ME 4041 at the Georgia Institute of Technology

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1. Overview

ME 4041 (Interactive Computer Graphics and Computer-aided Design) is a senior design elective offered every semester. Coursework is based upon the principles of interactive computer graphics hardware and software including programming for the solution of thermal and mechanical design problems. Instruction is divided into a weekly 3 hour lecture and 1-1/2 hour laboratory session. In the lecture students learn the theories governing geometric modeling and computer graphics. They are also exposed to the theories of finite element modeling (FEM) and explore the mathematics of 1, 2 and 3 dimensional structural and thermal analyses. In the laboratory the students put the lecture theories into practice by modeling and analyzing a system of components using the I-DEAS software package.

2. Lecture

ME 2016 (Computing Techniques) is a prerequisite to ME 4041. In ME 2016, students gain a working knowledge of a variety of numerical techniques used in mechanical engineering analysis and some practical experience with their use. ME 4041 is taught every semester (including summer) by an academic faculty member.
Topics covered are:

- Computers in Design, Analysis and Manufacturing
- Drafting
- Feature-Based Modeling
- Variational and Parametric Modeling
- Geometric Modeling
    - Vectors, Cubic Splines, Beziers, NURBs
    - Surfaces, Planes, Patches (Bidirectional lofting, Bezier patches)
    - B-rep/Surface Models, Constructive Solid Geometry
- Finite Element Theory
    - 1-D, 2-D & 3-D Elements
    - Elastic Theory
    - Stiffness Matrix Formulation
    - Convergence, Mesh Refinement

The lecture culminates with a midterm exam and is further reinforced by a design project and a technical design report and presentation.

3. Laboratory

In a lecture setting during the first half of the semester, students are led through the proper techniques to create parametric solid models and assemblies by a research faculty member. They also get instruction on building and analyzing finite element models and relating them to real world systems. For the latter half of the semester the students pair off in groups and model a real world system working as design engineers.

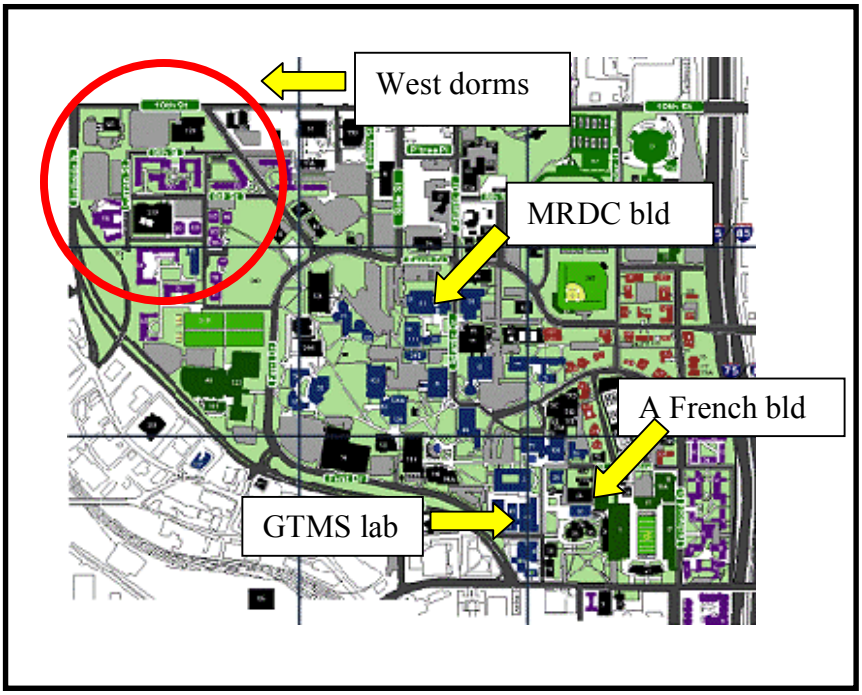
Our laboratories are equipped with the latest in computer hardware: 17 workstations running Windows NT, 26 workstations running UNIX (see Figure 1). Thanks to our strong relationship with Structural Dynamic Research Corporation (SDRC) Georgia Tech receives the latest releases of I-DEAS and we are currently running I-DEAS Master Series 7m1. We have 125 licenses of every major module of the I-DEAS software package. SDRC offers free training to the faculty and staff of Georgia Tech, Tord Dennis our lab instructor takes two classes at SDRC's site every year.

Figure 1. Lab Facilities

Beginning with the Master Series release, I-DEAS features a centralized relational database system called the Team Data Manager (TDM) that provides a mechanism of centrally locating design data with extensive capabilities for storage and retrieval of design documents, check-in/check-out, assembly modeling, and data exchange with others. SDRC also released a Student Edition of I-DEAS, which is bi-compatible with the commercial version run in the labs.

The I-DEAS Team database and related files are installed on a SUN workstation in the A. French building of the College of Engineering. The I-DEAS executable files are loaded locally on workstations dispersed throughout the campus. (see Figure 2). All of these facilities, including the student dormitories located on the west campus and the GT Motorsports (GTMS) labs, are connected via a T1 ethernet network. When a student logs into a workstation, the I-DEAS Team directory is automatically network mounted to their computer. By storing part models in the library (the I-DEAS Team directory), the students have access to them from any computer on campus. I-DEAS TDM handles the data, the data conversion processes (from UNIX to NT and vice-versa) and file locking. As students build parts, others can conduct the assembly process and other tasks (e.g. finite element analysis) working on referenced parts with read-only privileges.

Emphasis is placed on working as a team sharing data through the I-DEAS data manager software. in the near future we will introduce Metaphase to the curriculum (it is presently used only at the graduate level).

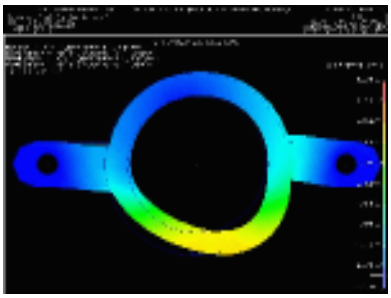


4. Projects

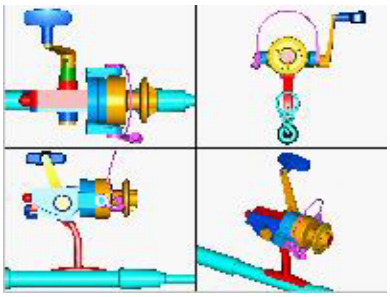
To reinforce the theories from the lecture and put their I-DEAS knowledge to work, students form groups of two to create a design project. The design project involves two phases: solid modeling and finite element analysis. In the solid modeling phase, students use the Master Modeler and Master Assembly modules of I-DEAS to build components and investigate how they function in an assembly. Students may also choose to use Mechanism Design and explore rigid body animation, to layout their parts in Drafting Setup and/or develop NC (Numerical Controls) codes to drive machining operations or Rapid Prototype components. The second phase involves investigating the durability of their design by performing a finite element analysis on their components or assemblies. Based on their project, students have the option to perform structural, thermal or potential flow analyses.

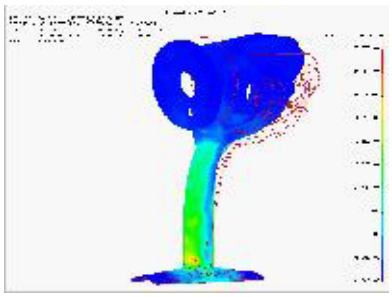
Students have the option to choose whatever project they desire:

- These students choose to work on a project on a project from ME 4182; to design and build a drill press that can be used with any hand-held drill.

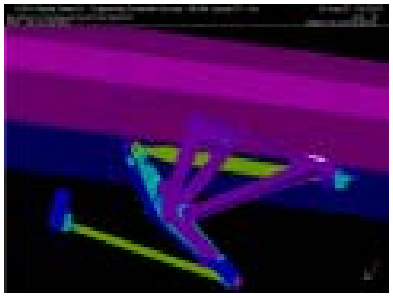


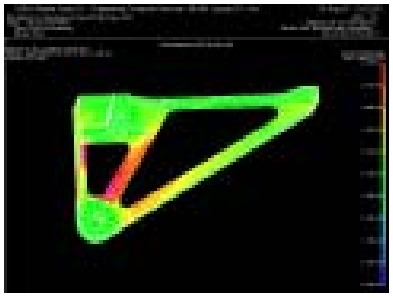
- These students were avid fishermen and modeled and analyzed their favorite spinning reel.



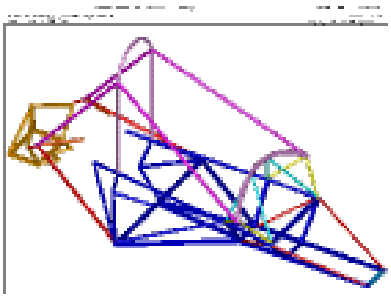


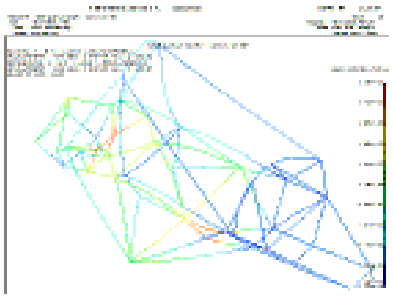
- These students worked as co-ops with Delta. They modeled and analyzed the bellcrank assembly of a Boeing aircraft.



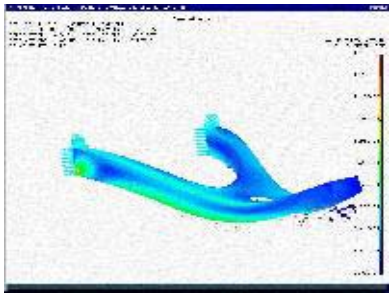


- These students modeled and analyzed the frame of the Georgia Tech Formula SAE racecar.





- These students modeled and analyzed the front control arm of their Ford Taurus after theirs failed when a tire blew-out while traveling on the interstate.



More ME 4041 student projects can be review on-line at **http://www.cad.gatech.edu/courses/me4041.html**

5. Benefits

Presently, the Woodruff School of Mechanical Engineering produces 153 undergraduates every year who are versed in CAD and CAE using I-DEAS. While many of these students enter the workforce with strong engineering skills, some remain to pursue advanced degrees at Georgia Tech delving deeper into functions of I-DEAS and Metaphase not covered in their undergraduate studies. In the next fiscal year, we plan to increase the number of students taking ME 4041 from 153 to 204 per year by adding more workstations to our instructional laboratories.