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Engineering Graphics Educational Outcomes for the Global Engineer: An Update

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Introduction

Graphics has always been the language of engineering and the preferred media for conveyance of design ideas (Booker, 1963). The first record of what appears to be an engineering drawing is a temple plan from 2130 B.C. found in an ancient city in Babylon. From Egyptian times, dated about 1500 B.C., papyrus remnants have been found of drawings that used a grid of straight lines made by touching the papyrus with a string dipped in ink pigment, thus setting the stage for early “drafting” practices. The first written record discussing drafting and the use of geometry for design representation is given by Vitruvius (1914), a Roman builder from the turn of A.D. Vitruvius writes how “an architect must have knowledge of drawing so he can make sketches of his ideas.” In about 1500 A.D., the first record of what could be called related multi-view projections appeared in Renaissance Italy. Some of the engineers and inventors of that time were also famous artists. Drawings left by Leonardo da Vinci were artistic pictorial sketches that resemble axonometric sketching techniques still taught and in use today. In 1795, Gaspard Monge published his well-known treatise on descriptive geometry, which provided a scientific foundation to engineering graphics that lasted for 200 years. During the past century, engineering graphics used different manual tools that made production of orthographic projection drawings easier. Drafting boards, T-squares, triangles, and mechanical pencils were common equipment purchased by engineering students. The development of the computer hailed yet a new era in engineering graphical communication technology. Computer-Aided Design (CAD) systems slowly replaced drawing boards with an electronic tool. By the late 1980’s, it became evident that a new 3-D solid modeling approach would became the core technology for engineering graphics, and the author has spent the last two decades promoting an engineering graphics curriculum based on this 3-D paradigm (Barr, et al., 1994).

Methods

In an effort to attain consensus on educational outcomes for engineering graphics, a survey was conducted amongst engineering graphics faculty. This survey presented a list of potential engineering graphics outcomes affirmed by a literature search of related journal papers (Meyers, 2000; Branoff, et al., 2002; Smith, 2003; Bertozzi, et al., 2007; Planchard, 2007) This resulted in a list of fourteen major graphics outcomes. Figure 1 shows the list of fourteen original outcomes contained in the survey. The survey was conducted twice at ASEE EDG mid-year meetings, in 2004 and again in 2012.

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FOURTEEN PROPOSED EDUCATIONAL OUTCOMES FOR ENGINEERING GRAPHICS

OUTCOME 1: ABILITY TO SKETCH ENGINEERING OBJECTS IN THE FREEHAND MODE.

OUTCOME 2: ABILITY TO CREATE GEOMETRIC CONSTRUCTION WITH HAND TOOLS

OUTCOME 3: ABILITY TO CREATE 2-D COMPUTER GEOMETRY.

OUTCOME 4: ABILITY TO CREATE 3-D SOLID COMPUTER MODELS.

OUTCOME 5: ABILITY TO VISUALIZE 3-D SOLID COMPUTER MODELS.

OUTCOME 6: ABILITY TO CREATE 3-D ASSEMBLIES OF COMPUTER MODELS.

OUTCOME 7: ABILITY TO ANALYZE 3-D COMPUTER MODELS.

OUTCOME 8: ABILITY TO GENERATE ENGINEERING DRAWINGS FROM COMPUTER MODELS

OUTCOME 9: ABILITY TO CREATE SECTION VIEWS.

OUTCOME 10: ABILITY TO CREATE DIMENSIONS.

OUTCOME 11: KNOWLEDGE OF MANUFACTURING AND RAPID PROTOTYPING METHODS.

OUTCOME 12: ABILITY TO SOLVE TRADITIONAL DESCRIPTIVE GEOMETRY PROBLEMS.

OUTCOME 13: ABILITY TO CREATE PRESENTATION GRAPHICS.

OUTCOME 14: ABILITY TO PERFORM DESIGN PROJECTS.

Figure 1. Engineering Graphics Outcomes.

Results

The results of the survey are shown in Table 1 for the 2004 survey and Table 2 for the 2012 survey. Even though the surveys are separated by eight years of on-going

Table 1. Graphics Faculty Outcomes Survey Results for 2004 (N=24).

Outcomes	Rank
Ability to Create 3-D Solid Computer Models	4.75
Ability to Sketch Engineering Objects in the Freehand Mode	4.67
Ability to Visualize 3-D Solid Computer Models	4.46
Ability to Create Dimensions	4.38
Ability to Generate Engineering Drawings from Computer Models	4.33
Ability to Create 3-D Assemblies of Computer Models	4.29
Ability to Create 2-D Computer Geometry	4.21
Ability to Create Section Views	4.13
Ability to Perform Design Projects	3.96
Ability to Analyze 3-D Computer Models	3.71
Knowledge of Manufacturing and Rapid Prototyping Methods	3.42
Ability to Create Presentation Graphics	3.42
Ability to Solve Traditional Descriptive Geometry Problems	2.29
Ability to Create Geometric Construction with Hand Tools	2.13

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Table 2. Graphics Faculty Outcomes Survey Results for 2012 (N=24).

Outcomes	Rank
Ability to Create 3-D Solid Computer Models	4.75
Ability to Sketch Engineering Objects in the Freehand Mode	4.54
Ability to Visualize 3-D Solid Computer Models	4.54
Ability to Create 3-D Assemblies of Computer Models	4.54
Ability to Create Dimensions	4.38
Ability to Create Section Views	4.33
Ability to Generate Engineering Drawings from Computer Models	4.29
Ability to Analyze 3-D Computer Models	4.13
Ability to Create 2-D Computer Geometry	4.08
Ability to Perform Design Projects	4.08
Knowledge of Manufacturing and Rapid Prototyping Methods	3.63
Ability to Create Presentation Graphics	3.46
Ability to Solve Traditional Descriptive Geometry Problems	2.75
Ability to Create Geometric Construction with Hand Tools	2.71

change in the field, the results are very similar. Specifically, the top three highest ranked outcomes are the same for both survey years 2004 and 2012, and come in the same order: 1: Ability to Create 3-D Solid Computer Models; 2: Ability to Sketch Engineering Objects in the Freehand Mode; and 3. Ability to Visualize 3-D Solid Computer Models. Thus, it appears that some stability in the teaching of engineering graphics has arisen after three decades of constant change. These results support the contention in Figure 2 that 3-D solid modeling has become the central theme in most engineering graphics programs. Indeed, four of the top seven ranked outcomes pertain to modern computer tools to generate a graphical image. In addition, several traditional graphics topics (sketching, dimensioning, engineering drawings, and section views) were also ranked high, receiving average rankings above 4.00. On the other hand, the long-standing traditional topics of descriptive geometry and manual geometric construction techniques were ranked low by the respondents. They were the only two topics that received average rankings below 3.00.

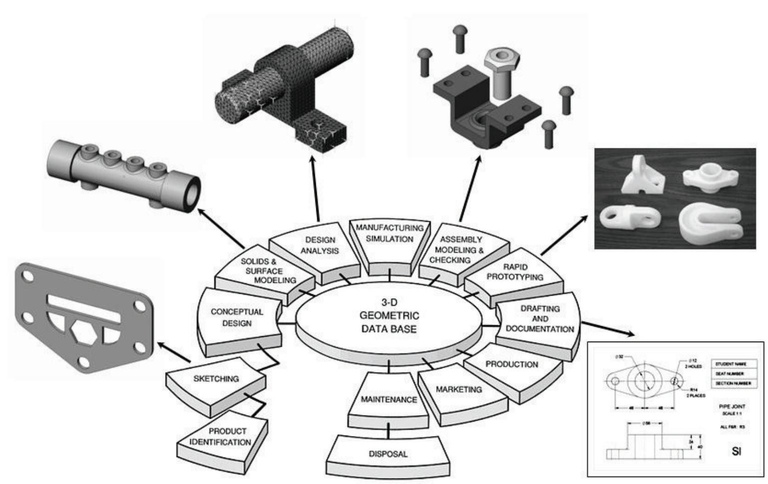

Figure 2.

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Discussion

This paper discusses the formulation of educational outcomes for engineering graphics that span the global enterprise. Results of two repeated faculty surveys indicate that new computer graphics tools and techniques are now the preferred mode of engineering graphical communication. Specifically, 3-D computer modeling, assembly modeling, and model application to design and manufacturing all received significant notices in the survey results. Results of the surveys also show strong sentiment for some traditional graphics topics such as freehand sketching and dimensioning. Thus, modern engineering graphics should focus on three areas of instruction, as shown in Figure 3.

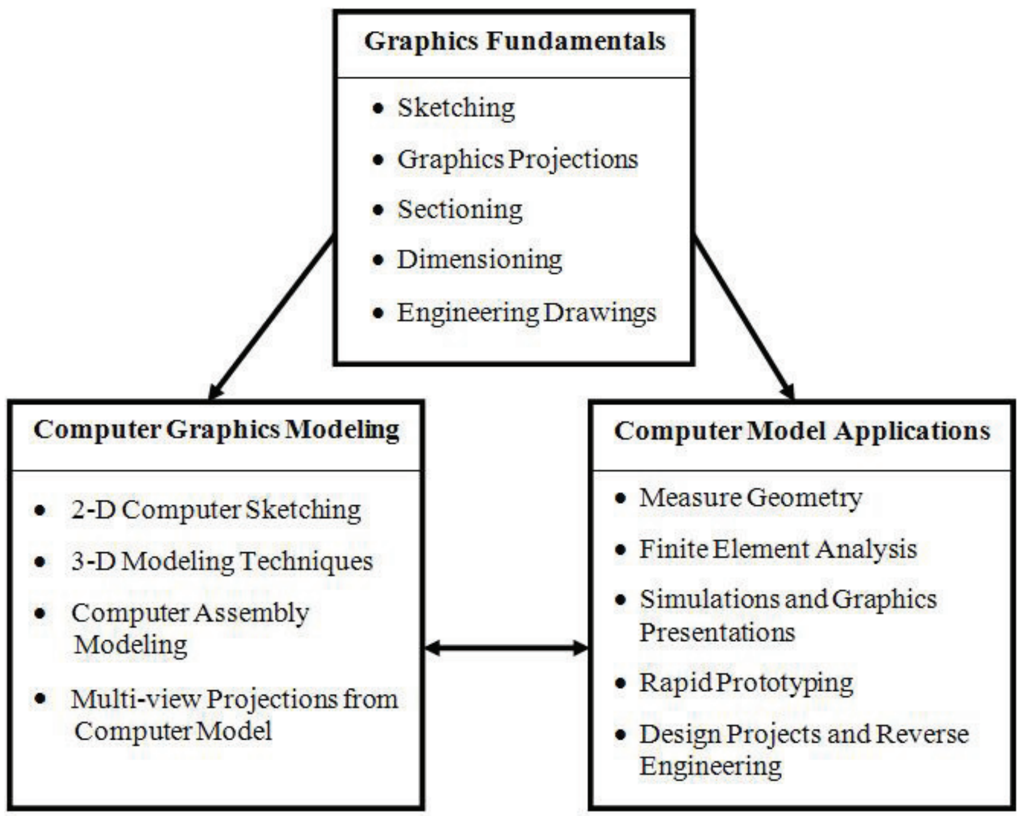

Figure 3.

References

Barr, R. E., Juricic, D., and Krueger, T. J. (1994): “The Role of Graphics and Modeling in the Concurrent Engineering Environment,” *Engineering Design Graphics Journal*, 58(3):12-21.

Bertozzi, N., Hebert, C., Rought, J., and Staniunas, C. (2007). Implementation of a three-semester concurrent engineering design sequence for lower-division engineering students. Engineering Design Graphics Journal, 77(1): 1-13.

ISSN: 1949-9167

Booker, P. J. (1963). A history of engineering drawing. Chatto and Windus, London.

Branoff, T. E., Hartman, N. W., and Wiebe, E. N. (2002): "Constraint-Based Three Dimensional Solid Modeling in an Introductory Engineering Graphics Course: Re-Examining the Curriculum," *Engineering Design Graphics Journal*, 66(1):5-10.

Meyers, F. D. (2000): "First Year Engineering Graphics Curricula in Major Engineering Colleges," *Engineering Design Graphics Journal*, 64(2):23-28.

Planchard, M. (2007): 3D CAD: A Plus for STEM Education, *Engineering Design Graphics Journal*, 71(2):1-4.

Smith, S. S. (2003): "A Design-Based Engineering Graphics Course for First-Year Students," *Engineering Design Graphics Journal,* 67(2):33-42.

Vitruvius (1914): *The Ten Books on Architecture* (Translated by M. H. Morgan), Harvard University Press, Cambridge, Mass.

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