Engineering Graphics Educational Outcomes for the Global Engineer: An Update

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Summary

Introduction

Graphics has always been the language of engineering and the preferred media for conveyance of design ideas. Civilizations, from ancient Babylon to Egypt to the Roman empire, all developed graphical techniques to convey their design and building concepts. Modern forms of graphics began to take shape during the European Renaissance, where artists such Leonardo da Vinci developed pictorial sketches that resemble axonometric sketching techniques still taught today. In 1795, Gaspard Monge published his treatise on descriptive geometry, which provided a scientific foundation to engineering graphics projections. During the past century, engineering graphics used different tools, such as drafting boards and T-squares, to produce orthographic drawings. The development of the computer hailed yet a new era in engineering graphics technology. Computer-Aided Design (CAD) systems slowly replaced drawing boards and by the late 1980's, it became evident that a new 3-D solid modeling approach (Figure 1) would became the core technology for engineering graphics.

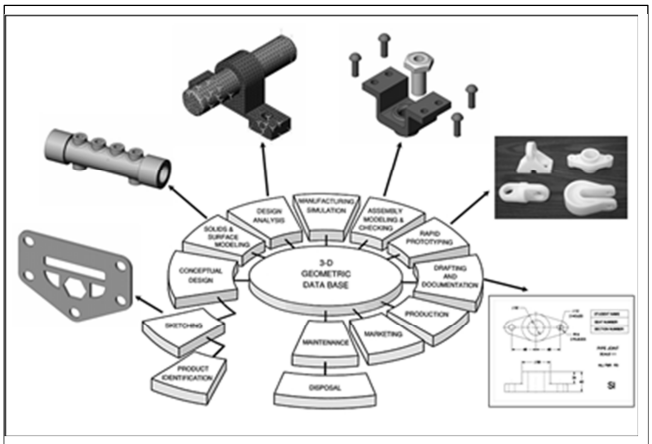

Figure 1. The Solid Modeling Paradigm

Methods

In an effort to attain current 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 derived from a literature search of related journal papers. This resulted in a list of fourteen major graphics outcomes (Table 1). The survey was conducted twice, first in 2004 at an ASEE EDG mid-year meeting, and then again in 2012 at a second EDG meeting.

Results

The results of the survey showed remarkable consistency, even though the surveys are separated by eight years of on-going change in the field. Specifically, the top three highest ranked outcomes are the same for both survey years 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. These results support the contention in Figure 1 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, based on a 5-point scale. On the other hand, the long-standing traditional topics of descriptive geometry and manual geometric construction techniques, were soundly rejected by the respondents. They were the only two topics that received average rankings below 3.00.

Table 1. 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

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 2.

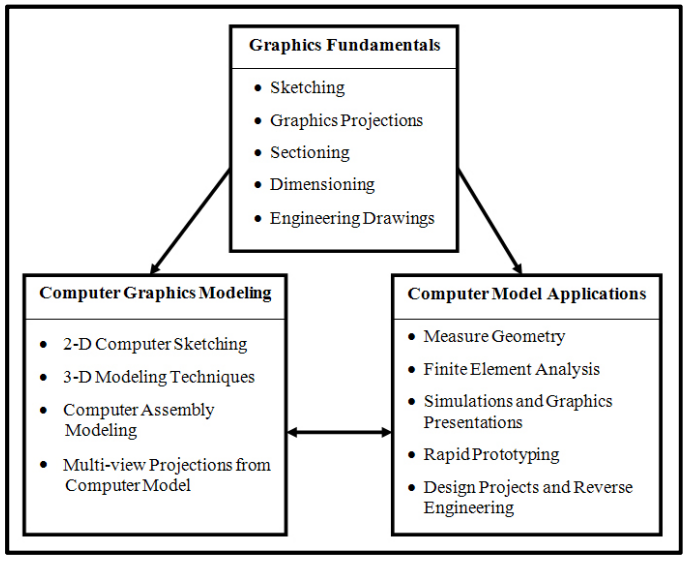

Figure 2. The Modern Engineering Graphics Triad.