Institutionalizing a Reform Curriculum at Large Universities
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Intro physics at Georgia Tech
Intro Physics I and II at Georgia Tech are the calculus-based courses required for all engineering and science majors. These are large enrollment courses, with up to 1700 students per semester in Physics I & II combined.

The course content (up to Summer 06) has been entirely traditional. The courses consist of large lecture sections (often with more than 200 students), with accompanying small lab sections (about 20 students)

Problems with traditional course at GT
Over the past several years, several problems have been identified with the standard Intro Physics course:
- Significantly lower course GPA and higher failure rates in Intro Physics than other GT intro courses.
- Intro. Physics is often unpopular with students.
- An external review committee criticized the structure and outcomes of GT intro physics.

Implementation Methodology
Implementation was initiated in 2006 with the hiring of an M&I experienced post-doc (Kohlmyer) to train TAs, set up M&I lab activities and deliver lectures in the pilot M&I lecture sections.

Faculty involvement:
The radically different course content of M&I poses a barrier to faculty adoption. To increase faculty acceptance, we have implemented a bootstrap apprenticeship model with the pairing of an experienced M&I instructor and a GT faculty member. Initially, the M&I post-doc served as the experienced instructor, who worked closely with GT faculty on course content and logistics. In subsequent semesters, parallel sections of M&I intro physics have been taught in common by a group of GT faculty containing some M&I experienced instructors, who help faculty new to M&I become accustomed to the curriculum.

From reactions faculty new to the course have been very positive. By the end of Fall 2006, the GT School of Physics will have six GT tenure-track faculty and instructors experienced in M&I.

TA training and management:
M&I labs are much different from traditional course labs at GT. In the M&I labs there is a strong connection between lab and lecture content. The M&I labs are in an interactive studio style, where students do hands-on experiments, computer modeling activities and group problem solving.

Assessment via Standardized Instruments
Brief E&M Assessment (BEMA): The BEMA was designed to be valid for both traditional and M&I E&M courses. The BEMA is a qualitative and semi-quantitative multiple-choice test. The questions span the range of content of a typical E&M course, from Coulomb’s law to Faraday’s law of induction.

The BEMA was administered to both M&I and traditional Physics II sections at the end of the Fall 06 and Spring 07 semesters. The results are shown below in Fig. 1. The M&I sections did significantly better on this instrument than the traditional sections.

Why is this here? Talking about BEMA. This section should be recast for results.

Features of Matter & Interactions
Modern content: The atomic structure of matter and 20th-century physics are major themes of the course.
Modeling: Students analyze complex systems using a small set of fundamental principles.
Computer modeling: Students create computer models of physical systems using the VPython programming language.

Implementation
The M&I curriculum has been phased in at GT over the past 2 years. In Fall 08, approximately one-half of all GT intro physics students will use the M&I curriculum.

<table>
<thead>
<tr>
<th>Term</th>
<th>M&amp;I Mechanics</th>
<th>M&amp;I Electromag.</th>
<th>Faculty w/M&amp;I Experience</th>
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Acknowledgements
This effort is funded in part by the National Science Foundation (DUE0618519) and by Georgia PRISM (Partnership for Reform in Science and Mathematics), Atlanta Metro Region. It is part of a collaboration with NC State University and Purdue University, both Matter & Interactions adopters, to examine the challenges of implementing curricular change at large institutions.

Fig. 2. The “ball & spring” model of a solid is used in Matter & Interactions to help students understand a wide variety of phenomena, including elastic deformation, the speed of sound in solids, and entropy.

Fig. 3. Graphical output from a student-written VPython computer model of a spacecraft interacting with the Earth (left) and the Moon (right). The arrow represents the momentum of the spacecraft.