**Why not change the world … for the better?**

**Team Project Description**

**Project Background**

There are many issues facing the world today where engineering design can provide solutions. This semester your team is challenged to define a project that has the opportunity to change the world … for the better. Regardless of the issue your team chooses to address and the project that you define, the goal must be to show how your ideas and proposed design solutions are an improvement over what is currently done today and how your design can help change the world for the better. Your team may choose from one of the following team project topics described on LMS:

* Biometric Monitoring and Logging
* Robotic Platform
* Sustainable Energy Generation-Collection

Other projects must be specifically approved by the instructor. Sponsored projects require approval by the course supervisor.

Together these projects encompass one or more of the following project areas:

**Sustainability:** Sustainability refers to making products and services in a way that maximizes the use of renewable resources and minimizes environmental impact. “Sustainable design” is a way of achieving sustainability with the thoughtful application of life cycle engineering principles. Proponents of sustainable design believe that the current environmental crisis is in large part caused by conventional design and industrial practices, which disregard the risks and environmental impacts associated with producing goods and services. Possible projects in this area may involve the redesign of an existing system such that it reduces or eliminates environmental impacts by substituting less harmful “environmentally friendly” materials for conventional ones. A project in this area may also be to design a system that produces energy in a sustainable fashion and reduces our reliance on non-renewable energy sources.

**Universal Design:** Universal designis a relatively new way of thinking that has emerged from "accessible design" and “assistive technology.”Such terms however primarily refer to providing a level of accessibility and assistance for people who may be mentally and/or physically challenged. Past results often result in separate and stigmatizing solutions. In contrast, universal design strives to be a broad-spectrum solution that helps everyone, not just people with disabilities. Moreover, it recognizes the importance of aesthetics and user interaction. Possible projects in this area would be to create a new system design related to a common everyday activity that has the potential of helping people with disabilities, yet appeals to a wide range of potential users.

**Design Innovation:** Our economy depends upon innovation to increase the value of products, processes, and services so that businesses can make a profit. The term innovation may refer to both radical and incremental changes. While innovation is typically thought of as a positive thing, it may also have negative impacts as new developments displace the old. Organizations that do not innovate effectively may be destroyed by those that do. Hence innovation typically involves risk. The goal of innovation, like design itself, is to solve a problem in a way that provides greater value at less cost. Projects in this area may stem from a combination of creative ideas that the team considers potentially innovative. The challenge for the team will be to convince others that the idea is truly a design innovation that is genuinely new, useful, and better than what is currently done today.

**Public Service:** Engineers must learn that our work may also have public service elements. Whether funded by corporate or industrial companies or philanthropic foundations, projects may be targeted for and designed to meet the needs of those without direct access to engineering services. These projects may focus on assistive technologies for the physically challenged or may help bring technology to emerging economies or might be in support of the various green initiatives.

**Project Objectives**

Regardless of the team project / area(s) that your team chooses to address, the main objective is to design, analyze, build and test a working system prototype. It is the responsibility of the team to define a specific problem related to one or more of the themes outlined above and develop a concept solution. Important considerations for system design and development include the following:

***Customer Focus***

It is the responsibility of the team to clearly identify the potential users of their system design and show how it meets the needs of the customer. Teams will be given extra credit for system prototypes that receive direct user feedback regarding the positive and negative elements of their design.

***System Specifications***

An effective engineering design will define system specifications that are a direct translation of customer needs. To the extent that it is practical, system specifications will be quantifiable and lend themselves to analysis and test.

***System Integration***

Your system prototype should consist of modular subsystems that can be analyzed and tested independently and then integrated into a complete working system for simplicity, ease of testing and troubleshooting, and for clear task allocation among team members.

**Project System Design Teams**

The trend in modern design practice is toward ever increasing integration of engineering disciplines to tightly link the performance of individual subsystem elements. Your instructor(s) will organize project teams that will be responsible for developing a system concept design solution to address the problem area that you define. The project team will identify the necessary subsystems (modules) with each team member taking ownership of a subsystem. Each team member will then follow the complete design process for their subsystem, i.e. design, build, and test. The team will then integrate and test the subsystems to form and demonstrate the complete project. This will place an obligation on each team member to communicate with the others and to establish interface standards.

Design of complex special purpose connections and interfaces should generally be avoided and done only with the prior consultation of your instructor. Connections between modules should be through standard “off the shelf” electrical, mechanical, and/or software interfaces. The overall system design should seek to minimize the number of interfaces and dependency between major functional subsystems elements. Each subsystem must be thoroughly designed, analyzed, built, and tested. Analysis and test will establish the robustness of the design and confirm that the design will work reliably.

Project features should be testable as a sub-system or module prior to system integration. Testing should demonstrate key features of the design or be used to collect data that forms the basis of key design rules or operating logic. Each team should consult with their instructor regarding experimental test plans. It is anticipated that several different experiments may be required during the design process.

In line with modern engineering design practice, you are encouraged to use engineering analysis to predict and specify design details prior to prototype construction and to incorporate standard components and processes wherever possible.

**Project Timeline:**

The project will be managed and assessed by the achievement of a series of milestones. The timing for these milestones is established in the syllabus. These milestones will consist of the following:

***Milestone One: System Concept Proposal***

There are two deliverables for this milestone. The first is a PowerPoint presentation by each team of a clear system concept and a proposed project plan during an oral design review with the class. The presentation should explain the problem statement the team is addressing, some examples of benchmarking against available products / technology, information and sketches on the proposed solution and how the team’s solution is unique. You will have 15 minutes for the presentation and 5 minutes for Q&A.

The second team deliverable is a written proposal in the form of a concept memo. Each team member is to write a portion of the memo. Individual modules and their design owners must be clearly identified at this stage of system development. Note: The proposal is not simply a collection of writings of individuals, but should be edited as a comprehensive and contiguous statement of the proposed project. The concept memo should be 5-15 pages in length including a project plan and sketches / illustrations of the proposed project. The “concept memo template” is provided on LMS.

Your instructors may reject your proposal if the system concept is not strong enough or if the project is perceived as trivial / too simple or if the proposal is a repeat of readily available products / technology. Teams with a rejected proposal must work with their instructors to quickly create a new and acceptable proposal.

***Milestone Two: Prototype Demonstration***

For this milestone your team will give a demonstration of your *working* functional prototype design showing it *in operation* and will answer questions on its operation. The demonstration should give the audience a clear understanding that the subsystems in your prototype actually work and meet their functional specifications. The team does not need to explain the design or operation of the project as that will be covered in Milestone 3. There will be a peer evaluation of the demo. You *may* distribute a one page handout describing the salient features of your design and/or how you will demonstrate them. PowerPoint or poster presentations are not required. You will have up to 20 minutes for the demo including setup / removal and Q&A.

***Milestone Three: Design Review and Documentation***

There are two deliverables for this milestone. The first is a PowerPoint presentation based on the technical contents of your final report as well as on the Professional Development aspects (i.e., MBTI, Conflict Resolution, Giving & Receiving Feedback, etc.) and how these tools impacted your team development. You may include video clips to enhance your presentation. The presentation should be submitted electronically to your instructor prior to class. Emphasis should be on the work done since the system concept proposal. There will be a peer evaluation of the presentation based on milestone #3 guidelines. Each team will have up to 15 minutes for the presentation and 5 minutes for Q&A.

The second deliverable is a written technical report. A template (“IED-PD1 Final Report Template”) is provided on LMS. The template includes instructions on how to complete the report, what information is required for each section, etc. The report is typical of that used by industry for the technology transfer aspect of projects. It provides the final documentation for the project and would allow others to understand and perhaps repeat your work or use it as the basis for their own developments. It should be complete in and of itself. The reader should not require your concept memo, demonstration or presentation materials to understand the report.

The **final report is due in electronic form** to your instructor by the date shown on the syllabus. A hard copy may also be required at your instructor’s discretion.

**Grading:**

Your team system design project contributes to 50% of your overall course grade with the following point distribution:

Milestones One: System Concept Proposal  10%

Milestone Two: Prototype Demonstration  15%

Milestone Three: Design Review and Documentation  25%

Your IED/PD-1 instructors will assess your individual contribution to the team project. This will be based on their observations during class time, during shop/lab time, office hours, and on the end of semester peer evaluation submitted by your team mates.

Depending upon your individual contribution to the team project effort, your individual percentage of team assessment points may be adjusted accordingly (either up or down) based upon an ICF (individual contribution factor) that will be assigned to individual members of the team. The ICF for an individual member of a team may be less than, equal to, or greater than 1.

**Project Guidelines and Constraints**

Each team is expected to follow a standard set of design guidelines and constraints that include specific directions on prototype fabrication. In general, these guidelines are to help simplify the project’s fabrication / construction aspects, reduce costs and to ensure safety.

1. All project teams must follow the School of Engineering General Safety Rules and Operational Policies for Manufacturing and Prototyping Areas. Questions and concerns related to safety should be brought to the immediate attention of your instructor.
2. Ideally, major functional elements of the system should be presented in self contained modules or subsystems. The overall system design should seek to minimize the number of interfaces and dependency between major functional subsystems elements. Design of complex special purpose connections and interfaces should generally be avoided and done only with the prior consultation of your instructor. Connections between modules should be through standard “off the shelf” electrical, mechanical, and/or software interfaces.
3. Project features should be testable as a sub-system or module prior to system integration. Testing should demonstrate key features of the design or be used to collect data that forms the basis of key design rules or operating logic. Each team should consult with their instructor regarding experimental test plans. It is anticipated that several different experiments may be required during the design process.
4. The final system configuration should be easily transported and operable on a table top. A system weight of less than 20 pounds is recommended. The final system should nominally fit within a 24”D x 36”H x 36”W rectangular envelope (excluding the external computer) unless approved by your instructor.
5. Use of liquids requires the prior approval of your instructor. If used, the amount of liquid in the final system design should be less than 1 gallon and be non-toxic and non-staining. Disposal of liquids must follow School of Engineering shop operations safety guidelines.
6. The use of welded connections is discouraged and requires the approval of your instructor.
7. Teams should select from the following list of recommended structural materials for their projects:
   * PVC or plastic pipe nominal 2 inch or smaller
   * Square aluminum tube no larger than 1.0 inch by 1.0 inch outside dimensions
   * Round aluminum tube no larger than 1.0 inch outside diameter
   * Steel tube known as EMT (sold in electrical sections of stores) no larger than nominal 1 inch
   * Flat aluminum bar stock no wider than 1 inch
   * Aluminum angle stock no larger than nominal 1 inch.
   * Plastic sheet ¼ inch thick or less
   * 80/20 series 10 modular aluminum extrusion or equivalent
8. You are restricted from altering radio wave emitters such as those used in microwave ovens. If your design uses radio waves, the transmitter and protection provided to shield the user from such waves cannot be altered in any way.
9. Computer based control (including micro processors) can be accomplished using hobby level microcontrollers such as the Arduino, Mobile Studio board, the 8051 board used in LITEC, Cypress PSoC, Basic Stamp or OOPIC or by using PC based software such as Visual Basic, C/C++, MATLAB, or LabVIEW as a data collection and control platform. Laptop data acquisition cards or devices that interface with LabVIEW are available for loan through IED. USB devices that link to other languages are planned for acquisition. Mobile Studio and USB devices can also be purchased by a team member for low cost and can be later used by that team member for other project work.
10. Where possible / practical, teams should select from circuit designs that are documented and presented in the Radio Shack Electronics Laboratory and the Radio Shack Sensors Laboratory. Several of these circuit kits are available for preliminary testing of circuit performance. After preliminary testing, the team will be required to purchase the raw electronic parts for assembly on proto-boards for full subsystem testing.
11. Teams should select from a standard list of motors that will be provided for use on projects whenever possible.
12. The cost of project materials is the responsibility of the team. Teams should establish a budget and procedures for monitoring costs. It is expected that all team members will equally share in the project costs. The typical investment per student is expected to be in the same range as the typical cost of one-two textbooks.
13. The Design Lab’s Fabrication and Prototyping Area will be open and available for IED students to use during regularly scheduled lab hours. IED TA’s will be assigned to this area for assistance with shop related services. Please see your IED TA’s for help with shop related services.
14. Water jet cutting, plasma cutting and rapid prototyping services are available for students to use on projects. Teams should plan for a 7 to 10 day turnaround time for these services. The forms for these services can be found on LMS.
15. Lithium ion batteries are not permitted in the circuits designed and built by your team. As you are, by definition, building a proof of concept prototype, you must select an alternate battery technology for your device. Lithium ion batteries that are an integral part of personal electronics or other purchased devices may be incorporated in your design. In the case of a purchased device that has a lithium ion battery inside, your project may not draw power from that battery unless it is from a USB port already built into the purchased device. For example, the following IS permitted – powering an Arduino from the USB port in a Lithium Ion powered commercially available laptop/tablet/phone. The following examples are NOT permitted: (a) opening the packaging on a commercially available device and adding a power connection to the Lithium Ion battery inside it and (b) designing and building a charger for a Lithium Ion battery.