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Guest Editorial

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THIS special issue of the International Journal of Engineering Education features a series of selected papers on computing in undergraduate mechanics education. Undergraduate mechanics has been taught since Stephen Timoshenko wrote his revolutionary books in the 1930's initiating an analytically intensive discipline using pencil and paper calculations. There are features of this tradition such as the freebody diagram that will undoubtedly not lose their relevance to problem solving and learning and will be with us for the foreseeable future. However the computer has made numerical methods rich in applications: the finite element method is pervasive, the solution of matrix algebra problems is a matter of keystrokes on an advanced scientific calculator and graphical software offer visualizations impossible just a few years ago. Assuming computers should have a positive impact on teaching mechanics, how then do we employ them in undergraduate mechanics? The answer is important not only because mechanics is fundamental to several engineering disciplines, hence must remain relevant, but also because educators cannot permit its teaching to rest upon past laurels.

The objective of this series of papers is to demonstrate how computers can be introduced into the undergraduate mechanics curriculum. It includes proposals for a new curriculum, applications of computers in undergraduate mechanics and ideas to stimulate interest in further development. These papers also demonstrate function, that is, practical use of computers in student learning and in classroom teaching as opposed to discussions on pedagogy. Issues addressed include computational foundations, a new course structure, software and its application and classroom demonstrations. Although these contributions conform to the theme, much remains to be done to fulfill the objective.

Most papers in this special issue result from presentations delivered at the Workshop on Computing in Undergraduate Mechanics Education which was part of the American Society of Mechanical Engineers Mechanics and Materials Conference held 12–14 June 1996 at The Johns Hopkins University, Baltimore, Maryland. The Workshop, which featured paper presentations and open round-table discussions, focused on curriculum content and enhancement. It was well attended by international representatives from academia, government and industry. Arguments over traditional approaches to teaching mechanics fundamentals versus what was viewed by some to be revolutionary approaches based upon computers and computational formulations grew heated and were not resolved, but a consensus formed around the evolutionary and cautionary introduction of computing to teaching as well as a need for it in general. As readers will discover from one paper, rather than argue over how to introduce computers into introductory mechanics courses, a practical way may be to just do it and work out the difficulties through experience over time.

One problem currently facing undergraduate mechanics educators is how to break instruction of the fundamental mechanics courses out of its traditional pencil-paper-chalkboard mode. This is reflected by students and instructors in these courses using high-powered calculators to do simple arithmetic, a mere extension of slide rule mentality, and ignoring even more powerful computing technologies surrounding them. It would be presumptuous to say this special issue solves the problem, but it is a forerunner to what is coming. Everyone concerned must pay attention. Things are starting to change and the papers in this issue, though not all controversial, are a good beginning.

The first set of papers in this issue provides enhancements to the mechanics curriculum. Cabell and Rencis *et al.* treat interactive learning over the World Wide Web through use of the Java programming language. Students located anywhere can learn to assemble finite element matrix equations assisted by on-line help and interactive feedback. Hence students seeking help can find it anytime and learn outside of the classroom. The paper by Yin describes two semester-long design projects for a mechanisms course; one addresses a four-bar linkage, the other a slider-crank linkage, and both employ a spreadsheet program for computations. In a similar vein, Broman and Östholm discuss the application of a standard software tool to simulate the dynamic response of rotors and structures. Finding inexpensive, easy-to-learn, sufficiently sophisticated software for class use is difficult. Kaw and Willenbring describe their free (to educators) software for the design and analysis of laminated composite materials which also includes matrix algebra software and a material properties database. They also touch on ways to avoid 'chalk and talk' lectures.

The second set of papers recommend significant change in the current formula for teaching fundamental undergraduate mechanics courses. Arguments for and contributions to reform of introductory statics and dynamics are offered by Soutas-Little and Inman through examples solved using mathematical software tools. Applications of simultaneous algebraic equations, direct vector calculations and numerical integration of equations of motion are provided. Salamon suggests the impact of computers can only be realized in a meaningful way if the theoretical basis for mechanics courses is matrix algebra. He proposes a sample series of lectures with illustrative examples on how to integrate traditional with matrix methods into an introductory mechanics of materials course. Axial deformation problems are covered with concepts of structural stiffness and energy introduced. Belytschko and Bayliss *et al.* describe an innovative pilot project, *Engineering First*, at Northwestern University which integrates linear algebra and differential equations with introductory engineering courses and open-ended design projects. A matrix software package is employed. They describe the syllabus, provide example problems and discuss student reactions.

Readers of these papers will find many ideas almost classroom-ready to include in their teaching. However one sub-objective, to stimulate interest in further development, depends upon readers' actions. Hopefully this special issue will prompt future work that will appear in these pages and elsewhere. Computers will certainly be introduced into undergraduate mechanics education. The mechanics community is invited to help shape the careful development that is so necessary.

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