

Materials by Design: an Introductory Web Site for Materials Science and Engineering

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Abstract

The rapid growth of the Internet due to the popularity of the World Wide Web is opening the way for the field of materials science and engineering to increase its name recognition among high school students and incoming university freshmen. Members of the Department of Materials Science and Engineering at Cornell University have produced the *Materials by Design* web site (<http://www.mse.cornell.edu/engri111/>) to provide a broad introduction to materials science and engineering. Via a series of interesting examples, the web site illustrates the importance of materials to our lives and provides an introduction to materials and their properties.

Introduction

Despite the importance of materials in all technological developments, few students enroll in undergraduate programs in materials science and engineering at many U.S. universities. Several observers have reported a significant lack of awareness among high school students of materials science and engineering as an undergraduate field of study ^{1,2,3}.

The tremendous growth of the Internet, fueled especially by the popularity of the World Wide Web (WWW), is opening the way for the materials science and engineering community to increase the name recognition of the field of materials science and engineering among high school students, their teachers, and their parents. Because 65% of all U.S. high schools have Internet access as of 1996 ⁴, a web site designed to provide a broad introduction to materials science and engineering has the potential to increase the awareness among high school students of the importance of materials in our lives and may attract high school students to enroll in undergraduate programs in materials science and engineering.

The *Materials by Design* web site (<http://www.mse.cornell.edu/engri111/>)

As part of an effort to introduce interactive multimedia into Cornell University's first-semester freshmen elective course in materials science and engineering, Engineering 111, a group of 5 graduate students, under the supervision of Professor Emmanuel P. Giannelis of Cornell

University's Department of Materials Science and Engineering, have produced the *Materials by Design* web site (<http://www.mse.cornell.edu/engr111/>). The web site is also intended to be used aggressively by Cornell University personnel, both within and outside the Department of Materials Science and Engineering, as a tool to attract and recruit high school students to enroll at Cornell University's undergraduate materials science and engineering program. The front page of the *Materials by Design* web site is shown in Figure 1 and the table of contents for the web site is presented in Appendix I.

We have chosen to produce a web site because the delivery of information via the Internet has several advantages over other forms of media such as print magazines, videotapes, and CD-ROM's. Because we only need to distribute the content electronically as "bits" rather than having to package the content into delivery containers made of "atoms"⁵, we can distribute the content ourselves simply by uploading the information onto our department's web server. Furthermore, we are able to make frequent updates and changes to the web site. To compensate for the short-term problem of low bandwidth into high schools and homes via modems with speeds of 33.6 kilobits per second or less, we have optimized the content for low-bandwidth connections by keeping photographs and drawings small (file sizes of 10 kilobytes or less) and by keeping video clips very short (10 seconds or less in length, with frame rates of 5 to 10 frames per second).

We designed the *Materials by Design* web site specifically to target teenagers who may not be aware of the importance of materials in our lives. We have chosen a theme-based, top-down approach to introduce students to materials. The front page of the web site features examples from categories including music, sports and recreation, transportation, telecommunication, medicine, and space. As each student selects an example from a particular category, he or she can learn more about the classes of materials, as well as concepts in engineering design and materials selection. The student can then explore further to learn more about the properties and other uses of each class of materials. Students will also find information regarding the research activities of our department's faculty members.

Among the examples found on the *Materials by Design* web site include several new eye-catching products: a waterproof acoustic guitar⁶ fabricated from fiber-reinforced composites); a solar-powered scooter featuring semiconductor solar cells and an elastomeric polymer torsion system coupling the deck to the rear axle; and a controversial made-for-television ice hockey puck with embedded semiconductor infrared light emitting diodes.

We have also chosen to include several examples from sports and recreation on the *Materials by Design* web site because teenage students generally have some familiarity and experience with sports and sports equipment⁷, and because we can also highlight several members of the Cornell University community who are actively-involved in many sports and recreation activities. We have used the following examples to introduce students to materials:

1. The Cornell University Racing Team competes annually the Formula SAE race car competition.

2. The Cornell University Men's Ice Hockey Team (NCAA Division I) is most popular sports team at Cornell University during each winter.
3. Cornell University Materials Science and Engineering research technician Glenn Swan, who designs and builds his own competition bicycles, has won a championship at the World Masters Games.
4. Dr. Laura L. Beecroft (Ph.D., Materials Science and Engineering, Cornell University, August 1996) won two gold medals in rowing at the Empire State Games.

We also feature on the *Materials by Design* web site undergraduate students, including 1997 Rhodes Scholar Jessika Trancik, who are actively involved with research being carried out in our department. By doing so, we show high school students that they will have the opportunity to participate in materials research and the opportunity to use state-of-the-art tools and equipment by enrolling in the undergraduate materials science and engineering program at Cornell University.

The *Materials by Design* web site is now part of our department's high-school outreach program. The address of the web site is now printed in all flyers mailed by our department to high school science students and teachers. Faculty members and students of our department demonstrate the web site on their visits to high schools. Furthermore, the *Materials by Design* web site has been designated by Cornell University as one of the *coolsites@Cornell* because of the web site's "creativity and alignment with the teaching, research, and outreach missions of Cornell" ⁸.

Response from students

On the first day of the Fall 1996 semester, we required each student enrolled in Engineering 111, to explore the entire *Materials by Design* web site and to evaluate it in a 100-word essay. The students responded very positively. Some of the reactions by the students include:

"This web site is incredible. I get so excited as I browse through it because it shows the true realm of materials science. One certainly can come away with enthusiasm towards the major and an appreciation for its value."

"This web site was very interesting, entertaining, and well done...The descriptions not only explained the scientific workings and principles, but also showed their use in society and the everyday world."

"The applications of advanced materials in our daily lives was very interesting to browse with color pictures and easy access to the information desired. I especially enjoyed the section about materials in medicine. I had no idea that superconductors have already found applications in the medical field. Also, the sections about each type of material were presented very well with color pictures and helped me understand why a material behaves as it does. This page will probably make a good reference for me in the future."

"I think that this web site is an excellent overview of the course. The solar-powered scooter was interesting to read about because it is so unusual. It was nice to learn about the new ice hockey puck after hearing about it on television...I never realized how much work went into picking the perfect material for each part of a product."

Summary

In order to increase the awareness of the importance of materials among high school students, members of Cornell University's Department of Materials Science and Engineering have produced the *Materials by Design* web site (<http://www.mse.cornell.edu/engri111/>). Using a theme-based, top-down approach, the web site is designed to introduce teenage students to the field of materials science and engineering via a series of topical examples which are carefully chosen to match the interests of teenage students. The web site also highlights the activities around the Cornell University community. The reaction among incoming freshmen students to the *Materials by Design* web site has been overwhelmingly positive. The web site is now an important component of our department's high-school outreach program.

Members of Cornell University's Department of Materials Science and Engineering will continue to update the *Materials by Design* web site each year with fresh topics.

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Appendix I: Table of Contents for the *Materials by Design* web site as of December 1996

Materials by Design Front Page

Themes

- Medical Equipment
 - Magnetic Resonance Imaging
 - X-ray Techniques
- Music
 - Guitars
- Spacecraft
- Sports and Recreation
 - Auto Racing
 - Cycling
 - Golf
 - Ice Hockey
 - Rowing
 - Skiing
 - Tennis
 - Windsurfing
- Telecommunications
- Transportation
 - Solar-powered Scooters

Materials

- Five major classes of materials
 - Ceramics and Glasses
 - Industrially Important Ceramics
 - Industrially Important Glasses
 - Manufacturing of Ceramics and Glasses
 - U. S. Companies Conducting Ceramics Research
 - Optical Fibers
 - Composites
 - Fibers-reinforced Composites

- Particle-reinforced Composites
 - Composite Matrices
- Metals and Metal Alloys
 - Properties
- Polymers
 - Important Characteristics
 - Industrially Important Polymers
 - Elastomers
 - Thermosets
 - Polymer Processing
- Semiconductors
 - Transistors
- Materials with special properties
 - Magnetic Materials
 - Magnetic Properties of Materials
 - Piezoelectric Materials
 - Superconductors
 - Critical Values
- Additional Concepts
 - Bonding
 - Elastic Modulus
- Techniques
 - Electron Microscopy
 - X-ray Techniques
 - X-ray Diffraction
 - X-ray Radiography
- Miscellaneous
 - About this site
 - Acknowledgements
 - Engineering 111 Course Information
 - Feedback

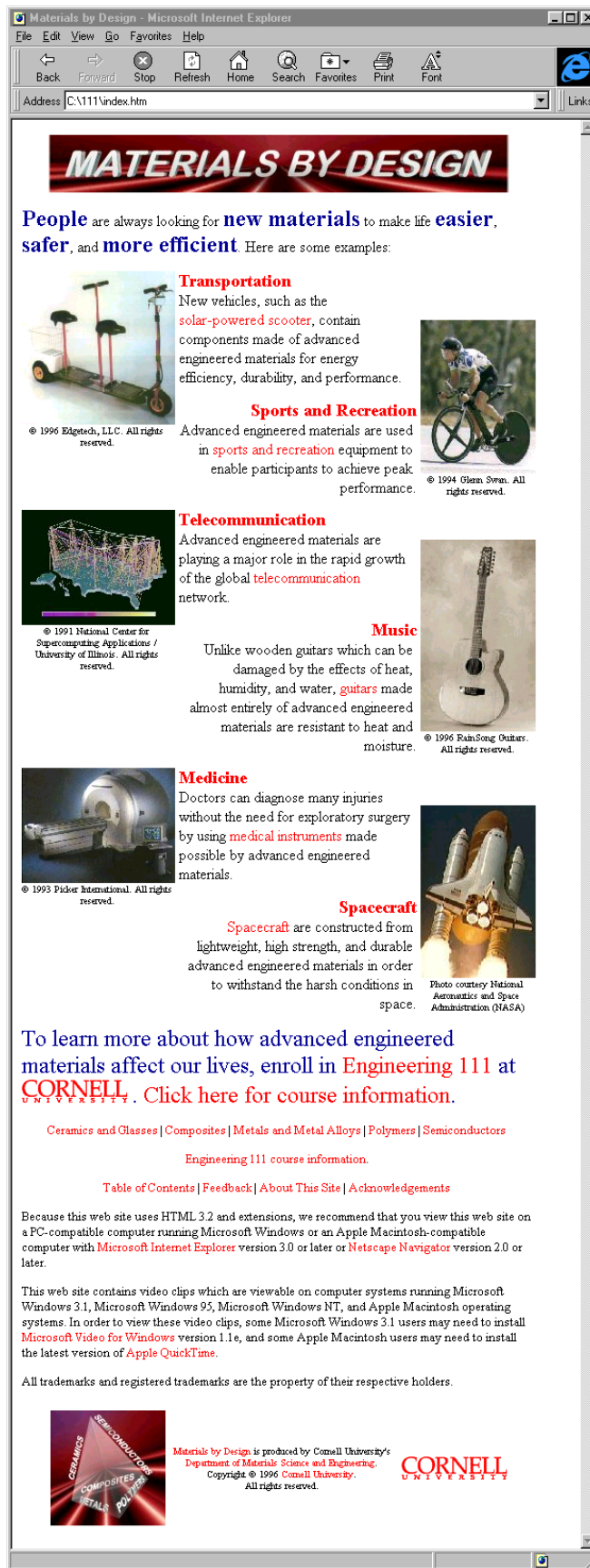


Figure 1. The front page of the *Materials by Design* web site as of December 1996.