1 Introduction
An earthquake disaster has befallen Los Angeles and USC. Thankfully, we are all safe, communications infrastructure has been restored, but teaching facilities are damaged. It is not time to take a vacation. We can continue our education remotely and even use the material we’ve learned to help develop products that may improve personal safety, aid first responders, or reduce property damage in the future. You and your teammate will partner with another team to conceptualize, refine, and then develop a “proof-of-concept” prototype for a product utilizing some kind of embedded system. Your four-person team will then create a Powerpoint presentation to market and demonstrate your product.

2 What you will learn
This lab will help you expand your embedded coding skills, knowledge of embedded I/O standards, and ability to find and research components that could form the basis of your embedded product. You will grow your teamwork and independent learning skills while utilizing teleconferencing software.

3 Background Information and Notes
Course Continuity in Crisis Grant
EE 357 received a grant in 2011 to pilot the capabilities of USC to continue offering courses in the face of a disaster that precludes in-class meetings. USC has an obvious interest in continuing course offerings and not shutting down. However, a major issue is the information technology needed to support remote access and video/tele-conference capabilities. Thus, to accomplish this project your group will meet with me as well as some group meetings using remote conferencing technology. For one week of class, we will not meet in our traditional classroom, but instead meet remotely. Each team will have a 20-25 minute scheduled meeting with me during normally scheduled class time on either Tuesday or Thursday of the specified week. For these group/instructor meetings we will use Adobe Connect for video/desktop sharing and AT&T teleconferencing facilities for voice conferencing. To use these tools, use the information provided below as well as the separate handout (if provided).

AT&T phonebridge:
Call-In Number: 866-528-2256 – Then enter access code 5360058 followed by the ‘#’ sign and wait for other participants to arrive.
Adobe Connect
1. Using a wired/Ethernet connection when at all possible, go to
   http://usccst.na4.acrobat.com/redekopp/
2. Click "Enter as a Guest"
3. Enter your first and last name
4. Click Enter Room. The first time you login a download will be required.

For your own group meetings you are not precluded from some in-person meetings, but you will be **required and encouraged** to collaborate remotely at least a portion of the time using any available tools including Google Docs, Blackboard group features [file-sharing, messaging/discussion boards, etc.], video teleconferencing tools such as Skype (www.skype.com – 1-to-1 calls), ooVoo (www.ooovo.com – up to 3-person chats), etc., and any other tools you desire. The assumptions are working telephone and network connections but travel is limited. At the conclusion of this assignment you will be asked to evaluate Adobe Connect as well as provide input on what online collaboration tools your group found most helpful or unhelpful.

**Product Framework:** Your actual assignment is to ‘(re-)invent’ a product and define it to the point that a simple **proof-of-concept** device can be built and programmed using your embedded microcontroller boards. Your first task is to think of a product that may be of use during or in the aftermath of a disaster or earthquake. It can be a simple product that might protect home property loss, a device to help groups/families cope or communicate after a disaster, or a device that might be deployed in numbers to provide command and control (status) information useful to organizations or even municipalities and their first responders. Your product may already exist in some embodiment or it can be completely new. You are simply encouraged to be creative and innovative. You may want to do some research/reading/etc. on disaster preparedness or contingency plans.

Once you have settled on a product, your group will need to determine what other major components are needed. You do not need to itemize every single resistor and capacitor in the device, but for major components you should select specific parts and also determine all the signals/interfaces that will be connected to your microcontroller to implement the product. [Together you and the instructor will determine the final requirements of your design and prototype]. Deliverables for this assignment will include:

- A component list and references to data sheets for each component
- A design schematic showing what pins (PORT’s) of your microcontroller will be utilized.
- Some proof-of-concept device (may involve only I/O on your microcontroller or may include other prototype hardware connected to your microcontroller via the Tower system) that demonstrates your team’s ability to utilize the chosen I/O components
Interfacing Embedded Components: Your MCF52259 microcontroller has several serial I/O (IIC/I2C, SPI, RS232/UART, and other protocols) as well as GPIO capabilities. Many common sensors, actuators, and transceivers (including wireless modules) are available that can communicate with your microcontroller via these serial I/O capabilities. As you think of the product you’d like to design you will need to research possible components that could be included to accomplish your task. It will be helpful to visit certain websites that sell electronic devices that you may want to consider for your product. These include:

1. Sparkfun Electronics: www.sparkfun.com
2. Parallax: www.parallax.com
3. Digi: www.digi.com
4. Digi-key: www.digikey.com

In selecting components you will need to consider the interface protocols to ensure that the 52259 can in fact interface with the device. To do this you will need to learn about some of these serial protocols if they are unfamiliar to you. Online video lectures may be provided on certain protocols and online sources should also be referenced.

I/O Components to consider:

- The 52259 contains 3 serial protocol interfaces: UART (RS-232) [up to three UART’s are available in UART0, UART1, UART2], I2C [two independent master controllers in I2C0 and I2C1], and SPI/QSPI [1 controller]. These can be used to interface to other components you may want to include in your system including wireless transceivers, LCD displays, FLASH memories, certain sensors, etc.
- The 52259 has a real-time clock onboard that can perform the stopwatch functionality you’ve build on your own in the previous lab. It can main time of day at the second granularity and generate alarm interrupts or a minute counter interrupt.
- The 52259 and its ‘edge-port’ functionality can allow an external device connected to one of the edge-port (PORTNQ) pins to trigger an interrupt to occur. Thus external devices can trigger interrupts to your microcontroller.
- A wireless transceiver to communicate between two devices. These usually have some serial protocol (UART or I2C) to interface your microcontroller to the transceiver which then transmits the data with the receiver buffer data until read by the receiving microcontroller via the corresponding serial protocol. We will attempt to provide a ‘component-of-choice’ and make them available to you for prototyping.
- The 52259 has pulse-width modulation units (PWM) that can generate a high/low pulse for a specific period and duty cycle (duty cycle is the % of the period that the pulse is high). By running this through a low-pass filter (i.e. an RC circuit) a sine wave of appropriate period can be created. This could
be useful for certain sensor including ultrasonic (object/distance detection) sensors, servo motors, etc.

- The 52259 has several A-to-D converters that can be used to interface sensors to your microcontroller.

**Designing your Device:** After defining your product and what components will be needed, you should produce a schematic showing pin assignments and interfaces between your microcontroller and your selected components. You should show pertinent connections on each chip (both microcontroller and peripheral component) so as to ensure that pins are not double-booked or used in a conflicting manner. You will need to turn in this schematic as part of your assignment. The schematic should just be a computer drawn block diagram using Port names/Bit numbers as the pin labels (e.g. PORTAN[3] <-> Z-axis accelerometer).

To read about the features available on your 52259, the pin-outs of your microcontroller and the functionalities (GPIO, etc.) reference the following documents on Blackboard:

- MCF52259 Data Sheet Section 1.2 (and in particular 1.2.28)
- MCF52259 Reference Manual (and in particular Chapter 15 and Figure 15-1)

**Available Embedded Components:** To demonstrate your teams learning, you will be asked to prototype a small piece of your design. This may be writing code to read and respond to some sensor input, communicate with some device (though maybe not the one you will use in your actual design) via the serial protocols used in your design, or communicate wirelessly between two nodes. A list of parts that we can provide you for your prototyping will be furnished as the assignment progresses. Also, this course has some funding that we may use to purchase actual equipment as determined by the instructor. If you do want to pursue the purchase of equipment, you must consult with the instructor as early as possible to allow for procurement time.

4 **Procedure**

**Schedule:** Below is a general week-by-week schedule for this project:

1. Meet your team:
   - Teammate 1: Yourself
   - Teammate 2: __________________________ Contact: ______________
   - Teammate 3: __________________________ Contact: ______________
   - Teammate 4: __________________________ Contact: ______________

2. Over spring break think of possible products your team would like to design.
3. Week 1 – By the end of week 1 your team should submit an short status report/writeup on Blackboard that includes:
   - Final product selection, description, requirements
   - A general list of necessary components (i.e. a wireless transceiver, a temperature sensor, etc.)
   - A brief description of the piece of the design that you will actually prototype. This should not be too small (i.e. a re-work of something we’ve already done) nor should it be the complete system design.

   You should also begin researching specific interface technologies that you are likely to use.

4. Week 2 – No in-class meetings. Each team will meet with the instructor remotely. Modifications may be made to the requirements of your product and what piece you will actually prototype. Your group meeting time will be:

   ___________________________ T / Th

   By the end of week 2 you should have completed the following and submit another short status report/writeup on Blackboard that includes:
   - A finalized (modified from original) product description & requirements
   - A specific component list (part numbers) and a list of URL’s to their data sheets.
   - A final description of what you will prototype and what you will demonstrate to the instructor/class.

5. Week 3 – Complete the prototype and presentation (meeting the requirements below and in the grading rubric).

6. Week 4 – Your team must make a 10 minute presentation in-class that would be appropriate for a technical entrepreneur who may want to fund your product. It should include
   - An overview of the device and what it does and why it is useful.
   - A component list and general cost analysis (assume you can buy components in bulk…you can utilize electronics component vendors such as www.digikey.com or www.jameco.com).
   - A schematic/block-diagram of the design. If need be, break the schematic into several pieces to make it readable and understandable.
   - A description of what you actually prototyped
• A description of what specific protocols and/or devices your team researched, what resource you used to learn more about these protocols/devices, and a general overview of these that would help another student in the class understand and learn something that they may not already know.

• A demonstration of what you prototyped

• A lessons-learned slide should be included discussing the experience of the assignment and any lessons your team learned either technically or in collaborating remotely (what mistakes might you want to avoid or do differently if you repeated this assignment).

7. Submit a soft-copy of your report on Blackboard. You may also be asked to submit code you wrote for the prototyping portion of the assignment (check with the instructor).

8. A separate team evaluation will be distributed and needs to be completed.

9. A short survey and Adobe Connect evaluation will likely be distributed and needs to be completed.
## 5 Continuity in Crisis Project Grading Rubric

<table>
<thead>
<tr>
<th>Item</th>
<th>Wt</th>
<th>Score</th>
<th>10 (Excellent)</th>
<th>8 (Good)</th>
<th>5 (Med.)</th>
<th>2 (Poor)</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Product Selection</td>
<td>1</td>
<td></td>
<td>Challenging, innovative, and practical</td>
<td>Simplistic or impractical</td>
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<td>Presentation</td>
<td>2</td>
<td></td>
<td>High quality graphics, excellent organization, and professional presentation by the team</td>
<td>High quality graphics, average organization, and/or some teammates uninvolved or unprofessional</td>
<td>Average quality graphics and/or organization. Some teammates uninvolved or unprofessional</td>
<td>Poor quality graphics and organization. Unprofessional team presentation.</td>
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<tr>
<td>Component List</td>
<td>1</td>
<td></td>
<td>Complete with part numbers, vendors, and data sheet URLs</td>
<td>Some missing detail</td>
<td>Some missing components or lack of detail</td>
<td>Incomplete listing</td>
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<tr>
<td>Schematic</td>
<td>2</td>
<td></td>
<td>Excellent level of detail that clearly shows what connections are required between components and micro-controller</td>
<td>Good level of detail, some lack of clarity on the required connections</td>
<td>Average level of detail and/or poor clarity of required connections</td>
<td>Poor level of detail and clarity of required connections.</td>
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<tr>
<td>Prototype</td>
<td>3</td>
<td></td>
<td>Well-designed prototype that meets agreed upon requirements</td>
<td>Meets majority of requirements though some minor features may not work</td>
<td>Some major requirements are not working</td>
<td>Minority of requirements are working</td>
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<tr>
<td>Team Score</td>
<td>1</td>
<td></td>
<td>Participated well in the team, met expectations for individual responsibilities, and was responsive and open to input from the team</td>
<td>May need some growth in cooperation or participation with the team, but met expectations for individual responsibilities</td>
<td>Did not meet some expectations for individual responsibilities or lacked participation in the team</td>
<td>Did not participate with the team and did not meet expectations for individual responsibilities</td>
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**TOTAL**