

## Improving Mechanics Student and Instructor Satisfaction Through On-Line Laboratory Report Submission

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### Abstract:

*On-Line laboratory report submission has drastically improved both student and faculty satisfaction in a mechanics course. Prior to this implementation, students needed to submit printed copies of their reports resulting in incurred cost to the student and bulky stacks of reports to be handled by the instructor.*

*This paper compares and contrasts two mechanisms for electronically submitting laboratory reports. In addition, this paper shows how the best of both worlds was obtained by integrating eSub™ directly into WebCT™. Student out-of-pocket costs have gone down as has instructor grading time; a tremendous benefit to both user groups.*

### Introduction:

A lower division, four credit hour mechanics class is divided into three one-hour lectures and one two-hour laboratory per week, with credit being allocated at 75% for lecture and 25% for laboratory. The laboratory portion has traditionally required printed laboratory reports be submitted on mostly a weekly basis. These reports utilize standard suites of software extensively, including MS Word™, MS Excel™, and MS PowerPoint™. Digital images and screen captures from laboratory automation software drastically increase the size of these reports, which average 7MB and 20 formatted pages per report per student. Over the course of a semester, the student will often utilize their own printer to produce these reports or risk missing a deadline due to long queues at the various university computing laboratories with color printers. This direct student cost can exceed \$200 over the course of a semester and has become a source of some student discontent. Laboratory data distribution to various team members has also been problematic.

Recent implementation of WebCT™ has directly improved the student satisfaction with respect to laboratory report submissions and laboratory raw data dissemination. Directly from laboratory computers, students are able to upload their experimental data directly to their team's WebCT directory, which is accessible only by that team's members. Following individual (and sometimes team) report writing, the reports are uploaded directly to their individual account in the course's WebCT directory. The immediate effects of implementing this form of data dissemination and laboratory report submission has been to improve student access to laboratory data after laboratory is complete and to improve the time from report completion to report submission, saving student funds. This paper will describe the experiences with these two course enhancements, both positive and negative and describe a plan to compare and contrast the electronic submission capabilities of two software packages: WebCT™<sup>4</sup> and eSub™<sup>2</sup>.

### **Mechanics Laboratory Report Submission: The “Old Way”**

Traditionally at Purdue University, laboratory reports (in all formats) were submitted in hard-copy form with laboratory graphs stapled at the end. Starting in Fall, 2000, Microsoft Office™ was required of students for their write-up, including raw data collected during that particular experiment. Additionally, an on-line folder that was accessible by the students was populated with digital photographs taken during the laboratory set-up, actual experiment, and/or tear-down stages; students were encouraged to incorporate these resources into their reports. The upside of these two structural modifications to the report submission process was that the reports took on a current, professional appearance commonly seen in industry. The downsides of that process were many:

1. as the electronic file size increased into the 5-9 MB range with an average of 7MB, the utilization of the ubiquitous floppy disk was precluded.
2. as the submitted report length was roughly doubled to approximately 25 pages for formal reports and to approximately 15 pages for shorter memo reports with an average of 20 pages, the “stack” of turned-in reports became unwieldy for the instructor.
3. as the “stack” size increased, the likelihood of lost reports increased
4. with the increase in student academic dishonesty, searching for similar submissions became almost impossible by hand.
5. keeping an archive of who turned in what by when was a manual task subject to error.
6. students that missed class due to illness or other reasons, would increase the likelihood of it becoming misplaced by the instructor.

### **Mechanics Laboratory Raw Data Dissemination: The “Old Way”**

Traditionally, raw laboratory data was recorded either by hand on a worksheet or recorded using an XY plotter. This raw data was photocopied and handed out to the laboratory group members. During Fall 2000, the first author utilized the course web folder to “post” raw data from lab, either by scanning the plot into JPEG format, posting an Excel™ spreadsheet, or Word™ document. The upside of these methods was that all team members had access to the raw data immediately after lab period (in the case of the photocopy method) or after the instructor posted the data to the course web folder (which could take from several minutes to the next day). The downside was that the individual team data needed to be tediously hyperlinked by the course instructor, who also happened to be the Mechanical Engineering Technology Department’s Webmaster, on a case-by-case basis, which on several occasions led to delays in raw data availability to the student teams.

### **Transition: from the “Old Way” to the “New Way”**

An example in the transitioning from the “Old Way” to the “New Way” at Purdue University is described in a previously published paper<sup>1</sup>. The need for a robust submission system was set forth in another previously published paper<sup>3</sup>. The authors suggested utilizing email and course folders as possible avenues to support electronic laboratory report submission for this same Purdue University mechanics course, MET 211, Applied Strength of Materials.

This investigation included WebCT™, direct submission to the course web folder, eSub™ (a program written by a Purdue University, School of Technology faculty member, the second author, Kyle D. Lutes), and a combination of WebCT™ and eSub™. Both WebCT™ and eSub™ have the capability to accomplish the needs of MET 211 laboratory report submission. Due to permission restrictions, undergraduate students did not have (they still don’t) write permission on

the School's web server, which eliminated choice two from consideration. WebCT™ and eSub™ were chosen for pilot testing in Fall 2002 based to address electronic laboratory report submission. Secure grade posting was a by-product of this investigation as numerous campuses are increasingly experiencing student privacy issues and is one focus of Purdue University's Office of the Provost.

### **Mechanics Laboratory Report Submission and Raw Data Dissemination: The “New Way”**

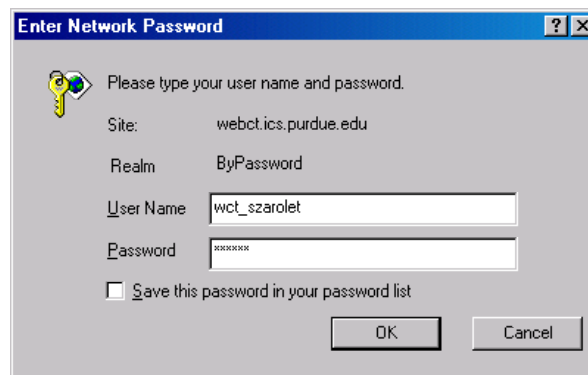
Given the handling problems associated with large stacks of submitted laboratory reports, electronic submission of laboratory reports was initiated in Fall 2002 for MET 211. The author populated the course with students on an individual basis while looking at digital photographs of that particular student, as a memorization aid. During the course, ten laboratory projects were required to be submitted in this manner and they are shown in Figure 1 below. This is the screen that the student “sees” when logged onto WebCT™. It is estimated by the authors that the average student will save approximately \$10 per report through electronic submission; a total of \$200 per semester savings by not having to print out and submit hard copies of their reports.

### **MET 211 Electronic Submission Process Highlights using WebCT™:**

To submit a report, students login to WebCT using their Purdue University assigned login name and password, find the appropriate laboratory folder, and click submit. The login screen is depicted in Figure 2, a particular lab submission folder is depicted in Figures 3 and 4 (in this case, the Combined Stress Laboratory) and the submission screen is shown in Figure 5. It is informative to note that Figure 5 also depicts global raw data files containing information of importance to all team members. Team-specific lab data (available only to one of the nine assigned teams) is shown in Figure 6.



**Figure 1: Student View of MET 211 link on WebCT™ with ten laboratory folders along with a lab group folder for raw data uploads and downloads.**



**Figure 2: Student and Instructor view of WebCT™ login screen detail. Login Name and Password are unique for each student and instructor (and Teaching Assistants), supporting secure course score and grade posting.**

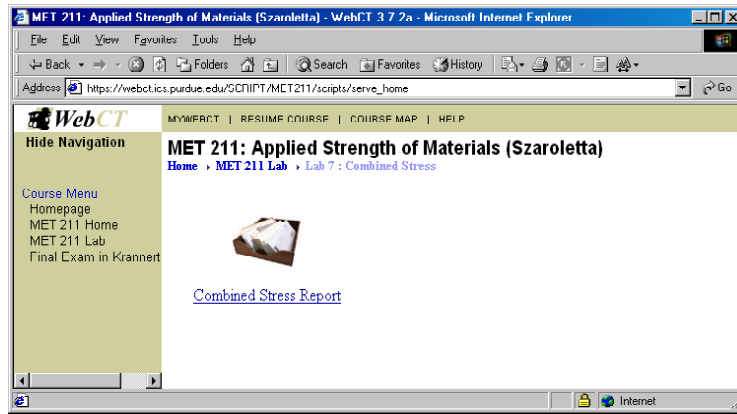
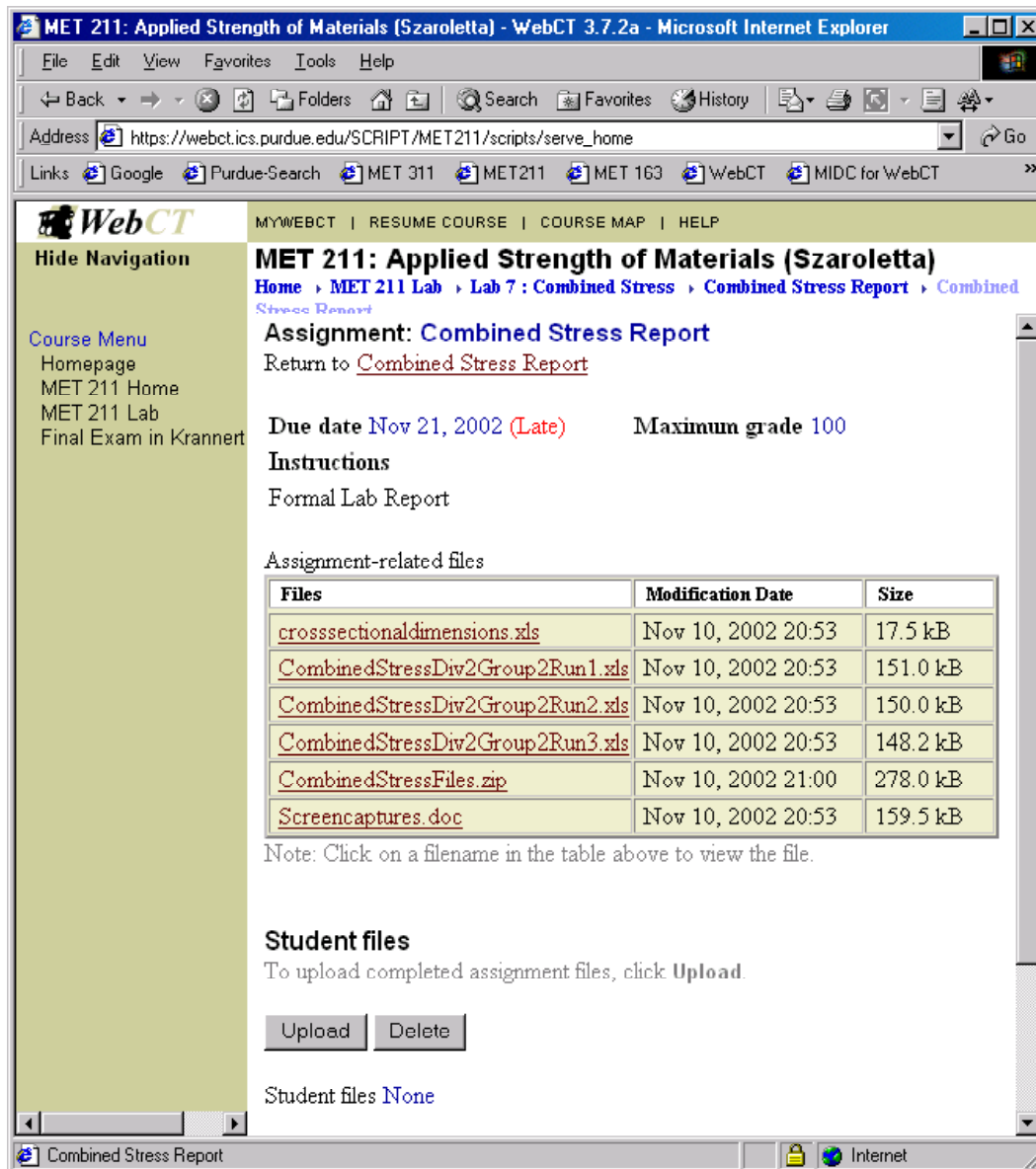


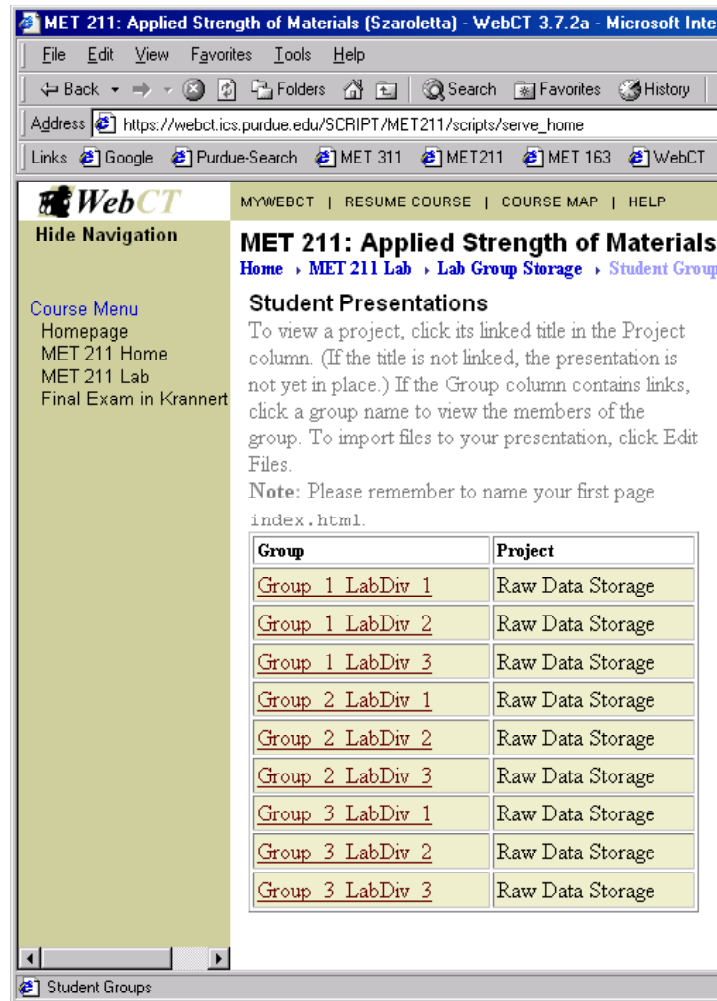
Figure 3: Student View of Individual WebCT™ lab folder.

Title	Availability	Grade	Status
Raw Data	From: Immediately Due: Aug 3, 2002 23:55	-- / 0001	Unavailable
Strain Gauge Report	From: Aug 30, 2002 07:00 Due: Sep 4, 2002 20:00	-- / 100	Unavailable
Punching Shear Report	From: Sep 4, 2002 07:00 Due: Sep 24, 2002 20:00	/ 100	Unavailable
Tensile Testing Report	From: Immediately Due: Sep 26, 2002 22:00	-- / 100	Unavailable
Torsion Report	From: Oct 3, 2002 11:00 Due: Oct 12, 2002 18:00	-- / 100	Unavailable
4-Point Bending Report	From: Oct 22, 2002 20:00 Due: Oct 30, 2002 22:00	-- / 100	Unavailable
3 Point Bending Report	From: Immediately Due: Nov 6, 2002 22:00	-- / 100	Unavailable
Combined Stress Report	From: Immediately Due: Nov 21, 2002 22:00	-- / 100	Not Submitted (Late)
Photoelasticity Report	From: Nov 17, 2002 07:00 Due: Nov 26, 2002 22:00	-- / 100	Not Submitted (Late)
Fatigue Report	From: Nov 23, 2002 07:00 Due: Dec 3, 2002 22:00	-- / 100	Not Submitted (Late)
Column Buckling Report	From: Dec 3, 2002 07:00 Due: Dec 5, 2002 17:00	-- / 100	Not Submitted (Late)
Homework 31: Excel Deflection Spreadsheet and Chart(s) Submission	From: Immediately Due: Nov 13, 2002 13:20	-- / 10	Unavailable

Figure 4: Student View of WebCT™ Laboratory report submission status page



**Figure 5: Student View of laboratory report submission status and raw data dissemination page. Students click “Upload” for electronic submission and can also download any raw data file.**



**Figure 6: Instructor View of Team-Specific raw data files and dissemination page. Individual raw data files for each of the nine teams are stored in the nine folders, respectively. Students can only upload and download raw data files to their assigned team's folder.**

### **MET 211 Electronic Submission Process Highlights using eSub™:**

Unlike WebCT™, eSub™ is not a complete course management system. Rather it is a web-based system used by students and instructors to manage electronic assignment submissions. Instructors who use eSub™ typically use other systems for posting course grades, hosting discussion forums, posting lecture notes, etc.

eSub™ was originally developed by Purdue School of Technology faculty in Fall 2000 to solve problems associated with collecting assignments in large (> 150 students) computer programming courses, but is currently used by faculty in a variety of courses at many campuses in the United States and Canada. Since April 2001, students have created over 4,000 accounts and submitted over 130,000 files to instructors. The eSub™ home page can be found at <http://submit.tech.purdue.edu>.

### **How Students use eSub™**

Before students can begin to submit files, they must first create a new account using simple form

that asks for a unique user name, a password, name, and optional student ID, telephone number, and email address. Whenever it is necessary to submit a homework assignment, the student logs on using his or her eSub™ user name, password, instructor name and course code (provided by the course instructor) as shown in Figure 1.

**eSub™**

[Logon](#)  
[Logoff](#)  
[Change Account](#)  
[Submit a File](#)  
[Retrieve a File](#)  
[List All Submitted Files](#)  
[Delete a File](#)  
[Show Password Hint](#)  
[Suggestion Box](#)  
[Help](#)

**Student Logon**

User Name:

Password:

Instructor:  [Search](#)

Course Code:

New users can create a student account by clicking [here](#).

Course instructors click [here](#).

**Figure 7 Student Logon using eSub™**

After an account is created, a student can submit a file using only four mouse-clicks (not counting clicks to browse for the file to submit). The student selects *Submit a File* from the menu, selects an assignment from the displayed list (Figure 8), and uploads a file using the web browser interface. Immediately after the file is received, a confirmation message is displayed to the student as shown in Figure 9.

**eSub™**

[Logon](#)  
[Logoff](#)  
[Change Account](#)  
[Submit a File](#)  
[Retrieve a File](#)  
[List All Submitted Files](#)  
[Delete a File](#)  
[Show Password Hint](#)  
[Suggestion Box](#)  
[Help](#)

**Select Assignment**

Select an assignment from the list below to continue.

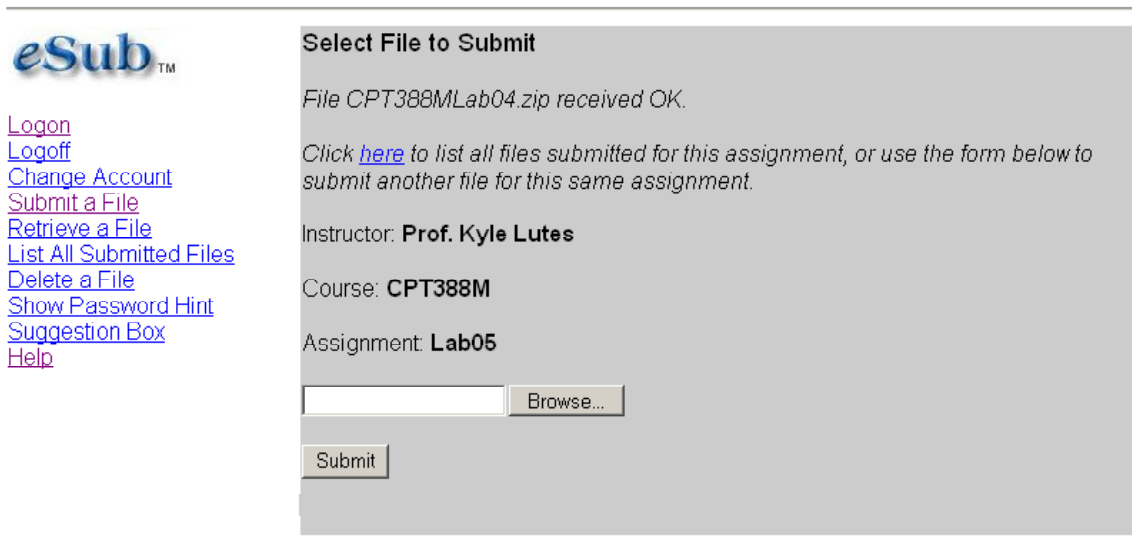
Instructor: **Prof. Kyle Lutes**

Assignments for course: **CPT388M**

Title	Due Date	Submit After	Submit Before
<a href="#">Lab01</a>	2/4/2003 10:00 pm		2/4/2003 10:00 pm
<a href="#">Lab02</a>	2/11/2003 10:00 pm		2/11/2003 10:00 pm
<a href="#">Lab03</a>	2/18/2003 10:00 pm		2/18/2003 10:00 pm
<a href="#">Lab04</a>	3/4/2003 10:00 pm		3/4/2003 10:00 pm
<a href="#">ProjectIdeas</a>	3/10/2003 10:00 pm		3/10/2003 10:00 pm
<a href="#">Lab05</a>	3/11/2003 10:00 pm		3/11/2003 10:00 pm

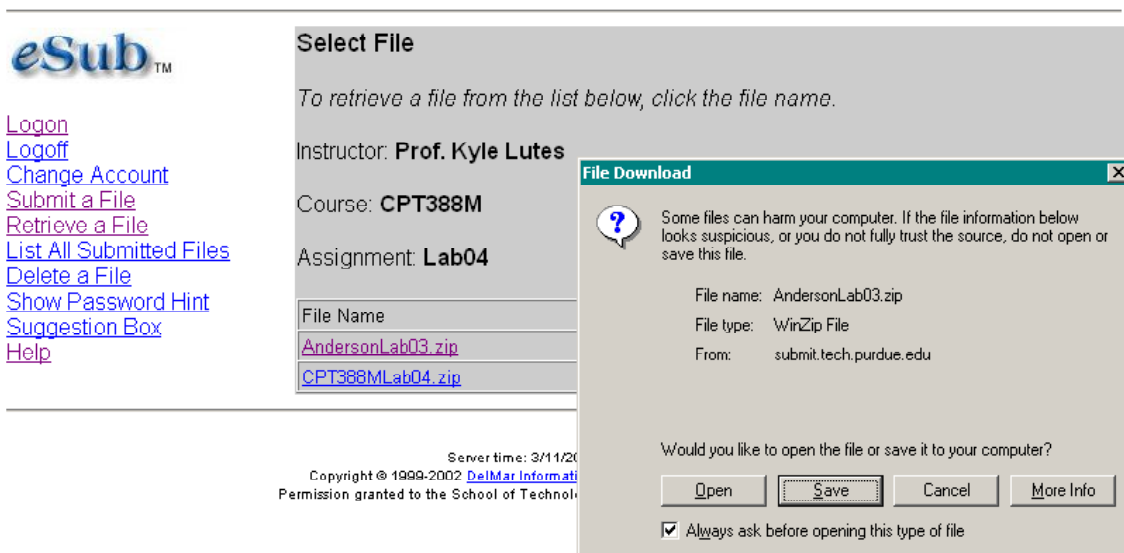
**Figure 8 Assignment Selection using eSub™**





**Figure 9 File Selection using eSub™**

After an assignment has been graded, the student can retrieve the feedback documents if the instructor is using eSub™ to provide feedback to the student. The student logs on as previously mentioned, chooses *Retrieve a File* from the menu, selects an assignment from the assignment list, and selects the file they wish to retrieve. This process requires just three mouse-clicks. Figure 10 shows an example.



**Figure 10 File Retrieval by Students after submission using eSub™**

### How Instructors use eSub™

Instructors use the system from a similar web interface. Before using the system, an instructor account must be created. At the beginning of each semester, the instructor can add an entry for each course he or she is teaching, or can recycle the previous semester's data. Whenever an assignment is made, the instructor logs on and defines the entry for the assignment as shown in Figure 11. Note that assignments can optionally be marked with a due date and valid submission

dates. Turning off the *Allow Retrieve* indicator can be used to allow students to submit files, but not retrieve them. This option is for more private submissions such as lab practical exams.

**Figure 11 Instructor Assignment Management using eSub™**

After the assignment's due date, the instructor logs on and selects *Package Student Files* from the menu. After selecting this option, the instructor is prompted to select the course and assignment he or she wishes to retrieve the files for. A package file (i.e. archive) is immediately created on the web server, which is then easily retrieved and saved on the instructor's local PC.

The package file is opened using the integrated archive program as shown in Figure 12. Selecting *Extract* from the menu or toolbar will create a folder for each student who submitted files for the assignment. Each student folder will contain all the files the student has submitted for the assignment. If students submit zip files, the packager can also automatically un-zip the file. The assignments can now be graded offline as normal.

Folder	File	Type	Modified	Size	Packed
Anderson_Erik_309	2003-Mar-ditesubs.LG1	LG1	3/4/2003 8:33 PM	222B	114B
Anderson_Erik_309	CPT388MLab04.zip	ZIP	3/4/2003 8:33 PM	49.4KB	37.3KB
Baggili_Ibrahim_699	Baggili_Lab04.zip	ZIP	3/4/2003 6:02 PM	99.0KB	95.7KB
Baggili_Ibrahim_699	2003-Mar-ditesubs.LG1	LG1	3/4/2003 6:02 PM	781B	166B
Baggili_Ibrahim_699	~001_Baggili_Lab04.zip	ZIP	3/4/2003 3:10 AM	72.7KB	50.5KB
Baggili_Ibrahim_699	~002_Baggili_Lab04.zip	ZIP	3/4/2003 2:12 PM	112.5KB	107.8KB
Becker_Ken_3389	2003-Mar-ditesubs.LG1	LG1	3/4/2003 9:58 PM	115B	109B
Becker_Ken_3389	BeckerKen_Lab 04.zip	ZIP	3/4/2003 9:58 PM	139.0KB	134.7KB
Dyer_Adam_806	AdamDyerCPT388MLab04.zip	ZIP	3/4/2003 7:50 PM	138.4KB	134.4KB
Dyer_Adam_806	2003-Mar-ditesubs.LG1	LG1	3/4/2003 7:50 PM	113B	102B
Freeman_Gabriel_3843	CPT388MLab04.zip	ZIP	3/4/2003 6:10 PM	72.8KB	69.5KB
Freeman_Gabriel_3843	2003-Mar-ditesubs.LG1	LG1	3/4/2003 6:10 PM	111B	99B
Gao_Jie_4556	JieGao_CPT388MLab04.zip	ZIP	3/4/2003 8:50 PM	106.8KB	101.2KB
Gao_Jie_4556	2003-Mar-ditesubs.LG1	LG1	3/5/2003 10:08 AM	231B	141B
Hirani_Zahara_6344	2003-Mar-ditesubs.LG1	LG1	3/4/2003 9:17 PM	110B	99B
Hirani_Zahara_6344	CPT388MLab04.zip	ZIP	3/4/2003 9:17 PM	92.1KB	79.4KB
Leshney_Seane_796	2003-Mar-ditesubs.LG1	LG1	3/4/2003 9:59 PM	112B	99B
Leshney_Seane_796	CPT388MLab04a.zip	ZIP	3/4/2003 9:59 PM	74.9KB	71.5KB
Love_Rett_720	2003-Mar-ditesubs.LG1	LG1	3/4/2003 9:57 PM	232B	125B

57 files displayed, 0 files selected.

**Figure 12 Instructor File Download Management using eSub™**

After logging on, an instructor can retrieve all student files for a given assignment, un-package, and un-zip them on a local computer using just 11 mouse-clicks and no keyboard typing.

To provide feedback to the students, a separate document can be copied directly to the student folder. This document contains information about what was done correctly or incorrectly, and the score the student received on the assignment. Depending on the type of files submitted, notes could also be typed directly in the documents the students submit.

After all assignments have been graded, the integrated archive program can be used to compress them back into a single package file and uploaded to the eSub™ web server. Once back on the web server, the instructor chooses *Replace Student Files* from the menu, selects a package file, and the student files are extracted from the package file and replaced into the individual student folders for the students to retrieve. Student files can be re-zipped, packaged, and returned to the students' eSub™ accounts using just 12 mouse-clicks.

Instructors have additional abilities such as changing their account information, displaying a list of students who have submitted files for a given assignment, retrieving student files one at a time, and building a student roster file.

### **Pros and Cons of eSub™ as Compared to WebCT™**

WebCT™ and eSub™ are contrasted below and the Pros and Cons of eSub™ relative to WebCT™ are reported.

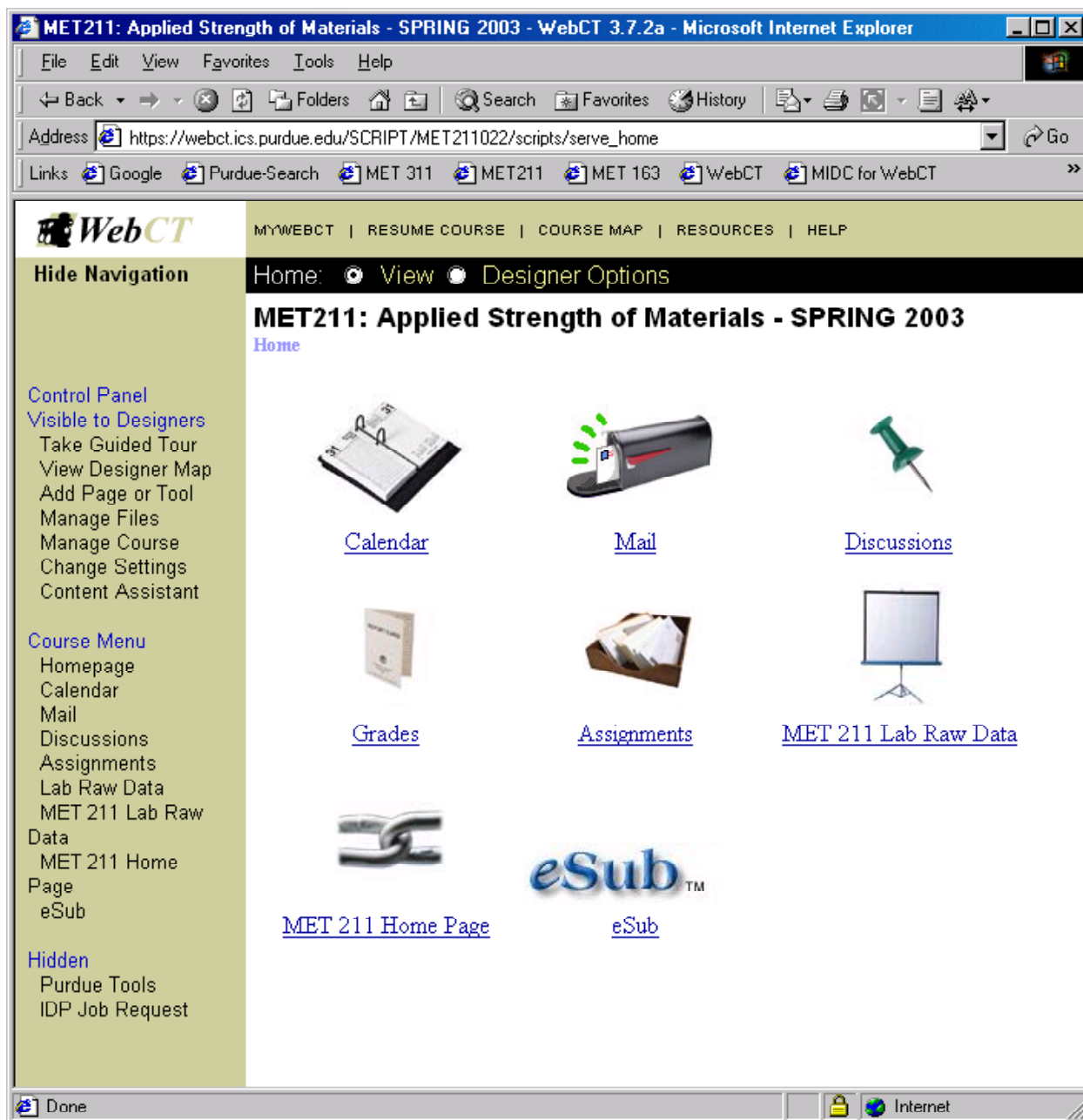
#### **Pros:**

- Students manage their own accounts so instructors do not have to define student information.
- Instructors can retrieve all files for a given assignment with just 11 mouse-clicks.
- Assignments can be marked to allow students to retrieve or not retrieve.
- Instructors can grade assignment off-line and optionally return graded assignments using the same web interface.
- The integrated packager program will automatically un-zip and re-zip files, which give instructors the option of allowing students to submit a single zip file for an assignment.
- Students can retrieve a file after they've submitted it to verify its contents.
- Since eSub™ uses a simple HTML web interface, it can be integrated with WebCT™.
- eSub is currently free to use.

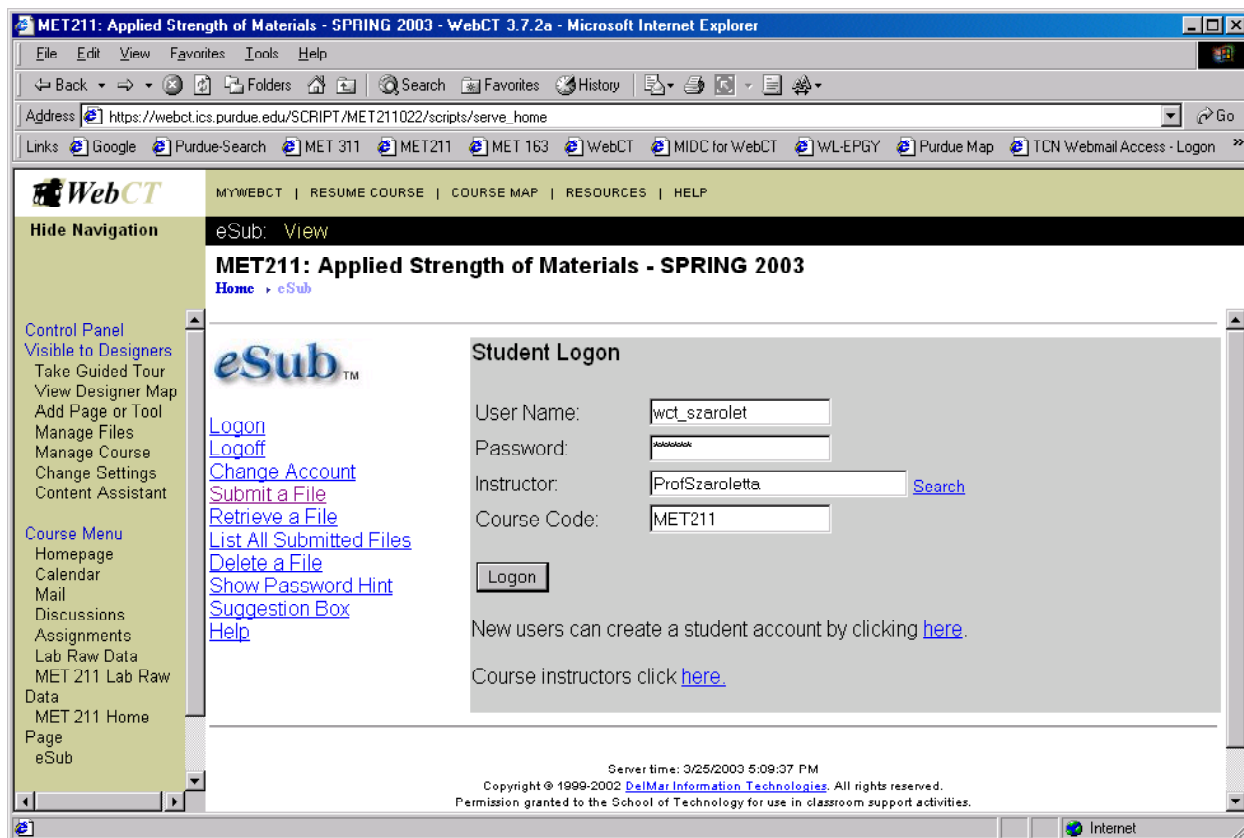
#### **Cons:**

- eSub™ is not a complete course management system and so is typically used in conjunction with other systems.
- eSub™ currently does not have any direct support for team assignments.

Figure 13 below shows how eSub™ was integrated into WebCT™ as discussed above while Figure 14 shows how students access eSub™ within the WebCT™ window. Students utilized this interface and when surveyed, said that being able to immediately “see” and “retrieve” their submission was much better than WebCT™, which can “hide” their submission.



**Figure 13 Integrating eSub™ into WebCT™**



**Figure 14 Student View after Clicking eSub™ icon within WebCT™**

### Potential Areas for Improvement:

Instructor grading of laboratory materials is not clean with either method. It was and still is easier to make marks and comments directly on a hardcopy report than electronically convey student feedback. To get around this deficiency, a system of having a hard-copy grade sheet alongside the workstation is utilized. Scoring and comments are made on the grade sheet, which is handed back to the students with their overall score

Upload and download time by students was one source of feedback to the instructor during Fall 2002. Some students learned that submitting a 7 MB file over a dial-up connection would not be as fast as over an on-campus 10MB/sec or 100MB/sec network connection. No difference was experienced between WebCT™ and eSub™ with upload and download time, though the number of “clicks” for each function was less for eSub™.

Creation and management of course information by the instructor using a Windows-like functionality are expected. For example, being able to copy and/or move multiple files simultaneously, rather than one at a time, would be a major improvement.

### Conclusions:

A course evaluation showed that overall student satisfaction for the web-based portion of the course went up over a non-WebCT, non-eSub™ MET 211 taught in Fall 2001, from 4.6 to 4.7 out a maximum of 5.0. An informal, three question survey conducted after the course was completed in December, 2002 and January, 2003 showed that 95% (38 out of 40 respondents) of the students from Fall 2002 MET thought that electronic submission and data dissemination saved

them money, was helpful from their point of view, and should be continued in Spring 2003. While 4.6 to 4.7 is not a huge statistical increase due to already high level of web utilization in the course, the word-of-mouth and above survey clearly show the eSub™ within WebCT™ to be an improvement. With instructor satisfaction being roughly inversely proportional to grading time of submitted laboratory reports, this satisfaction level experienced a dramatic increase through using eSub™ within WebCT™.

Some of the benefits that the authors observed using electronic file submission techniques described within this paper include:

- Elimination of bulky stacks of paper; both student out-of-pocket expense and instructor “carrying” load go down.
- Reduction in the likelihood of lost assignments.
- Improvement in the ease multiple files can be searched and compared relative to student academic honesty (or dishonesty).
- Improvement in the ease with which instructors can keep an electronic archive of all student work as it was submitted and after it has been graded.
- Improvement in student and instructor flexibility with respect to file access.

This last benefit translates to students being able to submit assignments from any computer, at any time, as long as they have a network connection and instructors being able to access these submitted files within the same ground-rules.

For future work, the authors plan to investigate further synergies between WebCT™ and eSub™ to continue to assemble a robust electronic submission system that will be of benefit to both students and instructors.

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**Biography:**

WILLIAM K. SZAROLETTA, P.E.

Professor Szaroletta is an Assistant Professor of Mechanical Engineering Technology (MET) at Purdue University. A member of ASEE, he has 18 years industry experience in engineering and project management positions, with 12 awarded patents. He received his B.S. Degree in Mechanical Engineering from University of Michigan, Ann Arbor in 1977, M.S. Degree in Engineering (Product Design) from Stanford University in 1984, and a Master of Applied Mathematical Sciences Degree (Computer Science) from University of Georgia in 2000. He has 7 years university teaching experience, where his current applied research interests are rapid product design engineering, experimental mechanics laboratory automation, and applied optimization.

KYLE D. LUTES

Kyle Lutes is an Assistant Professor of Computer Technology (CPT) at Purdue University. His teaching and scholarly interests cover all areas of software development, including programming languages, web application development, mobile computing, object-oriented programming (OOP), software engineering, client/server information systems, user interface design, and rapid application development (RAD). Prior to his current appointment at Purdue, he held various software development positions in industry and has worked on projects for such industries as banking, telecommunications, publishing, hospitals, medical schools, retail, and pharmaceuticals. Kyle has been writing software professionally since 1982 and has written numerous periodical and journal articles.