Part One of a Survey of Graphic Professionals Focused on the Emerging Themes of Technical/Engineering Graphics Education in the United States.

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ABSTRACT - *This research was conducted in the fall of 2008 to explore emergent trends in technical/engineering graphics education. This study surveyed Engineering Design Graphics Division (EDGD) members and was a follow-up to studies that were conducted in 1998 and 2004. The areas researched in this study were: course offerings, student populations, professional development, technical/engineering graphics education, and research. The study used the same instrument as the previous studies, but was expanded to include more questions covering distance education and professional development. This paper reports an overview of the results and compares them to the results of the previous studies.*

I. Introduction to the Study

This research focused on professional technical/engineering graphics educators, who were located in the United States. The primary research question was "What are the current trends and future issues for technical/engineering graphics education in post-secondary education?" 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 (NCSU).

The initial study was conducted in 1998 and the second study was conducted in 2004. Both previous studies concerned members of EDGD who resided in the United States as a part of the population, but the 1998 study also included members of the National Association for Industrial Technology Teacher Education (NAITTE) and the Council for Technology Teacher Education (CTTE). The population of the study was narrowed to Engineering Design Graphics Division (EDGD) in 2004 (Clark & Scales, 2006). Only individuals who had obtained at least a Bachelors degree and currently taught at least one course per year at the time of the survey were asked to respond.

The members of EDGD were believed to be active in the graphics profession and the most knowledgeable population to consult when compiling data for this study. Respondents were believed to either be interested in the study or willing to share their opinion. Also, it was believed that all respondents answered questions honestly since they were under no pressure to complete the survey.

The survey instrument was originally developed in 1998, and had questions added for the 2004 study (Clark & Scales, 2006). The survey instrument from 2004 was modified for this study to include additional questions about distance education and professional development. The instrument included the following sections: course offerings, student populations,

professional development, technical/engineering graphics education, and research.

The first category covered course offerings and topics currently taught at intuitions. The distance education section of the 2004 survey instrument was expanded to cover instructor preparation, perceptions, and institutional implementations.

The second category researched was student populations, with special interest on gender, ethnicity, and the major of students who take technical/engineering graphics courses. Questions in this category remained unmodified from the 2004 survey instrument.

The third category looked at the instructors of technical/engineering graphics education. The third section was expanded from the 2004 survey instrument with additional questions focused on professional development.

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 from the fourth category remained unmodified from the 2004 survey instrument.

The final category focused on current research, grants, collaborations, and research. Questions from this category remained unmodified from the 2004 survey instrument.

II. Methodology

The survey instrument used was designed originally developed in 1998 by Clark and Scales and revised for the 2004 follow-up study (2006). The instrument was expanded to collect more information related to the topics of distance education and professional development. The revised instrument was reviewed by technical/engineering graphics educators at NCSU and modified in accordance to the provided suggestions. The survey instrument was delivered via an online survey hosting website.

Contact was made with EDGD members listed in the 2007-2008 American Society for Engineering Educators (ASEE) Membership Directory via emails by the Chair of the executive committee for EDGD.

A mass email that contained background information on the study was sent out on September 29, 2008 with a link to the online survey. The link was randomly generated, unique to the study, and contained a case specific 28-character string, which consisted of lower-case letters, upper-case letters, numbers, and underscores. This prevented the link from being easily identified. The existence of study and survey link was not advertised which helped maintain the security of the study.

Two weeks after the initial email was sent, a reminder email was sent to the same population. Four weeks after the reminder email, and six weeks after the initial email, a second reminder email was sent to the same population. Two weeks after the second reminder, a final reminder was sent. The survey was taken offline 24 hours after the final reminder. All four emails contained standardized information. The survey was presented to respondents once the emailed link to the website was followed.

III. Survey Results

The initial and reminder emails were sent out to 239 members of EDGD, who had provided a valid email address, in September 2008. 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 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 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. AutoCAD was the most mentioned software followed by Solidsworks and Pro/E, respectively.

Respondents were asked if their program offered instruction in GD&T, and 53 respondents or 94.6% of the total respondents answered. A breakdown of the responses is provided in Table 1. Respondents who answered "Yes" to the previous question were asked if GD&T was taught in a separate course or if GD&T was integrated into the content of other graphics courses. This question was answered by 38 respondents or 67.9% of the total respondents and details were provided in Table 1. The survey asked respondents to indicate in how many different courses GD&T was presented. The question was answered by 42 respondents or 75.0% of the total respondents. Analysis of the data found that 52.4% reported one course, 31.0% reported two courses, 9.5% reported three courses, and 7.1% reported four courses.

Respondents were asked if they or their faculty peers taught the use of manual instruments in courses. The question was answered by 53 respondents or 94.6% of the total respondents and response details are provided in Table 1. A follow-up question was directed at respondents who answered "Yes" and asked if the use of manual instruments was taught in a separate course or if the use of manual instruments was integrated into the content of other graphics courses. The question gathered 25 responses or 44.6% of the total respondents and 24.0% reported the courses were separate. Respondents were asked in how many different courses were manual instruments used. A total of 27 respondents or 48.2% of the total respondents answered. The data showed that 66.7% reported one course, 22.2% reported two courses, 7.4% reported three courses, 0.0% reported four courses, and 3.7% reported five or more courses. A breakdown of responses is provided in Table 1.

Forty-nine respondents or 87.5% of the total respondents responded when asked which operating systems their institution used for: 2-D CAD, 3-D modeling, CAM, desktop publishing, website development, and animation. For each subject Windows was the most predominant operating system.

Respondents were asked if they, or their faculty peers, taught 2-D CAD in their courses. A total of 53 respondents or 94.6% of the total respondents answered the question and the results are in Table 1. A follow-up question for those respondents who answered "Yes" asked if 2-D CAD was taught in a separate course or was integrated into the content of other graphics courses at their institutions. The question was answered by 47 respondents or 83.9% of the total respondents,

and the details of the responses are provided in Table 1. Respondents were asked in how many different courses at their educational institution was 2-D CAD taught. The question was answered by 48 respondents or 85.7% of the total respondents. Analysis showed that 50.0% reported one course, 20.8% reported two courses, 10.4% reported three courses, 8.3% reported four courses, and 10.4% reported five or more courses. Respondents were asked what software packages were used in the instruction of 2-D CAD courses. A total of 46 respondents or 82.1% of the total respondents answered the question, and the top two responses were AutoCAD and Solidworks respectively.

Respondents were asked if they, or their faculty peers, taught courses or parts of courses devoted to hand sketching in their program's curriculum. A total of 52 respondents or 92.9% of the total number of respondents answered this question, 22 respondents or 42.3% of the 52 responses answered "Yes." The next question collected data regarding the overall percentage of respondents, or their faculty peers, who taught technical/engineering graphics courses that only used sketching and computer graphics or just computer graphics in their courses. A total of 50 respondents or 89.3% of the total respondents answered, who indicted that, on average, 52.3% of their courses only utilized sketching and computer graphics or simply computer graphics.

Course Offerings – 3-D. Respondents were asked if they, or their faculty peers, taught any non-constraint based 3-D modeling in their courses. The question was answered by 50 respondents or 89.3% of the total respondents. For details, see Table 1. A follow-up question targeted respondents who answered "Yes" to the previous question and asked if non-constraint based 3-D modeling was taught in a separate course at their institutions, or if 3-D modeling was integrated into the content of other graphics courses. A total of 25 respondents or 44.6% of the total respondents answered this question, and details of the responses were shown in Table 1. Respondents were asked in how many different courses was non-constraint based 3-D modeling offered at their educational institution. A total of 41 respondents, or 73.2% of the total respondents, answered the question. A total of 14 respondents reported one course, 6 respondents reported two courses, 15 respondents reported three courses, 5 respondents reported four courses, and 1 respondent reported five or more courses. Respondents were asked what software packages were used for 3-D modeling in the technical/engineering graphics courses at their institution. A total of 37 respondents, or 66.1% of the total respondents, answered the question and the top two responses were Solidworks and AutoCAD respectively.

Respondents were asked if they, or their faculty peers, taught 3-D constraint-based modeling (i.e. parametric, variational) in the course offerings of their institutions. The question was answered by 51 respondents or 91.1% of the total respondents, and details of the responses were provided in Table 1. A follow-up question for respondents who answered "Yes" to the previous question asked if 3-D constraint-based modeling was taught in a separate course at the respondents' institutions, or if 3-D constraint-based modeling was integrated into the content of other graphics courses. A total of 38 out of 56 respondents answered, or 67.9%, and the breakdown of responses were detailed in Table 1. Respondents were asked in how many different courses was 3-D constraint-based modeling instruction offered at their educational institution. The question was answered by 38

respondents or 67.9% of the total respondents. A total of 1 respondent reported that one course was offered, 18 respondents reported two courses, 15 respondents reported three courses, 2 respondents reported four courses, and 2 respondents reported five or more courses. The next question asked respondents what software packages were used for parametric modeling in technical/engineering graphics courses offered at their educational institutions. A total of 37 respondents, or 66.1% of the total respondents, answered, and the top two responses were Solidworks and Inventor respectively.

Course Offerings – Ethics & Descriptive Geometry. Respondents were asked if they, or their faculty peers, taught ethics in relation to graphics (i.e. copyright, patents, etc.) in the courses offered at their educational institutions. The question was answered by 49 out of the 56 respondents, or 87.5%, and the details of the responses are displayed in Table 1. A follow-up question for respondents who answered "Yes" asked if ethics in relation to graphics were taught in a separate course or was integrated into the content of other graphics courses. A total of 23 respondents, or 41.1% of the total respondents, answered this question, and details are provided in Table 1. Respondents were asked in how many different courses was ethics related to graphics taught at their educational institution. The question was answered by 24 respondents or 42.9% of the total respondents. A total of 13 respondents reported it was taught in one course, 8 respondents reported two courses, and 3 respondents reported five or more courses.

Respondents were asked if they, or their faculty peers, taught CAM as a part of the course offerings of their educational institution. A total of 49 respondents, or 87.5% of the total respondents answered, and the responses are recorded in Table 1. A follow-up question for respondents who answered "Yes" asked respondents if CAM was taught in a separate course or if CAM was integrated into the content of other graphics courses. The question was answered by 21 out of the 56 respondents, or 37.5%, and Table 1 summarized the results. Respondents were asked in how many different courses was CAM taught at their educational institution. A total of 24 respondents, or 42.9% of the total respondents answered. A total of 15 respondents reported one course, 7 respondents reported two courses, 1 respondent reported three courses, 0 respondents reported four courses, and 1 respondent reported five or more courses. Respondents were asked what software packages were used for CAM instruction at their educational institution. The question was answered by 17 respondents, or 30.4% of the total respondents, and the top two responses were MasterCAM and Solidworks respectively.

Questions about descriptive geometry in the course offerings were asked to respondents. A total of 48 respondents, or 85.7% of the total respondents answered, and results are shown in Table 1. A follow-up question asked respondents who answered "Yes" if descriptive geometry was taught in a separate course or if descriptive geometry was integrated into the content of other graphics courses. The question was answered by 26 out of the 56 respondents, or 46.4%, and response details are shown in Table 1. Respondents were asked in how many different courses was descriptive geometry taught at their educational institution. A total of 26 out of 56 respondents, or 46.4%, answered. A total of 19 respondents reported one course, 5 reported two courses, 2 respondents reported three courses, 0 respondents reported four courses, and 0 reported five or more courses. A question asked respondents if

software packages were used to teach descriptive geometry in technical/engineering graphics courses at their educational institution. The question was answered by 27 respondents, or 48.2% of the total respondents. Overall, 12 respondents or 44.4% answered "Yes." A follow-up question for respondents who answered "Yes" asked respondents what software packages were used in the instruction of descriptive geometry. A total of 13 out of the 56 respondents, or 23.2%, answered this question, and the top two responses were AutoCAD and CATIA respectively.

Course Offerings – Desktop Publishing & Web Site Development. Respondents were asked if they, or their faculty peers, taught desktop publishing as part of the course offerings of their educational institution. The question was answered by 49 respondents, or 87.5% of the total respondents (see Table 1). A follow-up question targeted respondents who answered "Yes and asked if desktop publishing was taught in a separate course, or if desktop publishing was integrated into the content of other graphics courses. A total of 14 respondents, or 25.0% of the total respondents answered, and details are summarized in Table 1. Respondents were asked in how many different courses was desktop publishing taught at their educational institution. The question was answered by 12 respondents, or 21.4% of the total respondents. Overall, 8 respondents reported one course, 1 respondent reported two courses, 2 respondents reported three courses, 1 respondent reported four courses, and 0 respondents reported five or more courses. A question asked respondents what software packages were used for instruction in desktop publishing at their educational instruction. A total of 11 respondents, or 19.6% of the total respondents, answered and the top response was Adobe InDesign.

Questions about website development within the course offerings were asked to respondents. The first question was answered by 47 respondents, or 83.9% of the total respondents. The results are displayed in Table 1. A follow-up question targeted respondents who answered "Yes," and asked them if website development was taught in a separate course, or if website development was integrated into the content of other graphics courses. A total of 16 out of the 56 respondents, or 28.6%, answered this question (see Table 1). Respondents were asked in how many different courses was website development taught at their educational institution. The question was answered by 16 respondents, or 28.6% of the total respondents. Overall, 9 respondents reported one course, 3 respondents reported two courses, 3 respondents reported three courses, 1 respondent reported four courses, and 0 respondents reported five or more courses. Respondents were asked what software packages were used for website development instruction in the technical/engineering graphics courses at their institution. A total of 11 respondents, or 19.6% of the total respondents, answered this question and the top two responses were Dreamweaver and HTML editors respectively.

Questions about animation within the course offerings were asked to respondents. The first question was answered by 48 respondents, or 85.7% of the total respondents (see Table 1). A follow-up question targeted respondents who answered "Yes," and asked the respondents if animation was taught in a separate course or if animation was integrated into the content of other graphics courses. A total of 28 out of the 56 respondents, or 50.0%, answered this question, and the results are presented in Table 1. Furthermore, respondents were asked in how many different courses

was animation taught at their educational institution. A total of 27 respondents, or 48.2%, of the total respondents answered. A total of 15 respondents reported one course, 7 respondents reported two courses, 3 respondents reported three courses, 1 respondent reported four courses, and 1 respondent reported five or more courses. Respondents were asked what software packages were used for animation instruction at their educational institution. The question was answered by 26 out of the 56 respondents, or 46.4%, and the top two software packages were 3D Studio Max and Solidworks respectively. The respondents were asked what the main focus of animation instruction was at their educational institution. Respondents were asked to select all options that applied. A total of 30 out of the 56 respondents, or 53.6%, answered (see Table 2). When respondents were asked if they planned to teach an animation course in the future, 18 respondents, or 32.1% of the total respondents, answered. A total 5 respondents or 27.8% answered "Yes."

Course Offerings – Distance Education. Questions about distance education courses were asked to respondents. The first question was answered by 46 respondents, or 82.1% of the total respondents. Overall, 15 respondents or 32.6% answered "Yes." A follow-up question targeted respondents who answered "Yes" and asked 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 questions addressed respondents who answered "Yes" to the first question in this section, 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.

Respondents were asked if their 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, 35 respondents or 92.1% answered "No."

A question asked 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 46.7%, answered "Yes," and 53.3%, answered "No." A follow-up 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 answered "Yes," and 31 respondents answered "No."

Respondents were asked if they had taught a course that utilized online/distance education. Overall, 46 respondents, or 82.1% of the total respondents, answered. Analysis showed that 39.1% of respondents answered "Yes." A follow-up question focused on respondents who answered "Yes," and 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 answered "Yes."

A 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 answered "Yes."

Questions about if respondents considered themselves prepared to teach a technical/engineering graphics education course through online/distance education were asked. The first question was answered by 45 respondents, or 80.4% of the total respondents and 20 respondents answered "Yes." A follow-up question asked respondents 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 answered "Yes."

Respondents were asked 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 answered "Yes," while 29 respondents answered "No."

A question asked respondents 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 and 4 respondents answered "Yes." Another question asked respondents 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 and 24 respondents answered "Yes." The next 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 and 39 respondents answered "No."

Respondents were asked if they felt the instructor role, within the classroom of a major university, could be outsourced within the next five years. The question was answered by 44 respondents, or 78.6% of the total population and 31 respondents answered "No." The next question asked respondents if they would consider the outsourcing of an instructor radically different from a teaching assistant being the lead of a course, given a sufficient level of communication. A total of 40 respondents, or 71.4% of the total respondents, answered the question and 25 respondents answered "No."

Questions about hybrid courses were asked to survey respondents. The first question asked respondents if their educational institution offered hybrid courses and was answered by 44, or 78.6%, of the total respondents and 27 respondents answered "No." A follow-up question targeted respondents who answered "Yes," and asked them 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 and 36 respondents answered "Yes."

Student Population. The first 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. The next question asked respondents 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.

When respondents were asked 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. The next question asked respondents 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 4 for frequency and percentage data.

The final question in the Student Population category had several parts and asked respondents to provide the percentage of their student population (0-100%) that were enrolled in technical/engineering graphics communications courses but were enrolled in a major other than their program. The question was answered by 41 respondents, or 73.2% of the total respondents and the top two reported majors were Engineering and Technical/Technology.

Professional. The first question in this category asked respondents how many full-time faculty members at their educational institutions taught technical/engineering graphics as their primary responsibility. A total of 40 respondents, or 71.4% of the total respondents, answered the question and an institutional average of 3.2 faculty members was calculated. The next question asked respondents what percentage of the faculty at their educational institution had an engineering/technical degree. The question was answered by 33 respondents, or 58.9% of the total respondents. The overall responses had an average of 34.7% of faculty members had attained an engineering/technical graphics degree. Another question asked respondents how many full-time faculty members at their educational institution taught technical/engineering graphics, but not as their major course load. A total of 38 respondents, or 67.9% of the total respondents, answered this question and the responses had an average of 2.1 faculty members per institution.

Respondents were then asked how many part-time instructors taught technical/engineering graphics courses at their educational institutions. A total of 39, or 69.6%, of the total respondents, answered the question and the response data had an average of 1.8 faculty members per institution. The next question asked respondents how many faculty members from various fields taught technical/engineering graphics at their institution. The question was answered by 34, or 60.7%, of the total respondents (see Table 5).

Respondents were asked about the basis for merit pay in regards to increases/tenure/promotions at their institutions. The question asked respondents to provide a percentage (0-100%) breakdown for how much teaching, research, and service was taken into account for merit pay. The question was answered by 28, or 50.0%, of the total respondents. For Teaching, 28 respondents, or 100.0% of those who answered, stated that 54.9% of their teaching on average was the basis of their merit pay. For Research, 23, or 82.1%, of those who answered stated that their merit pay was based on

research an average of 26.8%. For Service, 26 respondents, 92.9% of those who answered, stated that service on average was 24.8% of the basis for their merit pay.

Respondents were asked if they had witnessed an increase or decline in tenured positions at their educational institutions. A total of 39, or 69.6%, of the total respondents answered. Twelve of the 39 respondents stated that they had seen an increase in the number of tenured positions at their educational institutions, while 12 respondents stated that they had seen a decrease in the number of tenured positions at their educational institutions, and 15 respondents stated they did not know. The next question asked respondents how many faculty members in their program/department were classified in various ranks and to indicate the range of salaries for each position in their program/department. The question was answered in some part by 24, or 42.9%, of the total respondents. For the average number of employees that hold specific ranks and salary ranges see Table 6.

Respondents were asked what their current major concerns were related to teaching technical/engineering graphics communications at the post-secondary level. The question was answered by 24, or 42.9% of the total respondents, and the top three reported concerns were: the phasing out of graphics instruction from the undergraduate engineering curriculum, the preparedness and abilities of incoming students, and the need of instructors to have more industrial experience.

The next question asked respondents what future trends they thought would occur within the next five years in relation to the instruction of technical/engineering graphic communications. The question was answered by 23, or 41.1%, of the total respondents and the top three reported concerns were: increased software related instruction, less instruction using manual instruments, and a migration to online and distance education.

When respondents were 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 stated that their professional activities included attending conferences, 17 participated in workshops, and 18 of the 28 respondents stated that they participated in training/seminars.

Respondents were asked if they had undergone retraining associated with professional development in the last five years. Overall, 34 respondents, or 60.7% of the total respondents, answered this question and 17 respondents replied “Yes.” A follow-up to question asked respondents if they were currently scheduled to attend any professional development related courses/seminars/workshops in the next year. The question was answered by 36 respondents, or 64.3% of the total respondents. Similarly, a total of 18 respondents replied “Yes.” The next question asked respondents if they believed they should attend a professional development course in the next five years to keep up with the changes within the field of technical/engineering graphics education. A total of 36 respondents, or 64.3% of the total respondents, answered this question and 31 of the 36 respondents replied “Yes.”

The respondents were asked if they had presented at any technical/engineering graphics education conference(s) in the last five years. The question was answered by 33 respondents, or 58.9% of the total respondents and 18 of the 33 respondents stated “Yes.”

The following question asked respondents 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 to the question (see Table 7).

Respondents were asked 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 and 23 of the 35 stated "Yes." The next question asked respondents if they felt the need to establish a professional development certification for instructors. The question was answered by 33, or 58.9%, of the total respondents and 22 respondents answered "No."

Respondents were asked 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 8).

The final question in this category followed-up the previous question asked respondents if they believed their implemented strategies had improved student achievement. A total of 26 respondents, or 46.4% of the total respondents, answered this question and 20 of the 26 replied "Yes."

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 and but 28 respondents answered "No." The next question asked respondents 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 and 27 respondents answered "No."

When respondents were asked if their educational institution offered a graduate degree in technical/engineering graphics communications the question was answered by 39, or 69.6%, of the total respondents and 34 respondents answered "No." The next question asked respondents if their educational institution offered any visual or graphic communication degrees for students who wanted to teach technical/engineering graphics communications. A total of 38, or 67.9% of those who took the survey, addressed the question and 33 respondents replied "No." A question asked those respondents, who worked for an institution that offered a graphics degree, in which fields former students usually found work. A total of 13, or 23.2% of the total respondents, answered the question and the top two responses were industry and manufacturing.

The final question in this category asked respondents if they thought a national honor society organization should be established. Overall, 32 respondents, or 57.1% of the total respondents, answered this question. Analysis showed that 25 respondents, or 78.1%, stated "No."

Research. The first question in this category 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 top two responses were NSF and private industry. The next question asked respondents if they collaborated with instructors outside of their program but within their institution. A total of 31, or 55.4% of the total respondents, answered this question and 22 respondents replied "Yes." Another question asked

respondents if they collaborated with instructors outside of their institution. The question was answered by 32, or 57.1% of the total respondents and 18 of the 32 respondents answered "Yes."

IV. Comparisons

The 2008 data set was compared to that of the two previous studies and any resulting anomalies were documented. Overall, the data for questions which appeared on all three surveys were compared.

Questions asked respondents if their program offered instruction in: GD&T instruction, manual instruments, 2-D CAD, non-constraint based 3-D modeling, constraint-based 3-D modeling, CAM, and animation. The reported percentage of respondents who stated their educational institution offered GD&T was 71.2% in 1998, 68.6% in 2004, and 66.0% in 2008 (see Table 9). The reported percentage of manual instrument instruction peaked at 71.2% in 1998, then dropped to 54.9% in 2004, and dropped again to 49.1% in 2008 (see Table 9). The percentage of 2-D CAD offerings was reported to be 93.6%, 88.2% in 2004, and 86.8% was reported in 2008 (see Table 9). The reported percentage of non-constraint based 3-D modeling instruction was highest in 1998 of 65.3%, but dropped to 52.9% in 2004, and then dropped again to 50.0% in 2008 (see Table 9). The reported percentage of respondents who stated their educational institution offered constraint-based 3-D modeling was lowest at 49.5% in 1998, then rose to 74.5% in 2004 and stayed the same, at 74.5%, in 2008. The percentage of CAM offerings peaked at 59.0% in 1998, then dropped to 47.1% in 2004, and dropped again to 46.9% in 2008 (see Table 9). The reported percentage of animation was 35.8% in 1998, then increased to 51.0% in 2004, and increased again to 58.3% in 2008 (see Table 9). Animation was the only course topic that increased in percentage over all three surveys.

A question asked respondents what percentage (0-100%) of their student population, within graphics courses, were women. The reported percentage was 16.4% in 1998, then rose to 17.0% in 2004, and declined in 2008 to 16.1% (see Table 10). Another question asked respondents what percentage (0-100%) of their student population enrolled within graphics courses, were of a minority (excluding gender). The reported percentage was 14.2% in 1998, dropped to 13.0% in 2004, and increased to 21.1% in 2008 (see Table 10).

A question asked respondents how many full-time faculty members taught technical/engineering graphics as their primary responsibility at the respondents' educational institutions. The reported average was 2.19 faculty members in 1998, 2.15 faculty members in 2004, and 3.15 faculty members in 2008. Another question asked respondents how many full-time faculty members taught technical/engineering graphics courses at their educational institution but not as their major instructional load. The average was 1.97 faculty members in 1998, 2.94 faculty members in 2004, and 2.05 faculty members in 2008.

Respondents were asked what their current major concerns were related to teaching technical/engineering graphics communications at the post-secondary level. The top three reported concerns in 1998 were: high or increasing costs of adequate funding, software emphasized over basics/problem-solving skills, and difficulty keeping hardware/software up-to-date. In 2004, the top three common concerns of respondents were: preparedness of students entering the program, keeping up with changes in technology, and issues regarding graphics as an area of study. In the 2008

study, the top three reported concerns were: the phasing out of graphics instruction from the undergraduate engineering curriculum, the preparedness and abilities of incoming students, and the need of instructors to have more industrial experience.

A question asked respondents what future trends they thought would occur within the next five years in relation to the instruction of technical/engineering graphic communications. The top three future trends reported in 1998 were: an increase in 3-D parametric modeling, more sophisticated/integrated software programs, and a decreased reliance on technical drawing. In the 2004 study, the top three concerns of respondents were: online and distance education instruction, more emphasis on 3-D CAD, and more 3-D prototyping. In the 2008 study, the top three reported concerns were: increased software related instruction, less instruction using manual instruments, and a migration to online and distance education.

V. Conclusions

The data reported are descriptive at best and was, therefore, completely dependent on the respondents that participated in this study. Conclusions were drawn only from the questions that were covered in all three studies, and the data from this study were compared to the data sets from the two previous studies. The conclusions drawn from the studies were solely a product of the answers provided by respondents; therefore no trends can be proven based on this research and data analysis.

Some common answers were garnered from the 1998, 2004, and 2008 surveys when respondents were asked to provide their 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. The second main concern of respondents supported research into the current standing of the field and possible future directions of the field. The 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.

Two possible future trends in the curriculum of the field came from responses to a question which asked respondents what future trends they thought would occur within the next five years in relation to the instruction of technical/engineering graphic communications.

The first of the possible future trends, an increased emphasis on 3-D CAD, was based on responses to the 1998 and 2004 studies and has been supported by the greatest reported increase, percentage wise, of any subject across all three studies (see Table 10). The second possible future trend, a migration to online and distance education, was based on reported trends from the 2004 and 2008 studies. Also, the listing of this possible trend as the top concern of respondents in the 2004 study, led to an increased number of questions covering online and distance education in the 2008 study.

A third possible trend was identified from the responses to a question in all three studies which asked if respondents, or their faculty peers, taught animation. The reported amount of animation instruction in the technical/engineering graphics curriculum had

increased across the three studies. Reported animation instruction rates started at 35.8% in the 1998 study, then rose 15.2% in the 2004 study, and then rose another 7.3% in the 2008 study to a final total of 58.3%. This is important because the increased instruction of animation shows the incorporation of a new topic into the field.

VI. References

Clark, A. C., & Scales, A. Y. (1999). A barometer for engineering and technical graphics education. *Published proceedings of the American Society for Engineering Education Annual Conference and Exposition*, Charlotte, NC, Session 2438.

Clark, A. C., & Scales, A. Y. (2006) A study of current trends and issues for graphics education: Results from a five-year follow-up study. *Engineering Design Graphics Journal*, *70*(2), 23-30.

Table 1. 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.

Table 2. The Main Focus of Animation Instruction in Technical/Engineering Graphics Courses

Focus	Frequency (n = 30)	Mean %*
Technical	26	86.7
Simulation	24	80.0
Scientific	10	33.3
Artistic	7	26.5
Gaming	7	23.3
Web	6	20.0

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

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

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

Table 4. 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%.

Table 5. 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

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

Table 6. 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

Table 7. 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

Table 8. 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%.

Table 9. Technical/Engineering Graphics Subjects Offered at Educational Institutions

Subject	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

Note: Maximum percentage for each subject was 100% per year.
Note: % is percentage of responses that offer the subject.

Table 10. Minority Students Enrolled in Graphics Courses

Type	1998 %	Change %	2004 %	Change %	2008 %
Gender minority	16.4	+0.6	17.0	-0.9	16.1
Ethnic minority	14.2	-1.2	13.0	+8.1	21.1

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