Session 3664

WEB-BASED TEACHING: FACT OR FICTION?

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Abstract

Innovative, interactive worldwide web-accessible multimedia instructional tools were developed to provide undergraduate students in the Materials Science and Engineering (MSE) Department and in other departments in Iowa State University (ISU) with a relevant and practice-oriented education in polymers that is attractive to industry. These instuctional tools are useful for: (a) demonstrating to students the synergistic effect of interdisciplinary scholarship in solving fundamental problems using innovative, computer-based instructional modules; (b) developing simple practical polymer materials science demonstration kits for high school science students and other distant education teaching aids; (c) developing cooperative student learning groups, and (d) disseminating the authors' key research findings to students via the web. The interactive web-based multimedia instructional modules of lectures that students can access on a 24-hour are expected to be attractive to engineering students with diverse backgrounds and to other students who desire an introduction to the important, ubiquitous, and pervasive class of materials known as polymers.

Introduction

In Fall 1995, Otaigbe taught the introduction to polymers and composites course to both students from ISU and Iowa industries over the Iowa Cable Network (ICN) for the first time. The ICN allows simultaneous and interactive teaching of students located at several sites across the State of Iowa. This distance education experiment was very successful, as judged by both the ISU students and remote students from industry who took the course.

This paper describes results of our efforts to build on the ICN experience just mentioned by developing interactive computer-based instructional modules of the lectures that students can access on a 24-hour basis (see Figs. 1 to 12). The web-based instructional modules that include QuickTime (video animation software) movies created from video tapes of research results and materials processing operations that cannot be easily transported from the laboratory into the classroom. The QuickTime software allows integration of video, animation, still images, digital sound into interactive audio visual computer presentations. The QuickTime movies developed are compressed and saved on portable computer zip drives or shared hard disk servers for students to access and playback using a remote personal computer. These innovative computer instructional modules are thought to be invaluable to the students' learning process by providing real-time visualizations of materials science and engineering concepts.

Because increasing the undergraduate enrollment in MSE is one key goal of the MSE department at ISU, it was thought that developing and integrating simple practical demonstration experiments into the web-based instructional module (Figs. 9a and b) can be profitably used as recruitment tools to bring high school and two-year college students into the MSE degree program. The practical demonstration experiments include simple and safe experiments that explain interesting but challenging materials science concepts such as controlled internal nucleation and crystallization of glass (optically transparent, luminescent, and machinable glass-ceramics), thermodynamic phenomena (heat given off reversibly on stretching of polyisoprene), interfacial polycondensation of polyamides (creating nylon rope from adipoyl chloride and hexamethylenediamine or the "rope" trick), elasticity of fluids (the Weissenberg or rod-climbing effect), shape memory alloys, and fiber strengthening (stiff, strong, and lightweight composites) (see Fig. 9).

The innovative education strategy discussed in this paper facilitates development of cooperative student learning groups with stable membership whose primary responsibility is to provide each student the support, encouragement, and assistance they need to make academic progress. The output of the student base groups in the form of powerpoint presentations on self-directed projects is incorporated into the computer web-based instructional multimedia tools that students can access from any remote computer and on a 24 hour basis. By using student base groups, video tapes, demonstration kits, interactive computer-based instructional modules, lecture notes, homework problems, case studies, and learning in different contexts and off-campus environments, we hope to dramatically improve teaching effectiveness at ISU. We feel quite strongly that this pedagogical development will have a substantial impact on teaching in the material sciences and chemical engineering at ISU, making the learning process easier for the students.

Significance of Web-based Teaching

At Iowa State University (ISU), there is a rich and long history of new materials synthesis, processing, and characterization involving inorganic materials such as chalcogenide and phosphate glasses, intermetallic compounds, composites, and biodegradable plastics derived from natural agricultural products. By contrast, undergraduate students at ISU have almost no access to teaching laboratories where they can acquire hands-on experience in the behavior and analysis of polymers, despite the ubiquitous and pervasive nature of these materials. The web-based computer instructional modules described in this paper will address this deficiency in the undergraduate curriculum by providing students access to the first innovative, interactive computer web-based teaching multimedia tools that students can use on a 24-hr basis, making the learning experience easier for his students. It is hoped that the interdisciplinary nature of the subject matter of the computer web-based instructional modules will make it attractive to a broad spectrum of undergraduate students at ISU. These interactive instructional modules are expected to encourage students to take creativity excursions outside the imagined constraints of their specialized areas that may ultimately lead to most exciting opportunities for the future.

Because molecular structure and arrangement of polymers can be changed in a facile manner (unlike metals and ceramics), polymer science and engineering offers the exciting opportunity of tailoring the materials for specific high performance technologies. Only engineers who have received training or exposure to fundamental aspects of polymers in relation to other materials will be prepared to deal with real-world engineering problems that they must encounter during their professional lives as engineers. Because of the significant developments and advancements in the field of polymer science and engineering since the 1950's, it is becoming practically impossible for the traditional engineer or scientist to pick up the understanding of polymers on the job which is needed for him or her to advance professionally. The computer web-based instructional modules described in this paper are expected to be accessible and useful to off-campus engineers on a 24-hour basis, making it easier for these persons to develop some understanding of polymers.

Studying the web-based instructional modules includes time for reflection on the information by the student that is unlikely to be possible in a traditional classroom-based teaching. This use pattern may better accommodate individual student attention spans, allowing better learning and absorption of the material. The flexibility of the web-based teaching provides better educational experience for the students than that obtained from the traditional, contiguous (fixed length) classroom teaching format. This flexibility includes the range of a variety of multimedia available, and the opportunity for the student to study the material wherever, whenever, and as often as they wish. Further, the design of the web-based instructional tools facilitates "chunking" of course material into bite-sized elements which is known to have a positive effect on learning [4].

Students Feedback

The innovative, interactive web-based teaching multimedia tools described in this paper was made accessible to students taking the introductory undergraduate course in polymers and composites for the first time in 1998. A sample of students' comments from the written narrative forms on this innovative teaching approach follows:

"I liked the courseworks pack very much! The web was helpful…………"

"The web site was nice, but it could be more integrated into the class……………"

"Web page was excellent. Needs clearer explanation of concepts."

"The web page is excellent, it was very useful to me in homework and research, etc. I enjoyed the class."

"Web page was excellent."

"…………Web page was highly useful, could put HW solutions on them though."

"Excellent course for an introduction to polymers."

Concluding remarks

The innovative, interactive web-based teaching multimedia tools described in this paper appears to be amenable and useful in teaching undergraduate courses such as the one on polymers and composites discussed. Due to the versatile, innovative, interactive, and visual nature of these multimedia tools together with the fact that students can spontaneously access them from any computer on the internet on a 24-hour basis, the prospect of making the learning process easier and interesting to students can be significantly enhanced. It is felt that this pedagogical development will have a substantial impact on teaching in the material sciences and chemical engineering at ISU because students can choose the order and delivery style of the material (while in the traditional classroom lecture format all students follow the order and delivery provided by the instructor). The students can enhance their knowledge of the material by navigating their way through the interactive web-based instructional multimedia tools that includes digitized video tapes, demonstration kits, interactive computer-based instructional modules, lecture notes, homework problems and solutions, students grades, research results, case studies, links to other relevant interesting web sites on-line, and references available in print media. The multimedia tools can be used to support students learning in different contexts and offcampus environments, improving teaching effectiveness at ISU and making positive impact on the Nations scientific research, education and human resources. The visualizations of practical demonstrations of experiments that explain interesting but challenging concepts in material sciences and chemical engineering may also encourage students to take creativity excursions outside the imagined constraints of their specialized areas that may ultimately lead to discovery.

Acknowlegments

Partial funding of this work by the U.S. National Science Foundation through a CAREER grant (DMR-9733350) is gratefully acknowledged. JUO would like to thank all the students of his introductory course in materials and polymers and composites who, in the past few years, have endured his experimenting with new and innovative ideas. Kim Windom and Paul Duncan-Whitman and JUO's graduate students (past and present) also provided valuable assistance for which we are most thankful. JUO thanks his teachers at UMIST (Manchester, UK) for making the macromolecular gospel so compelling and all-embracing.

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(1998). (Hardcopy available from ISU Bookstore).

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6. Moore, J.W. "Learning is a do-it-yourself activity" *Journal of Chemical Education*, 76(6), 725 (1999).

7. A long list of references and other web sites are given in reference #1 above.

8. Special thanks to Michael H. Marty for his expert graphics support.

Biography

Dr. Joshua Otaigbe joined the ISU faculty in 1994. Before joining Iowa State, he worked as a Project Leader for Corning Incorporated in New York. Earlier, he held academic positions at the University of Alberta, Canada, and University of Benin in Nigeria. He earned his B.S. degree in industrial chemistry in Nigeria and the Ph.D. degree in polymer science and engineering from the University of Manchester (UMIST), England. Dr. Otaigbe's research is in the areas of polymer engineering and materials science. His research blends chemical engineering sciences with materials structure and property principles to understand and improve processes for advanced materials. He is also actively involved in university-industry partnerships to solve industrially relevant problems. These problems are often at the boundaries between established disciplines or in areas combining many disciplines that may ultimately lead to discovery. Through careful mentoring, he is empowering young engineers to develop the discipline to continue learning, and encouraging them to take creativity excursions outside the imagined constraints of their specialized areas that may ultimately lead to most exciting opportunities for the future.

Brad Tischendorf is a graduate student in the Department of Materials Science & Engineering at ISU working towards his PhD degree under the supervision of Dr. Otaigbe.

Meagen Marquardt is an undergraduate research assistant in Dr. Otaigbe's polymers and composites research group at ISU.

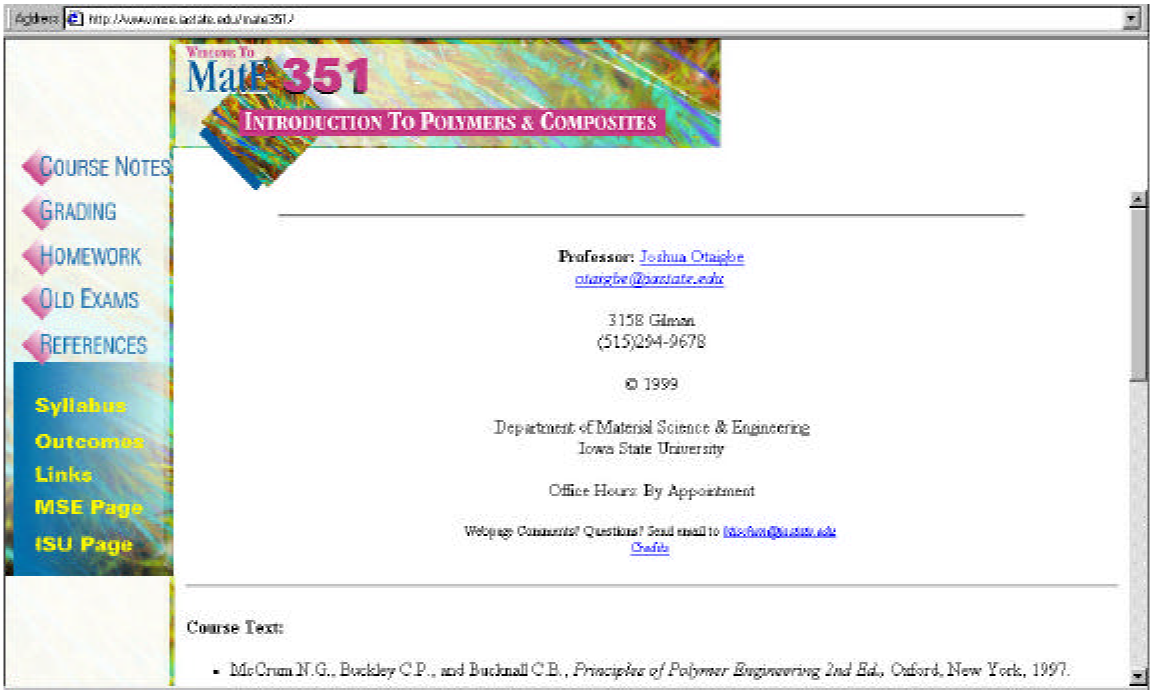

Figure 1. Example web page showing a portion of the main page and links to other pages. To read the rest of the page, please go to reference #1.

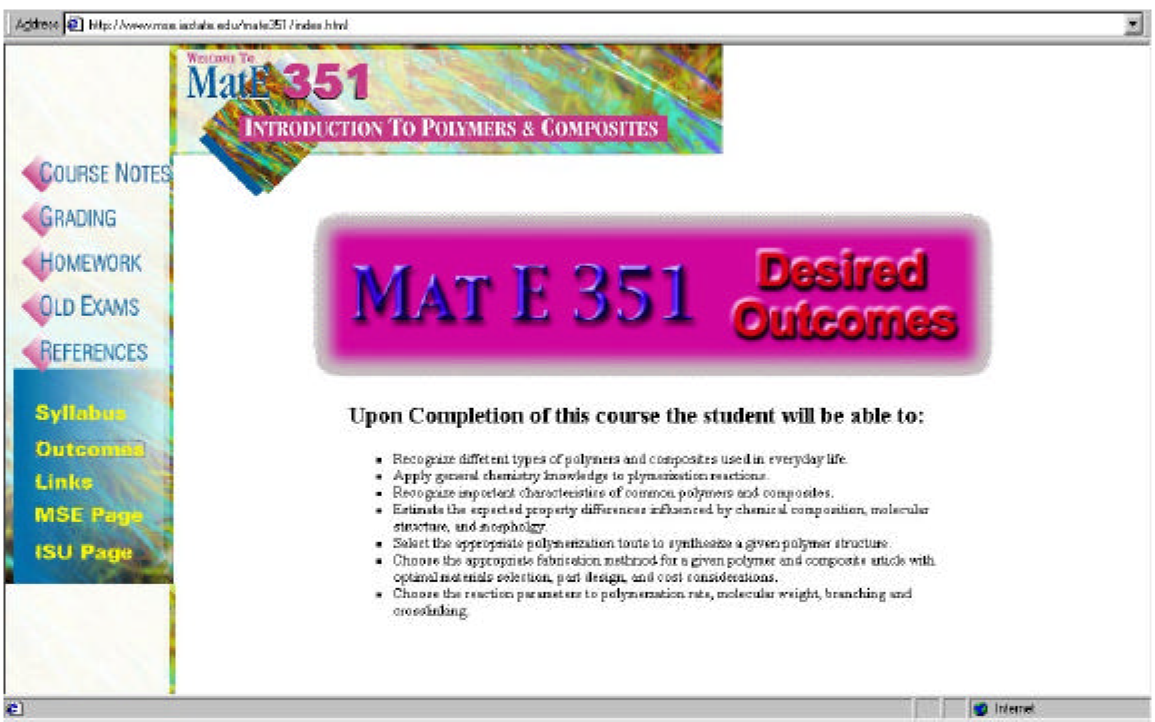

Figure 2. Example web page showing desired outcomes for the course.

Figure 3. Example web page showing a portion of course syllabus. To read the rest of the page, please go to reference #1.

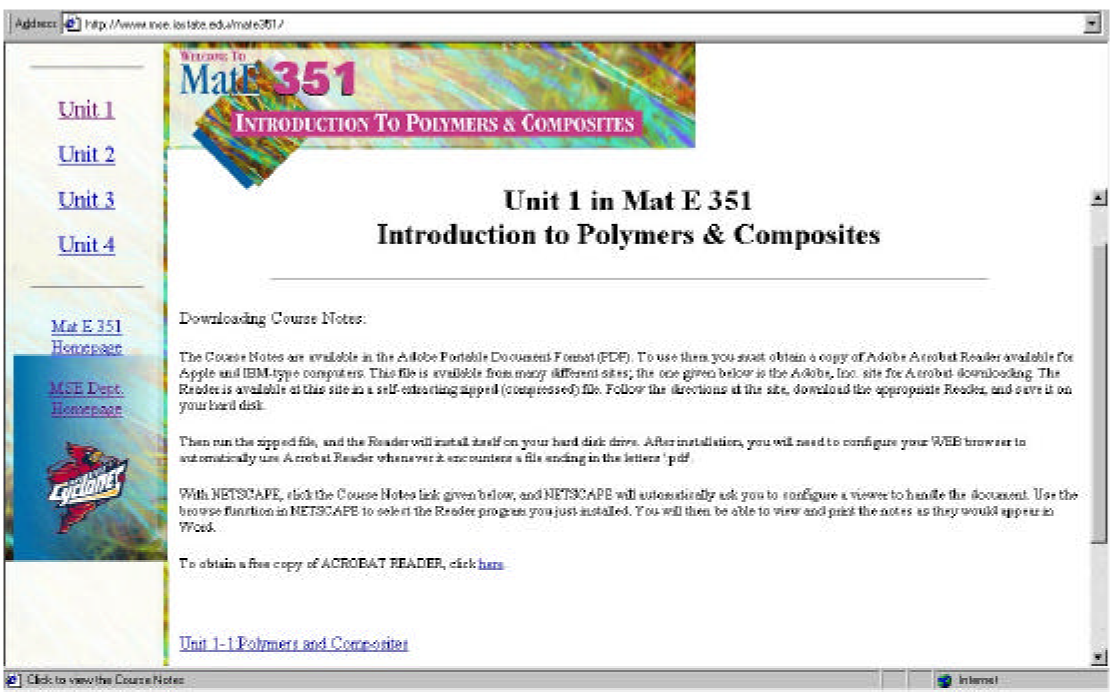

Fig. 4. Example web page showing the four units of the course. Clicking on each unit via the internet will take you to the coursenotes for that unit.

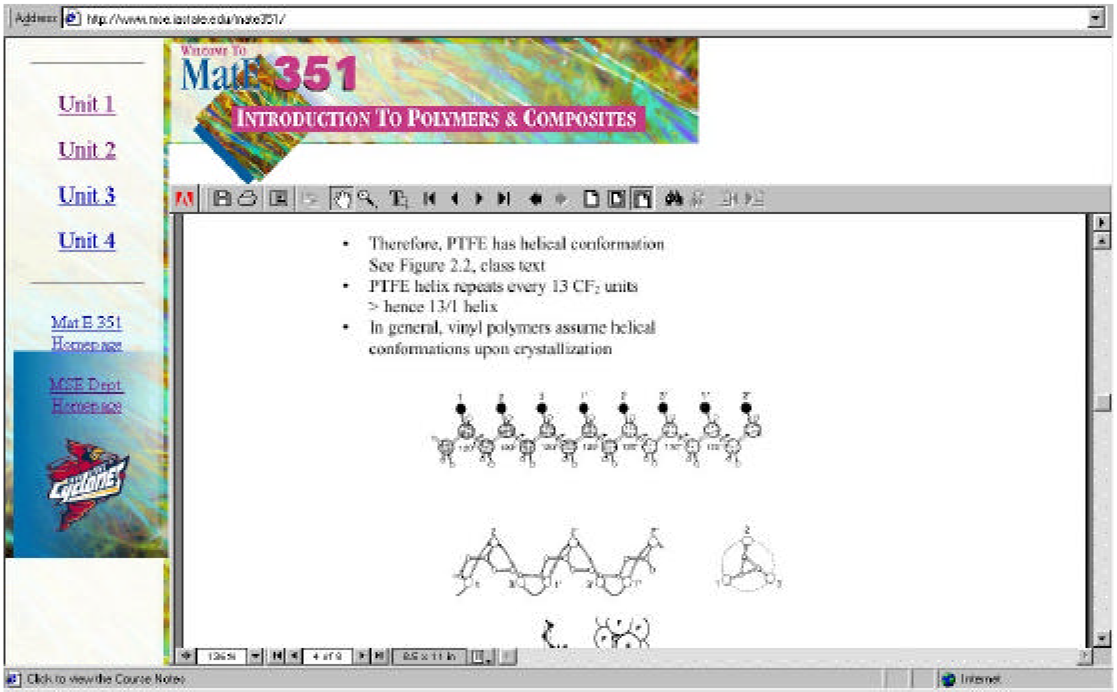

Figure 5. Example web page for the coursenotes showing a portion of notes for a 50-minute lecture. To read the rest of the page, please go to reference #1.

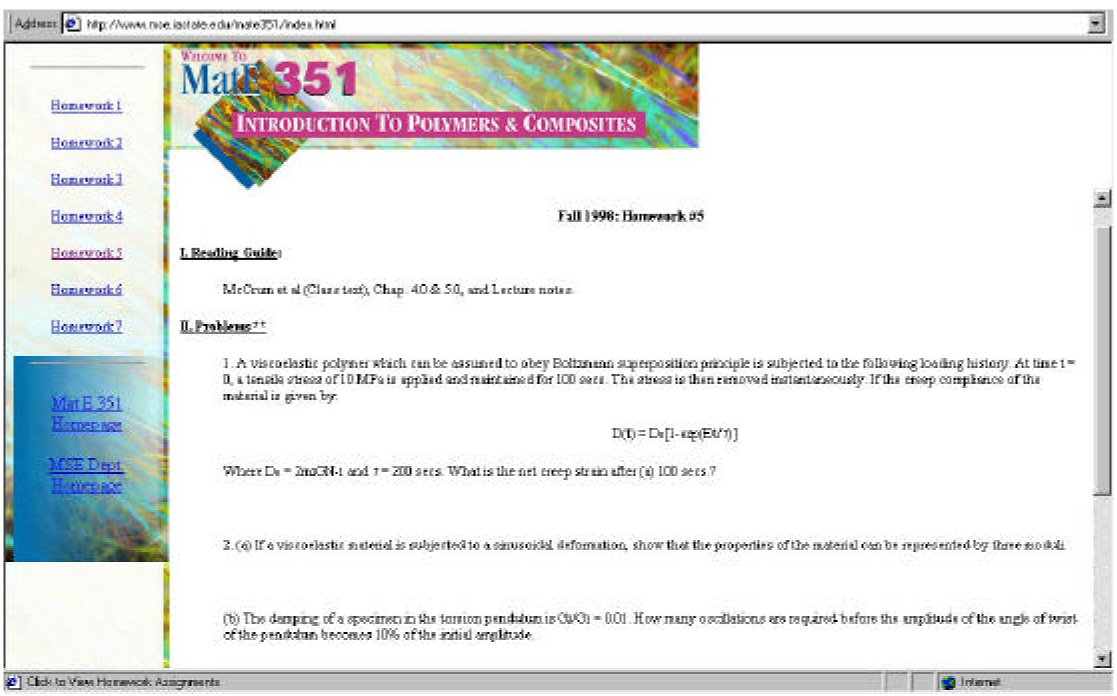

Figure 6. Example web page showing a portion of a typical set of homework problems. To read the rest of the page, please go to reference #1.

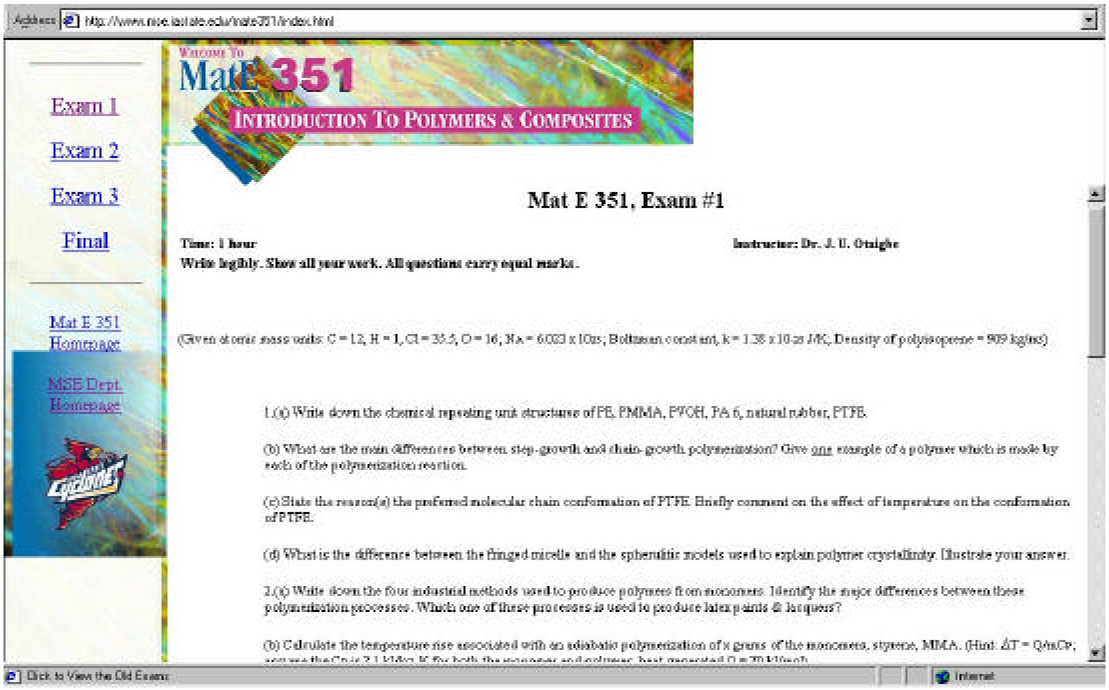

Figure 7. Example web page showing a portion of a sample exam. To read the rest of the page, please go to reference #1.

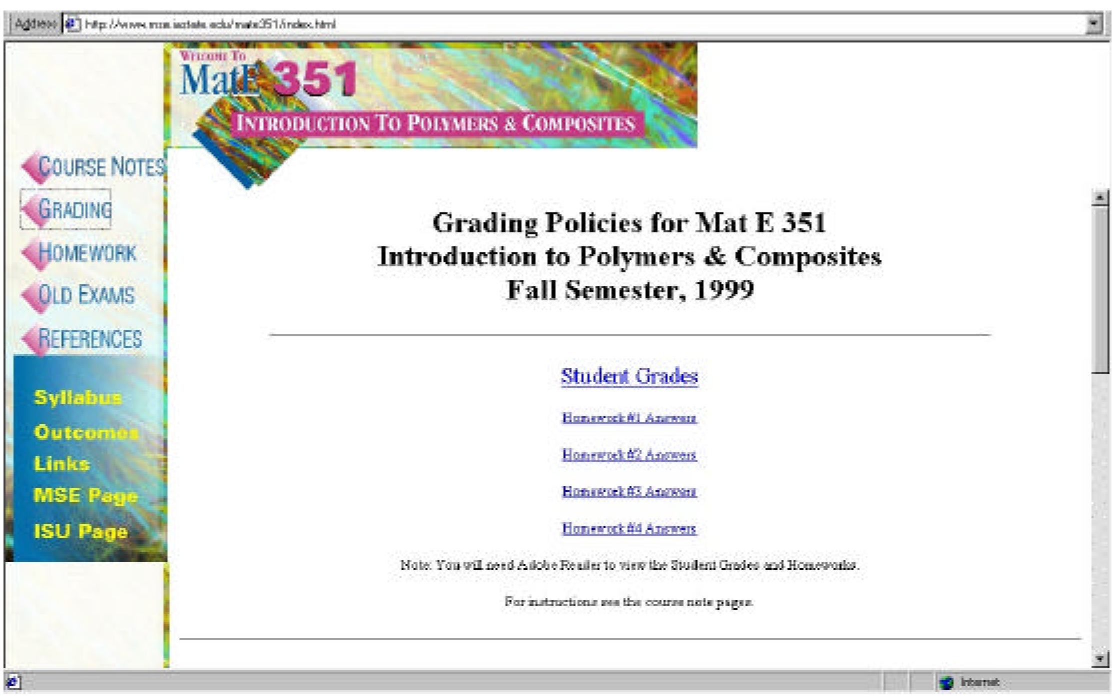

Figure 8. Example web page showing links to answers to homework problems and student cumulative grades.

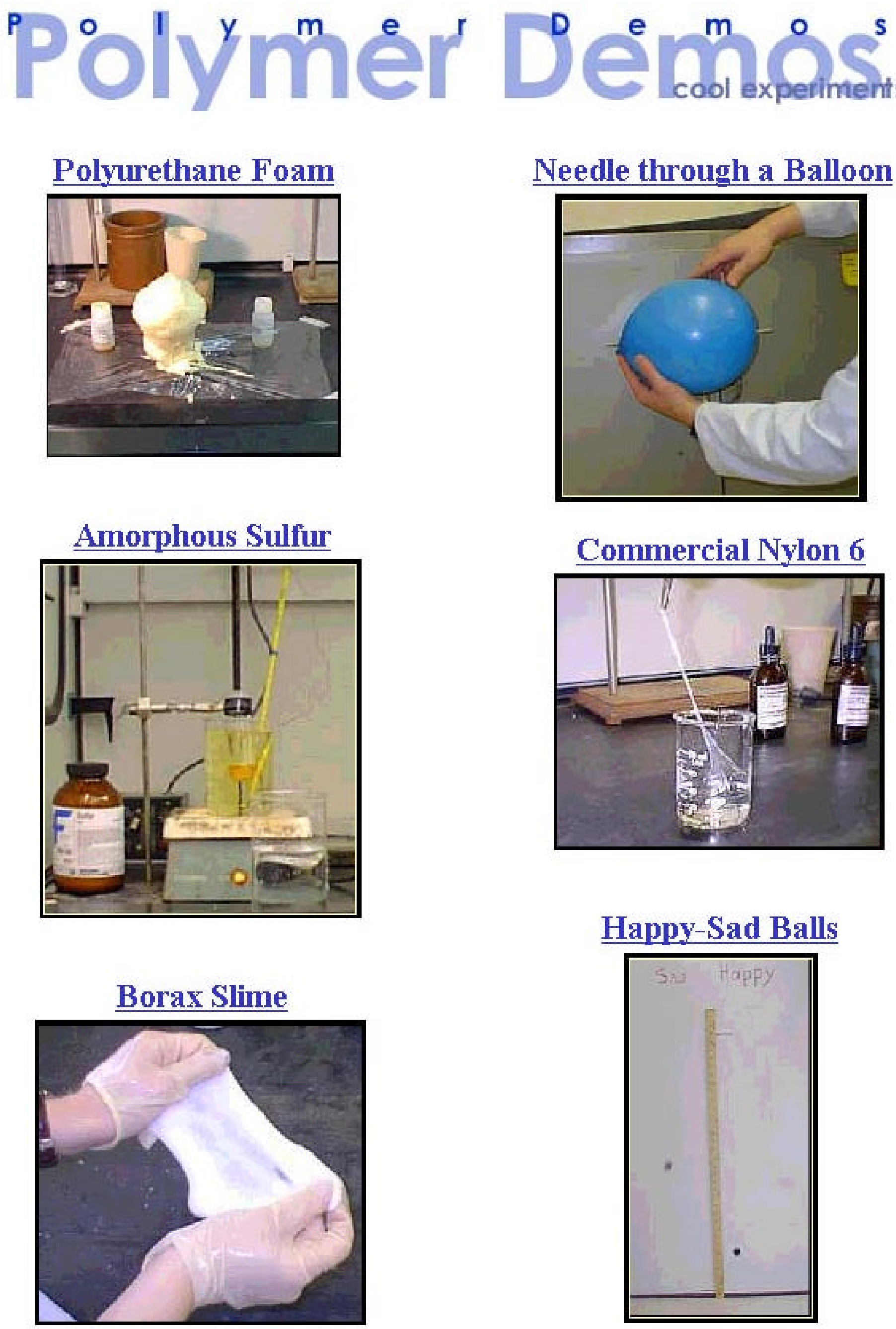

Figure 9a. Example web page showing photo frames of some of the interesting practical demonstration experiments that are accessible via the web site. Click on each picture to view video animations of the experiment and a description of the experiments such as the one shown in the next figure 9b.

Polyurethane Foam Formation

Overview

Polyurethane foam is made by mixing equal amounts of a two component foam system. When these two liquids mix, the resultant foam produced has a volume 20-30 times the original.

Materials

-
  - 40 ml Part A and

    40 ml Part B of two component polyurethane foam system

    Two 50 ml paper cups

    Paper Towels

    1 large disposable cup

    2 stirring rods

Procedure

1.
   1. Measure equal amounts of Part A and Part B liquids into the two 50 ml paper cups.
   2. Cover an area of about 2 square feet with paper towels.
   3. Place the large cup in the center of the covered area and pour the A and B liquids into the cup.
   4. Mix the liquids with a stirring rod and stop stirring when foam begins to form.
   5. Do not handle the fresh foam until it has cured because it may contain unreacted iso-cyanate.

Discussion

The polyurethane system used consists of Part A which is an amber colored viscous liquid that contains a polyether polyol, a blowing agent, silicone surfactant, and a catalyst. Part B is a dark colored viscous liquid containing a polyfunctional isocyanate.

When the liquids are mixed, they make a thick amber mixture. Once foam starts to form, it takes a matter of seconds to greatly increase in size. After the foam is cured, it makes a light amber colored hard mass.

The foam is made by producing polyurethane polymer in the presence of a freon propellant fluorocarbon blowing agent which causes the void volume to increase within the polymer. The polymer is formed by the following reaction:

Due to the functionality of the reactants, a high degree of crosslinking occurs and a rigid foam results. Bubbles of gas are trapped in the polymer matrix as it is formed, and a cellular product results. In order for the foam to form well, the gas evolution process and polymer formation must occur at a matched rate. This is why a catalyst is used. The silicone polyalkylene oxide block copolymer acts as a foam stabilizer during the early stages of foam formation when the polymer is still weak.

Rigid foams, such as the one formed by this experiment are used for thermal insulation. The gas trapped inside the closed cells makes them useful for this purpose. Flexible foam s which are not as highly cross-linked are used in cushioning applications such as upholstery and garment shoulder pads. Intermediate products know as semi-rigid foams are used in the manufacture of car crash-pads and packaging.

References

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Figure 9b. A typical recipe of one of the interesting, practical demonstration experiment that is accessible via the web site.

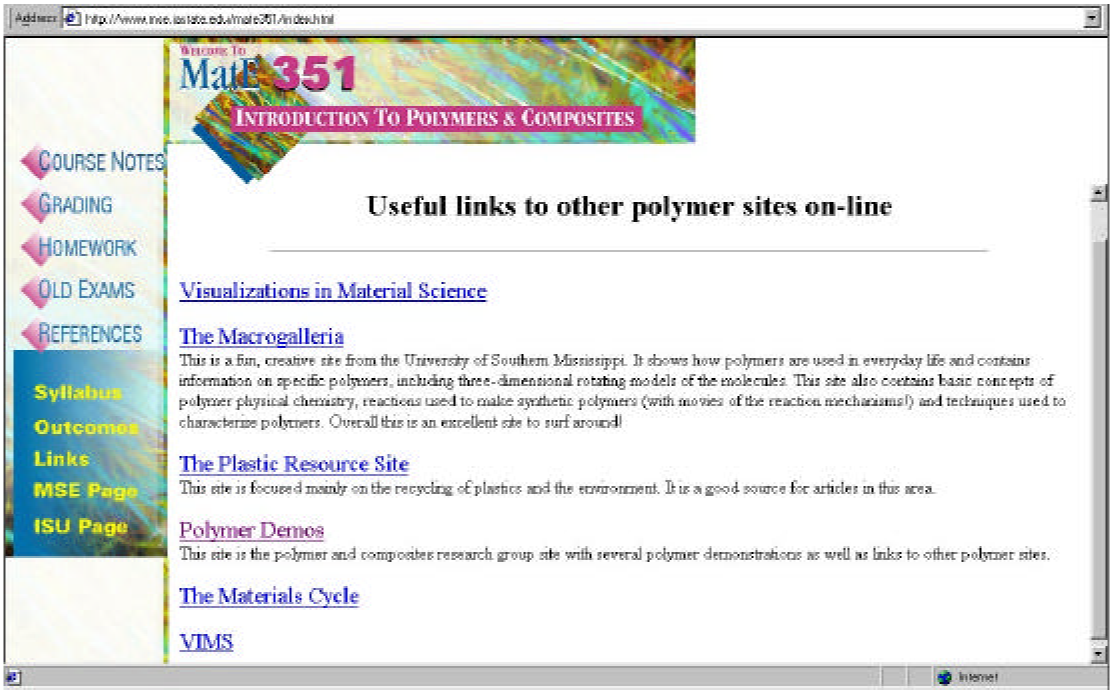

Figure 10. Example web page showing a portion of interesting, useful links to other related web sites on-line.

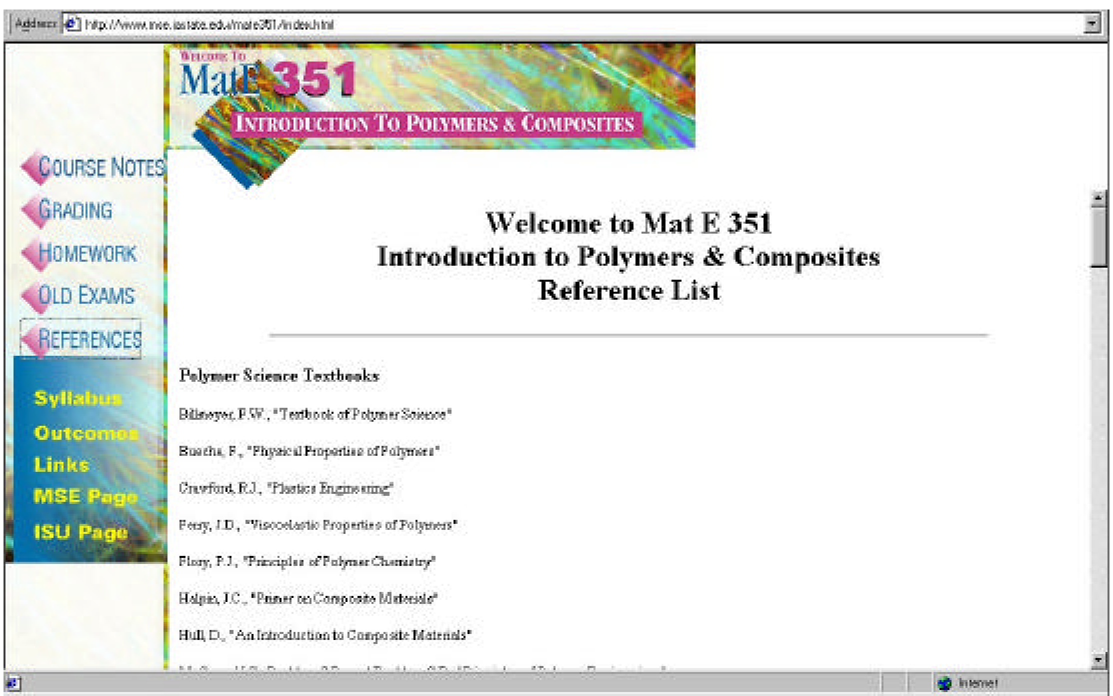

Figure 11. Example web page showing a portion of a long list of references in print for the course. To read the rest of the page, please go to reference #1.

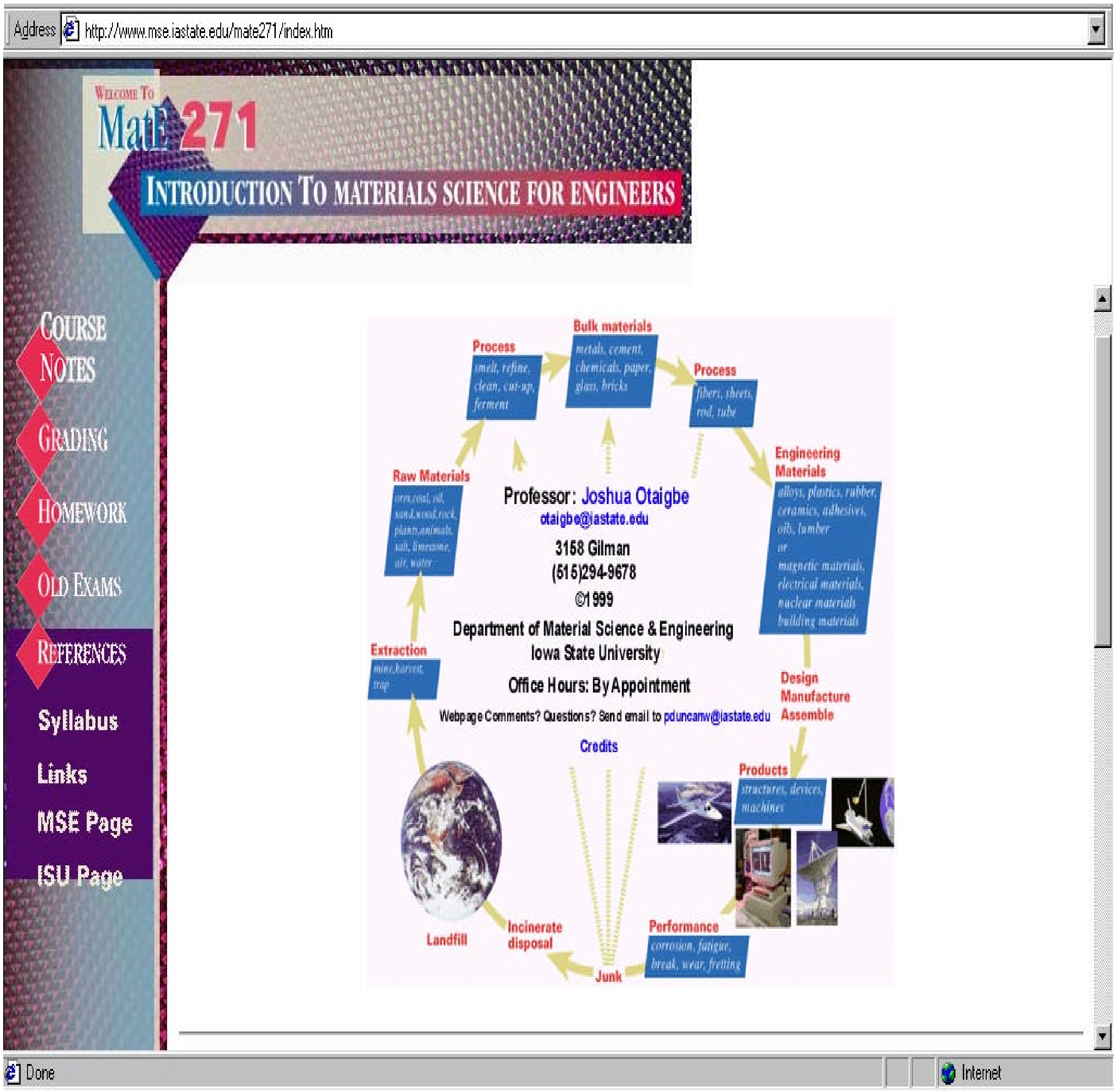

Figure 12. Example web page showing the main page for an *Introduction to Materials Science for Engineers* course that is being developed by the authors.