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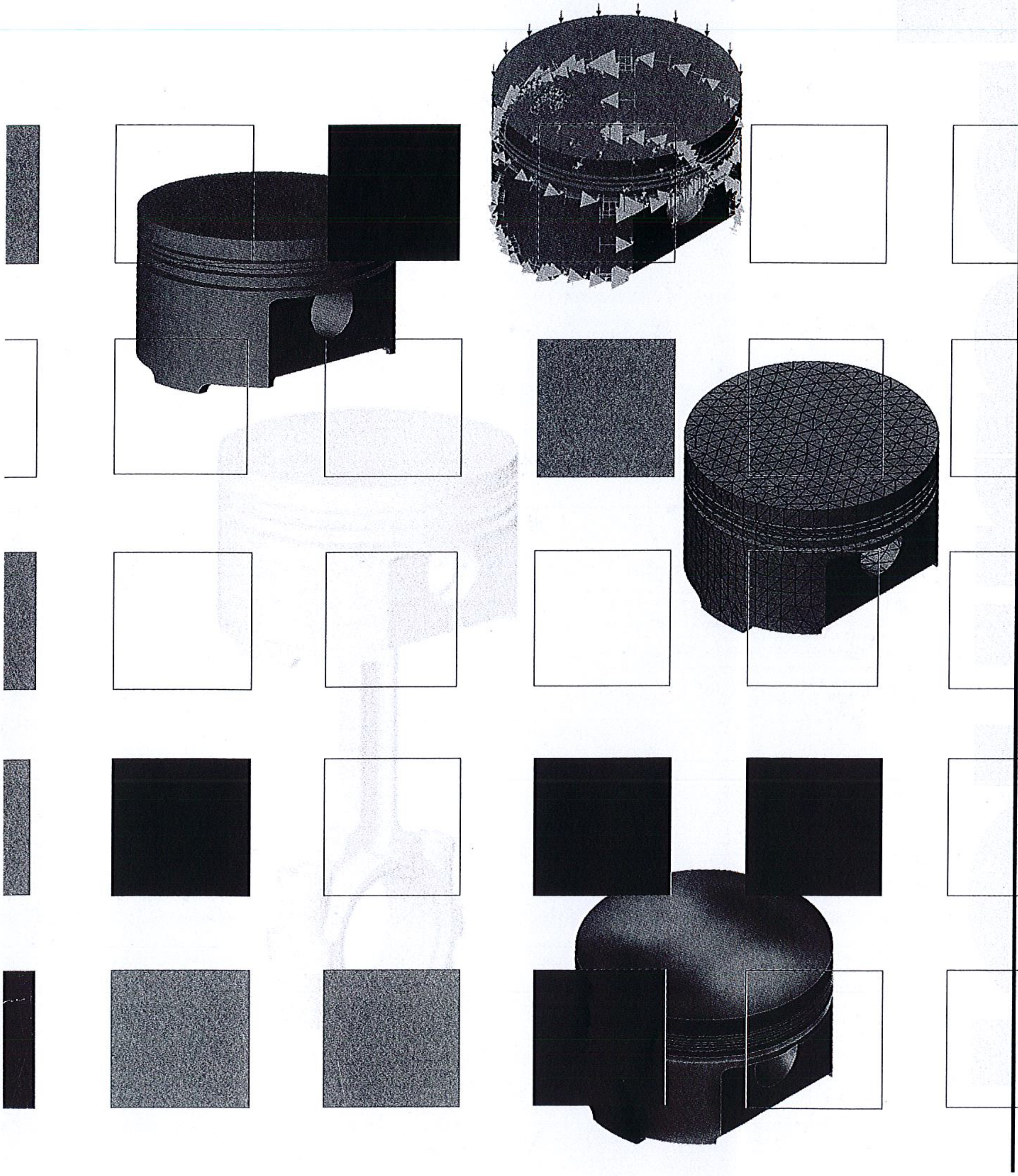
THE ENGINEERING DESIGN GRAPHICS Journal



ENGINEERING DESIGN GRAPHICS DIVISION

ASEE

THE ENGINEERING DESIGN GRAPHICS
Journal

AUTUMN 2002

volume 66 number 3

The Engineering Design Graphics Journal is the official publication of the Engineering Design Graphics Division of ASEE. The scope of the Journal is devoted to the advancement of engineering design graphics, computer graphics, and subjects related to engineering design graphics in an effort to 1) encourage research, development, and refinement of theory and applications of engineering design graphics for understanding and practice, 2) encourage teachers of engineering design graphics to experiment with and test appropriate teaching techniques and topics to further improve the quality and modernization of instruction and courses, and 3) stimulate the preparation of articles and papers on topics of interest to the membership. Acceptance of submitted papers will depend upon the results of a review process and upon the judgement of the editors as to the importance of the papers to the membership. Papers must be written in a style appropriate for archival purposes.

Cover graphics from pages 6-11 of the Barr, Krueger, and Aanstoos paper.

ISSN 0046 - 2012

[From the Editor]

Dear Members:

This issue not only contains a variety of very interesting papers but also a look at the upcoming officer candidates for the Division. As members you will be given the opportunity to vote on these officer positions in the Spring ballot. The following members that have accepted nominations for the open position within the Division for the coming year are Holly Ault and Jerry Vinson for Vice Chair, Tim Sexton and Doug Baxter for Secretary-Treasurer, and Kathryn Holliday-Darr and Eric Wiebe for Director of Publications. In addition, the proposed changes to the EDGD Bylaws are also printed in this issue so everyone will have the opportunity to review the changes before voting on them in the Spring.

This past summer at the Annual Meeting the Executive Committee voted to reinstate page charges for papers published in the *Journal* for EDGD members along with increasing the page charge for non-EDGD members. This charge is necessitated solely to help offset the increasing costs of the *Journal*. The rates will be $40 per page for EDGD members and $80 per page for non-EDGD members. The rate will be determined by the status of the first author listed on the paper at the time the paper is received by the Editor. Page charges are due upon notification by the Editor and are payable to the Engineering Design Graphics Division.

As we begin a new year please support Sheryl Sorby as Chair and the other officers with the planning of events for 2003. Many times it is too easy to forget how much time goes into the success of these activities.

Susan G. Miller

Susan G. Miller

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[Message from the Chair]

Sheryl Sorby
Michigan Technological University

Wow! Some of you who may know me will find it hard to believe that I am actually at a loss for words. I know that this is my chance to write something really thought-provoking, inspirational, and profound, but I'm not sure where to start. I read through the messages of previous Division chairs and I was humbled. I was also honored to know that I had been elected to serve as chair of a Division such as this. We are a Division "on the move." We have been making steady progress towards all of the goals that we have set for ourselves over the past few years. Our membership has grown; we have instituted several new awards to honor our members; we have seen an increase in the number of members who actively participate in the work of the division. So what is there left to do? All of my predecessors had some agenda item that was the focus for their term—sometimes it was an agenda item of their own choosing, sometimes it was one that the membership championed.

I have listened to many exciting presentations at division meetings over the past eight years, but only a fraction of these end up being submitted to the Journal for publication. I urge you to dust off some of your previous conference presentations, start up a new research study that promises exciting results, or write up the results from that work you did but never got around to publishing. Enlighten us. We are interested in what you have to say.

I have not heard of any burning issues that were brought up during the annual meeting, so I guess that means I might be able to pick an agenda item, all by my self. What a scary thought! I feel so powerful and in command!

Actually, when I realized that I was going to have to come up with a profound topic for discussion on my own, I couldn't think of anything at first, but thought it would be silly to write a Chair's Message that consisted of only five words—"Keep up the good work." I asked our journal editor for guidance on how many words were required, and was informed 10,000 (I think she was joking). But in the process, I discovered that there was no real rush to complete this message because there was only one paper ready for publication at the time. After cogitating for a while on our lack of papers, I decided that this would be the message I would like to focus on for this issue of the journal.

Although I have not been around for as long as some (read Larry Goss here), I believe that this division was founded on the premise that engineering graphics educators needed to: 1) be able to meet to share ideas for teaching graphics, and 2) have a forum for publication of topics of interest to a broad spectrum of engineering graphics educators. I believe we are achieving the first of these objectives very well. Our meetings are informative, interesting, and sometimes just plain fun (read Pat Connolly here). However, it seems that we are somewhat lacking in achieving our second objective.

I have been told that our *Journal* is the oldest or one of the oldest in all of ASEE. I would hate to see the *Journal* die a slow and painful death through lack of submissions from members. I have listened to many exciting presentations at division meetings over the past eight years, but only a fraction of these end up being submitted to the *Journal* for publication. I strongly believe that professional development is a crucial component for preserving your sanity as a faculty member. We desperately need a creative outlet and some intellectual stimulation that we typically do not get from teaching our courses day in and day out. Nor do we get this sort of intellectual stimulation from sitting in endless committee meetings on our campuses. As a Division, we need to be engaged in scholarly activity. If we are to be respected among our academic peers, we must write and publish papers that are of high quality and that highlight our scholarly work. We need to be asking and answering significant questions through well-planned research and curricular studies. I realize that it is difficult to carve out the time for scholarly work from our already frenetic schedules, but doing so will enable us to move forward in our quest for excellence in graphics education.

Many of the papers presented in our midyear and annual meetings would be of interest to our colleagues who cannot attend our meetings. They will likely never hear of our work unless it is published in the *Journal*. So, if we ever get enough papers to publish this issue of the *Journal* and you get a chance to read this most inspiring message, I urge you to dust off some of your previous conference presentations, start up a new research study that promises exciting results, or write up the results from that work you did but never got around to publishing. Enlighten us. We are interested in what you have to say.

Oppenheimer Endowment Fund

Dear EDGD Members:

The Engineering Design Graphics Division of ASEE is establishing an endowment fund for the Oppenheimer Paper Award, which is given each year to the author/presenter of the Best Paper at the annual EDG Midyear meeting. Frank Oppenheimer created the award to improve paper presentations at the EDG Midyear meeting, and he has personally sustained it financially over the last three decades. The purpose of the endowment is to permanently honor him and his contribution to the EDG Division by having a fund to support his award in perpetuity.

Individual EDG member donations are being solicited over the next several months until a target corpus is met. Several donations and pledges in the range of $50-$250 have already been received. If you would like to donate, write your check made out to "ASEE EDG Division," write a note for "Oppenheimer Endowment," and send it to:

Ronald E. Barr
Chair, Oppenheimer Endowment Fund Committee
Mechanical Engineering Department
Mail Code C2200
University of Texas at Austin
Austin, Texas 78712

The New Digital Engineering Design and Graphics Process

R. E. Barr, T. J. Krueger, and T. A. Aanstoos
University of Texas

Abstract

With current computer-aided design technology, the traditional tasks of a designer, drafter, analyst, and prototype maker are all performed by a single engineer using modern digital engineering design tools. These digital tools include computer systems with 3-D solid modeling software, seamless links to engineering analysis and manufacturing simulations, and digital interfaces to rapid prototyping machines. While these new technology tools have been developed and are commercially available, they have not yet been integrated into mainstream engineering graphics education as the contemporary curriculum. This paper will summarize the digital engineering design process using current software that is widely available for the educational setting.

Introduction

The discipline of Engineering Design Graphics has been a cornerstone for engineering education for almost a century. During the majority of that time, the curriculum has centered on instruction in graphical techniques to solve spatial problems and to make orthographic engineering drawings. The past two decades have witnessed dramatic changes in the types of tools and techniques used by engineers to solve graphical problems. The field has gone from using drafting boards, to computer-aided design and drafting systems, and now to 3-D featured-based solid modeling. The power of this latest digital design paradigm is only now being realized as low-cost analysis, simulation, and rapid prototyping software and hardware systems are becoming available for educational use (Ault, 1999; Barr, 1999; Cole, 1999; Newcomer, McKell, Raudebaugh, & Kelley, 2001; Tennyson & Krueger, 2001).

Computer Sketching

Sketching is a natural element of creative ideation, and is the beginning of the engineering design process. Modern parametric modeling software starts with a 2-D sketch on a planar grid. While computer sketching may be more accurate than manual freehand sketching, computer sketching still retains a certain creative feeling. To aid in this computer sketching, the software offers a variety of 2-D primitive selections, such as line, circle, rectangle, arc, spline, and ellipse. In order to complete these 2-D profiles, the software includes 2-D editing functions such as extend, trim, mirror, offset, and array. Parametric dimensions and other geometric constraints are then added to the sketch to initially fix the geometry. When a 2-D sketch profile is complete, such as shown in Figure 1, it is then either extruded or revolved to form the 3-D base of the part.

Feature-Based Solid Modeling

The base part, such as shown in Figure 2, is usually not a finished model. Additional material removal and/or material thickening may be needed to accurately represent the final 3-D geometry. Different workplanes can be positioned in the modeling space, more 2-D sketches can be created on these workplanes, and these secondary profile sketches can then be used to cut through the base part or to add more material. Also, common design features, such as fillets, rounds, chamfers, ribs, bosses, cuts, and holes, can be created with simple commands that do not require sketches. A finished part of an automotive piston, with all needed features, is shown in Figure 3.

Modification of Parametric Solid Models

Sometimes it is necessary to modify the geometry of a completed 3-D geometric model.

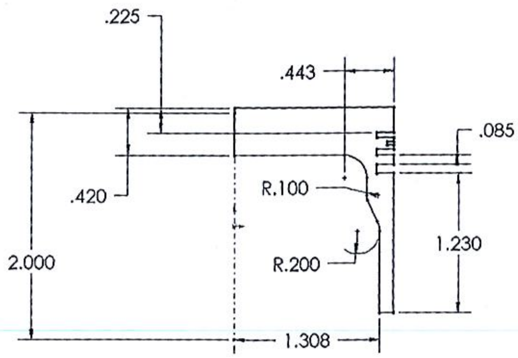

Figure 1 *A 2-D Parametric Computer Sketch*

Figure 2 *The Initial 3-D Base Solid Model*

Figure 3 *The Finished 3-D Solid Model of the Cylinder Head with all Features Added*

With parametric modeling software, these modifications are simplified. For example, to change the dimension of a particular design feature, the user can simply revise that dimension on the 2-D sketch that created the part, and then re-build the model. Ability to quickly re-adjust dimensions of a designed part is one of the major advantages of parametric modeling software.

Analysis of Solid Models

One of the advantages of the new digital design approach is that physical properties and behavior of the solid material can be analyzed without actually embodying the part. One example is mass properties analysis. Once the model is built, the user can assign a material (or density) to the part, and then select the appropriate command to generate a "Mass Properties Report" (MPR). The report can be saved in a file and, if needed, imported into a technical document. Typical parameters included in this MPR are: mass, volume, surface area, center of mass, and moments of inertia. A typical MPR report for the part in Figure 3 is shown in Figure 4 for a density of 0.281 pounds per cubic inch.

Density = 0.281 pounds per cubic inch
Mass = 1.264 pounds
Volume = 4.499 cubic inches
Surface area = 49.272 square inches
Center of mass: (inches)
X = 0.000
Y = 0.542
Z = -0.001
Principal axes of inertia and principal moments of inertia: (pounds * square inches)
Ix = (0.000, 0.001, 1.000) Px = 0.894
Iy = (1.000, 0.000, 0.000) Py = 1.018
Iz = (0.000, 1.000, -0.001 Pz = 1.442
Moments of inertia: (pounds * square inches) Taken at the center of mass and aligned with the coordinate system.

Lxx = 1.018	Lxy = 0.000	Lxz = 0.000
Lyx = 0.000	Lyy = 1.442	Lyz = -0.001
Lzx = 0.000	Lzy = -0.001	Lzz = 0.894

Figure 4 *A "Mass Properties Report" for the Cylinder Head Solid Model*

Another analysis amenable to the solid modeling environment is Finite Element Analysis (FEA), which is quickly becoming a powerful tool for computer-aided mechanical analysis and design. In many cases, the FEA software can now be accessed inside the parametric solid modeling software command structure. To start, the user builds the solid model part, such as the piston. The user then invokes the FEA software and starts a study. First, the user applies fixed restraints and uniform pressure loading vectors to the solid model (Figure 5). Next an FEA mesh is applied using a specified quality of resolution (Figure 6). Finally, the results of the FEA study can be seen by plotting the Von Mises stress distribution on the model (Figure 7). The use of a color gradient scale on these stress plots offers an excellent visualization tool for the engineer to view the computer-generated results, all in essentially a real-time environment.

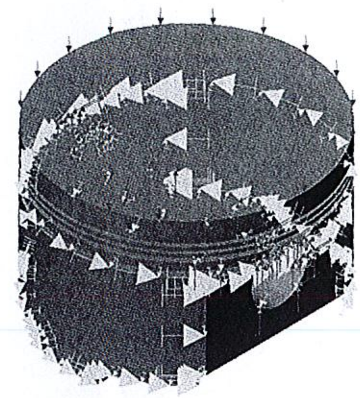

Figure 5 *Fixed Restraints and Uniform Pressure Loading Vectors are Applied to the Model*

Assembly Modeling

Most engineering products are not single parts, but rather are a collection of parts that mate together to perform a desired function. Modern parametric solid modeling software allows not only the creation of individual parts, but also the creation of an assembly of parts. An assembly model can be created by importing individual parts into an assembly file. For the piston assembly example, the remaining parts (connecting rod, rod cap, and wrist pin) are built. The first part is then imported into the assembly file and it becomes the base part of the assembly. Subsequent parts are imported and then mated together. In the mating process, a number of constraints can be attributed to the mated parts. Some of the common constraints used for mating the piston assembly (Figure 8) include coincident, concentric, and parallel features. Once the parts are mated properly in the assembly model, tolerance checks for clearance and interference can be made.

Figure 6 *A Mesh is Generated Over the Solid Model for the FEA Study*

Kinematics Simulations

While assembly models may show how the parts fit together, they are still only static images. With current solid modeling software, it is possible to study dynamic images through animations. For example, the piston assembly can be animated to show the motion of the piston head as it moves through a complete downward and then upward stroke.

Figure 7 *Results of the FEA Study Show the Von Mises Stress Distribution Over the Solid Model*

Rapid Prototyping of Solid Models

Once the 3-D geometry of the model has been constructed and verified through analysis, a rapid prototype of the individual parts can be made. The user saves each part individually as a stereolithography file (i.e. one with an .STL extension). The .STL file is then imported to any one of a variety of rapid prototyping machines. In the case here, the rapid prototyping machine is a Selective Laser Sintering (SLS) machine made by DTM Corporation. Basically, the .STL file-making process slices the model's geometry into very thin layers stacked one-by-one on top of each other, and then the SLS process sinters these layers together using fusible powder and a laser light beam. Example rapid prototypes of the piston assembly parts are shown in Figure 9.

Section Views of Solid Models

Sometimes solid model geometry becomes complex. Important features of the model may reside internally and not be visible from an external screen viewer. For example, two of the major features of the piston head are the internal bosses that support the wrist pin. In this case, the user may want to create a section view of the 3-D solid model. First, a cutting plane is positioned through the object. The plane could go through the middle of the object or be offset by a pre-defined value. Then a section view command is issued and the solid model is cut in half. Two examples of section views of the piston solid model showing internal features are depicted in Figure 10.

Generation of Engineering Drawings from Solid Models

Documentation has always been an important aspect of the engineering design process. Traditionally, this documentation centered around the generation of engineering drawings. As solid model databases become the mainstay of the digital engineering design enterprise, paper drawings are becoming less relevant. Nonetheless, most engineering companies will still require engineering drawings, if for no other reason than for legal matters. Fortunately, making an engineering drawing

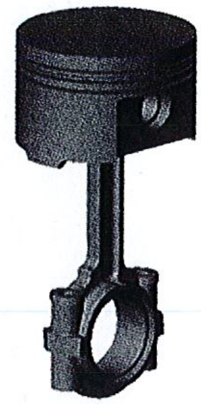

Figure 8 *The Piston Assembly Model*

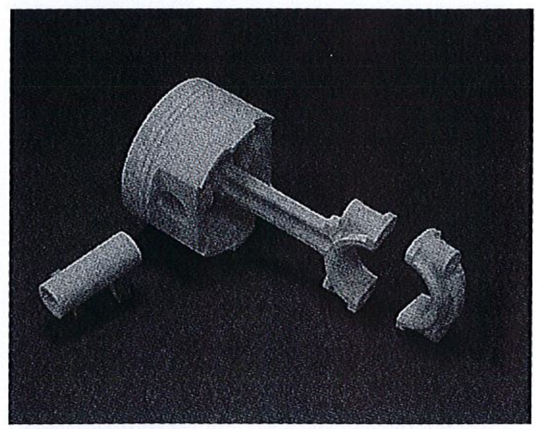

Figure 9 *Rapid Prototypes of the Individual Parts of the Piston Assembly*

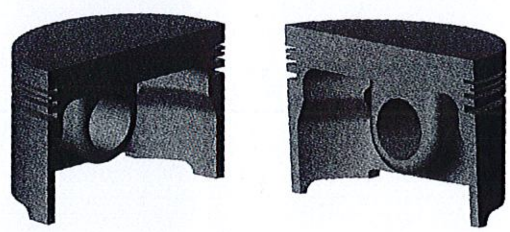

Figure 10 *3-D Section Views of the Piston*

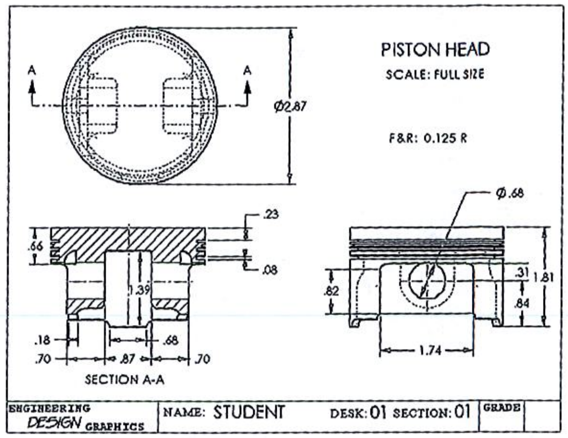

Figure 11 *An Engineering Drawing of the Piston Head Projected Directly from the Solid Model*

from a solid model is fairly straightforward. The user projects three views of the model onto a drawing sheet. Visible and hidden lines automatically come with the projection, but centerlines, dimensions, and notes must be user supplied. A typical student drawing of the piston model is shown in Figure 11.

Curriculum Laboratory Sequence

An Engineering Design Graphics curriculum outline, based on this digital engineering design process, is shown in Table 1. It consists of eight laboratory modules and a two-week design project. Outcomes of the curriculum include computer sketches, 3-D solid models of parts, assembly models, analysis results, kinematics animations, rapid prototypes, sections views, engineering drawings, and technical illustrations. The final design project involves reverse engineering of a mechanical assembly, a team project activity that has been successfully used as a capstone event in freshman Engineering Design Graphics courses (Barr, Schmidt, Krueger, & Twu, 2000).

Conclusions

Engineering Design Graphics curriculum content is at the threshold of a new era, a digital era where geometric computer models, and the attendant databases, are the center of instruction. The digital database starts with the building of a solid model from a 2-D sketch, and is then completed by adding 3-D design features. However, the true power of this approach is only realized when the solid model data is applied to analysis, simulation, prototyping, and design documentation activities. This paper has documented this digital engineering design and graphics process with realistic examples of freshman student exercises.

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Laboratory Sequence

Lab	Activities and Outcomes
1	**Computer Sketching:** Set up the sketch plane units and grid parameters; demonstrate all 2-D sketching primitives; demonstrate all line editing features; demonstrate the setting and editing of dimensions; set geometric constraints; make simple extrusions and revolutions to get 3-D geometry. Print hardcopies of 2-D sketches and simple parts for submission.
2	**Solid Modeling of Parts:** Create 3-D extrusions and revolutions of individual parts; use advanced sweep operations; add parametric design features; edit features and geometry in 2-D and 3-D; render the parts. Print color hardcopies for submission.
3	**Assembly Modeling:** Create individual parts; assemble parts as a mechanical assembly; mate features as appropriate; check for clearance and interference of parts; create color rendering of assembly. Print color hardcopy of the rendered assembly for submission.
4	**Analysis of Parts:** Perform mass properties analysis of 3-D parts. Perform an FEA study: set up applied forces, fix constraints, perform meshing, display color stress contours, visualize and interpret results. Print a mass properties report and obtain a color hardcopy of the FEA results for submission.
5	**Kinematics Simulation:** Create a mechanical assembly; mate the parts of the assembly, simulate motion of the assembly; generate an animation (.AVI) file; play the .AVI file externally on a suitable player. Print a rendered color hardcopy of the assembly and submit it along with the animation file.
6	**Manufacturing and Rapid Prototyping:** Create individual parts of a mechanical assembly; generate an .STL file of each part; send the .STL files to a prototyping machine; demonstrate mating assembly of prototype parts. Submit the rapid prototypes once finished.
7	**Section Views:** Create individual parts of a mechanical assembly; make different 3-D section views of the parts individually and as assembled; export acceptable color image files of the 3-D section views for presentation purposes. Make a 2-D section view of a model projection. Import the image files into a technical document page and submit printed hardcopies.
8	**Engineering Drawings:** Create a 3-D part and make a three-view orthographic drawing of the part; use a suitable sheet style template; add centerlines where appropriate; dimension the drawing; add a title block and appropriate notes. Print a black and white hardcopy for submission.
9-10	**Team Design Project:** Assign teams; acquire, study, and reverse engineer a common mechanical assembly; sketch shape and sizes of individual components; build computer solid models of parts and assemblies; perform appropriate computer analyses; make rapid prototypes of parts; generate drawings and other design documentation; propose design improvements. Submit final team project report.

Table 1

Acknowledgements

The authors wish to acknowledge the following corporations and individuals who contributed to this educational research paper:

- *Ford Motor Company* for sponsorship of the Project Centered Engineering Education (PROCEED) grant to the Mechanical Engineering Department at the University of Texas at Austin.
- *SolidWorks Corporation* for their grant of the feature-based modeling software SolidWorks 2000 that was used to build the solid geometric models.
- *Structural Research & Analysis Corporation (SRAC)* for their grant of COSMOS/Works design analysis software used in the FEA study.
- *Professor Ronald Matthews* of the University of Texas for supplying the piston assembly and FEA pressure loading data using Ricardo's WAVE program, a commercial engine simulation code that is available free to universities for educational purposes.
- *Professor Kristin Wood* of the University of Texas and DTM Corporation who donated the Selective Laser Sintering (SLS) machine that provided the rapid prototype parts of the piston assembly.
- *Mr. Balaji Sampath* of the University of Texas at Austin for the construction of the piston assembly solid models and the FEA study of the piston head.

Engineering Design Graphics as a Communications Tool for Mechanical Design: A Broader View

Holly K. Ault
Worcester Polytechnic Institute

Abstract

Amongst the many skills required of newly graduated engineers is the ability to clearly communicate their designs and engineering analyses using both verbal and graphical languages. The new ABET EC2000 criteria emphasize that students must have the ability to communicate effectively, (Engineering Accreditation Commission, 2001) but leave the interpretation of the outcomes that define effective communication to the individual programs. It is desirable for the students to learn these communication skills in the context of their specific disciplines; therefore, the trend has been towards integration of writing exercises through design and laboratory reports in the engineering courses in addition to their courses in the humanities component. Although much emphasis has been placed on the integration of both written reports and oral presentations into the core engineering curriculum, little has been said or done concerning the use of graphics as a communication medium. It has been said that graphics is the language of engineering (Bertoline, et al., 1995). Writing in the humanities does not depend heavily upon graphics. Mechanical design, in particular, requires extensive use of graphics, not only conventional orthographic drawings, but also sketches, solid models, graphical representations of various analyses and experiments, prototypes, and other graphical and physical models to communicate design concepts and outcomes effectively. This paper will present a review of the use of graphics tools by students in a sophomore level introductory mechanical design course and senior design projects with a focus on the use of graphical communication techniques and physical objects to develop and communicate design concepts.

Background

Engineering design graphics has been taught traditionally as the language of engineers (Bertoline, Wiebe, Miller & Nasman, 1995). Graphics is recognized as an important communication tool within the engineering community. Traditional entry-level courses focus on developing students' visualization skills through the creation of standard engineering drawings. Prior to the advent of computer-aided design (CAD), most engineering schools offered several courses in graphics and descriptive geometry. First year engineering students were required to take one or more of these graphics courses.

Recently, a trend towards removing engineering design graphics courses from the curriculum has emerged (Clark & Scales, 1999). This trend is driven not only by the availability of CAD software that facilitates the generation of engineering drawings, but also by pressures to include other topics in the curriculum. Furthermore, many schools have integrated graphics and CAD into other courses. In particular, entry-level introduction to design or introduction to engineering courses often contain a CAD component. The course described by Briller et al. is but one example of many such efforts (Briller, Hanesian, & Perna, 2001). However, many of these courses are electives, and the time spent by students learning graphical communications skills has been greatly reduced.

ABET's general accreditation criteria for engineering programs require that the students demonstrate: 3(g) *an ability to communicate* *effectively*, and 3(k) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice* (Engineering Accreditation Commission, 2001). Graphical communication skills are not specifically noted. Specific engineering program requirements likewise do not mention visualization skills, graphics or geometry, with the exception of geological engineering, which requires the ability *to visualize and solve geological problems of a three-dimensional nature* (Engineering Accreditation Commission, 2001). Thus, the individual institutions must define the graphical communications skills and modern engineering tools to be learned and used by their graduates.

This paper will attempt to address the question by reviewing the work of mechanical engineering students in an introductory mechanical design course and in senior design projects with an emphasis on the use of graphics as a design communications tool.

ME2300 Introduction to Engineering Design

This course utilizes a realistic design process to introduce sophomore and junior level students to the methods and techniques for solving engineering design problems. The course focuses on the early phases of the design process, particularly needs assessment, development of product specifications and concept generation. Lectures on design theory and structured design methods such as benchmarking, customer needs assessment, development of product specifications, brainstorming and creativity exercises, and decision strategies are presented. Lectures are also provided to support the specific design projects and may cover a variety of engineering topics such as fluid dynamics, heat transfer, mechanics, statistics, elementary programming, basic circuits and engineering economics. Prior knowledge of introductory calculus, physics and statics is assumed. Laboratory sessions are used to conduct benchmarking experiments and to build, test and demonstrate various prototype designs. The course is designed to provide a broad overview of engineering design (Worcester Polytechnic Institute, Undergraduate Catalog, 2001-2002).

Graphics and CAD are not covered in the course, and no prior knowledge is assumed. There is no prerequisite graphics course required. However, on the first day of class, the students are given an exercise that highlights the importance of graphics in engineering communications. The exercise is relatively simple. Each student is provided with a structure or mechanism built from a set of standard construction toys such as K'nex, LEGOs or GeoShapes. The students are instructed to describe the object such that a classmate can reconstructed the model from a duplicate set of parts, which may include extra pieces. Invariably, one or more students will ask whether they are allowed to use sketches or drawings in their description, however, the instructor merely re-emphasizes the original instructions to describe the object and communicate the necessary information to their classmates. Virtually all of the students include one or more sketches in their description, mostly pictorials. Fewer than half utilize orthographics; we have not collected data to determine whether those students who sketch orthographic views have also taken the introductory CAD/graphics course. Students are usually fairly successful in rebuilding their models; fewer than 5% fail to construct a model, and approximately 10-20% of the models have minor defects related to color or symmetry. As a conclusion to the exercise, the instructor leads a discussion on the importance of graphics and the use of proper technical terminology in communicating design ideas, noting that the descriptions containing well-annotated pictorial sketches and proper orthographic views were easier to follow than those that did not. Hopefully this insight will remain with the students when they begin to prepare their design reports.

The course runs for seven weeks, during which time the students complete two design projects, each lasting approximately three weeks. Both projects require the students to work in teams of 4-6 students. Students are required to keep informal design notebooks for both projects. The design notebooks are used to record ideas, meeting notes, test results, and any other information that demonstrate the student's work on the project. All work done on the project should be recorded in the design notebooks, including brainstorming sketches, design concepts and notes from project group meetings. Further documentation for the second project includes both oral presentations and formal written reports.

The first project involves the design of a robotic mechanism that is constructed from LEGOs MindStorms kits. The robot is required to perform some function such as navigating a maze or retrieving an object. The only documentation required for this project is the design notebook and an informal, intermediate oral presentation of preliminary design concepts (using PowerPoint). Students are graded based on the number of "quality" entries in their design notebooks, as well as their robot's performance in the final contest. A "quality" notebook entry consists of a concept sketch, written description of a design, test results, notes on programming the robot, decision matrix, photos of candidate designs, flow chart, minutes of team design meetings, etc.

The second project involves the design of an assistive device for a person with a disability. Example projects have included redesign of a headpointer, a laptray, and an adaptive fishing apparatus. The students interview the client to assess user needs, conduct product and patent searches to identify potential solutions and create concept solutions for the client. Documentation includes the design notebook, a formal oral presentation and written report to the client, and a physical prototype or scale model, if appropriate. A review of the documents generated by the students during these two projects shows the use of various graphical elements, as shown in Table 1.

In Table 1, the graphical elements are identified as follows. An informal sketch is hand-drawn, and may be a pictorial, diagram, chart or graph. Most of the informal sketches were pictorials of design concepts. A formal sketch or diagram is created using a 2D drawing package such as MS-Paint, or may be copied from another source such as a textbook.

Average Number of Graphical Elements in Introductory Design Course Documents

	Project #1 LEGOs		**Project #2 Assistive Devices**	
	Design Notebook (n=30)	**PowerPoint Presentation (n=8)**	**Design Notebook (n=29)**	**PowerPoint Presentation (n=9)**
Informal Sketches	21.5	-	14.4	1.0
Formal Sketch/Diagram	0.1	0.4	0.4	0.1
Orthographic Drawings	-	-	0.4	0.3
Solid Model Images	0.4	0.4	0.7	3.2
Function Plots	-	-	-	-
Photos	2.4	2.3	2.8	2.1
Other	0.3	0.6	0.3	0.4
Total	24.7	3.6	18.9	7.2

Table 1

Orthographic drawings are dimensioned multi-view layouts and may be generated either with a 2D CAD package, from a 3D solid model or hand drawn. Solid model images are renderings of solid CAD models, usually in shaded, axonometric views. Function plots are generally x-y curves and are typically used to represent experimental or analytical data (velocity vs. time, etc.). Photographs consisted mainly of digital images of their robotic prototypes for Project #1, or photos of items related to the disability project (laptrays, wheelchairs, etc.) for Project #2. Other items included miscellaneous graphics such as PERT charts, flow diagrams, organizational charts, copies of patent drawings, and screen dumps.

Table 1 shows that over three-quarters of the design notebook entries are hand-drawn sketches, although these tend to be of variable quality. Figures 1 and 2 show some typical sketches. Using a draw package to create neat, formal sketches is time-consuming and many students do not have the skills to use even these simple graphics packages to demonstrate their designs. Formal sketches are thus only generated when a formal report is required. An additional 10-15% of the graphics are digital photos. Students find this a quick and easy way to document their designs. The digital photos can simply be pasted into their notebooks. Orthographic drawings and function plots comprise fewer than 10% of the graphics used in the design notebooks for these concept designs.

Students are given a fifteen minute mini-lecture on using PowerPoint, however, there is no discussion of the use of graphics in the PowerPoint slides. None of the teams reported any difficulty in creating slides for their oral presentations. Graphics were incorporated onto about half of the slides. These graphics typically included digital photos (39%), renderings of solid models (34%), and scanned images of their concept sketches (10%). Only three out of nine teams used orthographic drawings in their oral presentations to the

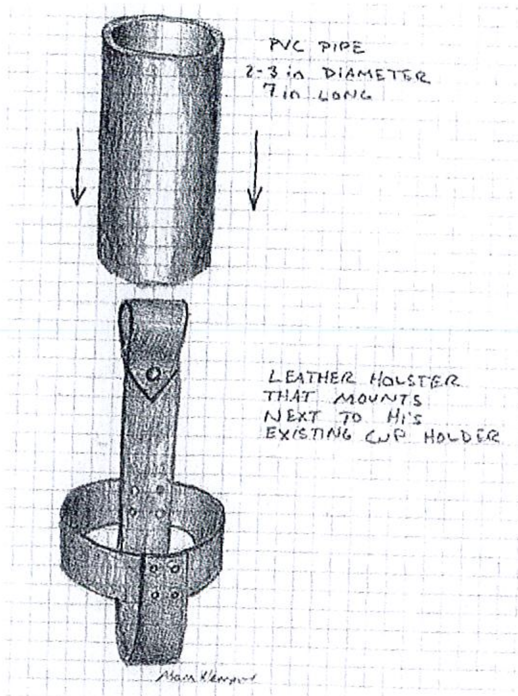

Figure 1 *Example of well-developed student design concept sketch*

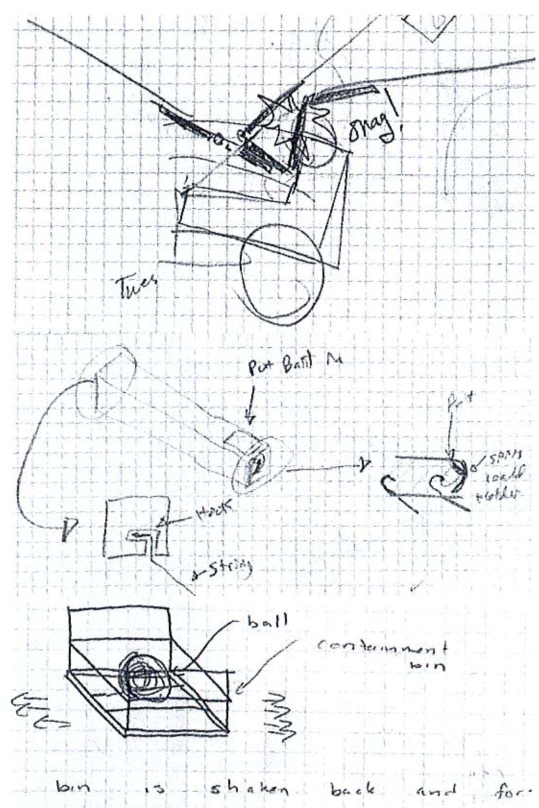

Figure 2 *Examples of rough sketches created by students in design notebooks*

clients for the assistive devices; none were used for the LEGOs robotics projects.

Senior Design Projects

All students are required to complete a capstone design project during their senior year. These projects are usually conducted as team projects and require an effort equivalent to three courses. There is no formal course associated with the project; student teams meet with their faculty advisor weekly during the year. About half of the projects are sponsored by local industry. All teams are required to submit a formal report; most teams will also participate in the annual project poster competition. All of the final reports submitted during the academic year 2000-2001 were reviewed to determine what types of graphics were used in the documentation. A total of forty-two (42) reports were submitted by 104 students, for an average team size of 2.6 students/team. Average report length was sixty (60) pages with an additional twenty-seven (27) pages of appendices. Table 2 shows the use of graphical elements in the senior design project documentation.

For the formal reports, there are wide variations in both the number and types of graphical elements used by the students. The % entry indicates the percentage of total graphical elements in all reports for each type, whereas the Team % entry indicates the percentage of teams that used the element type. Note the large standard deviations and ranges of instances for each graphic element type. This is certainly not unexpected, because of the wide range in topics for these projects. One project may have a large number of finite element analyses, whereas another may contain numerous plots from experimental data. All reports contained some graphic content generated by the students. The most common graphic elements created by the students were x-y plots of experimental data and/or analytical calculations (80%), most using Excel or similar spreadsheet software. Formal diagrams or pictorial sketches were generated by 75% of the teams, and an additional 15% of the reports copied sketches or diagrams from outside sources. Two-thirds used digital photographs taken by the project team; another 10% used digital images from outside sources.

Average Use of Graphical Elements in Senior Design Project Documents

	Final Report (n=42 teams)						Poster (n=26 teams)		
	Avg.	SD	Min.	Max.	%	Team %	N	%	Team %
Informal Sketches (hand drawn)	3.1	10.8	0	65	6	17	0	0	-
Pictorals/Formal Sketches	6.6	7.0	0	31	14	90	28	10	42
Orthographic Drawings	4.8	11.7	0	74	10	55	3	1	-
Photographs	8.4	9.8	0	53	17	76	123	44	81
Function Plots	15.9	24.1	0	102	33	80	72	25	69
Solid Model Images	5.4	8.2	0	35	11	60	37	13	15
Other Graphics	5.0	9.1	0	46	9	57	19	7	-
Total	49.2	34.5	5	137	100	100	282	100	100

Table 2

About three-fourths of the teams prepared either orthographic drawings or solid models (71%); solid models were slightly more prevalent at 60%, with orthographics in 55% of the reports. One-fourth of the teams with solid models did not create orthographic drawings. Only 17% of the teams that created orthographic drawings (4 teams) did not generate them from solid models.

Fewer than one-fifth of the teams included informal sketches, and only two reports contained copies of patent drawings. Statistical formats such as bar charts and pie charts were used occasionally. Other infrequently used graphics included flow charts, organizational charts and trees, electrical schematics, screen dumps and spectral plots.

In addition to the types of graphics used by each team, it is interesting to compare the number or frequency of use in each report. Surprisingly, since these are capstone design reports, there are very few orthographic drawings, averaging fewer than five (5) drawings per report, or about 10% of the total graphic content. Renderings of solid models appear with only a slightly higher frequency of 11%. Only informal sketches have a lower frequency at an average of three (3) per report or 6%. Pictorials and diagrams occur at a frequency of about 14%, however, approximately half of these graphics are scanned images from outside sources and were not created by the students. Digital photographs are easily obtained and occur with an average frequency of eight (8) per report, or 17%. Many of these photos have been enhanced or annotated using software such as Adobe PhotoShop. Finally, function plots comprise nearly one-third of the graphic content, with an average frequency of sixteen (16) per report, and tend to dominate the graphic content. The majority of these plots represent experimental data collected during prototype testing, benchmarking, or studies using analytical models.

Posters prepared by the students for their final presentations show similar trends, with the exception of the lack of orthographic drawings. Students used photographs more frequently, with a slight reduction in the percentage of data plots and images of solid models. Since specific details of the design, analysis and testing are less important in a brief presentation such as the poster session; digital photos serve primarily as an opening to the discussion with viewers of the poster, and technical detail is omitted. A general audience more easily interprets photos as compared to traditional technical graphics. During the poster session, students were provided desktop space and access to computers and video equipment. Many teams elected to display prototypes, utilize computers for software demonstrations, simulations and animations, or show videos of experiments. The use of these multimedia graphical communication tools enhanced the students' presentations.

Discussion

Students in mechanical design use a wide variety of graphical elements to document their designs. These include not only conventional "engineering graphics" such as orthographic drawings, but also digital photographs, function plots of experimental and analytical data, both formal and informal sketches and diagrams, statistical graphics such as bar and pie charts, patent drawings, images of solid models, and various other miscellaneous graphical elements. Students at our institution do not have access to rapid prototyping equipment, so there were no 3D graphical objects generated from their solid models, but students did use conventional prototyping materials and methods to prepare mock-ups or models of their designs.

Informal sketches are useful at the concept generation stage and for discussions with fellow students; however, the sketching ability of most students is not well-developed. Students working informally need sketching skills, as evidenced by the frequent use of sketches in their design notebooks. Some training in sketching would help to improve their skills in this area.

Digital photographs are a very popular method of documentation in student design reports. Many of the digital images were annotated or enhanced using either image editing software or within the word processor. Quality of photography may vary, but digital photos are easy and cheap, so only the best are presumably included in the reports and presentations. Nonetheless, it would be useful for students to have a better understanding of basic photography and digital image manipulation.

Formal reports often include function plots. Experimental data and results of design analyses are often displayed with x-y plots or other figures or diagrams. The display of various types of information for scientific purposes can take on many forms, and the use of simple function plots may not always be the best tool for scientific visualization (Tufte, 2001). Figure 3 shows a plot of experimental data comparing various design options. Note the use of multiple scales along both axes, which has the effect of superposing and sorting the data in this multi-dimensional representation, and allows the presentation of multiple design variables for comparison. Engineering students generally receive no formal training in scientific visualization methods, but would be well served to study this topic.

Diagrams, sketches and pictorials for reports and presentations are generated using 2D computer drawing packages or scanned from outside sources. Students seem to readily acquire basic skills with simple draw and paint type graphics tools, however, it can be time-consuming to create formal diagrams and sketches using computer software. This might be avoided with better sketching skills.

Conclusions

This study demonstrates the wide variety of graphics elements used by mechanical engineering students to document their designs, in both formal and informal settings. The documents surveyed in this report include only notebooks and reports, and do not include additional multimedia graphics or rapid prototypes that could be used in design presentations. These forms of graphics are coming into more widespread use in engineering communications. Although this is a limited survey conducted at a single institution, it may provide some insight regarding the use of graphics as a communication tool by student design-

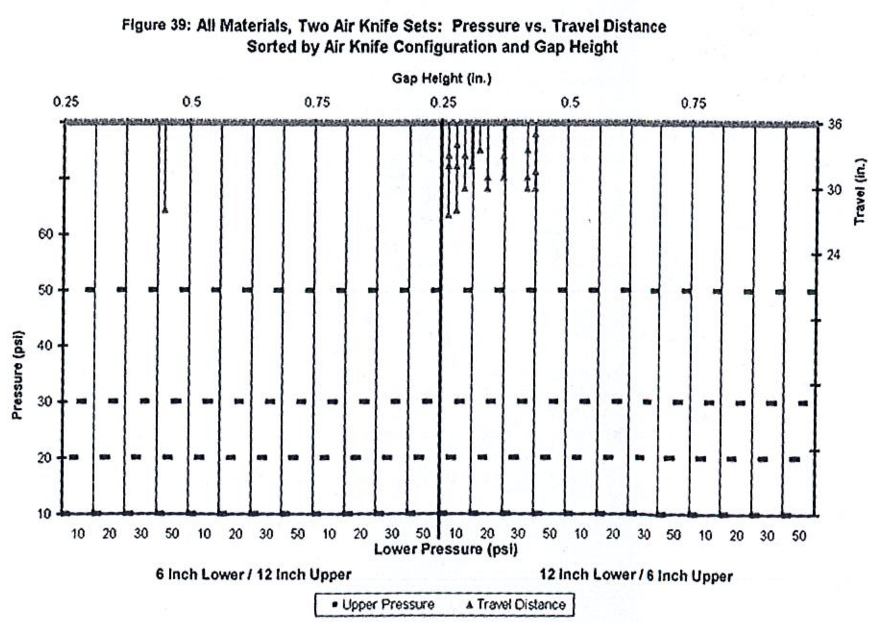

Figure 3 *Multi-dimensional plot of experimental data from a design experiment*

ers and the needs for changes in focus within the graphics curriculum.

Recommendations

Further research is needed to replicate this study across a broader spectrum of students in engineering and technology programs. A comparison of graphical communications skills used not only by engineering students but also by practicing design engineers would help to define the range of topics that should be covered in the engineering curriculum. All types of graphical or non-text communication media should be studied, including multimedia animations and 3D models such as rapid prototypes.

Based on this limited study, we conclude that our engineering students need more than just CAD skills to effectively communicate design concepts. The curriculum in Engineering Design Graphics has seen a reduction in content at many universities over the past few decades, particularly since the introduction of CAD. Students were previously taught sketching as well as skills needed to prepare formal engineering drawings, with or without CAD. This study shows that sketching is an important skill for design engineers, however, few students have good sketching skills and therefore find it difficult to produce informal sketches that can be interpreted by others. Furthermore, students utilize other graphical elements for visualization of complex data. These may be in the form of 2- or 3-D function plots, color contour plots, and various other forms of scientific visualization tools to display the complex data that are generated by sophisticated analysis techniques such as Finite Element Analysis and Computational Fluid Dynamics packages and experimental data collected with devices such as signal analyzers and data acquisition systems. Rather than reducing the emphasis on graphics in the engineering curriculum, students should be taught how to use a much broader range of graphical elements to communicate their design ideas.

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Using CADKEY to Solve Intersections of Thin-Walled Surface Models

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Abstract

Fundamental constructions in descriptive geometry deal with determining the intersection of various elementary solids, such as planes, cylinders, and cones. Systems involving planes, cylinders, and cones are generally produced from sheet metal or other thin materials. When panels of these thin materials are fastened together, complex objects result. Determining the lines of intersection between the basic shapes that create the final product by using manual methods has always been a complex procedure. The process is greatly improved when using a computer-aided drafting (or design) (CAD) program such as CADKEY; however, the orthographic results can be misleading. To avoid any problems associated with orthographic views of surface models, software developers should consider integrating within the modeler a means by which the surface model can be displayed as a solid model, thus eliminating hidden lines that nearly coincide with object lines.

Introduction

Determining lines of intersection of solids has always been a complex problem in descriptive geometry. Common solutions warranted use of cutting planes and transfer of points through various views in order to generate the correct intersection. Furthermore, when dealing with curved surfaces, the solution required one to plot several points and then establish the intersection by connecting the points with an irregular curve. The skill of the drafter was extremely important in the overall solution.

With three-dimensional CAD programs, lines of intersection can be determined very simply if the solid modeling software uses Boolean operations to enhance solid construction (Bertoline, 1997). Boolean operations include UNION, DIFFERENCE, and INTERSECTION functions. For example, in Figure 1, the pyramid and the triangular prism (Hawk, 1962) are generated separately and then using a UNION operation, are combined into a single solid.

Holes in solids can be generated using a DIFFERENCE operation. Figure 2 shows a triangular prism with a hole through it. The hole was produced by creating a cylinder long enough to pass completely through the prism and then using the DIFFERENCE operation.

Once the solids are formed, the lines of intersection are also formed and stored in the database. Most CAD programs permit the user to display the solid in many different ways including rendered, hidden lines removed, or hidden lines visible. Figure 3 shows a solid that has been rendered. The triangular prism intersects the pyramid as shown in Figure 3. It should be noted that after the intersection operation, the pyramid and prism characteristics extend only to the lines of intersection. This is shown in Figure 4 where hidden lines depict the intersection.

Solids Composed of Lateral Surfaces

Although CAD programs in general, and CADKEY in particular, can be used to easily determine the lines of intersection between two geometric solids, what about the lines of intersection between objects composed of surfaces only? These geometric solids are hollow and offer a somewhat different approach in their solution. The primary difference between thin-walled surface models and objects that are solid throughout is the surface model will show two parallel lines for the intersection due to the thickness of the surface that makes up its geometry. This is very important since many real world applications deal with objects constructed out of sheet metal.

The significant issue in dealing with thin-walled surface models is the actual construction of the model. Fortunately, most CAD modeling programs offer a shelling routine, which will automatically hollow a solid model to produce a thin-walled surface model. CADKEY has this capability built into its solid modeler and it is very easy to "shell out" the solid and be left with the surface model. Figure 5 shows the result of the pyramid and prism intersection in a surface model format. The left side of the figure shows the thickness of the material that composes the lateral surfaces. The right side of the figure simply shows the surface model without the hidden lines and it looks exactly like the solid model in Figure 1.

Orthographic Views of the Thin-Walled Surface Model

CADKEY, through its layout mode, offers the user a way to create a design drawing showing any number of orthographic views desired. It must be noted that when showing the orthographic views of the thin-walled surface model, thickness of the material is depicted and may offer some confusion. See Figure 6. When a layout of a solid is presented, single hidden lines allow ease of interpretation; when a layout of a thin-walled surface model is presented, often double hidden lines add a great deal of confusion. Figure 7 shows the orthographic views of a solid. Note the clarity of the intersection; however, if the intent of the design is to use folded sheet metal or other material to construct the solid, then the drawing (Figure 7) does not represent the true object. Figure 7 shows hidden lines only in the front view, which is correct. There is little chance that anyone trained in orthographic reading would misinterpret the intersection.

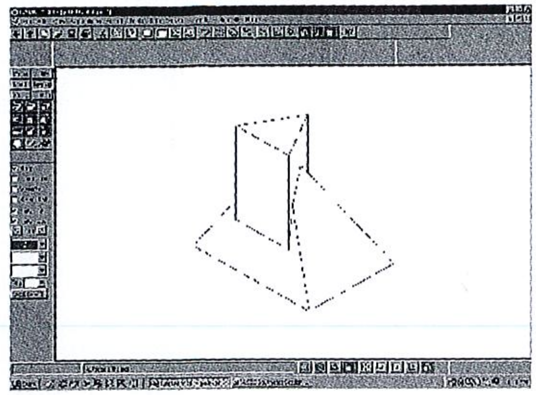

Figure 1 *Solid Model of a Pyramid and Triangular Prism formed by Boolean UNION*

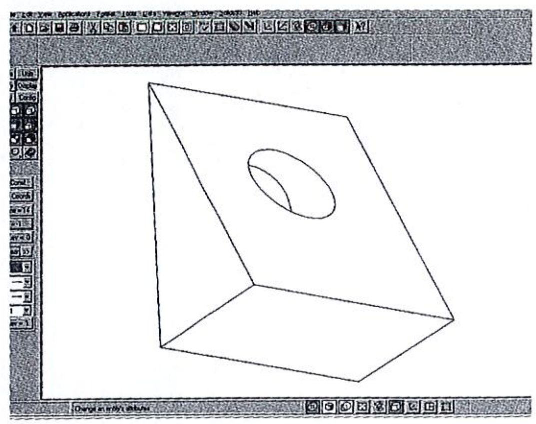

Figure 2 *Triangular Prism with a Hole Formed by Boolean Difference*

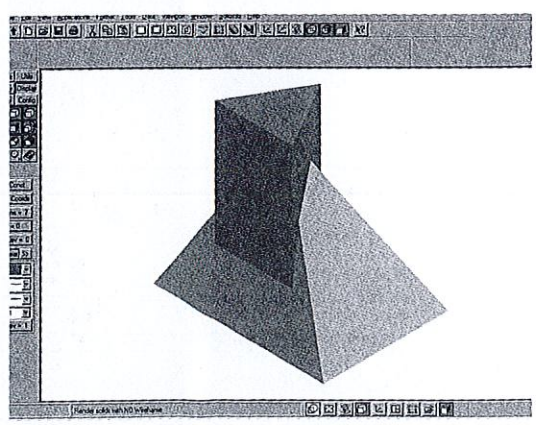

Figure 3 *Rendered Solid*

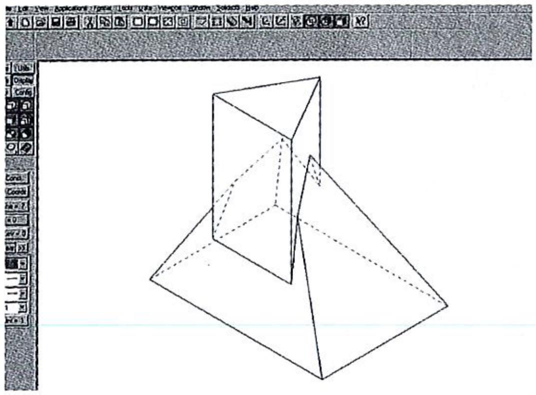

Figure 4 Intersection of Pyramid and Prism showing Hidden Lines

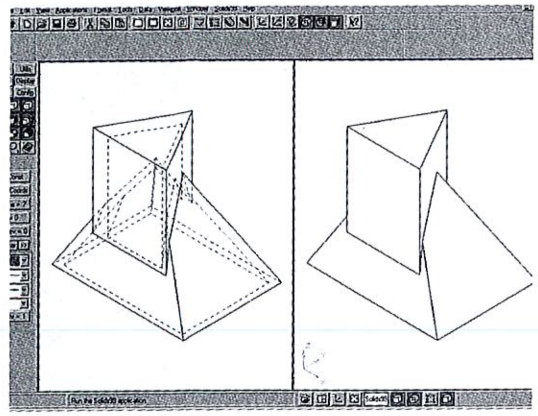

Figure 5 Intersection of Lateral Surface Generated Solids

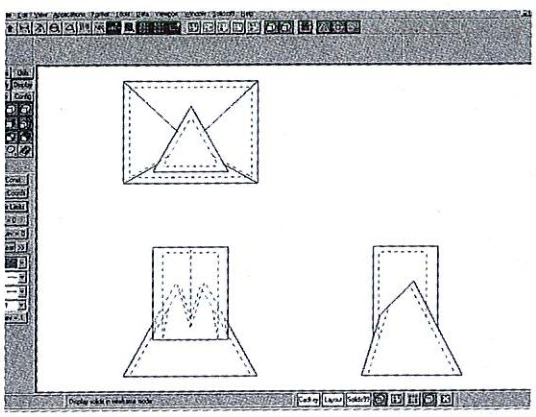

Figure 6 Orthographic Layout of Thin-Walled Surface Model

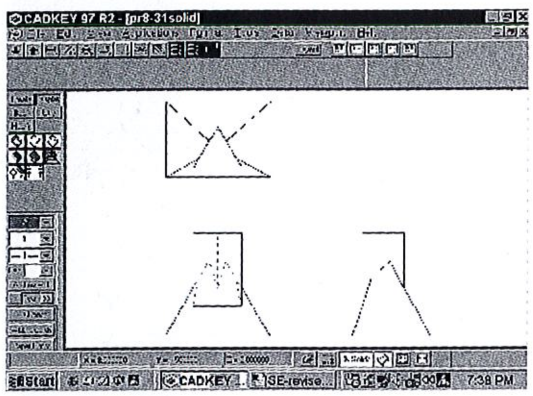

Figure 7 Orthographic Layout of Solid

This drawing, although orthographically correct, is geometrically incorrect if the drawing is meant to depict the orthographic views of a surface model. The engineering properties associated with the solid and the surface model are different.

Most CAD programs, including CADKEY enable the user to examine the engineering properties. Figure 8 shows a portion of the mass properties table for the solid as displayed in Figure 7, while Figure 9 shows a portion of the mass properties table for the corresponding surface model as shown in Figure 6. For example, the table for the solid shows a volume of 5.138 cubic inches and a surface area of 22.26 square inches. In contrast, the table of the surface model shows a volume of 2.390 cubic inches and a surface area of 39.74 square inches. These are very different properties.

Conclusions

CAD programs, such as CADKEY, are very powerful tools that can display complex intersections between solids without the cumbersome cutting planes and projection techniques of the past. The Boolean operations associated with most CAD modelers enhance one's ability to develop complex solid objects and enable us to have confidence that our geometry is correct. On the other hand, since many real world designs depend on objects developed from flat material such as sheet metal, CAD solid modeling software should be able to incorporate

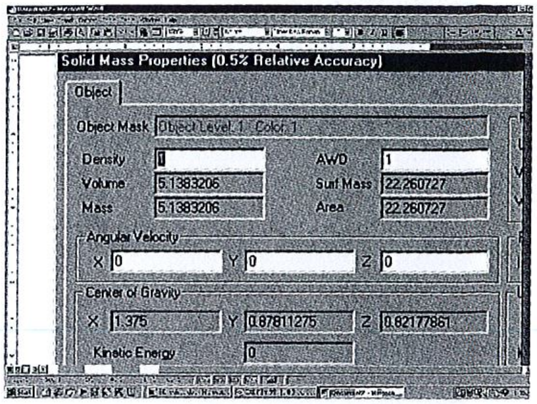

Figure 8 *Engineering Properties of Full Solid*

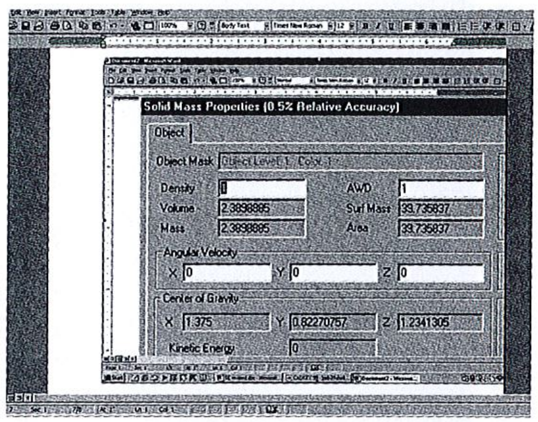

Figure 9 *Engineering Properties of a Thin-Walled Solid*

the standard representation of the solid objects made of these materials. The thickness of the material, although important to the flat pattern developers, is unimportant when constructing design drawings. The proper view representation can be achieved if a solid representation of the object is modeled; however, a solid does not represent the real world object and its engineering properties. Finally, it is recommended that software developers consider integrating within the modeler a means by which the thin-walled surface model can be displayed as a solid model, thus eliminating hidden lines that nearly coincide with object lines. This can be done to avoid any confusion associated with orthographic views of surface models.

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Distinguished Service Award

EDGD
2002 Distinguished Service Award
Presented to

John T. Demel

ASEE Annual Conference
June 18, 2002
Montreal, Quebec, Canada

Presented by Fritz Meyers and Frank Croft

I would like to thank the EDGD members for giving me this award and, more importantly, for sharing their friendship and the technical expertise over the years that I have been a member of the Division. I would also like to recognize a few of the people who have played important roles in the development of my professional career.

Mr. Mark Crandall - was my high school drafting instructor who taught me good drafting practices and how to do an ink drawings on paper. The skills that he taught me got me a job offer the second day of my freshman year at the University of Nebraska. (He was also the band instructor who taught me to play the drums.)

Dr. Richard N. DeVries, Engineering Manager, Sanitary District #1, Lancaster County, Lincoln, Nebraska - was the man who gave me that first job and allowed me to do the drafting in the District office. He also helped me learn about and practice engineering design and to do engineering field work with the surveying crew. I learned how to do contour plots, design earthen dams, and design residential and commercial sewers. All of this was interesting work for me as a mechanical engineering student.

Dr. Russell Nelson, University of Nebraska-Lincoln, whose enthusiasm for metallurgy and teaching that led me to consider a career as a professor and to switch from mechanical engineering to metallurgy for my graduate work.

Dr. Karl A. Gshneidner, Iowa State University - was my masters and doctoral advisor for my degrees in Metallurgy. Karl helped me learn how to do research that is so important in an academic's career. I had ample opportunity to use my graphics drawing and visualization skills to solve and illustrate crystal structures and phase diagrams.

Dr. Clyde W. Hall, Savannah State College, Savannah, Georgia - was my first boss in academia. From him I learned how to teach and how to write instructional objectives. My teaching activities were in the Mechanical Engineering Technology program and I taught 13 different courses over the course of four years and taught two quarters of graphics every year.

Dr. James H. Earle, Texas A&M University - is truly one of the giants in Engineering Design Graphics. I worked for and with him for five years and learned continuously about all aspects of graphics and about the organization of materials and people to teach large numbers of students. I also learned how to plan textbooks and get them published and I appreciate his getting all of the A&M EDG faculty involved in writing the course materials. His visiting engineers program tied the students to people in industry early and the use of design projects in both semesters helped the students learn about engineering design, presentation skills, and creativity. We have used his texts here at Ohio State because they are well written and beautifully illustrated.

I would like to give a special thanks to Professor Clyde Kearns, Professor Bob LaRue, Professor Fritz Meyers, Professor Michael Miller, Dr. Frank Croft, Dr. Ed Boyer, Dr. Audeen Fentiman, Dr. Bob Wilke, and Dr. Rick Freuler all who work here at The Ohio State University – These people have been and are my professional colleagues and my friends since 1980. I have learned much from these people and shared great times. Ed, Frank, Fritz, Mike, and Bob Wilke have been co-authors on books. The writing projects kept me sane when there was turmoil. Going to work every day to teach and to learn is a joy particularly when your colleagues are such special people.

Sharon Keillor Award for Women in Engineering Education

Audeen Fentiman

The Sharon Keillor Award for Women in Engineering Education recognizes and honors outstanding female engineering educators. The award consists of an honorarium of $2,000 and an inscribed plaque.

Audeen Fentiman received a bachelor's degree in mathematics (minor, physics) from Glenville State College (1972); a master's degree in mathematics from West Virginia University (1974); and a master's degree (1977) and Ph.D. degree (1982) in nuclear engineering from The Ohio State University (1982).

Fentiman currently serves as chair of the Nuclear Engineering Program and is an associate professor in the Department of Civil and Environmental Engineering and Geodetic Science at Ohio State University. Prior to joining the university, she was employed with the Battelle Memorial Institute for approximately 10 years, where she held various positions with increasing responsibility, beginning as a research assistant (1976-77), principal research scientist (1981-84), senior engineer (1985-87) and associate department manager (1987-89). She joined the faculty at Ohio State University in 1989 where she worked as senior specialist in the technology department (1989-90) and assistant professor of civil and environmental engineering and engineering graphics (1990-96). She has served as associate professor of civil and environmental engineering and geodetic science since 1996; director of the Environmental Science Graduate Program (1998-2001); and associate dean for outreach and special programs (1999-200 1). She has been chair of the Nuclear Engineering Program since 1999.

Fentiman is an outstanding classroom teacher who brings her industrial experience at Battelle Laboratories and her research into her classroom. She led the development of Ohio State's Introduction to Engineering that has increased retention of first year students by 15%. This development program provides instruction in cognitive development and new educational methodologies and technologies.

As an outgrowth of this Introduction to Engineering program development, Fentiman has obtained industrial funding to take it to a Cincinnati high school. Fentiman and the Ohio State staff have modified the program and provided instruction for the high school faculty who are teaching the courses. This has become, in effect, an advanced placement course for engineering similar to ones for math, science, and the humanities. Fentiman has also developed and taught courses for senior undergraduate and graduate students in environmental engineering risk assessment and radioactive waste management. She is co-author of the revision of the textbook for the latter course.

Audeen Fentiman is awarded the Sharon Keillor Award for Women in Engineering Education for her work as an outstanding classroom teacher and her leadership of the educational development programs that increased the retention of engineering freshmen at Ohio State University. This year she extended her college level program to a high school engineering advanced placement program. The hazardous waste fact sheets that she and her research team developed have helped educate the public, and her expertise led an Ohio legislature committee to invite her to teach them about hazardous waste issues.

As the associate dean for outreach and special projects, Fentiman developed and implemented a summer bridge program for women engineering students. The women who have participated in the bridge program have been retained at a higher rate than counterparts who do not participate. One of her externally funded projects was to develop fact sheets concerning hazardous waste so that the public could be properly educated about these issues. These fact sheets were used in Ohio, California, and New Jersey. This past year, Fentiman was chosen by her Ohio State Nuclear Engineering Program faculty peers to head the program.

Within ASEE, Fentiman has been active in the North Central Section and the ASEE Nuclear and Radiological Engineering and Environmental Engineering divisions. She was named a Battelle Fellow (1982) and a Fellow of the American Association for the Advancement of Science (2001). She is a recipient of the Boyer Award for Excellence in Teaching Innovation (1999), and the Outstanding Engineering Educator Award from the Central Ohio Society of Professional Engineers (2000).

Engineering Design Graphics Division (EDGD)

of the

American Society for Engineering Education (ASEE)

Bylaws

(Proposed 2002 Revision)

Article I: Name and Objectives

Section 1. The name of this Division of the American Society for Engineering Education (the Society) shall be the Engineering Design Graphics Division (the Division).

Section 2. The objectives of the Division shall be to:

a. Provide leadership and guidance for those engaged in the teaching of conceptual design and graphical analysis and their use in industry.

b. Investigate matters relating to engineering graphics and to inform the membership of current developments.

c. Encourage the early participation of engineering students in the areas of graphics and design.

d. Promote, stimulate and provide opportunities for the professional interchange of ideas among the membership.

Article II: Membership

The membership of the Division shall consist of all members of the Society who have indicated an interest in the Division and paid the annual Division dues. Division dues are billed, due and payable with the Society dues on the anniversary of the date on which a member joined the Society. Division dues are deposited by the Society to the account of the Division and disbursed upon request of the Division Chair or Secretary-Treasurer. Dues fund Division publications sent to each member.

Article III: Officers and Duties

Section 1. The Division shall be administered by an Executive Committee consisting of the following elected officers plus the immediate past chair: (See **Art. VI**)

- Chair - 1 Year
- Vice Chair - 1 Year
- Secretary-Treasurer - 3 Years
- Directors (**6**~~5~~) - 3 Years

Terms of office shall conform with the Society-year, beginning in June following the Annual Conference of the calendar-year in which elected (See **Art. IV, Sec. 1f**).

Section 2. The duties of the Division officers shall be those usually associated with the respective office and described as follows:

2a. Chair

2a(1). The Chair is the chief executive officer of the Division and of the Executive Committee and an ex official member of all Division committees. The Chair presides at all business meetings of the Division and the Executive Committee.

2a(2). The Chair is the senior member of the Division on the Executive Board of the ASEE Council for Professional and Technical Education.

2a(3). The Chair shall review the annual Division budget as prepared by the Secretary-Treasurer [See **Art. III, Sec. 2c(6)**]. The Vice-Chair shall be consulted during this review. If necessary, adjustments to the budget will be made and discussed with the Secretary-Treasurer. When finalized, the budget shall be presented by the Chair to the Executive Committee. Upon approval, the budget shall be submitted to the Executive Director of the Society.

2a(4). The Chair shall prepare a written report, including budget expenditures, for the term of office just completed and transmit, not later than thirty (30) days following completion of the term of office, copies to the Secretary-Treasurer.

2a(5). The Chair shall keep the Vice-Chair informed of all Division activities during the term of office, and transmit to the Vice-Chair at the end of the term all material needed to maintain continuity.

2a(6). The Chair shall appoint all bylaw committees (See **Art. VII**) except the Nominating and Elections Committees, designating the chair of each committee except where the chair is specified by the bylaws.

2a(7). The Chair shall appoint the chairs and, at his discretion, members of committees not specified by the bylaws but considered necessary for the adequate administration operation of the Division, and assign such committees to the Vice-Chair or appropriate Director for Administrative control.

2a(8). The Chair shall review and approve the composition of all committees.

2a(9). The Chair shall assure the effective operation of the Division by revoking the appointment of any appointee who is not satisfactorily performing the duties of the position to which appointed.

2a(10). The Chair shall, with the advice and consent of the Executive Committee, request the resignation of any officer of the Division who is not satisfactorily performing the duties of the office to which elected, and shall appoint another member of the Division to that office for the remainder of the unexpired term. If the officer refuses to resign or does not respond to the resignation request within thirty (30) days, the Chair shall relieve that office by executive fiat and appoint a replacement to serve the remainder of the unexpired term (see **Art. IV, Sec. 1g**).

2a(11). The Chair is responsible for all meetings of the Division and of the Executive Committee.

2a(12). The Chair shall arrange for a letter of welcome containing information about the Division and its objectives to be sent to each new member of the Society who has indicated an interest in the Division.

2b. Vice-Chair

2b(1). The term of office of the Vice-Chair begins with the Society-year beginning in June following the Annual Conference of the calendar-year in which elected (See **Art. III, Sec. 1**).

2b(2). The Vice-Chair succeeds to the Chair of the Division at the beginning of the Society-year following the term as Vice-Chair.

2b(3). In the event that the Chair is unable to perform the duties of the office, the Vice-Chair shall assume the Chair.

2b(4). In the absence of the Chair, the Vice-Chair shall preside at all business meetings of the Division and of the Executive Committee.

2b(5). The Vice-Chair shall be the junior member of the Division on the executive board of the ASEE Council for Professional and Technical Education.

2b(6). The Vice-Chair shall assist the Chair in the administration and operation of the Division.

2b(7). To provide continuity, the Vice-Chair shall, through communication with the Chair, keep informed on all current activities and become familiar with the Division's operational procedures.

2b(8). The Vice-Chair shall appoint the Nominating and Elections Committees (See **Art. VII, Secs. 1a and 1b**) subject to the approval of the Executive Committee.

2b(9). The Vice-Chair is the chair of the Elections Committee, and with the aid of the other members of the Elections Committee, counts the election ballots and submits a confidential report of the results of the election to the Chair of the Division.

2b(10). The Vice-Chair shall prepare a list of committees for the following year for presentation to the Division. Printed copies of this list shall be made available to the Executive Committee and provided to all persons attending the annual business meeting of the Division.

2b(11). The Vice-Chair is responsible for the functioning and performance of the following Bylaws Committees: Nominating, Elections and Distinguished Service Award. The duties and composition of these committees are defined in **Art. VII, Sec. 1**.

2c. Secretary-Treasurer (S-T)

2c(1). The Secretary-Treasurer is Secretary-Treasurer of the Division and of the Executive Committee.

2c(2). The S-T shall keep complete records of all meetings of the Division and of the Executive Committee and within sixty (60) days following each meeting or group of meetings shall provide copies of the minutes to all members of the Executive Committee and proxies. The S-T shall distribute copies of the minutes of the previous annual and mid-year business meetings to all members in attendance at the annual business meeting in June.

2c(3). The S-T shall receive and preserve copies of all reports and papers presented at the meetings of the Division and of the Executive Committee.

2c(4). The S-T shall transmit to the Director: Publications (See **ART. VIII, Sec. 1a**), the Division archivist, all archival records (minutes, proceedings, lists, etc.).

2c(5). When changes are made to these Bylaws, the S-T shall, within sixty (60) days following the annual conference at which the changes become effective, provide each Division officer with a copy of the (revised) Bylaws.

2c(6). The S-T shall prepare an annual budget and submit it to the Division Chair for review prior to presentation to the Executive Committee for final approval or revision.

2c(7). The S-T shall receive any Division money excluding Division dues and other funds under control of the Publications Committee. Such money shall promptly be placed on deposit in a suitable account in a federally-insured financial institution under the name of the EDGD-ASEE with signatures of both the S-T and Chair on file, with either having access to the account.

2c(8). The S-T shall be the disbursing agent for the Division, and will disburse funds upon approval of the Division Chair.

2c(9). The S-T shall submit an annual financial report at the annual business meeting and an interim report at the mid-year meeting.

2d. Directors

2d(1). There shall be sixfive Directors, each elected to serve for a three-year term. No more than two (2) directors shall be elected for any Society-year. Each Director shall be responsible for all committees in one of the following categories:

A. Liaison
B. Membership
~~B.~~**C.** Professional and Technical
~~C.~~**D.** Programs
~~D.~~**E.** Publications
~~E.~~**F.** Zones Activities

2d(2). General Duties of Directors
Directors are responsible for establishing functions and guidelines for the operations of each of their assigned committees. Each year, prior to the Annual Conference, they shall recommend to the incoming Chair names of suggested committee chairs and members of committees under the Director's jurisdiction. A Director whose term is ending should consult with the elected replacement as to the committee composition. The actual appointments should not be made until approved by the Executive Committee and the Division Chair as described in **ART. III, Sec. 2a(8)**. Directors shall maintain contact with the chairs of their assigned committees to ensure timely performance of the committees' functions. Directors are responsible for the presentation of reports on the activities of their assigned committees at the Executive Committee meetings during the Annual and Mid-Year Conferences. Directors may recommend the creation of new committees (or the discontinuance of committees that have fulfilled their function) within the category under their jurisdiction. Recommended actions must be approved by the Executive Committee and the Division chair. Directors shall be responsible for notifying the Division Chair of any appointee under their supervision whose unsatisfactory performance could require action under the provisions of **Article III, Sec. 2a(9)**.

2d(3a). Director: Liaison Committees
The Director is responsible for the functioning and performance of all liaison committees as defined in **ART. VII, Sec. 2a(1)**.

2d(3b). Director: Membership
The Director is responsible for the function and performance of the Membership Committee as defined in ART. VII, Sec. 2a(2)

2d(3**c**~~b~~). Director: Professional and Technical Committees
The Director is responsible for the functioning and performance of all professional and technical committees as defined in **ART. VII, Sec. 2a(3~~2~~)**.

2d(3**d**~~c~~). Director: Programs
The Director is responsible for the programs of all Conference sessions during the term of office. The Director shall be responsible for issuing a call for papers to be presented at each Conference. The Director shall maintain a Manual of Procedures to aid the Program Chair in planning the conference for which they are responsible, as well as keeping the Program Chair informed of all pertinent information regarding that conference including papers submitted, requests to participate, theme, and general guidelines. The Director will approve all proposed programs before submitting them for approval of the Division Chair and the Executive Committee. The Director: Programs is responsible for ensuring that all program committees are properly functioning and maintaining their time schedule. In the absence of both the Division Chair and Vice Chair, the Director: Programs will serve as interim chair, assuming the duties and responsibilities of Division Chair [See **ART. VII, Sec. 2a(4~~3~~)**].

2d(3**e**~~d~~). Director: Publications
The Director shall serve as Editor of the Engineering Design Graphics Journal (the Journal) and the Division archivist, and is responsible for the effective performance of all members of the Publications Committee (See **ART. VIII**).

2d(3fe). Director: Zone Activities
The director shall encourage and suggest activities by maintaining contact with Division zone chairs to share information of activities occurring in other zones [See **ART. VII, Sec. 2a(54)**].

Article IV: Elections and Succession of Officers

Section 1. Elected personnel shall be nominated and elected according to the following procedures:

1a. A slate of two candidates, for each office to be filled, shall be prepared by the Nominating Committee. An eligible candidate must be a current member of the Division who has expressed a willingness to accept nomination and to serve if elected to the office to be filled. The slate shall be published in the Winter issue of the Journal.

1b. A candidate for an elective office may be nominated by a written petition addressed to the Chair of the Nominating Committee bearing ten (10) signatures of members of the Division and accompanied by a statement from the nominee affirming a willingness to serve if elected. The names of candidates nominated by petition shall be added to the slate as prepared by the Secretary-Treasurer under the provisions of par. 1d, below.

1c. The nomination period shall close on December 31. A petition for nomination received after December 31 cannot be accepted.

1d. Not later than February 15, and returnable before March 15, the Secretary-Treasurer shall mail to each member of record (as provided by the Journal Circulation Manager-Treasurer) of the Division a ballot bearing the slate submitted by the Nominating Committee together with additional names presented by petition. A candidate receiving the largest number of votes for the office sought shall be declared elected. The ballot shall be designed to facilitate return mailing and bear the name and address of the chair of the Elections Committee, The Division Vice-Chair.

1e. The holder of an elective office whose term continues beyond the current Society-year is not eligible for nomination to another office or appointed position.

1f. Assumption of office by newly elected personnel shall be concurrent with that of the offices of the Society.

1g. If any elected person is unable or fails to perform the duties of the office, the Division Chair shall, with the advice and consent of the Executive Committee, appoint another Division member to serve in that office for the remainder of the term (See **ART III, Sec 2a (10)**).

1h. If the Chair-elect is unable to assume or continue in office, the Vice-Chair shall assume the office of Chair and the Executive Committee will elect a Vice-Chair from its membership. The newly elected Chair will appoint a qualified member to fill the vacancy on the Executive Committee.

1j. If both the Chair and Vice-Chair are unable to assume or continue in office, the Director: Programs shall serve as Interim Chair until a Chair and Vice-Chair can be duly nominated and elected at the next scheduled Division election. The Interim Chair may, if desired, appoint a qualified member to serve as acting Director: Programs.

1k. The Division Chair may be removed from office for failure to satisfactorily perform the duties and responsibilities of that office. Action to remove the Chair may be initiated by a petition, addressed to the chair of the Policy Committee, signed by at least three (3) members of the Executive Committee or ten (10) members at large of the Division. Upon receipt of such petition the chair of the Policy Committee will seek the counsel and approval to proceed from three (3) or more other members of the Policy Committee. The chair of the Policy Committee will either return the petition to its source without further action or poll the Executive Committee on the question of removing the Chair from office. A telephone poll, confirmed in writing, shall be conducted as expeditiously as practicable. Six (6) of a possible eight (8) votes will be required to remove the Chair from office. The chair of the Policy Committee will notify the Chair that the removal action is pending and of the results of the poll, and if the vote favors removal, request the Chair's resignation. If the resignation is not forthcoming, the Chair will be removed by executive fiat, and the Executive Secretary of ASEE so notified. Replacement of the removed Chair shall be in accordance with the provisions of **ART. IV**, Secs. 1h, 1i, or 1k, as applicable.

Article V: Conferences

Section 1. Annual Conference.

There shall be an Annual Conference of the Division to be held concurrently with the Annual Conference of the Society, and it shall include the annual Division dinner meeting, one or more conference sessions, and a luncheon business meeting. The Annual Conference shall be planned to include areas of interest to instructors in technical education as well as those instructing at junior and senior levels and employers of graduates. Joint meetings with other divisions and constituent committees of the Society are to be encouraged.

1a. Program for Annual Conference
The program for the Annual Conference shall be considered by the Executive Committee at the Mid-Year Conference of the Division at the mid-year luncheon business meeting along with other items of business. Written reports of committees shall be received and distributed.

1a(1). The chair shall transmit the program for the Annual Conference to the Executive Director of the Society. The tentative draft of the program shall be submitted when requested by the Society subject to modifications enacted by the Executive Committee at the Mid-Year Conference. The Division program for the Annual Conference shall be published in the Spring issue of the Journal.

Section 2. MidYear Conference

There shall be a MidYear Conference to be held at an appropriate date annually between November 1 and January 31, and shall include a Division MidYear dinner meeting, one or more technical/professional sessions, and a luncheon business meeting.

2a. Program for MidYear Conference
The program for the MidYear Conference shall be considered by the Executive Committee at the Annual Conference of the Division. The Chair shall present the MidYear Conference program to members of the Division at the annual luncheon business meeting. The program for the MidYear Conference shall be published in the Fall issue of the Journal.

2a(1). Site Selection for MidYear Conferences
Individuals wishing to host a MidYear Conference shall submit a letter of proposal to the the Chair of the Division no later than one-year in advance of the Conference date. The Chair of the Division shall then include the proposal on the agenda for the next regularly scheduled Executive Committee meeting. A representative of each campus wishing to host a MidYear Conference must be present at the Executive Committee meeting to present a brief proposal to the Committee. The Executive Committee will then be responsible for selecting sites for conferences. Whenever possible, preference will be given to geographic distribution of conference sites.

Section 3. Periodic Summer Schools shall be held at the direction of the Executive Committee.

Section 4. Division members are urged to plan group meetings of engineering design graphics instructors in connection with sectional conferences of ASEE, and are urged to make those meetings of interest to instructors in technical education and of junior and senior college levels with a view of including such instructors as members of the Division.

Section 5. Members of the Society and other interested persons are eligible to attend all open conferences and meetings of the Division.

Article VI: Executive Committee

Section 1. Duties

1a. The Division shall have an Executive Committee whose duty shall be to administer the affairs of the Division and report to the Division at the MidYear and Annual Conferences.

1b. The Executive Committee shall convene for a meeting prior to the annual and midyear business meetings in order to receive and discuss written reports from the Division's committees and to conduct such other business as required.

1c. The Executive Committee shall schedule and arrange for annual conferences, mid-year conferences and summer schools. It shall administer such other activities as may be desirable for the promotion of the objectives of the Division, including the appointment of special committees.

Section 2. Officers

The officers of the Executive Committee shall be the officers of the Division.

Section 3. Members

The members of the Executive Committee shall be the officers of the Division and the immediate past chair.

Section 4. Proxies

A member of the Executive Committee who cannot attend a meeting may designate a proxy. If no proxy is designated, the Chair of the Division may appoint a proxy from the membership of the Division.

Section 5.

The Chair of the Division is responsible for the agenda of the Executive Committee meeting and the Division business meeting. Persons desiring a place on either agenda should submit a written request, including a brief statement of purpose and justification, to the Chair at least thirty (30) days prior to the scheduled meeting. Persons not on the agenda desiring the floor at an Executive Committee or Division business meeting may be recognized at the discretion of the Chair.

Article VII: Committees

Section 1. Bylaw Committees

Each chair of a Bylaw committee is expected to submit a report to the Vice-Chair of the Division well in advance of the Executive Committee meeting at the Annual and Mid-Year Conferences. The Vice-Chairman will consolidate the reports of the committee chairs into a single report submitted to the Division Chairman. The report should be available for study by members of the Executive Committee so that controversial or other critical issues may by intelligently discussed and action taken at the Executive Committee meeting.

1a. Nominating Committee
A Nominating Committee shall be recommended by the incoming Vice-Chair to be confirmed by the Executive Committee at its annual meeting in June. The Nominating Committee shall consist of five members, three of whom shall be the most recent past Chairs of the Division, and two other qualified mem-

bers. The chair of the Nominating Committee shall be the senior past chairman, so appointed.

1b. Elections Committee
The Elections Committee for the following year shall consist of the Vice-Chair in office and two members of the Division appointed by the Vice-Chair. The appointments shall be subject to approval by the Executive Committee. The Vice-Chair shall chair the Elections Committee.

1b(1). The chair of the Elections Committee shall transmit the results of the election to the Chair of the Division. The Chair shall inform each candidate (including those not elected) of the results of the election for his office and shall transmit the names of the newly-elected officers to the Editor of the Journal for publication in the Spring issue of the Journal. The chair of the Elections Committee shall report the results of the election to the Division at the annual business meeting.

1c. Policy Committee
A Policy Committee shall be recommended by the incoming Chair to be confirmed by the Executive Committee at its annual meeting in June. The Policy Committee shall be composed of three (3) or more members, of whom three (3) shall be past Chairs of the Division. The Policy Committee shall consider all matters of policy for the Division that are assigned to it and make recommendations to the Division and the Executive Committee (See ART. III, Sec. 1k).
See ART. Vii. Sec. Ea (2) Professional and Technical committees for ANSI responsibility.

1d. Distinguished Service Award Committee
The Distinguished Service Award Committee shall be composed of the three immediate past Chairs of the Division. The senior past Chair shall chair the Committee. The Committee shall consider as possible recipients of the Distinguished Service Award those nominees thought to be worthy of the award because of exceptional service to the engineering profession, the Division, and to engineering education. Since the recipient is recognized by both the Division and the Society as a person of considerable professional stature, the Committee need not select a recipient in any year that none of the nominees fully meet the requirements established by the Division and set forth in these Bylaws.

1d(1). The purpose of the Distinguished Service Award is to encourage and recognize those persons who have made outstanding contributions to the teaching of students of engineering graphics, descriptive geometry, computer graphics, and other courses within the realm of interest of the Engineering Design Graphics Division.

1d(2). The Award. The award shall consist of an appropriate certificate and/or plaque presented at the annual awards dinner of the Engineering Design Graphics Division of ASEE.

1d(3). Requirements. In order to receive the Distinguished Service Award, a person must have made a clearly discernible contribution to the art and science of teaching courses in a recognized field of graphics in several of the following ways of which item (e) shall not be omitted:

a. Success as a teacher must be established both as to competence in a subject matter and ability to inspire students to high achievement.

b. Improvement of the tools of, and conditions for teaching. Evidence of such achievement may consist of subject matter (textbooks, etc.), courses of curricula, diagrams and models, laboratory and other teaching equipment, and other similar activities.

c. Improvements of teaching to include: the development of teachers in a department or in other schools, testing or guidance programs, promotion of cooperation with other types of educational institutions or industry, development of testing and guidance programs, and the coordination of fields of subject matter.

d. Scholarly contributions to literature, significant honors, etc.

e. Service to the Engineering Design Graphics Division of ASEE as evidenced:

- By regular attendance at its meetings as an indication of interest in the improvement of teaching.

- Service on its committees or an officer with a record of definite achievement.

- Contribution to its publications or summer school programs.

1d(4). Nominations. Nominations may be made by any member or group of members of the Division except members of this Awards Committee.

1d(5). Nomination Form. A nomination form shall be prepared by the Distinguished Service Aware Committee which will outline the qualifications and will provide space for a brief description of a nominee's performance in each category. This form shall accompany the election ballot (See **ART. IV, Sec. 1d**).

1d(6). The report of this Committee shall be made at the appropriate time and place.

1d(7). Nominees from the previous three years may also be considered for the award by this committee. A list of names of those individuals, and all supporting information, shall be passed on to the incoming chair of the Committee by the outgoing chair.

Section 2. Non-Bylaw Committees

Non-Bylaw committees shall be assigned to one of the following described categories under the supervision of the appropriate Director. They may be appointed by the Division Chair or by the Executive Committee when such a committee is deemed necessary for the proper functioning of the Division. Some special-purpose committees may be assigned under the control of the Chair or Vice-Chair.

2a(1). Liaison
Committees in this category are those whose purpose is to provide a connection between the Division and other related or interested groups both within and without the Society.

2a(2). Membership
The purpose of the committee is to perform all responsibilities to attract and retain members of the Division. Specific tasks include: advertise and provide new member material at all ASEE Annual and EDGD Mid-Year Conferences, revise and distribute the EDGD "Welcome Letter" and brochure to new members, coordinate and ensure new members receive a year's subscription to the EDGD Journal, ensure new members receive an EDGD Lapel Pin, and to coordinate and manage the EDGD Mentor Program.

2a(**3**~~2~~). Professional and Technical
The purpose of committees within this category is the advancement of knowledge in the many areas encompassed by the Division.

The Director: Professional and Technical Committees shall recommend, as required, an ANSI Committee to act for the Division to consider and approve or disapprove any American National Standards Institute (ANSI) Drafting Standards submitted to it in accordance with ASEE policy.

2a(**4**~~3~~). Programs
Committees in this category are responsible for planning and implementing the ongoing programs of the Division. There shall be an Ad Hoc Program Committee for each Annual and Mid-Year Conference, and it shall be responsible for all conference sessions sponsored totally or jointly by the Division during that con-

ference. Each program committee shall be appointed at the conference occurring approximately 18 months prior to the conference for which it is responsible, and shall cease to exist following the conference for which it was formed. A Program Committee shall generally consist of the Division Vice-Chair, the Director: Programs, a Program Chair, and at least one other person closely allied with, or especially qualified to represent and act as liaison for, the institution or area in which the particular conference is to be held. This person may also be the Program Chair.

2a(**5**4). Zone Activities
Committees in this category are to increase and promote Section and local activities of Division members within the various zones. There shall be a committee from each of the sections in the particular zone.

Section 3. Committee Chairs

Committee chairs are responsible for following the guidelines established by their Director and for keeping the appropriate Director informed of the activities of their committee. The chair directs the activities of the committee members within the constraints of those guidelines. The committee chair may suggest to the appropriate Director such additional activities as deemed necessary for the committee's proper functioning. Each chair shall prepare and submit reports to the appropriate Director in time for the reports required of the Director to be prepared. Required reports are interim for presentation at Mid-Year Conference and annual for presentation at the Annual Conference.

3a. Program Chair
Each Program Chair shall submit proposed programs to the Director: Programs for approval. The Director will in turn submit the proposal to the Division Chair and Executive Committee for their approval. The Program Chair for an Annual Conference and the Division Chair shall attend the ASEE planning meeting for that particular conference. The Program Chair, with the assistance of the Program Committee, determines the number, type and specifics of all national events, including participants and session moderators. Although it is the Director's responsibility to pass on to the Program Chair all available papers, abstracts, program suggestions and other pertinent information, it shall be the responsibility of the Program Chair to select and schedule the actual events and participants after the program has been approved by the Director: Programs and the Executive Committee.

The Program Chair shall also be responsible for preparing feature articles or announcements publicizing the program in the appropriate journal (s) and in other ways assist in the proper advertising and promotion of the program.

Article VIII: Publications

Section 1. Publications Committee

The Publications Committee shall be composed of the Director-Editor (See **ART. III, Sec. 2d** (3d)}, the Circulation Manager-Treasurer, the Advertising Manager, and such Assistant Editors as are deemed necessary by the Director-Editor.

1a. The Publications Committee shall be responsible for the timely publication of the Engineering Design Graphics Journal, and any other Division publications, as authorized or directed by the Executive Committee. A minimum of three issues of the Journal shall be published each year.

Section 2. Selection of the Publications Committee

2a. The Director: Publications shall be elected for a three-year term as described in **Article IV**.

2b. Circulation Manager-Treasurer
The Circulation Manager-Treasurer shall be

appointed by the Director: Publications, subject to the approval of the Executive Committee. The term of appointment shall be indefinite and continue for so long as: it is mutually agreeable with the appointee, the supporting institution, and the Director: Publications and the responsibilities of the office are properly served. The appointment may be terminated by resignation or death, by request from the supporting institution, or for cause by action of the Executive Committee. A recommendation to terminate the appointment may be made to the Executive Committee by the Director: Publications or may be initiated by the Executive Committee after suitable notice to the Director: Publications. Termination, for whatever reason, shall consider the best interests of the Division and be handled in such a manner as to ensure continuity of the operations of this office.

2c. The Advertising Manager shall be appointed by the Director: Publications and serve a concurrent term with and at the pleasure of the Director: Publications.

Section 3. Duties

The duties of the members of the Publications Committee shall be as follows:

3a. Director – Publications
The Director: Publications is chair of the publications Committee and Editor of the Engineering Design Graphics Journal and a member of the Executive Committee.

3a.(1). The Editor is responsible for soliciting, selecting and editing all articles and other material published in the Journal.

3a(2). The Editor will cooperate with the editor of the Society publication, Engineering Education, as to material referred to the Engineering Design Graphics Journal for publication, and as tomaterial refereed to Engineering Education for publication. The Editor shall supply two copies of each issue of the Journal to the Managing Editor of Engineering Education.

3a(4). The Editor shall report on all matters pertaining to the Journal to the Executive Committee at all of its meetings and at other times as requested.

3a(5). The Editor shall appoint, subject to the approval of the Executive Committee, any Assistant Editors required to assist in publication of the Journal.

3b. Circulation Manager-Treasurer
The Circulation Manager-Treasurer is responsible to the Director-Editor for all matters pertaining to the circulation and finances of the Journal.

3b(1). The Circulation Manager-Treasurer shall solicit subscriptions from viable non-member sources and provide current subscriber lists to the Editor.

3b(2). The Circulation Manager-Treasurer shall assist the Editor in any way requested to expedite distribution of the Journal.

3b(3). The Circulation Manager-Treasurer shall receive all monies due the Journal from non-member subscriptions, advertising income, fees, etc., and deposit such monies in a suitable account in a federally, insured financial institution under the name of the Engineering Design Graphics Journal. Signatures of both the Circulation Manager-Treasurer and the Editor shall be on file with either having success to the accounts(s).

3b(4). The Circulation Manager-Treasurer shall pay by check all costs, approved by the Editor, connected with publication of the Journal.

3b(5). The Circulation Manager-Treasurer shall maintain accurate financial records in a standard bookkeeping form and submit a financial statement and a report on other activities at the MidYear and Annual meetings.

3b(6). The Journal financial records shall be presented annually for audit bay an ad hoc audit committee appointed by the Division Chair.

3b(7) When a new Circulation Manager-Treasurer is appointed, the financial records will be audited and the incumbent Circulation Manager-Treasurer will transmit to the successor Circulation Manager-Treasurer all financial records together with all monies in the Journal account(s).

3b(8). The Circulation Manager-Treasurer shall maintain the Division-member roster and provide membership lists and/or mailing addresses to the Editor and to the Division officers or committee chairs who request them. Membership rosters and/or mailing addresses will not be released to other individuals or organizations without specific authorization from the Division Executive Committee.

3c. Advertising Manager
The Advertising Manager shall be responsible to the Editor for all matters pertaining to advertising the Journal.

3c(1). The Advertising Manager shall actively solicit, and procure advertisement from all appropriate sources.

3c(2). The advertising Manager shall represent the Journal in all business matters with advertisers, submitting bills according to the current rates, and promptly transmitting monies received to the Circulation Manager-Treasurer.

3c(3). The Advertising Manager shall maintain logs of advertising accounts, contracts, accounts receivable and recommendations for changes in advertising policy.

3c(4). The Advertising Manager shall submit reports on the status of all advertising activities to the Editor prior to the MidYear and Annual meetings.

3d. Assistant Editors
Their duties shall be assigned by the Editor.

Section 4. Advertising Rates

The Publications Committee shall fix advertising rates subject to the approval of the Executive Committee.

Section 5. Subscription Rates

The Publications Committee shall fix subscription rates for non-members subject to the approval of the Executive Committee.

Section 6. Finances

The Publications Committee will conduce an annual financial review of the Journal and other publications financed from Journal funds and prepare an operating budget for the coming year. Ina addition to the operating fund, an emergency contingency fund of sufficient amount to finance Division publications for one year will, financial solvency permitting, be maintained in a suitable account in a federally-insured institution in the name of the Engineering Design Graphics Journal. Funds in excess of the operating budget and emergency contingency fund may, by action of the Executive Committee, be transferred to the custody of the Division Secretary-Treasurer for deposit in the Division fund account to be used as the Executive Committee may direct. Available Division funds may, with the approval of the Executive committee, be transferred to the Circulation Manager-Treasurer of the Publications Committee, to meet existing or anticipated deficits in operating funds or to finance special or unusual "one time" projects. No separate account will be maintained by the Secretary-Treasurer of funds received from the Publications Committee, nor will funds made available to the Publications Committee by the Secretary-Treasurer be limited to amounts previously deposited.

Article IX: Parliamentary Authority

Section 1.

The rules contained in Robert's Rules of Order (latest edition) shall govern the Division in all cases to which that are applicable and in which they are not inconsistent with the Constitution and Bylaws of the Council of Technical Division and Committees, or the Bylaws of the Division; in other cases the constitution and Bylaws of ASEE shall govern.

Article X: Amendments to the Bylaws

Section 1.

These Bylaws may be amended at any annual business meeting of the Division by a two-thirds majority vote of the members of the Division who are present.

Section 2.

These Bylaws may also be amended by a letter ballot of the members of the Division as recorded in the office of the American Society for Engineering Education, mailed by the Secretary-Treasurer of the Division; the amendment being approved if two thirds of the ballots returned within thirty (30) days are favorable.

Section 3.

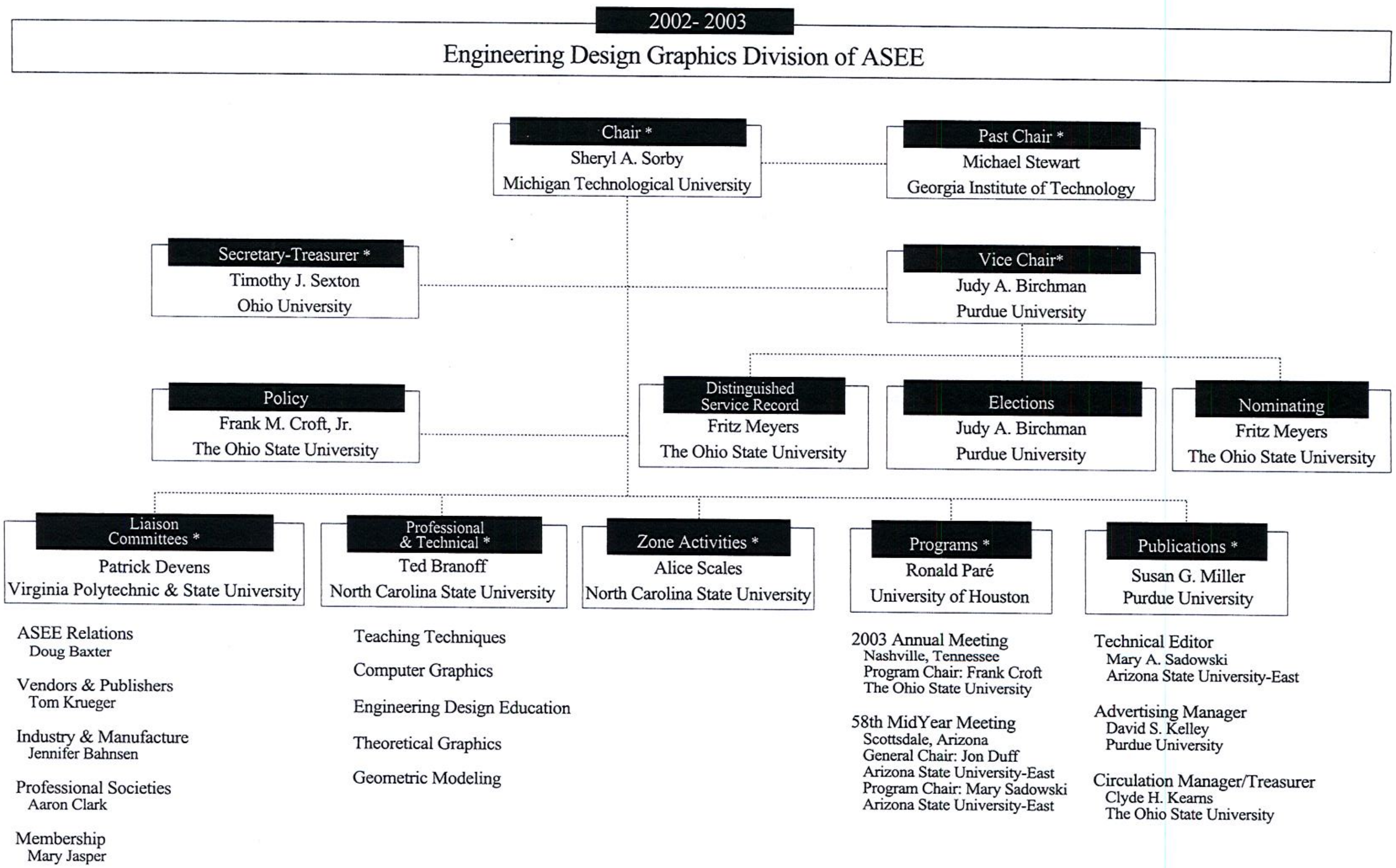
Proposed amendments may be submitted in only four ways as follow:

a. By a majority vote of the Executive committee.

b. By petition to the Chair signed by ten (10) individual members of the Division.

c. By recommendation to the Division Chair by the Constitution and Bylaws Committee of the Society through its Executive director.

d. By unanimous vote of the Policy Committee of the Division.



*Executive Committee Member

awards

Award	Given by	Consists of	Description	Criteria	Procedure	Details	Prepared by	Presentation made
Distinguished Service Award	Engineering Graphics Division of ASEE	Plaque	Highest award of merit given by the Division	Recognizes significant contributions to the Division–leadership, authorship, or support	Nomination forms are mailed to the membership with the spring ballot, returned to DSA Committee	Recipients selected by DSA Committee. Division Chair notifies recipient in timely manner	Distinguished Service Award Committee (3 immediate past Chairs)	ASEE Annual Meeting Awards Banquet, published in *Journal*
Oppenheimer Award	Engineering Graphics Division of ASEE	Framed citation and cash award	Best paper presentation at the annual Midyear Meeting	Presentation quality for oral presentation	Review board (3 attendees not giving paper) selected by Program Chair, standard form for ranking	Program chair compiles forms and informs Division Chair before Awards Banquet	Secretary/Treasurer, signed by EDGD Chair and Secretary/Treasurer	Midyear Meeting Banquet (announcement and cash, citation mailed after). Published in *Journal*
Chair's Award	Current EDGD Chair	Framed citation and cash award	Outstanding paper at the ASEE Annual Conference/EDGD sessions	Oral paper presentation, must be in proceedings. Criteria: 1. significance, 2. scholarship, 3. authorship	Review board minimum 3 members selected by the current Chair	Chair sends review forms and eligible papers to Review Board following Annual Conference	Current EDGD Chair	Chair notifies awardee and announced at Midyear Meeting, published in Winter issue of *Journal*
Editor's Award	Current Director of Publications	Framed citation and cash award	Outstanding *Journal* article published in previous volume (year)	All published papers are eligible. Criteria: 1. appropriate graphics, 2. scholarship, 3. authorship	Editor names 3 minimum from current *Journal* Review Board. Papers ranked on criteria.		Journal Editor	Editor notifies awardee by mail by April 30 of next volume year. Announced in the Spring issue of *Journal*
Memorial Award (Payne Award)	EDGD Executive Committee	Frame citation	Given to an individual who demonstrates support and encouragement of our division as was demonstrated by Rodger Payne	This award is given to an individual, is non-competitive, and is not given regularly but reserved to recognize extrodinary industrial support	The Nominating Committee proposes an individual at Midyear Meeting. Executive Committee votes at next Midyear Meeting	Established in recognition of Rodger Payne who epitomized the best in industrial and educational cooperation, was a strong support of graphics education, and true friend	Current EDGD Chair	Chair presents award at Midyear Meeting Awards Banquet. Published in Winter issue of *Journal*
Schroff Graduate Student Participation Grant (SGSPG)	Schroff Development Corporation (SDC)	Framed citation and cash award	Provides a maximum of $500 to graduate students to attend the EDGD Midyear Meeting	This grant is open to all graduate students in graphics-related programs or courses	EDGD Vice Chair prepares the SGSPG announcement and submits it to the EDGD *Journal*, listserve, and web site	Recipient selected and notified by the Selection Committee	EDGD Vice Chair	EDGD Vice Chair presents award at Midyear Meeting Awards Banquet. Published in Winter issue of *Journal*

Note: Additional information available at the Engineering Design Graphics Division web site: www.east.asu.edu/edgj/edgd/.

Vice Chair

Holly K. Ault

Holly received her BS, MSME and Ph.D. degrees from Worcester Polytechnic Institute in 1974, 1983 and 1988 respectively. She has worked as a Manufacturing Engineer for the Norton Company and Product Development Engineer for the Olin Corporation. She is currently Associate Professor of Mechanical Engineering at Worcester Polytechnic Institute and has been a co-director of the Assistive Technology Resource Center at WPI since 1999. In the fall of 2001, she was invited as the Lise Meitner Visiting Professor, Department of Design Sciences, Lund Technical University, Lund, Sweden. Her primary teaching and course development responsibilities include undergraduate and graduate level courses in computer-aided design, mechanical design and rehabilitation engineering. She served as the Director of Liaison for the Engineering Design Graphics Division of ASEE from 1995-8 and EDGD Program Chair for the ASEE Annual Conference in 2002. Her teaching and research interests include computer aided mechanical design, geometric modeling, kinematics, machine design and rehabilitation engineering. She is a member of ASME, ASEE, SWE, ISGG and RESNA.

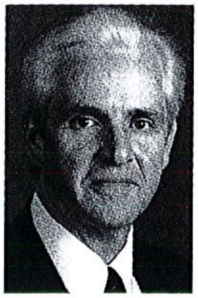
Gerald E. "Jerry" Vinson

Jerry has been head of the Engineering Design Graphics program at Texas A&M University since 1999 where he teaches both freshman and upper level engineering design graphics courses which include parametric solid modeling, animation, and rendering. The A&M program is among the nations largest with approximately 1700 students taking EDG classes each fall and spring semester.

Jerry has been a member of the EDGD since 1996. He was also active with ASEE in the 60's and 70's and was chairman of the EDG division of the Community College Association of Texas for several years. He has been chairman of the National Engineering Design Graphics Competition since 1999 and is responsible for getting $500 scholarships donated for the four contest winners and major graphics software for other entrants each year. The number of entrants has more than tripled since he became the chairman. In 2001 Jerry was a co-sponsor of the EDG midyear conference in San Antonio. He also presented a paper there and has authored five EDG workbooks and one EDG textbook during the past six years.

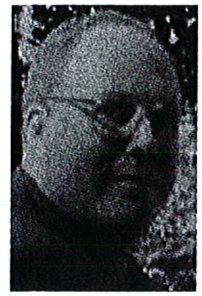
Jerry returns to industry as a faculty intern every few years to stay current with industry trends. His goal is simply to stay current and provide his colleagues and students with the best and most current EDG information.

Secretary-Treasurer



Timothy J. Sexton

Tim received a BS in Architecture from the University of Illinois, MS in Industrial Technology from Western Illinois University, and Ph.D. in Education from Ohio University. He has taught at Ohio University since 1985 and is currently a Professor of Industrial Technology. Prior to joining Ohio University, Dr. Sexton taught eight years as an Industrial Technology teacher in public high school and was a draftsman for an architectural engineering firm or two and a half years. He has presented several papers at ASEE/EDGD conferences and has authored one textbook entitled Hands-On CADKEY: a guide to versions 5, 6, and 7. He is presently serving his third year as the EDGD Secretary/Treasurer. For several years he has served as a reviewer for: the ASEE/EDGD Annual Conference Proceedings, the annual Chair's Award for best paper at the annual conference, and the annual Editor's Award for best paper of the EDGD Journal. He is a long-standing member of the Editorial Review Board for the EDGD Journal.



Douglas H. Baxter

Doug is the Director of CAD/CAM/CAE for the School of Engineering at Rensselaer Polytechnic Institute. He is responsible for overseeing all CAD/CAM/CAE tools used by the School of Engineering. He also manages all software evaluations in CAD/CAM/CAE. He earned his Bachelor's degree in Mechanical Engineering from Syracuse University in 1983. He earned his Masters Degree in Mechanical Engineering from RPI in 1987. He is presently finishing his Doctorate in Mechanical Engineering. His research concerns integrating solid modeling tools with design methodologies to produce intelligent design tools. He has been at RPI since 1993 teaching Engineering Graphics and Engineering Design and Introduction to Engineering Design. Prior to coming to RPI, Doug worked for International Business Machines Corporation where he first worked as a heat transfer engineer. He also worked in the Mechanical Design Project Office for IBM Mid-Hudson Valley where he coordinated Mechanical Development for all IBM Kingston products. Prior to leaving IBM for RPI, he worked as an FEA analyst. While working as an analyst, Doug helped develop software to integrate IBM's FEA packages with its solid modeling program, CATIA. This, in addition to training new analysts at IBM, gave him the desire to teach graphics once he returned to RPI to complete his doctorate.

[Director of Publications]

Kathryn Holliday-Darr

Kathryn Holliday-Darr has been an Instructor of Engineering Graphics in the School of Engineering and Engineering Technology at Penn State Erie since 1985. She also taught Industrial Arts at the high school level for seven years. She received her BA in Industrial Arts at the University of Northern Colorado, and her MS in Industrial Arts Education at the State University of New York at Buffalo. Her research and teaching interests include engineering graphics, visualization, and working with freshmen enrolled in engineering technology programs. She is the author of Applied Descriptive Geometry and was the 2000 Oppenheimer Award Winner.

Eric N. Wiebe

Eric is an Assistant Professor in the Graphic Communications Program at NC State University. Eric has authored or co-authored four texts on technical graphics used nationwide. He has been involved in Computer-Aided Design/3-D modeling development and use since 1986 and taught technical graphics and CAD at NC State for the past thirteen years. During this time, he has worked as a consultant through the Furniture Manufacturing and Management Center at NC State University on the use of product design and development technologies in the furniture industry. During the past seven years, he has worked on the integration of scientific visualization concepts and techniques into both secondary and post-secondary education. Eric has been a member of the Engineering Design Graphics Division of the ASEE since 1989. He is also a member of the Human Factors and Ergonomics Society and the Alpha Pi chapter of the Epsilon Pi Tau honorary society.

2003 ASEE National Design Competition
Engineering Design Graphics Division

Unlike the precisely propelled projectiles of the past, this contest is earthbound...in fact you will lose points if the project leaves the ground. The contest is to see which team of 3 to 5 members can design an **air-powered car** that traverses a 50' long x 8' wide serpentine course down and back within five minutes. The car will earn points by passing thru gates that are slightly offset from a straight line in a gently curving semicircle. Extra points will be granted if the car is able to demonstrate a controlled 360° spin at the start or along the course.

Power for the car must be self-contained and is limited to 4 AA batteries. Cost limit is $50.00 and copies of receipts are required to verify the "blue-book" value of the car. All components of the car must be constructed by students except the propeller, wheels, batteries, and motor (no kits or prefabs please). Steering must be on-board and autonomous...sorry, no remote controls permitted.

For safety, if a propeller is used, it must be guarded and the vehicle may not leave the ground at any time during its run. The car must be small enough to fit into a portable file box which measures 8.5" tall x 11" wide x 14" long. Design points (10pts) will be awarded for aesthetics and workmanship of the models. So get out the spray paint, heavy chrome, and whitewall tires to make your model a real showpiece. Major points will still come from the graphics and written report that is submitted.

The obstacle course is 50' long x 8' wide on an inside floor (tile, concrete, wood, or carpet are OK). A gentle serpentine curve defines the course with weighted Styrofoam cups (approximately 6- 8 oz. capacity) marking 5 gates which are 24" wide and are spaced every 12'-6" (see Figure A). The car will earn 10 points for each gate it passes through cleanly or 5 points for each cup that it hits. The score will be the total points accumulated from two runs (down the track and back) within five minutes. Points will not be awarded for cups blown over by wind blasts from the cars.

If your team cannot travel to the national ASEE conference to run the course an "AVI" animation burned onto a CD may be submitted to verify the operational prowess of the car. The instructor is responsible for governing the scoring and verifying a legal track layout that appears on the animation. Written reports are required in both hardcopy and electronic format. Reports from the 1st and 2nd place teams will be posted on the web for all competitors to review.

Reports must include but are not limited to:

1. Statement of the problem
2. Preliminary ideas with sketches
3. Refinement drawings with dimensions
4. Calculations for the thrust required or steering mechanism
5. Final design graphics with dimensions
6. Pictorials (or solid models) of the design
7. Conclusion and summary of the three runs

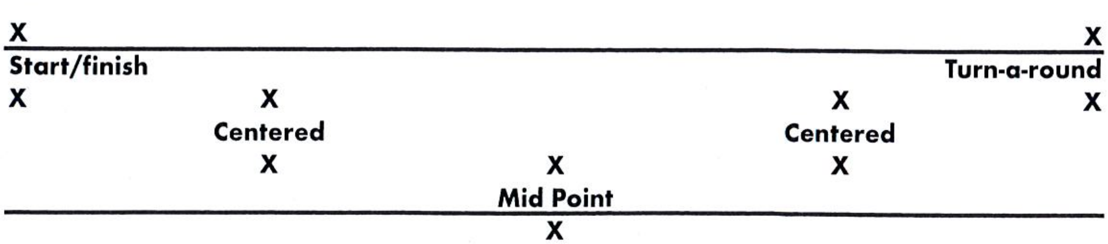


Figure. A *(not to scale): 50' x 8' track. Cars pass through equally spaced (24" wide) gates marked with X's turn around and return within FIVE (5) minutes.*

Scoring Breakdown:

1. Written report: 20 points
2. Graphics: 40 points
3. Design and aesthetics: 10 points
4. Performance on the track: 30 points

An optional run to add to your local contest would be for a "DRAG STRIP"speed run for the fastest time down the track and back. This adds a lot of excitement to the contest and maximizes the efficiency of the design relative to friction, drag force, and weight.

All entries must arrive on or before Monday, June 9, 2003.
Send entries to:
Dr. Jerry Vinson, EDG Program Coordinator
Texas A&M University,
Engineering Technology Dept.
College Station, TX. 77843-3138

If you have any questions or concerns please check the contest web sight for updates at: "http://edg.tamu.edu./asee_nedge"
Dr. Jerry Vinson at 979-845-1633 or email him at "vinson@entc.tamu.edu" for additional information.

Good luck and happy racing!

Contest entries have increased exponentially over the past three years and we anticipate an even greater number of contestants for the summer of 2003 "Air Powered Car Contest". Be sure to see the contest web sight for contest description and updates at http://edg.tamu.edu./asee_nedgc or contact Dr. Jerry Vinson who is the contest Chairman (979-845-1633) email vinson@entc.tamu.edu . Have a fun and meaningful contest...see you in Memphis!

2002 ASEE National Design Contest results

The annual EDGD Design contest was judged at the ASEE national conference in Montreal this summer with teams from The Ohio State University almost pulling off a hat trick. Both the first and second place teams were from The Ohio State University under the leadership of Professor Fritz Meyers. The first place team members were each awarded a scholarship check for $500 and given a copy of SolidWorks student software by Ms. Rosanne Kramer for their winning Frisbee launching device. Second place winners will receive a $125 scholarship and SolidWorks student software. The third place winners were from Washtenaw Community College in Ann Arbor Michigan under the guidance of Dr. Frank. E. Gerlitz. They will all receive student copies of SolidWorks software.

Team members were:

1st Place:
Aaron Friedman, Jim Bubnick,
Lisa Herman, and Elliot Kim

2nd Place:
Ben Finney, Ryan Otte,
Kevin Kolivich, and Jacob Carlson

3rd Place:
Steven Dean, Darris Ellis, and
Mike Stebelton

The fourth and fifth place teams listed in order were from Everett Community College (Eric Davishahl, instructor) and Virginia Tech (Dr. Jean Kampe). Each entry will receive student versions of SolidWorks.

Major contributors for this years scholarship awards were from Schroff Development Corporation, Kendall Hunt Publishing Company, and an anonymous donor. Software was provided by the SolidWorks Corporation with the help of Ms. Rosanne Kramer. Please thank these generous and dedicated donors every chance you get when you see them around your campus or at the conferences.

Calendar of Events

Division: http://www.east.asu.edu/edgj/edgd

58th Annual EDGD
MidYear Conference
Scottsdale, Arizona
November 15-19, 2003
General Chair: Jon Duff
Program Chair: Mary Sadowski

59th Annual EDGD
MidYear Conference
Williamsburg, Virginia
November 21-23, 2004
General Chair: Patrick Devens

2003 Annual ASEE Conference
Nashville, Tennessee
June 22-25, 2003
Program Chair: Frank Croft

2004 Annual ASEE Conference
Salt Lake City, Utah
June 20-23, 2004
Program Chair: Patrick Devens

2005 Annual ASEE Conference
Portland, Oregon
June 12-15, 2005
Program Chair: Kathryn Holliday-Darr

2006 Annual ASEE Conference
Chicago, Illinois
June 18-21, 2006

2007 Annual ASEE Conference
Honolulu, Hawaii
June 24-27, 2007

The Engineering Design Graphics Journal

The Engineering Design Graphics Journal is published three times a year by the Engineering Design Graphics Division (EDGD) of the American Society for Engineering Education (ASEE). Subscription rates: ASEE/EDGD members , $6.00; non-members, $20.00. If you would like to become a member of EDGD/ASEE, write ASEE, Suite 200, 11 Dupont Circle, Washington, D. C. 20036, and request an ASEE membership application. Non-members can subscribe to the EDG Journal by sending their name, address, telephone number, and a $20.00 check or money order payable to Engineering Design Graphics. Mail to:

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The Ohio State University
2070 Neil Avenue
Columbus, OH 43210

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Ann Arbor, MI 48106

Submission Guidelines

The Engineering Design Graphics Journal is published by the Engineering Design Graphics (EDG) Division of the American Society for Engineering Education (ASEE). Papers submitted are reviewed by an Editorial Review Board for their contribution to Engineering Graphics, Graphics Education and appeal to the readership of the graphics educators. By submitting a manuscript, the authors agree that the copyright for their article is transferred to the publisher if and when their article is accepted for publication. The author retains rights to the fair use of the paper, such as in teaching and other nonprofit uses. Membership in EDGD-ASEE does not influence acceptance of papers.

Material submitted should not have been published elsewhere and not be under consideration by another publication. Submit papers, including an abstract as well as figures, tables, etc., in quadruplicate (original plus three copies) with a cover letter to:

Sue Miller, Editor
Engineering Design Graphics Journal
Purdue University
Department of Computer Graphics Technology
1419 Knoy Hall
West Lafayette, IN 47907-1419
FAX: 765-494-9267
Phone: 765/496-1709
E-mail: sgmiller@tech.purdue.edu

Cover letter should include your complete mailing address, phone and fax numbers. A complete address should be provided for each co-author. Use standard 8-1/2 x 11 inch paper, with pages numbered consecutively. Clearly identify all figures, graphs, tables, etc. All figures, graphs, tables, etc. must be accompanied by a caption. Illustrations will not be redrawn. All line work must be black and sharply drawn and all text must be large enough to be legible if reduced. The editorial staff may edit manuscripts for publication after return from the Board of Review. Upon acceptance, the author or authors will be asked to review comments, make necessary changes and submit both a paper copy and a text file on a 3.5" disk.

A page charge will apply for all papers printed in the EDG Journal. The rate is determined by the status of the first author listed on the paper at the time the paper is received by the Editor. The rates are as follows:

$40 per page for EDGD members
$80 per page for non-EDGD members

This charge is necessitated solely to help offset the increasing costs of publication. Page charges are due upon notification by the Editor and are payable to the Engineering Design Graphics Division.

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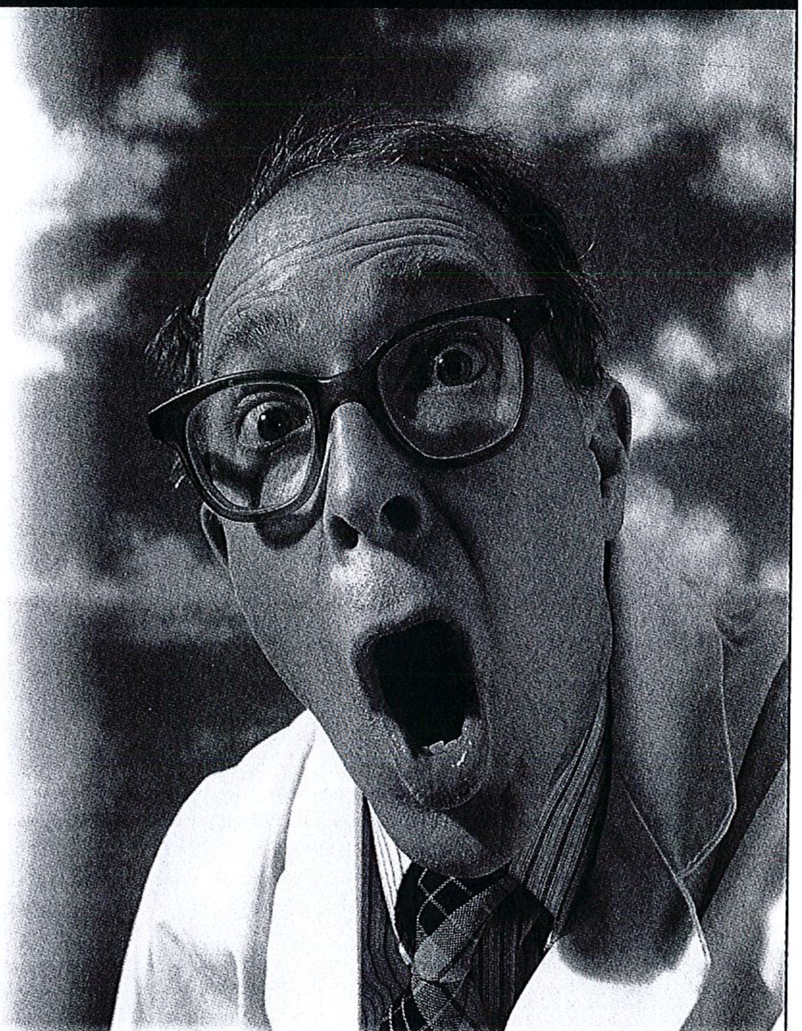

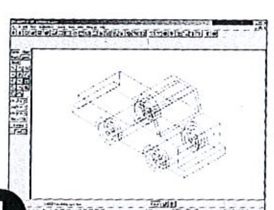

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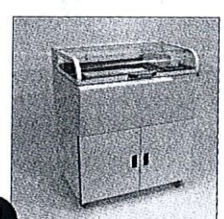

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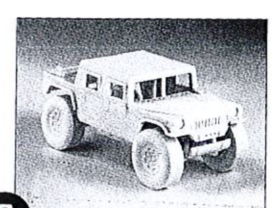

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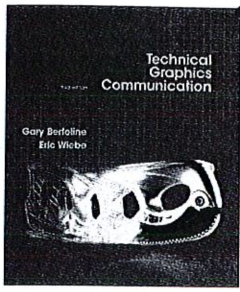

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Eric Wiebe, *North Carolina State University*
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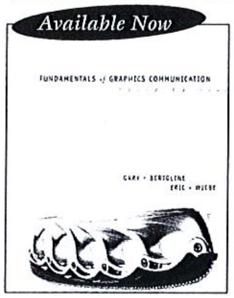

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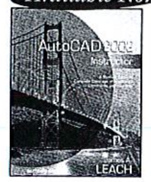

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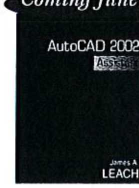

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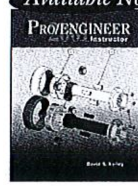

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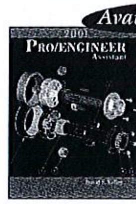

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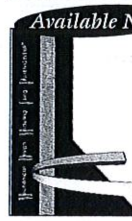

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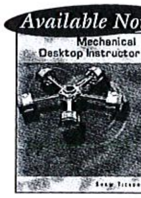

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