INTRODUCING STUDENTS TO CAD SELECTION AND CONTROL TECHNOLOGY ISSUES

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Abstract

Individuals involved in professions that utilize computer aided design equipment are often faced with challenges reflective of the rapidly changing nature of the tools they use. The pace at which new and improved products are being developed and released by the CAD industry and associated service providers is constantly accelerating. These challenges can include such varied topics as data exchange and transfer, product data management, automating of CAD procedures, and CAD testing, selection, and implementation processes.

For educators, the task remains to adequately prepare our students to succeed in professional careers that will require them to meet and overcome these challenges. Many of these former students will be given the opportunity to lead in management positions that will require them to successfully navigate these types of opportunities.

This presentation discusses a course developed in the Computer Graphics curriculum at Purdue University that exposes students to concepts of data exchange, product data management, automation, and CAD system selection and implementation. Subject matter used in the class will be reviewed, as well as assignments, projects, and other possible applications.

Keywords: *CAD, PDM, data exchange, implementation..*

1. INTRODUCTION

Computer Aided Design (CAD) usage and influence is continuously expanding in many companies and industries. Productivity and efficiency have increased in many critical areas of the design cycle because of this technology. One result of this influence is the large and growing number of producers of CAD and supporting products. It is estimated that the worldwide mechanical CAD/CAM/CAE software market total for 1999 alone exceeded the immense sum of $3.7 billion. [1]

Companies purchase, upgrade, and revise their CAD tools as technology advances, as their business needs require, and as personnel resources turn over. The important decisions that need to be made during these times involve careful consideration of processes, products and future directions. Among these issues, decision makers need to concern themselves with such topics as: (1) product data management (PDM) issues involving the control and protection of information, (2) the ability to transfer CAD and non-CAD data across networks, the Internet, and dissimilar platforms, (3) means and methods of automating the CAD design process, and (4) selecting and implementing proper CAD solutions.

2. AREAS OF FOCUS

2.1 Data Management, Transfer, and Automation

Managing all of the information associated with any design is a task of great significance. Important data regarding the product, its lifecycle, related business processes and strategies, and other pertinent knowledge must be controlled in an efficient and usable manner. Furthermore, the ability to transfer this critical information across platforms, networks, and the Internet in an accurate and timely fashion continues to grow in importance. Bertoline *et al.* states, “In larger companies, it is fairly common to have more than one CAD system, and the resulting data must be exchanged with the company’s CAM systems. In addition, data from the CAD/CAM systems of outside vendors supplying standardized parts must be integrated with the company’s systems.”[2] As hardware and software products continue to improve, the integrated nature of companies and industrial partners requires a more active and organized method of data exchange, data archiving, data sharing and data security. Individuals involved in many aspects of CAD applications are being tasked with finding and providing the answers to data management challenges. This is no small task as technologies continue to increase the ease and speed of data transfer and sharing. The difficulty of controlling and protecting proprietary or sensitive data increases proportionally with the technology.

As industries strive for faster time to market, more efficient design processes, and general streamlining of operations, the concept of automating the CAD modeling process continues to gain support. Companies that produce ‘families’ of related products are seeing the benefits of using captured modeling intelligence to quickly replicate similar parts, allowing for dimensional queries and options for the various model features. Through the use of programmable commands and processes, these companies are able to modify and iterate designs accurately at a faster productivity rate. This concept of “capturing” intelligence also enables industries to retain design experience that may otherwise be lost through employee attrition.

2.2 System Selection and Implementation

Every company that purchases and implements a CAD system goes through some sort of selection process. The selection process should be carefully planned, and can be quite detailed and time consuming. Selection may be accomplished utilizing company personnel entirely, or may include CAD suppliers and/or consultants with expertise in this area. An additional crucial consideration is the recognition of the need for a carefully laid out plan for product implementation. Bradley & Riddle state: “Implementation strategies are the substance from which you will either make or lose money with computers for your company. Computer and software technology is continually evolving. Your company will replace/upgrade your existing computers and software many times over the next decade. The single thread which will bind your management and design efforts together in a cost-effective manner during these changes is clearly defined implementation strategies."[3] The leading consultants in the CAD industry vary in their recommendations of what to consider when making selection and implementation decisions, but many include such items as the importance of analyzing business needs and processes, the critical nature of looking at least two to three years ahead, planning for training, and dealing with peoples' resistance to change.[4] It is also important to recognize that CAD system implementation is an on-going phenomenon due to the constant nature of change in the workplace. As one CAD/CAE expert has stated, "The implementation process never ends. Hardware, software, companies, and people are ever changing."[5]

3. DESCRIPTION OF COURSE

3.1 Justification

Many of the students currently involved in engineering graphics programs will move on to jobs where they will be utilizing and managing CAD technology. The nature of today's business environment will require unprecedented skills from these individuals in both the capability to solve problems and the speed in which they do so. As stated by Newby *et al.*, "Today we live in an age of lightning-fast information transfer. Technology has allowed individuals to obtain, assemble, analyze, and communicate information in more detail and at a much faster pace than ever before possible. One consequence of this is the ever-increasing demand on education to help all learners acquire higher-level skills that allow them to more readily analyze, make decisions, and solve complex 'real-world' problems."[6] Because this technology and these problem-solving skills are so critical to the success of companies, it is appropriate and important to provide students with as much experience in these areas as possible in their coursework.

3.2 Overview

In Purdue University's Computer Graphics Department, a course has been developed that exposes senior-level students to relevant CAD technical management issues. Computer Graphics 423, Manufacturing Documentation Production and Management, is arranged with modules that address the topics of product data management (PDM), data exchange and transfer, CAD design automation, and CAD system selection and implementation. The modular nature of the course allows for a three to four week segment for each topic during the semester. Each module includes lectures, class discussions, individual research and reporting, and small group projects. The format of the class allows for two one-hour lecture/discussion periods and one two-hour laboratory period per week across a sixteen-week semester. Grading for the class is heavily project and technical research paper oriented. Fifty percent of the final grade is based on group projects, twenty-five percent on short technical papers, ten percent each for midterm and final exams, and five percent for visiting and reporting on a relevant industry, trade show, or conference.

3.3 Lecture and Discussion

The lecture and discussions portion of the topic centers around recommended practices in industry, analysis of critical aspects of the topic, case studies, and practical applications. Module length allows for four to six lecture/discussion periods per topic. Variations in module length are at the discretion of the professor and are based on the level of expertise of the audience and new developments in the various topics. It is important to limit the amount of traditional lecture to allow for as much discussion as possible. The students have often experienced challenges in the topic areas first-hand via co-op, internship, and in-class opportunities, and can contribute greatly to the quality of the discussion. In our program, this has been particularly true in the area of data transfer. The typical student might be exposed to more than thirty different CAD, design, illustration, and animation packages by the time that he or she completes the four-year course of study. Through the use of so many software tools, and the need to be moving data back and forth between them, the students have a wealth of experience with data exchange quality. This results in excellent discussions and projects in the data translation module. It is not uncommon for one of the students to become the "expert" for a discussion period, sharing with the other students and professor important lessons learned by real-world experience. This is very rewarding for both teacher and student.

3.4 Independent Research Assignments

Independent research and reporting is a key segment of each module. Involving the students in a learner-centered environment, where each student is responsible for contributing to the knowledge of the class, has proven to be a very effective and enjoyable process for the students. To help accomplish this, the students are tasked with finding information relative to the topic and writing a brief technical paper discussing their findings. As the course currently requires a number of these reports, as well as a similar number of group projects, emphasis is placed on keeping the papers short and concise (one and one half to three pages maximum length, with two pages or less preferred). Guidelines to the students include that the information, must be current, relevant to the class and topic, and be well researched and documented. A brief explanation of what constitutes a good paper is provided, as well as instructions on referencing sources and a caution about plagiarism.

Grading criteria is based on the quality of the content, organization of the material, grammatical correctness, and overall flow of the text. A scoring rubric is used to quantify the results and provide uniformity across the grading process. In addition, the use of a rubric scoring system provides for speedier grading of the papers, which allows for quicker return of assignments to the students. The students are given the assignment at the conclusion of the first lecture or discussion in the module, with the paper usually due within ten to fourteen days. This provides adequate time to develop a topic and complete sufficient research.

3.5 Group Projects

The capstone aspect of each module is the small group project. This requires the students to apply the materials that have been discussed and reported on in a real-life scenario. The project is done in a small group setting to provide experience that will be beneficial in industry. An overall goal for the project is explained to the class, along with the expected deliverables from each group of students. The students receive guidelines for the project that include general instructions and specific requirements for each section of the project. For every project, the students are expected to complete research, provide a written report, and make an in-class presentation explaining their project and results. Each group consists of four to five individuals, with each member contributing to the success (or failure) of the group. To verify that each member of the group participates in the project, the groups are responsible for submitting a time log with their written report. This log must show who was involved in every activity, what was accomplished, and how much time was spent on the activity. Every member of the group is also required to actively participate in the in-class presentation.

Project grading is based sixty percent on the written report, thirty percent on the in-class presentation, and ten percent on the written time log. The report is graded using a similar rubric that is used with the short independent research assignments, although the project reports are expected to be significantly longer, more in-depth, and include relevant graphics. The in-class presentation is graded equally in five areas: relevance of topic, content quality and completeness, use of and quality of graphics in the presentation, professionalism of presentation, and participation by all members of the group in the presentation. The other students in the class grade each group presenting using these five criteria. Their scores combined make up one half of the group's total score for the presentation, with the instructor's scores for the five areas making up the other half of the presentation grade.

3.6 Group Projects

The Manufacturing Documentation Production and Management class has been taught for three semesters at this point in time. The results from the class have been rewarding and encouraging to the author. The students have responded well to both the topical content and modular approach of the course, and seem to enjoy the research and project portions of the course. They are less enthusiastic about writing the short technical papers, but do enjoy the discussions covering their individual research topics. Being able to solve real-world problems has been interesting and relevant to them, and has contributed to the accuracy of their reports and in-class presentations. The nature of the class requires the instructor to remain current in the topics, so the material prepared for and presented to the class must, obviously, be continually updated. This ensures that the information is relevant and useful for the students.

In the opinion of the author, the students benefit significantly from opportunities to write technical papers and make oral presentations. This provides experience in critical areas of communication that are required for professional success. Utilizing lecture/discussion periods of the class for group presentations is a very appropriate and effective use of class time that prepares the students for their future careers.

4. CONCLUSION

The growth of CAD and CAD-related technology is proceeding at an ever-increasing rate. Many managers and users of this technology find it difficult to effectively keep up with the capabilities presented to them in industry. As university students graduate into this high-speed technical environment, they must be able to contribute to the overall profitability of the company they are employed by. In order to assist with this, the Department of Computer Graphics at Purdue University has implemented a course that addresses topics of product data management, data exchange and transfer, design process automation, and Cad system selection and implementation.

The Manufacturing Documentation Production and Management class is a modular technical course that utilizes class discussions, individual research papers, and small group projects to teach senior level technology students. The students have responded well to the class and have benefited from the opportunity to develop their communication skills and expand their technical expertise by solving real-world problems in this setting.

5. REFERENCES

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