

2006-172: A WEB ENABLED STUDY OF MECHANICAL ENGINEERING

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AWESOME: A Web Enabled Study Of Mechanical Engineering

1 Abstract

In this paper we present a dynamic, multi-media, web-based approach to student learning. Hyper-linked text and images allow students to guide their own education with regard to the intent and content of mechanical engineering courses and to discover the applications of particular courses and subject areas.

2 Introduction

The goal of our research is not traditional engineering education as found in mechanical engineering courses such as dynamics, vibrations, and so on. In these courses the goal is to transmit a well defined body of knowledge. A mechanical engineering major knows that he or she needs a particular course for graduation, they take that course and they absorb (hopefully) the material.

Our concern here is rather different. We target students who have a broader and more diffuse set of needs. We answer the question of “why” and leave the class to provide the “how.” What is the point of taking a particular class and how does it fit into a larger picture? These are the issues we try to address. Whether they are undeclared students trying to decide what discipline to enter, are freshman mechanical engineers wondering what courses to take or are upper level students wondering what this is all good for, they all face the same basic dilemma - how to get good answers to their questions. They want insight into what mechanical engineering offers, how the courses interrelate and how the material they’ll be learning will be reflected in future jobs. This paper will examine the workings of a user-driven, multi-modal program that attacks these issues in a combination of ways.

3 Brief history and motivation

Year after year the first author has heard similar questions. Questions such as “What courses should I take?” “I’m interested in becoming an automotive engineer - what electives would be most relevant?” “The syllabus for ME 104 lists orbital mechanics. Why should I care about this?” “What sort of jobs are there for someone who minors in vibrations?”

These examples are typical of students who’ve already, for one reason or another, have entered the mechanical engineering program. A new question, one which will likely become more widespread as the undeclared major becomes a more popular avenue into college, is

“What do mechanical engineers *do*?”

These sorts of questions simply aren't going away - if anything they're becoming more common. It may be that questions of this sort were handled in the dim past by advisors, actual human beings with the depth of knowledge needed to know the answers and the time available to actually advise the students. This is certainly possible but, at least at the institutions the lead author has worked within, such admirable people are no longer in ready supply. Hence an idea took root that what is needed is an electronic advisor, one which is available to the student 24 hours a day via the internet. Electronic learning has been an object of steadily growing interest [3], [2] and our thought is to harness these ideas in a new and useful way. More than simply being a simple source of information, this resource was envisioned as an interactive experience, one for which a multiplicity of entry points exists and for which several levels of detailed information can be found.

4 AWESOME: What it does

The current version of our program is known by the easily remembered acronym AWESOME: A Web Enabled Study Of Mechanical Engineering. For ease of dissemination, the program has been designed for use via the web. As its title indicates, the program is initially being constructed purely with regard to mechanical engineering concerns and, more specifically, mechanical engineering at UC Berkeley. If the system proves successful it can be expanded in different directions. The most immediate extension would be to tailor it to different mechanical engineering programs, something for which much of the code will remain unchanged. A larger scale expansion would be to use the existing framework but alter the content to reflect completely different fields, electrical engineering, biology, and so on. The overall concept applies as easily to other disciplines as it does to mechanical engineering and with some work can be suitably modified by interested faculty for use in these other areas as well.

The web experience starts, not surprisingly, with a home page that contains both graphic imagery and text, both of which are linked to actions that access other parts of the site and display additional information. Pages are linked in such a way that the student can move through the site in a self-directed and individual way: there is no one “right” way to navigate through the information.

The sorts of questions that can be answered include the following. What does a mechanical engineer work on? If I'm interested in the wheel/tires of a car, what sort of companies would I investigate for employment? Likewise, if I'm interested in wheel/tires, what courses should I take here at Berkeley?

In addition to broad questions of career paths, quite specific questions can be answered. For instance, one might know from the syllabus that during the 10th week of undergraduate dynamics the topic for discussion in the class will be the kinematics of linkages. If the student is interested in knowing why this is happening and what it's good for, the answer can be found in a straightforward manner.

By making this program sufficiently dense in information and sufficiently easy to navigate, the student is able to gather as much or as little information as he or she desires. By having this resource exist on the web, the information can easily be updated and enhanced over time. The program will serve as an unbiased (hopefully), situation-neutral advisor, able to answer questions across the entire field of mechanical engineering and with great specificity, all without any concern over the time being taken up and without the students having to worry about whether they are going to commit the sin of asking a “dumb question.”

5 AWESOME: How it does it

A student's AWESOME experience begins, not surprisingly, at the AWESOME homepage. From this jumping-off point, users will be able to access a variety of hyper-linked pages which address the specific questions mentioned above. As users with different questions will require different types of information, the goal of the homepage is to direct users to the answer page which best addresses their questions.

Figure 1 shows an informational schematic of the AWESOME home page.

The AWESOME homepage currently addresses 4 questions

- **What is AWESOME?**
- **What is Mechanical Engineering?**
- **Why am I taking this class?**
- **I like [a particular subject or activity]. What should I do now?**

The page also contains a search function which should be useful for more specific questions. Each of the four questions directs the user to an answer page designed to address its respective question.

What is AWESOME? will direct the user to an answer page describing the goals and structure of AWESOME, along with tips for using the program.

What is Mechanical Engineering links to a page containing a broad overview of mechanical engineering. This link, the most important for users unfamiliar with mechanical engineering, is given special emphasis. An image-marquee scrolls a set of attention-grabbing, mechanical-engineering-related images (i.e. fighter jets, race cars, etc.) across the page. These images are chosen so as to cover all of the major fields within mechanical engineering. In addition to drawing attention, they will act as a visually-based photo-overview of mechanical engineering.

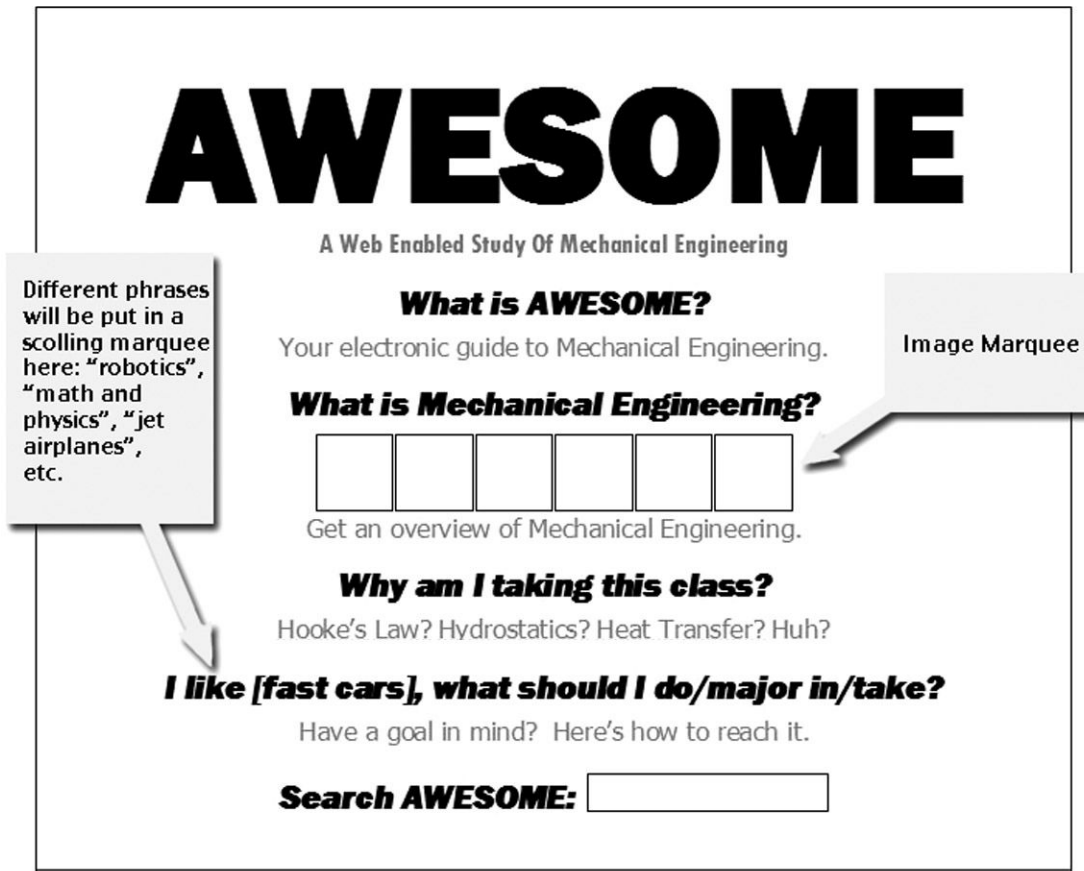


Figure 1: Schematic of AWESOME home page

Why am I taking this class links to an answer page which provides an easily understood explanation of all the classes in the mechanical engineering department and provides links to pages for specific classes.

I like fast cars. What should I do? directs the user to an answer page containing brief descriptions of the various fields in mechanical engineering. These descriptions will be tailored to allow users to determine under which field their goal falls.

Figure 2 below shows the logical structure of AWESOME. For clarity, only the most important links between pages have been included. In reality, the extensive cross-linking of pages would make a comprehensive flowchart overly complicated.

Mechanical Engineering Overview Page (MEOP)

Learning theory has shown that different people acquire information most readily by different means [1],[2]. Because users with varying backgrounds will be accessing the MEOP, its structure has been designed so as to incorporate multimodal methods of learning. In addition to written words, the page will contain static imagery, animations, and video. These components will be cohesively integrated to provide a page which will be comprehensible to a wide range of users.

One notable segment of MEOP is called Visual Path Finder (VPF). VPF is designed to aid visual learners navigate the site. Figure 3 below shows an early version of PathFinder.

Structure of AWESOME

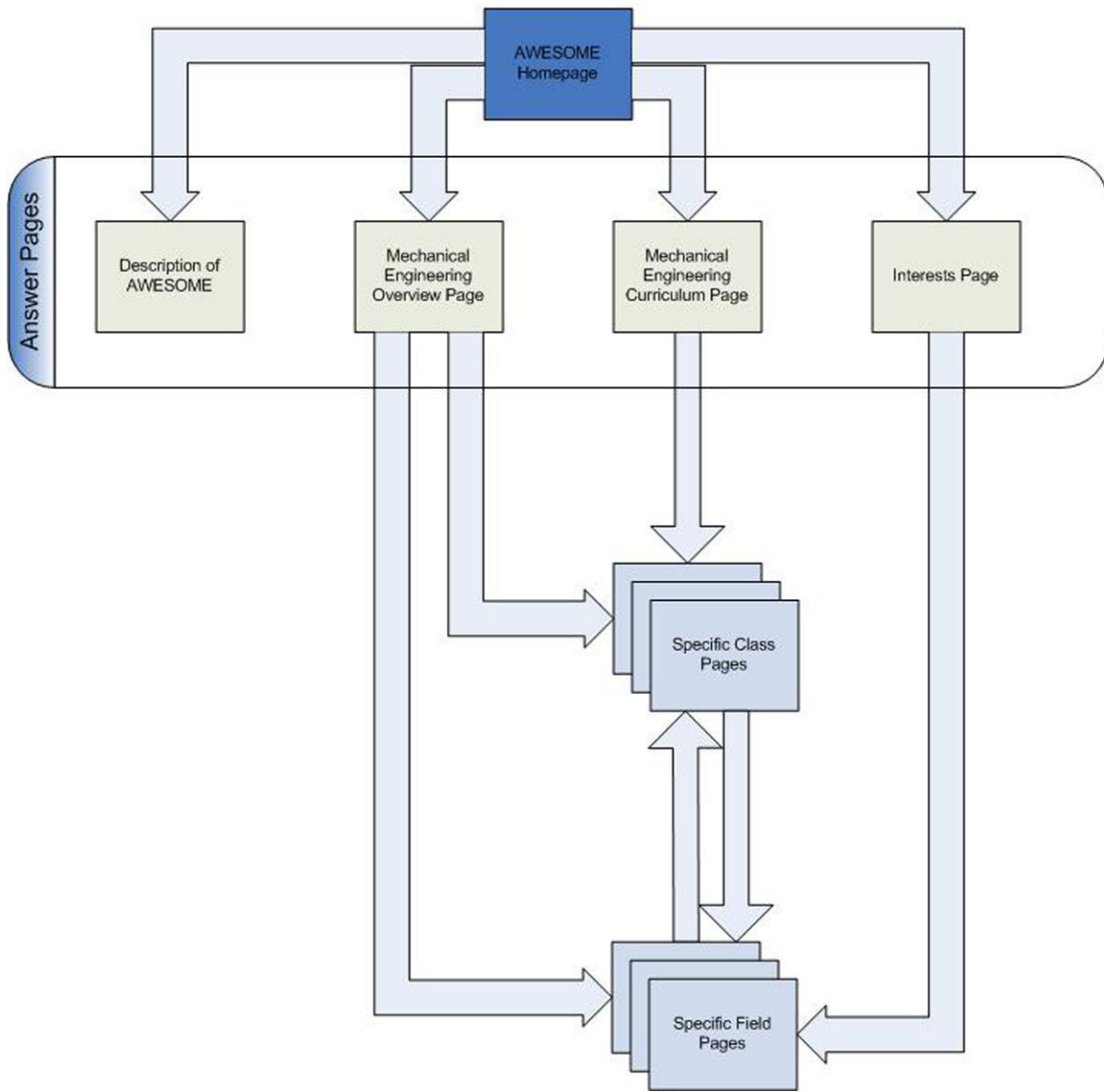


Figure 2: Schematic of AWESOME home page

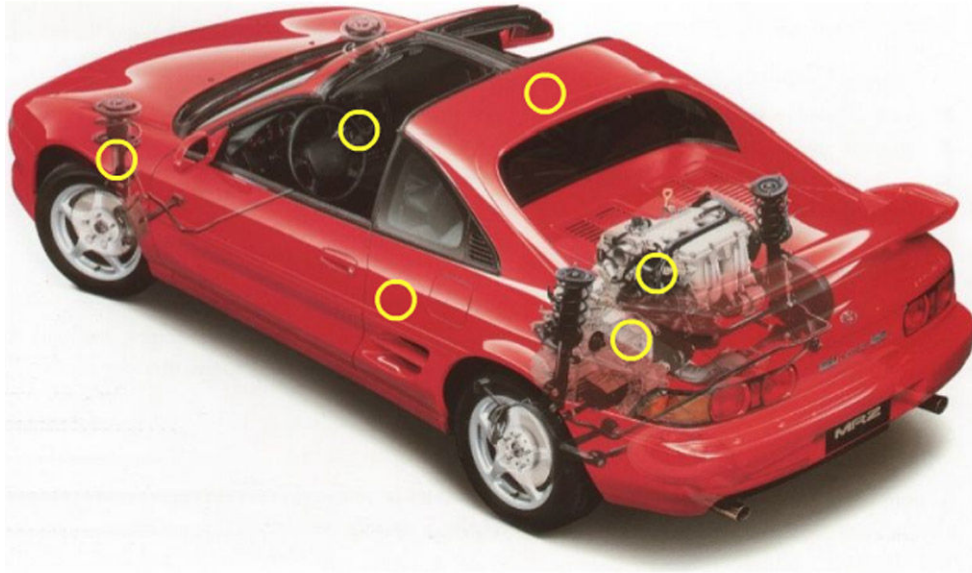


Figure 3: PathFinder

At first glance, Figure 3 appears to be a simple still-image of a car with certain areas highlighted by yellow circles. When the user moves the mouse over one of these circles, however, VPF activates an animation that displays the mechanical engineering concept related to that portion of the car.

For example, one of the yellow circles highlights the hood of the car. When a user moves the mouse across that circle, an animation is activated, showing air streamlines moving over the hood of the car. Clicking on this circle would link the user to a fluid dynamics page.

Mechanical Engineering Curriculum Page

The Mechanical Engineering Curriculum Page will summarize the mechanical engineering curriculum and provide links to class-specific pages, as illustrated in Figure 4. Each of the classes listed in the page are actually active links to pages about that class. An (incomplete) example of one of these class-specific pages is given in Figure 5.

The Mechanical Engineering Curriculum

Introduction

The ME curriculum at Cal is divided into three segments: fundamentals, core mechanical engineering classes, and technical electives.

Fundamentals

These classes are to ensure that mechanical engineers graduate with a strong foundation in the fundamentals science and math. Upper division mechanical engineering courses often build on or use concepts learned in these classes. Students are expected to have a basic understanding of these courses

Math 1a Math 1b Math 53 Math 54
Physics 7a Physics 7b Physics 7c
Chemistry 1a
Biology 1a

Engineering Fundamentals

These classes teach concepts useful for multiple engineering majors.

E28 E36 E45 E77
CE130
EE100

Core ME classes

These classes will teach you the core body of knowledge fundamental to mechanical engineering.

ME102 ME104 ME105 ME106 ME107a ME107b
ME124

Technical Electives

These classes cover specific topics in greater depth allowing students to focus their degree on a particular area within ME.

Design and Manufacturing Classes

ME101 ME110 ME119 ME128 ME130

Controls Classes

ME132 ME133 ME134 ME135

Combustion and Thermodynamics Classes

ME140 ME142 ME145

Dynamics Classes

ME170 ME175

Figure 4: Curriculum Page

E28 – Basic Engineering Design Graphics

Overview

E28 covers basic graphical design, engineering drawings and documentation, and introduces the programs AutoCAD® and SolidWorks®.

What Will You Learn

You will learn to create engineering drawings in both AutoCAD® and SolidWorks®, as well as tolerances, 3-Dimensional visualization, and basic descriptive geometry. At the end of the class you will complete a simple design project in which you will make a complete set of engineering drawings for your design.

E28 is the most hands-on class in the lower division ME curriculum. You learn to use AutoCAD® and SolidWorks® through tutorials in lab, and the final project requires you to combine many of the skills you've learned throughout the semester.

Example – throughout the class you might be asked to make an engineering drawing of a simple mechanical part (a bracket or a lamp stand), or draw an object from the top view, given the front and side views.

Why is this useful?

Engineering drawings are the primary method by which engineers communicate design ideas. Standardization of these drawings ensures that they can be unambiguously understood by all engineers. In E28 you will learn these engineering standards, as well as the computer-aided-drafting software to make engineering drawings.

The skills you will learn in E28 will be applicable in any engineering course or job that involves design.

Other classes you might like if you liked this class

If you liked E28, you might like E128, which teaches computer aided design using ProEngineer® and other CAD software.

If you liked the hands-on design portion of the final project, then you should look forward to lab classes like ME102, ME110, ME128, and ME130.

Subjects you might like if you liked this class

Drafting software is used in all fields of mechanical engineering.

Figure 5: Specific Course Page

The class-specific page is envisioned to be a comprehensive guide to the class. Through examples, pictures, and student comments, it will describe the material covered by each course. Additionally, class pages will explain the significance of the class in real-world engineering (eventually including commentary from professional engineers), as well as the class's relevance with respect to other areas within the mechanical engineering curriculum.

To aid students in planning their schedules, it will also list prerequisites, the estimated work load, helpful books and/or internet sites, places to get help, and other similar classes the student might like if he or she enjoyed the class.

Interests Page

This page is designed to guide students through mechanical engineering based on their particular interests. It will describe the various fields within mechanical engineering, noting the types of jobs available in each field and the academic subjects the field encompasses. Using these field descriptions, students will be able to determine the field within which their interest falls and navigate to the appropriate field page using links on the interests page.

It is worth mentioning that although the interests/fields page will be similar to the MEOP (they both describe mechanical engineering), they will not be identical. MEOP is directed more toward users who have very little knowledge of mechanical engineering, whereas the interests/fields page is directed more toward users who already know enough about mechanical engineering to have a goal in mind. MEOP will be more focused on grabbing attention with the particularly interesting parts of mechanical engineering. The interests/fields page will be more technical and structured, covering the academic subjects and career-related information in each field.

Field Page

The goal of the field page is to describe the field in more depth and give guidance to students trying to choose a field for an emphasis or a minor.

It will cover the types of jobs available to people studying the field as well as cutting edge research in the field, noting leading companies and institutions. It will also list the classes which are important in that field. The field page may also include statements from graduate students, professors, and professional engineers in that field describing their thoughts on the field.

Crosslinking of AWESOME

Another goal of AWESOME is for users to be able to navigate easily from one part of the site to the next via extensive cross-linking of pages. For example, a student who is interested in cars might start off in the interests page. There, the student might see an unfamiliar term, such as Lagrangian Mechanics. These words, as with all mechanical engineering terminology in AWESOME, would be a hyper-link. By clicking on it, the student would be taken to the class page for ME175, a class which covers that topic. In the ME175 page there might be a link to E36, a course the student will be taking the following semester. Thus students entering the site with one particular goal in mind may eventually find themselves in an entirely different area, hopefully having learned something about mechanical engineering during their journey.

6 Conclusions

We have presented a dynamic, multi-media, web-based approach to student learning. Text, graphics and video are combined to create a compelling environment within which students

are (hopefully) motivated to guide their own education with regard to the intent and content of mechanical engineering courses and to discover the real-world applications of their course material. This project is on-going and will continue to be refined over the next couple of years. Faculty interested in further details should contact the lead author.

References

- [1] Grasha, A.F. and L. Richlin, (1996), *Teaching with style: A practical guide to enhancing learning by understanding teaching and learning styles*, Pittsburgh, Alliance Publishers.
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