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INTERACTIVE AND COLLABORATIVE LEARNING IN MECHANICAL ENGINEERING USING INTERNET

Abstract:
In the process of preparing tomorrow's engineers and scientists, the universities are facing the challenge of gradually teaching students a reality of modern mechanical engineering, namely the mechanisms that occur from the interaction between different parts of complex technical systems. The use of Internet in the classroom offers the opportunity of efficiently adopting methodologies and advanced learning systems that can help the students to expand their views and explore new frontiers. This paper describes our experience concerning the possibility of using dedicated software (via Internet), for an interactive and collaborative learning in mechanical engineering.

Keywords:
mechanical engineering, educational dedicated software resources

INTRODUCTION

Globalization and advances in information technology have prompted a change in the credentials of the engineers today. Industry needs engineers who can work in a distributed, multifunctional, cross-cultural and multidisciplinary avenue. For responded to this change, in the process of preparing tomorrow's engineers and scientists, the universities are facing the challenge of gradually teaching students a reality of modern engineering, namely the mechanisms that occur from the interaction between different parts of complex technical systems.

The formal lecture, the oldest teaching methods, has been widely use in higher education for centuries. But lecturing alone cannot ensure that students become active learners. Generally, using lectures in combination with other kinds of instruction, such as discussion and cooperative learning, can increase their effectiveness.

The activities used to reach students with different learning styles are very important, while people have different preferences for processing new information. One recent "hot topic" in higher education has been the different ways in which students learn: some students prefer to learn by listening, others like visual representations, and still others learn by doing. Incorporating of various resources into lectures and seminar applications improves the chance of understanding of concepts by students with different learning styles. Possibilities include demonstrations, role plays, discussions, simulations, problem-solving, real-world applications, or multi-media.

USING OF THE DEDICATED EDUCATIONAL SOFTWARE IN MECHANICAL ENGINEERING EDUCATION

In mechanical engineering education, the concepts developed in the mechanics of materials course, essential in preparation for design courses in the engineering technology disciplines, provide the designer with the tools needed to choose an appropriate material and to establish the necessary sizes for the machine or structure. For the student, the key to success in the course is to develop technical problem-solving skills by working a number of problems taken from a wide variety of mechanical and structural situations.

This paper exposed our experience on the use of the educational software, exemplified with the software called MDSolids, [2], a computer program dedicated to aid students in the study of Mechanics of Deformable Solid. MDSolids was conceived as a tool to help students solve and understand homework problems typically used in the mechanics of materials course and consists of a number of modules, Figure 1a, each focusing on a type of problem typically studied. The software features educational routines for beams, flexure, torsion members, columns, axial structures, statically indeterminate structures, trusses, section properties, Mohr's circle analysis and stress and strain transformations.

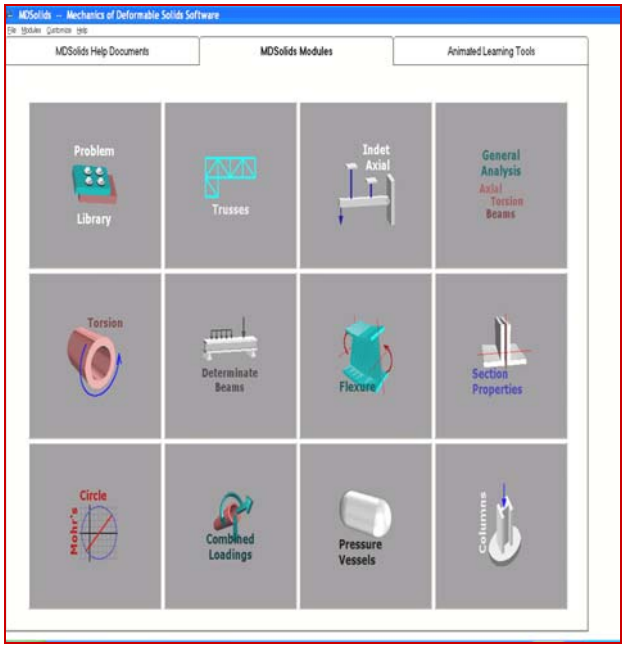

Figure 1. MDSolids Modules - Games and Learning

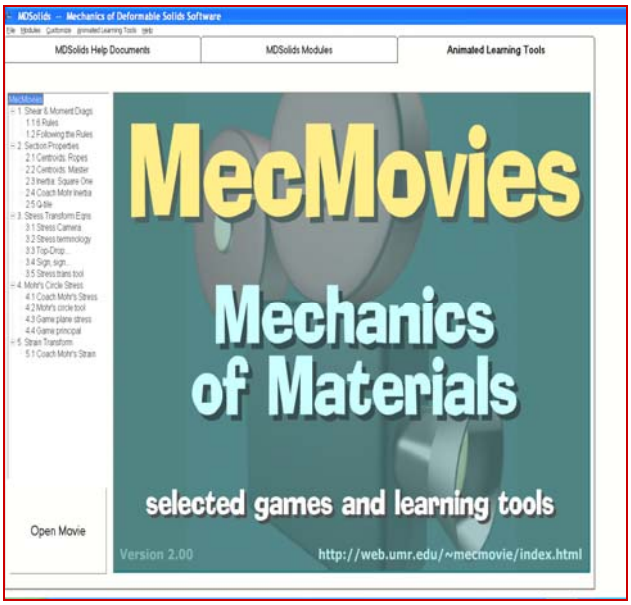

Figure 2. MDSolids Modules - Tools Modules

Also, MDSolids contains modules of Animated Games and Learning Tools, Figure 1b, for topics such as: Shear force and bending moment diagrams, Section properties (centroids, moment of inertia, Q), Stress transformation equations and Mohr's circle stress and strain transformations.

Concerning the MDSolids style, this educational software varies from a slideshow presentation of lecture notes to a MathCAD- or TKSolver-type of equation worksheet to a full structural analysis software package. The analysis routines are grouped in modules devoted to particular problem types. These modules focus on specific mechanics of materials concepts and problem-solving methods. MDSolids is powerful enough so that many different combinations of structure configuration and loading can be solved within each module and it is coordinated so that results from one module can be used in related modules. The modules are constructed so that data for a particular problem can be entered directly and intuitively from a textbook (see Figure 3). MDSolids does not require the user to know a particular sign convention or to enter the data in a particular set of units. Where necessary, the software presents these options in either a pictorial or descriptive fashion.

MDSolids' solutions give the final number and, also, show a picture of how the structure deforms and how the stresses are distributed.

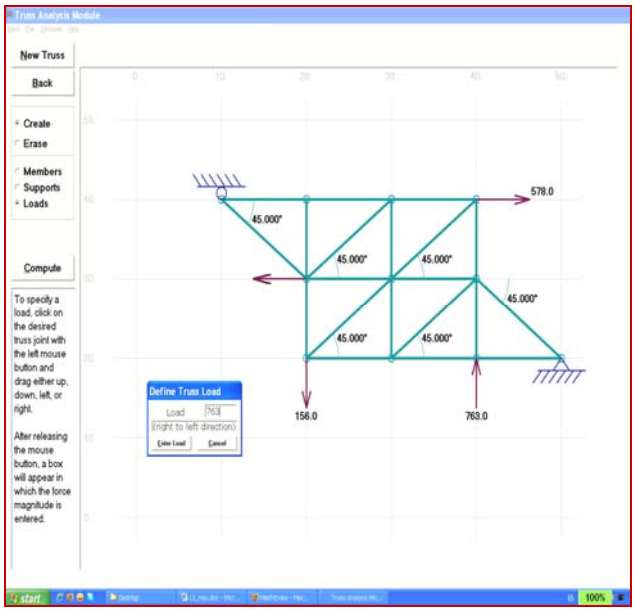

Figure 3. Sample of particular values entering

So, for the student, MDSolids can be helpful in several ways:

- *The MDSolids solution can confirm the results obtained by hand calculations. If the hand calculations are incorrect, the complete solution provided by MDSolids can be used to track down errors in the hand calculations.*
- *The solution of typical mechanics of materials problems can be somewhat lengthy. With the MDSolids solution as a reference to keep the hand calculations on track, more problems can be attempted and solved. This problem-solving practice is essential to firmly understand the concepts.*
- *MDSolids can build confidence in the problem-solving method needed for the various types of problems included in the modules. The software can also help the student to develop a "feel" or intuition for what the correct answer should be. Confidence in the method plus engineering intuition about the outcome will conquer most of the difficulties commonly encountered in the mechanics of materials course. (Figure 4 and Figure 5).*
- *MDSolids provides brief text commentary describing the solution, Figure 6. These explanations can help students develop the problem solving skills needed to succeed in the mechanics of materials course. The mechanics of materials course can be a much more satisfying educational experience if students get some extra help from a program such as MDSolids so that they can get themselves on the right track from the start.*

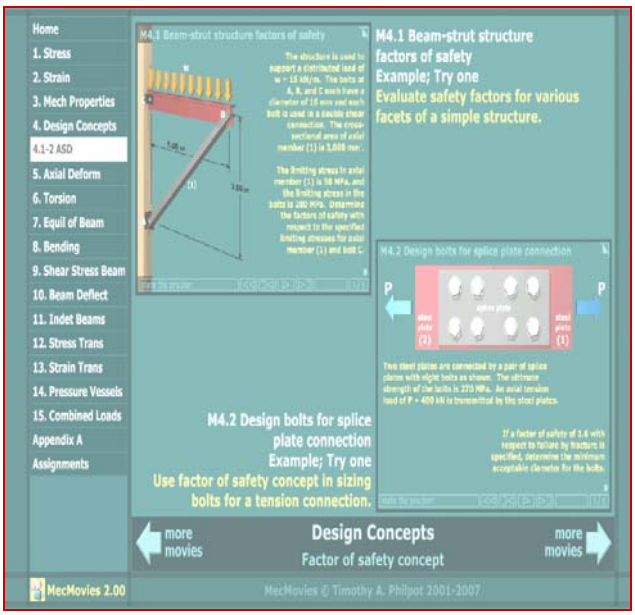

Figure 4. The Safety factor Concept in MecMovies Module

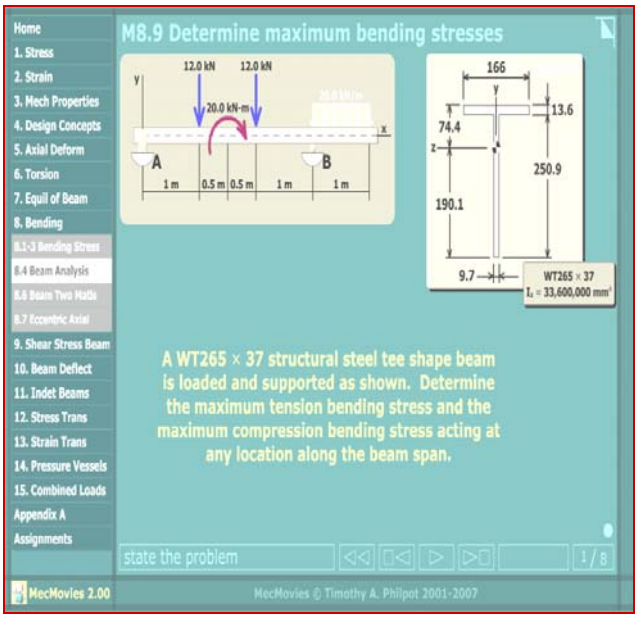

Figure 5. Beam analysis in the Design Concepts Module of MecMovies

- *MDSolids has a Help folder to provide additional information about using the software and the software "navigator". The Help folder also contain a number of files with worked examples that describe the procedures used to solve the problems. The MDSolids Navigator is intended to help the software in the context of Mechanics of Materials studies. At opening of a book that corresponds to class textbook, will find a list*

of problems that can be solved and explained by MDSolids. By click on a problem number, the MDSolids Navigator will briefly describe the steps that are required to make MDSolids solve the problem.

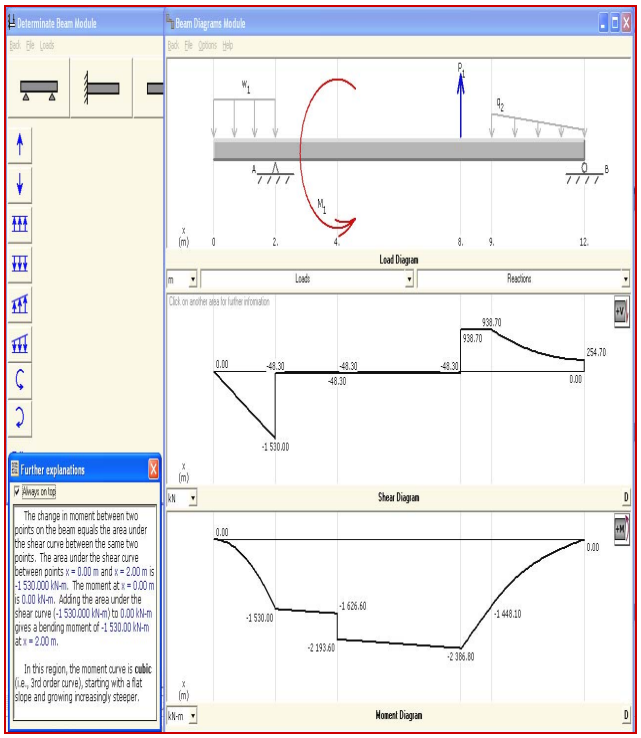

Figure 6. Comments on the solution in the describing box

DISCUSSIONS, APPROACHES AND INTERPRETATIONS

To develop the student understands of the mechanics of materials topics, homework assignments are the primary device used. The typical assignment can be somewhat lengthy; therefore, only selected problems can be assigned. Professors may expect that their students will work enough extra problems so that the fundamentals are firmly grasped, but students sometimes struggle just to keep up with the homework and exam schedule. To supplement the student's educational development, the self-study potential offered by software would seem to be the ideal means of filling the gap between the material presented in lectures and the understanding and skills expected in homework and exams.

Educational Benefits to use dedicated software, with on-line accessibility:

- *This can help students study mechanics of materials and develop the necessary problem solving, skills in several ways that are not inherent in lectures or customary assignments.*
- *Obtain correct Solutions and Intermediate Results: when learning a new concept, it's very helpful to use the correct solution as a benchmark. Knowing that the problem has been solved correctly gives the student confidence in their problem-solving skills and thereby provides a foundation for more challenging problems. Every textbook provides answers to selected problems for this reason. Software can provide the student with the correct solution for a particular problem, but in addition to the final answer, software can provide intermediate solutions that can be used to confirm the calculations along the way. These intermediate results can be helpful in tracking down faults in the problem-solving approach.*
- *What-If Analyses: Observing a cause-and-effect relationship can be quite helpful to students. For example, a student can develop a sense of the column buckling phenomenon without calculating a single number by assuming various end support conditions and then observing the effects on the buckled shape. This can help students to develop engineering intuition that will help them know what the correct solution should be before they calculate a single number.*
- *Availability: In the evening hours, during weekends or when working at home (which may be distant from the classroom), students don't have access to professors, graduate assistants, or others who can help them understand the course material. Having a versatile software tool at hand to supplement the textbook and lecture notes can be a big asset.*
- *Repetition: Some people must see or perform more repetitions involving a concept before they begin to fully understand it. Time limits the number of examples that can be presented in lectures and textbooks can present only a few examples. With software, students can drill themselves, trying various numeric combinations for a particular problem type until they feel confident in their understanding of the concepts.*
- *Visualization: Software can depict deformations or show stress distributions*

produced in the problem being considered. Visualization of the material's behavior in response to the loads acting on it can help the student to understand the relevant theory and to develop engineering intuition.

CONCLUSIONS

According to the exposed ideas, for a modern education in mechanical engineering field, there is a need to change the traditional lecture based of a passive learning methodology to an active technology using interactive and collaborative learning and the facilities offered by the information technology.
A very good and already experienced example can be the using of MDSolids software (by Timothy A. Philpot at Murray State University, [2]). That offers students numerical, descriptive, and visual results and details that illustrate and explain many types of problems in introductory mechanics of solids courses.
Compared with traditional instruction techniques, the using of educational software supports a learner's development of basic concepts and problem-solving skills through self-study.

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