Web-Based Engineering Portfolio System

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1   Introduction

Increasingly, engineering educators recognize the pedagogical value of student projects. Although exams, class exercises, and homework can effectively measure a student's mastery of facts and formulas, these sorts of assessment tools do not encourage students to develop their analytical capabilities, nor do they measure a student's ability to understand and apply what he or she has learned. Projects, in contrast, allow educators to emphasize, "the important role that experience plays in the learning process" (Kolb[1]). In an endeavor to foster projects in our classes, the Mechanical Engineering Department at UT has initiated PROject CEntered Education, PROCEED (Schmidt and Beaman[2]), which is intended to encourage both teachers and students to focus more on course projects, is a multi-faceted, department-wide program involving curricular innovations at all levels. The backbone of those innovations is a web-based portfolio system that allows students to document their educational progress. The PROCEED portfolio system provides students with a format to record their course work, present projects, and evaluate their own educational progress.

The system is intended to accomplish several goals. First, portfolios provide students with a bookkeeping center that will allow them to keep track of their courses, projects, and educational objectives without presenting the results to the public. Second, students will be able to use the portfolio not only to keep track of courses they have taken, but also to reflect on their

development as engineers. This reflective aspect of the portfolio system will facilitate the advising process between faculty and students and give the Department valuable information in assessing our effectiveness as educators. Finally, an electronic portfolio gives students a chance to showcase their best work, demonstrate their accomplishments to potential employers, and ultimately provide them with better job opportunities.

A student's portfolio will be a record of his/her educational goals and accomplishments. It will include summaries of pertinent courses and projects and links to the full text records of some projects, including work in engineering graphics, communication, and design. The concept of recording goals and accomplishments may well benefit students as they embark on their careers by giving them a record of their goals and their progress that they can reflect on as post-graduates. As Kolb suggests experiential learning is an integrated approach to education that has far-reaching effects for students. He anticipates the impact of the "continuing knowledge explosion" and notes, "it makes more sense to distribute educational experiences throughout adult life in order to assist in the preparation for and mastery of these changes. In this model the university becomes a center for lifelong learning." An electronic, academic portfolio can be a foundation of a reflective personal journal for professionals engaged in the process of lifelong learning.

This is by no means the only introduction of an online portfolio for university students. Approaches to online portfolios range from multiple university projects such as the ePortConsortium (http://eportconsortium.org/) to small personalized sites such as the Kalamazoo College Portfolio (http://www.kzoo.edu/pfolio/). Specifically, for engineering, one should recognize innovations by Rose-Hulman's RosE-Portfolio (http://reps.rose-hulman.edu/). The development of the online portfolios at UT Austin has been a unique one. This paper will describe the development of the PROCEED portfolio system by examining two initiatives to encourage students to keep a record of their projects and academic accomplishments on-line.

2   *Two approaches*

Simultaneously, the two authors of this paper undertook initiatives in the Department of Mechanical Engineering that approached the goal of helping students create an electronic record of their academic work from different angles. On one front, Matt Campbell began developing a department-wide electronic portfolio system as part of PROCEED that would be available to all students in the department. This top down approach is described in Section 2.1. On another front, Christy Moore began implementing curricular changes in her Engineering Communication course that would encourage students to publish their course projects on the web (see Bottom-Up Approach in Section 2.2). In this section, we will each describe, in the first person, the experiences of these two approaches.

2.1 From the Top-Down (Campbell)

Beginning in the summer semester of 2001, a study was initiated to learn how a department wide electronic portfolio system could impact the quality of our baccalaureate degree in mechanical engineering. As Julia Williams of Rose-Hulman has noted, the results of instituting a portfolio system has often been mixed. "Faculty complain of increased workloads, students do not see the correlation between course goals and portfolio objectives, and administrators envision portfolios as merely another means of grading student work" (Williams[3]). In our preliminary evaluation of portfolios, we soon realized another possible problem: web development is time-consuming and burdensome for many undergraduates. To begin our project, our first step was to identify other portfolio approaches that were being initiated at other universities (see references above). We then established a basic format for student portfolios that would allow students to have separate pages dedicated to their biographical information, their resume, their contact information, and their projects. Projects could include class assignments, semester long ventures, or summer employment activities.

From this initial study, a small course was established for seniors in the fall semester of 2001 to explore making a website portfolio. The assignments students were given had them perform similar investigations as those performed in the summer, and make incremental steps to building a website in Microsoft FrontPage. While the final websites students created in this course were successful in many ways, they suffered from more than aesthetic problems. First, the time required to construct the sites was more than expected, an outcome that led us to conclude that requiring all of our students to develop a website would mean sacrificing other parts of the curriculum. Second, many of the webpages had similar problems such as trouble in linking to other pages, cryptic statements about specific projects, and pictures often too large for quick transfers. Since these problems were common to many of the portfolios, it seemed likely that the same problems would then occur in other portfolios if students were given too much leeway in the development.

These summer and fall semester investigations provided me with a better understanding of where the web-based portfolio system should go. In opposition to allowing students complete freedom in making their websites, I decided to restrict the portfolio site to minimize errors in the webpage design and to reduce the possibility of extraneous information so as not to detract from students' academic accomplishments. Working with the Faculty Innovation Center (a facility at UT Austin devoted to improving faculty teaching and improving the use of new technologies in the classroom), I focused on developing a web-based tool that would be fun, easy to use, and something the students would be proud of. These three objectives reflect my belief that in order for this portfolio concept to work, it must cater to the needs and wants of the student. As noted by Young[4], "the tool is useful only if a student buys into the idea." Ideally, the portfolio concept is not a mandatory project done in the classroom but an activity that the students perform to enhance their college education.

We began developing the website in the Spring of 2002; it is currently in its final stages with over 150 users at the time of writing. Figure 1 shows a screenshot of the main page. This point provides an entry for both viewers of portfolios (faculty, potential employers, and parents) and for students developing their portfolios. A login at the bottom transports students to the webpage development tools. Students new to the system are introduced to their portfolio via the Portfolio Wizard (see Figure 2). This nine-step process guides students through the basics of creating their website. At the conclusion of the wizard, students have a complete site with four webpages: a home page, a contact page, a resume page, and one project page. After this introduction, students can return to the development side of the portfolio to edit their currently uploaded information or to add new projects. The format for projects is fixed by several templates that allow students to upload one, two, or three pictures along with a brief abstract describing the project. These descriptive project pages are both the most time-consuming and challenging aspects of the portfolio. While the technical issues with presenting the work clearly on a webpage has been
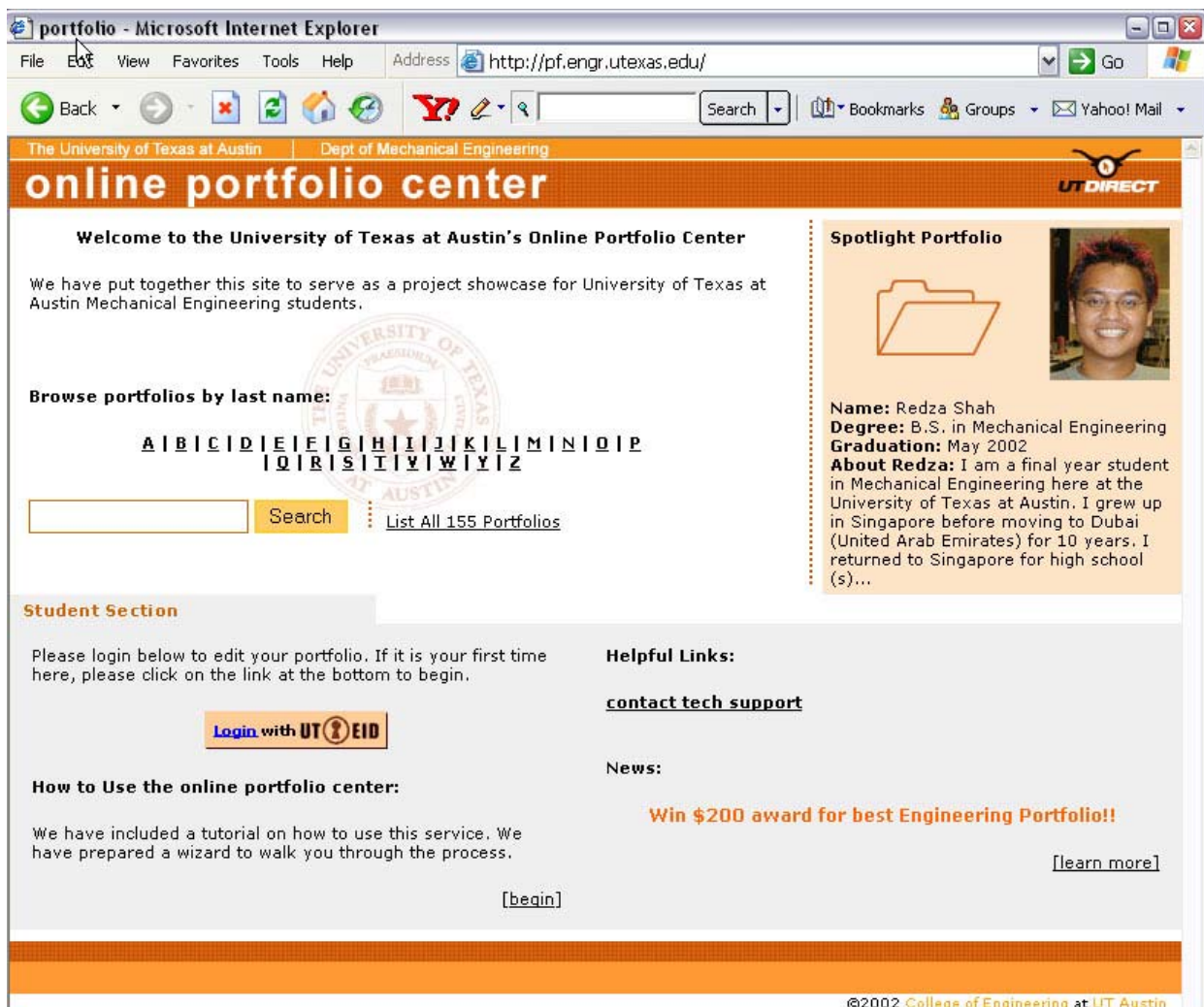

Figure 1: The front page for the PROCEED Portfolio system developed in the Mechanical Engineering Department at UT Austin.
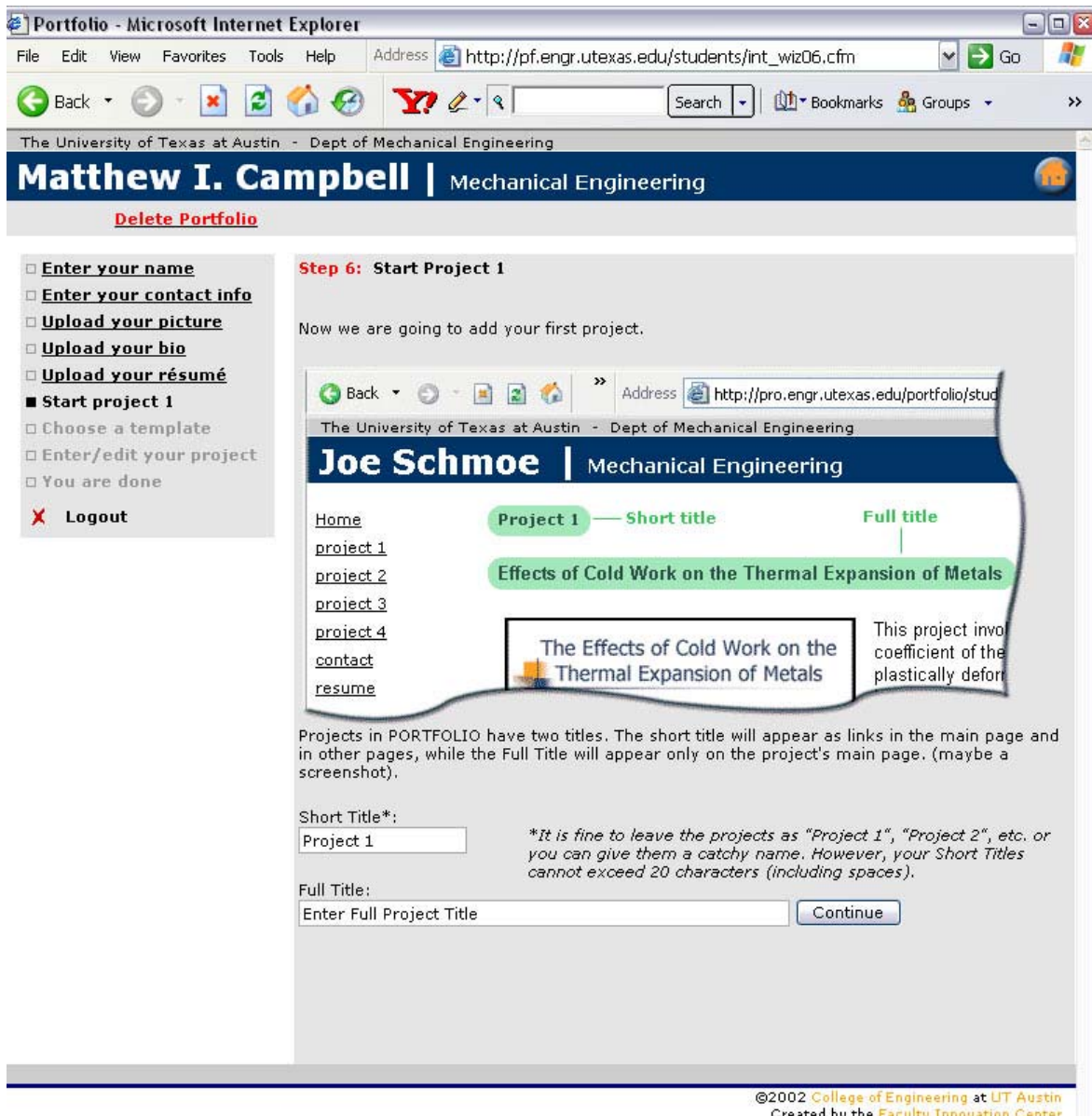
Figure 2: The students begin by developing their web portfolio within a nine step introductory "wizard".

resolved by an environment similar to that of a word processor, the issue of getting students to compose concise descriptions of their projects is still a problem. This difficulty is addressed in the next section.

2.2   From the Bottom up (Moore)

ME 333T, Engineering Communication, is a required course that students usually take during their junior year. It is a prerequisite for the design methodology course and the capstone design course. The major project in the course is a semester-long research project that culminates in a formal report on a topic relevant to engineering or science. In the spring of 2001, I began making

changes in the set up of the course and assignments to encourage my students to publish their papers on the web. I initiated these changes for several reasons. First, while the primary goal of my course is to foster better written and oral communication skills, I believe that as we move further and further into the information age, it becomes increasingly apparent that electronic literacy is also important for our graduates. Employers value recruits who can navigate the Internet and understand the rudiments of making their written work available on the web. Second, publishing written work on-line increases the audience for undergraduate writing from a limited audience consisting of the professor and graders to a wide and diverse audience. Increasing the audience gives students an incentive to do write well over and beyond the incentive of a grade. My hypothesis is, in other words, that when students know that parents, friends, colleagues, and recruiters will be able to read their paper, they will work hard to impress that audience. Third, I wanted to publish student papers on-line so that students would have a place to showcase the work they are doing in my class.

I anticipated numerous challenges in instituting such a change in my curriculum, not the least of which was student resistance to 1.) added work and 2.) content that they might not perceive as relevant to the course. Students in our department are already carrying a heavy academic burden. It seemed unlikely that they would embrace the added work of creating a web page on top of all the written and oral assignments I already had in my course. And yet, I did not want to eliminate assignments that help me achieve the primary goals of the course. In addition, I was faced with the difficulty of learning the technical details of web publishing myself well enough to teach it and of figuring out how to add that content to my course.

Interestingly, I found ways to meet these challenges that do not seem to compromise the content of the course; in fact, if anything the changes help me to meet the primary goals. I have minimized the issue of student resistance so far by making publication of the formal report online voluntary. Students can still turn in their final papers in hardcopy if they want to. I have given them incentive to submit their papers online by making it as easy as possible. First, I have arranged for the college to give each student in my class 200 megabytes of space on the college server that they will be able to keep until after they graduate. Second, I have given them a very simple, uniform design using FrontPage, which is available to all students for a nominal fee. They are not pressured to invest time on the bells and whistles to enhance their pages. Third, I do not make layout and design of the web page part of the grade. I do not want students to be penalized for putting their papers on-line.

The resistance I anticipated to the addition of material that students might perceive as irrelevant has not materialized. Even students who do not choose to publish their papers online consistently tell me that they are grateful for the opportunity to learn how to do it. So far, I have not had any students complain about the material itself.

The challenges of how to teach technical material I am not necessarily qualified to teach and how to add that content without cutting content from the rest of the course has been tricky, but not as difficult as I thought it would be. I have handled those problems by using one of the existing assignments in the course to offload the burden on to the students. One of the major

assignment in ME 333T has always been a set of instructions. In the spring of 2002, I changed the assignment slightly by assigning specific topics all of which concerned the publication of a web page. Students work in groups to create a written set of instructions and an oral presentation in which they teach other students in their workshop one of the following topics: "How to Create a Simple Web Page in Front Page,""How to Format the Formal Report in Front Page,""How to Use Photoshop to Manipulate Images for a Web Page," and "How to FTP Revisions to a Web Site." Because my workshops are taught in the computer lab, student presenters are able to walk the other student in the class through a demonstration that leaves them, at the end of class, with the task accomplished. Although students have varying degrees of knowledge and expertise in web publishing, when they come into the course the topics are defined narrowly enough and they are given enough resources that the assignment has been no more, perhaps even less, burdensome than it was previously. Moreover, although some presentations are indeed better than others, so far even the less successful presentations have been good enough to get us up and running. This use of the instructions assignment has been quite successful. For one thing, the instructional presentations, which have always been a part of the course, are now used to present content that directly and immediately benefits the audience. For another thing, having to learn topics well enough to teach them has immersed students in the process of web publishing much more completely than simply being part of the audience in a lecture could ever do. Finally, of course, the approach has allowed me to learn as I teach.

I first tried this whole approach to persuading my students to publish their projects on line in the spring of 2002 and again in the summer and fall of 2002. Each semester, the number of students choosing web publication of their papers rather than hardcopy submission has increased. In the spring, about half of the students in the class published their papers on-line. The cover of one of those papers is shown in Figure 3. In the fall, nearly 75% of the students published their papers on line. The level of participation would seem to suggest that student "buy in" to electronic publication of their work whether in a portfolio or on their own is pretty strong.

The benefits of having the full text and design of a project on-line seem obvious. Recruiters will be able to evaluate for themselves the communication skills of these students; students take a pride in their work that improves the product; and the skills acquired in learning to publish the first project can be applied to later projects. For instance, in the Design Methodology course and the capstone design course, which follow ME333T, students write reports that demonstrate their talents and accomplishments as writers, collaborators, and engineers. The web space they have been provided by the college and the skills they have learned in ME333T will allow them to showcase those other reports on the web.
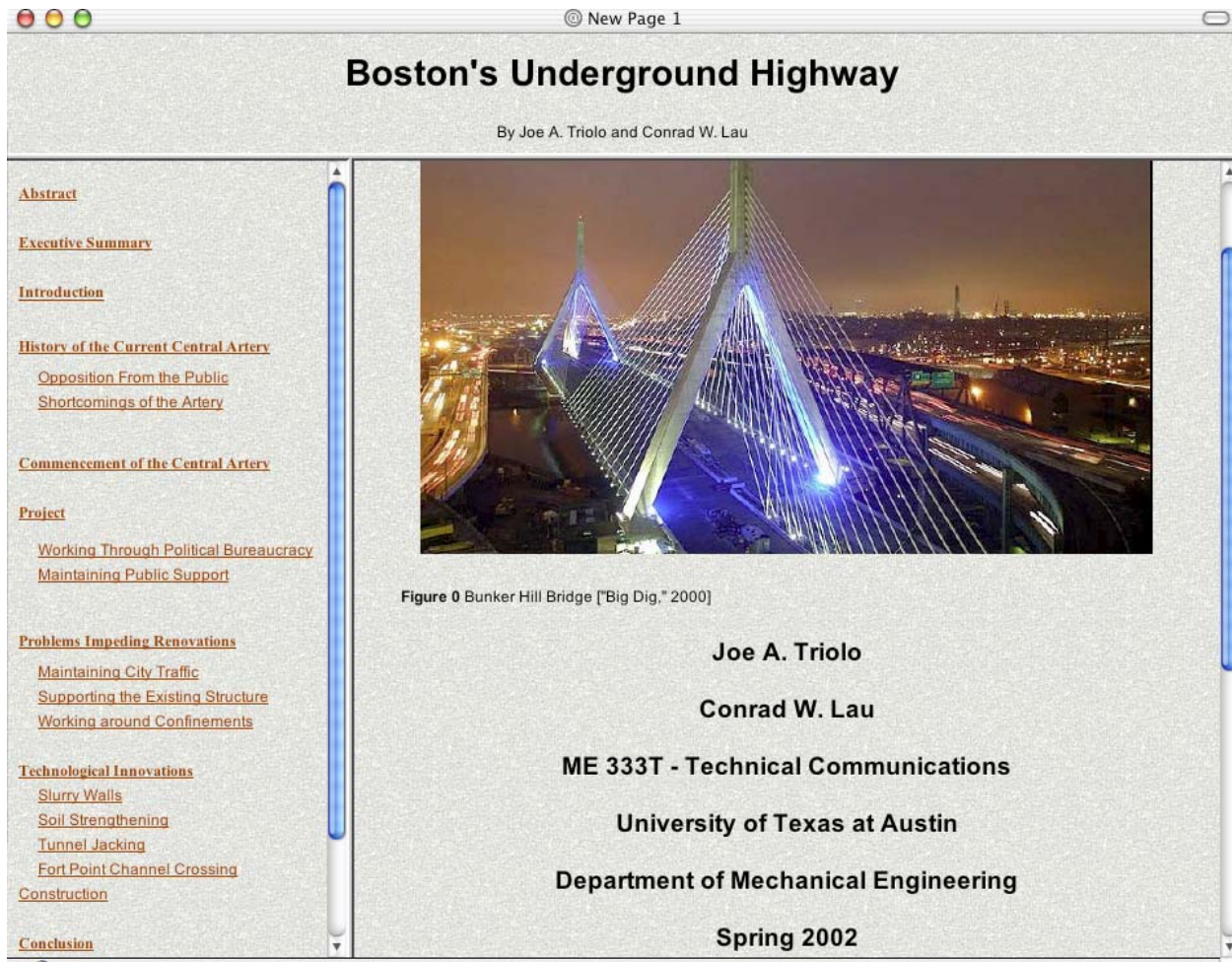
Figure 3. The cover page of a formal report in ME 333T, submitted as a web page.

3 Combining the Two Approaches

In the summer of 2002, after significant development of the website system discussed in Section 2.1, the portfolio was piloted in the Engineering Communications course discussed in Section 2.2. The efforts of the two authors had been occurring in tandem up until this point. Web consultants from the FIC who had designed the wizard came into the ME 333T workshops and walked students through the process of creating a portfolio page. The activity allowed the ME 333T students to see how their class efforts in publishing online papers could be realized as part of their online presence. The pilot project also allowed us to gather important "customer" information from a focus group that had recently been introduced to various facets of web designing.

Having already produced web materials for their research projects and instructions assignments, students were able to run quickly through the introductory wizard (as shown in Figure 2) in approximately 30 minutes. Figure 4 shows an example of a student project page. The clean

presentation of the class material portrays the students abilities free of web-centric frippery that can occupy a student in building a website from scratch. Through the easy-to-follows steps of the wizard, and the clean and professional look of the final website, the PROCEED portfolio system achieves its objectives of being fun, easy to use, and something to be proud of. Many students were thankful to have this vehicle to present and unify their accomplishments. Students recognize the benefits and prominence of having a website but are often too pressured by their present course load and extracurricular activities to focus time and energy on an engineering portfolio.
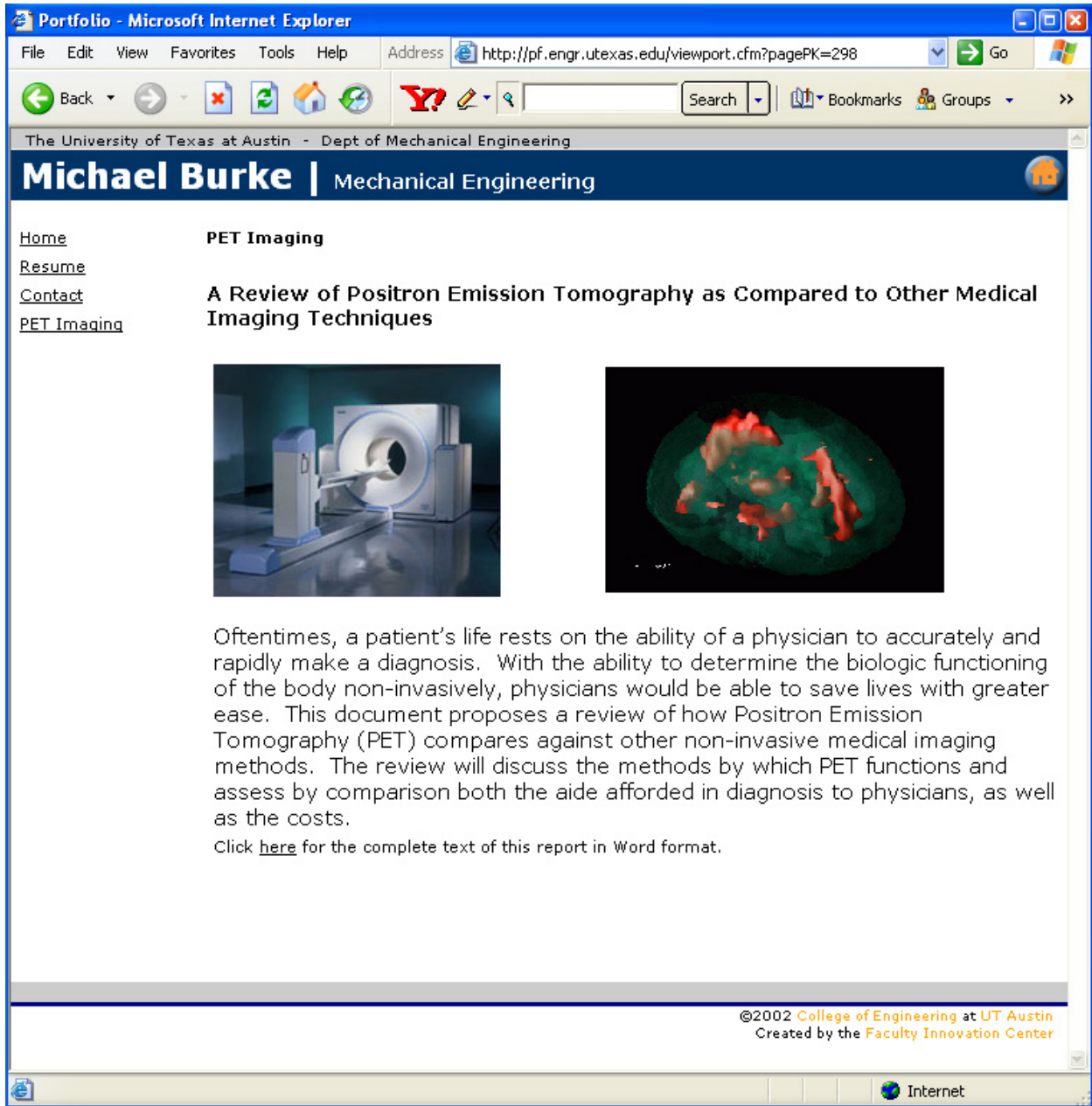

Figure 4. An example student project page with the PROCEED portfolio system.

4   Discussion

The authors of this paper are encouraged with the results of the online portfolio system, but there is much apprehension about the future of this endeavor. Since numerous institutions are exploring the portfolio concept, will the approach shown here be combined into a common format? Will employers recognize the value in student developed webpages? Is there a way to motivate students to create such a portfolio without making it an apparent or mandatory part of the curriculum? While there is no clear way to predict the future success of our approach, we feel that combining our two contrasting tactics (the top-down approach of creating a web-based system to guide the student through the production of at least a four-page website, and the bottom-up approach of creating concise presentations of student projects) will yield a more robust method for aiding students in developing web portfolios. Currently, we are in the process of evaluating our current progress. Through student surveys and workshop discussions, we are gathering the necessary feedback to modify and improve our portfolio system, an upcoming FIE (Frontiers in Education) paper will address these results.

One of the most difficult challenges confronting engineering portfolios, as compared to portfolios from the fine arts, is the presentation of material. Clearly, disciplines in the fine arts lend themselves to a portfolio presentation since the efforts of the students are directly correlated with their abilities. This is not true in engineering. Class projects provide only a fundamental exploration into a given engineering topic; they do not often result in innovative solutions or new knowledge. Furthermore, engineering projects convey a vast amount of information, often through text and equations that prove taxing to an online audience. Therefore, students must learn to summarize their projects with the goal of relating both what was accomplished, and what skills they exercised in the project.

To ensure the PROCEED portfolio system has "sticking power," the authors are also researching the use of portfolios as a reflective tool for the student. In order to help the student realize their individual skills and interests, we are exploring self-assessment tools to complement the development wizard and the ME 333T course material. As students develop into an engineers, they can access a "virtual locker" where they can list and reflect on their skills and efforts until they have matured to a level that they feel comfortable presenting to the outside world (i.e. potential employers).

In addition to student self-assessment, the development of a portfolio can help students and faculty in the advising process. At large universities, such as UT Austin, advising needs to be streamlined to allow students and faculty to quickly come to a decision about what courses will best suit individual needs. The portfolio can help students organize their thoughts and help them communicate these thoughts to a faculty member. This is not meant to substitute face-to-face communication between faculty and students but rather to supplement such communication and give students a touchstone for making better decisions.

In 2003, the PROCEED portfolio system will be implemented department-wide in Mechanical Engineering. If it is successful, the initiative will extend into other departments. The impact of

portfolios on the quality of engineering education is yet to be determined, but it is our belief that a web-centered portfolio can be useful in providing engineering students with a clearer sense of purpose and participation in the educational process.

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Biographical Information

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Dr. Matthew Campbell received his PhD from Carnegie Mellon University in the summer of 2000. He is currently an Assistant Professor at the UT Austin in the ME Department. His research focuses on theories of engineering design and how the computer can be leveraged to solve complex and conceptual design problems. His teaching activities include undergraduate Machine Elements (as described in this paper), a graduate class in optimization, and a collaborative Engineering/Art Project class.

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