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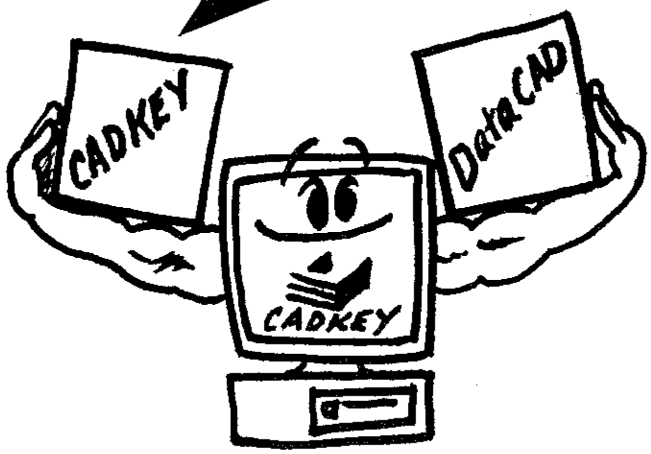

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THE ENGINEERING DESIGN GRAPHICS JOURNAL

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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.

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. . . from the EDGE

Engineering • Design • Graphics • Editor

Recently, I have been amazed at how quickly things continue to evolve and change. Not so very long ago, when someone mentioned animation, we thought of Walt Disney and Porky Pig or Snow White. For many years animation was limited to 2-D. In fact, we could quickly create our own 2-D animation through the use of a flip pad. (I think those might have actually been Cracker Jack prizes!)

Now when we think about animation, a whole cadre of options are available. We can do animations and simulations in 3-D space. Techniques that were a mystery and out of our reach not too long ago, are now available to our beginning students. In California, there is a special school where high school students are designing and preparing animations as part of their curriculum.

As if that were not enough, a whole new field is emerging called motion graphics. It is the combination of computer images created over film footage of actual images. This technique allows the animator to provide the viewer with such realistic animations that it is difficult to separate when the animation begins and real life takes a back seat.

As great as these things are, we must remember that tomorrow a new hardware and software will be introduced that will make everthing we are doing today look antiquated. With all of this going on, we must remember that the skills of visualization and sketching are becoming more rather than less important. While most of us have given up the drafting machine, compass, and dividers, the pencil is here to stay.

On page 45 is a copy of the award given to Bill Rodgers, from the EDG Division. It had been scheduled to be given at the 49th MidYear Meeting. Unfortunately, Bill took ill and was unable to attend the presentation ceremony. It was presented instead at the VPI Engineering Fundamentals Christmas party. This award was initiated to thank Bill for all his work on the EDG Division history and especially his work on the Spring, 1993 Special Edition of the *Journal*. That Special Edition chronicles people, places, events, and changes of our division. Few organizations have all of this information together in one place. (There are, by the way, copies of this issue still available. Just send Clyde Kearns a check for $10.00, payable to the EDG Division.) I would like again, to thank Bill for his service to our organization.

Plans for the 50th MidYear Meeting are well under way. If you haven't attended a MidYear Meeting recently or have never attended one, this might be the one to make. It will be held in Ames, Iowa, on November 15 - 17, 1995. Rollie Jenison and Jim Shahan have big plans to make it a great conference.

Mary A. Sadowski

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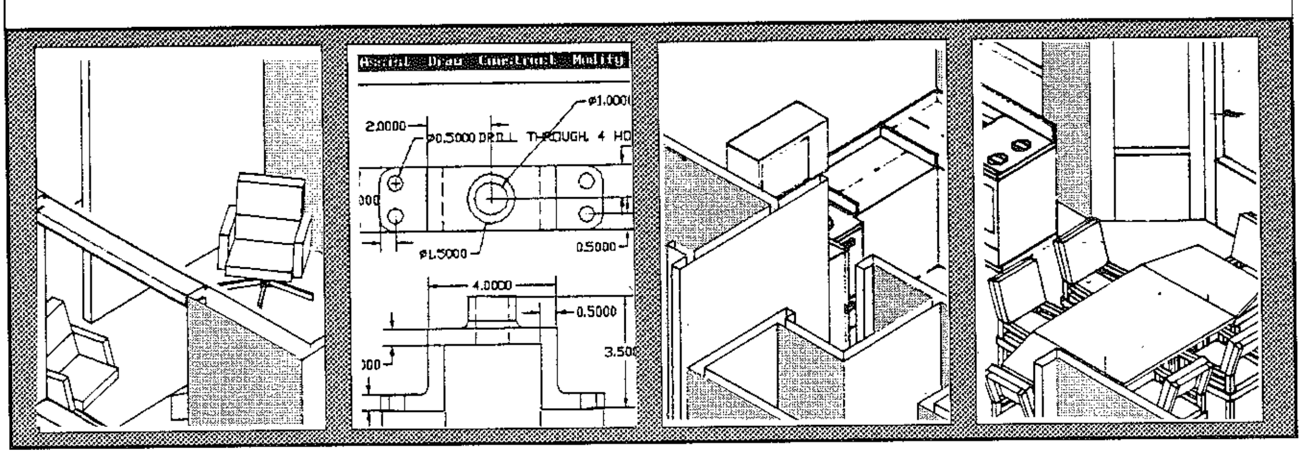

Engineering Graphics in Design Education: A Proposed Course Based on a Developed Concept

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Abstract

This paper presents a proposed course in Engineering Graphics at the University of Louisville that integrates an innovative approach to design for manufacturing of new products with traditional topics on engineering graphics for manufacturing. The need for engineering graduates to have practical design experience provided the motivation for the authors to develop a methodology entitled Design to Benefit Community and Industry (DBCI) to be implemented within the topical content of the proposed course. Pilot projects were offered in the 1994 spring and summer terms, resulting in successful student experiences and several potential inventions. Due to the versatile content of this course, the authors believe the course could be adopted by other engineering departments with minor modifications. The content of the course and its role in enhancing a student's competitive edge for the job market of tomorrow are discussed.

Introduction

The competitive job market and global economic recession have prompted many engineering companies to reevaluate the process they undertake to interview and hire recent college graduates. A massive set of budgetary cutbacks affecting colleges and universities has placed pressure on educational institutions to become more efficient and competitive. Increasing demands from leading industrial and political sources are placed on universities and engineering institutions, in particular, to produce graduates who are more current with the latest technologies and practices in the workplace. Industries have voiced concern for prospective engineering employees to possess experience in design and practical engineering applications. In an effort to address these issues, the authors present a proposed course in Engineering Graphics adapting a methodology entitled Design to Benefit Community and Industry (DBCI).

Review of Current Design Education

Even though educators and researchers are aware of the problems and challenges awaiting college graduates, there are still a considerable number of graduates entering the job market without adequate preparation. Graduate students from all backgrounds complain that universities do a poor job of preparing them for the job market (Magner, 1994). Downsizing and streamlining by almost every major company in the U.S. have affected all graduates, even engineers who were once in high demand (Heller, 1994).

Rajai suggested that engineering schools place emphasis not only on teaching theoretical concepts, but also on how these theories could be applied to practical applications (Kiger, 1990). A cooperative education internship program provides this learning opportunity; however, too few engineering schools require it. Rajai concludes that teaching a hands-on approach to application of design and manufacturing concepts should be given top priority by engineering schools. The proper practical application of design principles plays an important role in every aspect of engineering, from manufacturing of products to improvement in the quality of life, as indicated by many researchers (Roskam, 1991; Lutz, et al., 1990; Hartley, 1992; Suh, 1990; Zeid, 1991).

"...the engineering curriculum should be revitalized to include hands-on student experiences in design for manufacturing."

A survey of the undergraduate curricula of 30 engineering schools (Rajai, 1994) reveals the lack of a comprehensive hands-on approach to design and manufacturing topics. Although the survey was limited to doctoral and comprehensive institutions (primarily ABET accredited) in the Midwest and Southeast United States, the observations present an insightful impression. Even though some of the surveyed schools offer senior capstone design courses, none offered a particular task-oriented course that allowed students to invent and manufacture a product based on market needs. Lack of hands-on design application courses place students at a disadvantage in their quest for entry-level engineering jobs, particularly for those students not involved in co-op programs.

Despite the apparent lack of practical design experience provided in engineering schools, the students themselves recognize the need to acquire the knowledge and experience required to attain positions as successful engineers. Today's students are aware of the shrinking job market resulting from global recession (Magner, 1994). It is obvious that the growth period of the 80's, when most engineering students were assured a job in their field, has long past. Students feel compelled to acquire the appropriate tools and knowledge to effectively market their skills.

Engineering schools are aware of the challenging task of producing top quality engineers. In response to this challenge, some schools have provided special research funds or other incentives for faculty to develop new courses to enhance the quality of the design curriculum. The Mechanical and Manufacturing departments at Brigham Young University jointly developed a senior capstone design course (Magleby, et al., 1992). A structured approach to product and process design based on the Quality Function Deployment System was adapted. Students are required to build functional prototypes and manufacturable production samples. Widmer (1992) at Purdue University developed a method to improve students' understanding of design topics. The method required student involvement in the process from establishment of specifications to evaluation of success.

Responding to the Need to Revitalize the Engineering Curriculum

Based on findings cited in the literature, survey results, and personal observations, the authors believe the engineering curriculum should be revitalized to include hands-on student experiences in design for manufacturing. In response to this need, a different direction is proposed to address many of the previously discussed issues within the context of one course in engineering graphics. The new course, required for mechanical engineers, integrates traditional engineering graphics practices with design process concepts and a hands-on, team project approach to engineering design. The course is developed to simulate a variety of real-life experiences demanded by engineering design careers and to provide a start in developing the skills needed to prepare students for a competitive job market. Encountering these experiences early in the college course sequence provides the student with an overview of expected outcomes and helps the student tie together the many specialized studies in an engineering discipline.

Goals of the Proposed Course

The student goals of the course are as follows:

1. Experience a realistic, challenging, and innovative application of design for manufacturing.
2. Integrate the experience with traditional studies in engineering graphics for manufacturing, namely, detail drawing, assembly drawing, geometric dimensioning and tolerancing, threads and fasteners, and graphical representation of data.
3. Understand the design process and the concept of concurrent engineering.
4. Practice socially conscientious and environmentally responsible design.
5. Implement a methodology for generating design project ideas within a team environment.
6. Develop and utilize personal skills within a team environment, e.g., exercise oral and written communication skills, develop creative thought process, and provoke taking initiative toward a group effort.

The Proposed Methodology: DBCI

Future generations of engineers should not only be technically knowledgeable in their specialized fields, but also sensitive to the needs of society and responsible to the environment. In an effort to generate engineering design project ideas used to achieve this goal, the authors developed a concept entitled Design to Benefit Community and Industry (DBCI). This method was cultivated through the authors' research and personal experiences. During the development, Rajai directed a number of design projects within engineering classes that have resulted in statewide media coverage and patent applications for inventions (Cunningham, 1992; Kiger, 1990, 1991). The work of

Table 1. Design to Benefit Community and Industry

Phase I		
1	Develop a questionnaire to identify social and environmental needs of the local community and industry. Focus on the needs of the elderly, handicapped, medical industry. Each team conducts its own survey.	
2	Determine a random sample and mail the questionnaire. Personal interviews may also be conducted.	
3	Collect the questionnaires, then tabulate and analyze the data. Identify potential products or systems to fulfill needs indicated by the data that are also feasible engineering design team projects.	
Phase II		
4	Group meetings and discussions with the instructor are used to select the two best project ideas.	
5	Brainstorm to propose solutions and to foresee potential design considerations. Select one project based on the following criteria:	
	A.	It should be feasible to design and manufacture the product or system.
	B.	The product or system should be new, or a modification of an existing one, so it could qualify for a patent application.
	C.	The product or system should have a potential market and be economically cost effective.
	D.	The product or system should enhance the user's quality of life.
	E.	The product or system should be environmentally safe.
	F.	The product should be user-friendly.

other researchers in this area was also inspiring to the development of this concept (Earle, 1994; Hartley, 1992).

The DBCI concept is used in the proposed course as the primary time/activity management tool to spawn ideas for team projects. Each engineering team can consist of 3 to 6 members depending on class demographics. An outline of this method appears in Table 1.

Pilot Projects

Two pilot projects were conducted within the content of an existing freshman engineering graphics course--one during the spring term and one during the summer term of 1994. In each case, teams of 3 to 6 students participated in a tightly structured six-week schedule. Each group selected a team leader to be responsible for coordinating the activities of the members and to act as a liaison between team members and the instructor.

Within the six-week schedule, the process of ideation to documentation was undertaken. The DBCI method was employed to generate possible design projects. For each pilot course, several projects were selected that addressed needs of the community and of local companies. Each team member was required to submit a biweekly progress report to his/her group leader, who in turn submitted a summary report to the instructor. Students were encouraged to use a variety of tools (sketches, CAD programs, spreadsheets, presentation graphics packages) to develop ideation drawings, documentation drawings, and final presentation materials. The courses concluded with a final written, oral and graphical presentation by each team. An optional prototype or mock model was developed by almost every team.

"Ultimately, evaluation of an educational institution should be based not only on the knowledge and merits of its educators, but also on the success of its graduates."

Two factors greatly influenced the students' interest in the pilot courses: the possibility of local news media coverage and patent applications for worthy designs. Students were informed at the beginning of the course that other faculty and the local news media would be invited to attend their presentations. In addition, patents would be applied for worthy designs under team member and instructor names according to university policy. These features obviously had a positive motivational impact on the majority of students. Not only did every team fulfill the requirements, but every team except one prepared an optional prototype model for their presentation.

Several useful and interesting designs resulted from the students' efforts in the pilot courses. One four-member team working on an industrially sponsored project was able to design and build a fully functional machine called a Pipe End Reformer. The Pipe End Reformer solved a need of a local automotive exhaust system manufacturer to improve the number of parts meeting quality specifications. Other designed products included a portable automobile air bag, a wheelchair seat that could be raised and lowered, a corrosion-free battery, a multipurpose car tool, a universal screwdriver, and a rear suspension design of a vehicle for the 1994 Baja national competition.

Summary of Pilot Courses

The two pilot courses incorporated the design process from ideation to final documentation in a six-week period. Design project ideas were generated using the DBCI method. Each team completed its design and presented the project results in written and oral reports. A number of invited faculty and members of news media were present at the presentations. Patents have been pursued for several designs. Observations of the pilot courses are summarized below.

- Most of the students maintained their initial enthusiasm throughout the project.
- Even though the assignment due dates were vigorously enforced, most groups managed to budget their time effectively to meet the deadlines.
- The scope and difficulty of the project designs far exceeded the instructors' expectation for freshman and sophomore students.

- A majority of the students contributed equally to the progress of their group, thus successfully practicing the concept of team-oriented projects.

The following areas required improvement:

- Group leaders indicated a need for more guidance and direction to be more effective in managing the activities of team members.
- The design process and philosophy of concurrent engineering should be discussed in more detail.
- The lack of access to an adequate laboratory hindered the process of building more functional prototypes.
- The six-week schedule was too short to discuss and incorporate the intended engineering graphics topics effectively.

Proposed Course in Engineering Graphics and Design

Realizing the need for design experiences in the engineering curriculum has led many schools to offer a senior design course. However, the authors agree with Liebman (1989) who reported that students were often thrown into such a course without adequate preliminary instruction on design concept. He proposed that the science of design should be incorporated into the curriculum earlier, so students would be prepared to take design courses.

In an effort to incorporate a student design experience early in the engineering curriculum at the University of Louisville, a realistic and innovative course is proposed that integrates design concepts and practice with traditional intermediate engineering graphics topics. The proposed course is a 15-week, 1-credit-hour course to be required for freshman or sophomore mechanical engineering students. One of the primary goals in this course is to introduce the design process and indicate the role of engineering graphics throughout this process. The content of this course is shown in Table 2.

Conclusion

In this paper a course that addresses the needs of industry is proposed which integrates engineering graphics and practical experience in design for manufacturing. The content of this course offers these key features:

- A unique method is employed to generate project ideas.
- Students select projects that benefit the local community and industry.
- The design process and the concept of concurrent engineering are introduced at an early stage in the engineering curriculum.
- Students attain experience working in team-oriented design projects.
- Students employ written, oral, and graphical presentation skills.
- Inventing new products to enhance the quality of life is a primary objective, and patents are sought for the invented products.
- Members of the local news media and other faculty members are invited to attend the team presentations.

The result of the pilot projects surprised even the most optimistic observer. The students showed a surprising amount of enthusiasm and resourcefulness, which is an important trend to initiate in the first year. The pilot projects also indicated that an instructor's industrial experiences, personal commitment and enthusiasm can play a major role in motivating students to utilize their potential to the fullest extent.

In addition to the knowledge of engineering graphics topics, this course will give students a tangible educational experience in design for manufacturing, teamwork, social conscience, and personal presentation skills, thus enhancing their edge in the competitive job market of tomorrow. This is only a small, but important, step toward our goal as educators to produce top-quality engineers for the twenty-first century. Ultimately, evaluation of an educational institution should be based not only on the knowledge and merits of its educators, but also on the success of its graduates.

Table 2. Proposed Course Outline

Week	***Lecture Topics***	***Lab Activity/Assignment***
1	Course introduction, syllabus Freehand sketching	Sketching assignment–technique
2	The design process The concurrent engineering concept Introduction to team projects The DBCI method	Formulate teams Team meetings/select leader Formulate questionnaire/interviews Sketching assignment–isometric
3	Multiview drawing review Detail drawing Video presentation of previous projects	Sketching assignment--detail drawing Team meetings/conduct survey
4	Detail drawing continued	Team meetings/tabulate survey Brainstorm/select 2 projects Sketch design alternatives Biweekly report
5	Design methods, time/activity planning Submit design project proposals/sketches Team consultation with instructor Final design project selection	Team meetings/activity planning Preliminary design/drawings
6	Assembly drawings	Assembly sketches of design alternatives Detail sketches of design alternatives Biweekly report
7	Pictorial assembly drawings Cost analysis/safety	Pictorial design sketches Design alternatives cost analysis Team meetings/design analysis
8	Screw threads Team consultation with instructor Design alternatives finalization	Screw threads exercise Detail/assembly drawing planning Team meeting/biweekly report
9	Fasteners	Fasteners exercise Detail/assembly drawings
10	Limit dimensioning Design/drawing modification	Limit dimensioning exercise Detail/assembly drawings Team meeting/biweekly report
11	Geometric dimensioning and tolerancing	Detail/assembly drawings Prototype construction (optional)
12	Geometric dimensioning and tolerancing Design analysis/modification	GD&T exercise Team meetings/biweekly report Prototype construction (optional) Drawing modifications
13	Graphical representation of data	Team meetings Plan report and presentation
14	Presentation methods	Final report preparation Presentation materials preparation
15	Oral and graphical presentation Submit formal report	----

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Determining the Dimensions of Similar Ellipses of Specified Area and the Dimensions of Confocal Ellipses

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Abstract

A method is provided to determine the dimensions of nested similar ellipses, meeting the requirement that each ellipse have an area which is a specified multiple of the area of its predecessor, given the lengths of the semi-minor and semi- major axes of the original. Numerical and graphical examples of the method are provided. An extension of the method for nested confocal ellipses is also provided.

Nested Similar Ellipses

When an isometric view of concentric circles is constructed, the result is a nested set of similar ellipses. Using any of the many CAD packages, the drafter need only know the lengths of the semi-major and semi-minor axes to produce the figures. Recently one of the authors was requested by an artist at a local college to help him find the dimensions of nested similar ellipses having the property that each ellipse have an area which is twice that of its predecesssor. [Similar ellipses are defined as those such that the ratio of the minor axis (a) to the major axis (b) is constant. See Figures 1 and 2 for examples.] He had two other requirements:

1. The area of the smallest ellipse be $\frac{1}{8}$ square inch.
2. That $a : b = 1 : 2$.

He also requested that the dimensions be obtained for a : b = 1 : 3.

Since the area of an ellipse is ab, then finding the semi-major and semi-minor axes for an ellipse similar to a given ellipse but with twice the area is easily obtained by multiplying each axis by $\sqrt{2}$.

Proof

- Let a, b (a < b) be the semi-minor and semi-major axes of an ellipse.
- Then b = ka. A similar ellipse with axes m,n must have n = km.
- The area of the first ellipse is πab and that of the second must be πmn.
- If $\pi mn = 2\pi ab$ then $\pi mn = 2ab$
  Substituting, m(km) = 2 a(ka), so that $m^2 = 2\,a^2$ and $m = a\sqrt{2}$ and $n = b\sqrt{2}$

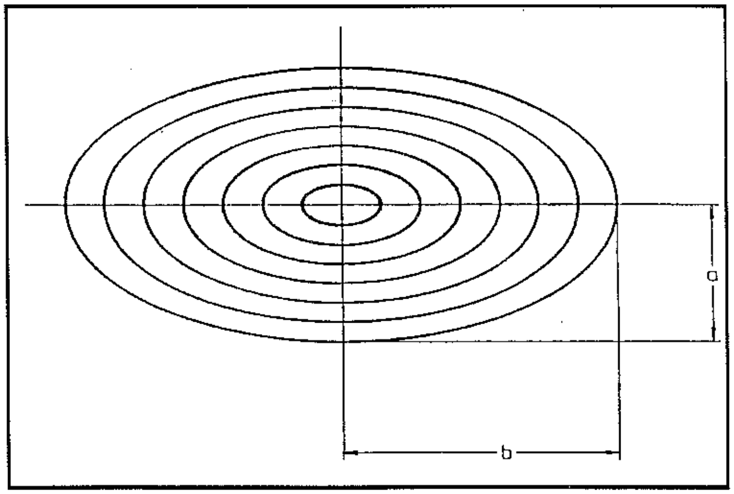

Figure 1. Similar Ellipses; a : b = 1 : 2

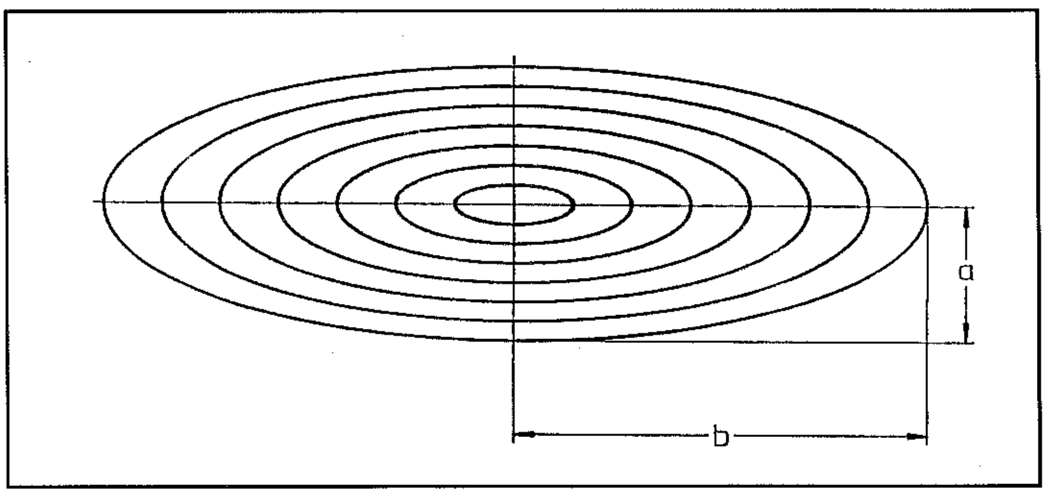

Figure 2. Similar Ellipses; a : b=1 : 3

Area (A) **(A)** *in square inches*	semi-minor axis **(a)** *in inches*	semi-major axis **(b)** *in inches*
0.125	0.141	0.282
0.250	0.200	0.400
0.500	0.282	0.566
1.000	0.400	0.800
2.000	0.563	1.126
4.000	0.800	1.600
8.000	1.125	2.250

Table I
Nested similar ellipses with each ellipse having area twice that of its predecessor, A_1=.125, a:b=1:2

Table I shows the dimensions for the 7 ellipses requested by the artist, when a : b = 1 : 2. These are the dimensions used to create Figure 1.

Table II shows the dimensions for the 7 ellipses requested by the artist, when a : b = 1 : 3. These are the dimensions used to create Figure 2.

Area **(A)** *in square inches*	semi-minor axis **(a)** *in inches*	semi-major axis **(b)** *in inches*
0.125	0.115	0.345
0.250	0.162	0.486
0.500	0.229	0.687
1.000	0.323	0.969
2.000	0.460	1.380
4.000	0.651	1.953
8.000	0.921	2.763

Table II
Nested similar ellipses with each ellipse having area twice that of its predecessor, A_1 = .125, a : b = 1 : 3.

Table III shows a nested sequence of similar ellipses, each having area twice that of its predecessor, when the first semi-minor axis = one and a : b = 1 : 2.

Area **(A)** *in square inches*	semi-minor axis **(a)** *in inches*	semi-major axis **(b)** *in inches*
006.283	1.000	02.000
012.566	1.414	02.828
025.132	2.000	04.000
050.254	2.828	05.657
100.530	4.000	08.000
201.739	5.657	11.313
402.124	8.000	16.000

Table III
Nested similar ellipses with each ellipse having area twice that if its predecessor, a:b = 1:2, a_1 = 1.

Table IV shows a nested sequence of similar ellipses, each having area twice that of its predecessor, when the first semi-minor axis = one and a : b = 1 : 3

Area **(A)** *in square inches*	semi-minor axis **(a)** *in inches*	semi-major axis **(b)** *in inches*
009.424	1.000	03.000
018.843	1.414	04.242
037.699	2.000	06.000
075.375	2.828	08.484
150.796	4.000	12.000
301.608	5.657	16.971
603.186	9.000	24.000

Table IV
Nested similar ellipses with each ellipse having area twice that if its predecessor, a : b = 1 : 3, a_1 =1.

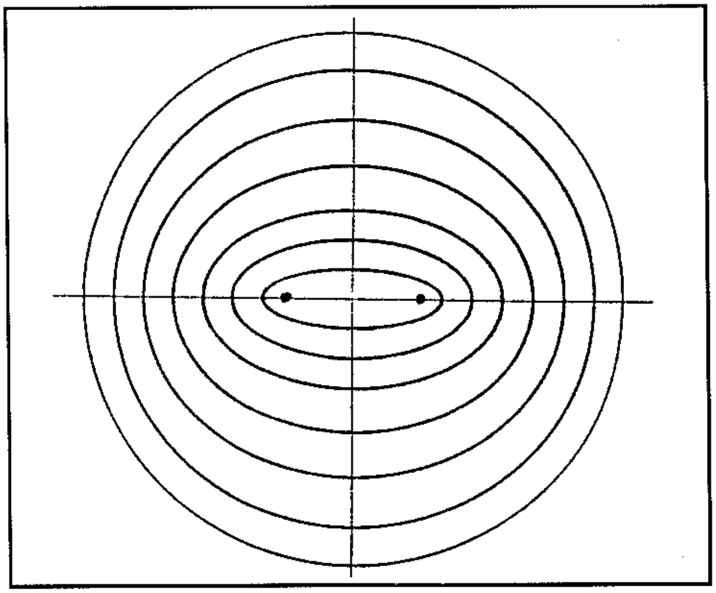

Figure 3. Confocal Ellipses with Foci at (-2, 0) and (2,0).

An extension of the problem is to consider a group of confocal ellipses, each of which has area twice that of its predecessor. *Confocal ellipses are those which have the same foci. These ellipses are not similar. Figure 3 shows a set of confocal ellipses. Notice that as the semi-minor axis gets large with respect to the focal length, the ellipse approaches a circle.* Does a general formula exist as in the case of similar ellipses?

Recall that an ellipse is the set of all points such that the sum of the distances from two fixed points is a constant. (See Figure 4.)

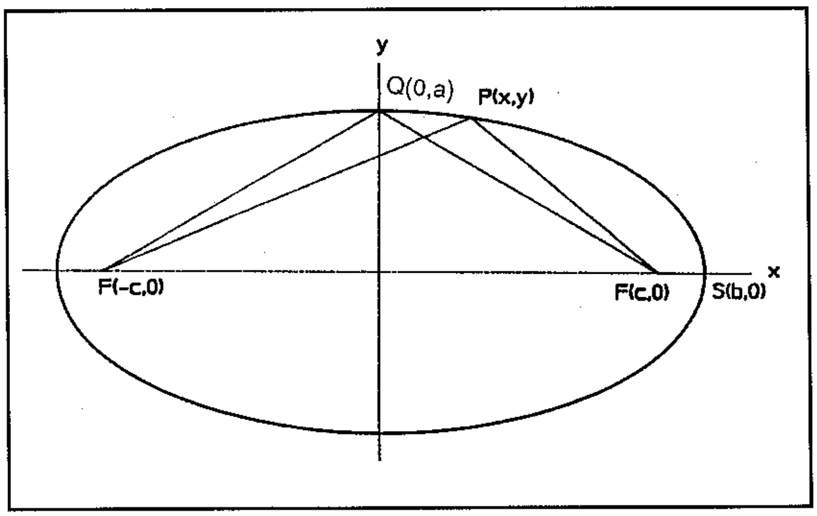

Figure 4. Model of the standard ellipse.

If a and b represent the lengths of the semi-minor and semi-major axes, and the two foci are located at F (c,0) and F' (-c,0) and PF + PF' = k, then

1. PF + PF' = 2b,
2. if Q = (0,a), then FQ = b; so that
3. $a^2 + c^2 = b$ or $b = \sqrt{a^2 + c^2}$
4. The foci of an ellipse, symmetric to the origin, having semi-major axis b and semi-minor axis a, are located at $\left(\sqrt{b^2 - a^2},\ 0\right)$ and $\left(-\sqrt{b^2 - a^2},\ 0\right)$.

Thus confocal ellipses have the following form for any fixed c

$$\left(\frac{y^2}{a^2}\right) + \left(\frac{x^2}{a^2 + c^2}\right) = 1.$$

Letting c = 2, and a take on the values of consecutive integers, beginning with one, we obtain the values in Table V, which were used to generate Figure 3.

Area	semi-minor axis	semi-major axis
007.025	1	02.236
017.769	2	02.828
033.986	3	03.606
056.197	4	04.472
084.587	5	05.385
119.205	6	06.324
160.096	7	07.280
207.245	8	08.246
260.407	9	09.210
320.380	10	10.198

Table V

Confocal Ellipses with Foci at (2,0) and (-2,0) and consecutive integers as values for the semi-minor axis.

Area	semi-minor axis	semi-major axis
007.025	1.000	2.236
014.050	1.703	2.626
028.087	2.676	3.341
056.169	3.998	4.472
112.295	5.081	6.148
224.592	8.338	8.574

Table VI

Dimensions of Confocal Ellipses with Foci at (-2,0) and (2,0) and each ellipse having area twice that of its predecessor.

Given two confocal ellipses, foci at (c,0) and (-c,0) with axes a,b and m,n respectively, their areas are as follows:

$$A_1 = \pi ab = \pi a\sqrt{a^2+b^2};$$
$$A_2 = 2A_1 \textit{ then}$$
$$\pi mn = 2\pi ab.,$$
Substituting and simplifying,
$$\pi mn\sqrt{m^2+c^2} = 2\pi a\sqrt{a^2+c^2}$$
$$m^2\left(m^2+c^2\right) = 4a^2\left(a^2+c^2\right).*$$

Thus for any fixed a and c, we can obtain b, m and n.

Example

$$a = 1,\ c = 2$$
Then $b = \sqrt{1^2+2^2} = \sqrt{5} \approx 2.236$

and the equation of this ellipse is
$$\left(\frac{y^2}{1}\right)+\left(\frac{x^2}{5}\right) = 1$$

To find the dimensions of the ellipse with twice this area and the same foci, we substitute into * getting

$$m^2\left(m^2+2^2\right) = 4(1)\left(1^2+2^2\right);$$
simplifying to
$$m^4+4m^2-20 = 0.$$
Solving for the positive value of m^2, we obtain
$$m^2 \approx 2.899 \text{ so that}$$
$$m \approx 1.703 \text{ and}$$
$$n^2 = m^2+4 \approx 6.899 \text{ so that}$$
$$n \approx 2.626$$

The equation of the new ellipse is then

$$\left(\frac{y^2}{2.899}\right)+\left(\frac{x^2}{6.899}\right)=1$$

Then, $A_1 = \pi(1)(2.326) = 7.025$;

$A_2 = \pi(1.703)(2.626) = 14.050$

and $A_2 = 2A_1$

Table VI shows a nest of six confocal ellipses, each having approximately twice the area of its predecessor, with

$a_1 = 1$, $F = (2,0)$ $F' = (-2,0)$.

Summary

1. If we wish to find an ellipse which has an area twice that of a similar ellipse, we need only multiply the semi-major and semi-minor axes of the original ellipse by $\sqrt{2}$.

   If we wish to find an ellipse which has an area k times that of a similar ellipse, we multiply the semi-major and semi-minor axes by $\sqrt{k}$

2. If we wish to find an ellipse with an area twice that of a confocal ellipse with semi-minor axis a, and foci (-c, 0) and (c,0), we need proceed as follows:

(a) For the original ellipse,

solve $b^2 = a^2 + c^2$.

(b) For the semi-minor axis (m) and the semi-major axis (n) of the larger ellipse solve the equations:

$$m^2 (m^2 + c^2) = 4 a^2(a^2 + c^2)$$

and $n^2 = m^2 + c^2$.

To obtain the ellipse with area k times that of a confocal ellipse having semi-minor axis a and foci (-c,0) and (c,0), find b as above. Then, for the semi-minor axis (m) and the semi-major axis (n) of the larger ellipse, solve the equations:

$$m^2 (m^2 + c^2) = k^2a^2(a^2 + c^2)$$

and $n^2 = m^2 + c^2$.

Design-Implementation-Based Simulation: A Graphics Tool

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ABSTRACT

This paper presents a new graphics tool for visualizing and simulating design-implementation processes, such as assembling, building, and manufacturing, in real-time. The Interactive Visualizer Plus Plus, or IV++, is a second-generation interactive visual simulation system that considers the dynamic nature of design-implementation processes. Unlike CAD modeling and animation systems that require post-processing, IV++ allows three-dimensional real-time visual simulations integrating time and spatial relationships with the physical constraints of actual design-implementation processes. The system can realistically simulate and evaluate design solutions by modeling physical objects and processes, and responding to 3-D data and changing conditions as though the modeled graphic-objects and processes were real. The new system uses a modular approach for implementing graphic-object manipulation. This paper discusses IV++'s graphic-user-interface (GUI) and its new Dynamics, Controls, and Reactive modules. IV++ uses knowledge-based rules to alter the behavior of graphic-objects and primitives according to the current status of the computer graphics environment. The interaction with other graphic-objects is handled by an intelligent reactive control that carries out the goals specified by the user. More importantly, since interactive visual simulation systems, such as IV++, allow designers to manipulate time–the fourth dimension–they can go back and forth in virtual-time and space to make design changes in response to problems detected while simulating the device or system being analyzed.

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Introduction: Need for Design-Implementation-Based Methodologies

Many companies are currently using CAD modeling and animation systems in the design of products, systems and processes to help correct design problems before actual design-implementation (assembly, manufacturing, building) begins. However, conventional CAD and animation systems usually fail to account for the actual time and the behavioral and geometrical constraints of the people, materials, and equipment used during the design-implementation phase. Further, such non-design-implementation-based systems lack the capabilities to effectively support the communication between all the parties involved in the design process: designers, contractors, manufacturers, suppliers, and so on.

Although a myriad of CAE, CAD and CAM software systems are commercially available, most are not effective due to the dynamic and concurrent nature of engineering and design-implementation processes. The development of new design-implementation-based tools like interactive visual simulation systems seems to be the logical step in the modeling and evaluation of future products and projects.

Visual simulation is defined here as a computer graphics system capable of modeling devices and processes and responding automatically to 3-D data and changing conditions as though the objects and processes were real. They may be used for visualizing, evaluating and predicting situations based on time, space and other physical constraints, such as gravity, inertia, aerodynamics, kinematics, and so on.

Theoretically, visual simulation systems may be used by design/construction/manufacturing teams to design, *build* (simulate), evaluate and *operate* projects before actual manufacturing occurs. Interactive visual simulation provides a methodology to evaluate design-implementation solutions, concurrently, throughout the entire design process. For instance, engineers can simultaneously evaluate the product geometrical configuration and its response to material and equipment physical constraints. In addition, design-implementation methodology may be evaluated concurrently by all the members of the team.

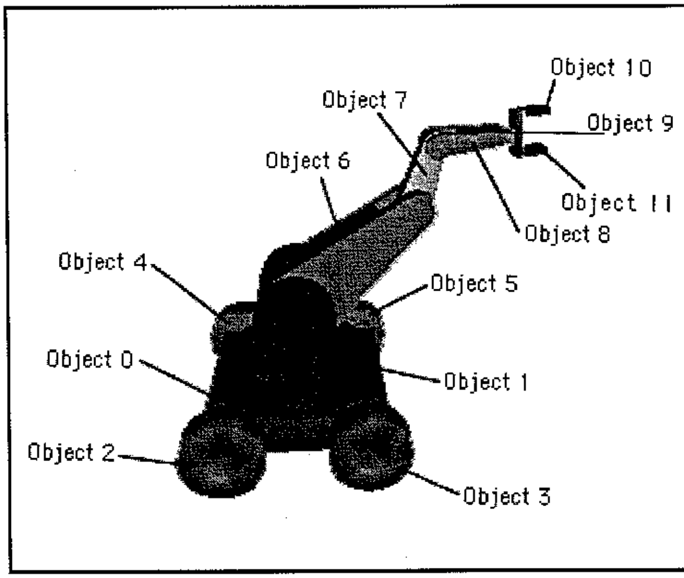

Figure 1. Machine's Objects

IV++: A Design-Implementation-Based System

The first-generation of the Interactive Visualizer (IV) visual simulation system was presented at the ASEE/EDGD 5th International Conference on Engineering Computer Graphics and Descriptive Geometry in Melbourne, Australia (Rodríguez, 1992). The second-generation of IV, called IV++, is an interactive visual simulation system designed specifically to address the dynamic nature of the design-implementation processes, in particular construction processes (Opdenbosch, 1994). The new IV++ environment contains predefined dynamic-graphic-objects that are interactive and intelligent-adaptive entities. They have a predefined geometric shape, such as the object called *ROBOTA1* (See Figure 1.) These kinds of dynamic-graphics-objects (also referred to as machines) are composed of geometric primitives and grouped objects that connect with each other in a hierarchical fashion (See Figure 2). The geometry of the machines may be created using off-the-shelf Computer-Aided Design (CAD) modeling packages, such as AutoCAD® and CADKEY®.

Every component of a machine is a collection of polygons. All the polygons of a machine object are grouped together in a

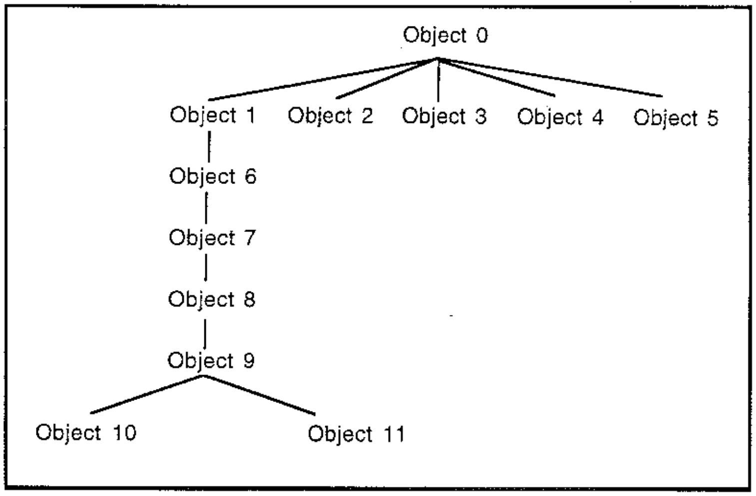

Figure 2. Machine Hierarchy

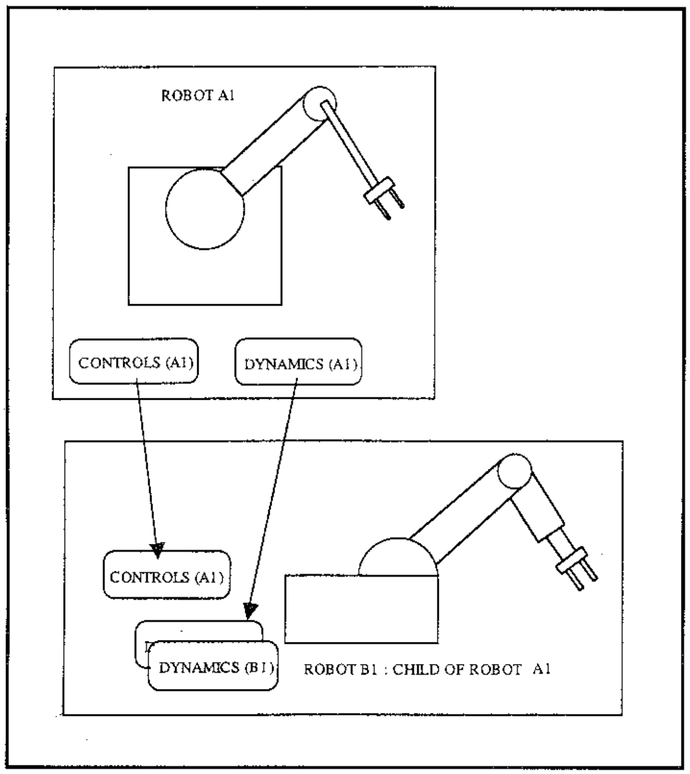

Figure 3. Machine Inheritance

logical and hierarchical way. To facilitate the modeling process, each machine object is assigned a special attribute that will later be used to identify its place in the overall machine hierarchy. For instance, if objects are created on CADKEY®, they are placed in different levels (or layers) according to their parent ID. For example, if two objects depend on object #3, then they are placed in level #3. This information is recorded in the geometry file as an additional attribute for that set of objects. The information can later be used when the files are converted to their final format to identify the parent ID.

In addition, other attributes, like line thickness or color, can be used to describe properties such as the material and shading style of the objects.

Dynamics, Controls, and Reactive Modules

The functionality of the design-implementation modules available in IV++ is described below. The Dynamics, Controls, and Reactive modules allow the user to manipulate the dynamic-graphic-objects or *machines*.

IV++ generated machines have the capability of interacting with its virtual environment through a module called Dynamics. This module uses basic physics knowledge-based rules to alter the behavior of the machines according to the current status of the environment.

The user can also interact with the machines through the Controls module by specifying the different commands that can be applied to interactively manipulate a machine. On the other hand, the interaction with other machines and obstacles is handled by the Reactive module which uses an intelligent reactive control approach to carry out the goals that have been given to the machines by the IV++ environment.

IV++'s Controls module establishes a link between the user and the machines. The routines in this module describe a set of commands that can be executed by the user. Each command is accompanied by a group of instructions that interact directly with the variables that define the state of the machine objects. For example, the control sequence for making a machine's object accelerate when a certain key is pressed is expressed as:

```
if ( key (A) = = PRESSED )

machine->object[0].accelerating = TRUE;
```

The accelerating variable of object #0 is set to true when the "A" key is pressed. The consequences of having the acceleration set to true are computed in the Dynamics module and, therefore, are not included in the Controls module.

The distinction of the functionality of these two modules makes it easier for the developer to describe how machines operate in the environment. In addition, changes are very easy to implement and debugging procedures become easier to handle.

One of the most powerful arguments for the implementation of a separate Controls module is inheritance. If two machines have the same control interface, but different dynamics, it is possible for one to inherit the controls from the other one and still have a new dynamics module, as illustrated in Figure 3.

Because of the interface limitations of a single computer, only one machine can be interactively controlled by the user at a time. The user can choose to control a machine by selecting the machine name from the control menu list. If no machines are going to be controlled interactively, the user can select ***no control*** from the same list.

Unlike the controls module, the Dynamics module is executed on every computer cycle. Machines are updated by Dynamics module even if they are not being controlled at the time. This has been done because the user is not the only factor that influences the behavior of the machines. Other factors in the environment can change the state of a machine without the intervention of the user.

The Dynamics module is the last interface between the machine and the environment. Changes to the state variables that took place in the Controls module and the Reactive module are used in Dynamics to modify the object location and orientation. As mentioned earlier, the procedures that take place in Dynamics are knowledge-based physical rules and special conditions that ensure the realistic behavior of the machines in the environment. If desired, the complexity of these procedures can be increased to produce very realistic performance. The problem with increasing complexity of the dynamic equations is the effect that it has on computer speed. The system can be so complicated and difficult to simulate that the capabilities of producing real-time graphics is lost.

Finally, the reactive module is an interface between the designer and the Dynamics module. It makes the machines capable of carrying the instructions that come from the planning algorithms.

Automation Without Hindering the User's Autonomy

The IV++ system facilitates design-implementation process simulation by allowing the use of machines that are capable of executing assembly procedures. These machines can operate in a completely autonomous mode when a design-implementation goal is provided. The machines' goal is generated by the designer after it is certain that the machine has the capability of completing the job. While executing the job, the machines will react to the changes in the environment, and adapt to them by using their pre-defined logic (knowledge-based rules). This *intelligent* adaptation continues until their goal has been achieved.

Even though the machines can operate in an autonomous mode, the user still has the ability to interrupt a process and perform it manually; therefore, IV++ provides automation without hindering the user's autonomy. Another IV++ advantage is that the user can, for instance, delete a machine or change it in the middle of a job, interactively. This is almost impossible to do with current animation systems.

Reactive Control Methodology for Manipulating Dynamic-Graphic-Objects

The adaptability of dynamic-graphics-objects (machines) has been achieved by the use of a methodology called *reactive control*. This methodology was originally conceived for autonomous control in the robotics field. It was developed so that robots would be able to adapt and react to complex environments.

The main characteristics of reactive control is the stimulus-response relationship that exists between the robot and the world (Arkin, 1990; Asch, 1992). Different behavior modes are used to cope with the state of the world, and they compete to control the robot-machine. The winner decides the next action that will be performed by the robot.

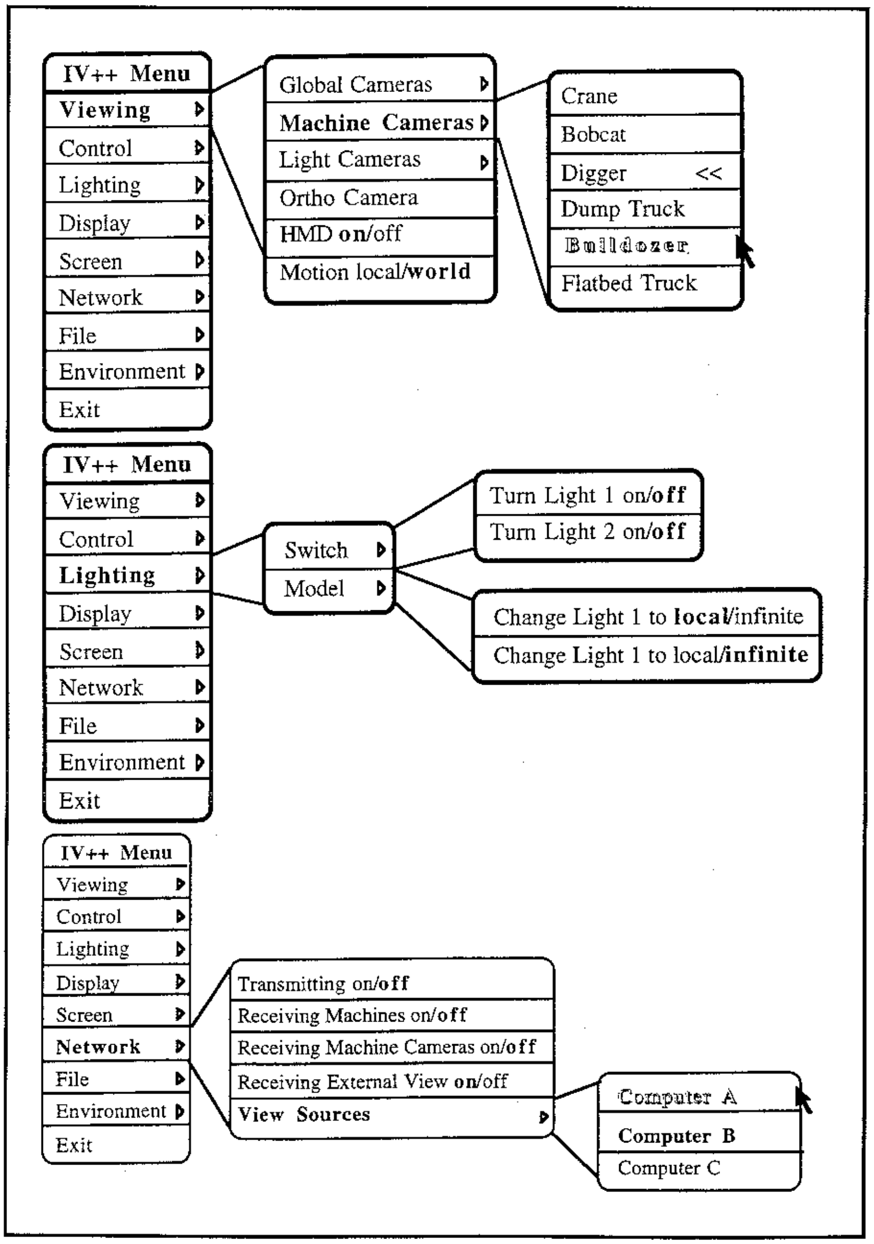

Figure 4. Sample IV++ Menus

Arkin (1990) defines the process to decide who is the winner as "arbitration." Arkin's Autonomous Robotics Architecture (AuRA) system uses a reactive control technique that applies potential field formulations to describe the robot-world relationship. Paradoxically, arbitration is no longer needed because the next action to be taken by the robot depends on all the potential field modules called motor schemas. The individual contributions are weighed according to the intensity of the output in each schema. The output is a velocity vector which determines the next direction and speed the robot is to assume (Arkin, 1990).

IV++ uses a similar adaptive strategy, but with the added feature of being able to control the machines with a friendly graphical-user-interface.

Graphic-User-Interface

IV++ originally was developed on high performance Silicon Graphics Iris® (SGI) workstations, and has been designed to support most of its interfaces and peripherals. Even though the application takes advantage of the SGI functions, the methodology developed can be implemented in other platforms.

IV++'s Graphic-User-Interface (GUI) consisst of simple pop-up menus (Figure 4) for selecting operations, such as viewing, controlling, lighting, displaying, networking, filing, and so on.

The Viewing menu option allows the user to select any viewing camera during the machine's simulation cycle (Figures 4 and 5). In addition, the user can add, remove, and place global cameras anywhere in the environment. The machines have cameras that let the user see the events from the machine's point of view. In fact, the Lights menu also has cameras that allow the user to view the scene lighted from a particular angle. The viewing menu allows the user to switch views to global cameras, vehicle cameras, and light cameras. This menu also includes a head mounted display option (HMD on/off) to activate and deactivate 'virtual reality gear' (VR) and the local/world option to switch the camera translation mode from local to world coordinates and vice versa.

When the HMD on/off is selected, the VR gear is activated to control the current viewing camera. Any movement on the head mounted display is emulated by the current camera. If the current camera belongs to a machine, the translations and rotations of the HMD will control the location and rotation of the camera with respect to the machine, but the camera will still be attached to the machine. Any change in orientation or location of the machine will be transferred to the camera as well. While the VR gear is active, the signal from the monitor is converted to NTSC video and is sent to the monitors on the HMD to complete the immersion effect. The menus have been designed with a font large enough to be visible in the small monitors inside the HMD. If selected again, the HMD on/off option will deactivate the VR gear and switch the camera control back to the keyboard.

The camera's coordinate system can be switched from world coordinates to local coordinates. If the camera is inside a machine, the world coordinate system is the coordinate system of the machine. In local coordinates, the camera will always move in its own coordinate system. Figure 6 shows the keys that have been assigned to camera controls and their functions. (Note the translation keys are in the world coordinate system.) The figure also shows the functionality of the translation keys when the camera is in local translation mode.

Cameras can also be controlled with a Spaceball,® if the device is available. The Spaceball is a six degrees of freedom input device that senses the force applied by the user. The information provided by the Spaceball is used to rotate and translate the camera in local coordinates.

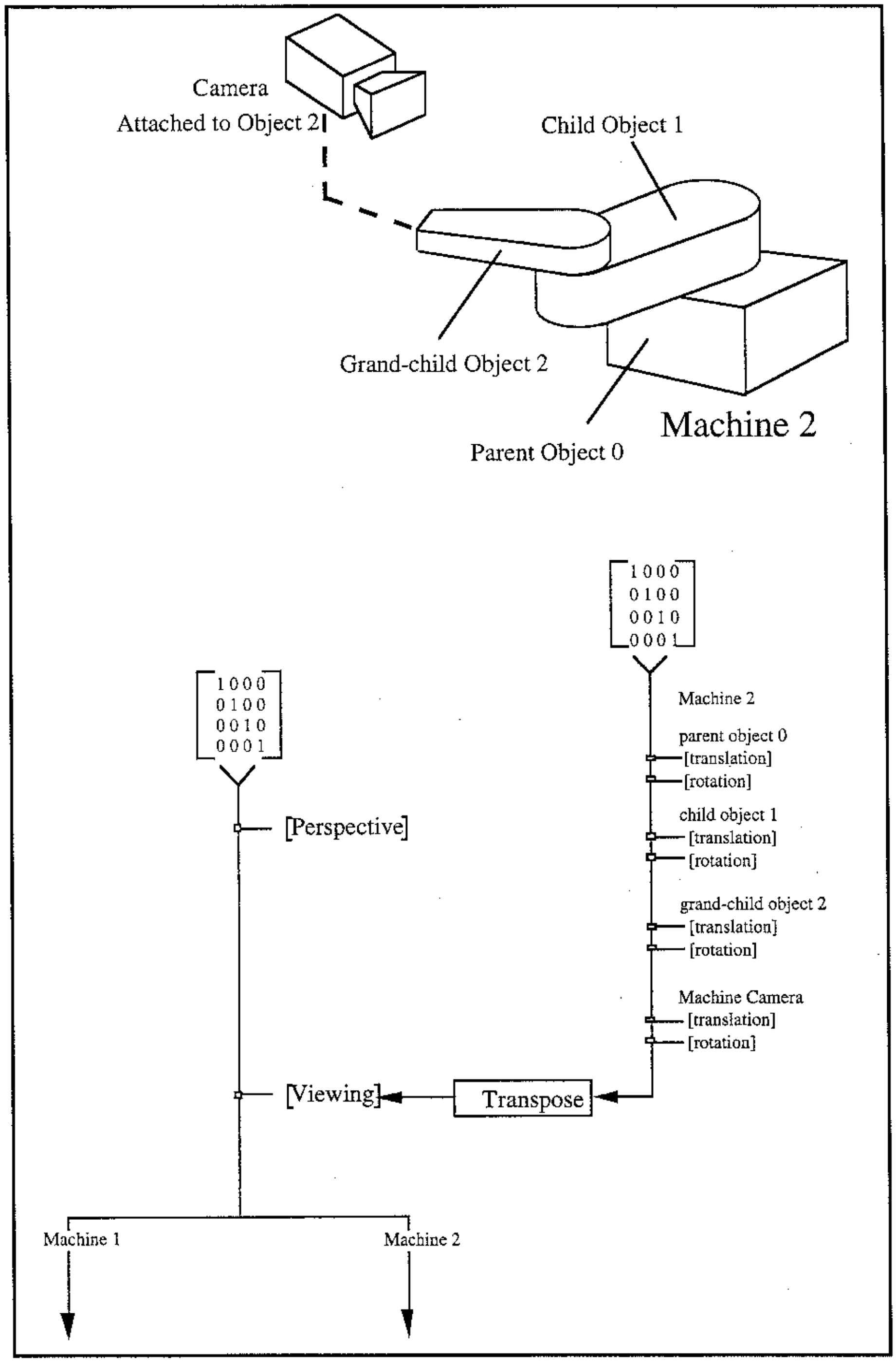

Figure 5. Hierarchical Viewing Manipulation

Another device that can be used to move the camera is the mouse. When the VR gear is active, the left and middle buttons of the mouse can be used to translate the camera forward and backward in the user's viewing direction. The right button is used to increment the travelling speed of the camera.

The Control menu is used to tell the environment what machine is going to be interactively controlled by the user. The menu will list all the machines that can be controlled and show the user the machines that are currently active. This is done by putting a mark next to the machine name. If the users do not wish to interact with any machines, they can select the ***nothing*** option from the Control menu.

The Lighting menu allows to specify, infinite (if all rays are parallel) or local. If the light is local, the rays originate from the specified light location in all directions.

The Display menu allows the user to determine the visibility of all the elements in the environment. Camera icons can be displayed on the environment, as well as icons, if desired. Machine and other objects can be made visible or invisible by selecting their name from a list in the Display menu. All the different display modes are controlled in the

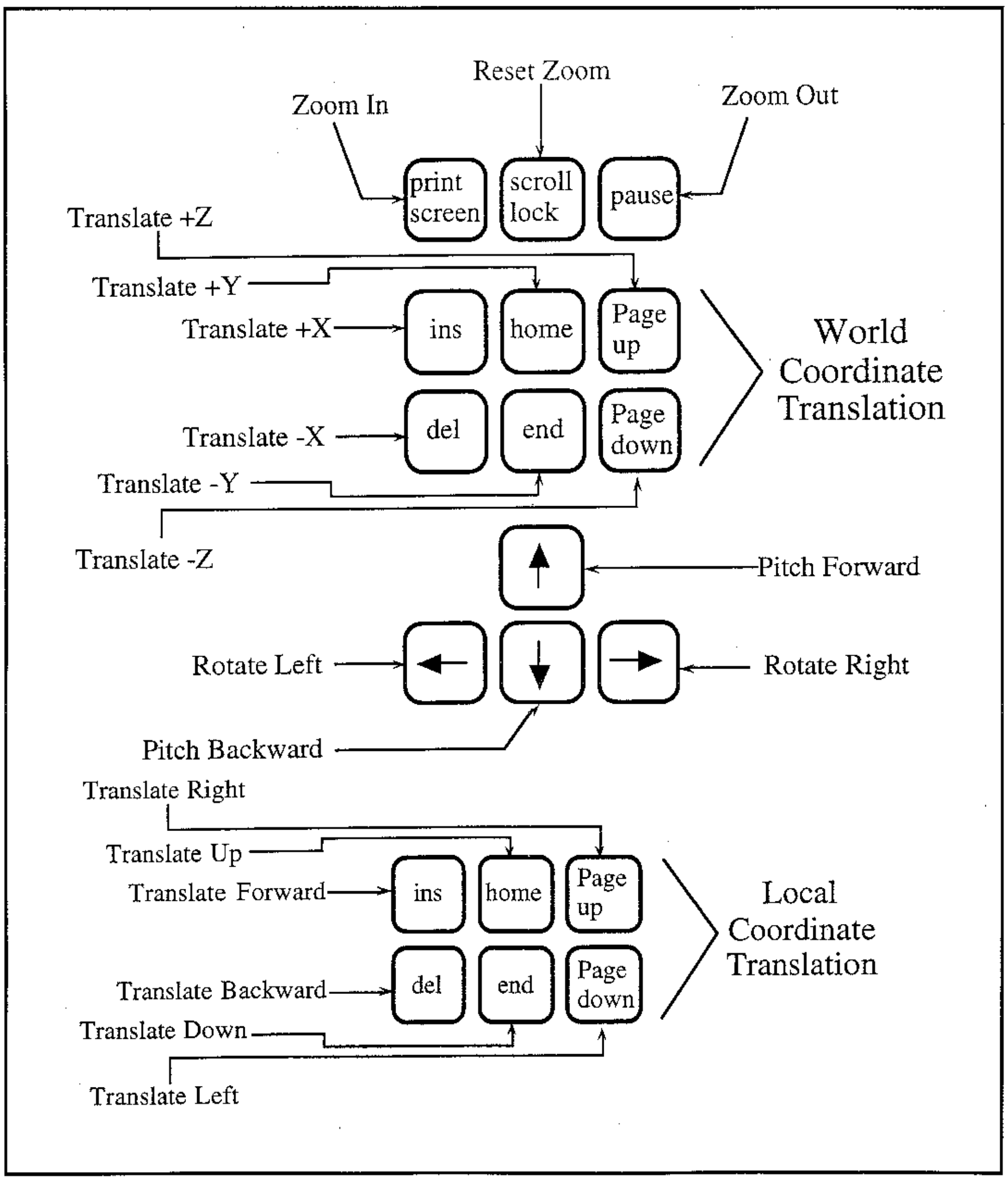

Figure 6. Camera Control and Local Coordinate Translation Functions

Screen menu. The size of the screen can be switched from full size to TV size (for making videos and having the image displayed in the HMD, for instance.) The video signal can be switched from standard RGB to NTSC, so it is compatible with regular video signals.

The Network menu features of IV++ are interactive. The user can begin to transmit information to other computers in the network by selecting ***start transmitting***. The information that is received from other computers can be filtered by activating different receiving options. The users can choose to receive machine information from other computers and still control the machine cameras by selecting ***receive machines*** only. If they choose ***receive machine cameras*** in addition to ***receive machines***, then both machine and machine camera information are going to come from the transmitting computer. Another option under Network allows the user to receive the view from another computer. If this is activated, a list of all the computers currently running in the network is attached to the menu. Thus, the source of the external view can be selected. This option can be used to control multiple computers simultaneously. It is possible to arrange many screens around the user and set them so they share the same view from the user's computer. The view of all the surrounding terminals can be rotated to match the user's point of view, creating a wide field of view effect.

The File menu provides the necessary features for saving and retrieving environment files. An environment file contains the entire definition of a virtual environment in IV++. A typical environment file would, for instance, define a robot machine with one light and one global camera, and also specify the terrain data file name. The user can make changes to any environment files by using an editor or creating one interactively. Environment files can be saved by using the save option under the File menu. Another option allows the user to retrieve a new environment while running the application. If the user chooses to load an environment, a dialogue box will pop up and display all the environment files available for selection.

The options under the Environment menu allow the user to change the texture mapping attributes of the terrain surface, add and delete the current terrain surface, and also add and delete machines in the environment. The ***texture on/off*** option will activate or deactivate texture mapping in the environment. The "number of copies" option lets the user choose how many times the texture pattern is repeated on the surface of the terrain. The user can also choose to change the texture picture of the terrain by selecting ***change texture picture***. This option will popup a dialogue box that will present the user with the list of possible terrain choices. Machines can be added to the environment by selecting ***add machine***. A dialogue box will display all the available machines that can be placed in the environment. After a new machine is selected, the user will be able to move the cursor over the terrain surface. This cursor uses the terrain evaluation functions to follow the surface of the terrain, while moving in the same coordinate system of the viewing camera. When the user decides where the machine needs to be located, the left mouse button can be clicked to place the machine.

In addition, IV++ user interface provides easy access to a programming library to create new virtual machines and link to CAD/CAM packages, like AutoCAD and CADKEY.

Conclusion

IV++ has opened a door that potentially leads to new visually-oriented design-implementation-based process technologies and a more productive design, construction, and manufacturing industries. IV++ is currently being used as an educational tool for pedagogical purposes as well as to identify future engineering design graphics research problems. The new system will eventually lead to computer graphics software products that may be marketed nationally as well as internationally. The integration of visual simulation techniques in design, construction, and manufacturing should also assist in optimizing the use of the limited natural resources of our planet Earth and improve competitiveness.

We need to improve the way complex products and projects are designed – not just the way they are built. Since interactive visual simulation systems, such as IV++, allow the design team to manipulate time – the fourth dimension – we can go back and forth in virtual-time and space to make design changes in response to problems detected while simulating the device or system being analyzed. The next step is to develop visual thinking tools that would allow designers, builders, and manufacturers to communicate and reason with images, rather than just with words and numbers. Such tools would enhance the user's ability to communicate and think visually, as well as verbally and mathematically. These visual thinking tools may not be necessarily classified as computer graphics, or artificial intelligence, or expert systems, but they will be like adding another dimension to the human mind.

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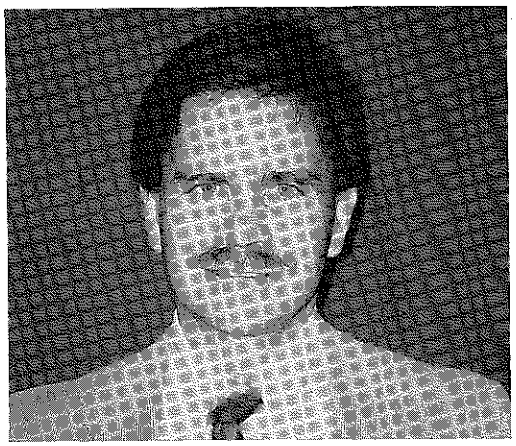
The Use of a Parametric Feature Based CAD System to Teach Introductory Engineering Graphics

Oppenheimer Award Recipient



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Abstract

New computer tools have significantly changed the role of engineering design graphics during the last few years. One tool, parametric feature based CAD, allows engineering graphics to go beyond the role of documentation and communication. The use of a parametric CAD system closely parallels the engineering design process. Parametric CAD systems allow an engineer to actually build a "virtual prototype" of a design idea or concept and subject that model to various what if scenarios. This virtual prototype can quickly be modified as the design solution is refined and implemented. Parametric CAD is a new paradigm or way of doing engineering graphics. A new parametric feature based CAD system, AutoCAD Designer, was used as the primary tool to teach fundamental concepts of three dimensional geometrical modeling and design in an introductory engineering graphics course at Northern Arizona University. Based upon this initial experience, parametric CAD promises to have a significant impact on the pedagogy and structure of engineering graphics courses.

Background

The role of drafting in an engineering curriculum has been the subject of much debate during the past few years. Drafting and descriptive geometry have been the sole medium for communicating design ideas for nearly 200 years. As computer technology developed during the last decade, engineering graphics instructors have begun to look at alternative forms of graphical communication. If one adopts the philosophy that engineers are primarily problem solvers and designers, then drafting is merely a vehicle used to communicate the solution to engineering problems.

During recent years most engineering schools have thoroughly revised, modified, or even initiated a design stem in their program curricula. Many colleges have introduced this design component into an introductory engineering graphics course. With this increased design emphasis in early courses, topics of traditional engineering graphics and descriptive geometry are often squeezed out of the program. With less time to teach more material, the pedogogy and methods used in the past are no longer adequate.

In the *Journal of Engineering Education*, Barr and Juricic (1994) document the "evolution of engineering graphics." They discuss the immediate past era, dominated by engineering drawings, which are conventional two dimensional orthographic representations of three dimensional engineering design solutions. With the advent of computer aided design (CAD) systems in the 1980's, drafting boards were replaced by electronic tools. These early (CAD) systems were essentially two dimensional "electronic drafting boards." CAD systems sped up the production and revision of engineering drawings, but did nothing to change the basic two dimensional nature of engineering graphics. In the late 1980's, Barr and Juricic (1989) proposed a curriculum change in engineering design graphics (EDG) based upon *three dimensional geometric modeling* rather than traditional orthographic representation. The new engineering design graphics model suggests that the engineering design process will start with a 3-D geometric model, then perform analysis and testing on this model, with the end result being a detailed set of 2-D production drawings.

Barr and Juricic's 3-D curriculum was first disseminated at the NSF Symposium on Modernization of the Engineering Design Graphics Curriculum (1990) in 1990. After considerable debate and discussion at various ASEE conferences, the three dimensional solid modeling approach to engineering graphics is now becoming accepted by many graphics instructors. The actual implementation of the 3-D solid modeling paradigm has occurred much more slowly than the acceptance. One significant barrier to implementing the new graphics paradigm has been limitations of the computer hardware and software. Until recently CAD systems capable of creating and manipulating 3-D solid models were slow, required expensive hardware, and were not always intuitive to use. During the spring of 1994, Autodesk introduced a new 3-D solid modeling tool, AutoCAD Designer, which significantly changes the way engineers create and use geometric modeling.

Fundamentals of Parametric Feature Based CAD

A *parametric feature based CAD* system represents a new paradigm, or way of doing engineering graphics. It is a tool which goes beyond generating engineering drawings. A parametric CAD system allows engineers to more easily create geometrical models of design solutions. In the 1970's engineers found they could be more productive in problem solving by using a new tool, the pocket calculator. This tool did not change the "problem solving process," but allowed engineers and engineering students to solve problems more quickly. In the same way, parametric CAD is a new way to create geometric models of engineering design problem solutions and will allow engineers to be more productive at solving design problems. Parametric CAD allows an engineer to ask *what if* questions and quickly model design alternatives. This new tool will have a significant impact on the pedagogy and structure of an engineering graphics course.

The process of creating a parametric CAD model is considerably different from creating conventional CAD drawings. With conventional CAD, the drafter worries about geometrical entities; circles, arcs, lines, polylines, etc. The drawing is composed of individual unrelated entities, and any changes to the drawing necessitate editing and/or redrawing all features of the drawing. The creation of a parametric CAD model is much like solving a design problem: you start with a two dimensional sketch, turn the sketch into a profile, and finally create a 3-D solid model from the profile. A parametric CAD system such as Designer has features which will create a 3-D solid by extruding, sweeping, or revolving a 2-D profile. Several Boolean operations can be used to create complex 3-D shapes.

Since all geometric entities which define the model are related to each other parametrically, any operation or modification of a single entity affects all other entities in the model. For example, you can change the length of one line and the entire 3-D model is correspondingly modified. This virtual design more realistically models the actual physical object than the group of unrelated geometrical entities comprising a traditional CAD drawing.

In addition to creating 3-D solid models with greater ease, Designer has automatic drafting features which allow for relatively simple creation of conventional two dimensional multiple view drawings from a 3-D solid model. The 2-D drawings have *bi-directional associatively*, which means that if you edit or change a feature on one of the 2-D views, the 3-D solid model is correspondingly modified.

The Design Process and Designer

Solving design problems is usually an iterative or continuous process. As the solution evolves, you are continually modifying and refining the design. Since the solution to a design problem is always changing, conventional CAD is a cumbersome tool for documenting the solution to a design problem. Any changes or iterations in the solution may require completely reconstructing the CAD drawing. A parametric CAD system is a much more natural tool for documenting the solution to a design problem. Since a parametric CAD model is not a group of unrelated geometric entities, you can change one parameter or geometric feature, and the entire model changes without having to be completely redrawn. For example, you can easily change the diameter of a hole, and all other related geometry is automatically updated to reflect that change.

The process of creating a Designer model parallels the process of solving an engineering design problem. Barr and Juricic (1994) describe the Engineering Design Graphics Process as having four stages: Ideation, Development, Communication, and Documentation. The steps of creating a Designer model closely parallel the four steps of the Engineering Design Process. The steps to create a Designer model are discussed below in terms of the Engineering Design Graphics Process:

Step One: Ideation

A design problem solution begins with creative ideas. These ideas are often the results of a brainstorming session and are expressed with freehand sketches. Likewise, a Designer solution begins with a sketch. Using Designer, the engineer will also create a quick sketch, not worrying about dimensions, orthogonality, connecting line segments, parallel features, etc. In the following steps, Designer will be used to automatically analyze this sketch and "clean it up" by closing endpoints, aligning parallel lines, snapping entities to horizontal and vertical angles, and applying any other needed geometrical constraints.

Step Two: Development

This phase of the design process begins with a geometric model. The model is usually constructed from the freehand sketches created in Step One. Likewise, the 2-D sketches drawn in Step One are used by Designer to define a geometric model. When commanded to create a *profile* from the sketches, Designer applies rules to analyze the sketch and snap lines orthogonal, parallel, collinear, and close endpoints. This step replaces the conventional AutoCAD drawing aids such as object snap, ortho mode, and snap. At this stage in the design process, the solution may change frequently. Because modifications to the model are particularly easy with a parametric CAD system, Designer is ideal for this stage in the design process. Using the "cleaned up" profile which Designer created, the engineer then defines the geometry by adding *parametric dimensions*, or dimensions which are used to define the shape and size of the model. Unlike conventional dimensions which only give a "measure" of the geometry, Designer's parametric dimensions actually drive or determine the size and shape of the object.

Step Three: Communication

Once you have a 2-D fully defined profile, special 3-D features of Designer can be used to turn it into a three-dimensional solid. Designer can create a solid by extruding, sweeping, or revolving the profile. This task is simplified through "intelligent" dialog boxes which indicate graphically how each operation will affect the resulting 3-D object. Complex models can be created from the basic 3-D solid by defining additional "profiles" and performing the Boolean operations: cut, intersect, or join to create complex 3-D objects. Features such as holes, countersinks, fillets, and chamfers can be added to the model through the use of graphical dialog boxes.

Step Four: Documentation and Implementation

By definition, design is an iterative process. The design engineer will be required to modify the model in response to these iterations. With a non-parametric CAD system, this usually requires reconstructing the entire 3-D model to accommodate even minor design changes. Defining the 3-D model parametrically allows the engineer to make changes and have the software automatically update all related features and geometry.

The final phase of the design process is implementation, which refers to the testing, construction, manufacturing, and documenting the solution to the design problem. Designer has an important role in several of these activities.

The documentation of your design solution must be clearly communicated with others. Designer has the capability to automatically generate multiple view drawings from a 3-D solid model. Orthographic, auxiliary, isometric, detail, and cross-sectional views can be quickly created with a few clicks of the mouse using graphical dialog boxes. Since bi-directional associatively is maintained between the 3-D model and the 2-D drawings, any changes to the model are automatically reflected in the views presented in paper space. This capability is one of the big payoffs to using Designer for engineering documentation.

A Designer model represents a complete unambiguous 3-D model of your design solution. Therefore, it is relatively simple to use this model as input for other important engineering applications such as finite-element analysis, rapid prototyping (using stereolithography or CNC applications), and photorealistic rendering.

Parametric CAD or Traditional CAD?

Is a parametric CAD based curriculum appropriate for freshman and introductory Engineering Design Graphics? Parametric CAD based design tools are becoming widely used for industrial mechanical design, but have not yet been widely adopted in engineering graphics education. A rich collection of teaching materials and curriculum based upon conventional engineering graphics is available for freshman level courses. However, materials and experience in parametric CAD systems are very scarce at this time.

This instructor holds the opinion that a parametric based CAD approach to introductory Engineering Design Graphics offers significant advantages to a traditional approach. This opinion is based upon two semester's experience with using a parametric CAD paradigm in an introductory course. Engineering Design Graphics is often the first course to introduce engineering design principles. A parametric CAD based methodology more closely parallels the engineering design process than a traditional graphics approach to design representation. Traditional CAD is focused more on the mechanics of geometric construction rather than on the representation of design solutions. Parametric CAD allows a student to concentrate on understanding the design process and the result of that process, rather than the details of drafting. Yet with its automatic drafting features, a parametric CAD system can be used to easily construct conventional orthographic drawings. Conventional 2-D engineering drawings to be "taken off" the 3-D solid model. Designer is a quicker and easier way to document and model engineering design solutions. The topics of drafting can be covered in much less time using a tool such as Designer, allowing more time for coverage of other engineering topics. Some of the advantages of using a parametric CAD based approach to engineering graphics courses are summarized below:

Simplifies 2-D geometric construction

All the tedious intricacies of geometrical construction are considerably simplified with Designer. The engineer starts with a "quick and dirty" sketch, rather than a fully dimensioned orthographic drawing. During the second step in the design process, the software analyzes the sketch when converting it to a profile and will snap lines to the horizontal or vertical, close endpoints, make center locations collinear, snap lines tangent to arcs or circles, etc. The software completes in seconds what might take hours to draw in detail using conventional CAD drawing aids. No longer does the design engineer need to worry about using exact dimensions, locations, and scales when beginning the model. Dimensions are added later in the form of numeric constraints. Since these constraints drive or define the geometry, the software will automatically modify the model to reflect the constraints the engineer specifies.

To illustrate this process, consider the sketch shown in Figure 1. This sketch was quickly created with polylines, with no regard to dimensions, closing end points, tangency, or orthoganality. No AutoCAD drawing aids were used to construct this sketch. Figure 2 illustrates this sketch after Designer ***cleaned it up***. Designer automatically snapped the lines horizontal and vertical. These lines were also snapped tangent to the arc, and the symbol T assigned to denote a tangent constraint. The symbols H and V denote horizontal and vertical constraints which were assigned by Designer.

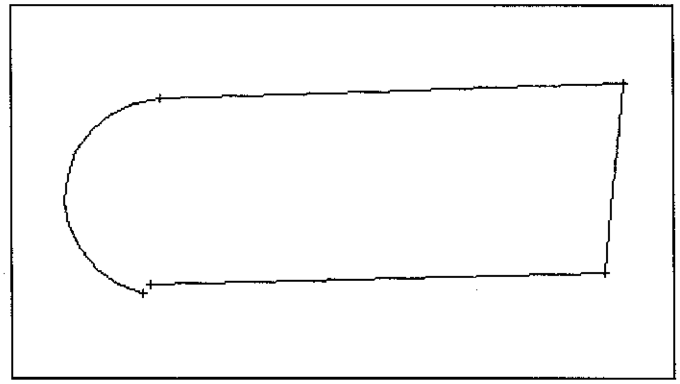

Figure 1 Simple AutoCAD Sketch Used as Input to Designer

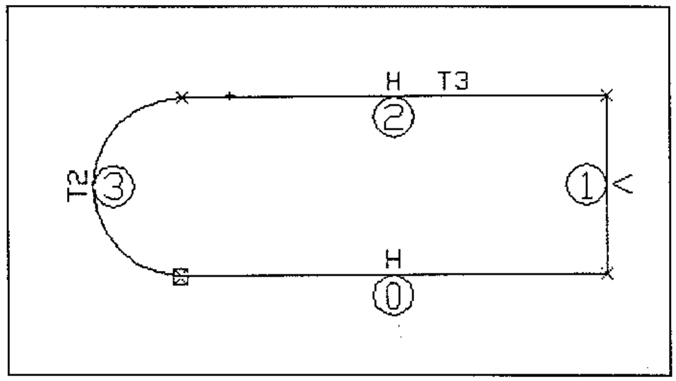

Figure 2 Cleaned Up Profile Generated from Designer

Automates Drafting Process

Automatic orthographic and auxiliary view creation

Orthographic views are created automatically from the 3D solid model. Graphical dialog boxes are used to specify scales, linetypes, label views, etc. When generating a primary orthographic view from the 3-D model, Designer automatically constructs hidden lines and centerlines. The views are lined up according to the rules of orthographic projection. This feature greatly assists students in three dimensional visualization skills since they can dynamically see the relationship between the various views and the 3-D object.

Automatic Dimensioning

Dimensioning is applied automatically when generating 2-D orthographic views from a 3-D model. Since geometric and numeric constraints are used to define the parametric based solid model, the 3-D solid represents a fully defined representation of the actual physical object. The model database contains information such as dimensions, geometric relationships, mass properties, etc. All necessary dimensional information is automatically included in the 2-D views created from the 3-D model.

Automatic sections

Cutting planes through a 3-D model are specified with a graphical dialog box. Designer will automatically create the cross sectional view through that cutting plane. The full AutoCAD hatch pattern library can be applied to that section.

Simplified 3-D solid model construction

Designer enhances and simplifies the 3-D construction tools and concepts used to create an AutoCAD AME solid model. The concept of ***sketch planes*** and ***work planes*** are introduced in Designer to assist in 3-D construction. A sketch plane can be thought of as a two dimensional sheet of paper that can be moved anywhere in space. The ***sketch*** you draw is always constructed on this plane. The sketch plane can be associated with a UCS, viewport, or with a particular piece of geometry. Since sketch planes are parametric, if the geometry moves, the sketch plane moves along with it.

The Boolean operations *cut*, *join*, and *intersect* can be used to create complex 3-D shapes. In addition to various extrusion operations, 3-D geometry can be constructed by ***revolving*** a profile around an axis or ***sweeping*** it along a three-dimensional ***rail***.

Parametric design

Without parametric features, Designer is nothing more than an enhanced drafting tool. The real power of Designer shines when parametric relationships are applied to the model. Mathematical equations can be used to define geometry or relationships between geometric elements. For example you can define the diameter of a shaft as equal to the hole diameter plus some clearance value. If the model is modified through the design process, this clearance will always be maintained, since the shaft diameter will automatically be modified according to the mathematical relationship you specify. Parametric relationships allow an engineer to use CAD as if it were a geometrical spreadsheet. Once the basic model is defined, parameters can be easily modified and the model used as a ***what if*** tool for examining design alternatives.

Engineering Design and Graphics at Northern Arizona University

In 1991, NAU instituted a new course, *EGR 180: Engineering Design Graphics.* EGR 180 evolved from a traditional engineering graphics course. One goal of EGR 180 is to help reduce the high dropout rate during the freshman year by exposing students to the ***creative*** aspects of engineering through the design process. This is accomplished by introducing freshman engineering students to the use of the computer as both a problem solving and communication tool in engineering. The basic philosophy of this course is to integrate traditional design principles and visual thinking with the new trends in computer graphics simulation and visualization techniques. Drafting is taught within the framework of the design process, and is viewed as a technique to communicate a two dimensional representation of a three dimensional design solution. As this course evolved, engineering design topics have gradually displaced descriptive geometry and traditional drafting. During the Fall 1994 semester *AutoCAD Designer* was introduced in EGR 180. A team design project is the culminating activity in EGR 180, and Designer is used as the tool to model and communicate graphical representations of design solutions.

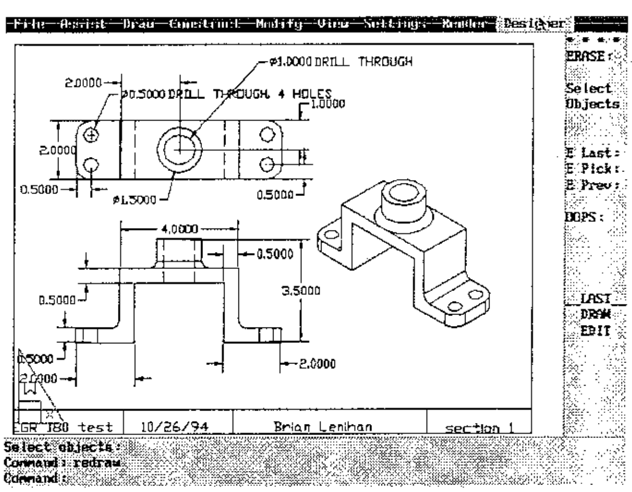

Figure 3 Designer mid-term exam

Course Structure and Implementation

EGR 180 is structured to meet twice per week for a total of 15 weeks. The classes are two hours in length, consisting of a 30 minute lecture followed by a 90 minute computer lab exercise. During the Fall 1994 semester EGR 180 began with a 5-week introduction to the design process and fundamentals of computers and AutoCAD. Prior to introducing Designer, students were taught the basics of CAD such as: drawing and editing commands, using files, plotting, and CAD construction aids. During the sixth week of the semester, students were introduced to Designer and the fundamentals of parametric CAD. Three weeks were then spent covering six lessons in Designer. The following Designer topics were covered during the three weeks:

1. Introduction to Constraints and Parametric Dimensions: Creating a 2D profile from a Designer sketch
2. Using Extrusion to Create a 3D Solid Model from a 2D Profile
3. Creating Conventional Engineering Drawings from a Designer 3D Model
4. Using Boolean Relationships to Create a Complex 3D Model
5. Advanced 3D Construction: Work Planes, Work Axis, and Revolutions
6. Using Parametric Equations to Define the Model: Basic Assemblies

At the end of the ninth week, the students were tested on the fundamentals of

CAD and Designer. They were given a one hour exam, asking them to construct a 3D solid model of the object shown in Figure 3. From this 3D model they had to construct a fully dimensioned working drawing consisting of the principle orthographic views and an isometric view of the part.

Other tools for engineering design were introduced during the second half of the semester such as equation solving software and electronic spreadsheets. During the last four weeks of the semester, students were divided into teams of 2 or 3 to complete a ***capstone*** design project. All of the tools and design topics covered during the course were integrated into solving an open ended design type problem. The culmination of this project was a written and oral presentation, including a complete set of working engineering drawings. The drawings were constructed using AutoCAD Designer.

The Semester in Retrospect

The learning curve for Designer was surprisingly easy. After only three weeks instruction, the students were producing 3D models and complete engineering drawings. The quality of the engineering drawings were superior to those produced after a full semester of instruction in conventional drafting and CAD. Designer greatly assisted students in developing visualization skills. Students who were having difficulty with 3D visualization and seeing the relationship between orthographic views and a 3D model were able to grasp those concepts. Designer allowed those students to interactively ***see*** the relationship between orthographic projections.

When tested with the problem shown in Figure 3, over 90% of the class was able to completely finish the exam in less than an hour. This included creating the 3D model and constructing an isometric and a fully dimensioned orthographic drawing of the object. In fact, several students completed the exam in 20 minutes or less. The completion rate and quality of work was far superior to what students had accomplished in previous semesters using a conventional CAD paradigm.

Summary and Conclusions

Concepts of parametric CAD were easily grasped by freshman engineering students. Students were able to see the relationship between CAD and the engineering design process, since creating a parametric CAD model closely parallels the design process. Students were excited and motivated in their study of engineering because of the ***fun*** of using a modern design tool.

A team design experience gave introductory engineering students a ***taste*** of the creative side of engineering. AutoCAD Designer allowed the students to focus on the process of engineering design without getting bogged down in the details of drafting. Designer allowed the students to model and graphically represent the solution to their design problems. Graphical representation of design solutions is done more efficiently with a parametric CAD tool such as Designer. Less time was spent covering drafting fundamentals, thereby allowing more time in the course for other topics related to the design process.

Acknowledgments

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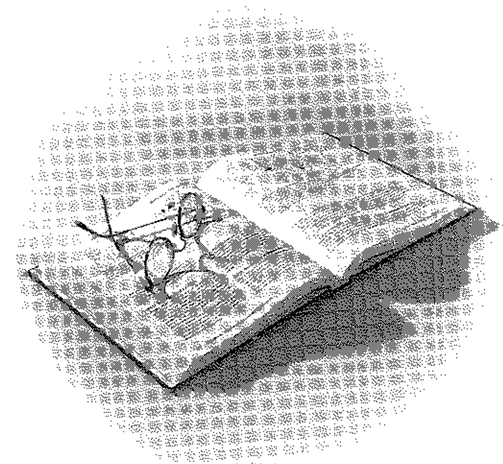

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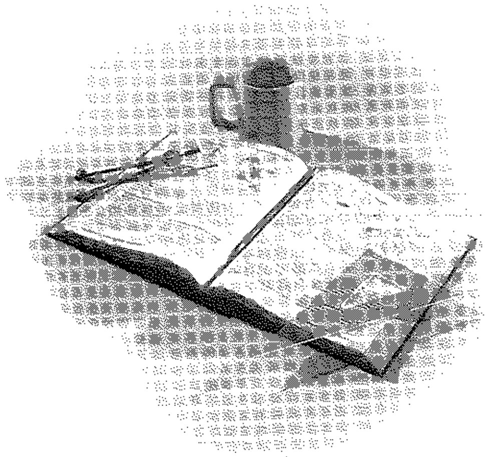

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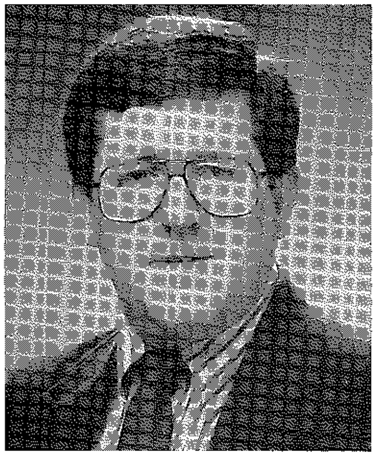

Chair's Message
William A. Ross

Personally I am always ready to learn, although I do not always like being taught.

Winston Churchill

What's graphics got to do with it? If you were unable to attend the 49th Mid-year Conference in Houston, you missed an excellent opportunity to find out more about this important question. General chair Ron Paré of the University of Houston and program chair C. Wayne White of Purdue University did a highly commendable job in organizing and hosting a fine meeting. The technical sessions were excellent and the visit and tour of the NASA Johnson Space Center was an inspiring and memorable experience.

As always, it was good to see many old friends and familiar faces at the Conference. It was especially good to see a number of new faces in the form of visiting graduate students and newer faculty. We welcome you to our organization and hope that you will consider joining our ranks. In fact, please go out of your way to bring a colleague or friend along with you.

On the forward edge of instructional and curriculum issues, it was encouraging to hear lively presentations and see demonstrations on parametric modeling, instructional animation, Internet, Mosiac, and the World Wide Web. Congratulations again to this year's Oppenheimer Award winner, Steve Howell of Northern Arizona University, for an outstanding presentation on, *The Use of a Parametric Feature Based CAD System to Teach Introductory Engineering Graphics.*

It is vital that new ideas and methods find their way into engineering design graphics courses. This is especially true for programs and departments within Colleges or Schools of Engineering where curriculum modernization efforts are setting new priorities for support and foundation courses. In order to remain educationally relevant to engineering, we must enthusiastically embrace change by listening, learning, experimenting and incorporating new technologies and methods into our courses. Keeping Mr. Churchill's observation in mind, we must be willing to learn and to be taught from a variety of sources; even those we may not immediately understand. As always, if you believe that engineering design graphics is an important educational foundation, you must be willing to continuously justify and prove its value.

Looking ahead, the 50th EDGD Mid-Year Conference will be held in Ames, Iowa, November 15 through 17, 1995. The conference is to be hosted by Rollie Jenison and other faculty members within the Engineering Fundamentals and Multidisciplinary Design Divsion of the College of Engineering at Iowa State University. As Barry Crittenden said in a previous Chair's Message, may I also encourage you to contact Division "senior citizens" who may be living in your region and encourage them to join us in Ames, Iowa, in November, 1995. Plans are already well under way to offer a series of exciting and useful hands-on workshops in the emerging areas of parametric feature based CAD, 3D computer animation, Mosiac & World Wide Web on Internet, instructional authoring systems, and possibly multimedia. Our 50th anniversary conference should be a memorable occasion. We look forward to seeing you in Ames!

edgd Officer Candidates

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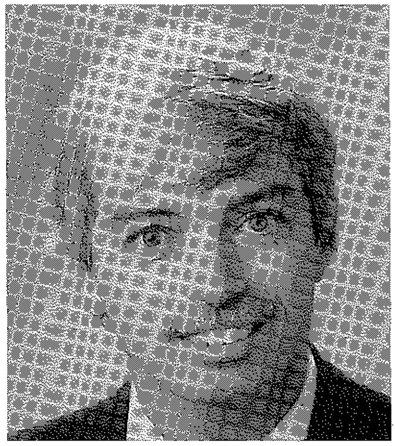
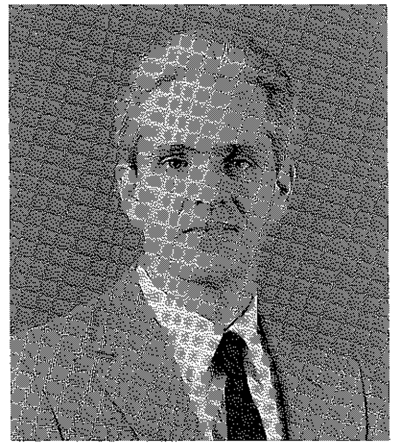




Gary R. Bertoline

Gary is a professor in the Department of Technical Graphics at Purdue University. He received the Ph.D. degree from The Ohio State University in 1987. Prior to joining the faculty at Purdue, he served three years as a faculty member in the Department of Engineering Graphics at The Ohio State University and three years on the faculty of the Celina, Ohio branch of Wright State University. He has been a member of ASEE and EDGD for eleven years.

Gary is active in ASEE, having served as treasurer and vice chair for the North Central Section. He served as chair of the Industrial Advisory Committee and the Technical and Professional Committee of EDGD. He was program chair for the 1990 EDGD Mid-Year Meeting and has been awarded the Oppenheimer Award for the best paper at the EDGD Mid-Year Meeting three times. In 1990, Gary was named to the Steering Committee for the International Society for Geometry and Graphics. Currently, he is the administrator for the Autodesk University Partners Program at Purdue.

Gary has presented over forty-five papers at professional conferences in North America, Australia, and Europe. He has authored numerous papers in journals and trade publication on engineering and technical graphics, CADD, and visualization research. His research interest is in measuring and improving visualization in engineering and technology students. He has authored books in computer-aided design and engineering graphics and serves on the Board of Review for *The Engineering Design Graphics Journal* and the *Journal of Technical Graphics and Computing.* Gary's greatest authoring accomplishment is the notable new textbook, Engineering Graphics Communication, published by Irwin Publishing Company.

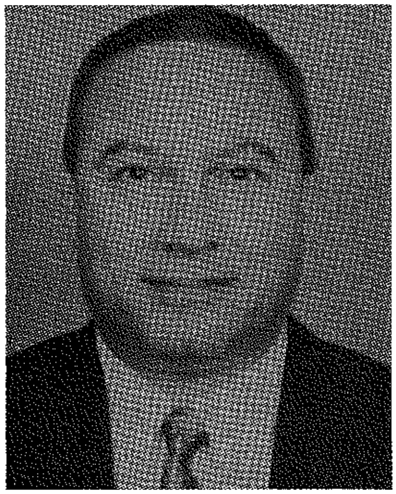
Tim Sexton

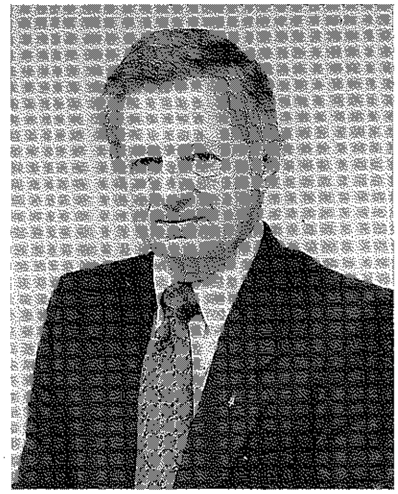
Tim is an associate professor of Industrial Technology in the Russ College of Engineering and Technology at Ohio University in Athens, Ohio. His responsibilities at Ohio University include teaching courses in engineering graphics, architectural drawing, computer applications in industry, and managing the college's computer graphics lab. His research interests include: measuring and fostering abilities in spatial visualization, developing instructional material using CAD for entry-level engineering graphics courses, and designing and developing presentation graphics. He is authoring a textbook on CADKEY software which is scheduled to be published by Irwin Publishing Company in 1995.

Tim has been a member of EDGD since 1987, presented numerous papers at ASEE and ASEE/EDGD meetings, is currently on the Review Board for The Engineering Design Graphics Journal, and was the facilities chair for the ASEE/EDGD's 1993-94 Mid-Year Meeting. In addition to ASEE, he is a member of the National Association of Industrial Technology (NAIT) and Epsilon Pi Tau (EPT).

Prior to going to Ohio University in 1985, he taught drafting for eight years at the high school level and was an architectural drafter for two years. He received a B.S. in Architecture from the University of Illinois (1973), an M.S. in Industrial Technology from Western Illinois University (1977), and a Ph.D. in Instructional Technology from Ohio University (1991).

Director of Programs





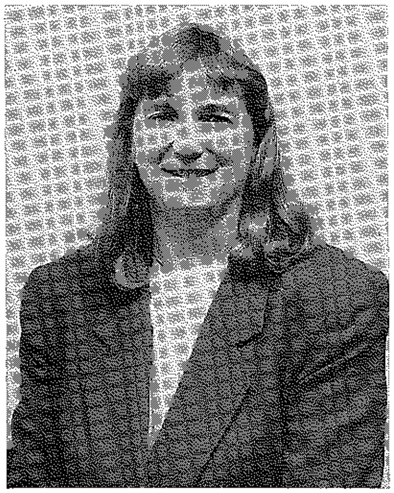
Moustafa R. Moustafa

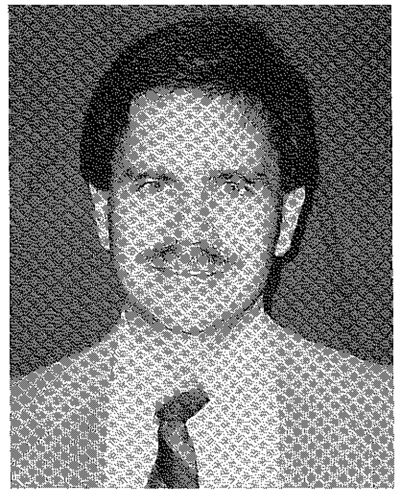
Moustafa is an associate professor of Mechanical Engineering Technology at Old Dominion University, Norfolk, Virginia. Moustafa holds two M.S. degrees from the University of Illinois and a B.S. from the Higher Industrial Institute in Egypt. His teaching experience spans twenty-five years in mechanical engineering and engineering graphics at Helwan University in Egypt, the University of Illinois, and Old Dominion University. Professional affiliations include ASME, AIAA, AAM, SME, and ASEE. In addition to several awards and grants, Moustafa has several papers and presentations to his credit. He has served as associate editor for the Journal of Theoretical Graphics and Computing, EDGD program chair for the ASEE Annual Conference in Lincoln, Nebraska, and general chair for the EDGD Midyear Meeting in Norfolk, Virginia. Moustafa is the current EDGD Director of Zones.

F. D. "Fritz" Meyers

F. D. "Fritz" Meyers is an associate professor and section head for Engineering Graphics at The Ohio State University. Before joining the OSU faculty, he worked in private industry as an engineering manager for thirty years. He has been active in the EDGD for the past ten years and served as program chair for the annual meetings of the Division in 1990 and 1994. His professional interests are quality improvement, teaching design, and Geometric Dimensioning & Tolerancing (GD & T). Fritz has received awards for outstanding teaching in the OSU College of Engineering, and he was one of eight professors to receive the OSU Alumni Award for Distinguished Teaching in 1994.

Director of Liaisons





Holly Keyes Ault

Dr. Ault holds a B.S. ('74) in Chemistry and M.S. ('83) and Ph.D. ('88) in Mechanical Engineering from Worcester Polytechnic Institute. She was a Rotary Foundation Undergraduate Scholar at the University of Bergen, Norway, and was employeed as a Manufacturing Engineering in the Grinding Wheel Diamond Products Division of Norton Co. She worked in product development, manufacturing engineering and research at the Olin Corp. and she was a post-doctoral fellow in the Newman Center for Biomechanics and Rehabilitation Engineering at MIT.

Holly is currently Associate Professor of Mechanical Engineering and Director of the Computer Aided Design Laboratory at WPI. She teaches both graduate and undergraduate courses in CAD and Geometric modeling, kinematics and introduction to design. Dr. Ault's research interests include computer-aided design, computational geometry and geometric modeling, kinematics, biomechanics, rehabilitation engineering and design theory. She has been active in the ASEE Engineering Design Graphics and Computers in Education divisions, serving as session chair and reviewer and is co-director of the North/South America region of the International Society for Geometry and Graphics and serves on the Western Hemisphere Organizing committee for the 7th International conference.

She is a member of ASME, ASEE, ISGG, ACM-SIGGRAPH, SWE and Sigma Xi. She belongs to Tau Beta Pi, Phi Lambda Upsilon and Pi Tau Sigma honor societies.

Steve Howell

Steve is an associate professor of Mechanical Engineering at Northern Arizona University. He received his Ph.D. degree from the University of British Columbia in 1983. His MS and BS degrees in mechanical engineering were received from Southern Methodist University in 1977 and 1976. Prior to joining the engineering faculty at NAU, Steve taught various mechanical engineering courses at University of the Pacific, beginning in 1983. From 1986-87 he worked with the College of Engineering at the University of Zimbabwe under a US Agency for International Development grant. While in Zimbabwe he helped install and implement the first computer-aided learning lab in Sub-Saharan Africa.

Steve has been active in the EDGD of ASEE since 1991 and active in the ASEE since 1987. He has presented numerous papers in the field of computer-aided learning and computer graphics. He has authored a book on *Engineering Design and Problem Solving* and is currently working on an AutoCAD Designer book. He twice won the Oppenheimer Award for the best paper at the EDGD Mid-Year Meeting.

ENGINEERING DESIGN GRAPHICS DIVISION ASEE

Call for Papers

The 50th Mid-Year Conference

Engineering Design Graphics Division
Iowa State University, Ames, IA
November 5 – 7, 1996

The program for the 1995/1996 Mid-Year Conference is being developed. This is the 50th annual conference and therefore is a milestone meeting. Abstracts (250 words) related, but not limited to the suggested topics listed below are being sought. Indicate if a paper presentation or poster session would be the most appropriate format.

Conference Theme:

THE FUTURE ISN'T WHAT IT USED TO BE.

Suggested Topics:

I. **YESTERDAY:** *How Did We Get To Where We Are?*

- ✔ What has happened to the topics that were important?
- ✔ What topics should we still be teaching?
- ✔ Why is there a split between computer and traditional graphics?
- ✔ Has visualization been enhanced by computers?
- ✔ Any special topics related to the 50th anniversary meeting

II. **TODAY**: *Current Topics*

- ✔ The role of visualization and analysis to teaching graphics
- ✔ What is the state of the art in teaching?
- ✔ The role of design and synthesis in teaching graphics
- ✔ Can traditional and computer graphics be integrated?
- ✔ What determines effective teaching software?
- ✔ Effective teaching aids
- ✔ Role of standards in a rapidly changing environment

III. **TOMORROW**: *The Future of Engineering Design Graphics*

- ✔ Instructional initiatives
- ✔ New/Breaking technologies
- ✔ Recommendations for development

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Call for Artifacts

There will be an Artifacts Display at the Midyear Conference in November at Iowa State. If anyone in the division has items of historical significance relating to graphics practices or the profession, we'd like to consider them for display. We will provide security during the display and they can take whatever is on display with them when they leave. Items might include unusual instruments, graphical devices, rare books, maybe models, and we decided that unusual slide rules or other graphical calculating devices would qualify (not "typical" slide rules). Anyone who has a candidate item should contact me directly. I can be reached by regular old-fashioned mail or:

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August 19-23, 1994

by Rollie Jenison

The 6th International Conference on Engineering Computer Graphics and Descriptive Geometry (ICECGDG) was a resounding success. Our gracious Japanese hosts, led by Professor Saburo Nagann, University of Tokyo and the Chairman of the Japan Organizing Committee, and Professor Kenjiro Suzuki, University of Tokyo and the Conference Secretary, conducted a well planned conference. The Conference was held at the Chiyoda Campus of the Otsuwa Women's University, a modern campus located in downtown Tokyo adjacent to the Emperor's Place.

A total of 207 registrants attended the conference with 136 of those from Japan. What tremendous support from the members of the Japan Society for Graphics Science! The Conference Proceedings contains 165 papers from authors representing 24 countries and covering topics on theoretical graphics and applied geometry, engineering computer graphics, and graphics education. In addition to the support from the Japan Society for Graphics Science, the Conference was aided by 54 Japanese industries, the Engineer-ing Design Graphics Division of the American Society for Engineering Education and the Department of Computer and Graphic Sciences of the University of Tokyo. A gala Conference dinner was held at the 5-star Akasaka Prince Hotel, which also served as Conference headquarters.

The social part of the Conference included a one-day trip to Mt. Fuji and a post-conference three-day trip to Kyoto with a ride on the famous Japan Bullet Train. Most of the Conference participants also took advantage of the nearby Ginza shopping district to look for appropriate souvenirs to bring home.

Thanks go to our Japanese colleagues for their outstanding planning for the Conference and for handling the numerous needs and questions of the attendees. We all look forward to returning in the future for another excellent Conference.

The International Society for Geometry and Graphics (ISGG), formed at the 5th International Conference in Melbourne, held its first official meeting in Tokyo with newly elected president, Walter Rodríguez, presiding. Other officers include Vera Anand, Secretary-Treasurer, Kenjiro Suzuki, Vice-President for Asia/Australia region, Hellmuth Stachel, Vice-President for Europe/Africa region, and P. J. Zsomber-Murray, Vice-President for North/South America region. The next task will be the selection of the remainder of the directors for the governing board and the establishment of membership and fee guidelines.

Interested persons should contact Walter Rodríguez or Vera Anand if you wish to receive information about membership. ISGG plans to make announcements through various publications from the international societies as well as through individual contacts in a newly established database for previous attendees of International Conferences.

The ISGG officers approved the next two International Conferences. The 7th Conference is scheduled for July 18-22, 1996 at the Cracow University of Technology in Cracow, Poland. The conference chair is J. Tadeusz Gawlowski and the Conference vice-chair is Lidia Zakowska. The first announcement letter has been sent out. The 8th Conference was approved for the University of Texas in 1998. Davor Juricic is currently designated as the Chair for that Conference.

Calendar

1995 North Central Section Spring Conference
Strategies for the 21st Century
The Ohio State University, Columbus, Ohio
April 20-22, 1995

1995 Annual ASEE Conference
June 25-28, 1995
Anaheim, California
Program Chair: Janak Dave
College of Applied Science
University of Cincinnati, Ohio 45206-2822
(513) 556-5311
FAX (513) 556-4015
EMAIL: davej@Uc.edu

1995-1996 EDGD 50th Annual
Mid-Year Conference
Iowa State University,
Ames, Iowa
November 5-7, 1995
General Chair: Roland D. Jenison
Program Chair: James Shahan
Division of Engineering Fundamentals,
Iowa State University,
206 Marston Hall,
Ames, Iowa 50011-4007
(515) 294-1614
FAX: (515) 294-4007
EMAI: estaben@iastate.edu

1996 Annual ASEE Conference
June 23-26, 1996
Washington, D.C.
Program Chair: Moustafa R. Moustafa,
Engineering Technology,
Old Dominion University
11-KDH
Norfolk, Virginia 23529-0244
(804) 683-3767
FAX: (814) 863-5655

1996-97 EDGD 51st Annual Mid-Year Conference
Location: North Carolina State University
General Chair: Eric N. Wiebe
Program Chair: Bob Chin
Graphic Communications Program
Department of Occupational Education
College of Education and Psychology
North Carolina State University
Box 7801, Raleigh, NC 27695-7801
(919) 515-2234
FAX: (919) 515-7634
EMAIL: eric_wiebe@ncsu.edu

1997 Annual ASEE Conference
Milwaukee, WI, June 15-18, 1997
Frank Croft, Program Chair

ICED '95 Praha
International Conference on Engineering Design
Aug. 22-24, 1995
Czech Technical University (CVUT), Prague, Czech Republic
Theme: Design Science for and in Design Practice
Contact: Czech Technical University (CVUT)
Faculty of Mechanical Engineering,
Technicikå4, CZ-166 07 Praha 6, Czech Republic
Tel: +42-2-311-1273
Fax: +45-2-311-1273

EDUGRAPHICS '95
Second International Conference on Graphics Education

COMPUGRAPHICS '95
Fourth International Conference on Computational Graphics and Visualization Techniques
Alvor Algarve , Portugal
December 11-15, 1995

In Cooperation with the "International Society for Geometry and Graphics," these conferences will be held concurrently.
Contact: Harold P. Santo
Department of Civil Engineering - IST
Technical University of Lisbon
Av. Rovisco Pais, 1
1096 Lisboa Codex Portugal
Tel. + Fax : +351-1-848-2425
E-mail: chpsanto@beta.ist.utl.pt
Submission deadline: May 31,1995

CADEX '95
International Conference and Exhibition on Computer Aided Design
Seville, Spain
December 4-8,1995
Contact: Harold P. Santo (See above)
Submission deadline: May 31,1995

EUROGRAPHICS '95
Graphics•Multimedia•Virtual Realtity
Maastricht, The Netherlands
August 28 - September 1, 1995
Contact: Lidy Groot, Congress Events
P.O. Box 83005, 1080 AA Amsterdam, The Netherlands
EMAIL: eg95@cwi.nl
FAX: +31-20-6758236

NSF Supported Workshop

Enhancement of Faculty Design Capabilities

For: Engineering faculty teaching undergraduate engineering science courses in all disciplines

July 30-August 11, 1995
Contact: Dr. Charles M. Lovas
Southern Methodist University
(214) 768-3207

Enhancement of Faculty Design Capabilities is a two-week workshop offered from July 30 to August 11, 1995 at Southern Methodist University in Dallas, Texas. This workshop is offered for all engineering disciplines and faculty who intend to or are presently teaching design in engineering courses to undergraduate students. This workshop strives to address needs of faculty from two-year and four-year institutions who teach non-design, or engineering science courses and desire to include design into the course work.

The workshop addresses topics in design methodologies, design content, design constraints, design tools, and teaching design through a multi-faceted format using lectures, laboratory sessions, discussion sessions, work sessions and industrial tours. Participants are expected to develop a design plan, design problems, design projects, and design case studies. Workshop participants will work individually, in single discipline teams, and in multi-discipline teams to design materials for use in incorporation into courses at their home institution. Faculty leaving this workshop will have a design plan, design materials for courses, a plan of implementation at the home institution, and a network of design faculty with whom to interact.

This workshop will guide faculty to a different way of thinking, a freshened approach to processes and procedures of design synthesis as opposed to highly analytical skills generally emphasized in research activities and engineering science courses.

Dear Mary,

I want to thank you for the effort and the trouble you went through to publish the article on the Equilateral Triangle. There is no way to estimate the difficulties an Editor agonized through to get each issue to the printer. After an article appears in print, it is difficult to know how many will take time to read it, and appreciate the effort others have taken in getting it before our group.

Although you went to the trouble of rearranging my article even to the task of retyping some of it, one tiny error slipped in. This one and one other which I let get passed me, made a sum total of two for the entire five pages. Both errors appear on the same page, this page being 42.

In step #1 on page 42, the angle should be A'11' instead of 11'. The other error is in #7. This instruction should read: With O as center . . . the rest of that statement is correct.

Sincerely, Clarence E. Hall

Dear Clarence,

The article on *The Equilateral Triangle* appeared in the Spring 1994 issue. (Vol. 58, NO. 2.) I am including here, the two steps that contained the errors. It seems that no matter how hard I try, a few errors slip in. Thank you for your contribution and your insight.

Mary

1. After having located point 1 on line AA', line A'11' is drawn making an arbitrary angle with line AA' as shown in Figure 3. It is suggested that the angle chosen be between 10 and 25 degrees. This will result in a more reasonable appearing diagram. Even though angle A'11' is arbitrary, its exact value is $(2\theta - 30°)$.
7. With O as center, construct circle having a radius O-A. This circle will circumscribe the triangle ABC when completed.

RESOLUTION

Whereas the forty-ninth annual midyear meeting of the Engineering Design Graphics Division has occurred at the University of Houston's Conrad Hilton conference center -

And, whereas Bernard McIntyre, Dean of Engineering at the University of Houston, has provided us with a suitable forum for the exchange of ideas, concepts, methodologies, and conviviality;

And, whereas Professor Del Bowers, Division Program Chairman, Ron Paré, General Chairman, and C. Wayne White, Program Chairman, have attracted scholars from across the United States who presented excellent papers;

And, whereas Irwin Publishing represented by Betsy Jones, Tom Casson, and Kelly Butcher has hosted the get-acquainted reception and the Graphics Series dinner;

And, whereas the publishing and software vendors, Glencoe, Prentice-Hall, Irwin, Delmar, Addison-Wesley, PWS-Kent, Autodesk, Silverscreen, and Cadkey have displayed and demonstrated their wares;

And, whereas the coffee breaks were sponsored by Silver Screen and Cadkey;

And, whereas the spouses and division members have enjoyed the NASA space center tour, the ambiance of Houston, Galveston Island, and the Galleria;

Now therefore it is resolved that the Engineering Design Graphics Division of the American Society for Engineering Education extends its thanks and appreciation to the aforementioned individuals.

Copies of this resolution shall be transmitted to these individuals and shall be spread on the records of the division.

1994-95 Mid-year Meeting Resolution Committee

Frank M. Croft, William A. Ross, & Larry D. Goss

SPECIAL RECOGNITION AWARD

The Engineering Design Graphics Division of the American Society for Engineering Education by this token acknowledges the many services and contributions rendered by

WILLIAM BRADLEY ROGERS

through the years 1947-1993

The Division expresses its deep appreciation for his constant devotion and service, and takes great personal pleasure in having his friendship. His wit and humor have brought to us all a grateful awareness of his personal and sensitive interest in our problems.

Presented this day November 2, 1993
at the Mid-Year Conference, Athens, Ohio

John Barret Crittenden
Chairman

James A. Leach
Secretary-Treasurer

COMPUTER GEOMETRIC MODELING: SUGGESTED PRACTICES FOR MULTIVIEWS

Pat Kelso
Louisiana Tech University

Because computer geometric modeling need not use orthodirectional projection, a line need not first appear in true length to obtain its Point View, nor does a plane need first appear as an edge in order to obtain its true shape view. This paper suggests three new practices in the presentation of traditional multiviews of computer views to accommodate this phenomena.

The first suggested practice is the use of a phantom line to designate the direction of projection of an auxiliary view. Draw the phantom line from the geometric element that determines the direction. The specifice purpose of a phantom line is to alert the viewer that the newly projected view may not be orthodirectional with the view from which it is projected. Note in Figure 1 that the first auxiliary direction of projection is determined by the direction required to obtain a Point View of a line of a plane in the top view. The same practice shows how the direction of

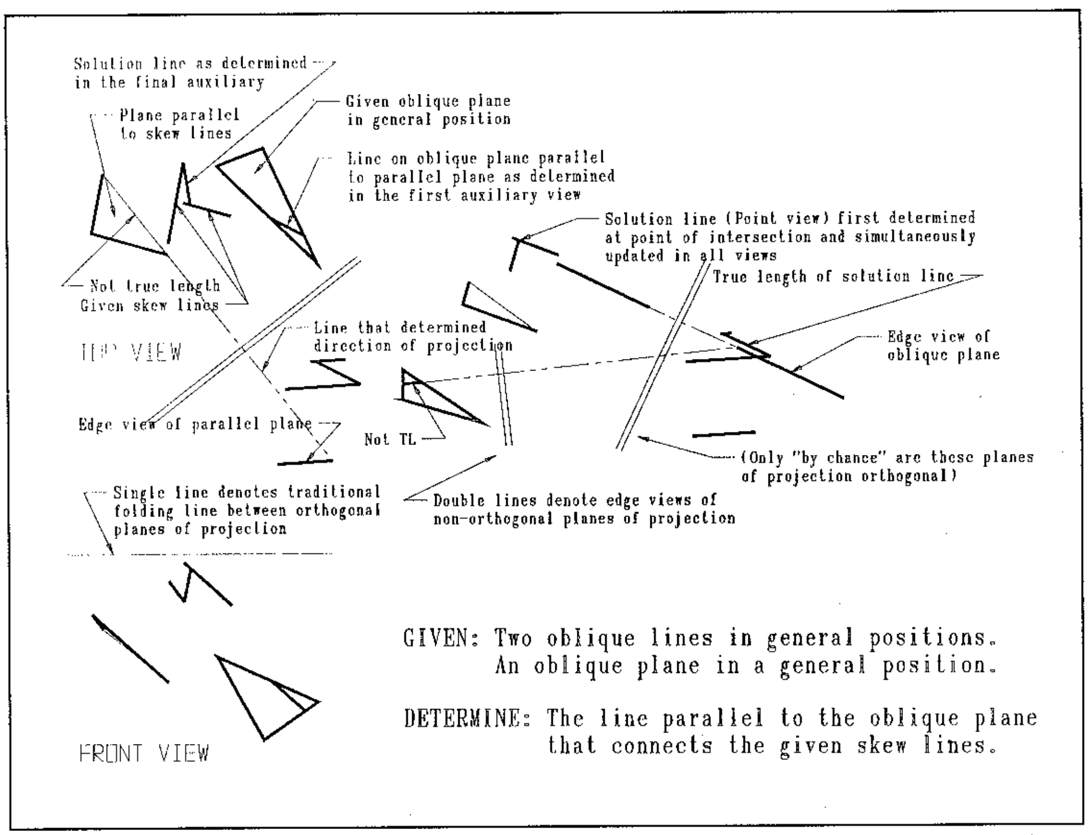

Figure 1

projection is determined from the second auxiliary to the third, and from the third to the fourth.

Notice that by switching the software program (in this case, Cadkey) to 2-D that the computer treats the edge view of the oblique plane in the third auxiliary view as a line.

The second suggested practice is to use double lines between views. These double lines do not need to be orthodirectional.

The third suggested practice addresses the projection of the true shape view of a plane. When a true shape view and the view from which it is projected are not necessarily orthodirectional, it is suggested that phantom lines connect (representative) vertices of the plane between views. See Figure 2.

It was interesting to determine the non-orthodirectional direction of projection from a given view to display the true length-shape of a plane in only a single auxiliary: the direction perpendicular to a true-length line on the plane in a given view. It is not necessary for the operator to draw the true length line nor does Cadkey display it automatically, but it seems that it must be implied by the software. Cadkey technical support was unable to explain how Cadkey arrives at the particular direction of projection that their software uses to project the true shape view, but whoever devised it has my compliments.

Pat Kelso

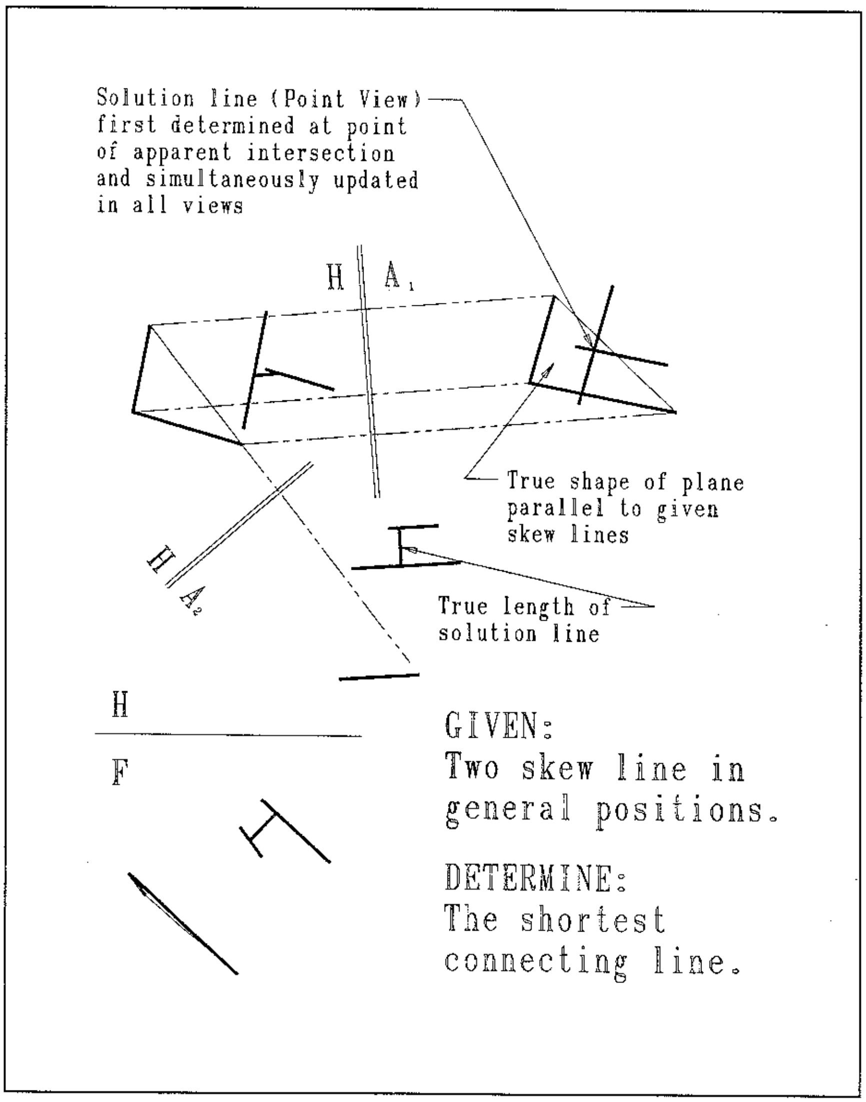

Figure 2

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

Mary A. Sadowski, Editor
Engineering Design Graphics Journal
1419 Knoy Hall / Technical Graphics
Purdue University
West Lafayette, IN 47907-1419
FAX: 317-494-0486 PH: 317-494-8206

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.

Page Charges

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$25 per page for non-ASEE members

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Article copies and 16, 35, and 105 mm microfiche are available from:

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Ann Arbor, MI 48106

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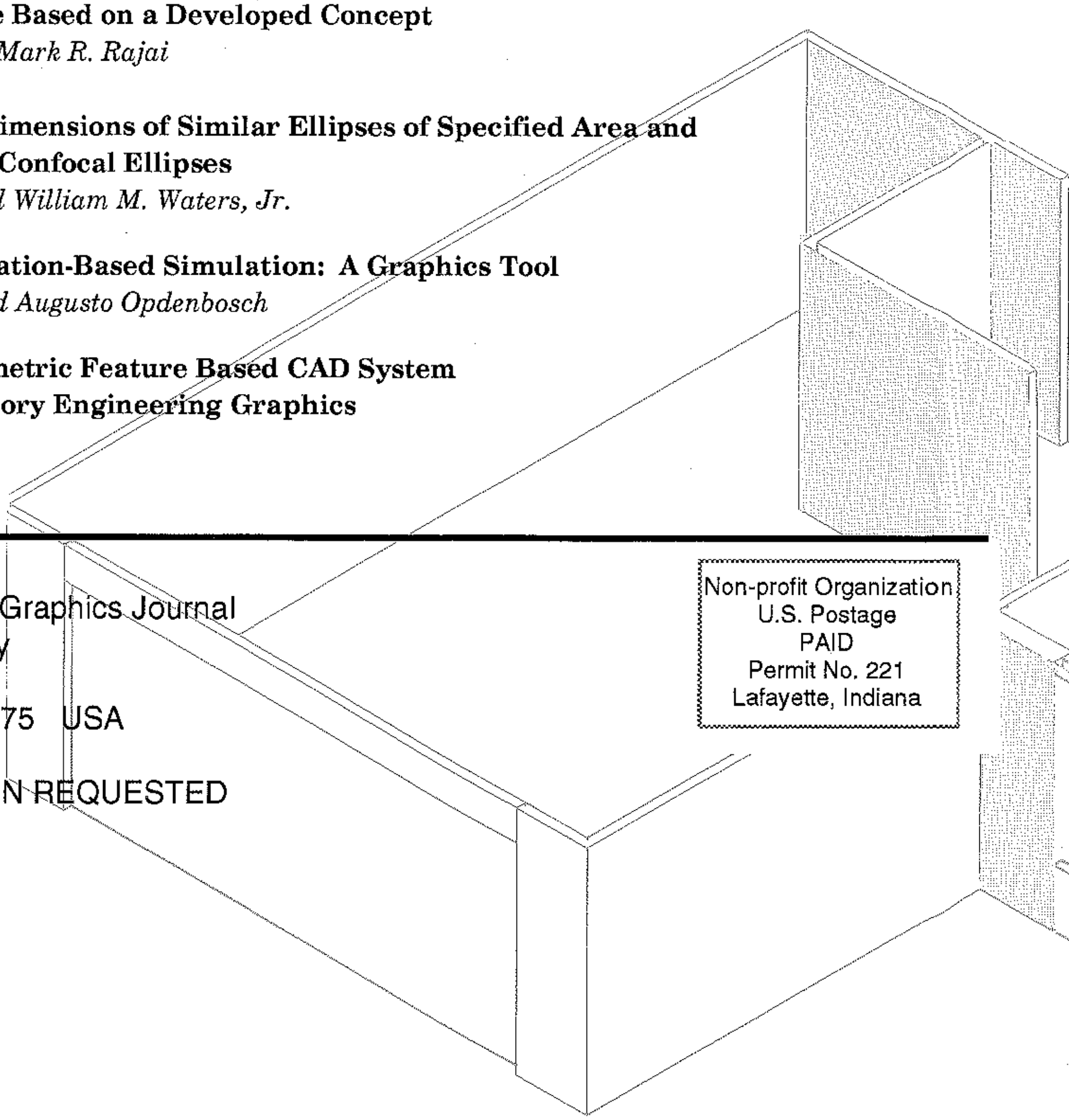
PAPERS



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