

***Interacting with the Concepts: MDSolids in a  
Mechanical Engineering Course***

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## Interacting with the Concepts: MDSolids in a Mechanical Engineering Course



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### **Why use technology?**

In my Machine Design classes, I needed a mechanism to reinforce the concepts that my students learned in their Strength of Materials courses. Our focus in class, in the design projects we assign and discuss, is very, very practical. The students must understand the concepts and turn right around and apply them in real-world applications. I decided to try learning technology to help make the basic concepts stick in students' minds. I was looking for something that provided visual representations and interactivity with the concepts, to help illuminate the course material.

Lambton College is not a degree-granting facility; rather, in two- and three-year programs we train mechanical engineering technologists for careers in manufacturing, systems design, materials testing, project administration, and research and development in the process and manufacturing industries. We are a small college, but we have a progressive environment in terms of being willing to look for teaching tools, especially learning technology. With both the petrochemical and auto industries having a strong presence in the area, our technologists must compete – and they do very well – against people with mechanical engineering degrees. Just recently, I learned that two of our students won jobs after interviewing against mechanical engineering graduates.

### **The strategy**

About two years ago, on the recommendation of a colleague, I investigated an engineering software package called MDSolids, developed by Professor Timothy A. Philpot at Murray State College in Kentucky. I liked the software immediately and contacted Professor Philpot to ask if we could put it through on our network at Lambton. Professor Philpot said, "Yes, provided you give me some input." So I've given him some thoughts about MDSolids and about what I'd love to see in the software. And he always seems to exceed what I'm thinking.

Because of limited access to computers in class, I use MDSolids mainly as a demonstration tool in my Strength of Materials class, but I always capture students' interest with it. I also encourage the students to download the software from the Web, and many students do that for homework – it's offered as shareware for one month, after which the user must pay a modest fee to continue using it.

### **The courses**

The courses I teach provide students with the skills they need to design and test structures and machines. Students take the courses in the second and third years of Lambton's three-year

program for mechanical engineering technologists. In Strength and Materials I (typically 30 students enrolled) and Strength and Materials II ( typically 15 students enrolled), the students learn, among other things, the concepts of stress, strain, and deformation analysis due to various loading conditions. The students also study the forces on mechanical structures and their internal members, eventually learning how to design members. In the laboratory components, the students learn mechanical testing practices, and the theories are reinforced for them. I teach both classes in a lecture room and bring in a laptop with a projector for presentations and demonstrations. I will typically work through a problem manually on the board, to make sure they have the basics, and then use MDSolids to demonstrate the concepts I am presenting.

Machine Design I and II have approximately 30 students each, and Machine Design III enrolls 15 students; these courses cover the fundamentals and design of power transmission components in machines, with progressively more complex design projects required. All the lectures are integrated into the labs, and I let the students start using MDSolids right away for their class problems and design projects.

In their first year, the students take all the basic courses, including mathematics, information technology skills, and engineering drawing and AutoCAD. They learn to do manually all the calculations they'll need later – these can be laborious and, if the students make a mistake somewhere, they must go back and rework the equations, which can take several hours.

### **The learning technology**

*MDSolids: Educational Software for Mechanics of Materials:* I chose MDSolids for its versatility and ease of use. It is readily integrated into a Strength of Materials course – it duplicates much of the material in the textbook, but it helps explain and illustrate the problems we cover, providing results numerically and visually along with the text descriptions. Using what it calls “educational routines,” it approaches the subject with the hypothesis that students most want – and will pay most attention to – an application that helps them solve the homework problems they are assigned. By doing just that, MDSolids helps develop students' problem-solving skills. And the visual interface allows users to develop an intuitive understanding of the concepts.

The topics covered by the routines include: beams, trusses, columns, flexure, statically indeterminate structures, and Mohr's circle analysis, including stress and strain transformations, and more. The software groups the routines into modules very much like textbook chapters. In fact, besides being available on the Web, it is now being offered with a new engineering textbook, *Mechanics of Materials, 2<sup>nd</sup> Edition*, by Roy R. Craig, Jr. (Wiley).

I make sure the students know the manual calculations beforehand, because MDSolids does all the calculations for the user, giving prompts for entering the data. The neat thing about this is students can change the parameters and see the results, in many cases with three-dimensional illustrations, without having to do hours of calculations by hand – this allows them to grasp and work with the concepts, which aren't lost in the concern about possibly making a mathematical mistake. For example, strain gauges are used to measure the strain on a material to see how much it deforms per unit length. These gauges are very accurate, reading to one millionth of an inch per inch. To get the raw strain data and change it over into something useful for engineering purposes is not that difficult, but it's very time consuming. MDSolids does it instantly.

In one exercise, I have the students perform a shaft design. I give them a number of different specifications defining the type of machinery the shaft will be running – perhaps it's one gear running a conveyor and another gear running a hoist, and they're all coming off one shaft. We have to determine what kinds of loads, for a given torque, we would have on the shaft in a particular location. This creates what are called shear and bending moment diagrams, which help us determine what the shear and bending moments are anywhere along the shaft. That information goes into the design of a shaft, and the calculations by hand can be quite long. If they find from the catalog that they can't get a particular size gear, that the gear they chose won't fit the shaft, or that they have to move the gear along the shaft, it's easy for them to enter a new force or a new distance into the MDSolids program. The program does the new calculations in a few minutes.

I also tell students to have a Word document running while they work on a design in MDSolids – they can do a “print screen” and paste the captured screen graphic into their project report, which is required for every design project. They're building their report as they go along.

MDSolids is Windows-based and can be downloaded from its Website:  
<http://www.mdsolids.com>.

### **The results**

The software's ability to let the students interact with the problems and make changes in turn allows the students to see the trends in the problems through dynamic observation. They actually like doing new iterations and redesigns – rather than going nuts because they have to spend the next two hours recalculating, they start to streamline their designs and modify them. They don't mind doing it because it's simple and now they're having fun with it. This aspect of the software is so effective that it's being adopted by engineering firms for use in their basic design work – I know because some of my students who have “co-op” jobs at companies in the area have introduced the software to their bosses.

If you have any questions about how I use MDSolids, you can contact me at:  
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LINKS	
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