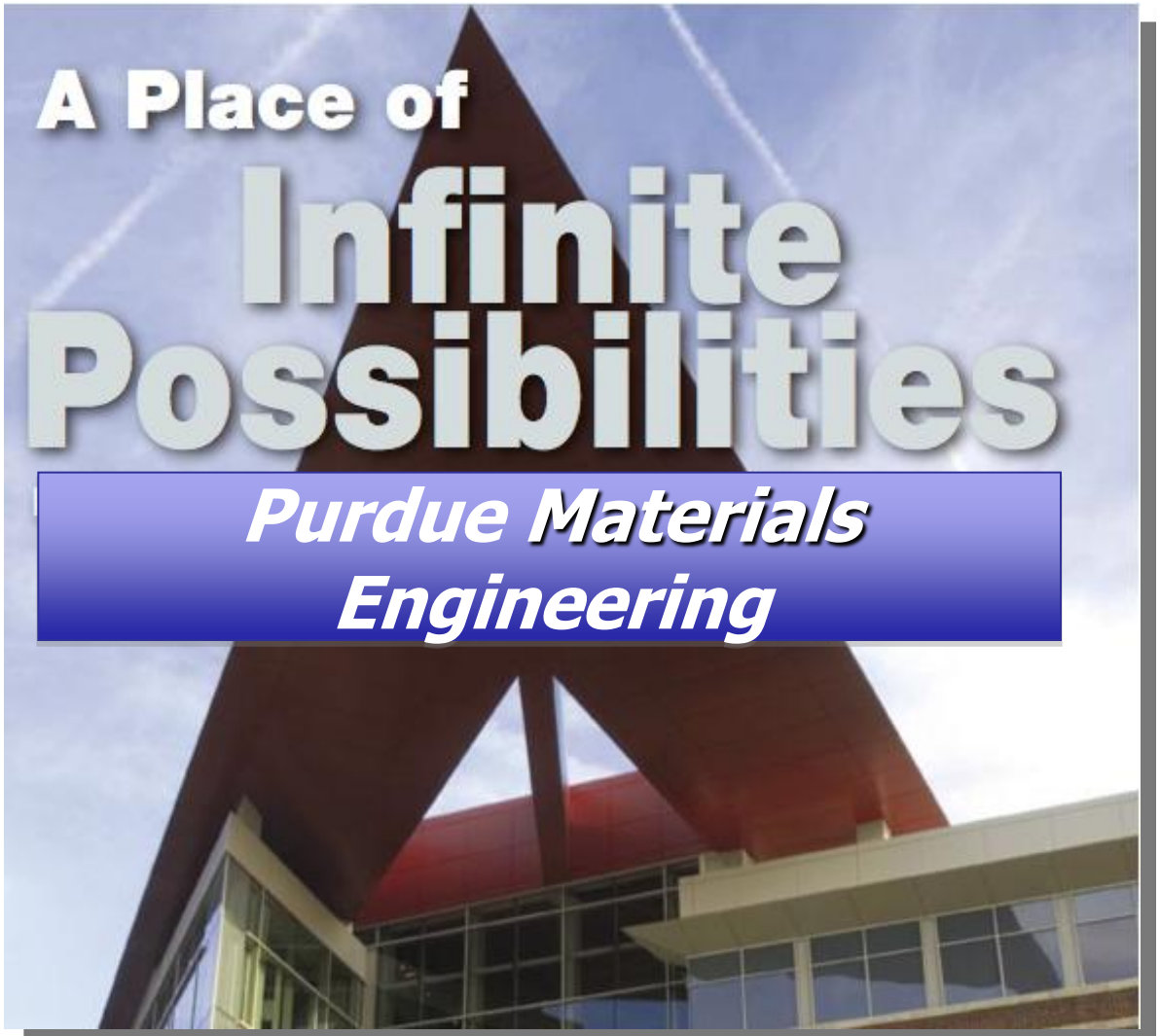
Materials Engineering at Purdue

Prof. Rod Trice

rtrice@purdue.edu

Chair of the Undergraduate Committee

You can't build it without materials…



Nanotechnology

Microelectronics

Energy Materials

Biomaterials

Automotive Materials

Aerospace Materials

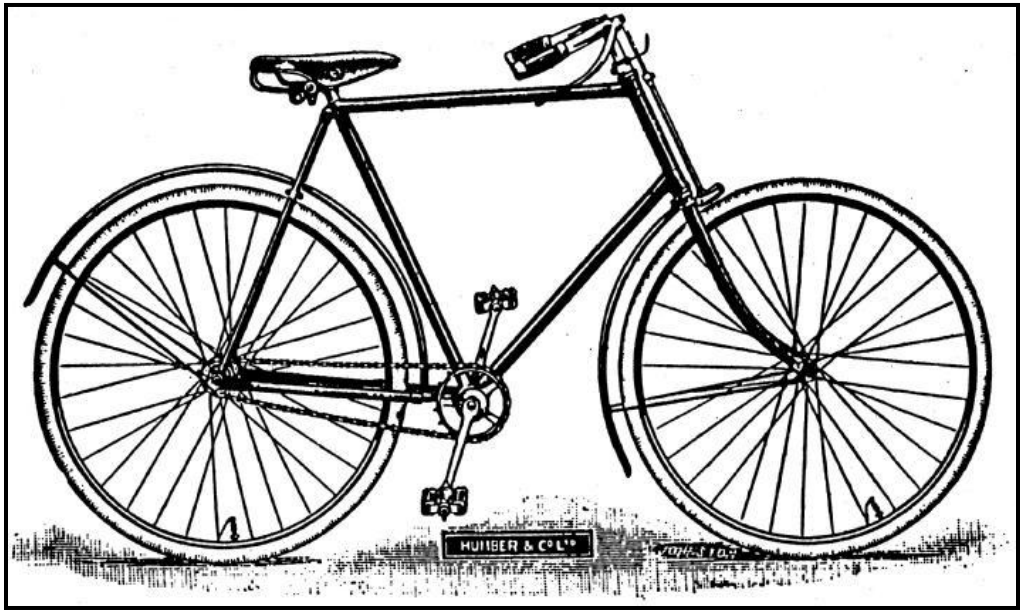
Green Materials

2nd Floor and Basement of Armstrong, Physics and MSEE Building

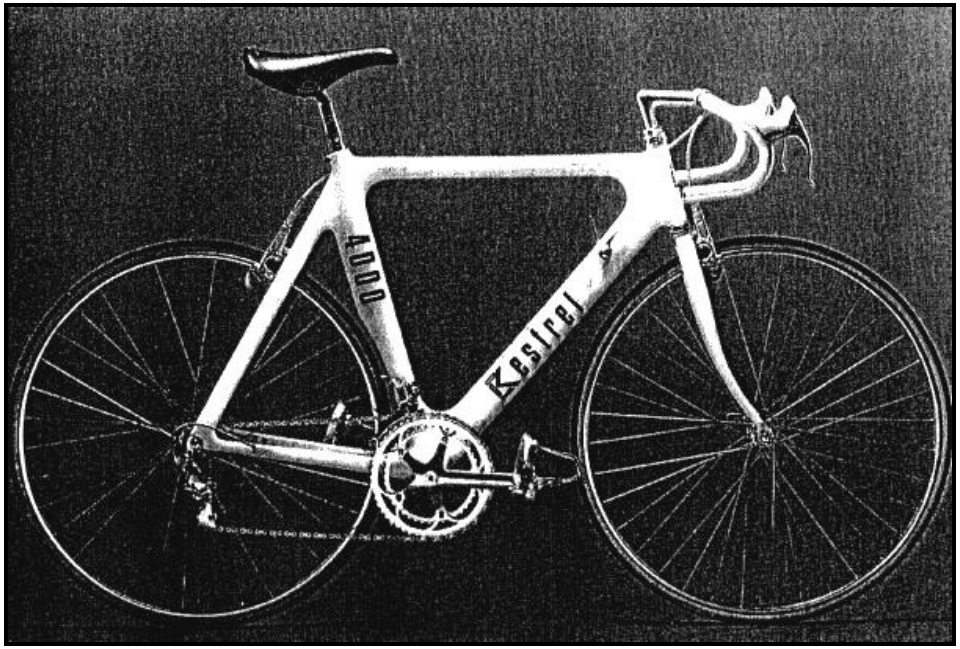
Questions We Intend to Answer Tonight!

- 1. What can you do with a Materials Engineering Degree?
- 2. What kind of experience will I have in MSE at Purdue?
- 3. What is the culture in our department?
- 4. How is Materials Engineering different than Chemical Engineering?
- 5. Can I tour your facilities? Meet more professors and students?

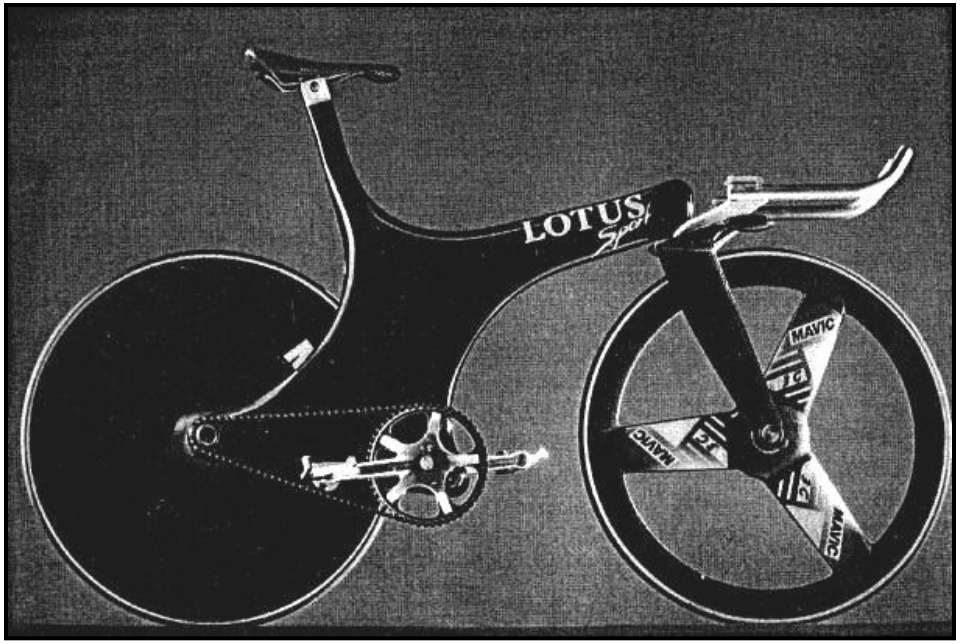
Materials Engineers develop materials that improve people's lives…



The Humber, 1890.
(From A. Sharp, Ioc. Cit.)



A monocoque CFRP frame by Kestrel.

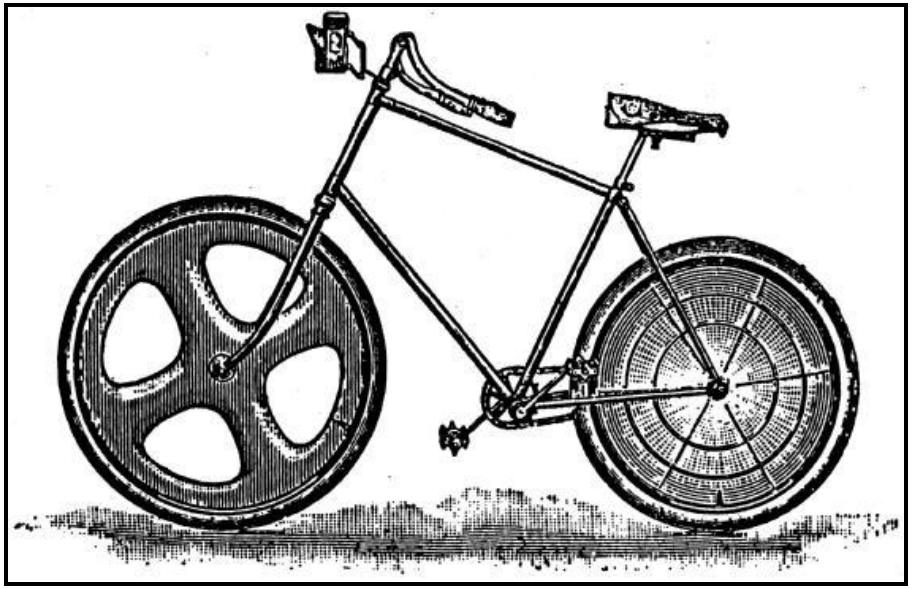


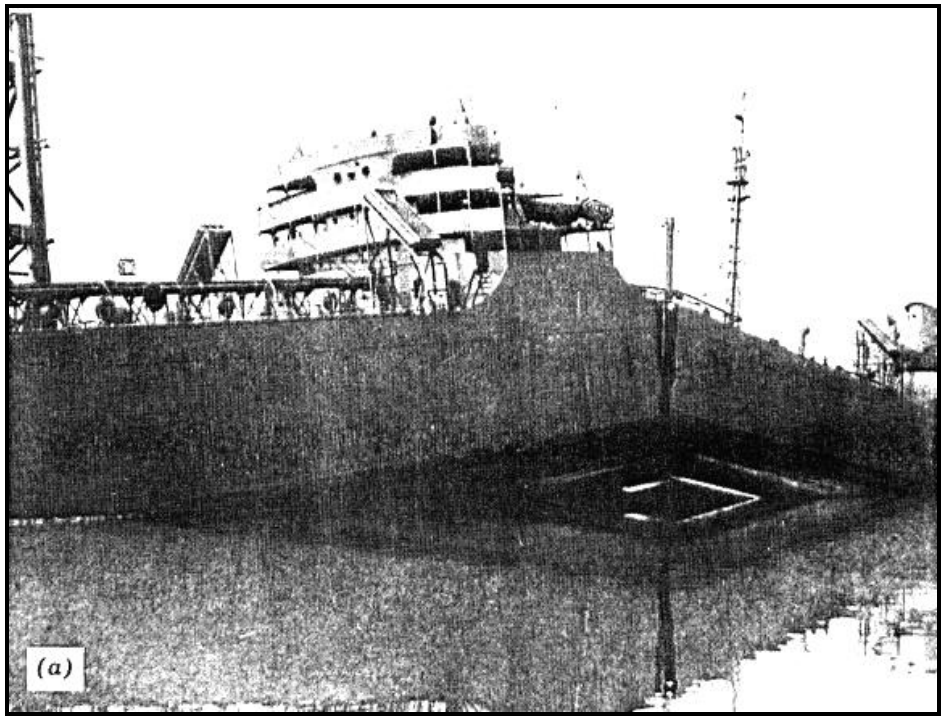
Materials Engineers develop new materials that make futuristic designs possible/better…

The Lotus monocoque pursuit racing bike.

A rendering of an early bicycle with a rear disc wheel and an open-spoke wheel in the front (1896).

(A. Sharp, 1896, loc. Cit. p. 352.)





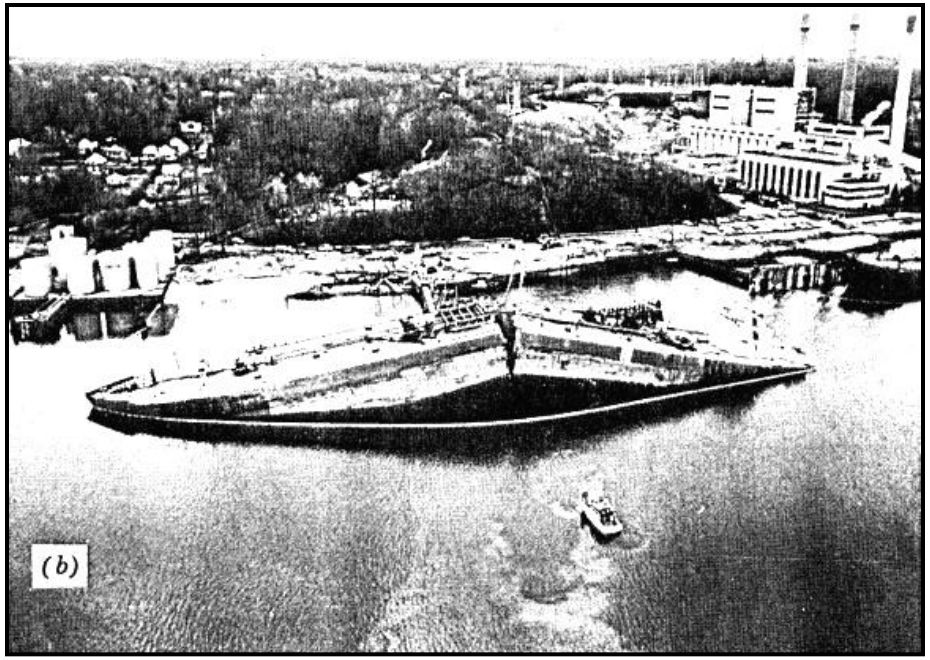
Materials Engineers understanding provides key design information that saves lives/money…

Fractured T-2 tanker, the S.S. *Schenectady,* which failed in 1941.

(Reprinted with permission of Earl R. Parker, *Brittle Behavior of Engineering Structures*, National Academy of Sciences, National Research Council, John Wiley & Sons, Inc., New York, 1957.)

Fractured oil barge, *Martha R. Ingram*, which failed on January 10, 1972.

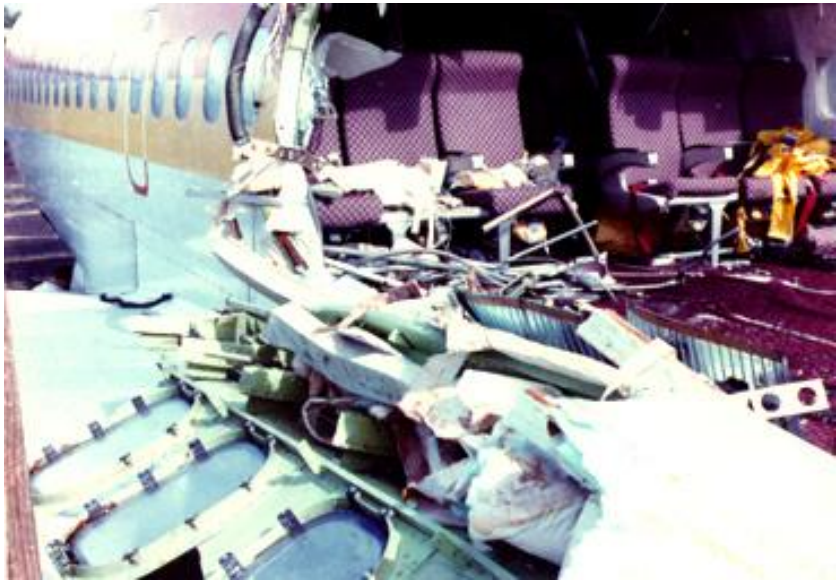
(With permission from the New York Times.)



Aloha Airlines Flight 243

April 28, 1988

The aircraft lost 1/3 of its roof due to a stress fracture while cruising at 24,000 feet. One Flight Attendant was sucked from the airplane, which subsequently made a safe emergency landing.



Materials Engineers are involved in all industries…

Employing companies in recent years include:

Aerospace Industries: Northrup-Grumman, General Electric, Lockheed-Martin, Bell Helicopter, Rolls-Royce, Honeywell

Heavy Equipment: Caterpillar, Cummins

Materials: AK Steel, Alcoa, US Steel, Arcelor Mittal

Oil Industry: Schlumberger

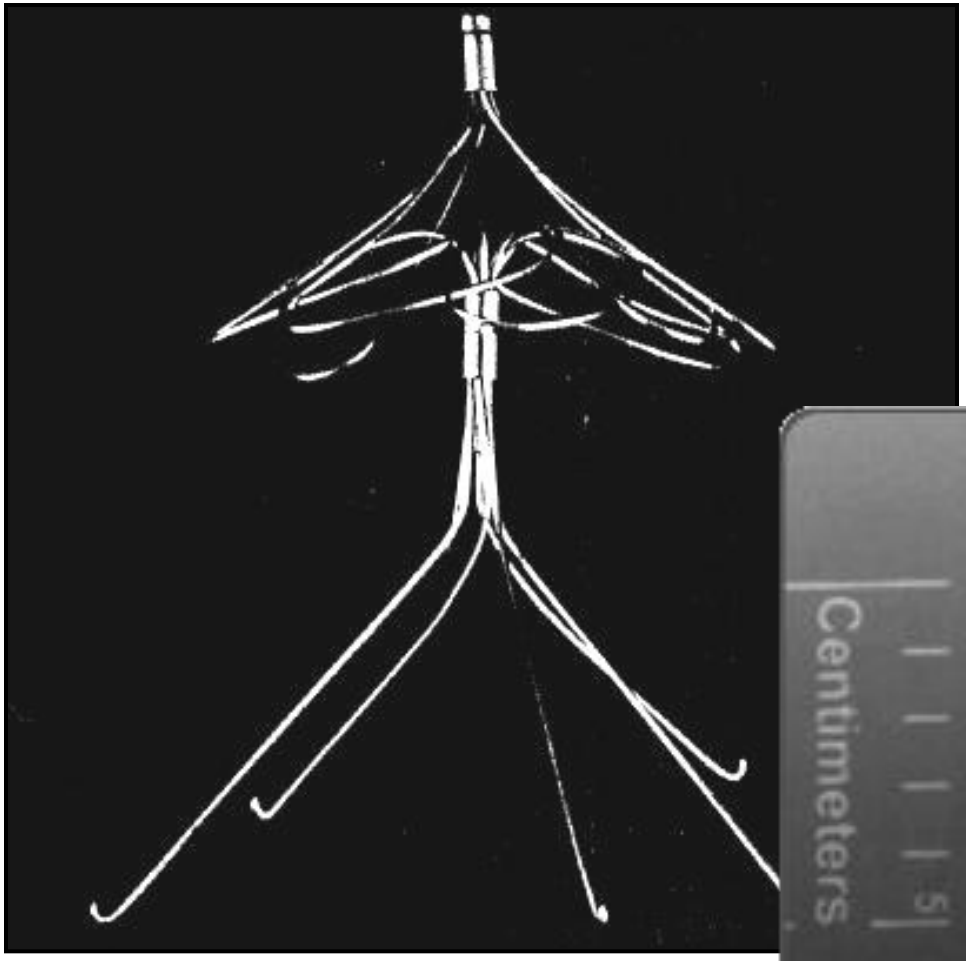
Speciality: Timken, Bechtel-Bettis

Computer: Intel

Misc: US Patent Office, Boston Scientific

Biomaterials Company: DePuy, Zimmer

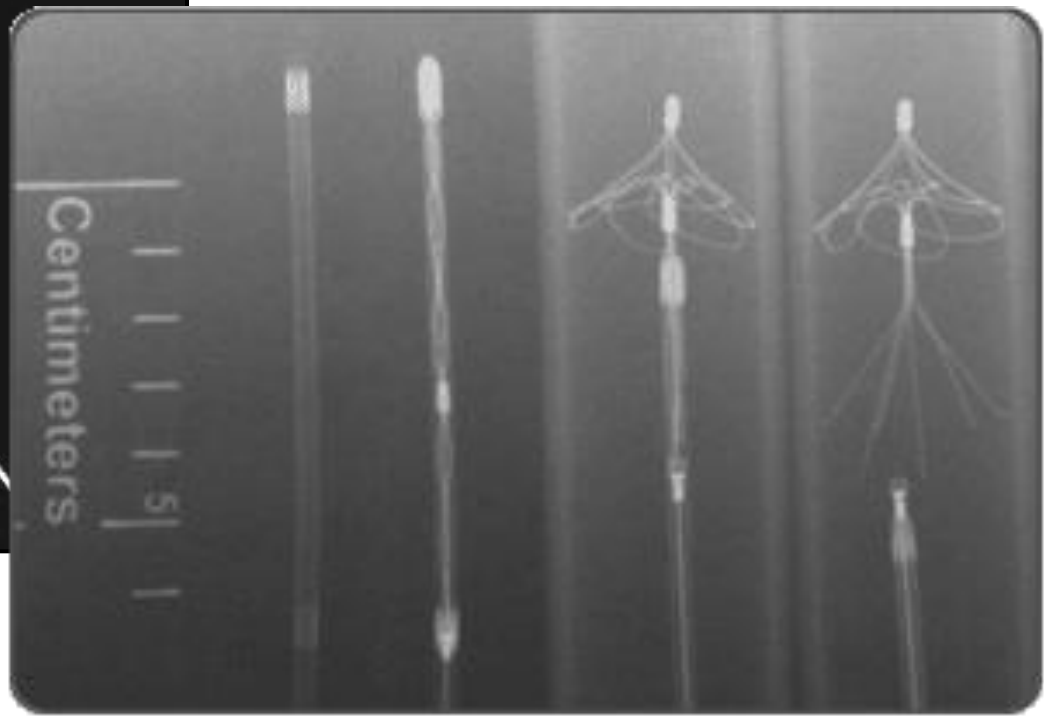
Simon Nitinol Filter



Nitinol = Ni/Ti Shape Memory Alloy

-Straightened/formed at cool temperatures (4-10C)

- reforms into predetermined filter shape at body temperatures



Materials Engineers are involved in leading engineering problems of the day…

Materials Engineers are involved in materials selection…

Let's welcome: Prof. Kevin Trumble
1990 Ph.D. UCSB

Nikki Spencer, BSMSE, Purdue University

Works for IBM in Burlington, Vermont in the area of Microelectronic Packaging and Reliability.

- Microelectronic packaging is what you actually see when looking at a circuit board. The packaging connects the silicon chip to the outside world and protects the chip from the environment.

What Nikki does:

1) Before a microelectronic device is massed produced it goes through testing that simulates real operating conditions. Nikki works with customers to develop and implement the "Qualification Plan" that defines the conditions under which the device is tested. Tests look at the effects of temperature, stress, and environmental factors like humidity on the lifespan of the device. If a component fails during qualification, the device is modified to address the cause of failure. Once the device passes qualification, it goes into mass production.
2) Adjusts the device assembly process to incorporate new developments that improve performance or decrease device cost.
3) Performs forensic analysis on devices that failed in service to determine the cause of failure and develop remedies to the problem. She uses instruments like a scanning acoustic microscope that uses sound waves to image damage inside of the microelectronic device.

Katherine Swit, BSMSE, Purdue University

Works for Proctor & Gamble in Cincinnati, Ohio

What Katherine does:

1) Katherine is one of a group of "Materials experts" for the manufacturing plants. Most of the time, their job addresses the effect of changes in a manufacturing process on the plant itself. For example, new dishwashing liquid formulations must be tested to make sure that changes in the formulation do not result in the corrosion problems in the manufacturing plant. This involves looking at effects of temperature, chlorine content and production rate on the stainless steel in the plant.
2) Like Nikki, Katherine does forensic analysis on any catastrophic or recurring equipment failures. For example, when the cutters used to make Pringles potato chips fail due to fatigue, the company loses thousands of dollars for every hour it takes to replace the cutters. Therefore, understanding why they fail will lead to the choice of alternative materials that will result in less down time.
3) Katherine is occasionally involved in major design projects. A Pringles plant was transformed into a factory to make "Torengos" tortilla chops. Since raw corn is much more abrasive than potatoes, Katherine helped redesign the manufacturing process including selecting materials with better wear resistance.

BIRDS EYE VIEW OF MATERIALS ENGINEERING

PERFORMANCE

How fast…
How far…
How strong…

PROPERTIES

Mechani
Thermal
Electrica

STRUCTURE

Crystal
Grains
Bonding

PROCESSING

Cast
Roll
Extrude

What is the Difference Between Chem. E and MSE?

- "Chemical Engineering is more focused on phenomena on the molecular scale and less so on the behavior of macroscopic objects. Materials Engineering examines materials on length scales from the atomic to the macroscopic. In the end this means that Materials Engineers need to understand both the chemical and physical behavior of materials because we need to understand how materials are made in order to make new materials (the chemical side), and understand their physical properties (e.g., strength, thermal conductivity, electrical conductivity, etc.) so we can select the appropriate materials for a given application." *Prof. Elliott Slamovich*

- MSE averages about 40 graduates/year; Chem E. is around 200 graduates/year. Implied is a small class size: this means you will get to know most if not all of the faculty through classes

What is the Difference Between MSE and Other Majors?

- Materials engineers design the materials that electrical engineers use to make the next electronic device.
- Materials engineers create/make the materials that mechanical engineers build an apparatus from.
- Materials engineers design a process that a chemical engineering will scale up to an industrial setting.

MSE Recent Statistics

Average starting salary: $58,550

Salary range: $53,000 – $61,300

- Average class size is now 40-45 students
- Student to faculty ratio is 5:1
- Approximately 25% Women
- 30-50% Graduate School:
  - Northwestern, Univ. of Colorado, Univ. of Michigan, Case Western, Berkeley, Stanford, UCSB, Arizona State, U. Minnesota, Purdue
- CO-OP: 5% co-op students.
  - Active Co-Op companies include: DePuy, Biomet, Raybestos, GE Aircraft, Toyota, TRW, Rolls Royce and Howmet.

MSE Curriculum

3 Lab classes in the core curriculum with increasing "hands on" experience as one progresses.

Courses cover the major classes of materials (metals, ceramics, polymers and semiconductors).

- Maximizes career after graduation.
- Rare to find cases where a component is made from only one type of material.

2-Semester Senior year group projects solve real problems and are sponsored by industry.

• Rolls Royce	Gas turbine engines
• Howmet	Turbine blades
• Luminos	Semiconductor Lasers
• Piezotech	Piezoelectric Actuators
• Praxair	Thermal Barrier Coatings
• DePuy	Coating for Titanium Orthopedic Implants

One in six students graduate with a study abroad experience, including study in China, Japan, Switzerland, Australia, Germany, Italy, France or England.

Six study abroad experiences summer 2008

Research with a Faculty Member

For Credit:

- MSE 499 – 1, 2, or 3 credit hours – counts toward your 18-hrs of technical electives

For Pay:

- Summer Undergraduate Research Fellowship (SURF)
- Hourly Basis During the Semester

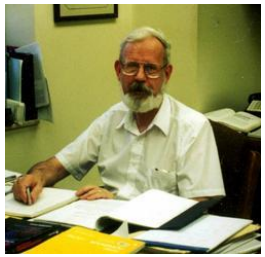
MSE Faculty and Their Expertise

John Blendell
Ferroelectrics

Carol Handwerker
Pb-free Solders

Jeff Youngblood
Self-Cleaning Coatings

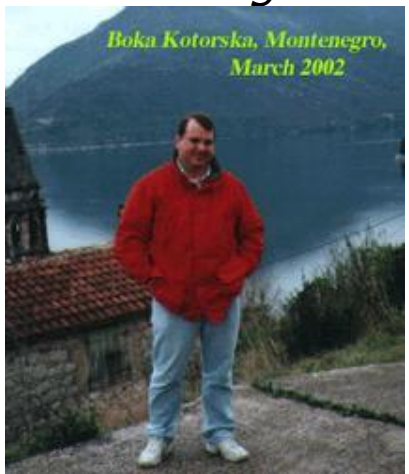
Keith Bowman
Piezoelectrics



David Gaskell
Steel Processing

Carlos Martinez
Soft Materials

Matt Krane
Casting



Edwin Garcia
Battery Design

David Johnson
High Temperature Materials

MSE Faculty and Their Expertise

Byron Pipes, NAE
Composites

Lia Stanciu
Bio Ceramics

Eric Stach
TEM Techniques

Rod Trice
High Temp Coatings

Kevin Trumble
Superalloys

Eric Kvam
Thin Films

Prof. Day
Diffusion

Timothy Sands
Energy Conversion

Elliott Slamovich
SOFCs

Ale Strachan
Atomistic Modeling

Robert Moon
Cellulose Materials

Other Perspectives on the Department

Nathan Wenning – Senior in MSE

Aaron Betker – Senior in MSE

Holley Dickmeyer – Senior in MSE

Prof. Carlos Martinez: PHD UIUC 2002, National Research Council Post Doctoral Fellowship at NIST, Visiting Scientist at Harvard

Want More MSE Info?

- Come up front and sign up today!
- MSE Callout Tuesday, November 3 at 5:00 PM, MSE Office, 2118 Armstrong Hall
  - located near central elevators
  - Tours/talk with faculty and current MSE students
  - if you leave an email, we will contact you
- Email vicline@purdue.edu or rtrice@purdue.edu if have other questions

Questions for the Panel?

Aaron Betker

Holley Dickmeyer

Nathan Wenning

Prof. Carlos Martinez

Prof. Kevin Trumble

Prof. Rod Trice

Vicki Cline – Academic Advisor for MSE

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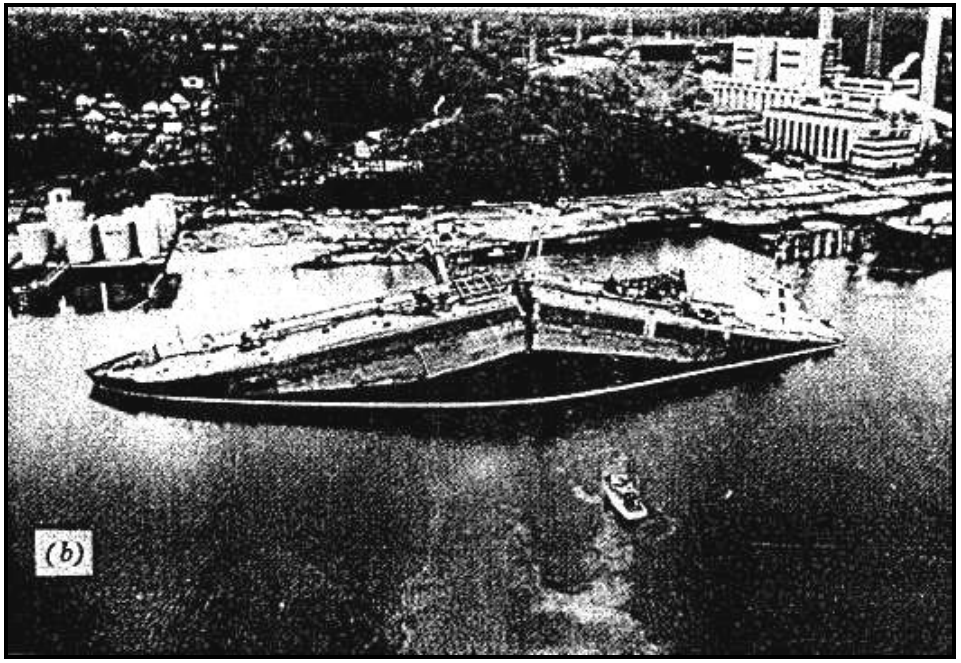
MSE 190

Wednesdays at 3:30PM



MSE 190 Homepage:

http://Engineering.Purdue.edu/MSE/Resources/MSE190

School of Materials Engineering Homepage:

http://Engineering.Purdue.edu/MSE/

Prof. Rod Trice – rtrice@purdue.edu

Most undergrad classes number less than 40 students

All students have hands-on laboratories every year in the program

Over 1/4 of students conduct one-on-one undergraduate research with access to state-of-the-art equipment.

Student to faculty ratio ~5:1

Purdue Materials:

Facilities

Armstrong Hall and Birck Nanotechnology Center

- Computing cluster

-State-of-the-art microstructure characterization facilities

-XRD, SEM, TEM, AFM, PFM, Mechanical Testing

Michael Golden Labs (MET Manufacturing lab)

- 5000 ft^2, including foundry, 300-lb air induction furnaces

- Home to new high-pressure die-casting machine

Investment Casting Lab (MSEE Building)

- 880 ft^2, 5-lb VIM furnace, shell mold making

Crystal Growth Lab (Physics Building)

- Levitation zone melter (1-inch dia.), High-frequency skull melter, Cold-hearth arc, Bridgeman and Czochralski

Over one in four graduates of Purdue's College of Engineering takes at least one or more courses from materials engineering.

Materials engineering offers a one credit introductory engineering course (MSE 190) for all engineers in both fall and spring semesters and undergrad research opportunities are available to first year students.

Purdue Materials:
Infinite Possibilities

https://engineering.purdue.edu/MSE