Count Every Drop, Because Every Drop Counts

**Final Project Presentations: 5/1/2019, 4-6pm, CETA**

The intent of the group project in EG110 is to enable you to practice the engineering design process, creative problem-solving, teamwork, project management, as well as to learn and apply new technical skills.

The structure of this project is designed to encourage creative design and to challenge you to explore technologies, to learn new skills, and to engage in fruitful discussions with faculty and staff. This project will provide opportunities for you and your team to research, learn, and solve many problems on your own. *Your instructors are resources but will rarely provide the answers or a solution. Instead, we will provide guidance, which sometimes will be in the form of asking your team additional questions to help you overcome a hurdle or to assess your progress and your ideas. We view this project as a valuable opportunity for you to truly immerse yourself in the engineering design and the problem-solving process.*

The research step in the design process will be done individually. Team formation will occur after the initial idea generation, to help the team get to a starting point of rich discussions, with all team members sharing ideas and teams determining which ideas to develop and assess for potential products.

You and your team will continue to follow the engineering design process and utilize tools and skills, learned through reading and practiced in class, to assist you and your team in achieving milestones and deliverables. While working on this project and practicing the engineering design process, *you will gain an appreciation for following the process and the importance of following a plan.* You will learn project-specific engineering jargon and engineering and technical skills, as well as practice and refine your teamwork, leadership, project management (time and budget), communication and presentation skills.

We will guide you through the engineering design process and provide feedback that will help you learn and improve.

*You will be working on an authentic project with a real-life problem! Your solution has the potential to positively impact society! Keep this in mind as you work along, and focus on the user and on the benefit of your design. Let the need for a solution be an inspiration to you and your team and a force that will help you overcome obstacles and persist in the problem-solving process.*
Project Description

Safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes. Improved water supply and sanitation, and better management of water resources, can boost countries’ economic growth and can contribute greatly to poverty reduction.

In 2010, the United Nations’ (UN) General Assembly clearly recognized the human right to water and sanitation. Everyone has the right to sufficient, continuous, safe, acceptable, physically accessible, and affordable water for personal and domestic use (Organization, n.d.).

Every day in rural communities throughout sub-Saharan Africa (the geographic area in Africa that is south of the Sahara Desert), millions of people suffer from a lack of access to clean, safe water. For school-aged children it’s a burden that traps them in poverty. Globally, 1 in 9 people still have no access to clean water (Project, n.d.). But in some places in the world, it’s 9 out of 9. Clean water supply is a daily and crippling challenge.

Without water you can’t grow food, you can’t build housing, you can’t stay healthy, you can’t stay in school, and you can’t keep working. Figure 1 provides a glimpse into some of the economic and demographic statistics in sub-Saharan Africa (Nations, n.d.). As shown in Figure 1, by 2020, the predicted number of Africans that will face water shortage can reach 250 million.

Children often bear the burden of walking miles each day to find water in streams and ponds, full of water-borne diseases that are making them and their families sick. Health issues and the time lost to seek and retrieve water robs entire communities of their future.

But the water crisis can be solved. Because it is such a critical world issue, many groups are working on solutions for different countries, settings, and specific water-related issues.
EG110 is joining the water quest and will work collaboratively with the Water Project (https://thewaterproject.org/) in Concord, NH, to provide a solution to one community in sub-Saharan Africa, specifically in Kenya.

Your work will help the Subane Primary School community in Kenya ensure that clean water supply is continuously available for students and staff. This community is located in an area that experiences regular rainfall and collects water using a water catchment structure similar to the one shown in Figure 2. The water flows down a roof and is then collected in the concrete tank, shown in the picture. The collected water serves the school community.

Several problems with water management and quality require your attention. **First, there is a supply management issue.** No monitoring system is available to indicate to school staff how much water is in the tank. This is a problem because there is no way to know when the water level is low, which can help staff determine when to enforce water consumption rationing in order to stretch the supply until the water level increases when it rains again.

**The other problem relates to water waste through the faucet** (see Figure 3). Students using the faucet do not always fully close the faucet, causing precious water loss. Solving this problem can save badly needed water from being wasted.

**Another engineering design problem relates to rainfall data collection.** Currently, there is no data-collecting system that can provide information, statistics, and trends on rainfall in the area. This knowledge is desirable as it can help establish rainfall trends and patterns and roof cleaning procedures.

Lastly, water safety is an issue. Being collected from roofs and gutters, water does not necessarily meet clean water status as determined by several water governing bodies. Levels of microbacteria need to be measured to help school staff determine when to treat the water.

Your solution will help the population transfer from dangerous open water sources to a clear protected and monitored water source. It will allow children to focus on their education, and remain healthy.
Challenge

Your team challenge is to develop a prototype solution to one of the three following problems:

- Identify and implement methods to continuously measure and display the amount of water in a collection water tank.
- Identify and implement methods to monitor rainfall.
- Identify and implement methods to prevent water waste through a faucet.

Requirements

1. Your team shall provide a low-cost, low maintenance solution.
2. Your team shall use at least one (1) microcontroller (Elegoo MEGA2560) to control either a motor, sensor, or display via a simple electronic circuit.
3. Your team shall create, draw, and manufacture at least one (1) 3D printed part that will be integrated in your product(s).
4. Your product(s) shall be aesthetically pleasing.

Supply and Budget

Your team will create a prototype from simple supplies available in the EG110 laboratory and CETA workshop. During one semester, we do not have the time to create products that are ready for the market, so your only focus is on a prototype that showcases your design. The nature of an open-ended project is such that we do not know what product each team will end up making. This makes it difficult to predict which supplies to prepare for the course. As we work with you on your project, we might be able to get team-specific supply. Remember: low cost, low maintenance solution, is one of the requirements.

In addition to buying CETA supplies, each team can spend up to $15 out of pocket to purchase supplies on their own. Please keep a tab of your expenses as you will need to submit, in your final report, a budget sheet listing everything you used to make your product and how much each item cost.

If you borrow or use something from your home, then you can assign a “yard sale” value for this item, which is 30% of the store cost.

*Note: Anything you use from your own Elegoo kits is “free.”

YOU MUST BRING A 1” BINDER WITH ALL OF YOUR PROJECT DOCUMENTS TO EACH CLASS! YOU MUST HAVE ACCESS TO ALL ELECTRONIC DOCUMENTS DURING CLASS VIA A LAPTOP. NOT HAVING THE BINDER OR LAPTOP WILL RESULT IN A 1 POINT DEDUCTION OF YOUR PROJECT GRADE!
**Tentative Schedule of Project Activities**

Note: It is best to keep all of your project files and papers in a small binder (1”) and organized electronically in a location that is easy to access.

<table>
<thead>
<tr>
<th>In class</th>
<th>Out of class</th>
<th>Activity</th>
<th>Individual</th>
<th>Teams</th>
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<tbody>
<tr>
<td>✔️</td>
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<td><strong>Project Wk1:</strong> P1-Project planning: read the project, identify and record milestones and deliverables, ask questions.</td>
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<td><strong>Project Wk2:</strong> P2A-Research: framing your project: questions, information, stakeholders. (information will be gathered mostly out of class)</td>
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<td><strong>Project Wk2:</strong> P2B-Research results: you will find information you need and answers to the questions you came up with.</td>
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<td><strong>Project Wk2:</strong> P3-Problem statement: you will use your research information to write a problem statement.</td>
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<td><strong>Project Wk3:</strong> P4-Requirements, verification, success</td>
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<td><strong>Project Wk3:</strong> P5-Generating ideas</td>
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<td><strong>Project Wk4:</strong> Team formation – and planning</td>
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<td><strong>Project Wk4:</strong> P6-Concept development</td>
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<td><strong>Project Wk5:</strong> P7-Concept presentation (in class presentations will be on 3/8/19)</td>
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<td><strong>Project Wk6:</strong> P8 – Concepts evaluation, selection, and detailed design</td>
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<td><strong>Project Wk7:</strong> P9 – Rapid prototyping</td>
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<td><strong>Project Wk8:</strong> P10 – Test plan</td>
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<td><strong>Project Wk9-13:</strong> The rest of the time in and out of class will be used for building, testing, data analysis, iterations, creating a final poster, and writing a final report.</td>
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<tr>
<td>✔️</td>
<td>✔️</td>
<td>Project journal entry – <strong>weekly!</strong></td>
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<td>2 peer evaluation forms will be completed outside of class and will contribute to each team member’s project grade.</td>
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Yellow shading – Research Step (~2.5 weeks; weeks 1-3)

Blue shading – Create Step (~3.5 weeks; weeks 3-6)

Green Shading – Execute Step (~7 weeks; weeks 7-13)
# Project Deliverables

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Brief Description</th>
<th>Due Date</th>
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<tbody>
<tr>
<td><strong>Weekly Project Journal Entry</strong></td>
<td>Each student will enter a brief account of what activities and tasks he/she completed during the week as well as what they plan to accomplish next week. In addition each student will discuss, in short, any issues and suggestions for remediation.</td>
<td>Weekly</td>
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<tr>
<td><strong>Documents</strong></td>
<td>You will be asked to generate multiple types of documents as you work through the engineering design process (some of which you will submit individually and some you will submit one per team). All the P#s listed on page 5 are activities that will require you to submit documents. All documents must be submitted at or before the due date and time corresponding to the document. Specific instructions will be provided in each case.</td>
<td>When applicable</td>
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<tr>
<td><strong>Documents Revisions</strong></td>
<td>Some of the documents that you will submit will only be graded after you received feedback from your instructor and had the opportunity to work on editing and correcting. This is part of the learning process – we do not expect perfection first time around – but we do expect thorough editing per provided feedback.</td>
<td>Within a week after receiving edits, suggestions, and feedback</td>
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<tr>
<td><strong>10-minute Power Point Presentation</strong></td>
<td>Each team will prepare a presentation detailing 3 viable concepts the team evaluated as candidates for the solution. The presentation will include through explanations of the science, engineering, and technology that are involved with each concept (how each concept solves the problem). Include advantages and disadvantages of each design and proof of concept. Schematics/drawings are expected.</td>
<td>3/8/19</td>
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<tr>
<td><strong>Poster Presentation; Final Report; Final Prototype</strong></td>
<td>Instructions will be provided for these deliverables in class. Note: Your poster and prototypes will be appraised for their merits by your “customers.”</td>
<td>5/1/19</td>
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Project Grading

EG110 team project counts as 45% of each student’s final grade. The following are the grading categories, what is evaluated, and how it is evaluated. Detailed grading rubrics will be provided to you for some of the project assignments (e.g., presentations and reports).

Teamwork and Leadership (10%)

What is evaluated?
- Each team member’s performance within the team (self, peer, and instructor evaluated).
- Weekly journal entries.

Methods of Evaluation: Questionnaires, classroom observations, documentation of submissions, 2 peer evaluations.

Engineering Design Process and Related Skills (50%)

What is evaluated?
- How well did you follow the process?
- Proficiency in utilizing process-related skills and tools (such as idea-generation techniques used; morphological charts; drawings; document of requirements; concept evaluation tool).
- Quality of research done to obtain scientific, technical, and engineering background necessary.
- Data-driven decision making (quality of data collected and soundness of technical decisions made by the team, such as changes to design based on valid feedback, testing, and data collection).
- Iterations and improvements based on feedback received in class, during presentations and team’s discussions, evaluations, and experimentations.

Methods of Evaluation: classroom observations and discussions, documents submissions.

Prototype Evaluation (10%)

What is evaluated?
- Does the prototype meet the requirements documented?
- Effort, quality, and complexity of the design and execution.

Methods of Evaluation: presentations, prototype demonstration, observation and discussion.

Communication (report, poster, presentation) (30%)

What is evaluated?
- Quality of documents.
- Meeting technical writing/presentation requirements (content and style).
- Presentation skills.
- Improvements evident from first to last presentation and documentations (are you implementing feedback?)

Methods of Evaluation: Observations, review of documents.
Documenting the Process: Your Engineering Design Notebook

You are required to document all of the information related to your project work in a binder. All the notes, handouts, sketches and assignments that are related to the project will be kept in your binder. Your instructor will review your binder in class, so make sure it is up-to-date and organized. In addition, good and detailed documentation will be used to grade your performance on the project, so make sure that you thoroughly review how your project is graded and keep well organized all data, information, and documentation in your binder.

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A good engineering design notebook is one that can be used to reconstruct your work even years after you have completed the original project. Other engineers should be able to use the notebook to reconstruct your work. The notebook will be used to determine the rightful owner of patents and other proprietary ideas.

Your grade is largely determined by the quality of your documentation – make sure you provide the instructors well-organized, easy-to-read documentation that has sufficient levels of details. NOT SURE IF YOU ARE ON TRACK? ASK!

Rules for Keeping an Engineering Design Notebook/Binder

Keep a numbered table of contents at the front of the notebook.

Number all pages in your binder.

Make all entries in ink and ensure that they are legible.

Do not be obsessed with neatness at the expense of faithfully recording everything as it happens.

Do not crowd the materials on the pages.

Make your entries at the time you do the work.

Include all results and learned information whether favorable or unfavorable.

Include all information, even if you do not fully understand it at the time of entry.

If you make errors, just cross them out with an X or a single line. Do not mark through anything so that it cannot be read.

Do not erase anything, and never tear a page out of the notebook or remove a page from the binder.

All data must be in their original form (calculations, charts, pictures, sketches on scrap paper, etc.), not after recalculations or transformation.

Rough drawings should be done directly in the notebook. More careful drawings such as machine drawings or computer-generated plots should be made and entered as well.

Information on loose sheets of paper should be entered into the notebook/binder.

Information that can be retrieved easily (such as research articles from journals) should not be entered into the notebook. Enter only the needed information and the location of the information in case you must retrieve it again.
References
