, Austria, Poland, Australia, the United States, and most recently South Africa. This highly successful conference in Vancouver spawned a new international graphics society that is planning its next conference in Odessa, Russia. The significance of this is that the people involved in the planning and operation of this first international conference have been distinguished contributors to the work of this Division. These people included:

Amogene F. DeVaney
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EDGD DSA 1985

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Robert Foster
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Steve Slaby
EDGD DSA 1983

Clyde H. Kearns
EDGD DSA 1990

Mary Blade
EDGD DSA 1980

One person is missing from this list. Jack Brown was the Treasurer and Registration Chairman for this conference. Tonight, Jack Brown is the last organizer of this pivotal conference to be honored with the Distinguished Service Award from the Division. With this presentation, every person associated with the organization and operation of the First International Conference on Descriptive Geometry will have received the DSA.

Now, let me say a few words about Jack. He spent 32 years teaching graphics at his alma mater, the University of Alabama from which he received his BSCE degree in 1952. Jack went on to receive a Masters in Engineering Graphics from Illinois Institute of Technology in 1959 (he was the 4th graduate of the program). Finally he received a Ph.D. from Texas A&M in 1972. He has won numerous awards for teaching at the University of Alabama. In 1984 he received the Outstanding Commitment to Teaching Award from the University of Alabama National Alumni Association. Before his retirement, Jack received the Outstanding Teacher Award and the Distinguished Professor Award at Alabama.

was so surprised to receive the call telling me I hand been chosen to receive the Distinguished Service Award . . . and started writing my acceptance speech . . . and I started it by remembering what I had begun teaching with . . and after finishing i began to practice to my wife . . . she stopped me very shortly and said . . . "You won't be in the classroom, and you won't be doing a 90 minute lecture on drawing . . . all you need to do is tell them how honored you are and thank them" . . so I want you to know I'm very honored, humbled and I thank each and every one of you and class dismissed.

Jack C. Brown

Jack's association with the Engineering Design Graphics Division of ASEE is long and distinguished. He has served the Division in many capacities including: Director of Liaison, Vice Chair, Chair, International Conference Committee member, and he was known as the "Ad Hoc Chaplain" for the Division during his active years. He was the gracious host of two Mid-Year Meetings at the University of Alabama, which many of us fondly remember.

In summary, it is an honor and a privilege for me to make this presentation this evening. I have known Jack for over 20 years and he has been a dedicated servant to the Division and ASEE. It gives me great pleasure to present the Distinguished Service Award to " A Jack of all Trades and a Friend to All", Jack C. Brown.

JACK C. BROWN is hereby recognized by the Engineering Design Graphics Division of the American Society for Engineering Education for his outstanding contributions to the Division and to Engineering Education. He has served the Division in many capacities including Reviewer on the EDGD Journal Technical Review Board, Director of Liaison, Vice Chair, and Chair of the Division. He has been the gracious host for two of the Division's Mid-Year Meetings and, he was treasurer and registration chairman for the First International Conference on Descriptive Geometry held in Vancouver, B.C. During his active service with Division, members came to know him as the "ad hoc chaplain" for the Division. As an active member, educator, and officer Jack has served the Division faithfully and well.

This award is the highest that can be presented by the Division to one of its members. Jack C. Brown has been selected for this honor by his colleagues for his outstanding career as an Engineering Educator at The University of Alabama.

Presented this 26th day of June, 2001, at the ASEE Annual Conference, Albuquerque, New Mexico.

2001-2002

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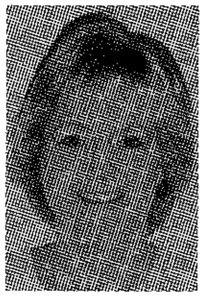
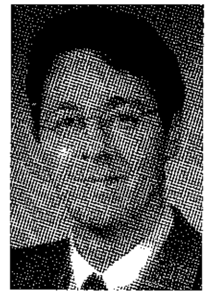


Judith A. Birchman

Judy Birchman is an Associate Professor in the Department of Computer Graphics Technology at Purdue University. She received her Bachelor of Science and Master of Science Degrees from Purdue University. A member of the Graphics Department since 1974, she has taught courses in engineering graphics fundamentals, drawing systems, CAD, publishing and multimedia. Most recently, she has taught courses covering both print and web-based publishing as well as multimedia authoring. Professional activities include presentations, papers and workshops on design, graphics and multimedia topics.

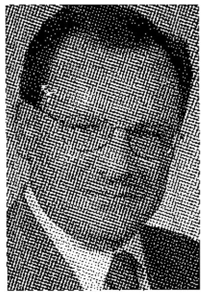
Professor Birchman is the past Editor of the Engineering Design Graphics Journal and is currently serving as the Technical Editor, supervising the paper review process. Previous to being Editor, she served as Technical Editor of the Journal for six years. As Director of Publications for the Engineering Design Graphics Division, she was responsible for implementing their initial web site. She is a member of the American Society for Engineering Education (ASEE), the Engineering Design Graphics Division (EDGD) and the National Association of PhotoShop Professionals (NAPP).



Eric N. Wiebe

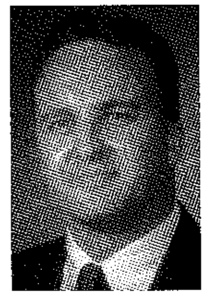
Eric N. Wiebe, Ph.D., is an Assistant Professor in the Graphic Communications Program at NC State University. Eric has authored or co-authored four texts on technical graphics used nation-wide. He has been involved in Computer-Aided Design/3-D modeling development and use since 1986 and taught technical graphics and CAD at NC State for the past thirteen years. During this time, he has worked as a consultant through the Furniture Manufacturing and Management Center at NC State University on the use of product design and development technologies in the furniture industry. During the past seven years, he has worked on the integration of scientific visualization concepts and techniques into both secondary and post-secondary education. Eric has been a member of the Engineering Design Graphics Division of the ASEE since 1989. He is also a member of the Human Factors and Ergonomics Society and the Alpha Pi chapter of the Epsilon Pi Tau honorary society.

Professional and Technical



Aaron Clark

Aaron Clark is an Assistant Professor in the Graphic Communications Program at North Carolina State University. He received his B.S. and M.S. in Technology and Technology Education from East Tennessee State University. He earned his doctoral degree from NC State University. His teaching specialty is in introductory engineering drawing, with emphasis in 3-D modeling and animation. Research areas include graphics education and scientific/technical visualization curricula development. He presents and publishes in both vocational/ technology education and engineering education. He has been on the faculty at NC State since 1993, prior to coming to North Carolina, he has worked in both industry and education administration in Tennessee and Maryland. He has been an active member within ASEE-EDGD and has presented papers at both the Mid-year and Annual Conferences. He has worked with membership recruitment for ASEE-EDGD for the past three years.



Theodore J. Branoff

Ted Branoff has been teaching in the Graphic Communications program at North Carolina State University since 1986. He has a bachelor of science in Technical Education, a master of science in Occupational Education, and a Ph.D. in Curriculum and Instruction from NC State University. He was previously employed with Measurements Group, Inc. as a draftsman and with Siemens, Switchgear Division as a specifications draftsperson. Along with teaching courses in introductory engineering graphics, computer-aided design, descriptive geometry, instructional design and course design, he has conducted CAD and geometric dimensioning & tolerancing workshops for both high school teachers and local industry.

Dr. Branoff is a member of the Engineering Design Graphics Division of the American Society for Engineering Education, Epsilon Pi Tau, Omicron Tau Theta, Kappa Delta Pi and Phi Delta Kappa.

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