MSC/pal IN THE CLASSROOM

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ABSTRACT

MSC/pal has been utilized for the past three semesters for a finite element application methods course in the Mechanical Engineering Department of Texas Tech University. This paper will describe the course content, show example problems, and describe our experiences with MSC/pal in an undergraduate laboratory equipped with MS/DOS microcomputers and an Ethernet local area network. In addition, the paper will describe the TTU Mechanical Engineering Department's expectations for the role of MSC/pal in meeting the ABET design requirements in the undergraduate curriculum.

INTRODUCTION

MSC/pal was introduced into the curriculum of the Mechanical Engineering Department of Texas Tech University in the Fall semester, 1985. Since that time, approximately 100 junior and senior students have utilized the program in an FEA applications course, senior design projects, and individual study courses. We have found that the students soon master the basics of utilizing FEA methods with MSC/pal. They are stimulated by the analytical power which the program gives them and attempt much more ambitious individual projects than they otherwise would. In addition, students who have become adept at utilizing MSC/pal have found that they have a skill not common to most other graduating engineers and therefore, have an advantage in the job market.

The principle mechanism for introducing FEA in the undergraduate curriculum is a new course on FEA application techniques. The principal objectives for this course are 1) to provide instruction in FEA theory, software, and application techniques, 2) to develop basic computer skills, and 3) to re-enforce engineering concepts learned in previous materials, solid mechanics, and design courses.

HARDWARE AND SOFTWARE REQUIREMENTS

The hardware utilized for the FEA applications course consists of a computer lab equipped with 25 TI Professional microcomputers. These machines are equipped with dual floppy disk drives and 8087 coprocessors. The MS-DOS machines are comparable in processing power to IBM PC/XT level machines but are not directly compatible. The 25 individual microcomputers are connected through a 3Com Ethernet LAN to three file servers and printers. The software utilized for the course is the MSC/pal INTRO package, the DFEDIT full-screen text processor, and Microsoft BASIC. Students may access this software through the Ethernet file servers or from their own diskettes.

Students appreciate being able to legally copy the MSC/pal INTRO software and to execute it on their privately owned MS-DOS computers. During the fall, 1986, semester, MSC/pal INTRO was available for the first time for Apple Macintosh computers. Students who utilized this software in conjunction with a laser printer were able to produce extremely high quality graphics for the reports which were required for the course. The students have found that the use of a full-screen editor allows them to be much more productive than with the line editor which comes with the MSC/pal system. BASIC is used primarily for the quick programming of relatively simple preprocessors.

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FEA APPLICATION TECHNIQUES COURSE CONTENT

As the course name implies, the principal emphasis is on FEA application techniques rather than theory. A simple cantilever beam example is developed over the first week of classes as a mechanism for bringing the students "up-to-speed" with the MS-DOS operating system and text editor, and to introduce the MSC/pal analysis system. Thereafter, the students complete approximately one analysis project per week for the remainder of the semester. Each project includes an analysis and short engineering report which describes the objectives, methodology, and primary results. These reports are typically 3-5 pages in length, including figures.

FEA theory is introduced through a very simple two degree-of-freedom spring-mass-damper system. The development of the theory is coordinated with an explanation of the significance of the basic MSC/pal modeling commands. By coupling these discussions, students are able to directly observe the impact of modeling decisions such as element selection, "zeroed" degrees of freedom, and static elimination on the resulting mathematical model. Throughout the semester, only qualitative descriptions of the theoretical basis for element mass, stiffness, and damping characteristics are given. The details of the derivations are left to senior elective and graduate course work.

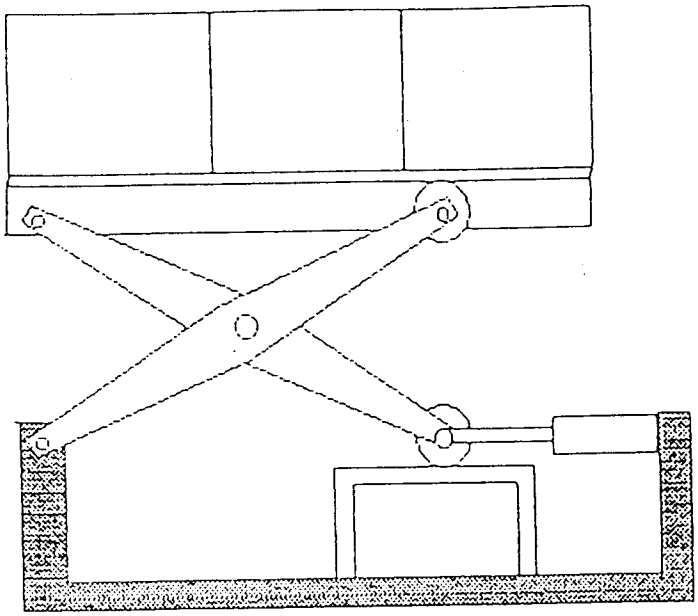
Our approach has been to expose the students to as many different application techniques as possible through relatively simple problems rather than delving deeply into fewer, more complex analyses. The MSC/pal INTRO package is ideally suited to this instructional approach. The analysis system includes virtually all of the analysis capabilities and element types of MSC/pal 2 but is limited to 25 nodes. The 25 nodes are sufficient to allow a reasonably realistic representation of simple mechanisms with comparatively short execution times. Simple models such as those illustrated in Figure 1 are adequate for introducing a broad spectrum of element types, boundary conditions, and loadings. By being limited to 25 nodes, students can typically edit a model definition data file, formulate the mathematical model, and perform a static or dynamic analysis in 5-10 minute iteration cycles. The short execution times reduce student frustration, sustains their interest level, and encourages them to try alternate modeling techniques.

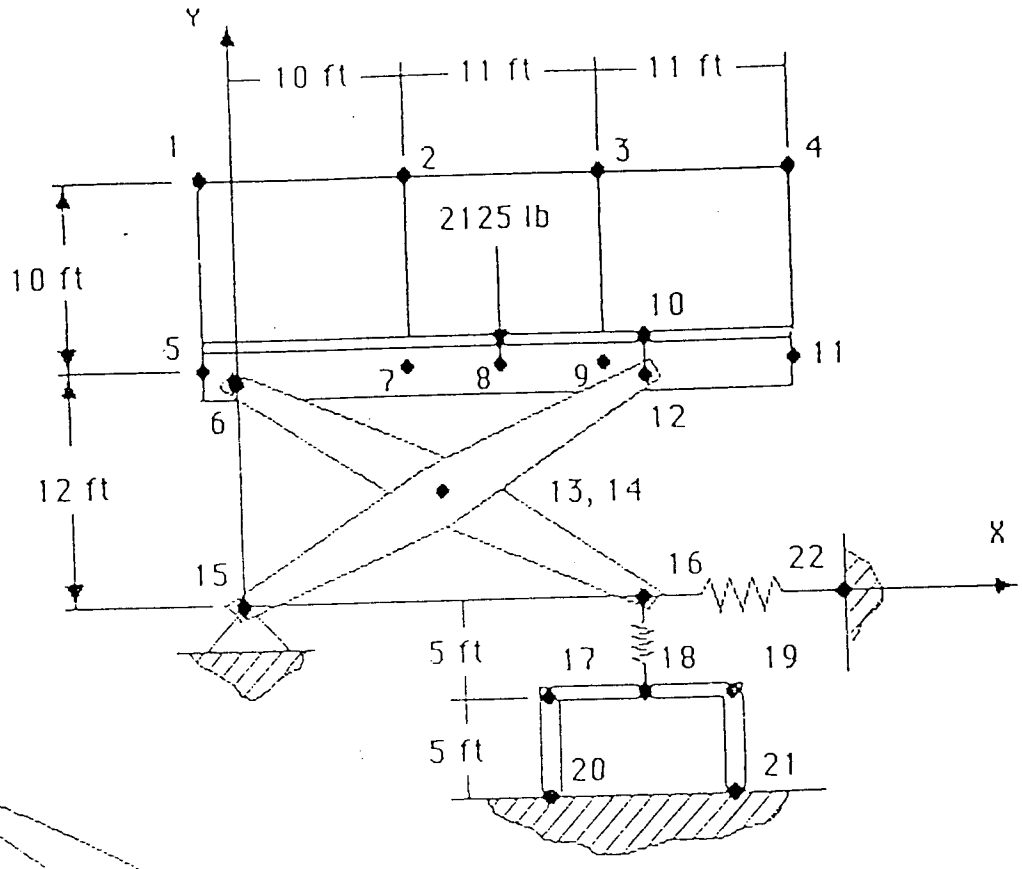
In developing the materials for the FEA applications course, we became aware that little was available for a text which carried the philosophy described above. Consequently, we have arranged the course notes of the past two years into textbook form. The table of contents for this book closely follows the topical sequence which has been utilized in the course and is presented in Table 1. We hope to release the text to a publisher within the next 60 days so that copies could be available by as early as fall, 1987. The MSC/pal INTRO software package will be bundled with the book.

MSC/pal IN A MECHANICAL ENGINEERING CURRICULUM

The recent emphasis on "engineering design" by the engineering accreditation organization ABET has caused many ME departments to critically examine their curriculm, Texas Tech included. The department will be beginning implementation of a new, design oriented curriculum in the fall, 1987, semester. New features of the revised curriculum will include expansion of our current senior "capstone" design course to two semesters, introduction of a new computer-aided-design course, and two junior/senior level design electives.

The previously described FEA applications course will be made available to students as a design elective. The computer-aided-design course will utilize approximately 30programming, computer graphics, numerical methods. The CAD course will serve as a synthesis of these topics since most of them are covered in greater depth in other courses within the curriculum. The remainder of the CAD course will be devoted to a survey of commercially available computer based engineering analysis tools. These tools will include continuous systems and controls modeling software, pipe network, fan, and heat exchanger design software, and MSC/pal as an example of commercially available mechanical system analysis

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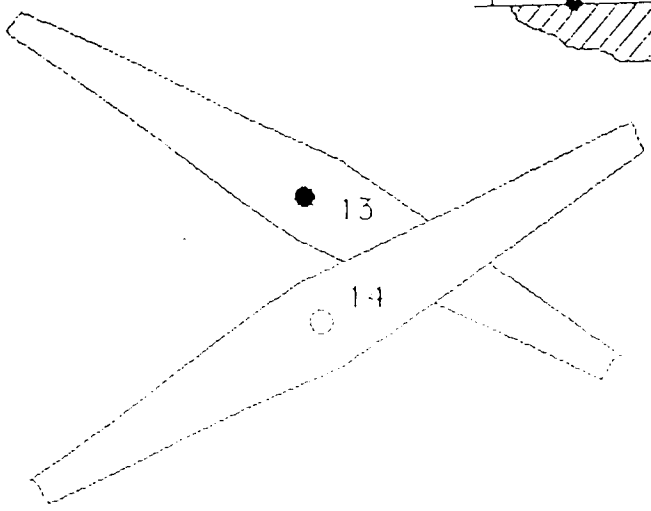
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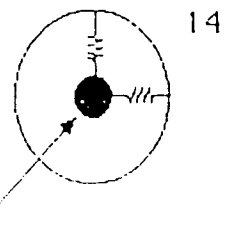
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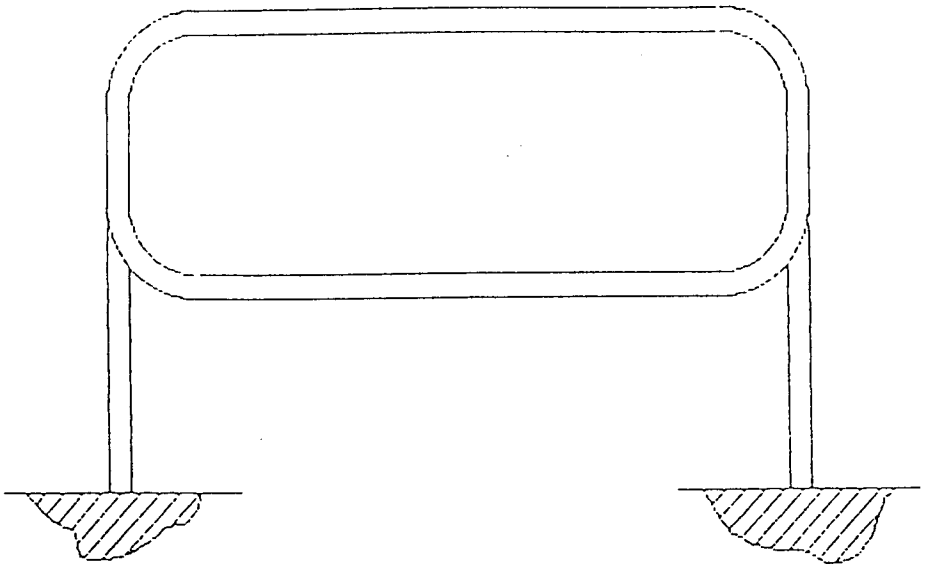

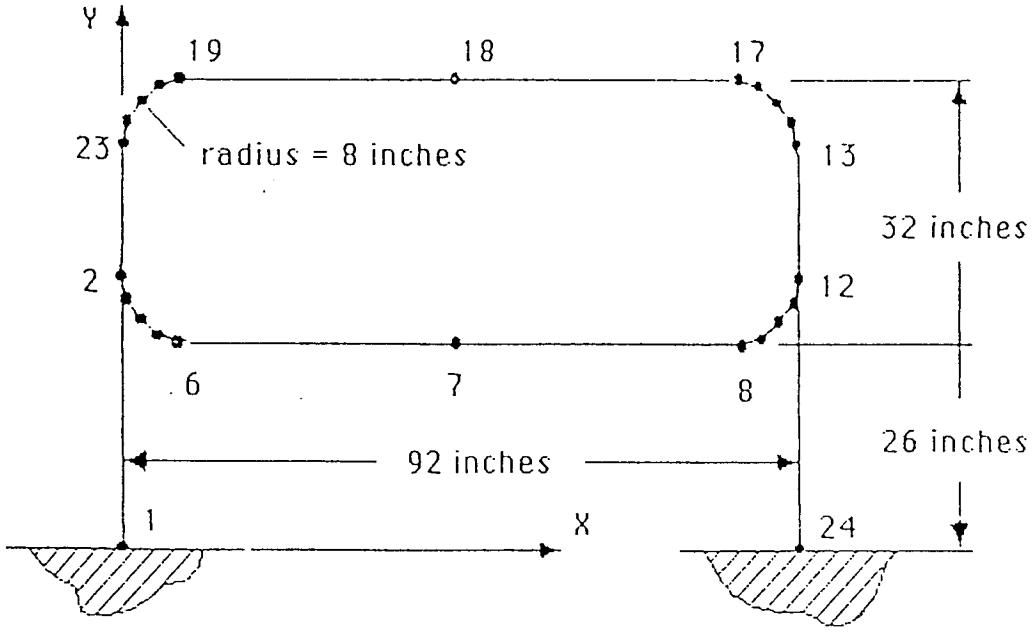
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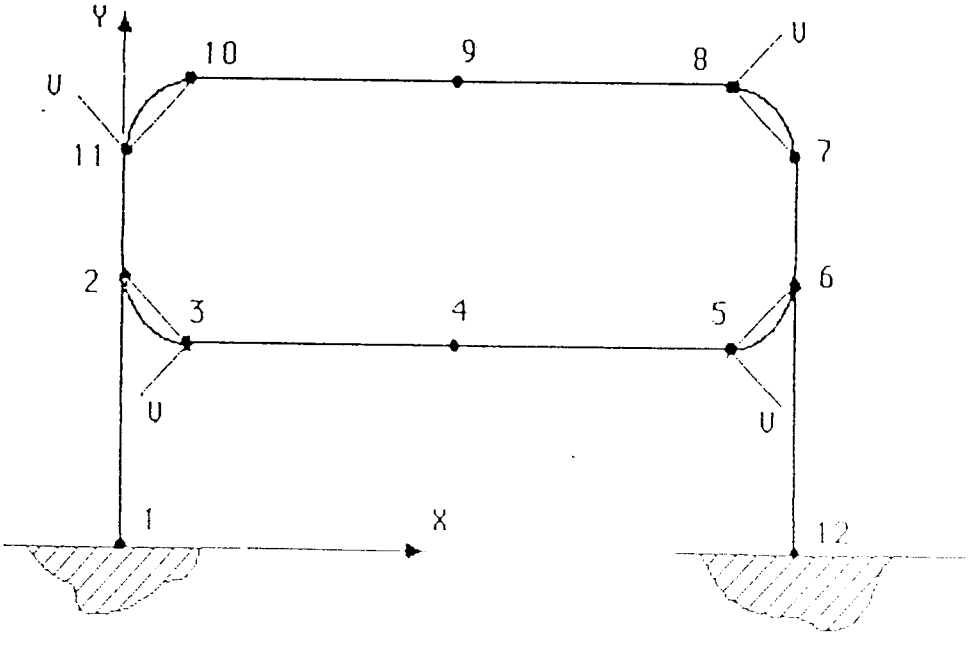
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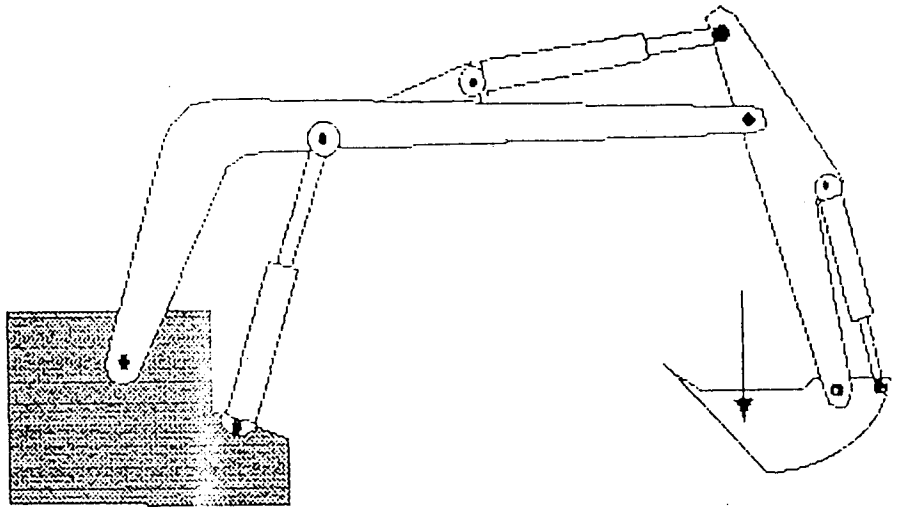

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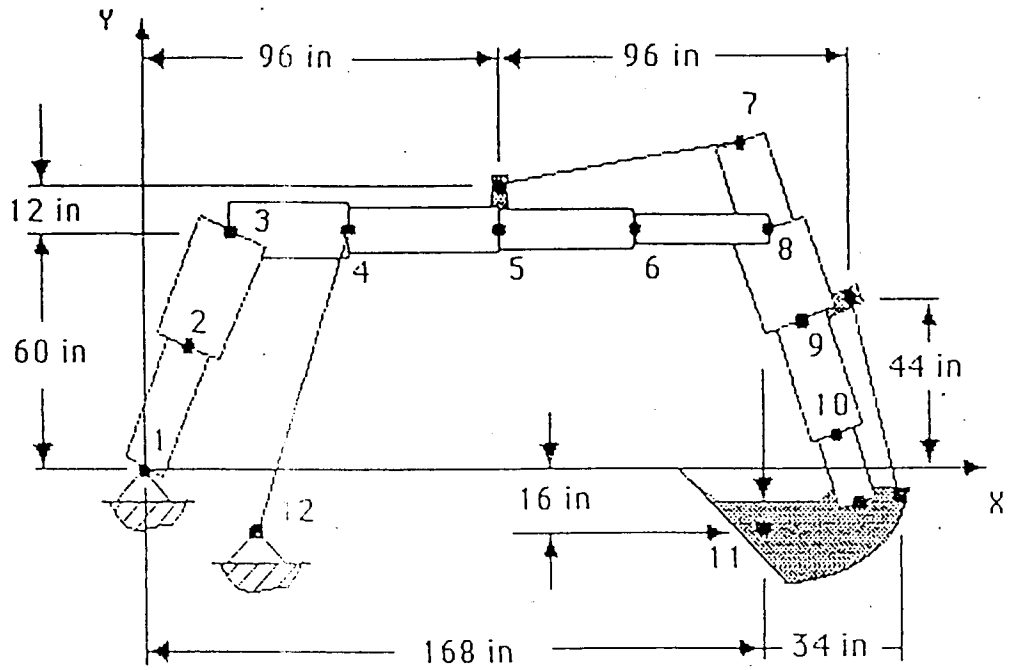

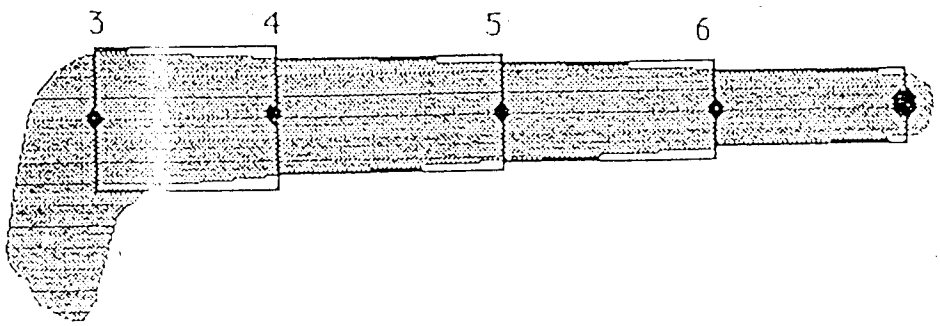

TABLE OF CONTENTS

software. The curriculum is organized such that the design elective and computer- aided-design course can be taken prior to or in conjunction with the capstone design course. Consequently, students will be equipped to utilize MSC/pal and the other analysis tools in their design projects.

CONCLUSION

MSC/pal has been found to be a valuable component in the undergraduate curriculum of the Department of Mechanical Engineering of Texas Tech University. Instruction in FEA techniques equips engineering students with a valuable tool which enhances their position in the job market and their eventual worth as practicing engineers. The use of software like MSC/pal serves as stimulant to enhance the educational impact of several other of the undergraduate courses besides the FEA applications course. The MSC/pal INTRO package has been found to be ideally suited for introducing students to FEA. It has adequate analysis capabilities and is conducive to the presentation of a large number of practice problems over a one semester course.