

University of Wales Trinity Saint David

School of Engineering



Group Project

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Electrical and Electronic Engineering HND

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Group Project and Research Methods – GOEE....

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Introduction

The goal of the group was to design and build a low-cost project that is simple to manufacture and which acts as a solution to one of the topics that were presented as options to the group to pick from.

The following topics were the options given to the group for the project to solve;

- Design an easy to medium difficulty STEM (science, technology, engineering and mathematics) project for school children in developing countries which step-by-step instructions on construction. This project should help encourage and promote STEM in an engaging way, and be as fun and interactive as possible.
- Design a product that is aimed at helping people to be more eco-friendly at home. This could include making people more aware to help limit the amount of water, food or electricity wastage in the household.
- Design a low-cost assistive device to help people with an impairment or disability. The device should be aimed at improving the quality of everyday life of the individual.

The entirety of the project was based around the Arduino microcontroller being used to control the electronic functions of the system.

Main Body

Topic Research and Group Planning

Before designing the project, the first task of course was to choose which of the three topics to build the project around. When given the assignment brief, the first thing the group did was conduct research into what kind of projects can be built with an Arduino microcontroller that fit into each of the topics. Below are some examples of possible project ideas that the group had come up with together:

STEM Research

- Smart watch, (Joseph, 2023).
- Alarm clock, (Guitarman9119, n.d.).

Eco-Friendly Research

- Water quality monitoring system, (RowlesGroupResearch, n.d.).
- Metal detector, (TechKiwiGadgets, n.d.).

Disability Assistive Device Research

- Braille bot, (Mukesh_Sankhla, n.d.).
- Smart walking stick, (avlokam, n.d.).

Deciding on a Project

After extensive research, the group decided to combine multiple ideas together to make a more impressive project that was more complex and could perform many tasks. The original concept was a water purifier that could also monitor the quality of said water which children in developing countries could use to take dirty water from rivers or lakes and convert it into safe drinking water. The initial idea was that the project would also be solar-powered making it eco-friendly also. The aim of this idea was to help children in developing countries recognise the importance of and encourage STEM.

Project Research

Research was conducted which would decide how the project would be able to perform as the group had envisioned.

In terms of water filtration research, water particle filtration and UV purification would be used. The idea was to first filter any particles that would be inside of the water with a filter made of natural resources, then install UV light which would kill any remaining bacteria in the filtered water, making the water clean.

The water quality monitoring of the project would be executed as a screen which displays many variables of the water quality to determine if the water is safe to drink. Examples of such variables would be pH, turbidity, temperature, and dissolved oxygen in the water (Michigan Sea Grant, 2024). An LCD display would be used in order to visually monitor such variables. The idea for a water quality monitoring system with a display was then discontinued as the group considered that the project may take a considerable amount of time to code the display and every sensor required.

Instead of monitoring every variable of the water, to indicate if the water was clean or not, a turbidity sensor would be used which would measure the turbidity, or cloudiness, of the water. The reason turbidity was chosen over other variables is that in water with high turbidity, it can promote regrowth of pathogens in the water, which leads to diseases when humans drink the water, (Water Science School, 2018).

Group Roles and Organisation

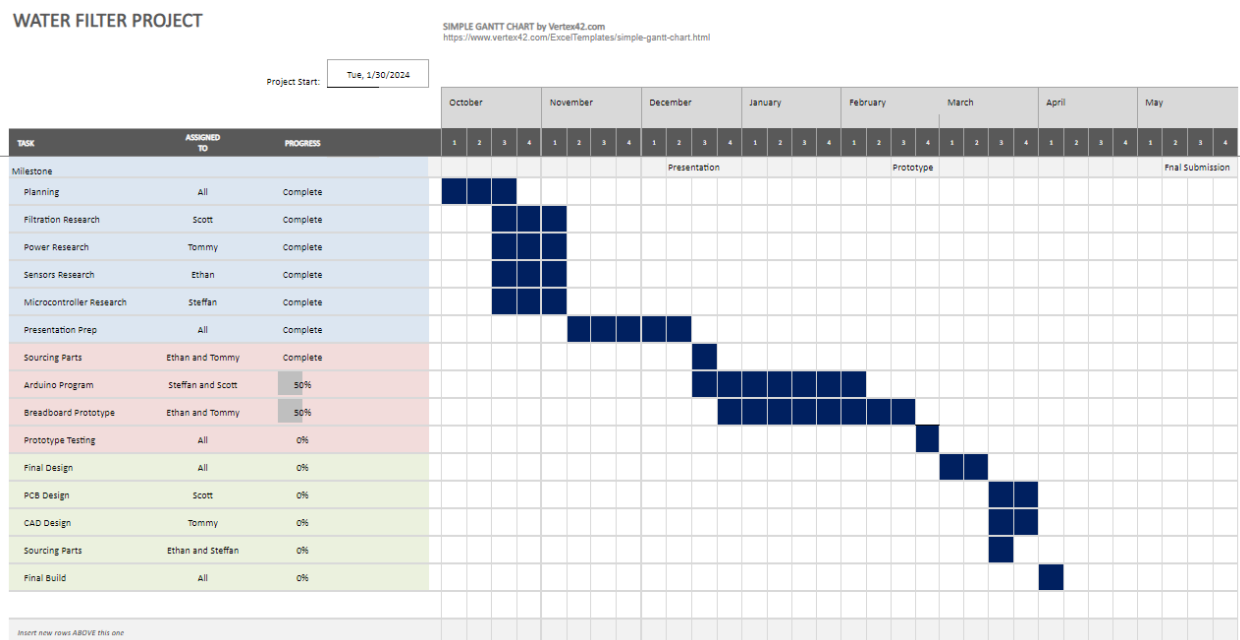
As the project was going to have many stages such as coding and CAD design, the group split up the workload by deciding, based on each individual's skills, who would take lead of each stage of design.

Each stage of design was thus given to each group member to lead as follows:

- Coding - Steffan Weaver was the lead in coding as he had the most experience in coding with Arduino during Robotics competitions.
- CAD Design - Tommy Rosser was the lead of this stage as he had the most experience with CAD software.
- PCB Design – Scott Tavner was the lead in PCB design as he previous experience with PCB design and soldering through competitions.
- Breadboarding / Prototyping – Ethan Byrne felt most comfortable with hands-on work.
- Sourcing Parts – Scott Tavner had previous experience with producing order forms, although sourcing parts was performed mainly as a group.

After assigning roles to each member of the group the next step was to create a Gantt chart, which would show the amount of work that the team tries to foresee completed in certain periods of time, and also when certain deadlines are.

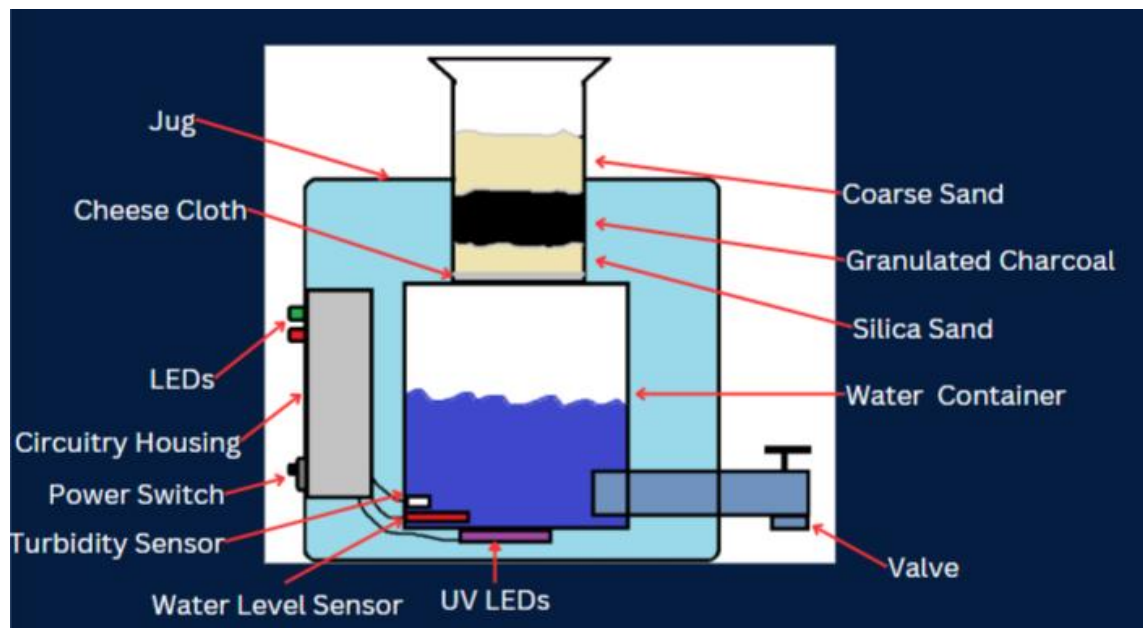
The Gantt Chart created by the team can be seen below:



The group initially had high expectations for the completion of each task of the project which may not have been realistic after completing the project and reflecting on the chart. As most of the work for the project was divided between members, the tasks which were split would be worked on simultaneously, but the group had not expected many of the setbacks which occurred, one example being the coding, which is discussed in the Coding section.

Project Design and Plan

A design was created by the group which would represent the final build of the water purifier, which can be seen below.



This diagram shows a large water container which will contain all of the parts of the project, keeping in theme of the water purifier.

At the top of the container will be a filter which is made of natural resources. Then the water would slowly drip from said filter into the space with the turbidity sensor and water sensor. The water sensor will sense when the water has reached a certain height in the container, and then the UV LEDs will activate for 10 seconds to destroy any of the remaining bacteria in the water. After this is done, the turbidity sensor will tell if the water is high or low in turbidity. If the turbidity level is too high, then the red LED will illuminate, and that means the cycle must be repeated. If the turbidity levels are low, however, then the green LED will illuminate instead, which means that the water is now safe to drink.

After the whole process is done, a valve will open which the water will pour from.

Sourcing Materials

Amazon and RS Online were used to source the materials for the project, and the order forms were created by Scott, who had the most experience with creating them, while the whole group were working together to source the correct parts for the project.

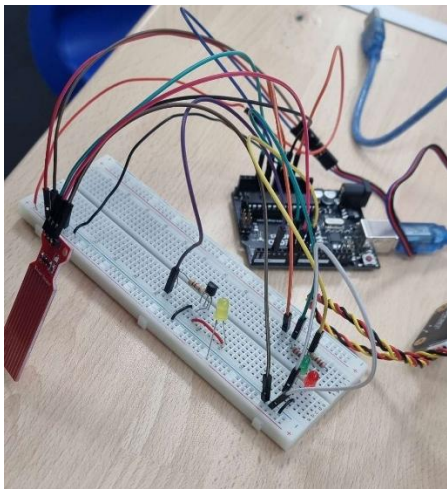
Prototyping

Ethan was the member who took charge of prototyping as he felt more comfortable with hands-on work, and Scott also helped to build the circuit on the breadboard also.

Building a prototype allows the group to flesh out the design and make sure that the project works as intended and make adjustments if needed. Creating a prototype was also necessary as there were parts used that none of the group had experience working with when, including the turbidity sensor and the UV LEDs that were used.

Breadboards were used to test the circuit for a variety of reasons, such as being easy to procure, simple to build a circuit on, the whole group had experience with using them, and it would be simple to find faults in the system. As expected by the group, this section had been simple enough.

Below is an image of the breadboard once prototyping was completed.



Breadboard Prototype.

Although the circuit looked messy, it was tested numerous times and finetuned to make sure that it functioned correctly.

Coding

Steffan oversaw the coding, and Ethan had helped him with it. As an Arduino was used as the microcontroller base for the project, the software used for coding was Arduino, and the Arduino model used was the Arduino UNO. The language used for coding was C++.

There were many difficulties which the group had to tackle when it came to the coding. The main cause of these difficulties was the turbidity sensor, as the group was less experienced with the component. There were also limited sources for coding that particular component. Because of this, trial and error played a major role in overcoming this problem. Also, because of limited resources, the group's code was messy, so it was more difficult to find issues when they arose. After extensive research, some sources were found which acted as a baseline for the code to start from, one such source being a video on YouTube by Mellow Labs, (Labs, 2023).

In reflection, the different sensors should have been researched more extensively before deciding on one, as the turbidity sensor may not have been the best choice because of the complications that came with that particular sensor. A better choice may have been a pH sensor, as there are more sources for coding them and they can more accurately differentiate between dirty and clean water.

Apart from the turbidity sensor, the rest of the code was simple to create. The coding was one of the reasons that the initial expectations of the group and the Gantt chart were unrealistic, as the coding took almost all the way until the end of the final build to get working as intended.

PCB Design

The leader of the PCB design of the circuit board for the project was Scott, who had done all of the work for this aspect. Fusion was the software used for designing the PCB of the project.

As the prototyping phase was completed before this step, the next step was to evolve the breadboard circuit into a more permanent circuit for use with the final design of the project. The PCB was designed so that it could be plugged directly into the pin heads on top of the Arduino with the green/red LEDs and power switch protruding through the circuitry housing to allow interaction with them when necessary.

There were also some issues that were faced when designing the PCB. One such problem was that the printers in the college could not be printed double-sided, and the plan for the circuit was that it would be double-sided. The board therefore needed to be changed to be single-sided instead, which would mean that the board would need to take up more space as the components would all need to be on one-side as opposed to using less space by having some components on both sides, although a benefit of the board being single-sided was that the manufacturing speed was now faster than it would have been, (Cadence PCB Solutions, n.a.).

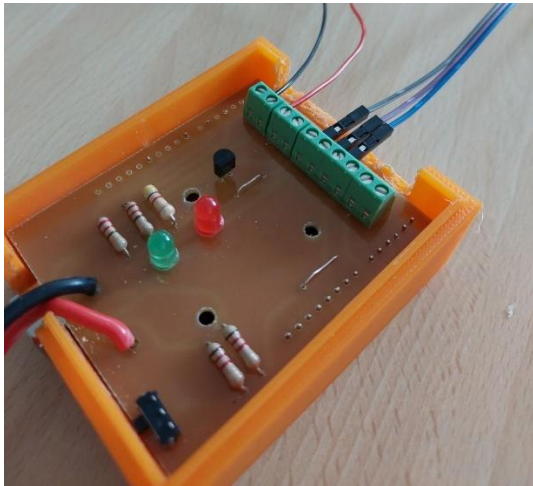
CAD Design

The leader of the CAD design was Tommy, and Scott contributed a lot to the CAD design also. The CAD software the group initially decided to use was Techsoft Design V3.

The reason that Techsoft was chosen was because Tommy had previous experience with this software, but because of the college computers lacking the application for the software, Fusion software had to be used instead. Because of this change, Tommy struggled to do the CAD design by himself, so Scott had to take over from him, and they both had to learn how to use the software's CAD design for the first time.

The parts for the build that were designed in Fusion were the Circuitry housing and the valve for dispensing the water. After the design process was completed, in order for it to be 3D printed the group had to splice it in the flash print software. This is because it is the software that comes with the printers the group had access to.

Below are images of the parts that were 3D printed.



Circuitry Housing containing the PCB.



Valve.

Final Project

After the coding, PCB design, and CAD design were all done, the project could finally be built.

The group had some issues when creating the project, mainly as a result of time constraints and waiting on the 3D printing to be completed in time for the deadline of displaying the project, as 3D printing takes a large amount of time to complete, and the CAD designing process also took longer than expected.

Although there were complications and some amount of rush involved when making the project, it was nonetheless completed on time. Below is an image of the completed project.



Final Build of the Project.

This image shows dirty water entering through the handmade filter made of charcoal and sand, and then passing through to the bottom of the container. The circuitry housing can also be seen with the circuit board exposed in order to display the components used, but there is a lid which can be placed on top of it which hides everything but the LED lights, which will always be visible. Then at the bottom of the image a valve can be seen, which will pour the clean water into a mug, as shown.

One regret the group had was that the final build was not very presentable. In order to avoid this, the group could have designed the container in the CAD design process as well as the other parts. Despite that aspect of the project, the group was happy with the project and were satisfied with the function of the project, as it had indeed worked as the group wanted it to.

Evaluate Individual Contributions

In terms of individual contributions, Scott and Steffan contributed the most to the project. Scott contributed to most of the tasks, including prototyping, PCB design, and CAD design. He also helped with a lot of the issues that arose, and his feedback was considered very carefully.

Steffan was the individual who made most of the code, and the one to troubleshoot the code consistently to make sure that the project worked as intended.

Ethan helped Steffan with the turbidity code, which was the biggest hurdle. He also came up with many ideas on how to improve the project and streamline it.

Tommy helped with some tasks, but because he was inexperienced with most of the software used for the CAD design which he was initially assigned to oversee, it was difficult for him to do on his own.

Conclusion

In conclusion, the group project which was created was a water purifier which fell under the topic of a STEM project for school children in developing countries which should help encourage and promote STEM for those children. The project was built using an Arduino microcontroller to control the functions of the system.

There were many complications throughout every process of building a water purifier, but the group over came them through various ways. The group learned how to communicate different ideas and bring them together to form one cohesive project, and also learned how to rely on each other when they were struggling with something.

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