Session 3150

EXPERIENCE with the INTRODUCTION OF MULTIMEDIA INTO MECHANICAL ENGINEERING TECHNOLOGY, Mechanics of Materials Laboratory

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Abstract

The Penn State Associate Degree in Mechanical Engineering Technology program offers a two course sequence in mechanics of materials, one of which is a laboratory course (MCH T 214). The educational objectives of this one credit course, as described in the Penn State Associate Degree Programs Bulletin, are “measurement of mechanical properties of materials; structural testing; data acquisition and analysis; technical report writing.” Components of this course were revised to incorporate multimedia software into the laboratory experience. For the first time students were given an opportunity to integrate communications software, online web research, photo and video software, spreadsheet software, word processing, and presentation software. Accomplishments and future goals in the evolution of this course are discussed.

Introduction

The Associate in Mechanical Engineering Technology degree candidate arrives with a set of expectations that this program will provide them with state of the art training. As with many institutions, maintaining state of the art laboratories is quite expensive, virtually impossible to maintain, and is even more challenging for a campus that is one of many. Penn State University has a number of campuses geographically dispersed throughout the Commonwealth of Pennsylvania. Penn State/Wilkes-Barre is one of those campuses.

It is financially difficult for these campuses to keep pace with the technological changes as it relates to laboratory equipment. The financial burden placed on many technology programs forces these programs to adapt and modify courses to reflect the state of technology training at the laboratory level. This is where my perspective is from: utilizing state of the technology laboratory equipment with state of technology software to make the laboratory experience memorable. It is the goal of any lab exercise to explore ways to improve the next version.

This paper will discuss the experiences that occurred during an offering of the *Mechanics of Materials Laboratory* at Penn State/Wilkes-Barre. The paper will present an overview of how the software packages were integrated, discuss how students prepared for the lab exercise, and discuss suggestions for future versions of the course. Finally, the paper will present anecdotal information in support of integrating multimedia into the laboratory experience.

Background

At Penn State/Wilkes-Barre the *Mechanics of Materials Laboratory* course is offered during the same semester as the accompanying lecture course: *Mechanics of Materials*. The lecture is a three-credit course that meets three times per week and the laboratory course is a one-credit course that meets once a week for two periods.

Prior offerings of this laboratory course followed the traditional approach to a lab exercise. The traditional approach included a discussion on the purpose of the lab exercise, performing the exercise, and preparing a technical report. The technical subject matter was covered during lecture periods immediately preceding the lab exercise.

The course required a number of lab exercises be performed to enable a student to:

- Recognize the various macrohardness systems and their applications and conduct Rockwell hardness tests;
- Recognize the various microhardness systems and their applications and conduct Knoop or Vickers tests;
- Understand and operate a typical benchtop universal materials testing machine;
- Conduct a standard tensile test on a material and prepare a concise, coherent written report of the results, including strengths, modulus, strains, etc.
- Conduct a torsion test to obtain the shear properties of a material and describe the necessary specimen design;
- Understand beam normal and shear stresses and predict failure mode(s) for each type of stress;
- Install strain indicators;
- Conduct impact toughness tests and investigate transition temperature(s); and
- Understand and predict critical column loads and the potential mode(s) of failure.

In addition, the lab course mandates a communications component consisting of four laboratory reports prepared as formal, written technical reports. However, the course does not require computer usage or library usage.

Philosophy

The idea was to modify several laboratory exercises to integrate computer usage and library usage into the laboratory experience. The computer usage component included multimedia software, word processing, spreadsheet, and presentation software. Library usage included on line library research accessed via the web as well as traditional library research. To facilitate the understanding of structures, the tensile test laboratory exercise was modified to include several lab exercises devoted to testing a variety of specimens to highlight connections and supports. Bridges play a vital role in our society and as such were chosen as the ideal candidates for the purpose of highlighting the various types of connections and supports. With this in mind students were asked to take photos or video, and conduct visual inspections of any number of bridges on their way to campus. This material was discussed in the lecture course and provided a great transition to the lab exercises.

The change in this offering of the lab course was the approach to gathering and reporting information relating to the lab exercise. Prior versions of the laboratory course focused on a written technical report as the only vehicle to convey results. Technology is changing and we as engineers must take the initiative and incorporate this technology where and as appropriate to our daily tasks. The task of faculty is to provide students an opportunity to be exposed to appropriate technology as it applies to a particular course. The driving force to incorporate multimedia into the lab experience was to prepare students for the workplace where presentations are a norm and not an exception. Thus the intent was for students to perform their work and present it as if they were at work and defending their results. As with many engineering workplace environments the engineers perform multiple functions and one very important one is to communicate results to peers at the workplace or to peers in industry.

Where previous lab exercises included a discussion of the (1) engineering subject matter, (2) importance of a good specimen, (3) established testing procedures, (4) life experiences, and (5) technical reporting; the new approach focused on integrating computer usage through multimedia and other software to enhance the experience. This phase of the course content, based on thirty class hours per semester, required:

- 1 class for Qpro, Photoshop, and Adobe Premier training
- 1 class for PowerPoint and FirstClass training
- 1 class for tensile testing of round and flat specimens
- 2 classes for fabrication of specimens
- 2 classes for testing of lap and butt joints
- 1 class for updating of projects
- 2 classes for presentations

Due to the increase in the workload students were required to conduct library research and to photograph various types of bridges on their own time. In addition, the fabrication of welded and riveted specimens occurred outside of the classroom setting.

Expectations

As with any new or modified lab exercise the desire is to watch it develop and have students embrace the concept. With this in mind students were expected to take ownership of their project and become active participants from inception to reporting of results. That is exactly what happened in this phase of the course. The students were not expected to become accomplished technicians, presenters, or technical writers, but simply to appreciate the depth and breadth of the process and procedure to conduct an experiment and produce a technical report that could be conveyed to a wide audience. Once the challenge was issued as to the requirements of fabricating specimens, taking photos, editing any video, and making presentations to their colleagues, they immersed themselves in these tasks. As a matter of fact one student provided footage of an arch bridge from Austria where she visited recently. From drilling and riveting, to welding these students took the work so serious that most of it was performed on their own time.

Grading for this portion of the course included the following areas of evaluation: (1) research of the subject matter, (2) performance of the lab exercise, (3) written lab report, and (4) multimedia presentation by the group where the groups critiqued and graded each other's performances. These additional tensile test exercises accounted for forty percent of the entire grade for the course.

Procedure

Student groups consisting of two members per group performed tensile tests on a variety of specimens. The focus for each of the tensile tests was to confirm the predicted "mode of failure,"[1] and to observe the impact of localized regions of stress caused by changes in geometry. Since there were four groups and only one tensile tester (see figure 1) preparation was key. Student centered discussions took place one week in advance of any tensile test for the purposes of assigning tasks to various groups so that no duplicate research, photographs or video footage would occur. Each group was responsible for the collection of photos, or video of connector types and supports used by the various bridge designs. The groups either used a traditional camera, video camera, or a digital camera to obtain the necessary footage. Video was processed and enhanced using Adobe Premier software while camera footage was enhanced using Adobe Photoshop. The footage was used as a guide in preparing the specimens for destructive testing, and for the Power Point presentation that followed the lab exercise.

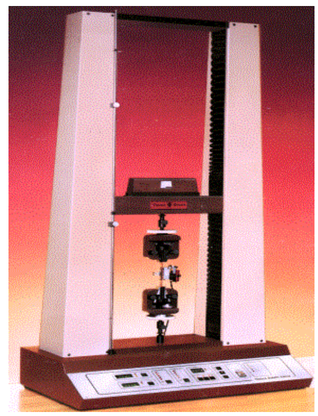

Figure 1

The department purchased, as customary, round (see figure 2) and flat specimens (see figure 3). However, no department funds were allotted for the purchase of the additional tensile specimens. So, one of the first tasks for each group was to fabricate their own specimens. This task was very important because it was the first time, within this course, that students designed specimens for the sole purpose of destroying them to verify the predicted mode of failure.

Figure 2

Figure 3

To facilitate the fabrication of the specimens, the groups designed the specimens as a collaborative effort simulating an engineering design group. Once the designs were finalized two students fabricated the specimens (see figures 4-7) at home. During fabrication other groups collected visual data; i.e. photos, of connectors and supports of bridges. Students communicated with faculty and themselves by the intra-university communications software (see figure 8). The software enabled conferencing, chatting, and file transferring among the students.

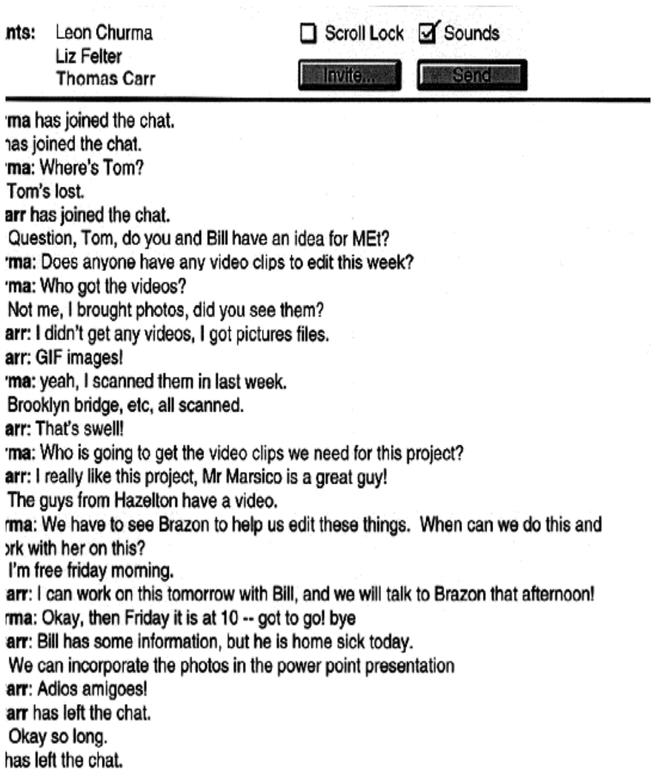

Figure 8

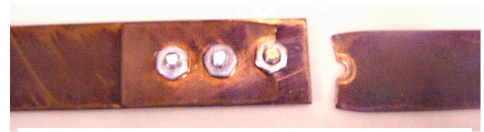

Figure 4

Figure 5

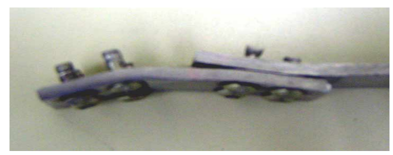

Figure 6

Figure 7

For each tensile test an XY plot was generated, and when possible an extensometer (see figure 9) was attached to the specimen. The extensometer was used, when appropriate, to underscore the importance of an accurate reading of strain for the purposes of producing a stress versus strai ere

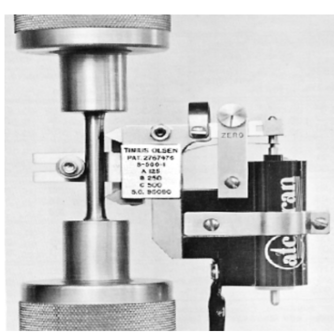

Figure 9

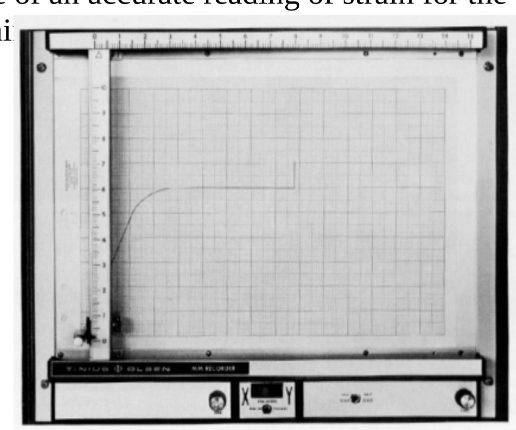

Figure 10

scanned for later presentation, and the data transferred to Qpro spreadsheet to perform necessary calculations.

After conducting the tensile tests, each group gathered their information and prepared a written lab report for evaluation prior to preparing a Power Point presentation. All groups were given the opportunity to score each others presentation based on such factors as technical content, number of group members participating in the presentation, flow of the presentation, and graphics content.

Challenges

This particular class of students fell into two categories: half from another Penn State campus and half from Penn State/Wilkes-Barre. This was the first time that a large number of the class was comprised of students from another campus. The students from the sister campus had a nominal commute of thirty miles one way. In addition to the distance factor, the student schedules did not have out of class common times to meet for lab report preparations. Thus it was extremely important to maintain communications amongst students. The students utilized the First Class software to facilitate discussions and post lab reports for discussions prior to class.

Another challenge to overcome was the need to introduce the software packages quickly and have the students become familiar with the packages. To aid in this process every lab exercise highlighted and included at least a component of a software package so that a working knowledge was being fostered. Several students familiar with some packages became teaching assistants for this endeavor. A campus person responsible for conducting training sessions for these packages aided students requesting additional help.

The additional preparation for conducting tensile tests on additional specimens created a special problem for several reasons. One was the fact that to create riveted, and welded specimens students would have to fabricate on their own time. And the other was the need to procure materials for fabrication. A class member working at an aluminum manufacturing plant donated material for fabrication, bolts and nuts were purchased from the local hardware store, and rivets from the campus facilities group donated material for fabrication.

Student Reactions

At the beginning of the semester students were asked to participate in this inaugural version of the modified content lab course, and they all agreed to the concept. The students approached the additional work as a challenge because it was the first time, in their educational experience, that a lab exercise was approached in this way. The students rated the exercises as an opportunity to learn new software packages while integrating them into the lab exercise. Others enjoyed the collaborative concept of performing a large number of tasks by dividing the work among the group members. Another response dealt with organizational skills that were developed as part these additional lab exercises.

And I would like to say that this was unintended. Overall the students enjoyed working together in designing and fabricating, but the most fun for them was during the destructive testing phase. Here the students witnessed how well the data correlated to their theoretical calculations.

Results

This lab course as presented at Penn State/Wilkes-Barre focused a segment of the semester on integrating multimedia software into the laboratory experience. The students were exposed to the traditional aspects of any lab exercise while at the same time learning how new technologies could be used to enhance the learning experience. Students became deeply involved in the process because it was different from other experiences. Furthermore, the lab exercises enabled them to appreciate how engineers take advantage of technology to facilitate their work.

Students were asked a series of questions to evaluate the experience and the majority indicated a preference for integrating computers and multimedia into the lab exercises. These exercises enabled them to experience first hand how theory is placed into practice with respect to various types of connections. In addition, students rated the experience of fabricating the additional specimens very rewarding because the process merged theory with practice. As to the multimedia software and other software packages, students were grateful at the opportunity of taking various packages and using them in an integrated fashion and not as stand alone individual pieces as they would in other classes. The only negative comment related to the amount of work to de done compared to the one credit course.

Recommendations

There are a number of ways to complete the educational objectives of the course without placing additional burdens on students. Integrating multimedia into a curriculum requires a vast amount of time and energy of both the students and faculty. Adding multimedia and other software packages in an incremental fashion throughout the semester would surely minimize the burden. In addition, existing footage of various bridges and supports would be extremely helpful because it would cut down on out of class time needed for that purpose. Fabricating the test specimens could take place during the lab hours so that all lab partners could participate. And lastly, the department allotment should be increased to enable faculty to explore new ways to make the lab experience relate theory to practice.

Conclusion

The educational objectives of the laboratory course were satisfied while at the same time multimedia was integrated into the course content. The inclusion of the software packages into the course content provided students with the tools necessary to gather and report information and results in a professional manner. The software packages did not change the results of the lab exercises, but what they did was increase student participation in discussions on the subject matter. Coverage of the subject matter went from breadth to depth because the students wanted a greater understanding of the relationship between theory and practice. Student feedback suggests that the integration of computer usage into the curriculum had a positive impact on their learning. The multimedia component of the course did not substitute for the fundamentals of the subject matter but provided a platform for developing and presenting technical reports. It is hoped that future versions of this course explore the use of the web along with multimedia for the purposes of creating a more interactive and real time approach to the presentation of the reports.

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