AC 2010-211: A SURVEY OF GRAPHIC PROFESSIONALS FOCUSED ON DISTANCE EDUCATION TRENDS IN TECHNICAL/ENGINEERING

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A Survey of Graphic Professionals Focused on Distance Education Trends in Technical/Engineering Graphics Education in the United States; Part II

Abstract

Research was conducted in the fall of 2008 to explore emerging trends in technical/ engineering graphics education. The study surveyed Engineering Design Graphics Division (EDGD) members through a follow-up study that had been used in previous years to collect data on current trends and issues related to the field. This paper will discuss the overarching issues and trends currently in technical/engineering education and one significant area within the survey that dealt directly with new instructional strategies for graphics education (i.e. distance education). One section of the survey explored distance education in technical/engineering graphics education; as prior research suggested that changes had occurred in the instructional topics and practices of the field. Previous research also shows that instructors wondered if the same topics were being taught and the same technology was being used by graphics professionals as a part of their curriculum at other institutions. The study sample of fifty-six (*N*=56) graphics education instructors was selected from Engineering Design Graphics Division (EDGD) members that were listed in the 2007-2008 membership directory. The EDGD members were contacted via email and responses were collected by an online survey instrument. Overall, the results were checked for invalid responses and then compiled. The results indicated that respondents were interested in remaining up-to-date with changes to distance education technology and topics even though the field might not be as up-to-date as they would desire. Possible future trends identified in this study were an increase in professional development and a migration to online and distance education from traditional classroom instruction. The field's interest and adaptation of distance education technologies and practices appear to be strong.

Introduction to the Study

Identified boundaries and limitations of technology and knowledge today may or may not be limits in the near future. Zuga and Bjorquist[1] wrote: "There will be newer and smarter machines tomorrow, making the knowledge acquired about today's model very perishable. By contrast, the learned ability to develop ideas and create solutions will always serve the learner". Changes in the types of work within the field of technical/engineering graphics education have led to changes in the curriculum. With constant change in the curriculum, efforts must be taken to ensure course content is updated with regards to technology[2]. Overturn in the subject matter has created barriers for technical/engineering graphics educators as instructors are responsible for retooling with relevant emergent technologies[3]. This responsibility supports the continual search for enhanced training methods and new research areas, such as distance education and professional development. Stevenson[4] wrote "Although no one can predict the future, we have an obligation to identify evolving attitudes and practices and try our best to understand how they might affect the physical setting we use for learning".

This research focused on professional technical/engineering graphics educators, who were located in the United States. Collected were data, thoughts, and opinions in relation to emergent themes in graphics education. The study was based on two previous research studies conducted

by Clark and Scales from North Carolina State University. The initial study was conducted in 1998 and published in 1999, and the second study was conducted in 2004[5]. The survey instrument from 2004 was modified for this study to include additional questions about distance education and professional development. The primary research question was "What are the current trends and future issues for technical/engineering graphics education in post-secondary education?" Expansion of the primary question led to the study of secondary areas, such as the technological turnover within the profession, an increase in the influence of distance education and an emergent need of professional development that this paper focuses on.

Why Now?

The purpose of this research was to identify possible new trends in the profession and to see how identified trends have changed since the last survey. Clark and Scales[6] stated that change will always be present and should be embraced "as we grow towards a greater and better future for the students we teach". Many industrial partners depend on university based engineering education to provide updated technical advancements to future employees. This process has been a delicate balance between industrial needs and academic ideals, as modern technologies became involved. Students will one day need to meet the expectations of future employers, so this situation has remained in constant balance. This responsibility makes the successful retention of the balance critical[7].

Clark and Scales[3] found that engineering graphics educators have changed what and how technology topics were taught. They also found that instructors wondered if the same course content was taught by other graphics professionals. Instructors also expressed that the act of overcoming challenges and dealing with new technology was part of the job and wondered if other instructors had a similar experience. If uncertainty existed amongst instructors, then important questions needed to be asked during new course development, in hopes of creating the most up-to-date course(s) as possible. Some of the questions addressed in this study included: What role might distance education play in the future of technical/engineering graphics education? Will professional development soon be required to ensure instructors obtain training related to changes in the field of technical/engineering graphics education? The five main categories researched in this study were: course offerings, student populations, professional development, technical/engineering graphics education, and future research plans[5]. Some categories looked at the present status of technical/engineering graphics education, to see what parts of the previous generation of topics were still taught and to what magnitude. Some survey questions offered graphic professionals the opportunity to look forward and make predictions of what is to come for the field. This paper will focus on the distance education and professional development categories and elements associated with this study. A brief overview of the other categories will be included.

Categories for the Survey

The survey was divided into different categories. The first category of the research covered course offerings and topics currently taught at institutions. The expanded survey instrument included additional questions focused on distance education. Clark and Scales[5] identified distance education and online instruction as the fastest growing future trend in the profession.

The distance education section of the 2004 survey instrument was expanded to cover instructor preparation, perceptions, and institutional implementations. The change was driven by research that found students viewed the computer as a "natural medium" for the presentation of information in technical/engineering graphics. These findings meant that more students have become comfortable with courses in desktop publishing, website development and distance education[8]. While students have begun to embrace distance education the adaptation of distance education into the field of technical/engineering graphics education, has been slow[9], even after it was predicted that 50% of all education will take place online by 2015[10]. As a result of this dramatic shift towards distance education, the ability to teach and work online will be an essential skill in the 21st century. The need for instructors to stay current with students' needs exists, so that instructors can properly prepare students with the necessary skills for the modern workplace. The second category researched was student populations, with special interest on gender, ethnicity, and the major of students who take technical/engineering graphics courses. This research could aid researchers who investigate if the population of gender minority and ethnic minority students had increased, decreased, or remained the same. Questions in this category remained unmodified from the 2004 survey instrument.

The third category looked at the instructors of technical/engineering graphics education. The questions delved into their employment status and pay scales. Pay scale has been previously linked with job satisfaction[11]. The third category also had questions that covered major concerns, ideas on future trends, and professional activities related to the profession. This portion of the survey was used to collect data on the forward thinking ideas of respondents in regards to where the profession may be headed. The collected data could help educators instruct engineering students on innovations as educators develop and inspire transformational change[12]. The third section was expanded from the 2004 survey instrument with additional questions focused on professional development. The new questions examined the level of involvement and the opinions of continued education from respondents.

The fourth category examined the major and minor offerings of institutions, along with information on the job fields in which recent graduates found work. Questions were also asked that covered the title of degree, minor offerings and the annual number of departmental graduates. This research could aid institutions as educators adapt curricula and advise students as course content changes. Questions from the fourth category remained unmodified from the 2004 survey instrument. Finally, the last category focused on current research, grants, collaborations, and future research plans. These areas were specified based on Flowers[13] 2001 work identifying continuing education as "the greatest job-related educational need". Continuing education could bring in employed educators as well as industrial workers that need to only take a few courses but not enough for a traditional degree. Questions from this category remained unmodified from the 2004 survey instrument.

Methodology

The survey instrument used was originally developed in 1998 by Clark and Scales and revised for the 2004 follow-up study[5]. This survey instrument was selected because it was specifically designed to collect information on current trends within technical/engineering graphics and to also collect thoughts and ideas that concerned the future of the profession. The instrument was

expanded to collect more information related to the topics of distance education and professional development. These areas had previously been identified as expanding areas that required additional research. The revised instrument was reviewed by technical/engineering graphics educators at NCSU and modified in accordance to the provided suggestions. The two original studies contacted possible participants and collected survey results with hardcopy mailings. Email was not used in the 1998 study, and it was only used to send out a reminder in the 2004 study. For this study, email was the only means of contact between the researcher and the population. The survey instrument was delivered via an online survey hosting website. Contact was made with Engineering Design Graphics Division (EDGD) members listed in the 2007-2008 American Society for Engineering Educators (ASEE) Membership Directory A population of EDGD members, who currently had obtained at least a Bachelors degree and currently taught at least one course per year at the time of the survey, was chosen because the opinions of current instructors could influence changes to the field in order to retain those instructors. Positive changes could generate a more satisfying environment for new instructors in the future[11]. A mass email that contained background information on the study was sent out in September 2008 with a link to the online survey instrument as suggested by Downing and Clark[14]. Two weeks after the initial email was sent, a reminder email was sent to the same population.

Findings

Given the theme of this paper and the large amount of data collected as part of this study, the findings will focus on distance education and professional development categories and elements associated with this study with a brief overview of the other categories.

Initial and reminder emails were sent out to 239 members of EDGD who had provided a valid email address. A total of 57 responses were returned, but one respondent stated that her or he was retired and, therefore, did not meet the teaching requirement. After this individual's responses were removed from the data set, the final number of responses totaled 56, thereby yielding a total response rate 23.4%. All descriptive data reported proportionally was rounded to the nearest hundredth, and data reported via percentages was rounded to the nearest tenth.

Course Offerings

The first series of questions asked participants to provide information in regards to the courses offered at their educational institutions. The first questions of the survey asked how many different technical/engineering graphics courses their educational institution offered at least once every two years. The question was answered by 54 respondents or 96.4% of the total respondents. A total of 7 respondents or 13.0% reported one course, 7 respondents or 13.0% reported two courses, 8 respondents or 14.8% reported three courses, 7 respondents or 13.0% reported four courses, and 25 respondents or 46.3% reported five or more courses. Respondents were then asked to list the top three CAD/modeling/CAM/animation software packages used at their educational institutions. This question was answered by 49 respondents or 87.5% of the total respondents. The variety of responses given by respondents covered programs dedicated to various disciplines within the field of technical/engineering graphics education (see Table 1).

Table 1

Top Seven CAD/Modeling/CAM/Animation Software Packages used in Technical/Engineering Graphics Courses

Software	Frequency (n = 49)	Mean %*
AutoCAD	36	73.5
Solidworks	23	46.9
Pro/E	13	26.5
Inventor	12	24.5
CATIA	5	10.2
Maya	5	10.2
NX	5	10.2

* Note: Percentage for each row (Software) has a maximum of 100%.

Respondents were asked if their program offered instruction in various topics and subject matter related to engineering/technical graphics and whether or not the topics were taught as separate "stand alone" courses, or integrated into existing courses. Table 2 shows the findings.

Table 2

Topics Offered in Technical/Engineering Graphics Courses that were taught Separate or Integrated

Subject	Offered* % (n)	Not Offered % (n)	Separate % (n)	Integrated % (n)
GD&T	66.0 (35)	34.0 (18)	21.1 (8)	78.9 (30)
Manual Instruments	49.1 (26)	50.9 (27)	24.0 (6)	76.0 (19)
2-D CAD	86.8 (46)	13.2 (7)	40.4 (19)	59.6 (28)
3-D Modeling	50.0 (25)	50.0 (25)	16.0 (4)	84.0 (21)
3-D Constraint	74.5 (38)	25.5 (13)	31.6 (12)	68.4 (26)
Ethics	49.0 (24)	51.0 (25)	12.5 (3)	87.5 (21)
CAM	46.9 (23)	53.1 (26)	42.9 (9)	57.1 (12)
Descrip. Geo.	54.2 (26)	45.8 (22)	30.8 (8)	69.2 (18)
Desktop Pub.	28.6 (14)	71.4 (35)	71.4 (10)	28.6 (4)
Website Dev.	31.9 (15)	68.1 (32)	68.8 (11)	31.3 (5)
Animation	58.3 (28)	41.7 (20)	28.6 (8)	71.4 (20)

Note: Maximum percentage for each subject was 100%.
Note: % is percentage of responses, (n) is the total of responses for each category and question.
Note: * indicates a category.

Course Offerings – Distance Education

The respondents were asked if they or their peers taught any part of their courses online or through distance education. The question was answered by 46 respondents, or 82.1% of the total respondents. Overall, 15 respondents or 32.6% answered "Yes," while 31 respondents or 67.4% answered "No." A follow-up question was asked tor respondents who answered "Yes" that

inquired if courses were taught online. A total of 13 out of the 56 respondents, or 23.2%, answered with an average of 4.4 courses per institution that utilized online distance education. Another question also addressed respondents who answered "Yes" to the first question on distance education, and asked if courses were taught through other distance education formats. A total of 9 respondents, or 16.1% of the total respondents, answered, and an average of 1.3 courses per institution utilized other distance education formats was calculated.

Another question asked if the respondents' program offered any online/distance education degree programs or online/distance education certifications related to graphics. The question was answered by 38 out of 56 respondents, or 67.9%. Overall, 3 respondents or 7.9% answered "Yes," while 35 respondents or 92.1% answered "No." A separate question served as a follow-up for those respondents who answered "Yes" to previous question and asked them what subjects were taught through online/distance education formats. A total of 4 respondents, or 7.1% of the total respondents, answered. Here were selected responses: 'Intro' classes and "MS in Technology-Graphic Information Technology concentration." were the most common.

Respondents were asked if the faculty within their program had received any training focused on distance education in the last 5 years. The question was answered by 45 respondents, or 80.4% of the overall respondents, and 21 respondents, or 46.7%, answered "Yes," and 24 respondents, or 53.3%, answered "No." Another question asked respondents if they were scheduled to have any training in the next year focused on distance education. A total of 44 respondents, or 78.6% of the total respondents, answered and 13 respondents, or 29.5%, answered "Yes," and 31 respondents, or 70.5%, answered "No."

A question was asked to respondents to find out if they had taught a course that utilized online/distance education to instruct any course. Overall, 46 respondents, or 82.1% of the total respondents, answered. Analysis showed that 18 respondents, or 39.1%, answered "Yes," and 28 respondents, or 60.9%, answered "No." For those that indicated yes to the question, they were asked if the respondents had used distance education to instruct a technical/engineering graphics courses. The question was answered by 26 respondents, or 46.4% of the total respondents, and 9 respondents, or 34.6%, answered "Yes," and 17 respondents, or 65.4%, answered "No.

Another question asked if the respondents' program offered any online/distance education degree programs or online/distance education certifications related to graphics. A total of 44 respondents, or 78.8% of the total respondents, answered and 19 respondents, or 43.2%, answered "Yes," and 25 respondents, or 56.8%, answered "No.

Respondents were asked if they considered themselves prepared to teach a technical/engineering graphics education course through online/distance education. The question was answered by 45 respondents, or 80.4% of the total respondents, and 20 respondents, or 44.4%, answered "Yes," and 25 respondents, or 55.6%, answered "No." To follow up this question, they were asked if they considered themselves prepared to single-handedly retool a traditional course to be an online/distance education course. A total of 43 out of the 56 respondents, or 76.8%, addressed this question and 19 respondents, or 44.2%, answered "Yes," and 24 respondents, or 55.8%, answered "No.

Questions were asked to respondents about what hurdles they thought existed for the instruction of technical/engineering graphics education content through online/distance education courses. Overall, 33 respondents, or 58.9% of the total respondents, answered. Other questions asked respondents if their program valued the instruction of an online/distance education course any differently than the instruction of a traditional course during tenure considerations. A total of 33 respondents, or 58.9% of the total respondents, answered. Furthermore, 4 respondents or 12.1% answered "Yes," while 29 respondents or 87.9% answered "No." A question addressed respondents who answered "Yes" to the previous question and asked respondents to please detail the differences. A total of 5 respondents, or 8.9% of the total respondents, answered this question. Most stated that institutions did not provide additional benefits to the instructors of online courses.

Respondents were asked whether their programs compensated instructors of online/distance education courses any differently than instructors of traditional courses. A total of 32 respondents, or 57.1% of the total responses, answered. Moreover, 4 respondents or 12.5% answered "Yes," but 28 respondents or 87.5% answered "No."

Respondents were asked if they would go out of their way to teach a course they were interested in, even if it required the course to be taught through online/distance education. The question was answered by 38 respondents, or 67.8% of the total respondents. Overall, 24 respondents or 63.2% answered "Yes," but 14 respondents or 36.8% answered "No." Another question asked respondents if they believed an instructor who used online/distance education should be required to be available 24/7 to students. Overall, 42 respondents, or 75.0% of the total respondents, answered the question. A total of 3 respondents or 7.1% answered "Yes," while 39 respondents or 92.9% answered "No."

A question was asked to respondents if their program offered any courses in a hybrid format, meaning the course contained traditional and online/distance education portions. The question was answered by 44, or 78.6%, of the total respondents. Seventeen respondents or 38.6% answered "Yes," but 27 respondents or 61.4% answered "No." For those respondents who answered "Yes" to the previous question, they were asked to provide percentages of courses offered in traditional/hybrid/online format, in a manner such that the total percentage came out to 100%. A total of 17 respondents, or 30.4% of the total respondents answered. Overall, an average of 64.5% of courses utilized a traditional format, an average of 35.6% of courses utilized a hybrid format, and an average of 7.4% of courses utilized a totally online format.

The final question in this category asked respondents if they believed the amount of hybrid courses offered at their educational institutions would increase over the next five years. A total of 41 respondents, or 73.2% of the total respondents, answered the question. Moreover, 36 respondents or 87.8% answered "Yes," but 5 respondents or 12.2% answered "No."

Student Population

A question in the Student Population category asked respondents what percentage (0-100%) of their student population enrolled in graphics courses were women. A total of 45 respondents, or 80.4% of the total respondents, answered the question. The responses had an average of 16.3%

of the students enrolled in technical/engineering graphics courses were women. Respondents were asked how this percentage had qualitatively changed over the last 5 years. A total of 46 respondents, or 82.1% of the total respondents, provided an answer and the results are documented in Table 3.

Table 3

Changes in the Percentage of Women Enrolled in Technical/Engineering Graphics Courses over the Last Five Years

Change	Frequency (n = 46)	Mean %*
Increased	18	39.1
Decreased	2	4.3
Stayed steady	26	56.5

Changes in the Percentage of Minorities Enrolled in Technical/Engineering Graphics Courses over the Last Five Years

Change	Frequency (n = 43)	Mean %*
Increased	14	32.6
Decreased	1	2.3
Stayed steady	28	65.1

* Note: Percentage for each row (Change) has a maximum of 100%.

A question asked respondents what percentage (0-100%) of their student population enrolled in graphics courses were of a minority (excluding gender), a total of 41 respondents, or 73.2% of the total population, replied. The responses had an average minority population of 21.1% of the entire student population enrolled in technical/engineering graphics courses. Respondents were then asked how this percentage had changed over the last 5 years. The question was answered by 43 respondents, or 76.8% of the total respondents. See Table 3 for frequency and percentage data.

Professional

As from the previous surveys, respondents were asked about the backgrounds of the faculty teaching engineering/technical education courses at their institutions. Table 4 shows this information including the average number of employees that hold a certain rank and salary.

Table 4

Background Fields of Faculty Members who Teach Technical/Engineering Graphics

Major	Response Rate % (n = 34)	Average # of Faculty Members
Engineering	73.5 (25)*	3.0
Education	41.2 (14)*	1.6
Design	29.4 (10)*	0.6
Other	23.5 (8)*	8.8
Technology	5.9 (2)*	4.4

Faculty Positions and Salary Ranges

Position	Average # of employees that hold this rank	Standard Deviation for avg. #	Salary Range	Median Salary
Full Professor	3.4	6.2	45K – 150K	85K
Associate Prof.	4.0	3.9	40K – 95K	70K
Assistant Prof.	4.0	3.1	35K – 90K	60K
Instructor	2.2	2.6	32K – 68K	45K
Lecturer	1.7	2.4	45K – 68K	55K
Adjunct	3.0	1.6	3K – 35K	3K

*Note: Maximum percentage for each subject was 100%.
*Note: % is percentage of responses, (n) is the total of responses for each category and question.

Respondents, in an open-ended format, were asked what they considered to be future trends within the next 5 years related to the teaching of technical/engineering graphics communications. Overall, 23 respondents, or 41.1% of the total respondents, answered the question. One respondent, for example, stated these thoughts on future trends: “The most significant would be efficiency (vs. effective [ness]) of delivery and the continued migration to online and distance delivery of instruction.” Another response suggested: “Integration with the math and sciences to provide applied learning opportunities in the traditional math and science classes.” Another question asked what type of professional activities respondents, or their faculty peers, have participated in on a regular basis that relate to graphics communications. The question was answered by 28 respondents, or 50.0% of the total respondents. In their responses, 27 of the 28 respondent, or 96.4%, stated that their professional activities included attending conferences, 17, or 60.7%, of those who answered participated in workshops and 18 of the 28 respondents, or 64.3%, stated that they participated in training/seminars. A question asked respondents how they kept up with changes in the curriculum. A total of 25 respondents, or 44.6% of the total respondents, answered this question. One particular participant in the survey stated that his or her approach to staying current with curriculum changes was to: “Read, attend conferences, talk with our advisory committee, and serve on accreditation visiting committees.” Another respondent kept up with the changes by: “Review technical and industrial articles. Attend occasional presentations at more general Engineering Education conferences (such as ASEE or FIE).”

Respondents were asked how many items related to graphics they had published in the last five years. A total of 21, or 37.5%, of the total respondents, answered some part of the question. For the number of articles published, 17 respondents, or 30.4% of those who answered question, replied. For the number of books published, 15 of the 21 respondents, or 26.8% answered. For the number of chapters published, 14 respondents, or 25.0% replied and for the number of white papers published, 12 of the 21 respondents, or 21.4% answered. For the number of miscellaneous materials published, 12 respondents, or 21.4% of those answered the question. For the average number of items reported (see Table 5).

Table 5

Publications by Faculty over the last Five Years

Publication	Mean (n)	SD	Response Range	Median
# of Articles	5.6 (17)	5.1	0 – 17	7
# of Books	1.5 (15)	1.4	0 – 5	1
# of Chapters	0.9 (14)	1.2	0 – 3	0
# of White Papers	1.4 (12)	1.9	0 – 6	0.5
# of Misc. Materials	4.8 (12)	3.4	0 – 10	5

A question was asked to respondents if they believed professional development training should be required for instructors in order to teach a technical/engineering graphics course through distance education. A total of 35, or 62.5%, of the total respondents, answered this question. Overall, 23 of the 35, or 65.7%, stated "Yes," but 12 respondents, or 34.3%, answered "No." A question in the survey asked respondents what percentages (0-100%) of their time were devoted to teaching, service, and research as a part of their duties as instructors. The percentages for these were supposed to total 100%. At least some part of the question was answered by 33, or 58.9% of the total respondents (see Table 6).

Table 6

Average Distribution of Faculty Duties

Area	Average %* (n)	SD	Response Range
Teaching	66.3% (33)	20.4	20% – 100%
Service	20.2% (30)	12.2	3% – 50%
Research	19.7% (26)	17.2	0% – 60%

* Note: Percentage for each row (Area) has a maximum of 100%.

Technical/Engineering Graphics Education

Questions were asked to participants to provide information in regard to technical/engineering graphics education. The first question in this category asked respondents if their educational institution offered a major in technical/engineering graphics communication. A total of 39 respondents, or 69.6% of the total respondents, answered this question. Overall, 11 of the 39 respondents, or 28.2%, answered "Yes," but 28 respondents, or 71.8%, answered "No." Another question targeted respondents who answered "Yes" and asked them to provide the areas of emphasis within their technical/engineering graphics communication major. The question was answered by 12, or 21.4%, of the total respondents. One respondent listed these areas of emphasis: "virtual product integration; animation and gaming; interactive media; construction graphics."

Respondents were asked if their institution offered a minor in technical/engineering graphics communications. A total of 38 respondents, or 67.9% of the total respondents, answered this question. Overall, 11 respondents, or 28.9% of those who answered the question stated "Yes," and 27 respondents, or 71.1%, answered "No." For those respondents who answered "Yes" to the

question, they were asked to provide the total number of hours needed to obtain a minor at their institution. Overall, 8 of the 56 respondents, or 14.3%, answered this question. The number of hours required to obtain the minor varied from 15 hours to 30 hours. A new series of question were asked to respondents about student work and placement. Questions were asked to those who worked for an institution that offered a graphics degree, in which fields former students usually found work in upon graduation. A total of 13, or 23.2% of the total respondents, answered the question (see Table 7).

Table 7

Industries Where Former Technical/Engineering Graphics Students Found Work

Industry	Frequency (n = 13)	Response Rate
Industry	13	100.0
Manufacturing	8	61.5
Business	7	53.8
Education	6	46.2
Sales	6	46.2
Entertainment	3	23.1

* Note: Percentage for each row (Industry) has a maximum of 100%.

Future Research Plans

In the final category of this study, questions asked participants to provide information in regard to future research plans. One new question was of particular interest to the researchers of this study. The question asked respondents to name the major sources of funding for the research in their program/department (i.e. NSF, NIH, DOD, etc). The question was answered by 16 respondents, or 28.6% of those who completed the survey. The responses are summarized in Table 8.

Table 8

Major Sources of Funding for Technical/Engineering Graphics Research

Source	Frequency (n = 16)	Mean %*
NSF	11	68.8
Private Industry	3	18.8
Internal	2	12.5
NREL	1	6.3
NASA	1	6.3
Keen	1	6.3
DARPA	1	6.3
DOE	1	6.3

* Note: Percentage for each row (Source) has a maximum of 100%.

Discussion, Concerns and Conclusions

This survey was a third in a series of instruments to gather a "snap-shot" as to what the engineering/technical graphics profession has been doing both in the classroom and as professional service. The 2008 data set was compared to that of the two previous studies and any resulting anomalies were documented. Data for 16 questions which appeared on all three surveys were compared. Table 9 shows some areas of comparison over the years of these questions from the three surveys to see what trends were developing. Over the years, minority students enrolled in graphic courses have not statistically changed. Also, institutions offerings degrees and minors in our field have averaged about the same number over the past 10 years as indicated by the data sets in Table 9. From the data sets listed in Table 9, animation was the only course topic that increased in percentage over all three surveys.

Table 9

Technical/Engineering Graphics Subjects Offered at Educational Institutions

Subject/Type	1998 %	Change %	2004 %	Change %	2008 %
GD&T	71.2	-2.6	68.6	-2.6	66.0
Manual Instruments	71.2	-16.3	54.9	-5.8	49.1
2-D CAD	93.6	-5.4	88.2	-1.4	86.8
3-D Modeling	65.3	-12.4	52.9	-2.9	50.0
3-D Constraint	49.5	+25.0	74.5	0.0	74.5
CAM	59.0	-11.9	47.1	-0.2	46.9
Animation	35.8	+15.2	51.0	+7.3	58.3

Minority Students Enrolled in Graphics Courses

Gender minority	16.4	+0.6	17.0	-0.9	16.1
Ethnic minority	14.2	-1.2	13.0	+8.1	21.1

Degree Offerings for Technical/Engineering Graphics Communications

Major	23.6	+12.4	36.0	-7.8	28.2
Minor	15.2	-5.0	10.2	+18.9	28.9

Note: Maximum percentage for each type is 100% per year.
Note: % is percentage of responses.

After the three data sets were compared, some common answers were garnered from the 1998, 2004, and 2008 surveys regarding major concerns. The first common concern of respondents appeared in the top three responses in the 2004 and 2008 data sets. Respondents were concerned about having difficulty keeping up-to-date with the changes in the field and linked their difficulties to hardware and software updates. This concern is important to the field because instructors are relied upon to train the next generation of graphics professionals. If instructors are

unable to remain current with changes, then the field is going to ultimately be held back as students graduate without being exposed to current trends.

The second main concern of respondents supported research into the current standing of the field and possible future directions of the field. This concern is important because if the current and possible future subjects are not centered on the fields' foundational subjects, then steps will need to be taken to ensure the survival of the field. A large shift in subjects could force the field to refocus, or potentially redefine itself. Considering this possibility, the more time the field has to prepare for such a scenario, the better suited the field will be for such a change. It is a positive sign that respondents supported this type of research. Also, it seems that online and distance education will become more prevalent in the discipline in the near future.

A third major concern reported by respondents was the skills level and preparedness of incoming students. This concern was the fifth major concern in 1998, the first major concern in 2004, and the second major concern in 2008. This concern for students questioned the existing quality of instruction that prepares graphics students for post-secondary education. Other factors considering this lack of quality includes limited professional development and the migration towards online learning environments.

In conclusion, based on the findings of this survey of the profession, even though the shift towards 3-D CAD and animation would have a great impact on the field, the possible trend towards online and distance education could have an even greater impact. The trend, if it occurs, would not only impact the software utilized in the profession, but it could also impact the role and requirements of instructors and the professional development they need. The use of online and distance education at institutions would require courses that were originally setup for a traditional format, to be reworked. Additionally, the professional culture at institutions could change from one where instructors interact with students in face-to-face situations, to one where instructors might never meet their students. It is recommended that we conduct this survey again in another five years to see where these concerns and future directions will take the profession of engineering/technical graphics.

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