

## **2005-2007 LITRE Grant Proposal**

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### **1. Project Title:**

Interactive Modules for Undergraduate Laboratory Preparation

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### **2. Project Coordinator:**

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### **3. Other Participants:**

Eric Klang, Director of Undergraduate Programs, MAE

Chau Tran, Director of Undergraduate Laboratories, (Mechanical Engineering)

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### **4. College or Unit:**

Engineering

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### **5. Department:**

Mechanical and Aerospace Engineering

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### **6. Project Description:**

This project will develop on-line instruction modules to prepare undergraduate students for laboratory sections in MAE 405: Mechanical Engineering Laboratory III. The modules would provide the students with the theoretical background required to perform the laboratory experiments, instructions for performing the experiments, and motivation for the specific experiments. In addition, the module would include a quiz, taken and graded on-line, that each student must pass before attending the laboratory session.

The current undergraduate laboratory sequence in the Mechanical Engineering program is:

MAE 305 – Mechanical Engineering Laboratory I

MAE 306 - Mechanical Engineering Laboratory II

MAE 405 - Mechanical Engineering Laboratory III

and the Aerospace Engineering program is:

MAE 357 – Experimental Aerodynamics I

MAE 358 - Experimental Aerodynamics II

MAE 466 - Experimental Aerodynamics III

MAE 469 – Dynamics and Control Laboratory

## MAE 473 – Aerospace Vehicle Structures Laboratory II

For each of these laboratory courses, the students attend one lecture per week (approximately one hour) reviewing the theoretical background for the weekly experiment and explaining the procedure for performing the experiment. Any safety requirements are also presented at this time. The students then perform the laboratory experiment either immediately after the lecture or at another laboratory session in the same week. Feedback from the laboratory courses has indicated that students have difficulty relating the experiments to courses or real-world applications. In addition, students generally listen to the lecture, perform the experiment, record the data, and only process the information when they write the lab report, often a week later.

Therefore the objective of this project is to develop and implement interactive modules to be completed by the students prior to laboratory sessions. This process will better engage the students in the experimental process and thus increase student learning in these laboratory courses. Specifically, this project will develop 5 interactive laboratory modules, one per laboratory session for one-half of the experiments for MAE 405. Each module would include the following elements:

- (1) A review of the theoretical principles to be applied in the particular experiment(s): The students will have previously been exposed to these principles in the course associated with this laboratory, so the module would provide an interactive review of the material.
- (2) Examples of the theoretical principles in real-world applications: These examples could be explained through the use of videos and/or interactive demonstration software well beyond the material currently presented.
- (3) Outline of the experimental procedure and specific safety instructions for the laboratory session. In addition, summary handouts outlining the procedure and other specific instructions will be available for the student to download.
- (4) Certification quiz to be completed by the student (on-line) successfully before the laboratory session. The questions in the quiz will test that the student (a) has reviewed and comprehends the theoretical background for the experiment; (b) knows the experimental procedure, and importantly, is aware of any safety requirements; and (c) can make scientific predictions as to the outcome of the experiment (for example, what trend(s) will the data follow, what are maximum/minimum values of parameters expected, etc.).

The students would be required to complete the laboratory module and successfully complete the quiz prior to attending the laboratory session each week. Furthermore, a procedure will have to be implemented so that students who do not pass the quiz can demonstrate that they have learned the material before the laboratory session, for example by providing written corrections for all missed or additional questions.

We have chosen to develop these modules for MAE 405 as an initial course in the MAE undergraduate curriculum for three reasons: (1) it is considered to be the most challenging laboratory course for the students; (2) it includes many non-traditional concepts from subjects outside MAE courses, for example electrical engineering; and (3) it is the lab during which the students spend the

most hands-on time. However, a key element of this effort is to develop these laboratory modules such that they can be easily transferred to the other labs in MAE 405 as well as the other undergraduate laboratory courses in the MAE department, once assessment and modifications have been made to these specific modules.

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### **7. Project Objectives:**

- Develop 5 laboratory modules for MAE 405, one module per laboratory session;
  - Implement these modules into two sections of MAE 405 for the Spring 2007 semester;
  - Perform assessment of the modules, revise as required and implement into all sections in of MAE 405 in Fall 2007.
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### **8. Estimated number of students affected:**

In the first year (2006-2007) approximately 36 students (two sections of MAE 405) will be directly affected by the proposed laboratory modules. As the laboratory modules are permanently adopted into MAE 405, however, all undergraduate students in the Mechanical Engineering degree track and the Aerospace Engineering degree track will be affected. The annual enrollment for MAE 405 is approximately 270 students per year.

In the long term, the laboratory module framework will be extended to all other undergraduate laboratory courses in the MAE department: MAE 305, 306, 357, 358, 473, 466. The combined enrollment for all of these courses per academic year is approximately 1000 students.

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### **9. Outcomes of the Project:**

The projected outcomes of the interactive undergraduate laboratory preparation modules are the following:

- Increase student's critical thinking skills. Several of the questions in the quiz will require the student to not only digest the theoretical background material but also to use this knowledge to make predictions as to what will occur during the experiment. This process of "forming a scientific hypothesis" is lacking from the current laboratory instruction, as the students are given the preparatory lecture then immediately perform the experiments.
- Increase student comprehension of background material. One purpose of the current preparatory lecture is to reiterate to the students relevant material learned in the lecture courses as a significant amount of time may have passed since they initially learned the material. Replacing the review lecture with interactive learning will potentially increase the students' retention of the material since they can work through the module at their own pace.
- Increase participation of all students in group activities. Students who are prepared for laboratory sessions and comprehend the exercise are more likely to actively participate in the experiment.
- Increase student knowledge of relevance of the laboratory courses to other course material.

- Improve laboratory safety through the requirement that all students successfully complete the quiz prior to attending the laboratory session.
  - Obtain more productive use of student contact hours. With the reduction in the preparatory lecture, more instructor time can be focused on answering student questions and providing feedback during the actual experiments.
  - Promote uniformity across laboratory sections. The large number of laboratory sections required and therefore multiple TA instructors involved can lead to significant variations in the current laboratory lectures. A unified instructional module for each experiment would reduce these variations.
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#### **10. Project impact on NCSU:**

Although the goal of this project is to develop laboratory specific modules for MAE 405, the fundamental idea is to make the framework of the modules generic, such that they could be applied to any hands-on laboratory course. Once the framework has been created, existing teaching materials from other courses, both within and outside of the MAE department could be implemented into the framework. Therefore, the modules will be made available to other departments at NCSU who wish to apply the same strategy.

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#### **11. Project Assessment Plan:**

The assessment of the proposed modules will occur during a pilot program in the Spring 2007 semester. For the assessment process we will choose several sections of MAE 405 into which we will implement the developed modules into the 5 laboratory sessions. The hands-on, laboratory portion of each session will remain the same. The use of several sections will eliminate the effect of TA variability. From each section, we will then choose a few undergraduate volunteers who will provide detailed feedback throughout the semester from representative laboratory sessions both with the interactive modules and without the interactive modules. This feedback will focus on:

- What course(s) does this lab relate to?
- What is your perception of the usefulness of this lab?
- What did you learn from this lab specifically?

Additional factual questions on the presented material may also be included. The purpose of the data collection is to measure what the students actually learned, as well as how motivated they were to learn the material and participate in the course. We will also seek input from other faculty on the material in the modules themselves and feedback from the TAs involved in the pilot program. These TAs will provide their opinions on the student and group interaction during the particular lab sessions.

Finally, we will revise the 5 modules as required and implement them into all sections of MAE 405 in Fall 2007. In the future, the other 5 laboratory experiments in MAE 405 would be integrated into the interactive learning modules to provide continuity for the course and maximize the positive impact of these modules.

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**12. Staffing and Support:**

We will hire a TA for the Fall 2006 semester to develop the laboratory modules for MAE 405. Additionally we will pay the undergraduate students who participate in the course assessment on an hourly basis.

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**13. Financial Support Requested:**

**EPA salary total:**

**SPA salary total:**

**Other salary:** \$6600

**Equipment:**

**Cost associated with assessment:** \$200

**Other financial support requested:** \$3200

**Total Funds requested:** \$10,000

**Additional Explanation of how funds will be used:**

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**14. Funding Breakdown:**

**Total funding requested for fiscal year 2005-2006:**

**Total funding requested for fiscal year 2006-2007:** \$10,000

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**15. Staff Support and/or Technical Support Requested:**

We will require approximately 80 hours (@ \$40/hour) of LTS staff technical support to assist us choosing the appropriate software(s) for the project and training the TA in these softwares. Dr. Klang has considerable experience in using web-based class assignments and grading, however we will need additional expertise in the optimum selection of different tools and their implementation into the modules. The project coordinators will work in collaboration with the TA on the project and will therefore work closely with the LTS staff and TA during this phase, making decisions on the format and testing the developed modules.

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**16. Timetable for Implementation:**

Fall Semester 2006 - Training of TA, development of 5 laboratory interactive modules

Spring Semester 2007 - Implementation of developed modules into several MAE 405 sections, collection of data for assessment of student learning

April-June 2007 - assessment of student learning and revision of laboratory modules

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**17. Human Subjects Protection:**

If your proposal project involves research using human subjects, you will need approval from the Institutional Review Board for the Protection of Human Subjects in Research (IRB) prior to final approval. IRB information is available at <http://www.ncsu.edu/sparcs/irb>



**18. Proposal Release:**

By submitting this proposal the applicant grants the LITRE Advisory Board permission to make this proposal available as an example for future grant applicants. All personal information will be removed if this proposal is used as an example.

