

## ***Final Project: Overview***

### **Your Strobe Lab Project**

A major component of your activity this semester your Strobe Lab Project. This is your opportunity to select a real world problem to work on, to figure out how to solve that problem, to conceive and implement experiments that will yield the data necessary to formulate a rational solution, and—through the project report—to communicate what the problem was, what you did, how you did it, and what your results were. You will demonstrate that your group knows how to select a project, devise a set up, trouble-shoot and debug, and execute a substantive lab project with minimal guidance from the course staff.

### **What are the ground rules?**

The final project must be a *substantive* project that usually involves some form of *imaging*. Notice that the imaging need not be of high-speed phenomena. Time-lapse, for example, is quite acceptable, as are other photographic and videographic techniques.

By *substantive*, we are looking for a *quantitative* effort, one that requires laboratory measurements to gather data. The focus can be on the data gathered, *or* on developing the process that allows data to be gathered.

Your project topic must be cleared through the course staff to insure that we agree that it is substantive. Topics tend to be complex—try to distill yours down to the minimum components that satisfy the above criteria. Then, time permitting, you can add back complexity.

### **What is the time-line and deliverables?**

The *Mark I* work is a proof-of-concept, or feasibility study. The goal is to take two weeks to show that you can carry out the key piece of the experiment. For example, suppose your project is to study the flow of people through Lobby 7 as classes change. Then, for Mark I, you would like to capturing a small set of images (perhaps a short video sequence) and demonstrate that you can track how people moved across the Lobby, including where they entered the space and where they leaved the space.

#### *Mark I*

- Lab work over two weeks (Oct. 26 – Nov 4)
- Mark I report has written and oral component, both are group efforts. Oral component is due Nov 16 (Strobe 1-3) & Nov. 18 (Strobe 4&5), the written component is due Fri. Nov. 20.

#### *Final Project*

- Lab work begins week of Nov. 9
- Written component of final report (group effort) is due the last day of classes (Dec. 10), but there is no penalty if it is up to 24 hours late.
- Oral component of final report (group effort) presented during last 2 lectures  
Strobe 1-3 present on Dec 7--Strobe 4-5 on Dec 9.

**What do we expect from you?**

At the end of the term you will turn in your project report. The report will usually contain two or more significant *graphs* of information you collected as well as sketches of your experimental set-ups, and an indication of the equipment used. This information will make it possible for any competent engineer to reproduce your work and achieve exactly the same results you did. There will be a class presentation of your results, including graphs and photographs as appropriate. Grades are based upon demonstration of having done good work, not upon pounds of paper.

**Two examples.**

- A. You decide to build a system that automatically performs the fine adjustment of circuit boards to produce a given spectral output from an electronic flash. This might consist of a computer-driven system that fires the flash, measures the spectral output, recommends changes in circuit components, and then iterates the procedure.

*Would a great difference between the desired and actual spectral output guarantee that you flunk the project? **Not at all!** We are far more concerned with the quality of approach and technique employed in your practical work than whether it works or fails in the first breadboard version.*

- B. How about the problem which at first appears to be entirely qualitative in nature and therefore is not a suitable selection by the above rules? An example might be “Photography of Bullets Penetrating Cardboard.” Bang, Bang - just another batch of pretty pictures! But, rethink the topic slightly. However, our synchronizer is not very precise in setting the position of the bullet when the photo is taken. How about working up a “precision synchronizer” to take the picture. A series of tests experimentally determines, say the (graphable) “precision as a function of bullet velocity.” The goal of the experiment is now slightly be altered to determine the velocity of cardboard particles as a function of bullet position during penetration. Note that this requires additionally an accurate determination of DISTANCES as well! Most qualitative projects have the necessary quantitative supporting elements, and the “pretty pictures” still will results, but as the final application.

**Some project ideas:**

- 1) Capture hard throws, catches, or blocks of a frisbee as in ultimate frisbee.

Prof. Seth Teller writes, “In ordinary photos I have seen significant deformation of the frisbee itself, and of the thrower's hand, wrist and forearm during throwing, and of the hand during catching. High-speed might capture provide some measurable quantities about release speed, impulse force imparted to the hand, etc.

- 2) High-speed studies of athletic events (e.g., archery, golf, football, baseball)

- 3) Use high-speed video to create instructional videos for 8.01

- 4) Water drops can be made to flow up hill on an inclined ratcheted surface.

<http://www.uoregon.edu/~linke/dropletmovies/>

Is the motion of the drop reproducible? Does it vary with density, viscosity, or specific heat?

5) Use the Wiimote as a remote data collection device. Use high-speed video and multiframe photography to validate the data from the Wiimote.

Prof. Brian White (of U Mass Boston) notes:

The Wii has an capable and easily interfaced remote unit for game. It is a handheld device with bluetooth capability that has:

- 3-axis accelerometers that sample at 100hz and read in g's directly.
- high resolution 100hz refresh IR-video camera

There are free pieces of software that interface with the "Wiimote" The Wiimote is cheap - about \$40 retail. (<http://sourceforge.net/projects/darwiin-remote/>). Some specs and cool projects are at <http://www.cs.cmu.edu/~johnny/projects/wii/>

I've been playing with this and it is way cool. You could do standard experiments and then integrate the  $a(t)$  to get  $v(t)$  and  $x(t)$ . I had my son put it in his sock and measured the "g's" as he did a somersault. You could do the same on a bike, car, or baseball bat.

6) The D200 camera (used in Lab 5) can conduct time-lapse images. You might find an interesting application of time-lapse photography.

7) Dr. Michael Long, of Brain & Cognitive Sciences wants to capture a repetitive motion by a squash player to study how we learn motor skills. He writes:

"Humans are capable of learning a wide range of complex motor movements in which timing is critical for success. Examples include playing an instrument, driving a golf ball, or using spoken language. My goal is to use high-speed video to capture an example the temporal precision involved in a complex learned movement - hitting forehand drills in squash. Beginning squash players often have trouble executing a precise forehand, while experts can do this easily. The project would involve filming local squash players across a variety of skill groups to quantify the variance involved in repeated swings, and analyze their motions with motion analysis software available at the Edgerton Center."

Here are a variety of topic titles from past years which may serve to stimulate your thinking. Do not feel in any way LIMITED -- they are intended only to be starting points. Discuss with me and/or the TA what you want to do, so that we agree that your work will be substantive and mutually acceptable.

### Some Past Projects

- Stereo Time-Lapse Imaging
- HSV studies of gymnastics
- Methods for Imaging Flying Insects
- Precision timing for bullet photography.
- Creating *Matrix*-Like Special Effects
- Dynamics of an Eye-Blink
- Shooting Pencils through Plywood
- Crashing Corks at Mach 0.5
- Photographing the Satellites
- Rock Fracture Videography

- Animating Stroboscopy wheels
- Three-D Multiflash photography
- Precision timing for Bullet Photographs
- Optical Triggering and Compression Studies
- Momentum and Friction of a Pool Table
- Measuring the Velocity of a Bullet using a Ballistic Pendulum
- Measuring the Velocity of Cracks in Glass
- Muzzle Velocity and Impact Force of a Paintball Charge
- Turn-On Characteristics of a Light Bulb
- The Curve Ball from a Batter's Perspective
- How a BB Breaks a Window
- Effect of Shape on Energy Transfer for an Object Dropped into a Fluid
- Effect of Viscosity on Splash Characteristics