Description of VLSM

There are five modules in VLSM dedicated to the topics covered in the Statics course. The title of each module along with a sample of topics covered within it are shown in Table 1 below.

Table 1. Description of Statics modules and samples of corresponding topics

Module	Sample of Topics
1. Concurrent Force Systems	Trigonometry; Analytic geometry; Vectors; Force resultant; Newton's laws; Free-body diagram and equilibrium of particles under 2- or 3-dimensional loading condition
2. Non-Concurrent Force Systems	Distributed forces; Moments about a point and axis; Rigid supports; Free-body diagram and equilibrium of rigid bodies under 2- or 3-dimensional loading condition
3. Trusses, Frames, and Machines	Analysis of plane trusses, frames and machines
4. Friction	Static and kinetic friction; Single- and multi-body contact problems
5. Geometric Properties of Shapes	Centroid; Center of gravity; Area and mass moments of inertia; Radius of gyration

VLSM is designed to be learner-centered with a presentation style that demystifies the concepts many students find difficult to understand and to learn. It contains elements that highlight the relevance of course material to students in all engineering disciplines but more so to those in aerospace, biological, civil, and mechanical engineering. Its various features are designed to support almost all learning styles.

Among students who take Statics, some start with a weak foundation of prerequisite topics in trigonometry, calculus, and physics. Consequently, they tend to quickly fall behind their peers and do poorly in the course. In response to this problem, several sections in Module 1 are devoted entirely to the discussion of mathematics essential in developing the student's ability to work various problems discussed in the Statics course.

Each module has a main page similar to that shown in Fig. 1 with the corresponding table of contents shown in the left frame. The user can select any item on that list and see the corresponding content appear in the right frame.

- *Frequently-Asked Questions*

In all modules, the first item that appears in the left frame is a question. This is done to immediately engage the student in thinking about the topics he/she is about to study. This question is then followed by a list of other frequently asked questions and answers. Depending on the nature of a question, the answer is given either in textual form or in combination with figures and equations. The collection of questions—asked by former students—are used to form the initial list with continuous updates and expansion over time.

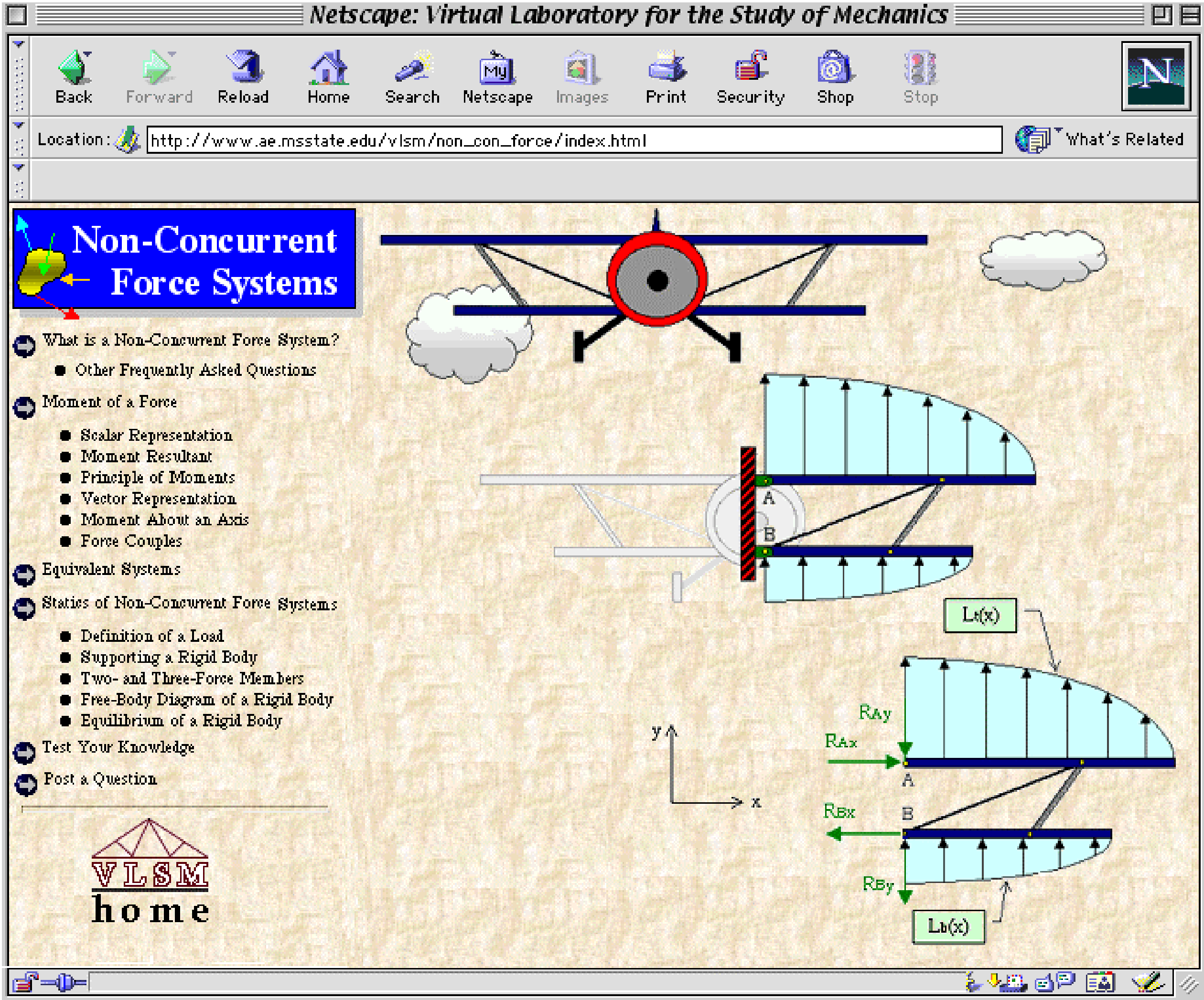


Fig. 1 View of the main page of the Non-Concurrent Force Systems module

- *<u>Tutorial Discussions</u>*

These discussions elaborate on specific topics in each module. They use a blend of text, figures, mathematical expressions, and in some cases interactive models and demonstrations. The interactive models are developed using the Macromedia's Flash/Shockwave software. They are designed to provide a vivid depiction of concepts that students find difficult to visualize and understand from still photos/drawings or textual descriptions found in most textbooks. The visual, and interactive features make the tutorial discussions particularly attractive to sensing, visual, and active learners. Figure 2 shows the tutorial discussion about the rigid supports. By clicking on a particular support, a new window appears. By clicking on the animate button, the general motion allowed by the support is animated and the free-body diagram of the connected member with reaction forces and possibly moments are drawn. There are a total of 20 animation or interactive models in the Statics modules of VLSM.

Fig. 2 Discussion of the rigid supports in the Non-Concurrent Force Systems module

- *“Textbook-Style” Example Problems*

These example problems demonstrate the analysis process and the application of solution techniques in a methodical and step-by-step fashion. However, unlike most textbooks, these examples describe all the intermediate steps and provide more explanations for various steps in the solution process, as shown in Fig. 3.

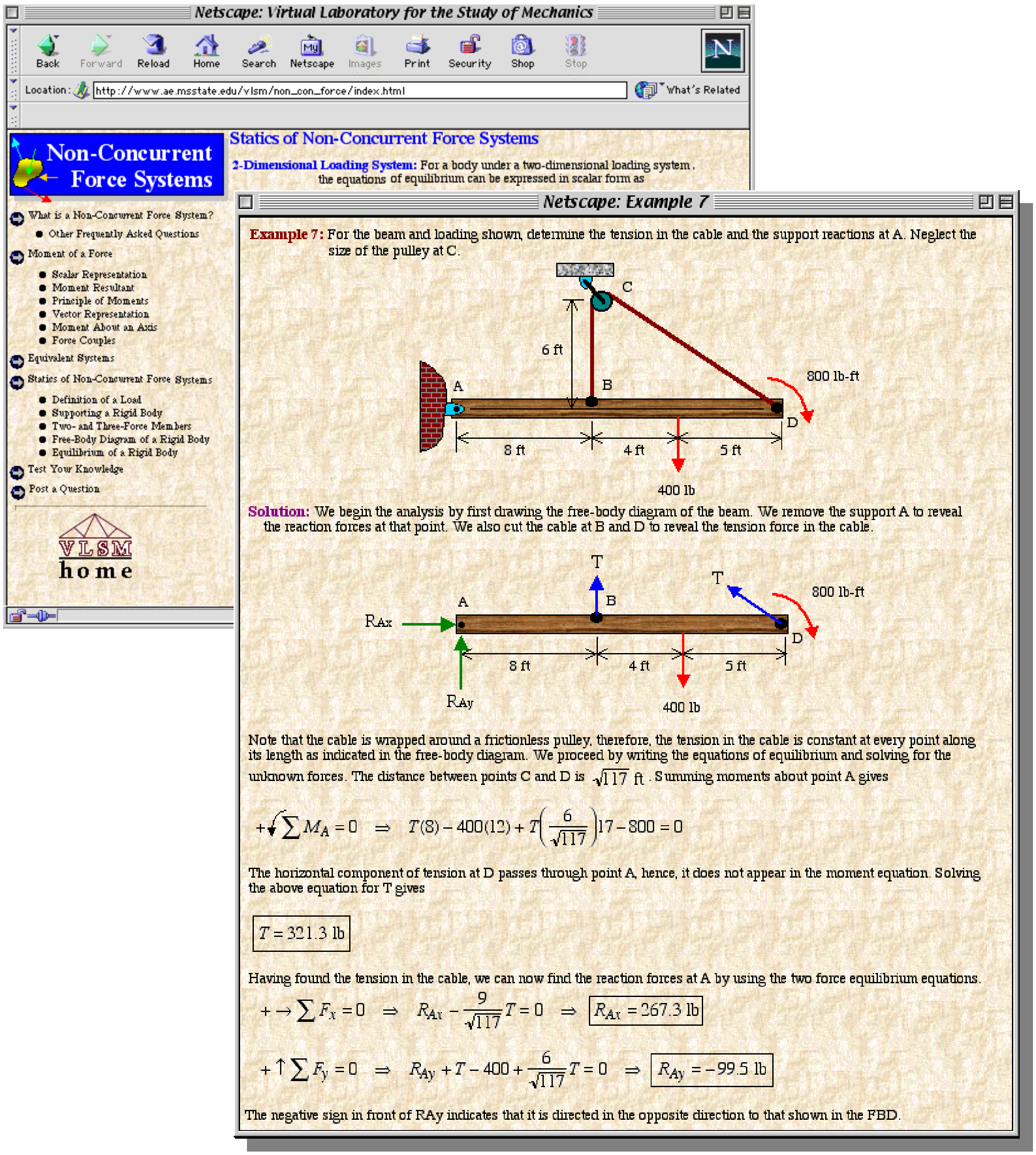
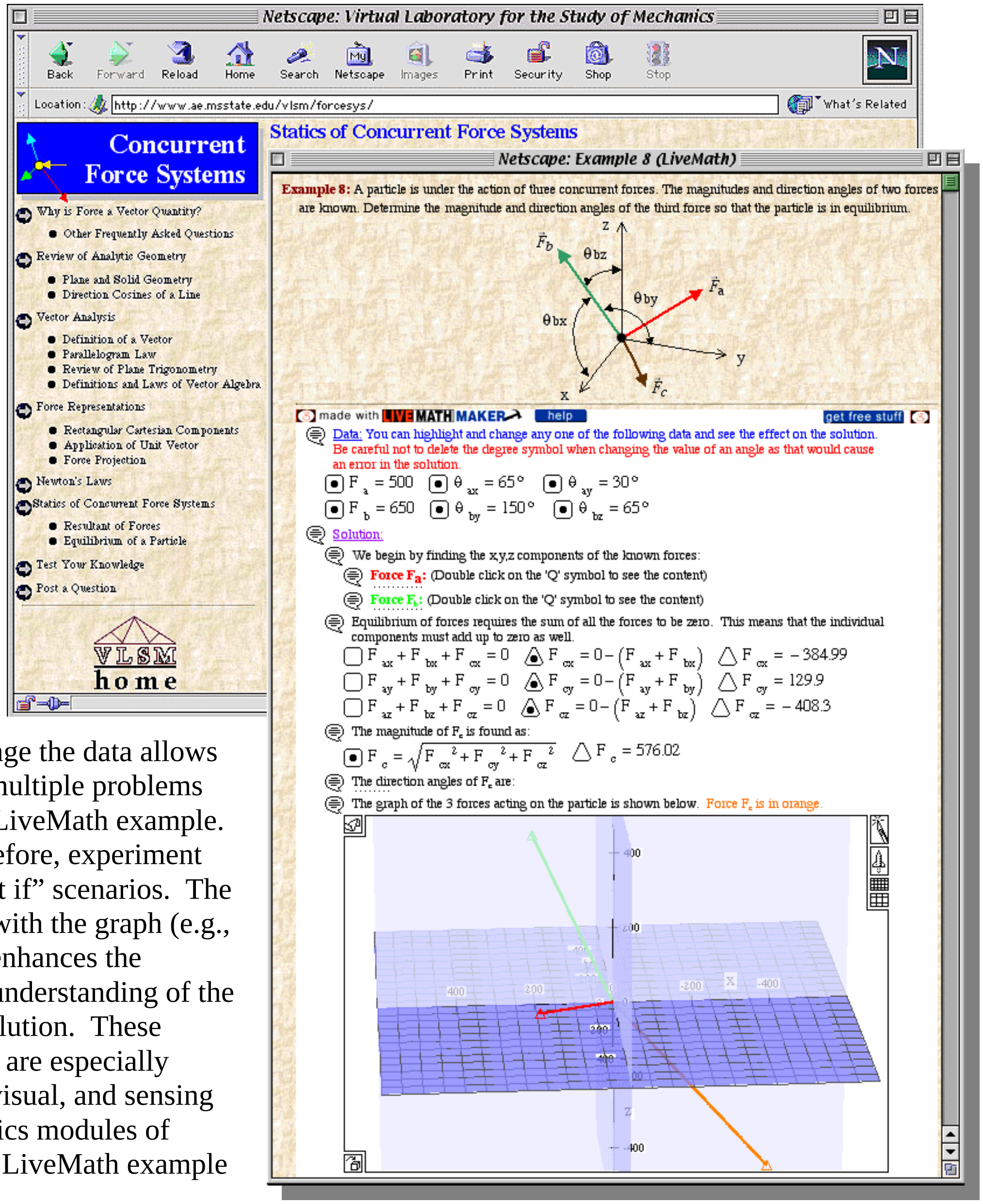


Fig. 3 An example problem in the Non-Concurrent Force Systems module

While helpful to all, these examples are more appealing to sensing, visual, verbal, sequential, and reflective learners. The Statics modules of VLSM contain 43 such example problems.

- *LiveMath Example Problems*

These example problems differ from those in the previous group as they were developed using the Theorist Interactive's symbolic mathematical software LiveMath®. Although initially the solution is based on the data specified in the problem statement, LiveMath makes it possible for the user to alter the data directly from the browser window and immediately witness the changes reflected in every step of the solution as well as in the accompanying 3-dimensional graph, as shown in Fig. 4.



The ability to change the data allows students to solve multiple problems based on a single LiveMath example. Students can, therefore, experiment with various "what if" scenarios. The ability to interact with the graph (e.g., rotate and zoom) enhances the visualization and understanding of the problem and its solution. These example problems are especially helpful to active, visual, and sensing learners. The Statics modules of VLSM contain 22 LiveMath example problems.

Fig. 4 A LiveMath example problem in the Concurrent Force Systems module

- *Test-Your-Knowledge Exercises*

In each test-your-knowledge exercise, as shown in Fig. 5, the student is asked to solve a particular problem and to input one or more numerical answers. When an answer is correct (within a specified margin of accuracy), the system responds with a positive message. More importantly, when an answer is wrong, the system responds with a hint as well as a link to the discussion that deals with topics related to that problem.

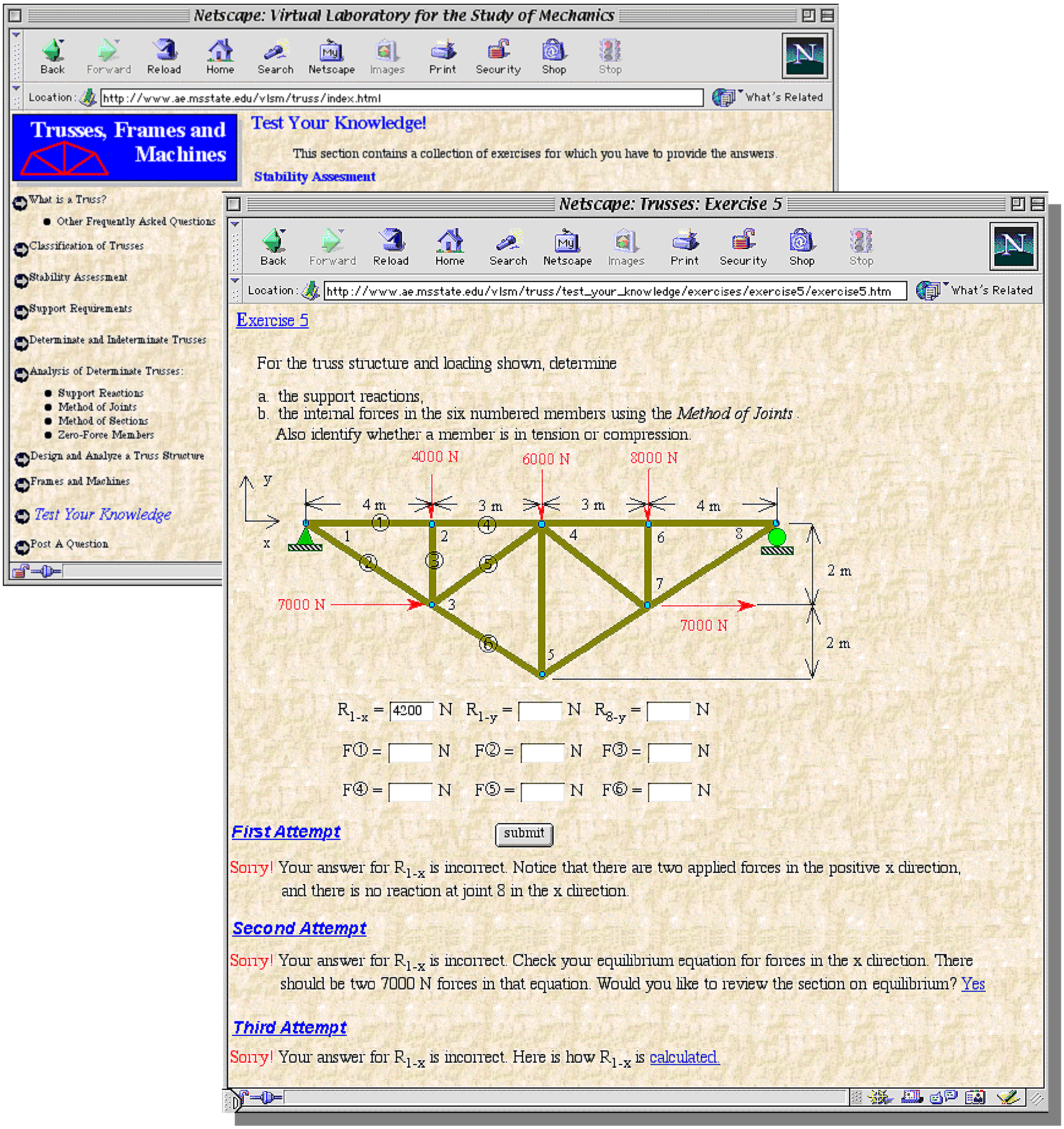


Fig. 5 A test-your-knowledge exercise in the Trusses, Frames, and Machines module

In each exercise, the student is given multiple opportunities to input an answer but will receive hints for up to three attempts. Each hint provides more helpful suggestions than the previous one with the final hint also containing a link to the solution. The hints in each exercise are based on a predetermined set of responses and do not involve artificial intelligence. The intent of these exercises is not to assign grades but to encourage students to improve their skills and competency in analysis of various problems and in application of solution techniques taught in the Statics course. As such, they are helpful to all learning styles. The Statics modules of VLSM contain 21 test-your-knowledge exercises.

- *Design and Analysis Tools*

In order to help stimulate higher-order thinking, as in synthesis and evaluation, we have developed two Java-based software tools for rapid development of alternative design models with accompanying analysis solutions. Figure 6 shows the Shape Design and Analysis Tool (S-DAT) in the Geometric Properties of Shapes module.

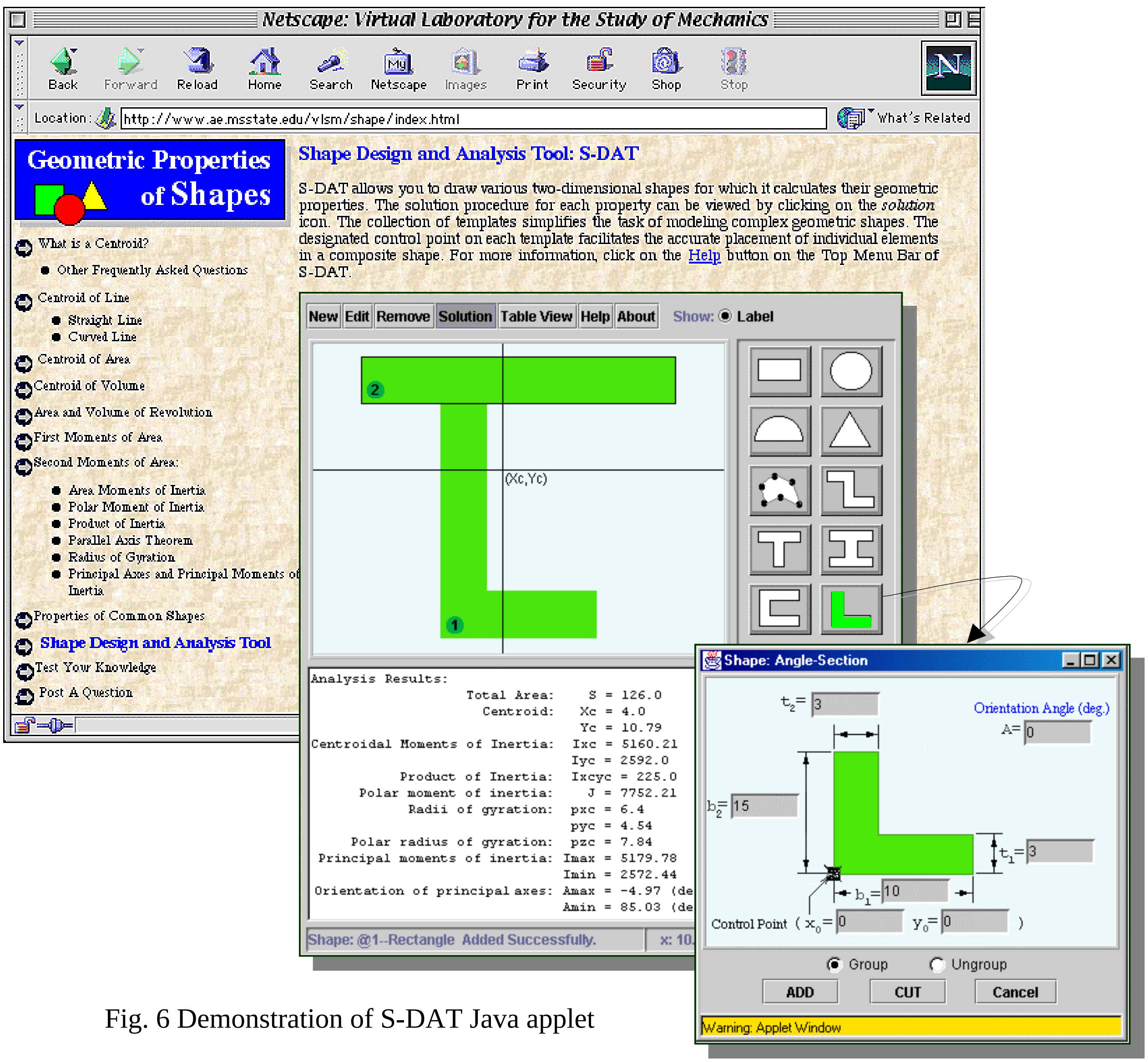


Fig. 6 Demonstration of S-DAT Java applet

With the help of S-DAT, students are able to generate a drawing model of any two-dimensional shape that can be formed using the available templates shown in Fig. 6. S-DAT would then analyze the model and provide numerical values for geometric properties such as centroid and area moments of inertia. S-DAT also allows the student to modify the model and to see the effects on the calculated geometric properties. One important feature that sets these tools apart from those previously developed is that they do not simply provide the final answers, but rather demonstrate a step-by-step solution sequence consistent with the methods and techniques taught in the course. Although helpful to all, these tools are of particular interest to sensing, visual, and global learners.

Although not as sophisticated as S-DAT, there is also a truss design and analysis tool (T-DAT) in the Trusses, Frames, and Machines module. In that case, students can choose any of the built-in truss models and go through the step-by-step solution sequence for solving for support reactions as well as for finding the member forces using the method of joints.

- *Post a Question*

If a student encounters a problem while using VLSM or thinks of a question to ask his/her instructor, he/she can send an e-mail to his/her instructor using the built-in message window in VLSM. This feature is set up to include the list of all instructors who are teaching Statics in a particular semester or summer session. Of these questions, those that could benefit other students are reformatted and added to the list of frequently-asked questions mentioned previously.

Effectiveness Assessment

The criteria we have established for evaluating the quality of VLSM and its effectiveness on student learning are outlined in Table 2 below.

Table 2. Criteria for evaluating the quality and effectiveness of VLSM

Constituency	**Criteria**
Students	• Views on VLSM's content presentation, clarity, and user friendliness. • Preference in using VLSM in addition to / instead of the textbook. • Interest in the course as a result of using VLSM. • Knowledge and comprehension of concepts in Statics. • Skills in analyzing problems and applying solution techniques.
Educators	• Views on VLSM's content and pedagogical style. • Use of VLSM as a preferred tool for in-class concept demonstrations and example problem discussions. • Willingness to experiment with instructional technology as a result of having access to VLSM.

VLSM Related Publications

- Rais-Rohani, M. "On Development, Application and Effectiveness of a Computer Based Tutorial in Engineering Mechanics (Statics)," Proceedings of the 2001 ASEE Annual Conference and Exposition, Albuquerque, NM, June 24-27, 2001.
- Rais-Rohani, M., "On Effectiveness of an Online Tutorial to Enhance Statics Instruction," *Computers in Education Journal*, Vol. XI, No. 2, 2001, pp. 38-43.
- Rais-Rohani, M., "VLSM: An Online Tutorial for Solid Mechanics," *Computers in Education Journal*, Vol. XI, No. 1, 2001, pp. 38-44.
- Rais-Rohani, M. and Brown, D., "Development of a Virtual Laboratory for the Study of Mechanics," Proceedings of the ASEE Annual Conference and Exposition, St. Louis, MO, June 18-21, 2000.

Request to VLSM User Community

In an effort to improve the effectiveness of VLSM both as an asynchronous tutorial and a teaching tool, we solicit feedback from all who have used VLSM in any fashion. Please e-mail your comments and suggestions to Dr. Masoud Rais-Rohani (masoud@ae.msstate.edu).