EMCH 367 PROJECT

One of the best learning experiences that a student can have is to work, HANDS-ON, with tools, computers, and other devices. For this reason, the EMCH 367 course has a cumulative final project. This project will involve a team of two students developing a microcontroller-controlled application.

PROJECT OBJECTIVE

Throughout the labs, you have been learning how to apply microcontroller functions to various electro-mechanical systems. The project will be the application of all of these skills and the culmination of your efforts. You will work in team, just like in the lab. This will strengthen your team-working aptitudes, since the grade will be shared equally by the team partners. You and your partner will develop the project idea and submit a brief proposal prior to the start of the project period. The instructor and student will iterate on the project idea until a suitable project is obtained.

HOW THE PROJECT WILL WORK

First, you must develop an idea. The idea can come as an improvement to an existing device through the use of microcontrollers (I'm sure that you can think of a few) or a process which may not have able to have been done before microcontrollers. We listed examples of both on the first day of class. For each idea, there are four conceptual aspects that must be specified:

1. HOW CAN A PROCESS BE CONTROLLED USING A MICROCONTROLLER:

Microcontrollers have a large amount of control capability. Most processes can be controlled through a combination of a microcontroller and external circuitry. The essential aspect in relation to the project is to figure out how it should be done. Two steps must be considered: measuring external events, and acting on the judgments of the microcontroller to reach the project objective.

During the course of the class and lab experience, you will learn many aspects of data acquisition and communication. These include time measurement (using the input capture functions), time scheduling (output compare function), parallel communication, serial communication, and measurement of analog signals (A/D converter). By using a combination of these tools, the microcontroller can determine a lot about its environment. Similarly, the output compare, parallel communication, and serial communication can output different signals. These signals, through the proper use of circuitry, can be translated to useful control over external devices such as motors, magnets, pumps, etc. In this manner, the microcontroller can become a valuable measuring and control tool. Discussing potential project ideas with your TA will help.

2. WHAT MAKES THE USE OF A MICROCONTROLLER BETTER THAN THAT OF A PHYSICAL SYSTEM:

Now that you have determined that a microcontroller can control your desired system, the following question arises: why would someone want to use a microcontroller for your system? Some things can be performed very well using only physical mechanisms (door handles, for example). Why would someone want to improve upon that by using a computer control? (This is done in a variety of places....) What benefit does the use of the microcontroller bring? The answer can be rather complex. A few examples are:
Rapid learning -- smart machinery can learn a new process by being shown once
Record keeping -- how many Snicker's bars were bought? when do we run out?
Fast response -- try making anti-lock braking without a microcontroller

Discussion about the system qualities that can be improved by using a microcontroller will be also emphasized in the course. Do not hesitate to talk to the instructor and TA's about this.

3. HOW CAN THIS PROCESS BE SIMULATED:

We have very few external resources for this lab. We can't buy a car because someone wants to do an anti-lock braking system. Moreover, this is a microcontroller project, NOT A PROJECT INVOLVING THE UNIVERSITY OF SOUTH CAROLINA MACHINE SHOP. We have a number of simulation tools including Lego, Erector Sets, etc. to model physical systems. We have a number of pumps, motors (stepper and DC), digital display chips, LED's, IR emitter-detectors, potentiometers, cermets, etc. Using some combination of these tools, you should be able to simulate the process. YOU ARE REQUIRED TO BUILD ALL CIRCUITRY ASSOCIATED WITH YOUR PROJECT. A brief list of available circuitry is shown below:

- Breadboards
- LED's
- Buffers
- 7-Segment Displays
- IR Emitter-Detectors
- Piston Pumps
- Logic Gates
- Capacitors
- Comparators
- Potentiometers
- DC Motors
- Solenoids
- Wire
- Resistors
- Miscellaneous Chips
- Stepper Motors
- Mosfets
- Transistors
- Other Parts

You will be building the external circuitry to the microcontroller. OPTOISOLATOR, 8-PIN LED DISPLAYS, AND ANY OTHER PROTECTION CIRCUITRY IS REQUIRED TO STAY IN THE LAB. If you let the instructor know of a desired part that is not available early enough, there is a possibility that it can be ordered or purchased through a local distributor. Don't hesitate to discuss simulation ideas with your TA.

4. IN WHAT WAY DOES THE MICROCONTROLLER “THINK”:

This is what separates the projects from the labs. In the labs, you develop tools and learn one simple application. In the project, you combine the tools developed in the lab and develop a methodology for the microcontroller to make intelligent decisions. A SWITCH DOES NOT MAKE INTELLIGENT DECISIONS. If I switch on a light switch, that requires very little microcontroller thought. If I switch on a light because I detected motion, and can then follow and more or less predict the direction of the
motion, then it is no longer a simple switch, but a complex device making intelligent decisions. After determining the relevant parameters in the environment by making whatever measurements are necessary, the microcontroller must determine the condition of the surroundings. Are the measured parameters within tolerances for whatever process is being controlled? If there is an immediate problem, the microcontroller must act to try to correct the problem immediately.

What about the "long term" control? The best way to control a process is to correct for problems before they occur, to react to indications that a process may be heading in the wrong direction, and thus prevent any immediate problems from occurring. The microcontroller is especially adept at performing these predictive activities. With memory to store the results of the past measurement, the microcontroller can quickly compare data points and determine trends. Based on these trends, the microcontroller can predict the state of affairs at a future time. This is often referred to as extrapolation. By extrapolating over very short time periods (the microcontroller can do this on the order of millionths of seconds), the microcontroller can obtain a very good approximation of future behavior. It can then act to maintain the desired external conditions. By comparing the effects of its actions and the behavior of the environment, the microcontroller can gage its progress in maintaining the control of the external system. This is one of the primary reasons that people use microcontrollers. THEY THINK!!!! Your project must think, as well.

PROJECT PROCEDURE
The following are procedural aspects of the project: getting partners, writing a proposal, project presentation, and project report.

GETTING PARTNERS:
A project is, by definition, more involved than a laboratory exercise. As such, students will be allowed to work in teams of two. In order to ensure that the teams are developed early enough for the students to start discussing the project and developing ideas. The project teams should be emailed to the instructor by the deadline shown in the Schedule section of this document. Any student not able to form a team by the end of class on that date please contact the instructor by email to request the assignment be done by the instructor ex officio.

WRITING THE PROJECT PROPOSAL
Before going into full development work for the project, a proposal is required. A long, drawn out doctoral dissertation is not expected or desired. All that is necessary is a short description of the project idea. Show why a microcontroller would be good for this process, how this project is not a simple "switch", and how the microcontroller "thinks and takes decisions". Ideas for simulation are helpful, but not required. The purpose of this is to make sure that you are thinking about the project and doing some background development. In addition, progress reports like this are often useful to organize your thoughts. It will also help you develop the list of hardware necessary for your project. To ensure that you are thinking about the project ahead of time, the project proposal is worth 10% of the project grade. The project proposal, including the hardware list, should be emailed to the instructor by the deadline shown in the Schedule section of this document. It should be noted that that this date leaves you approximately one month to do the rest of the work. It should also be noted that labs are wrapping up at that time.
**PROJECT PRESENTATION**

Formal project presentations will be organized for each group in the lab on the date shown in the Schedule section of this document. PowerPoint or transparency presentations are permissible, but the former is encouraged. The presentation should be planned to last 20 min, including real-life demonstration in the lab and questions time. Consider that any topics related to your project, even remotely, can be asked by the instructor and the TA’s. This includes both hardware and software components of the project, as well as utility, applicability, and commercialization. There is a very basic template available on the EMCH 367 website.

**PROJECT REPORT**

The Project Report should address everything involved in the project. This includes: circuit diagrams, software flowcharts, a relevant description of your program, the purpose of your project, and why microcontrollers are a good device for this process. These are all things that you should be developing through the course of the project. The preparation required for the project report should be minimal, provided you keep good notes during the project and perform it in an organized way. Examples of past project reports are available for your examination. They may be obtained from your TA. **These reports must stay in the lab.** There is also a template available on the EMCH 367 website.

**ANSWERS TO FREQUENTLY ASKED QUESTIONS**

**WHERE DO I GET PROJECT IDEAS?**

Look all around you. Microcontrollers touch each and every part of your life. Think about processes that you take for granted. Think about topics that may interest you personally, and extend the role of microcontrollers to that topic. Look at some of the suggested readings in the Class Syllabus. Talk with your TA. Talk with the Head TA or the Instructor.

**ONCE I HAVE AN IDEA, WHAT DO I DO?**

Each group will probably approach their project differently, as each project has different goals and objectives. As such, writing one clear-cut approach to doing a Micro project is not an easy task. The following are guidelines to assist you:

1) List all tasks that need to be done. Many times, it is helpful to make more lists that are detailed, as the problem becomes better defined. This also helps to organize your thought processes and productivity by letting you know where you are in terms of the final project development.

2) Look at software development. Outline all the routines that need to be developed. **Write flowcharts for the program as a whole, and for each routine.** Without some sort of organization, a code will not function. Once the flowcharts are completed, write the codes for the corresponding program segments. Use the concept of **Modular Design** for these aspects of the code development. Write the code such that debugging is straightforward. Start with a base code that works. Then add one piece at a time. Test each program segment, debugging as you develop the program.

3) Look at hardware development. Draw circuit diagrams before building your circuits. Make sure that you understand what each component does. If you have questions, **ask your TA’s for assistance.** Then, build the circuits. Using the oscilloscope, check how the circuit responds by itself. If it doesn’t work and you are burning out chips, **DON’T**
JUST KEEP BURNING OUT CHIPS!!! Ask someone for assistance. Once you know that the hardware is behaving properly, attach the system together.

**How Do I Get Assistance From my TA’s?**

TA’s are a great reference. Typically, they are available right after the laboratory period for questions. They can also be reached through e-mail. Set up an appointment with them. If they can’t find the answer to your questions, they can refer you to someone who can help. During project time, each TA has at least four hours a week of office hours. These are hours that they will be actively engaged in helping students in the lab. Although TA’s are encouraged to schedule these hours during the scheduled lab times, many offer additional times to assist students. As such, **there will be 20+ hours of TA assistance available for the class each week until projects are completed.** A complete list of times will be posted in the lab, on lab doors, etc. The obvious implication is that the earlier you get progress made on the project, the more TA help time you will have. You will not be restricted to use only your lab time. You can go to the lab every day if you wish. Project questions take priority over general questions.

**When Do I Sign Up For My Project Presentation?**

Sign-up sheets will be made available during the last week of classes. There will be a large variety of time slots available. The scheduling is on first come, first serve basis. If a group wishes to reschedule with another, both groups must agree.

**When And How Do I Get Hardware For The Project?**

After you have developed your project proposal, you are ready to get the hardware. Every group that has partners assigned and a project proposal submitted will be issued hardware based on a checkout sheet reflecting the hardware list sent by you with the Project Proposal. After the end of Lab 9, groups may start getting their hardware from their lab TA. **You are responsible for this hardware and making sure that it is returned to its proper location in the lab once your project is completed. This includes properly disassembling your project after the presentation, unless you are instructed otherwise.** Instructions for proper placement of lab equipment will be provided in the lab during the project time.

**When Is The Lab Available For Project Work?**

The lab will be available 24 hours a day from project start till project end. You will be issued the lab door access code. You must also comply with the building access procedures. This open-door policy may be restricted if improper use of lab facilities takes place. **If you are unsure about any aspect of the hardware you are using, do not use the lab without a TA!**
## PROJECT GRADING POLICY

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\[ T = \Sigma T_i \]

\[ T = 100 \]

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\[ H = H_3 \ast (H_1 + H_2) \]

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\[ LC = \Sigma LC_i \]

\[ LC = 100 \]

| Proposal Turned In On Time      | 0 or 100        | 100             |

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<td>[ F = 100 ]</td>
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