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Introducing CAD to an Undergraduate Engineering Curriculum: Advantages and Difficulties

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I. INTRODUCTION

Obviously, the uses of computer graphics and computer-aided design and manufacturing techniques are growing rapidly in modern engineering and systems design. Most organizations engaged in industrial production, both large and small, now recognize that computer graphic techniques have proven to be very effective for improving the man - machine communication interface. Such techniques range from interactive design at the onset of an engineering project through the final production of the manufactured part. In many industries, this has become, or will become, a totally integrated process.

It is necessary that universities be fully responsive to the future directions of engineering practice. Specifically, we must provide education in the development and application of computer-aided design systems. These systems must be "active," and allow the student to participate in the iterative design loop, without losing sight of the conceptual aspects of the problem. Furthermore, we must train the next generation of students to not only use and be familiar with computer-aided design methods, but to harness the awesome computational power that will be commonly available in the future.

Consistent with this philosophy, Cornell University has established an Engineering College Computer-Aided Design Instructional Facility. Its primary objective is to introduce new techniques to enhance instruction, comprehension, and design insights in all areas of the undergraduate engineering curriculum. With this new facility, we are bringing sophisticated computer graphic and computer-aided design tools into the classroom. We hope that this will have a significant effect on the curriculum of each specific discipline in engineering, and may well introduce substantial changes in the modes of instruction.

II. VISUAL PRESENTATION

Slides of the Computer-Aided Design Instructional Facility and classroom instructional modules.

III. PROBLEMS AND DIFFICULTIES

Despite the inevitable advantages and potential, there are many problems in establishing the capabilities for teaching computer-aided design, computer-aided manufacturing, or computer graphics at an institution of higher education in the United States. The following are some personal observations or comments related to commonly existing obstacles.

1) Many universities are suffering from the financial constraints which prohibit them from keeping pace with current computer technology. Most major university computer systems were in existence prior to the economic and technological breakthroughs of computer graphics. Universities are frequently burdened with the continuation of these older systems, partly because of the necessity for administrative continuity. Thus, research and instructional facilities may be encumbered by an outdated technology. I believe that it is necessary to accept this situation, and to eliminate the dependence on the older systems. It is necessary to enter this field with new computer systems. It is clear that the technology will continue to improve in both cost and performance, and education in this field must recognize this trend.

2) Because "A picture is worth 1024 words," it is easy to understand. People do not realize the immense amount of software which is necessary to drive the system. Computer graphics itself is quite seductive, and has enormous implications, but the task of creating powerful, interactive software is tremendous.

3) Another difficult situation is caused by the common misconception that software which can be demonstrated can also be used for commercial purposes. However, in most cases, the software was written on an experimental basis, possibly by a graduate student who has already graduated, and documentation is generally poor. Furthermore, universities are not in a position, nor should they be, to provide software maintenance. Industry should provide financial support to universities for the development of ideas, but industry must assume responsibility for the actual production of the computer code.

4) The proper reward structure for software development, particularly in computer science or computer-aided design, does not exist. Appropriate credit is not given for a well-developed, operable piece of software, particularly software which is used for teaching. It is much easier to obtain publications which are theoretical, or even ones which are design-oriented, rather than write a fairly extensive computer program. Since one's ascent up the ladder of tenure is partially judged by one's external publication record, this severely hampers cultivating the software development interest of younger faculty.

5) In a general sense, computer-aided design spans many subject areas. Creation of a usable system can require knowledge in programming, operating systems, graphics software and hardware, numerical methods, human factors, and color science, as well as an intimate knowledge of the application field itself. Obviously, these projects cut across the traditional, discipline-specific, departmental boundaries. Thus, it is not infrequent that the development and education of computer-aided design is retarded by existing university organizational structures.

6) Perhaps the most difficult of all the problems, is the training of faculty to use these new techniques. Tools can be provided which will enable ideas of broader concepts and new dimensions to be explored, and still create a communication language which both the student and the professor can understand. To use this tool properly, one must rethink the entire approach to teaching certain subjects and redevelop a curriculum to use these technologies.

I do not know any specific solutions to these problems, but it is clear that we can not continue to base our goals or solutions on what were accepted practices in the past. We must recognize the new technologies, and step back far enough from the problems to ask ourselves the correct questions. Only with this approach can we attain proper solutions to the computer-aided design education of future engineers. Thank you for your attention.

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