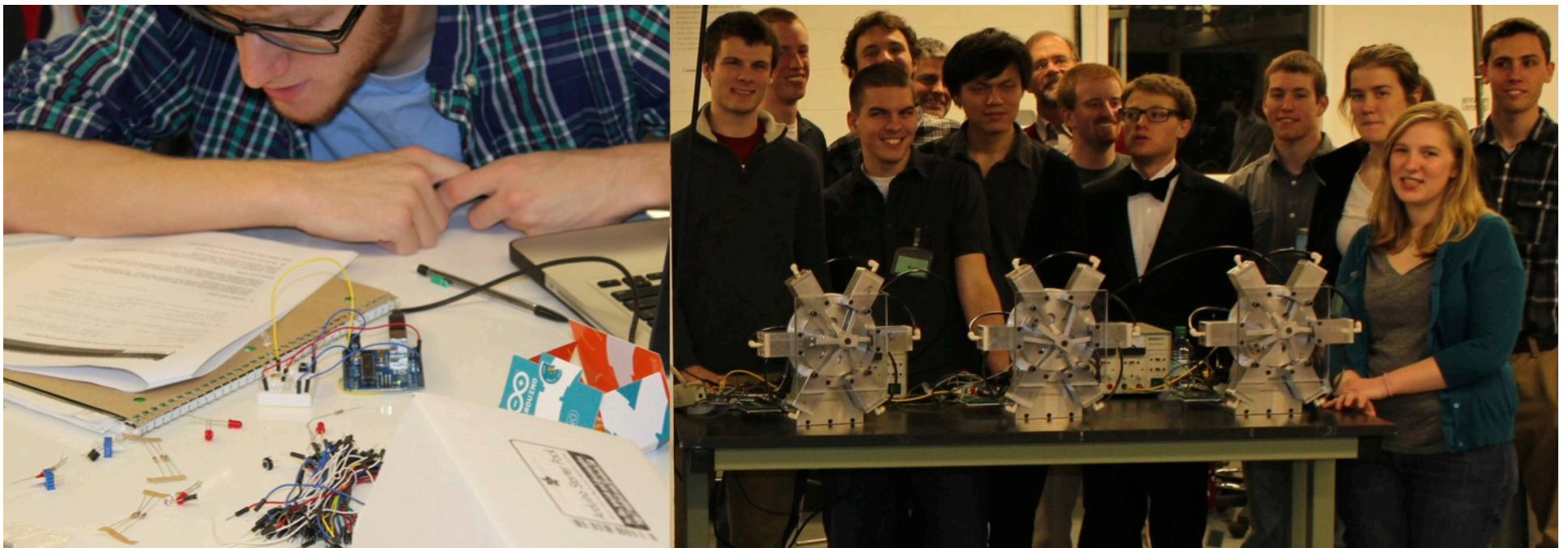




Re-inventing the ME Curriculum at Ohio State



Re-inventing the curriculum

Context

After 90 years on a quarter-based academic calendar, Ohio State University converted to semesters in 2012.

The Department of Mechanical and Aerospace Engineering took the opportunity to re-think how we teach mechanical engineering.

With input from students, alumni, industry, and other institutions, we designed a curriculum that affords more experiential learning for our students.

Re-inventing the curriculum

Commitment to change

The new curriculum is based on four major innovations:

More emphasis on computational skills in elective courses

An open-ended 'capstone laboratory' course in senior year

A year-long capstone design project

A new emphasis on engineering design

Focus on design and fabrication

Emphasis on design: two new courses

Two new courses ‘bookend’ our program:

ME 2900: An ‘introduction to design” course for students entering the major in which they fabricate an electro–mechanical system.

ISE 4500: A manufacturing processes course specifically designed for mechanical engineering students at the senior level.

A basic course in design fundamentals

ME 2900: Introduction to design in mechanical engineering

A crucial component of our curricular re–design is a new course that introduces students to mechanical engineering.

This course is intended to give students a good overview of the discipline while imparting skills that students will use throughout their careers.

Students enroll in this class immediately after admission to the major, in the second semester of their second year.

A basic course in design fundamentals

Motivating factors

The course was motivated by:

Dissatisfaction among students, employers, and alumni about the lack of practical design skills in our students.

A real lack of mechanical intuition in our students;

A wide variance in skills and experience;

A desire to expose students to the common themes and problems faced by mechanical engineers.

A basic course in design fundamentals

The fabrication experience is central

From the beginning, we decided to place a hands–on experience at the heart of our effort – it provides the scaffold around which the course is built.

Lectures are delivered on a ‘just in time’ basis: students apply what they hear in lecture to specific tasks they face that week in the shop or electronics lab.

The primary problem in teaching this course was developing an appropriate ‘teaching platform’ that would support our goals.

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Designing an effective teaching platform

Because the device that the students build is the heart of the course, it must be:

Simple enough for students to build and test in one semester;

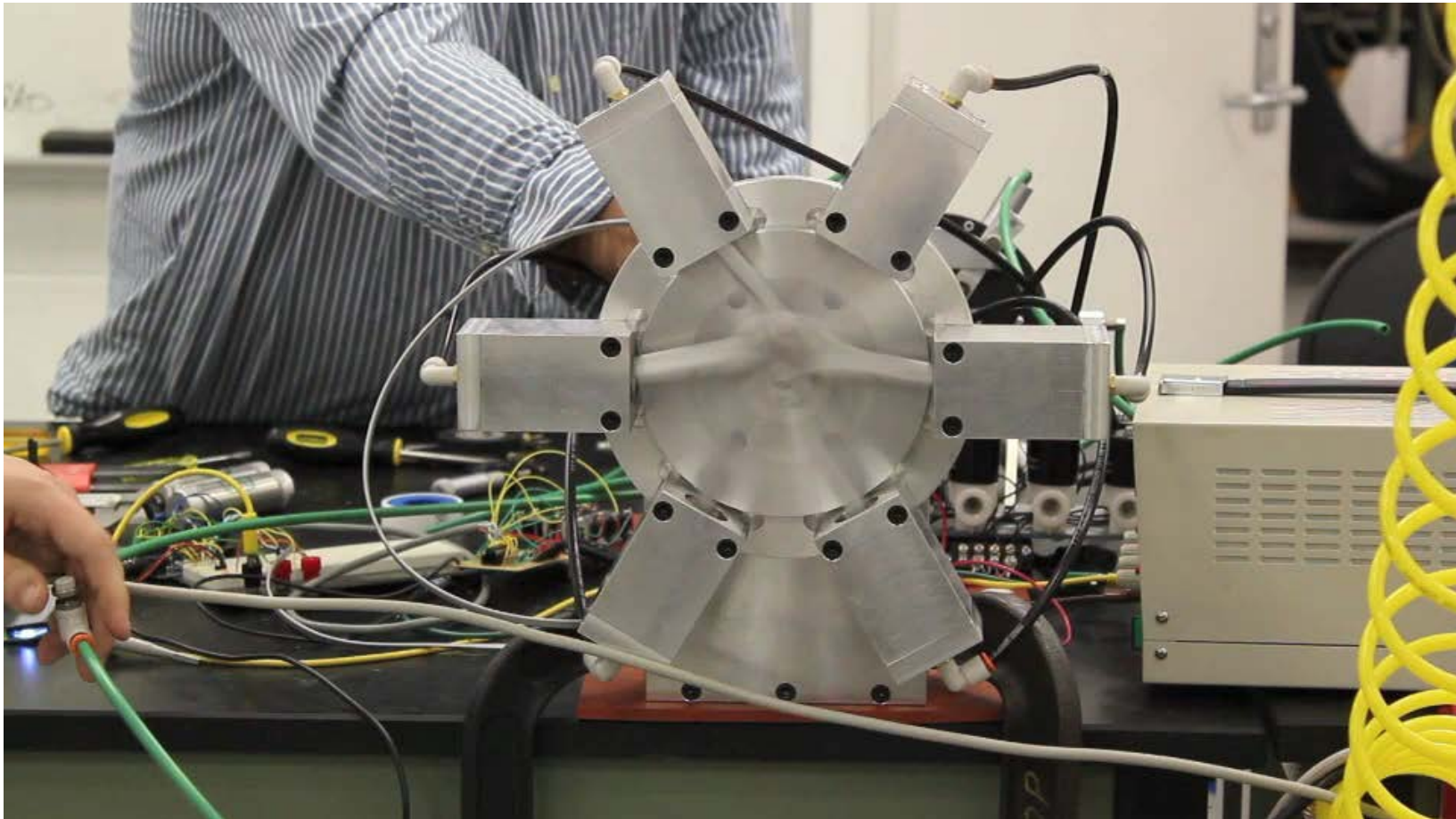
Complex enough to hold students' interest;

Sophisticated enough to support its integration into the remainder of the curriculum.

After a year-long process involving two pilot courses, we settled on a radial compressed-air motor as our teaching platform.

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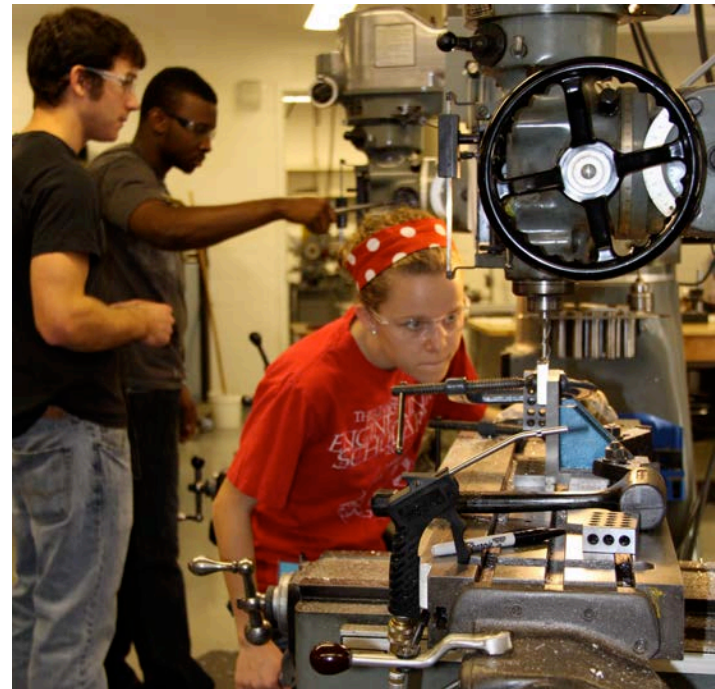
The six-cylinder radial air motor



A basic course in design fundamentals

Our ongoing problem

We are confronted with the task of providing a rich experience to very large classes: 198 students in Autumn, 163 students this Spring.



A basic course in design fundamentals

Managing the numbers

We divide the students into two cohorts, one starting in the machine shop, the other in the electronics lab.

Each cohort attends lecture together, and are split into lab sections of eighteen students, maximum.

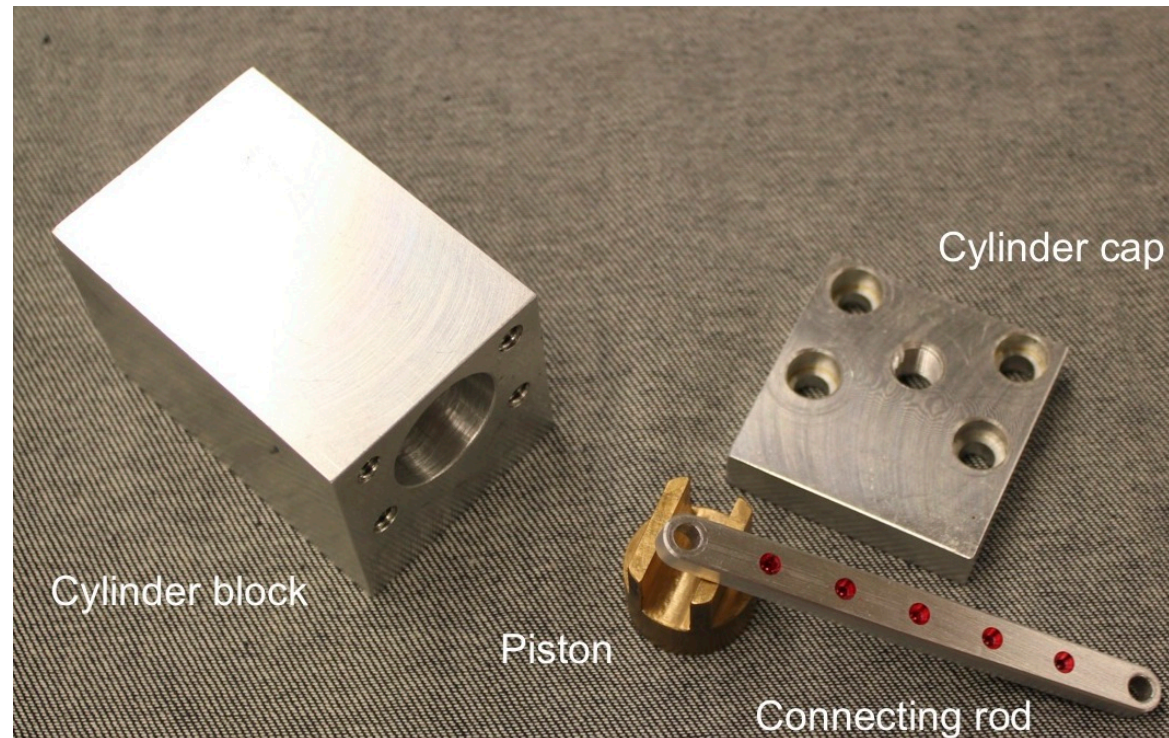
The lectures support the specific tasks the students are facing in lab that week.

In mid-semester, the groups switch roles.

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In the shop, each student fabricates four components

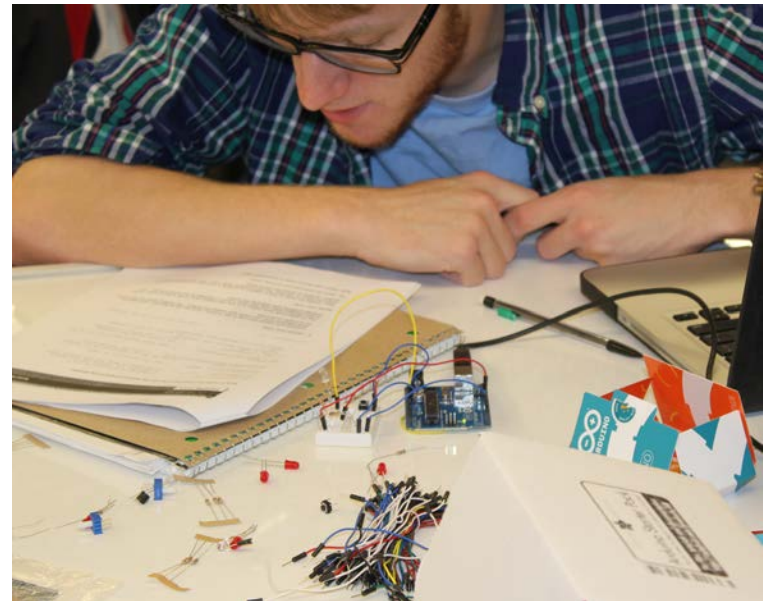
The material cost of these components is \$14.



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In the lab, students learn to program a microprocessor

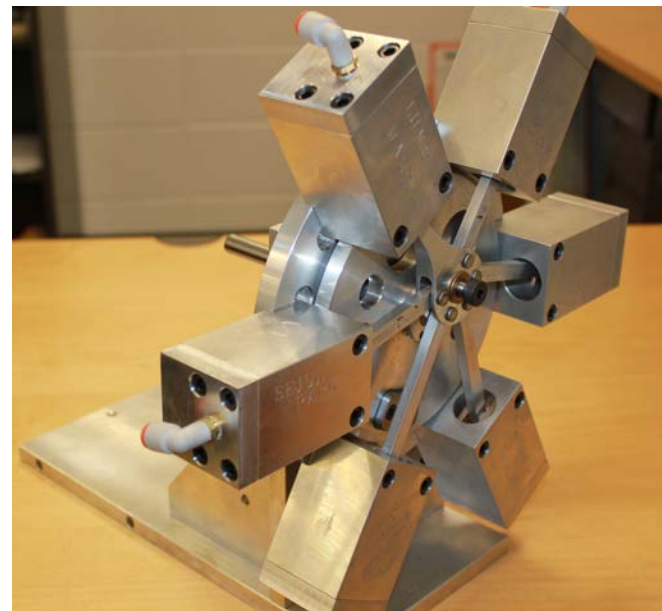
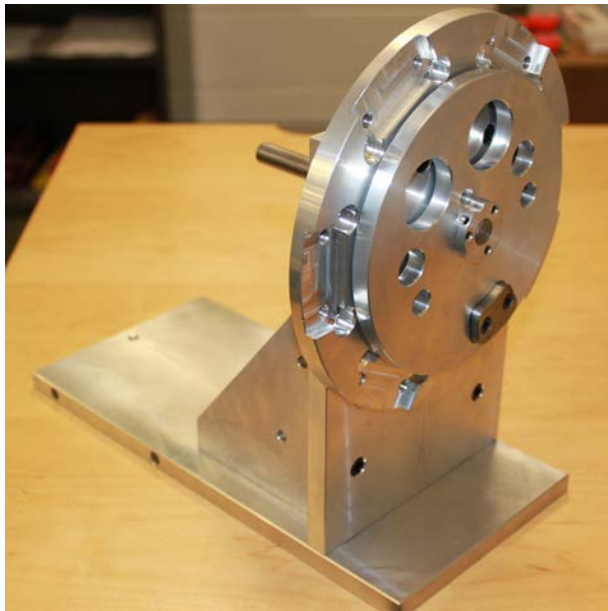
Each student purchases an Arduino microprocessor along with other parts for \$90. They use the Arduino to control the airflow to each cylinder of the motor, and in an open-ended design project.



A basic course in design fundamentals

Controlling costs with a modular design

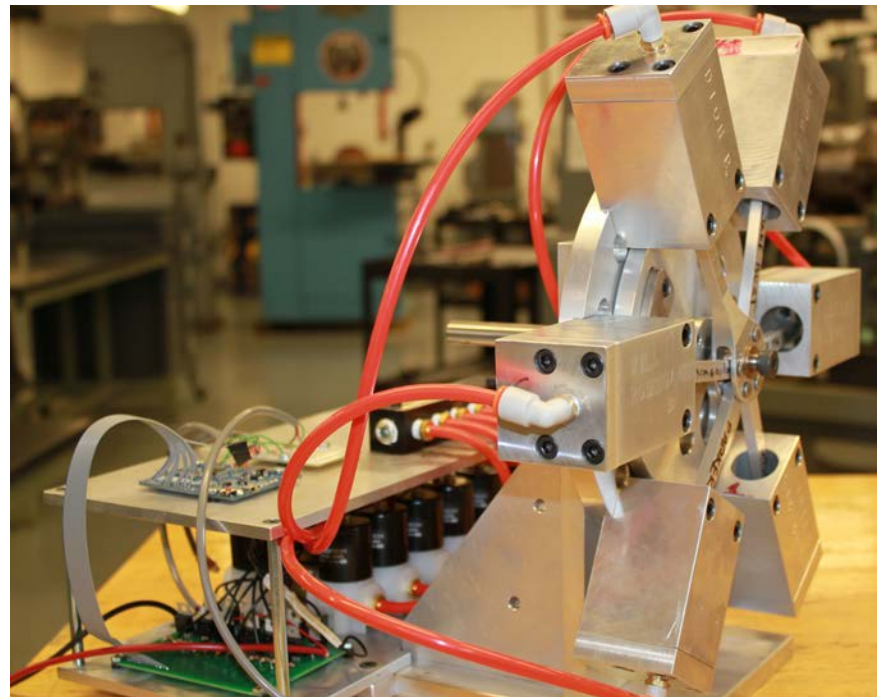
Teams of six students assemble their components to a common frame, which we re-use. We've built 34 of these frames.



Some details about the air motor

The complete motor

The team's motor is then attached to one of nine test rigs, and the students each test their own Arduino code on their motor.



A basic course in design fundamentals

Hidden costs

This course is expensive, both in dollars and in faculty time.

A complete test rig costs approximately \$600.

My colleague Lisa Abrams and I teach both sections twice a year.

We are supported by two skilled machinists, two graduate TAs, and seventeen undergraduate TAs.

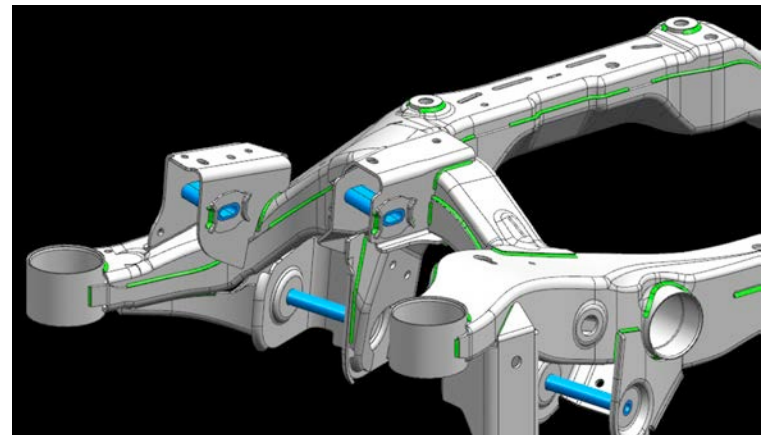
It's essential to have adequate staff support, especially with so many students in the machine shop.

An advanced course in manufacturing

ISE 4500: Manufacturing Processes for Mechanical Engineering

The new course in manufacturing is taught by Industrial & Systems Engineering and requires a background in machine design, heat transfer, and fluid mechanics.

Delaying the manufacturing processes course until the final year allows us to teach manufacturing processes at a much more sophisticated level.



An advanced course in manufacturing

Analysis, simulation, practice...

The course integrates theory, simulation, and lab work to allow our students to apply concepts they've learned in the junior year.

The course serves two purposes:

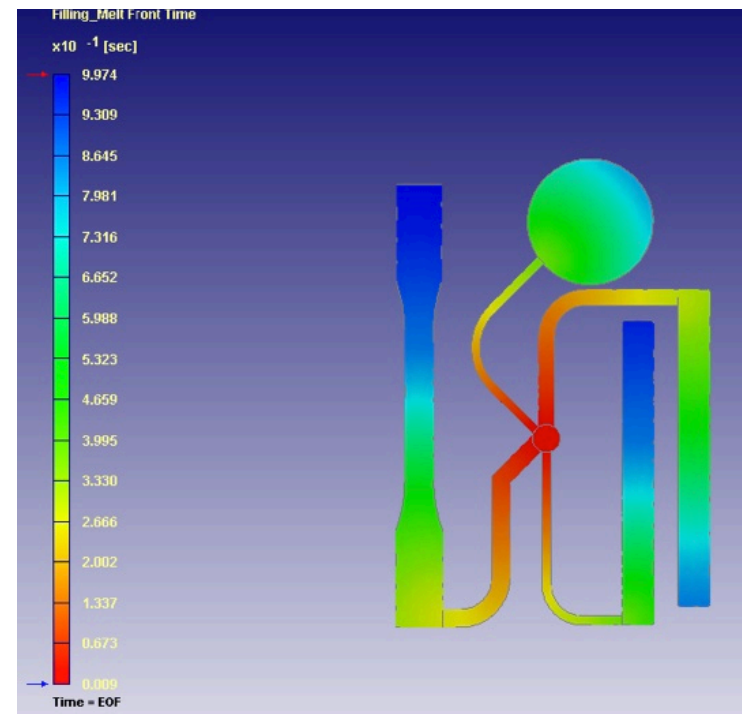
It integrates material from earlier courses to explain complex material behavior;

It gives our students much better preparation in manufacturing than has been the case.

An advanced course in manufacturing

Example: injection molding

Students apply fluid mechanics and heat transfer to develop an analytical model of the flow of a thermoplastic into a mold cavity.



An advanced course in manufacturing

Example: injection molding

Students immediately compare the results of their simulated model against the actual behavior of the material.



An advanced course in manufacturing

An up-to-date overview of manufacturing processes

The basic schema of analysis, simulation, and practice is repeated for a wide range of traditional and contemporary processes:

Sheet and billet forming

Metal casting

Additive manufacturing

Electronics fabrication

Ultra-precision machining

Students enrolled in this class will also have had eight weeks of machine shop practice in ME 2900 as sophomores.

A major change in our curriculum

Support for these courses

This effort began in the summer of 2009 with our first meeting with alumni, industry, and other schools.

At that time, the department established a Curriculum Fund and began a major fundraising campaign, which ultimately raised \$1,000,000.

The OSU–Honda Partnership currently supports our efforts at the level of \$96,000 per year.

Support for these changes among the faculty is a work in progress.

A major change in our curriculum

Questions?

Please contact me at lilly.2@osu.edu for more information.

