A Study of Current Trends and Issues for Graphics Education: Results from a Five-Year Follow-up Survey

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Abstract

During the 1998-1999 academic year, a survey was conducted to look at current trends and issues in the profession of graphics education (Clark & Scales, 1999). The survey solicited information from the membership of the Engineering Design Graphics Division of American Society for Engineering Education related to their view of future areas of growth, problems that exist, and direction the profession of engineering graphics education is headed in the future. This survey, conducted in the spring of 2004, is a five-year follow-up using the same instrument, but with new categories added to provide for current trends in post-secondary graphics education. New areas added to the survey asked questions on certifications, distance education, salaries, and research interests.

Introduction

This paper provides the results from a survey to the engineering design graphics profession on current trends and issues related to the teaching of engineering/technical graphics in post-secondary education. The survey was previously used in the Fall of 1998 (Clark & Scales, 1999) to look at the same trends and issues, but modifications were made to meet current events and developments facing the graphics education profession. This survey was conducted in the Spring of 2004 to the membership in the Engineering Design Graphics Division (EDGD) of the American Society for Engineering Education (ASEE). It was the belief of the researchers for this study, as with the previous study, that members in this division are active within the profession of graphics education and can provide needed information about were the status of graphics education is within the United States. Only members of the EDGD that reside within the US were sent survey instruments.

The survey contained five major categories, four from the original instrument developed in 1998 that included course offerings, student populations, professional, technical/engineering graphics education, and future research plans (Clark & Scales, 2000). The last category titled research is new for this study and was added at the request of members within the profession. Course offerings category asked questions about type of courses offered at participant's institutions and whether or not certain topics were separate courses or integrated into other courses. The instrument asked about the topics in manual drawing, three-dimensional modeling, geometric dimensioning and tolerancing (GD&T), sketching, animation, descriptive geometry, desktop publishing, website development, ethics, and CAM. Ethics was a new area added at the suggestion of the membership within EDGD at the last Mid-Year meeting (2003). Also, within this major category, questions about offering online and distance education courses were asked. Again, this area was added to this version of the instrument at the request of the membership. The second major category looked at student populations, especially in regards to gender and the degree majors taking courses related to engineering/technical graphics. This category was not modified from the previous study. The third category asked questions about the backgrounds of faculty teaching engineering/technical graphics, professional activities and development, as well as major concerns within the profession and future trends. New areas asked within this category include salary structure for faculty, responsibilities and duties, and strategies to deal with teaching problems. The fourth major cat-

egory looked at graphics education, in particular, the number of minors and majors in fields related to technical and engineering graphics. One new question asked within the category was whether or not a national student organization is needed for majors within the field. The last category asked questions related to future research plans. This new category asked participants the areas of research they are currently working on, including major funding sources for research, collaboration, future interests, and future research topics needed for our field.

Methodology

The survey instrument used data collecting procedures established by Lybery (1997). The questions were originally selected by asking professionals in the disciplines of engineering, technical and technology education for input and comments. Once the instrument was developed, faculty at NC State University in the College of Education with expertise in statistics, graphic communications, technology education, and survey development, gave feedback with four rounds of edits (Clark & Scales, 1999). The instrument used for this study was this original survey instrument, but new categories and questions were included from informal discussion with members of the EDGD community over the last five years.

Survey participants were chosen from the EDGD Membership Directory for 2003-04 (Kerns, 2003). Of the membership, 350 members were from the United States and were sent the survey representing most of the 50 states. Participants that received the survey had to be in a post-secondary institution, a current member of the EDGD, and listed within the membership directory (Kerns, 2003). After two weeks, the membership that participates with the EDGD listserv was sent reminders about the survey and the final tally was taken in mid-June of 2004.

Once the survey instruments were collected, those sent back from retired professors were excluded if they had retired before 1998; the remaining instruments were included with descriptive statistics and qualitative analyses performed on the data. This research paper provides results of the descriptive findings made for this survey given the responses from the participants. Please note that the original survey conducted in 1998 included participants in professional organizations like NAITTE (National Association for Industrial Technology Teacher Education) and CTTE (Council for Technology Teacher Education). This survey was only conducted with the membership in the EDGD-ASEE division.

Survey Results

A total of 350 surveys were mailed to members of the EDGD division of the ASEE in May of 2004, with a return rate of 51 or 14.5%. Listed below are the descriptive findings found from those that responded in the survey. Please note that all percentages are rounded to the nearest whole number for simplicity of reading.

Course Offerings

On average, the participants indicated that 6.29 courses were offered in engineering and technical graphics at their institution on a regular academic year basis from a total combined number of 302 from the 48 participants that responded to this part of the survey. Sixty-eight percent (or 35 participants out of 51 that responded to this question) offer some form of GD&T at their institution. Of these 35 participants, 32% offer a separate course in GD&T, 65% offer it integrated into existing course offerings and three percent offer both integrated and separate courses in GD&T. Of those that responded, GD&T is offered on average in 1.96 courses, ranging from 1 to 5 courses.

Questions regarding teaching with manual drawing instruments were asked to participants. Fifty-five percent, or 28 participants of the 51 responding to the survey, use manual instruments in some form. Of those that responded, 29% offer a separate class using manual instruments, while 72% integrate the use of manual instruments into existing course offerings. On average, 1.53 courses are offered at participating institutions that involve the use of manual instruments with a range of 1 to 4 course offerings.

In the area of two-dimensional (2D) computer aided design (CAD), 82% or 45 participants out of 51 teach this area. Of those offering 2D CAD, 31% offer it as a separate course, 67% integrate 2D CAD with other courses, and 2% offer both separate and integrated 2D CAD courses. Two-dimensional CAD is taught, on average, in 3.02 courses ranging from 1-17 courses per year.

AutoCAD was the most recognized software used in this area.

Participants were asked questions about sketching and the integration of sketching into their existing course offerings. Eighteen out of 51 participants or 35% indicated that their institutions offer sketching only in some of their course offerings. Sixty-six percent combine sketching and computer graphics together or just do computer graphics only.

Questions about non-constraint based 3D modeling were asked to survey participants. Twenty-seven participants (or 53%) out of the 51 that responded to this question indicated that they do teach non-constraint based modeling. Thirty-two percent have separate courses that do just non-constraint based modeling and 68% integrate it within their course offerings. On average, the responding participants offer 2.64 non-constraint based modeling courses with a range from 1 to 12 course offerings. AutoCAD was the most recognized software used in this area with Solidworks and IDEAS mentioned by some participants.

Thirty-eight participants (or 75%) out of the 51 that responded to the survey indicated that they teach 3D constraint based modeling in their existing courses. Twenty-four percent offer separate courses in 3D modeling and 68% integrate this form of modeling. Eight percent indicated that they have both separate and integrated course offerings regarding 3D constraint based modeling. On average, 2.57 3D constrain-based modeling courses are offered, with a range from one to seven courses at participating institutions. Solidworks was the most recognized software used in this area with other packages like Inventor and ProE mentioned by the survey participants.

One new area the survey asked questions about dealt with the teaching of ethics. Twenty of the 51 respondents (39%) teach some form of ethics in graphics related courses. Ten percent offer ethics as a separate course offering and 90% integrate the teaching of ethics into existing course offerings. On average, 1.29 courses on ethics are taught in graphics related courses with a range of 1 to 2 course offerings.

Computer-aided Manufacturing (CAM) is taught by 24 (or 47%) of the 51 participants that responded to this question. Forty-one percent offer separate courses in just CAD, while 54% offer this area integrated into existing course offerings. On average, CAM is taught in two courses with a range of 1 to 8 courses. MasterCAM was the most recognized software used in this area.

Questions were asked about the teaching of descriptive geometry in graphics related courses. Twenty-nine (or 57%) participants out of the 51 that responded to this question offer some form of descriptive geometry. Of those that responded, 39% offer separate courses and 61% integrate descriptive geometry into existing courses. Forty-five percent indicated that they use software to teach this area. On average, 1.25 descriptive geometry courses are offered at participating institutions with a range of 1 to 3 course offerings. AutoCAD was the most recognized software used in this area.

The teaching of desktop publishing was asked to participants within the survey. Eleven (or 22%) out of the 51 participants that responded to this question teach some form of desktop publishing. For those who teach desktop publishing, 55% offer a separate course in desktop while 36% integrate it into existing courses. Nine percent reported having both integrated and separate desktop course offerings. On average, 1.78 desktop publishing courses are offered, with a range from 0 to 4 course offerings. Adobe products were the most recognized software used in this area.

Questions about website development and design were asked in the survey. Eleven (or 22%) participants from the 51 that responded to this question do offer some form of website instruction. Eighty percent of those that responded that do offer website development do so as a separate course offering and 20% integrate the instruction into existing courses. On average, 1.5 courses in website development were indicated as being offered with a range from 0 to 3 course offerings. Dreamweaver and Frontpage were the most recognized software packages used in this area.

Animation is being offered by 51% (or 26 participants out of the 51) of those participants that responded to the question. Of those participants that do offer animation, 24% do so as a separate course and 72% integrate it into existing courses. On average, 1.33 courses in animation were indicated as being offered with a range from 1 to 3 course offerings. Also, of those respondents

Course Offerings found in both Surveys		
Courses Offered	**1998 Survey (n=111)**	**2004 Survey (n=51)**
GD&T	79%	68%
- Integrated	52	65
- Separate	14	32
Man. Drafting	57%	55%
- Integrated	42	72
- Sepatate	14	29
2-D CAD	93%	82%
- Integrated	68	67
- Sepatate	21	31
3-D non-constraint	61%	53%
- Integrated	47	68
- Sepatate	12	32
3-D constraint-based	46%	75%
- Integrated	34	68
- Sepatate	10	24
CAM	56%	47%
- Integrated	18	54
- Sepatate	35	41
Animation	34%	51%
- Integrated	22	72
- Sepatate	12	24

Table 1.

that do offer animation (26 or 51%) 44% focus their animation instruction on technical animation, 40% on simulation, nine percent on artistic, and seven percent on scientific animation. Of those respondents not teaching animation currently, four percent indicated that they would do so in the near future. 3D StudioMax was the most recognized software used in this area.

Distance education and on-line instruction questions were new to this survey asking questions about this form of teaching methodology. Of those participants that responded to the teaching of on-line courses, 10 (or 40%) out of the 25 participants that responded to this question do teach either partially or fully using on-line methods. Four (or 21%) out of the 19 participants responded that they do teach using distance education methods. Only one respondent out of the 48 total that responded to these series of questions offer some form of distance or on-line certification program related to graphic communications.

As indicated earlier, questions from the original instrument developed in 1998 were used in this study. To compare the results from this survey to the same questions from the survey conducted in 1998, Table 1 shows a side-by-side comparison of the two surveys (see Table 1).

Salary and distribution of Faculty duties		
Rank	**Average # who hold this rank**	**Salary Range**
Full Professor	1.90	45K - 200K
Associate Professor	2.48	45K - 90K
Assistant Professor	2.14	40K - 80K
Instructor	2.35	20K - 85K
Lecturer	2.83	10K - 90K
Adjunct	4.02	605 - 50K
Average Distribution of Faculty Duties		
Teaching	*Service*	*Research*
75.22%	17.13%	7.33%

Table 2.

Student Population

Questions were asked about student populations taking classes in engineering and technical graphics. Of the 51 participants that responded to the survey, the respondents on average reported 17% of the student populations taking their classes are female. Twenty-two percent reported an increase in females taking their classes while six percent had noticed a decrease. Seventy-one percent reported no change in the number of females taking their graphics classes. Excluding gender, the participants of the survey reported that on average, 13% of their student population is minority. Thirty-one percent reported an increase in the number of minorities taking their classes and eight percent reported a decrease in number of minorities taking their classes. Sixty percent indicated no change in the numbers of minorities taking their classes.

Participants were asked about student majors taking their graphics courses. Of the 51 participants that responded to this question, they indicated that 67% of the students taking courses in graphics were engineering majors. Twenty percent were in technology and six percent from design majors. The next highest major were education with only 1.48% of the total being this type of major.

Professional

The survey asked questions about professional areas and activities associated with technical and engineering graphics education; daily tasks as an instructor, and professional development for faculty. From the 51 participants that responded to the survey, on average, 2.15 full-time faculty members teach technical and/or engineering graphics as their primary responsibility for any given institution. The number of full-time faculty that teach graphics, but not as their primary teaching load, was 2.94. Fifty-five percent indicated that the faculty teaching these courses has engineering and/or technical degrees. Other degree types held by faculty included technology, design, and education.

A new area in the survey looked at salary ranges for the different levels associated with post-secondary instruction. Also, the teaching, service and research load required for faculty were asked from the participants. Table 2 shows the different ranks and the average number of faculty at any given institution that would hold a rank, as well as salary ranges for the different ranks. The table also shows the average percent of time allocated for areas in teaching, research, and service from those participants that responded to the survey.

The survey asked questions about degree offerings by participant's institutions that are directly related to engineering/technical graphics. Eighteen participants (or 36%) out of the 50 that responded to the question indicated that their institution offers a major in engineering/technical graphics. Five participants (or 10%) reported that they offer a minor in areas related to graphics. Of those that offer a minor, the number of credit hours needed to complete the minor, on average, was 20.

The survey asked questions about offering a degree for students that want to teach graphic

communications. Five participants (or 10%) of the 49 that responded to the question do offer some type of degree in teaching this area. Of the five that responded, three indicated that their institution offers a B.S. or B.A. degree, one offers just a M.S. or M.E.d related to this area, and one said their institution offers both. As an interesting side note to the survey, eight participants (or 23%) of 35 responded that a national organization for students is needed.

Questions about professional development were asked to the survey participants about activities each participates in on a regular basis and related to graphic communications. Many write-in answers were given, but the most frequent response was ASEE and EDGD activities followed by NAIT workshops and conferences. AutoDesk sponsored events through AutoDesk University and courses at training centers were second only to the ASEE and EDGD activities. Other vendor sponsored workshops by Solidworks and CAD/CAM companies were mentions by many participants as well.

One new question to this professional category within the survey asked participants what strategies have they initiated to deal with teaching problems over the last five years. Again, many comments were made, but those mentioned most often included more utilization of web-based instruction and tutorials, emphasis on 3D visualization using testing and help sessions, and project-based learning with students working in teams.

The survey asked about the major concerns participants have related to the teaching of engineering/technical graphic communications at the post-secondary level. Overall, the most noted concerns were: 1) quality of students entering the programs, 2) keeping up with the changes in technology (i.e. cost of software/hardware, faculty development, complexity of new software), 3) issues regarding graphics as an area of study (i.e. curriculum changes, fitting into engineering programs, too much emphasis on research), 4) the need to maintain practices such as sketching and stop teaching software. Other concerns mentioned more than once were teaching content verses software; and complexity of software making workloads too great.

A final question in this category asked participants what they felt are the future trends for the next five years as it relates to the teaching of engineering/technical graphic communications. Numerous responses were given and few trends could be detected, but three areas that seem to standout most often were; online and distance education instruction, more emphasis in 3D CAD, and more 3D prototyping.

Research

At the request of the membership within the EDGD, a fifth category was created that looked at the status of research being conducted by professionals in engineering/technical graphics communications. One question asked the participants if they collaborate outside of their program area in research, as well as outside their institution. Twenty-six participants (or 67%) out of the 39 that responded to this question indicated that they do collaborate outside of their program for research. Fourteen participants (or 37%) out of the 38 that responded to the question about collaboration outside of their institution indicated that they do so.

The survey asked participants to indicate the areas of research for which they are currently involved. Of those that responded, rapid prototyping was mentioned more that any other area. Areas mentioned more than once included assessment, working with secondary schools, and online instruction. Considering this, the survey asked participants to identify their current or previous funding source for conducting research. The National Science Foundation (NSF) was the most mentioned source, followed by grants from private industry. When asked what grants are they currently involved with, no one grant or funding title was mentioned more than once for those that responded to the question.

The survey asked participants about the types and topics of research they were most interested in for the future. The most mentioned area was outreach to high school students, next was research in 3D printing and prototyping. Teaching and visualization were also mentioned in some of the responses. Finally, the survey asked participants what they felt were the main topics of research that are needed in our field. Again, many different responses were given and the list below shows the responses to this

question:

- reverse engineering in industrial and medical applications
- curriculum development
- change in manufacturing needs
- best ways to teach constraint-based modeling
- using parametric modeling as a means to teach visualization
- virtual reality and simulation
- improving visualization in 3D modeling
- visualization- pedagogy, solid modeling methodologies for practical application
- trends in industry as related to CAD and modeling
- rapid manufacturing technology
- simulation and reverse engineering
- integrating tolerances into CAD
- graphic decision-making, learning styles, and visual language
- education and new tools such as animation and analysis
- curriculum modernization and ABET requirement for graphics
- bridging between academics and real world applications
- assessment of student learning
- rapid product development
- 3D geometry, incorporating aesthetics

Conclusions

The information found within this paper is descriptive at best. All data found within the study can only be referred back to the respondents that sent back the survey. But, considering this, some observations can be made from what has been analyzed. From the questions asked in the course offerings category, the authors of this paper made the following conclusions. First, the profession has long been trying to eliminate the use of manual instruments from its instructional practices. But from the findings, over 50% are still using these instruments. Since the survey did not ask the area for which these instruments are used, no conclusions can be drawn. Next, 3D constraint-base modeling accounts for 75% of the type of software used in courses related to our field. The trend seems to be growing each year and will eventually replace traditional 2D CAD packages. Third, animation seems to be the next largest growth area for the type of courses we offer to our students with over 85% of the courses currently some form of animation being based on simulation and technical animation. New areas for the profession are the teaching of ethics, on-line instruction, and distance education. The authors see these two areas distance education methods as major growth areas and that ethics will be a part of the general content we all teach in our courses.

In the category of student population, one can see that the type of student that we attract to our course offerings is typically majoring in engineering, design and technology. As compared with the previous study, little gains have been made in increasing the number of female students in our classes but minorities taking our classes have increased over 30% in the last five years. It is suggested by the authors that more attention be placed in recruiting different majors to take our classes, as well as an emphasis on gender recruitment. The content we teach and the skills we develop in students are appropriate for many different types of majors with diverse backgrounds.

Professional develop is still a major concern for members of the EDGD community. The ASEE and EDGD meetings are major conferences that allow the membership to stay up-to-date with current events and trends for our field. Also, vendors play a major role in updating the skills needed to teach our courses. Stronger alliances are needed between the membership and vendors so that better and more productive professional development can continue in this area. Salary for the membership vary from institution to institution with the average starting salary for and Assistant Professor being in the $40k-50k range, Associate Professor 50k-60k range, and Professor at 70k and higher. The major responsibilities for the faculty that answered this survey is teaching, then service with research last, but, given the comments made throughout the survey, research is beginning to play a larger role in what we do as graphic communications faculty. The biggest innovation for improving teaching and course offerings to our students is the use of on-line instruction and tutorials. Our major concerns are the quality of students taking our classes and keeping up-to-date with current technologies. Although these concerns exist, one can easily see that the profession is trying to stay current and with major research areas

for many being K-12 outreach, that we are trying as a profession to help with the student quality issue. The largest growing future trend for the profession is in distance education and on-line instruction.

Finally in the research category, few conclusions can be drawn since this area is fairly new to the membership but the following conclusions are drawn from the data by the authors. First, most collaborative efforts are still done within the researchers existing program and institution. In order to facilitate better research, the authors suggest collabatories be established by the EDGD membership to help facilitate the research needs of the profession and individual and across many different institutions. The authors suggest that the leadership for the EDGD develop a structure for establishing such collabatories and that meetings be held at the mid-year and annual ASEE conferences for those members interested in collaborative research. From the comments given in the survey, it is suggested by the authors that these collabatories be in areas related to teaching and pedagogical practices, visualization, and k-12 outreach. As a final conclusion, since research has become a major focus for many in the area, that the membership look at offering workshops that will aid in the development and seeking of funding sources for research and that a new directors position be established for the executive committee within the division that deals directly with research. Also, given the concerns from the membership, trends in research, and service that members are doing currently, a second directors position should be considered that will be responsible for k-12 outreach.

In conclusion, the profession is doing very well and progress is being made on every front in post-secondary graphic communications education. The membership is active and has the ability to adapt too many changes being made in our profession. Overall, one can easily see that the future of our discipline looks bright and that we are stronger than ever as we move forward in this century that can be termed as the "visual age".

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