Project Proposals (WD1)
ME421 Mechanical Engineering Laboratory
Fall Quarter 2008-09

What. Write descriptions of three potential ME421 experimental design projects in which your team is interested.

- List the projects in order of preference.
- Type this deliverable using the template provided.
- Your supervisor will select your project from this list.

For each description, include

- A project title that captures the essence of the goals and potential results
- The "interesting question" the experiment addresses (i.e., the experiment motivation). Experiments are expected to answer interesting questions that go beyond mere measurement. The answer to your "interesting question" is generally not the thing you measure directly.
- A project description that describes the scope of work and potential methods

How. Model your project descriptions on the examples provided. To develop original ideas, consider the following:

- Brainstorm with your team on possible interesting questions you can answer experimentally. Co-op experiences or one of your previous courses may suggest interesting problems.
- The following triggers may help your brainstorming. Consider experimental projects that accomplish one of the following tasks:
    - Develops a theory/model.
    - Verifies a theory/model.
    - Develops an experimental result of interest to an engineering designer.
    - Develop an experimental system to solve a problem
- Before writing, talk to your instructor and consult with other faculty and technicians about taking your basic ideas from concept to implementation.

What happens if more than one group selects the same project?

- Some of the projects can be done in parallel by multiple groups.
- Others can be carved up so multiple groups do different parts.
- Others can only be done by one group. In this case, the faculty pick the group and ask the other groups to select another project.

Sample Proposals

Sample 1

Title: Experimental comparison of the coefficient of restitution of three types of golf ball

The interesting question: Manufacturers of expensive golf balls claim that you get your money's worth in longer drives. Is there any evidence to support this claim? Inquiring minds want to know!

Project description: Consistent with PGA test standards, experimentally determine the coefficient of restitution of three golf ball varieties: an expensive men's ball, an inexpensive men's ball, and a women's ball. Apply appropriate statistical techniques to determine if the differences among the three balls are significant. Since PGA standards require the ball to travel at 100mph, an apparatus will have to be designed that can be operated safely and such that reliable velocity measurements before and after impact can be made.

The interesting feature of this project is that the team develops a result of interest to a designer (the golf ball manufacturer's competitors, for example).

Sample 2

Title: Assessing the uncertainties associated with numerical integration

The interesting question: Numerical integration is a technique commonly used in analyzing experimental data. How does one apply uncertainty analysis techniques to a numerical-integration data reduction and how do the resulting confidence intervals compare to those associated with non-integration data reductions?

Project description: Determine the linear velocity of a pendulum bob based on simultaneous measurements of the normal and tangential components of acceleration. In the first method, based on the normal acceleration measurement, velocity is computed using

$$v = \sqrt{r a_n}\ .$$

In the second method, based on the tangential acceleration measurement, velocity is computed using

$$v = \int a_t \, dt\ ,$$

where the numerical integration is the data reduction equation. Determine if either method produces a superior experimental estimate of velocity $v(t)$. Compare the uncertainties associated with the two methods.

The interesting feature of this new project is that depending on the practical use of the acceleration data, we might be developing new theory, verifying a theory, or developing an experimental result of interest to an analyst of experimental data.

Sample 3

Title: Hysteretic Heating of cyclically loaded polymers

The interesting question: What parameters are important and what are the safe levels to prevent failure due to hysteretic heating?

Project background and description: One issue that is relevant to the fatigue life of polymers is the hysteretic heating that can occur with cyclic loading. Because of the time dependence of the stress-strain response, the unload stress-strain line does not fall on the load line. Therefore not all the energy of deformation is recovered elastically as with metals. The "lost" energy goes mostly to heat. Because of the poor thermal conductivity of polymers, the heat can cause a temperature increase. Since the properties of polymers are highly temperature dependent, this can result in property degradation and premature failure.

A designer would like to know what combination of conditions would be likely to cause problems for the design. Since the heating is likely to be dependent on multiple factors, possibly including amplitude of loading, frequency of loading, geometry of the part, material, and time, a Design of Experiments approach may be useful in characterization. The relevant variable to be measured would be temperature or temperature profile.

Sample 4

Title: Setting optimal conditions for injection molding

The interesting question: The tabletop injection molder in the Manufacturing Laboratory has several adjustable parameters such as pressure and temperature. Significant trial and error is needed (with attendant waste of material) when new materials and molds are introduced.

Project description: Develop a means to model the important parameters and provide quantitative guidelines for users of the machine. A Design of experiments approach would be a natural for this project since analytic modeling would be particularly challenging.

Sample 5

Title: Verification of Residual Stress measurements

The interesting question: Residual stress is a problem in design because it can't be easily detected and can act to reduce or eliminate the safety factor. A variety of methods are used to detect and quantify residual stress. A designer would like to know how reliable and quantitative these methods are.

Project description: Develop an experimental method to quantify the uncertainty in a particular method of residual stress measurement.

Sample 6

Title: Experimental Modeling of a Hinge Failure

The interesting question: Recently the hinges on the racquetball court doors at the SRC failed, probably due to fatigue crack initiation and growth. On area of the investigation that is incomplete is stress analysis. One of the tools that a failure analyst uses is testing, either of the actual parts or a model.

Project description: We would like to develop and characterize a model hinge for stress analysis. Characterization would involve quantifying the accuracy and repeatability of the model. Possible tools for experimental stress analysis in this circumstance include strain gages and photoelastic methods.

Sample 7

Title: Experimental System for Topographic characterization of the human breast.

The interesting question: Because the human breast is viscoelastic soft tissue without skeletal support, medical practitioners and researchers have significant issues with repeatedly finding specific locations (such as tumors) or characterizing shape and material properties. Dr. Olsen would eventually like data on the range and distribution of the geometry of the human breast.

Project description: As a first cut, we need an experimental system that is capable of characterizing topography for a range of material properties. For example, the measurement of the dimensions of a block of jello is problematic when done with a caliper. We also need a system that will accomplish the task in a reasonable time frame (a manual coordinate measuring machine could be very accurate, but slow). Given the time constraints of ME 421, a 2-D approach is the likely place to begin.

ME421 ME LabCM ____________
Members: _______________________, _______________________, Team No. ____________

_______________________, _______________________. Date ____________

Project Proposals (WD1)

Project 1 (first choice):
Title:
The interesting question:
Project description:

Project 2 (second choice):
Title:
The interesting question:
Project description:

Project 3 (third choice):
Title:
The interesting question:
Project description:

(an electronic version of this document is available to use as a template)