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STUDENTS AND GENERALLY
FOR THE CAPSTONE GUIDE*

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Grade 11 Semester 1

Journal 1

This is new year with new team determine two changes that you faced in dealing with your recent team differ from your first team in G10 semester

1

Personal Reflection/Team Collaboration

Ziad Salah

In Grade 10, when I was first assigned my team, I was furious. I didn't want to be with my team members and felt out of place, maybe it was my ego at the time, I felt like I had gotten the worst team ever - I had put high expectations hoping I would be with certain students.

I now realize that it was the best learning experience that I had in my entire life. This is also reflected by a couple of points that I've come to realize within my new team:

1. The familiarity with other peoples' works – when I was randomized into my new team, I was thinking who I would get and how good work was going to be, this shift alongside the team members being reduced to 4 members rather than 5 members indicated that each semester in Grade 11 is going to be way more interesting than Grade 10. I came to realize by our first tasks that this teams' cooperativeness and teamwork is great under my management as the team leader, they finish their tasks before their deadlines and are always up to my expectations. This is opposite to what I experienced in Grade 10, I always felt unsatisfied.
2. The strengths and weaknesses of the team members – when I was first assigned my new capstone team, I started analyzing everyone's points of strength and weakness so that I could properly assign the tasks correspondingly. Furthermore, this was an essential process that I didn't use in Grade 10. If I had used it, I could've properly distributed the tasks back then.

GREEN

Omar Adel

Being part of a new team has its own benefits like working with new people and understanding new thought process, however, there are still many difficulties and challenges that may arise.

1. Less team chemistry. For the last project we were all getting along by being able to communicate well, but now I face a problem were I have slightly drifted away from some friends

making us lack the chemistry we once experienced in other teams. We overcame this by doing things other than work together like playing games and studying together, this reinforced our friendship and collaboration

2. Disorder. Everyone is trying to improve many things from last year, whether it was skills like leadership or grades and quality in the project itself. The problem lies in the fact everyone tried to become a leader and organise work in their own perspective and time schedule. This is unlike last time where the sought for improvement wasn't as much. To overcome this we sat down together and discussed all the things everyone wants to improve so they don't overlap with other team members' ideas and schedules.

Finally I think we are only facing difficulties because we are just starting to get along, but if we keep putting in the effort to improve and start communicating our problems to each other I'm sure we will be even better than last time.

BLUE

Mazen Askar

STEM's teamwork system is very unique and requires flexibility to tend to your team's needs, but with the new year, teams have changed; thus, I need to get accustomed to their methods and habits. Two changes that affected me to deal with team changes were:

- 1- Changes in my sleep schedule, back in G10, my teammates and I had the same sleep schedule, which meant that agreeing upon task deadlines and team meeting times was easy; however, this semester, I found out that 2 out of my team members like to take naps in the day, and continue working at night. At the start of the semester, we couldn't agree upon when we would meet to discuss our business, nor when tasks would be handed in... so we solved this problem by agreeing upon two things:
 - Carrying out online meetings during the holidays when we are apart and at home, this method kept our sleep schedules unaffected by meetings because life at home is much more flexible than in the dorm.
 - Creating a shared online cloud, this way, any team member can hand in their task effectively, regardless of the time and their location.
- 2- Method of work: Me and my old G10 team were pretty coherent in the way we wrote down our tasks, which made it easier for us to complete each other's tasks, but this semester, my new team wasn't used to my formatting and narrative methods, which sometimes confused them when tasks were shared, but we agreed to solve this problem by setting a certain rubric that we all agreed upon for us to follow, this way sharing tasks is much more efficient because my teammates' tasks feel just like mine when I edit them.

BLUE

Malek Sayed

In the first year, all of us lacked experience, as it was the first year in a whole new system with projects and a lot of research. Additionally, we didn't choose our teams and didn't know who excelled in every topic within the project, so we couldn't distribute tasks properly.

- The first change is that we actually chose our teams and knew everyone's pros and cons, so we could distribute tasks properly, and every member knew their role even before the semester. For instance, I am the leader, so I distribute the tasks depending on everyone's skills and knowledge. Also, I solved any problems between our team members and helped them with their tasks
- The second change I have noticed is there is way less troubles between the team members because now every member know how to do his tasks and why the leader chose this specific task for him as in the first semester in G10 we distributed the tasks randomly leading in problems between the team members and the argued a lot about the tasks distribution as there were some tasks that was harder than others. But now we know the difficulty of each task, so for example, the research alone can be harder than writing 2 grand challenges in the portfolio.

To conclude this semester, we are already doing our 3rd project, so we learned how to deal with our team members and problems facing us in the capstone, unlike the first semester in G10 when we lacked experience.

GREEN

Baraa Ahmed

Working in this environment for a whole year now has definitely helped me grow my capabilities in terms of teamwork, individual work, organizing with teachers and personal passion projects; all of which I have never thought I would be capable of. My first capstone project in G10 S1 wasn't the most advanced, nor was it too simple. We had gone through ups and downs; all of which we learnt something from. We were unable to determine a specific direction for our work. In contrast, we can figure out exactly what we need to do, for at least two more upcoming weeks. I have learnt that this direction of work can be defined through two factors in particular: harmony between teammates to work together, and the level of the work per se. These are the most important two changes between G10 S1 and this

semester. The first was chosen because a cooperative team will always work together, whereas a divided one would leave each member work in their own direction, ultimately leading to no progress. This isn't enough, however. I had chosen my team members based on their academic capabilities, which has a direct effect over the quality of work we are able to present. Considering those two factors out of anything else, as a team leader, has saved me tons of time organizing and refining the work output of my teammates.

GREEN

- This is your third capstone challenge; therefore, you should have gained valuable experience in problem-solving by now. To facilitate a clear path to the solution, outline three critical points that need to be followed to reach the solution easily.

Using the Engineering Design Process (EDP)

Ziad Salah

Problem-solving is a cornerstone process that should be taken to help assess the problem itself and logically process what must be done – by experience and the progression of time, it was emphasized that several points must be taken to reach the solution:

1. Referencing and seeing what the Scientific Development Goals (SDGs) have in common with Egypt's grand challenges – a necessity so that the research may be done to conclude a definitive problem and a solution. Taking ideas from already existing problems and situations.
2. Try and visualize and or represent the challenges and problems in a tree-node system, something that branches off and becomes several different problems that can be solved in a certain manner. Revising and reordering this is essential to recognize the root problem itself.
3. Looking up prior solutions in relation to the problem – has this problem been solved before? How and what specific impacts did this prior solution tackle? This is important because you can therefore deduce negative side-effects or leftover problems that weren't solved by said prior solution. An example would be something like water filtration plants. Dangerous chemicals that might escape into the environment and cause problems but... essentially important.
4. Collect data and information about the problem to assess its severity – is this problem worth looking at and even finding a solution for or not? Same with prior solutions, try to look for important conclusions and information that might help in finding a solution.

BLUE

Omar Adel

After completing two capstones projects it is obvious many skills were gained that were helpful in other projects and everyday life-choices. The main skill I was able to improve and build upon is problem solving, it helped me develop a clear thinking process that follows some key steps.

1. Organising and following a clear plan. This is usually referred to as the EDP (engineering design process), however, there are many variations that fit each problem. Making a time-line and organising one's thoughts is essential to make sure nothing is overlooked or rushed.
2. Taking the most amount of time. Although we are taught to solve problems quickly to decrease its negative impacts as soon as possible, it is still essential to take time during each step and not rush through any process that might make the work not as good as it would have been, making the solution less effective than the desired result.
3. Taking advice and learning from others. Other people have probably went through the same problem if not worst than the one we are facing, therefore we can benefit from their wisdom and experience to be able to predict what might go wrong and plan ahead.
4. Self-confidence. Any solution even if it contributes only about 1% is helpful because it adds powerful insights that can be beneficial. This is the same for ideas found in everyday life problems, we must be confident in our capability to overcome these issues like a wrestler getting back up again and again to keep fighting.

BLUE

Mazen Askar

The first two capstone challenges taught me how to be organized and perform correct research. This year's challenge was no exception, as it demands a new solution, and a new solution requires correct steps to be effective, such as:

- 1- Clear identification for the problem: knowing exactly what you are trying to solve gives you a clearer idea of what to do, and what to search for, while allowing you to grasp fully why and how to solve the problem.
- 2- Valid research: Many people jump to conclusions when solving a problem; instead, what my team does is research the problem thoroughly. This way, we make sure the solution tends to the needs of the problem rather than just being convenient
- 3- Clear communication with the team: Communicating with the team facilitates teamwork and saves time and effort. I find my team to be pretty straightforward, on when to hand in tasks, and

what they should look like, for example a recent interaction with one of my teammates we were talking about a research task, and I told him that when he hands it in, it needs to be cited, if I hadn't told him, then he would have handed it in without citation, and would have had to redo the task, and that is a major inconvenience and waste of time.

- 4- Understanding prior solutions: knowing what has been done before, and what worked and what failed, saves a lot of time and effort and is a great method for avoiding mistakes that were already committed in the past.

These 4 methods not only make reaching the solution easier, but also ensure a great effective solution.

BLUE

Malek Sayed

As this is our third capstone project, we have gained a lot of experience from hard work in the previous year. We learned many valuable skills like problem-solving, leadership, and teamwork. So now we should reach the solution way faster than the first semester in G10, for instance, there are 3 critical points that I will make sure to follow to reach the solution faster.

- The first thing that I will make sure to do properly and focus on is defining the problem. Defining the problem is the most important step to solve any problem, as if you define the problem badly, you can even solve another problem for example our main problem is that 83% electronic waste is dumped without taking any benefit from it so we must find a solution for this specific problem if you defined the problem poorly you can solve a not related problem.
- The second critical point is doing background research. After defining the problem, we must research the consequences if we leave the problem unsolved. Also, we must research how we can solve this problem in the most efficient way, as there might be external factors that you didn't know about that affect your solution and make it not effective as a solution
- The 3rd and last thing I will focus on is looking for prior solutions for the main problem that I want to solve. And identify the pros and cons of every prior solution, and try to learn from the disadvantages and what caused the problems in each prior solution. And try to do a solution that has every advantage and avoids the disadvantages of every prior solution.

GREEN

Baraa Ahmed

The Engineering Design Process was the first thing we were taught in G10 S1, and now I could tell why.

It forms the backbone of any rigorous research-related project concerned with finding a solution to a problem in a clear, organized path. Following the EDP, The first critical point is identifying and specifying the problem very clearly. All research projects have to go through preliminary processes for outlining, and proposing, where the problem is specified in terms of spatial & temporal dimensions, the presence of a control group, independent or dependent variables, and other similar ultra-specific details.

The second is proposing a solution and preparing for it. By clearly defining the problem, we can tell exactly what needs to be fixed, therefore opening the path for multiple solutions to be proposed within our hands. This point includes multiple subpoints—studying previous solutions if present, and evaluating each into advantages and disadvantages. This subpoint ensures that the solution already solves old problems that have been already fixed—ultimately keeping the solution up-to-date.

The third is practical application of the solution. Whether it be a software-related project, or a large real-life prototype, or anything else—this step includes the acquisition of necessary materials for the project, building it up, and refining it altogether. Other subpoints include recording results & analyzing them carefully, therefore giving space for more research questions to be worked on.

GREEN

According to LO BI.2.01, how can understanding the trade-offs associated with genetically modified organisms (GMOs) enhance our decision-making when developing environmentally friendly prototypes that reuse electronic waste components?

Learning Transfer

Ziad Salah

Genetically modified organisms are a grace that science has gifted us; however, it has several downsides that cause certain problems. An example such as Bt. Corn, a GMO that was modified at first because of another organism/insect that would completely devour the crop during harvest and planting season. This was counteracted by modifying it with a different gene that gives the organism resistance towards this insect, mitigating the use of pesticides and therefore making the plant healthier. However, by the progression of time, these insects have developed a certain countermeasure that allows it to eat and devour the corn.

Likewise, in our environmentally friendly prototypes, we try to mitigate a certain problem which is the improper disposal of E-waste and the seeping of its components into the environment, even when trying to extract something from E-waste, volatile substances (things that release gases because they're not

stable) such as mercury or sulfur in chips may harm the environment. Therefore, when making decisions, we must take into considerations the side effects in the future.

Another point would be the use of metal-dissolving bacteria through a process called “bioleaching” to extract the metals in the form of a mixture. This is good because you repurpose the metals for something else like Japan did – they recycled metals to make Olympiad medals. However, this process has adverse effects that harm the environment. These bacteria are anaerobic and therefore release gases like Methane, Hydrogen and Arsenic sulfide (toxic and dangerous) when dissolving metals.

BLUE

Omar Adel

In Biology we were able to learn about GMOs and DNA in general along with some properties or things to look into when trying to apply it into any living organism.

When looking into building a prototype or completing a project in general we can notice that everything is balanced relatively, like no dynamo would generate a lot of electricity unless it is part of a better circuit that is more expensive, this is similar to how insulin extracted from E-coli GMOs isn't as safe as human made in the pancreas.

- quality trade-offs. Sometimes to achieve a better result like modifying some plants to produce proteins that protect it against insects and parasites, the taste may be hindered. This is the same when trying to add insulators to circuit parts and wiring, we could end up with weak connections that get dissipated in the material.
- Economic trade-offs. When modifying things like fruit by removing the DNA responsible for seeds and adding one that increases the production of sucrose, we can achieve better taste and benefits, however, this makes it more expensive as modifying is really delicate and requires different processes. This is linked in our device when we try to use high quality parts that contain materials like gold or silver as part of their circuitry. Although we recycled these parts, they are quite uncommon so it would be harder to recreate the project in countries that lack the same economic strength.

To deduce, we must work towards balancing every aspect of the project while trying our best to have some strong suits depending on its purpose, like increasing beneficial parts (even though they require more energy) as long as the location can satisfy their needs using solar panels or so, without much issues.

BLUE

Mazen Askar

In our Capstone Challenge, we explored how genetic modification and scientific instrumentation both rely on altering existing systems to create new, useful functions. GMOs are organisms whose DNA has been deliberately changed by inserting specific genes using tools such as restriction enzymes and plasmid vectors.

For example, the E. coli strain used to produce human insulin contains the insulin gene inserted into a plasmid, allowing the bacteria to synthesize the hormone during growth. The project also reflected on trade-offs associated with GMOs, them being environmental responsibility.

Improperly handled e-waste releases heavy metals into soil and water, while uncontrolled GMO use can disturb natural populations or transfer genes unintentionally. By focusing on controlled design and safe disposal, we addressed both issues together, showing that modern biology and sustainable engineering can advance scientific discovery while protecting ecosystems.

To confirm safe handling of both GMOs and E-waste in an environmentally friendly way, our team designed a low-cost lab incubator built from reused electronic parts, programmed to maintain 37 °C, the optimal temperature for E. coli replication.

This device can help culture genetically modified cells under controlled conditions without expensive commercial equipment.

This way, we repurpose old electronics into new devices that help bio-technological and biomedical purposes without risking trade-offs or environmental damage.

BLUE

Malek Sayed

In the first learning outcome of biology, we learned about genetic modifications, how it is done, and learned about their pros and cons and how it affects our daily life and long-term health.

Genetic modification talks mainly about taking genes or DNA from certain organisms and put it in another organism to solve a certain problem that this organism suffer from. For instance the scientists noticed that there is a specific bacteria that eats corn before it is ripe and before they can hatch it and eat it, so they added a certain gene that is immune to this bacteria and this method made the corn production way higher.

Actually it is related with our project and can help us understand which electric components that we must use to build a whole new eco-friendly device that we can use in the school labs. Like in GMO you

take specific genes and DNA from multiple organisms to solve a certain problem and making a living organism better. We take specific electronic components from already used devices to make a whole new efficient device.

For instance we can make an incubator that have the perfect condition for GMO like making the temperature exactly 37 degrees. This can help GMO a lot as it increases the chances for the genetic modification to success.

To conclude genetic modification is vey similar to our project so we can benefit from it in our solution and learn how to choose proper components to make an eco-friendly device recycled from e-waste

GREEN

Baraa Ahmed

It is a convention in any scientific project to evaluate matters in objectivity, without favoring a side for reasons personal, financial, or otherwise.

That being said, a project can be evaluated in main points as: strengths, weaknesses, additions to the concerned affected group, and harms to it. GMOs can be controlled to change characteristics, as improving taste, nutrition, and increasing immunity. In contrast, the main weakness of genetic modification lies in the limited research on the effects of consumption of GMOs by humans. GMOs haven't been proven to cause a certain type of disease, but trade-offs aren't absent either. Cases have been recorded for individuals who have experienced allergy towards GMO intake, which directly affected how they were looked at by the public—praised by some, and frowned upon by others; a very predictable result in any newly emerging scientific discipline. Looking at the final verdict nowadays; genetic modification of food is a very large multi-billion-dollar industry which has continued to thrive on the global scale. By forming an analogy between the decision towards GMOs and our project, we can form a similar evaluation pathway using the aforementioned four main points of evaluation. For example, the strength of recycling electronic waste lies in the cutting costs required for building up the project, whereas its weakness lies in the components being used for its unintended purpose, possibly yielding unpredictable results.

The additions and harms to the affected group study the project in action, and differ from one project to another.

GREEN

While the project described for this semester and the water cycle that you studied in (ES.2.01) seem completely different on the surface—one is about human engineering, the other a natural phenomenon—they share a powerful, fundamental similarity; explain the comparison between them

Learning Transfer

Ziad Salah

On the preface of the subject, the water cycle and the project face shocking similarities when deeply thought about. These thoughts can help achieve the design requirements and assess the problem itself, where two points of similarities exist as:

1. The closed cycle of both of the challenge AND the water cycle. The proposed problem requires recycling and the reuse of E-waste. E-waste, being the sequestration or storage site of the metals or components to be extracted and reused. Likewise, the water cycle is a closed loop within the hydrosphere & atmosphere, there exist several sequestration sites such as oceans, and clouds. Furthermore, the ability of water to be stored and released to something else is reflected by the recycling of the E-waste, being able to take out components from an old sequestration site and putting it into a new sequestration site to be used.
2. Both of them require management and human interference to stop adverse effects, essentially saving the environment from destruction by both of them. The environment is affected by both of them. Things like water vortexes, storms, and hail are environmentally destructive. Alongside that, E-waste's toxic metals such as Arsenic, Cadmium, and Mercury leak into the surrounding environment, potentially spreading like wildfire through organic hosts and soil. Both of which can be mitigated by human action. A certain disaster like a Tsunami is scary, but the beauty of human intervention and the creativity may repurpose this destruction into creation – generating electricity from the Tsunami's waves for example.

BLUE

Omar Adel

While the project described for this semester and the water cycle that you studied in (ES.2.01) seem completely different on the surface—one is about human engineering, the other a natural phenomenon—they share a powerful, fundamental similarity; explain the comparison between them

The water cycle serves as a power inspiration to human innovation and engineering projects. It stamped the idea of reusing and recycling parts for future use, just like water cycles through the environment, however, it is still unclear how we can learn more and actually use this knowledge practically than just inspirationally.

The water cycle serves as a power inspiration to human innovation and engineering projects. It stamped the idea of reusing and recycling parts for future use, just like water cycling through the environment, however, it is still unclear how we can learn more and actually use this knowledge practically than just inspirationally. • Order is important when looking at the water cycle; if someone is looking at the reason for a drought he might think it is a lack of condensation as rain, while another can deduce it's the lack of evaporation of oceans making less rainy clouds. Similarly when applying this to our project we need to pinpoint the exact point where the problem arises. This doesn't only help us understand where we might strive to solve the problem of e-waste, but also help connect each step to ensure the cycle is ongoing. • The role of each step. For the water cycle each step is important and the absence of one could lead to environmental imbalances like low amounts of water in droughts or high amounts in floods. The steps are generally: o Use by organisms o Disposal o Infiltration/evaporation o Condensation o Use again by organisms This is the same for our project which focuses on tackling its own 'evaporation and condensation' steps. Taking apart old projects and machines, then reforming them into new things is where this similarity shines. To conclude, we are continuously able to benefit from the water cycle as a practical example of recycling well with the conservation of different parts equally.

BLUE

Mazen Askar

Our Challenge, Turning Electronic Waste into Scientific Opportunity, we examined the importance of water as both a geological and environmental resource. Earth's abundance of liquid water supports ecosystems and drives natural cycles like erosion, sedimentation, and mineral formation.

Understanding these processes is essential when designing instruments that analyze or monitor water quality, especially in the context of pollution caused by e-waste. Water cycle provided different applications for our e-waste recycled electronics, such as: agriculture, water quality and health concerns, and industrialization, but these two similarities stood out the most to our team:

- 1- The distribution of water: only about 2.5% of Earth's water is fresh, and much of it is at risk from pollution. Our prototype demonstrates how recycled electronics can help protect this limited resource.
- 2- Likewise, only about 4% of E-waste is recycled or reused, which is a waste of scarce metals and industrially demanding components. Our group developed a water-quality testing device using recycled sensors and circuits from old electronic equipment.

This prototype measures conductivity and temperature, both depend on the physical and chemical properties of water. Water, being a solvent with high specific heat, dissolves salts and maintains stable temperatures.

By correlating conductivity with dissolved ion concentration, we could determine contamination levels, which is crucial for the Earth science facility for both the natural phenomena of the water cycle itself and human engineering.

BLUE

Malek Sayed

in the the first learning outcome in earth science we learned about water cycle, physical and chemical properties of water, as it may seem that they are totally different subject that doesn't relate to each other. There is a strong connection between them.

As in water cycle water is nearly conserved as it just changes forms between water vapor, liquid and ice. It starts in ocean's water that evaporate and condense as clouds that later begin to rain making rivers and some is conserved as underground water.

We can learn from it that we can also recycle the electronic waste as the metals used in electronic devices are limited and rare as gold, copper, cadmium are all used in electronic devices so we must recycle it preventing scarcity in these metals.

Also not recycling electronic waste can disturb the water cycle as there is hazardous chemicals that is used in electronic waste, burning them can cause acid rain and also dumping them in the water can cause severe water pollution.

To conclude water cycle is connected with our project, as not recycling electronic waste can disturb water cycle and can cause severe water pollution. And also causing acid rain and many other problems

GREEN

Baraa Ahmed

The water cycle, in its core, deals with the movement of water back and forth, between the earth, the atmosphere, and living species. A pond may evaporate and turn into a cloud, just for it to fall in clear rain drops once again somewhere else. For the idea of the project for this semester, it is mainly about reusing the same electronic components that have been previously discarded. The core of this analogy

lies in the fact that nothing gets discarded forever. The water cycle explains that the amount of water on the whole planet, between vapor, ice, and liquid state, together make an almost constant quantity—vapor does not ascend into outer space, and earth does not create it from emptiness either. The same thing can be applied to e-waste; recreating more electrical components without recycling would eventually lead to depletion of natural resources and polluting them; both at the same time. Reusing the components can directly prevent that, as well as reduce costs and efforts spent. This rule of sustainability in nature is very unique in itself, and its adaptation on larger scales of anthropogenic activity would clearly decrease the amounts of discarded electronic waste that could pollute the environment.

GREEN

Journal 2

Imagine that you have been working with your classmates in your previous school on a prototype project, and your team has already made good progress.

However, after a few weeks, you are transferred to a new school, where you will join another group that has already started working on a different project.

How would you handle the following situations?

1. When you join a new group that has already started working together, how would you gain their trust and integrate quickly into the team?
2. If you believe that the idea of your previous project was better than the one your new group is developing, what would you do? *

Personal Reflection/Team Collaboration

Ziad Salah

Integration and appropriation are hard when done instantaneously; however, when done right and all time is taken, then, it becomes way easier to understand other people and their thinking processes. This is emphasized in the question itself. Personally, I would do the following:

1. Before performing any work, I would first try to know who my colleagues are, their interests, and more specifically, their points of strength in work, whether that'd be programming, graphics designing, and whatever else. I'd begin to introduce myself and state the same facts about myself – especially programming (my field of strength). I would start to gain their confidence by performing my tasks at once, without any delay in performance. Trying to emphasize my skills in programming and its relation to this semester's project alongside outlining myself as a proficient researcher. This would allow me to gain their trust professionally; however, personally, I would require to interact with my team in meetings, and make clear points that stand out as proper arguments in the conversation.
2. In such a case, I need not do anything because this is already their idea; however, there are definitely several improvements that can be made. As to not try to steal the role of the team leader, I'll try to suggest improvements from older solutions similar to ours, trying to fix flaws. However, some flaws cannot be fixed, they can only be mitigated (improved upon.) I might aswell start suggesting ideas from my older solution yet making this specific project distinguished.

BLUE

Omar Adel

Following a perfect plan is always advised to maintain good progress, however, it is natural for obstacles to appear out of no where such as moving to a new school and joining a new team. gaining my new teammates' trust would be hard, but I would do the following:

1. Study their project and progress well, I need to understand their project well enough so I can make progress on my own in the best quality possible
2. Finish tasks as early as possible, I would want to make up for lost time, so I would finish my work early and start helping them in their own tasks. This is because they wouldn't trust me with anything difficult at the start so my work would remain small and negligible if I don't take initiative and start helping out more.
3. Construct a non-work friendship, I would start hanging out and studying with them to show that we really are friends and not just work partners, this should increase chemistry and trust.

After hopefully gaining their trust, I still face another problem; I would be attracted to my previous project idea more than their current one as they would be attached to their own one. So I can't just tell them to change it. However, I can try to persuade them into modifying some things that were strong points in my old idea following design efficiency and a more thorough test plan for each component not just the prototype itself.

I believe that communicating well with my teammates is the key to making up for what I had missed and constructing a good work environment for all of us.

BLUE

Mazen Askar

Transferring to a new school and joining a new team after you have already adapted to your old team can be difficult, especially if your old team was efficient. However, working with a new team isn't always a bad thing, as it could turn out that you have more synergy with your new team than the old one. But it is still likely to run into issues such as:

1. **Gaining your team's trust after they have already started working together:** At the beginning of your journey with them, likely, they might not want to share their work with you, but trust arises with patience and loyalty, so in order to quickly gain my team's trust, I need to initially not be very pushy, and only work in tasks that I am provided by them, in addition to that, I will attend team meetings, as such debates will let the team understand the way I think, and that will make future cooperation more likely.
2. **Disagreeing on the better team's idea:** Since I already left the old team, I no longer possess authority over my old idea, thus even if I thought it better than the new one. However, some elements of the old idea can be moved over to the new one for improvement, and before I suggest my ideas, I must ensure that I already have their trust, then I need to be gentle with how I present it, make it seem completely subjective.

Generally, transferring to a new team in the middle of the semester could be very harsh, but with patience, gentleness, and flexibility, the new team can be better than the old one.

GREEN

Malek Sayed

In our capstone project, as we are already in week 6, we have made significant progress. We have found a solution, designed our prototype, and determined which electronic parts to use from which device.

If I am transferred to a new school after this whole process, of course, it will be a challenge, as my new group can be working on an entirely different project with a different problem to be solved and a new design.

- To gain their trust and integrate quickly into the team, first, I will try to research about their project and try to find creative ideas and more cheap and easier materials to use in our prototype, then I will talk to them about what I have found about their project and the new Ideas

I came up with, also I will finish my tasks on time and try to avoid arguments between my new teammates to gain their trust

- After the research that I will conduct to understand their project further, if I find that the idea of my previous project is better. The first thing I will do is to suggest making the previous idea that I made with my old team and say why I find it better, and if they decline, I will ask them what their reasons are. And at the end, we will truly find which idea is better, and we will work on it.

To conclude, even if you made progress in something and it didn't continue, think about what the new thing you are going to do, not what you have lost.

GREEN

Baraa Ahmed

Academic integrity is one prominent trait that every scholar, teacher, student or otherwise, have to follow and adapt. Skepticism is another trait that is required in academia as well. Looking at the latter, the new team would be skeptical of the level of my work, its quality, time frame, and others. It is my duty in the first place to prove that I am able to perform, communicate, and make a helpful addition to the team and their already ongoing project. Good communication, and therefore coordination, is the foundation of organized work, so this is the first thing to focus on. Secondly comes the work itself, where I have to clarify exactly my strengths and mitigate my weaknesses. Concerning the former concept, 'academic integrity', it would not be appropriate to exclude a single member from a whole team who worked on a project; let alone having oneself take it for a different team. Other members have spent efforts and performed work that requires credit and acknowledgement, and excluding this effort would be an evident violation of honesty and work ethic.

YELLOW

Introduction:

In the Engineering Design Process, each team may focus on different design requirements based on their goals and priorities.

For example, one team might emphasize cybersecurity more than user-friendliness, while another might prioritize environmental sustainability over performance speed.

This variety shows that engineering solutions can differ depending on what each team values most.

Question:

Identify two design requirements that your solution must meet.

Explain why you chose each requirement, giving two reasons to justify the importance of each one. *

Using the Engineering Design Process (EDP)

Ziad Salah

A question derived from the introduction that's considered the answer of our question would be "Why do certain teams focus on certain design requirements?"

The answer would be: Since – certain projects have their own boundaries that must be met as not to copy someone else's idea and or mitigate as much problems as possible. For example, the team emphasizing cybersecurity more than user-friendliness definitely relies on a skilled team of users and tries to mitigate the chance of a hijack because of data sensitivity. Then – it would be mindful to assume the worst-case scenario in our project – this is emphasized in the following points in the form of design requirements:

- The limitation of the error percentage to 5%. Our project – an oscilloscope – is a device that measures a function's properties (most notably, frequency, and amplitude); however, this is extremely prone to error, and therefore, this constraint was set to prevent any miscalculation. Therefore, our project tends to take multiple stages to mitigate any error before calculating our needed variables.
- Limiting the device to one channel. Any oscilloscope has a multitude of channels (input points that calculate our variables); however, due to simplicity and limitations, we set a

boundary for ourselves to only have one input point to avoid any signal interruptions and mixing between variables and due to the limitations of components provided. A regular LCD – which is the device we'll be drawing our functions on – can only handle so much power before failing; therefore, we could only provide one input channel.

YELLOW

Omar Adel

Each solution must be balanced in all of its aspects to make sure nothing is overlapping the other, like being energy efficient is good but it would make the design expensive and harder to replicate in some regions. However, each region has its own needs and environment where one could be rich in electric parts but poor in energy and vice versa, making it need its own design that suits it best. My team and I have settled on the following as the all-rounder qualities that must be achieved to make sure it isn't only successful, but also complemented by its environment.

- Simple design, having a simple design achieves two great things:
 - First, user-friendliness, where it would be easier to understand and use with no prior experience.
 - Second, easy modification and reassembly, having a simple design means each region can customize the different parts with ones that complement their surroundings to achieve utmost efficiency.
- Economic efficiency, a solution that is economically efficient and can save money or cost as low as possible is always good no matter the region. This makes it so that a region can apply this solution many times.
- No divergence, any solution mustn't diverge the problem into another meaning if I'm filtering water, I shouldn't dump waste else where creating a different type of pollution which creates a new problem. This ensures that different solutions and problems don't overlap.

I believe that each problem and solution have their own requirements, however, Some requirements should exist in every solution due to their importance.

BLUE

Mazen Askar

Design requirements set for yourself a certain criterion to make sure that your project is successful.

While they differ, such as environmental sustainability vs performance speed, they ultimately serve the

same purpose of improvement. Still, for our team, we thought two design requirements were specifically crucial, those being:

- 1) Environmental friendliness and sustainability: A project must protect the environment to be considered successful, in my opinion, for the following reasons:
 - The Earth has already endured lots of pollution, and currently, people have gained more awareness of this issue; therefore, it is important to attempt to start healing rather than to continue damaging our home when we can clearly help sustain it.
 - Compatibility with our project: Our project depends on recycling and reusing E-waste, which naturally reduces the harm E-waste causes to the environment, in terms of losing valuable metals or emitting harmful toxins into the soil or air.
- 2) Portability and user-friendliness: Our project must guarantee accessibility for the following reasons:
 - Portability allows the project to be used anywhere, which could be useful in for example, in projects that use E-waste for water filtration. Such a device would require moving. For example, if a traveler can use the device anywhere, that means he has access to clean water throughout their journey.
 - User-friendliness and Safety allow anyone to use the project without needing knowledge of how it functions, which, when paired with its portability, allows the device could be used by anyone at any time.

GREEN

Malek Sayed

In our capstone project, we are working with old electronic devices and recycled electronic waste that can be malfunctioning and have a lot of errors. As we conducted our research about electronic waste that we must use in our project, we concluded our design requirement that fits our solution and really determines if it is efficient or not.

1. The first design requirement we put is that all the parts must be recycled. As one of our main challenges is pollution and recycling, **83%** of electronic waste is not recycled, and it has heavy metals like arsenic and cadmium that can leak to soil, water, and air, causing severe pollution like acid rain. So if we succeeded in recycling all of them, this would result in a significant pollution decrease and an economic spike, as there are rare expensive metals used in electronic parts, like gold and aluminum, which are so cheap and easier to recycle than to extract from raw ores
2. The second design requirement that we put is that we can't make more than 5% error, which is calculated by $(\text{absolute value of the measured value} - \text{the standard value}) / \text{the standard value} *$

100%. This determines the efficiency of the used old electronic parts and what the problem is in your device, whether it is a problem in the sensor or in the experiment itself. Also, this error, if it exceeds the determined value it can make all the calculations wrong and make our prototype considered a failure.

To conclude, design requirements are very important to determine the efficiency of your prototype and whether you really solved your problem or not.

GREEN

Baraa Ahmed

Getting back to the original problem to be solved, which is primarily concerned with the reuse of e-waste in new appliances, for the purpose of preventing leakage of harmful wastes into the environment, we see that the problem statement already narrows down the required objectives a lot. Engineering solutions are definitely variable depending on what teams value most. However, narrowing down the research question to a specific statement as previously stated has to create a form of constraint to what the priorities are supposed to be. In our previous example, sustainability and recycling comes first, whereas operation and usability come second. These have direct effect over the kind of design requirements we have, which state that no component should produce any kind of emissions or byproducts that are harmful to human use or to the environment overall during operation, and that the instrument should be able to make measurement or be measurable at an error value of less than five percent. Those two requirements tackle the aforementioned constraints, and it is a team's job to ensure good coordination of priorities through proper communication and following of the conventional steps of the Engineering Design Process.

GREEN

In CS.2.02, you learned that designing a database involves establishing relationships between tables to ensure effective data connections.

Similarly, when creating a new laboratory device from components of older devices, it is essential to establish functional relationships among these parts.

Explain how this understanding guided your decisions in selecting and connecting the components to design a successful and efficient device. *

Learning Transfer

Ziad Salah

Very similarly to how databases, tables, and entities are linked, our project – an oscilloscope that creates a function based off of an input signal calculating a set of variables (most notably frequency, and amplitude) is linked with 3 circuits that an electric signal must pass through. Provided with our oscilloscope is a channel which allows the input of said electric signal, which then goes in the process of filtering itself to reach our processor – extremely similar to how the bus topology is in networking.

The circuits are similar to how a database, in this case – our oscilloscope (the database) contains a set of tables, in this case – our multiple circuits which (the tables) contain a set of entities, in this case – our electronics. This understanding, alongside understanding how a bus process goes, allowed us to establish the following connection

1. The usage of a high-pass filter circuit that allows only a certain frequency to pass through, ensuring all redundant electric signal noise is cancelled – this then connects to:
2. An amplifier circuit, which increases the amplitude as to allow only a threshold voltage to pass through and be read by our processor while cancelling out all electric noise – this then connects to:
3. A bias circuit and an AC to DC circuit, this allows the signal to be read by our processor without any lag or miscalculations, ensuring efficiency and accuracy.

To conclude, similarly to how tables in a database may be connected to each other in a one-to-one form, our projects' circuits are connected in a series of one-to-one circuits.

GREEN

Omar Adel

When studying databases and table relations, two main things can be understood:

- First, Key or primary data and their importance.
- Second, structure and relation connection

These concepts help us construct an efficient database that stores information well. Utilizing this information in our project we can make a realistic relationship and connection that is most efficient between the components.

1. First, the components 'primary data'. every component in our project runs on electricity and sends signals in the form of voltage, this voltage and its frequency is what is translated into data and readings. Therefore we know it is the primary part of the circuit and must be handled carefully or false results will occur, So we utilized high quality wires and components that last for long times so they don't decrease the voltage and keep that information transferred through the circuit well.
2. Second, the structure and relation. We know that some tables have some relations between their data and it is essential to know exactly the relation and not mix it up or data will give false readings and results. Similarly in our project, we need to know the relation and correct connection between components; a sensor wouldn't be connected to a battery, but to an Arduino or micro-controller, such that the readings are received in the form of Many to one (many readings to one Arduino) while a battery would instead be connected to the Arduino so that the Arduino can power and display the sensor's output.

In the end it wasn't only helpful for studying databases and tables but also to inspire our components and the connections between them.

GREEN

Mazen Askar

Databases are organized systems for storing and managing data efficiently. They use structured tables composed of records (rows) and fields (columns) to represent real-world entities. Each record is uniquely identified by a primary key, while foreign keys link related tables together. The relationships between these tables, one-to-one, one-to-many, or many-to-many, are represented visually through an Entity-Relationship Diagram (ERD), which maps how data entities interact. These relationships ensure data integrity and eliminate redundancy through normalization, allowing reliable queries and analysis across interconnected datasets. In our Capstone Challenge on e-waste management and recycling, we

applied database concepts to organize information about collected devices, materials recovered, and processing locations. Designing an ERD helped us visualize how different entities, such as waste type, source location, and treatment method, were connected. We used primary keys to uniquely identify each collection event and foreign keys to link it to the corresponding material records. This logical structure allowed efficient tracking of recycling outcomes and resource recovery rates, simulating how a real e-waste monitoring system could operate on a national scale. Understanding relational databases (using the created functional relationships) reinforced the importance of structured information systems in environmental management. It showed us how computational tools can turn raw data into meaningful insights, supporting evidence-based decisions for sustainable solutions.

BLUE

Malek Sayed

As we learned in (CS.2.02), we learned about databases relationship between variables and tables, and how to connect variables to get a whole new outcome. This will be very important as we also connect old electronic parts to make a whole new device that measures something like humidity or heat, etc. We learned how to make databases using the PHP My Admin app.

As we are making a device that calibrates humidity and heat and makes a good environment for plants to grow, using these variables, similar to databases, we make connections between tables of variables that relate to each other. Heat and humidity strongly relate to each other as they must be suitable for plants to grow, as we add heat by air heaters that increase the temperature by heating the air itself self and also add humidity by boiling a little amount of water to increase the percentage of water vapor in the air. We connected this device to the same central hub and coded that if the heat increased, the humidity also must increase, as plants like rice require high temperatures and humidity. And we connected the sensors also to this device to measure the temperature and humidity to see if it is suitable or not.

To conclude this learning outcome benefited us a lot in understanding the connections between variables iin our prototype and how to make them work together to get the perfect output and environment for the plants

GREEN

Baraa Ahmed

Establishing relationships between forms of data, especially in tables, is an excellent analogy to the idea of creating a new laboratory – all devices are required to be operable for the main purposes of the laboratory itself, and similarly, all data in databases must be organized, coherent and maintaining relationship, for the sake of both the developer and the end user (if exists). For example, a simple

optical magnifying instrument cannot be used to examine cells – something that can only be done in a biology lab, and vice versa; a microscope cannot be used as a magnifier for a soldering station in the FabLab. It is, as a whole, a matter of determining the correct purpose of each component, and maintaining its applicability for each complementing part. In contrast, using parts for their unintended purposes may yield unclear results with great values of error. However, this is still avoidable; practically speaking, most components from old devices can be examined closely, and attributes such as the model number and/or manufacturing date can be used to examine more details of the component on the internet. The same analogy applies for aspects much broader than the idea of reusing e-waste – we can see that many doctors prevent patients from taking two certain medications at the same time, which may chemically react together, forming a potentially life-threatening condition.

YELLOW

Your capstone project this semester involves designing and constructing a scientific instrument for a school lab (Physics, Chemistry, Biology, or Geology) using primarily old electronic extracted components. Choose a specific device to build and explain how it can analyze the similarities and differences between electrostatic and gravitational forces, referencing Coulomb's Law and Newton's Law of Gravitation (PH. 2.02). Also, discuss how optimizing these principles could improve your instrument's performance and accuracy.

Learning Transfer

Ziad Salah

Our project this semester is essentially a function reader – an oscilloscope, this can be used to analyze an electrical signal into a function while most notably calculating the amplitude (voltage) and frequency at which the voltage comes and goes. This can be helpful for AC device measurements.

- This can be used in an intuitive manner using a “force sensor” to analyze certain aspects about the gravitational force of an object. Said force sensor can be linked to our detector – while hanging up a small steel ball on its weight and approaching another bigger, more dense steel ball. This would allow the analysis of the equation: $F_g = (G \cdot M_1 M_2) / R^2$, allowing the distance (R) between them (Masses M1 and M2) to be calculated using the gravitational constant (G).
- Similarly to this, we can induce a static charge into the device which reads, in a similar manner, the provided charge or distance using $F_e = (k \cdot Q_1 Q_2) / R^2$. This can also be used to analyze the differences in energy and how it can be derived – for example, energy can be derived from power

which equals the intensity times the provided force. Since we know the charge Q , and the voltage, we can use the time to calculate the energy!

- However, in gravitational forces, this can be different – the calculation of the potential energy and kinetic energy is way more straightforward.

These measurements require extreme precision and accuracy; therefore, such a project must be optimized to read such minute measurements reaching the 10^{-9} range.

GREEN

Omar Adel

A Force sensor device that measures how much force is applied to it in newtons is essential in many labs. This device wouldn't only help us calculate forces but understand some key similarities between coulomb's law and newton's law of gravitation.

How it would work is simple, a spring is connected to a block, a sensor measures how much the spring moves (according to the force applied to the block) and calculates the force.

- To calculate Gravitational force another block is placed nearby and its effect is then measured and compared to a calculated one using the law:

$$G M_1 M_2 / R^2$$

Where G is the gravity constant, M_1 mass of the block attached to spring, M_2 the other block's mass and R is the distance between them.

- For the electric field force, we would need to electrify the two blocks to give them electric charges then the force would be measured and compared to the calculated one using the law:

$$K q_1 q_2 / R^2$$

Where K is the coulomb's electric constant, q_1 is the charge of the block and q_2 is the charge of the other block

increasing the distance between the blocks by a factor of 2, the force decreases by a factor of 4, the device would be able to deduce the inverse square law as a similarity and the constants as well by varying the test subjects like mass/charge and the distance. Therefore to optimise the device I would insert a distance measuring sensor between the blocks to increase accuracy.

GREEN

Mazen Askar

In (PH. 2.02) we learned that static electricity results from an imbalance of electric charges between materials. When surfaces rub together, electrons transfer from one to the other, leaving one positively charged and the other negatively charged, a process known as electrification by friction. Other methods, such as conduction and induction, also redistribute charges without direct contact. According to Coulomb's Law, the electrostatic force between two charges q_1 and q_2 is $F = k \frac{q_1 q_2}{r^2}$. In our Capstone Challenge, where we turn E-waste into a scientific instrument for the lab, we used gravitation while calibrating a digital balance built from recycled sensors. The device measures weight, so linking voltage outputs to gravitational force was necessary to convert readings into mass. This made a universal law directly useful for a small, low-cost instrument. Newton's Law of Universal Gravitation is: $F = G \frac{m_1 m_2}{r^2}$. This practical connection taught us how a fundamental constant can validate a device made from e-waste, and how real-world factors limit accuracy. Understanding gravitational field strength and applying Newton's law turned raw sensor data into reliable mass measurements, showing that calibration and attention to experimental error are essential when turning discarded electronics into useful lab equipment. It also taught us handling sensors and metal casings safely required preventing unwanted static discharge. Learning how charges move and how electric potential forms guided us to insulate connections, ground components properly, and control current flow.

GREEN

Malek Sayed

as we learned in the first two learning transfers of physics. We learned about gravitational forces and electrostatic forces and how to measure them and use them in our capstone project. So we got an idea of making a device that analyzes the similarities and differences between electrostatic and gravitational forces in a specific area.

Optimizing these principles can make our device's accuracy more measurable as our device will measure the electrostatic and gravitational force. We can measure the accuracy of our device by observing the reading of both forces that our device has measured and compare it to the real value that we will get using Coulomb's law ($K \cdot q_1 \cdot q_2 / r^2$) and Newton's law of gravitation ($G \cdot M_1 \cdot M_2 / R^2$). Using these laws we can determine the real value and put it and the value that our device had got in this law ((the absolute value the value that our device measured - the real value that we calculated using the laws) / the real value * 100%) to measure the error of our device and determine the accuracy and the efficiency of our device.

To conclude we made a device that measures the electrostatic and gravitational force and used what we learned in Physics to measure the accuracy and efficiency of our device.

Yellow

Baraa Ahmed

In order to choose devices which makes use of both the electrostatic and gravitational forces, both Newton's law and Coulomb's law have to be analyzed first. Newton's law states that the gravitational force between two objects is directly proportional to the mass of each, and inversely to the square of the distance. Mathematically, it reads as $F_g = G (m_1 * m_2) / r^2$. Meanwhile, Coulomb's law states that the electrostatic force between two particles of charge is directly proportional with quantity of charge, and inversely with square of distance too, and the equation reads $F = k (q_1 * q_2) / r^2$. Both equations are very similar, where mass in the former is analogous to the charge in the latter, and the inverse-square law of distance applies for both as well. This similarity can be the key for a project idea: a distance measurer, where a lamp emits light in all directions, and the light intensity decreases with the square of the distance. By calibrating between the distances and the light intensity, the project can be optimized for better performance and accuracy. The difference between both equations lies in the fact that electrostatic force can be attractive or repulsive, whereas gravitational force is only attractive. A device that clarifies this is the one used in Milikan's Oil Drop experiment, when he wanted to quantify the charge present on a single electron through suspending charged oil drops by an external field. This is a clear aspect of difference for both laws of physics.

GREEN

Journal 3

During the Capstone execution, if you are a leader and notice that one of the team members is not performing their role within the group as intended, explain two strengths points of your team to help overcome this situation.

Personal Reflection/Team Collaboration

Ziad Salah

Now that we're nearing our capstone's climax and subsequently, the mid-terms, performance has degraded in my team's work; however, as the team leader, I can never let everything go to waste like this and help my team balance the work out.

I've noticed that work has especially decreased because of the mid-terms next week, especially when I kept telling one of my team members to write things in the research so that we can proceed with the development of our prototype; however, he procrastinated. He said that studying was more important to him. This required good social-skills that I personally lack; however, that's what a team is for. We can start saying from here that our strengths are:

1. Social compatibility, meaning that we can interact with almost anybody as a team despite some of us lacking common social-skills or find it hard to work with people. One of these skills is persuasion and the ability to convince someone to do something. This was important for our team member that procrastinated on their task.
2. Academic compatibility, meaning that we can finish each other's tasks, help each other in writing them and perform other academic tasks as a team with full optimum.

These two strengths (social and academic strengths) helped both persuade (a social thing) our team member to start writing the research (an academic thing) so that we can finish our prototype, and we also cleared up his mind and concerns about the mid-terms saying that we will help him study and write notes to study from together like a study group.

GREEN

Omar Adel

During the project it is natural that a fall out occurs where one member or both become unmotivated and decrease their work efficiency due to a number of reasons. It is our role as a team, leader or not, to help that teammate recover and get back to work well.

For my team we have different strengths that can help us in aiding each other:

- Work chemistry, my team and I have been friends for a long time and have already worked together on numerous things like class presentations, making us able to communicate our personal problems and help each other well. For example we noticed that one of our teammates was sad and his work efficiency declined, after talking to him we noticed that his family was moving and he was going to miss his old neighborhood, we reassured him that his friends there and here will stick by him and he shouldn't feel bad.
- Work ethic, our work ethic or the way we work together is simple; we understand that hardships occur therefore, we can take on extra work if necessary or exchange roles if someone is dissatisfied with their current one.
- Connections, we have been connecting with old alumni that share their experiences so we can become good at any role as fast as possible. This helped us teach the underlying teammate how his role is performed so that if difficulty is the reason he isn't performing his role, the problem is solved.

These are the reasons we are able to adapt well to any problem or a teammate lacking the ability to perform his work.

BLUE

Mazen Askar

Being a Team leader is not an easy task; having to monitor every member's performance, collect their tasks, while also facilitating communication, can be stressful, and one of the problems I occasionally face as a team leader is when some members are not performing their role as planned. It is crucial that every member sticks to their role and performs it effectively because each role is dependent on the other, whether that is the team leader, the writer, the researcher, the designer, or the prototype builder.

One of the problems that we faced recently was the overworking of our team's writer, and another was the inability of our prototype builder to work due to medical reasons. Thus, our team implemented 2 strong points to overcome those issues, which were:

1. Cycling of roles: We decided that every 2 weeks we will switch roles, even if we weren't as comfortable in our new role as our previous one, this way, each member gets to try every role, creating sympathy and a wide understanding of the effort that goes into the tasks presented by every member, while also giving each member a fresh change of pace.
2. Sharing work: Although every member has their own specific roles that they stick to, we share the work in tiny portions, even if it doesn't match our roles. This allows the team to synchronize while also encouraging teamwork and companionship on personal levels.

With these 2 points, the team was able to overcome drops in performance by members in their roles.

BLUE

Malek Sayed

in our capstone project, every member of the team has their own role. There are many roles, like the leader, the time manager, and the researcher. If I were the team leader and one of the team members is not performing their role efficiently, this will cause significant problems, as every role is very important to achieve good results. As a team leader, I will rely on these two strength points to solve this problem.

1. The first strength point of my team is understanding and helping each other. As we are friends before we are teammates, we don't judge each other quickly. We first understand what caused the problem we are facing. For example, if one of my teammates is not performing his role effectively, I will first ask him what causes this problem, as there might be personal problems or a specific struggle he is facing and needs help. In this situation, we will help him beat any problems or struggles his facing and even help him complete his work.

2. The second strength point we have is knowing our tasks from the beginning of the project. The first thing we do in our capstone is distribute the tasks evenly from the beginning of the term. Because if our teammate has no problems and is not doing his work stubbornly. First, we will ask for the reason. If he has none. I will try to convince him about the consequences of his lack of care as every role has a significant impact on our capstone project. If he is still not working. We will complain to the capstone leader.

GREEN

Baraa Ahmed

One of the most important qualities of group projects is malleability and resilience in communication, where a disturbance caused by one team member for example wouldn't pause progression for the whole team. This kind of resilience in communication requires a great deal of intelligent social and emotional managing; a soft skill required nowadays. This sort of patience may come in many ways, but it can be limited in our case of a capstone project to only a few. First of all, a change of mindset is necessary for good communication; where members think together as a team collaborating together for a shared goal, and not as a list of tasks that shall be done, regardless of what the rest of the team does. This shift of mindset ensures that there's actual care put into the work itself and its coordination with team members. If I were to apply this in my team with that scenario, then team members would be willing to take the extra mile of finishing off the rest of the work for the sake of the whole group. However, finishing work only is more of a temporary solution rather than a permanent one. We cannot intentionally leave a team member continue to underperform, which pushes forward to the next

strength that underlies the resiliency of a team: working on the team itself, and not the project. As counterintuitive as it sounds, it goes a long way in improving a team's performance. Examples include helping teammates learn each other's skills, to ensure balance. That way, our team member wouldn't be left behind for long!

GREEN

You are currently in the construction stage. Describe two key design requirements that were most important for your project, and explain how those choices influenced the design and construction of your prototype.

Using the Engineering Design Process (EDP)

Ziad Salah

The EDP is a cornerstone process that helps establish the pathway or flow things should go towards while constructing our prototype. The design requirements stated were a lot; however, there were two key design requirements that would change everything, those being:

1. The limitation of materials to recycled materials
2. The recalibration of sensors or devices to keep errors <5%

These two are the most impactful and are essentially what shape the prototype and results.

Considering that we must measure something and compare our results off of a standard device, my team and I chose a device called an "oscilloscope" – a device that analyzes electric signals. This caused the following changes to be made:

1. Initially, we thought we could use a normal Arduino development board to process the electric signal; however, it turns out that you have to make your own development board to be able to actually process things (to abide by the recycled materials design requirement.) By research, the Arduino forums showed a step-by-step guide on how to make one using their own microcontroller extracted from an old FM radio.

2. Another modification that was done was the filtration or noise-cancellation of incoming electric signals because it was initially going to be transmitted through a (headphone cord) which are known to be not accurate. Therefore, we implemented a high-pass filter consisting of one capacitor whose unit is $22\mu\text{F}$ and a resistor whose unit is 300Ω to block out frequencies below 20 Hz which are considered noise. This increases the accuracy of the device.

GREEN

Omar Adel

- As we are constructing our prototype, we have picked out a couple of design requirements that determine what our final product will look like. These design requirements are:
 - Simple design and easy to take apart. In our project we are supposed to use recycled electric parts and old ones in general, the problem with this is that these parts could be damaged or not withstand the same load of work as a new one therefore, we have decided that a lot of substitutions are going to occur and made it so that the wiring and connections can be taken apart easily and replaced if needed.
 - Easy calibration. Since most readings of measurement are just translated voltage and electric signals, we knew that some wires might get damaged due to external factors making the readings inaccurate. It is hard to know where damage occurred in a circuit, so simple calibration is really important to make sure that results can be revived and accurate. We did this by adding extra checkpoints in the circuit that measure the signals and voltage, if a major difference is noticed between two checkpoints then the damage is between them and either calibration of this region is required, by using voltage amplifiers that just enlarge the voltage and signal so it can be easier to read.

These requirements have made our design and construction phase change which is normal and expected; we found that the prototype is going to be larger with more circuitry and increased period of construction. However, this didn't affect us as much because we started the construction early in the case of any setbacks such as this.

BLUE

Mazen Askar

Upon initiating the construction stage, it is important to set design requirements to specify important criteria to determine whether the project is successful or not. Two design requirements that our team thought were crucial were: Portability and User friendliness: These two separate design requirements were necessary because they allow anyone to use the prototype at any time, safely, without confusion.

They affected our prototype's design as initially, our prototype was going to be made in a relatively larger size, where its dimensions would have been 40 cm * 20 cm* 10 cm, but after deciding on keeping it portable, the design was shrunk down to a 4*4*2 cm, which came with several complications as not only the container size was changed, but also some used materials such as LEDs were replaced to save on size.

Likewise, one of the boards was changed due to its complexity in code, which meant if the prototype were to malfunction later, the average user wouldn't be able to fix that issue, but by replacing it with a simpler board, it is now usable by anyone, even without proper education.

A bonus design requirement that affected our design was the safety of the prototype, which aligned with our user-friendliness, as our prototype initially required safe handling by experts. At the same time, it was easy for average users to get hurt in the process, but after changing the size and the board, the prototype became safe.

These two design requirements caused changes to the used materials and the design size, affecting the construction of the prototype.

GREEN

Malek Sayed

In the construction stage we must focus heavily on the design requirements as your prototype's efficiency relies heavily on the design requirements and after defining the problem and some research, we concluded our design requirement that fits our solution and really determines if it is efficient or not.

1. The first design requirement we put is that all the parts must be recycled. As one of our main challenges is pollution and recycling, 83% of electronic waste is not recycled, this shaped our prototype as we focused on getting only recycled electronic waste instead of new parts as this helps the environment by not polluting the soil, air and water and also economically as it preserves the expensive metals in e-waste, for example we are making an oscilloscope, so we extracted the sound receiver from an old mobile phone, and we made our aux cable from old headphones instead of buying them.

2. The second design requirement that we put is that we can't make more than 5% error, we focused heavily on this design requirement as we made sure to add microcontrollers and IC boards to clear and amplify the signals coming to our oscilloscope to prevent errors as much as we can and also create a 2.5 voltage bias as the aux cable gives readings from -1 to 1 volt and this negative inputs can cause errors in the readings so we added resistors and capacitors to make a DC offset of 3.5 V to make the center of the readings positive (2.5V)

To conclude, design requirements are very important to as it influences you in making your design for your prototype and constructing it.

BLUE

Baraa Ahmed

Our project, in summary, deals with a large part of this semester's physics curriculum, and employs a great portion of laws, from Kirchhoff's laws to Faraday's Laws of Induction, in particular. Our prototype is an analog Galvano-multimeter, which can measure voltage, current intensity, and resistance, appearing through the moving needle right above a certain calibrated scale. Considering the given info, our constraints and design requirements were taken straight from the principles we had to apply in our project. Considering that resistors behave quite differently under temperature, it was our first priority to ensure that not a single component of the electrical circuit would heat up above 55 degrees Celsius; avoiding non-Ohmic resistance. The voltmeter and ammeter employed are supposed to move linearly against a previously calibrated scale, which means that every single bit of stability is required for best accuracy. Speaking of accuracy and calibration, the main purpose of the multimeter; it was our second design requirement to ensure that correct reading (when avoiding parallax/human-eye error) does not exceed an error value of $\pm 5\%$. This percentage in particular is easy to achieve by many means, whether it be elongating the moving needle or increasing its range angle, and at the same time it can be negligible for small-scale, school-labs applications. Our choice of those two design requirements may make the construction of the project take longer, but it surely gives confidence that not much further adjustment would be needed after finishing the project.

BLUE

In CH2.01, you explored different ways to express concentration.

Recommend a device that could be utilized in a chemistry lab to measure one of these concentration terms. Furthermore, outline an experiment or a straightforward procedure that you could carry out to test or calibrate your device to ensure its accuracy.

Learning Transfer

Ziad Salah

In chemistry, there are several devices that can be used to measure the concentration of something or even other values such as pH . These devices utilize different methods; however, the most common and traditional method is just titrations, as we studied in CH.2.01.

An example for a device that we can use to measure concentration more accurately is called a spectrophotometer (the name is long, but we can split it up). Spectro here means spectrum (as in, across a range!), photo means image (or light), and meter means measuring device. This device utilizes several laws and it mostly depends on something called the Beer-Lambert law. What the device essentially does is that it utilizes something called "Brownian motion" which is a phenomenon that

occurs when light passes through a solution such as a colloid (as we studied in CH.1.08). Brownian motion causes the light to scatter in a certain way. The device then starts reading in those light waves and inputting them into certain equations through the processor to calculate the concentration of the solution.

This method is accurate; however, two methods can be used to check its accuracy and increase it, of which are:

1. The comparison between the result of the spectrophotometer and a standard, precisely done titration to find the concentration of the solution; this method is essentially just here to check whether the device is accurate and consistent with the real value from the titration or not.
2. The recalibration of the components and testing them.

BLUE

Omar Adel

Measuring the concentration of a solute in a solvent is hard if the solution wasn't prepared before-hand, as we don't know how much of each compound was used, however, there exists a number of devices that help in measuring this concentration or estimate it. One of these devices is the spectrophotometer.

How it works:

- it is quite simple, a light from an LD source is shined at a clear flask containing the solution, after it passes through, a sensor picks up the light and translates it into an electric signal. This signal is weak if the light is refracted too much, due to the collision of photons with the chemical particles. This signal is then compared to the initial light intensity and how the water in this solution already affects the light, the result of subtracting them from each other yields how much the compound has affected the light intensity and then it can estimate how many particles in this solution exist.
- After estimating the number of particles the device divides it by Avogadro's number to yield the number of moles:
 - $N \text{ of moles} = \text{number of particles} / 6.67 \times 10^{23}$ (Avogadro's number)
- After getting the number of moles we can then calculate either:
 - the molarity = number of moles of solute/ volume of solution in Liters.
 - The molality = number of moles of solute/ mass of solvent in liters.

To calibrate this device we can easily create our solution with measured and already known values, then compare them to what the device yields and see if it needs to increase or decrease.

BLUE

Mazen Askar

In this learning outcome, we explored different ways to express concentration, such as molarity ($\text{mol}\cdot\text{L}^{-1}$), molality ($\text{mol}\cdot\text{kg}^{-1}$), ppm, and mass percentage. This is fundamental in preparing accurate chemical mixtures and ensuring reproducibility.

Understanding these relationships allows chemists to compare solution strength and predict reactions precisely. Our team designed a spectrophotometer, which measures how much light a solution absorbs and is ideal for determining the concentration (molarity) using the Beer–Lambert law. The law states that absorbance is proportional to concentration, so with a calibration curve, you can convert measured absorbance into an accurate concentration. $A = \epsilon c l$ where A = absorbance (unitless), ϵ = molar absorptivity ($\text{L}\cdot\text{mol}^{-1}\cdot\text{cm}^{-1}$), c = concentration ($\text{mol}\cdot\text{L}^{-1}$), l = path length (cm).

To test and calibrate our device, we experimented with the following procedures:

1. Choose an analyte and a wavelength
2. Prepare 5 standards of known molarity (use volumetric flasks). Example: 0.01, 0.02, 0.04, 0.06, 0.10 M.
3. Set the spectrophotometer, clean cuvettes, and zero with blank (solvent).
4. Measure each standard in triplicate; record mean absorbance.
5. Fit linear regression
6. Determine unknown sample concentration from the fit:
7. Validate accuracy with a blind standard; compute percent error: $\% \text{ error} = |c_{\text{measured}} - c_{\text{true}}| / c_{\text{true}} \times 100\%$ (our project allows a 5% measurement error)

This process verifies the spectrophotometer's accuracy and ensures reliable quantitative analysis, connecting theoretical expectations to precise experimental practice.

BLUE

Malek Sayed

In CH.2.01, we learned about different ways to measure concentration, like molarity and molality. This can influence us to make a device that measures the concentration of solutions in the chemistry lab.

1. We can make a colorimeter, which is a device that measure molarity of the solutions we can use it to measure the molarity of sugar in water then calculate it by its law (number of moles/liters of solvent). And compare the two results to measure the error which is calculated by (the value from the law - the value from our device)/the value from the law.

2. We can also make a spectrophotometer, which measures the concentration of the solution by the divergence of light pathing through it. We can know if our device is accurate with this experiment, first we make a sugar solution and measure its concentration this passing the light and measuring the concentration through beer-lambert law the measuring the error by comparing the both of them.

To conclude this learning outcome, gave us a lot of ideas of devices to make in the chemistry lab and taught us how to measure its efficiency

GREEN

Baraa Ahmed

The chemistry lab has multiple measurement tools which can measure and express the same quantity in multiple different methods, each for different purposes. For example, a very little amount of salt in water may be quantified and expressed through molarity, molality, mass percentage, or even TDS. The most straightforward application in a chemistry lab would be a pH-meter device. It is quite self-explanatory; it provides a certain number which expresses the amount of free H^+ ions on a logarithmic scale, making it the most appropriate method of measurement between acids, bases, and water being at the middle of the scale for reference. Such device may also be calibrated through acid-base titration, a procedure followed on a great scale, from schools to research labs. It works by finding the exact amount of standard acid (base) with known concentration, in order to completely neutralize the complementary base (acid) with unknown concentration, in the presence of a pH color indicator. Both the device and the procedure would be helpful for the chemistry lab, but as aforementioned, both serve different purposes, where a digital device would be less time-consuming and maybe more accurate, whereas accuracy in titration takes much more time. Regardless, some applications require that titration be done instead, for a multitude of reasons.

GREEN

In Math 2.01 you studied Modeling with Functions. Explain how mathematical modeling functions can be used to design and predict efficient ways to reuse discarded electrical devices so that waste is reduced and the scientific and technological environment is improved.

Learning Transfer

Ziad Salah

In the same manner math is utilized in big industries like furniture, textiles, computers, and such, we can use it in recycling, calibration, and etc. This can be done by modelling garbage e-waste hauls every month versus the recycled e-waste hauls. We can then aim towards increasing/shifting the distribution towards the recycled e-waste hauls.

We know that when recycling e-waste, performance may have degraded due to wear and tear, overuse or overheating, therefore, we can use mathematical functions to describe the way that these components' efficiency and functionality fall against time. For example, something like a resistor that overheats during usage causes its resistivity to fall off exponentially. In our project, for example, we used mathematical modeling to find how we can collapse noise or get rid of it completely. This was accomplished using a high-pass filter which, if it detects something below a threshold, it collapses it.

We also used it to enlarge or magnify the incoming signal due to its minimized input so that we can process and kick out unwanted signals aswell.

The project we're making is called an oscilloscope which analyzes the electrical signal. Let's say we're feeding a sine wave $f(x)=\sin(x)$. We can then put it in our multi-stage filter, where if its frequency is above a certain threshold it passes. Meaning that $f(x)=\sin(ax)$ must have a fraction factor, and we said that we were going to amplify it so we say: $f(x)=b\sin(ax)$ meaning that it has a higher amplitude. We can then predict the voltage at any point.

GREEN

Omar Adel

Mathematical function modeling is very useful in determining the quality of any old electric device, this is because there is a lot of different functions that help show the relation between two variables.

In our work of extracting different electric parts, we used a graphing multimeter. It is simple, it increases the independent value like voltage or current intensity passing through the wire and plots it on

a graph against a dependent variable like heat produced, resistance or total conduction at the end of the circuit.

How these helped:

- In the case of a decaying function or a decreasing end behavior, we can then know the limit or highest point the voltage can reach before this part gets overheated and damaged making the voltage drop again. This makes it so we know which parts can withstand specific electric signals and where in our circuit we can use them.
- In the case of an elevating function or increasing end behavior, we can know that this part can withstand high voltages and signals without failing to conduct or pass it through the current, we can then determine its use like extracting the electric current from an outlet and splitting it into the different parts that withstand a lower threshold of electricity.

At the end we can now compare the recycled parts' capabilities to different parts that are new, this comparison should show us which part is still viable for use or not and where can we utilize it even against its intended use.

GREEN

Mazen Askar

Polynomial functions play a vital role in modeling relationships between scientific variables, allowing us to predict and understand complex physical behaviors. In our challenge, turning E-waste into functional lab equipment, mathematics is essential.

Polynomial curves are particularly ideal for expressing nonlinear data trends that often arise in real-life measurements, making them indispensable for validating the reliability of our recycled prototypes.

Our team designed a light intensity analyzer made from recycled scanner sensors. We used a polynomial function to model the relationship between input voltage (V) and light intensity (I). The output data collected during calibration formed a nonlinear pattern, best fitted using a polynomial of the third degree: $I(V) = aV^3 + bV^2 + cV + d$ where a, b, c, and d are constants obtained from regression analysis. This curve allowed us to interpret the sensor's analog response accurately and predict missing or extreme values.

By analyzing the polynomial curve, we could detect sensitivity regions and identify points of linear stability crucial for reliable readings. The polynomial's smooth continuity made it ideal for representing real instrument behavior without abrupt jumps.

The fitting process also revealed physical limitations of the reused photodiode, showing saturation when the voltage exceeded 4.5 V. Thus, polynomial modeling not only validated our recycled sensor's

usability but also provided a mathematical foundation for testing accuracy, analyzing trends, and comparing experimental data with theoretical expectations.

BLUE

Malek Sayed

In MA.2.01 we learned about modeling with functions and predict the behaviour of certain measurements. We can use the polynomial functions to graph the inputs of our prototypes.

For example our project is an oscilloscope that takes signal and clear and amplify it the it measures the amplitude and frequency. Our main function is graphing these signals to visualize the input from the calibrator, and we can also graph the difference in frequency between signals that we got. Also we can graph the rate of wasting the electronic waste through out the years this will help people see the danger caused from dumping the electronic waste and make people recycle them. Using the General Formula: $P(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_2 x^2 + a_1 x + a_0$ Where: $P(x)$ is the polynomial function, x is the variable, n is a non-negative integer (0, 1, 2, ...) called the degree of the polynomial, $a_n, a_{n-1}, \dots, a_1, a_0$ are constants called coefficients, a_n is the leading coefficient (and $a_n \neq 0$), and a_0 is the constant term, we can make a lot of functions that visualize our outputs and inputs in our prototype

BLUE

Baraa Ahmed

Our prototype is an analog Galvano-multimeter which can measure voltage, current intensity, and resistance in a given circuit/load, through a moving needle against a previously calibrated scale on the device.

When applying the voltmeter or the ammeter, the needle moves linearly, or by the same angle for each volt/ampere unit added. These can be modeled through a simple linear equation of $y=mx$, where no y -intercept is needed because the scale starts at zero, and the slope can explain the relationship between the needle angle and either the voltage or current. The ohmmeter works quite differently, though. Due to the presence of resistors connected in series and parallel the scale of measurement is not linear, but rather logarithmic, and the ohmmeter works by applying maximum current, giving zero ohms, and then measuring the magnitude by which it decreases. While the scale of the voltmeter and ammeter both start from left to right between zero and a finite number, the ohmmeter scale starts from right to left, between zero to infinity. An example for reference is this: adding 10 ohms would let the needle move 5 degrees, then 3 degrees, then about 1 degree, and so on, until the scale is too large to move further. This employment of mathematical modeling functions may enable us to measure the magnitude of error that may arise when performing measurements with the project.

GREEN

Journal 4

STEM School students have unique experiences they gained through studying in STEM Schools, that make them different from their peers those who study in other educational systems, explain two experiences you acquired, and how you will apply these experiences in your future academic life.

Personal Reflection/Team Collaboration

Ziad Salah

STEM Schools are a unique experience and the studies every student conducts – including me is actually quite lucrative; however, no experience is like any other.

In my eyes, my experience in STEM has been a journey of ups and downs – but as they say, “Maybe sometimes the best path to be taken is the hardest one.”. When I first thought about STEM schools, I mainly focused on the SKILLS I was going to gain and the EXPERIENCE I’ll have. I’ve never thought that today that these SKILLS would be so much.

I’ve passed through two transitioning phases that can be considered MY unique experience, of which are:

1. Transitioning from pen & paper notes to digital notes and relying on myself in my studies; this was a sharp shift in performance and was a unique experience; I first denied the idea of using a computer to write notes but by time and due to the help of other students, I managed to increase my writing speed and enhanced my style! When I started studying, I also relied on references and websites. All of these can be APPLIED by SELF-INDEPENDENCE AND RESEARCH in academic work.
2. Transitioning from non-scientific content to purely scientific and academic content – when I first entered, I was confused about what the capstone was – what journals were – but after time passed, I quickly picked up on what they were and started generating scientific content, especially in my team’s portfolio. This paved the pathway in my academic life to be able to write research papers, like one about arsenic and rice for ISEF and one for a rigorous program called Pioneer.

GREEN

Omar Adel

Studying in STEM didn't only elevate technical and educational experiences, it helped me improve as a person overall and changed the way I would encounter a problem or go on about my everyday life.

1. Self-dependence, having to look for my own study materials, research information and work on the capstone project didn't only influence my study habits, but also how I act through-out the day. Instead of relying on my parents and older siblings to do things like get groceries or cook food, I found out that if I just try to do it myself, I will be able to be self-dependent later on.
2. Helping others, throughout normal educational systems everyone is taught to do their own part and focus on themselves, however, while interacting in clubs and the STEM school community, I realized that helping others doesn't affect me negatively, instead they can help me in the future when I do need help. I truly understood the idea of a strong loving community due to the hardships and work we all shared.

For me these experiences and traits are invaluable and I must not waste them, I will keep hanging on them and use them in my future academic and non-academic life, I will keep depending on myself and learning on my own whilst helping others as much as I can even going as far as tutoring them too.

GREEN

Mazen Askar

STEM students are ahead of their peers in different aspects of academics or skills due to STEM's unique educational system, which offers excellent methods to digest more curriculum and soft skills in much less time than their Peers in other educational systems. Three of those experiences that I have acquired and treasure are:

1. **Presentation skills:** In STEM school, students are often required to present in front of an audience, whether that is due to explaining LOs, or presenting their projects in the capstone exhibition. This skill is critical in many aspects of applications other than just my future academic life, but also in job interviews, college admissions, and even simply being able to convey a point to someone.
2. **Teamwork:** STEM's educational system revolves around teamwork, whether that would be in helping teammates achieve their personal goals or collaboration on capstone projects. Once again, I will apply such skill in many things other than my academic path, as teamwork is a unique skill, and being able to collaborate with others effectively will increase efficiency in workplaces, or academic projects, etc.

- 3. Leadership:** STEM students are flexible, which is a critical part of being a good leader. This skill, in particular, I take pride in because not everyone, specifically a high schooler, can hold a team together, facilitate communication, and have his followers trust in his vision.

These three experiences that I have acquired from STEM shall be beneficial in my future academic life if used correctly.

BLUE

Malek Sayed

STEM educational system is unique in many ways as you are experiencing a whole different life compared to the life of people in other educational systems, working in the capstone with 4 teammates you don't know this makes people in STEM schools different from their peers who study in other educational systems.

The first experience I acquired is teamwork, when I came to the school for the first time I found myself working with other students I don't know to make a project that solves a certain challenge that Egypt is facing, this made us forced to work together and understand each other and everyone's advantages and disadvantages. for instance, in G10 S1 after we distributed our roles and tasks. Every one was working as an individual not as a group. But I came up with a strategy to combine our work. I made the team work on a shared word document this made every member of the group could see everyone's work. this will help me in my future work as in most of companies you work with your colleagues and this requires teamwork.

The second experience is time management. In the first semester I lacked experience, and I was nervous about the capstone and the learning outcomes I must study which made me get a bad grade in then first semester. But then in the second semester I learned how to manage my time to finish all the work without bias in a certain thing like focusing on the capstone without studying the curriculum. This taught me how to work under pressure in the future when there is a lot of work to be done in low amount of time.

GREEN

Baraa Ahmed

Students enrolled in STEM schools have been subjected to many kinds of experiences, whether it be on the academic, financial, or even personal levels. They're taught to learn much broader curriculums while maintaining balance with other activities; a quality that makes them distinct from students of other systems. The most two prominent experiences were: 1. The research-oriented curriculum, and 2.

The capstone project. While a student in conventional schools sits in their room all day, locked in a cycle between reading books, drinking immense amounts of caffeinated drinks, and attending online sessions, they may be able to form satisfactory abstract ideas, however, limited to the scope of their rigid curriculums, which do not have flexibility to allow for enough critical thinking and innovation. Comparing this typical scheme to my experience in a STEM system; I found myself to be at a much more superior level, in terms of research skills, work ethic, and work capacity.

For example, I was able to retain larger, more dense blocks of information at relatively shorter time intervals! Speaking of rigid curriculums, these will, in turn, give an output of students that're incapable of figuring out their own conclusions from different pieces of information. Therefore, it would be nearly impossible for a conventional-school student to fully create a capstone project. In my case, a capstone project has taught me even more about how things work in scientific communities; from collaboration, academic integrity, skepticism, and even more about critical thinking!

BLUE

During the prototype testing phase, it was discovered that one of the design requirements was not met. Describe in detail two strategies to overcome this issue.

Using the Engineering Design Process (EDP)

Ziad Salah

The EDP is a cornerstone process that helps with any problem relating to the capstone and the prototype, especially when trying to meet the DESIGN REQUIREMENTS in the TESTING phase.

When my team and I started constructing the prototype, we started off by constructing a microcontroller to process any input that we want (as in, program it and make it do specific tasks). And then we shifted to the actual prototype's parts which were mostly extracted from routers, headphones, and such. The prototype's idea itself is to read a FUNCTION or WAVE and analyze it (calibrated to read variables such as frequency, voltage, and time.)

When we finished constructing, we had made one filtration stage, this is so that the electric wave doesn't have any unwanted noise; however, when we tested by inputting ELECTRICITY from a FUNCTION GENERATOR from the FAB LAB, we found that the readings were extremely off, a READING of VOLTAGE was 0.9V while it was 4V on the function generator, this was a VIOLATION of the ERROR PERCENTAGE DESIGN REQUIREMENT.

To mitigate this issue, we performed two strategies:

1. We IDENTIFIED the PROBLEM by doing a SIMPLE SEARCH, we found that the FILTER had an issue because it was PASSIVE and not ACTIVE. We also found that the microcontroller could NOT read a negative voltage and that this would damage it and give false readings.
2. Looking into PRIOR SOLUTIONS and OLD ELECTRICAL COMPONENTS, we found something called an AMPLIFIER in a headphone, this was used to create an ACTIVE filter, which gives a more ACCURATE reading and also gives only a POSITIVE voltage.

BLUE

Omar Adel

It is common for a design requirement to not be met at first, and this is the use of the testing phase; to find out if anything went wrong or not working correctly before finalizing the prototype. When me and my team found out that our design requirement of low uncertainty and inaccuracy wasn't met, we took two necessary strategies to first find out about the issue and then fix it:

1. Reverse engineering, this is a common step when working with prototypes where we took it apart piece by piece and tested each phase. We took apart the latest installed parts and tested their connection integrity using multimeters, we then looked for any damaged wiring or weakly connected part. This helped us locate where the problem was, which was in faulty circuitry and components.
2. Researching and learning from others, although our issue might be unique, we can still use and learn from other people's experiences, even if the part damaged is different or damaged in a different way we can still learn how to fix it and then stop this from happening again in the future. We found out at the end that the damaged part had burned due to high electrical voltage and strain on the circuit which it couldn't handle.

Finally, we decided to get new parts and install a strong voltage regulator to this circuitry which decreases the incoming voltage such that the parts can handle it without getting damaged. At the end I think it was most beneficial to not only conduct the testing phase but to also follow these two strategies well to fix and overcome any issue.

GREEN

Mazen Askar

Our team assembled a prototype that measures light absorption using Photoresistance (LDR), and one of the design requirements that we set to achieve was portability, which we unfortunately failed to achieve as during the prototype testing phase, we realized that the prototype had increased significantly

in size in comparison to the original design's intended size, and thus we had to follow some strategies to overcome this issue.

- 1- Identifying what went wrong: Since our original design was smaller, we clearly committed a mistake during assembly that changed the size and ruined our portability; thus, we had to revise the steps of assembly using our portfolio. This resulted in the discovery of the first mistake, which was during the cutting of our wooden pieces. Instead of using MMs, which was the correct measuring unit, we used CMs.
- 2- 2- Researching possible solutions: while the extra size was a mistake, we quickly realized that we had happened to use all the space anyway, meaning we had to come up with a solution to shrink down the size, other than directly replacing the wood with smaller pieces. This resulted in us stumbling upon smaller sensors and microchips that serve that exact same function while being smaller.

Using these two EDP-inspired strategies, my team was able to quickly pin down the source of the problem, which is the first step in overcoming the issue, and from there, the team was able to quickly fix the prototype's size using the newfound information, ultimately causing our prototype to meet the design requirement of being portable.

GREEN

Malek Sayed

As we are already in week 10 and we have done so much progress in the capstone, after defining the problem (electronic waste recycling) and a lot of research we found our solution. Then we set the design requirements to reach maximum efficiency. but after building the prototype, when we started testing the prototype if it meets the design requirements or not we found that one of the design requirements is not met.

- The first strategy we will apply. Is searching for the cause of this problem. For instance if the error exceeds 5% I will look for what caused this problem, as we are making an oscilloscope. There is input signals that must be clear to achieve accurate results. if the signal is not clear or not amplified enough for the micro controller to read it and measure the frequency and amplitude also graphing the function. After applying this strategy I could find where is the problem.
- After applying the first strategy I reached what is the problem that causes this error. The second strategy I will apply. Is solving the problem I reached. For example the problem was that the signal is not clear which causes the readings to have a high error percentage. Therefore I will add a high pass filter to clear the signal which will result in more accurate results.

To conclude the test plan is very important as it decides if your prototype is successful or not. And makes you solve the problems in your prototype to make it efficient and meet all the design requirements.

Green

Baraa Ahmed

The design requirements we have stated for our project were put to ensure efficiency and applicability. However, during the prototype construction process, we found that we couldn't meet the most important design requirement: our prototype; an analog multimeter, had a reading error value of more than $\pm 5\%$!

We have followed many strategies, but we quickly learnt that only two were important, which are: The pre-mortem method: The pre-mortem method is predicting what would mostly happen, if a certain major setback has occurred during any given process, and how it would affect the rest of the project. We had already predicted our problem with the error value, and thought of a backup way to prevent it from happening. We concluded that: An inaccurate reading would not show big electric current changes in small time intervals (called fluctuations). It can be prevented by looking for higher quality components for the prototype. Revising the Engineering Design Process in the project. We had already met the problem and had to figure out why it happened. Therefore, we had to streamline the processes which had led to this caveat since the beginning of the project. We had revisited the following steps: Research Problem Prior solutions Selection of solution Selection of prototype Prototype specifications. From this process, we had concluded from one of the previous solutions that one of the faulty components could be replaced with another, entirely different model, thus minimizing the error value to $\pm 3.5\%$.

BLUE

In mech 2.03 you studied work done by various forces. In what ways can the concept of work done be applied to make the reuse of discarded electrical devices more effective in supporting scientific and technological development?

Learning Transfer

Ziad Salah

In (ME.2.03), we studied work and how it relates to the force, this relation is generically defined as: $W = F \cdot d$ where W is the work in Joules (energy unit), F is the force which is a vector in Newtons, and d is the displacement which is a vector. This means that work is the dot product of both of these and therefore relies on the angle θ between them ($W = F \cdot d \cdot \cos(\theta)$).

When looking at the concept of “work”, what do you think (when it comes to technology?)

You most commonly think of something that pushes, and most importantly, something called a LINEAR ACTUATOR (which is something that pushes things using electricity). And you’d be correct; both of these are extremely valid things that apply a FORCE and DISPLACE something by a distance.

Discarded electrical devices such as gym gear (cardio machines) for example can be used and recycled into making a new device, something that tests the work required to displace an object 10cm for example. Such a device can be placed in a mechanics or physics laboratory.

How can that even support scientific and technological development? Well, when looking at it the way I wrote, it may not be clear; however, if you look at it from a teaching standpoint, this is actually great for students who have never interfaced with scientific and technological equipment. What this means is that we can improve education by recycling discarded materials and reusing them for devices that can aid education and technological knowledge in the usage of complex measurement devices and the acknowledgement or focus on digital literacy.

GREEN

Omar Adel

Work done is a form of energy measurement of a system, it can be evaluated by the following equations:

- $W = \text{Force} \times \text{displacement}$
- $W = - \text{difference in potential energy}$

Since the law of electric force is,

- Kq_1q_2/R^2 ,

(where K is the coulombs constant, q_1 and q_2 are the charges and R is the distance) we can multiply it by the displacement (total length of the wire) to get the total work done:

$F(\text{electric}) * \text{length of wire} = \text{Work done}$

Although it might seem like this is irrelevant to electric components and recycling, it has proven otherwise. Since voltage is a form of potential energy, and the flow of electrons or electric signals is from high voltage to low voltage regions, we can deduce that the difference between voltage is the direction of electron flow. Therefore we can connect them to work:

- $-(V_1 - V_2) = W$

Where V_1 is the high voltage, V_2 is the lower voltage and W is the work.

How this helps:

When we know the strength of an electric field and its charge but not its voltage, we can't exactly know if it is safe for a specific component to handle this electricity; each component handles a specific range of voltage, being higher than this range can damage the part, being lower can decrease its efficiency. So by using it to calculate the work we can know the range of the voltage and determine whether it would be safe for the component to work under said electric field.

GREEN

Mazen Askar

In ME 2.03, we learned that work is done when a force causes displacement in the direction of that force, expressed as ($W = F * d$). This idea helps us understand how energy is transferred from one system to another. Whether the force is gravitational, elastic, or frictional, work done quantifies how much useful energy is available for performing tasks. Learning how to calculate work allows us to evaluate the efficiency of machines and identify where energy is lost to factors like friction or deformation. When reusing discarded electrical devices, the same physics applies. Many components, such as motors, gears, and fans, depend entirely on mechanical work to function. By understanding work, we can evaluate whether these components can still deliver useful energy. For instance, a salvaged DC motor can act as a generator when rotated, and by measuring the torque and angular displacement, we can estimate the mechanical work it can produce. This helps determine whether it is suitable for being reused in powering small prototypes or sensors. Work done by friction is also

important when inspecting reused moving parts. If excessive friction absorbs too much work, the component becomes inefficient. Cleaning, lubricating, or replacing worn contact surfaces restores efficiency and extends the part's usefulness in scientific instruments. Overall, the LO teaches to judge the mechanical effectiveness of recycled components, select those that can reliably transfer energy, and design low-cost recycled prototypes that support technological development while being sustainable.

BLUE

Malek Sayed

In ME.2.03 we learned about work done and kinetic energy. Work done ($F \times D$) is how much displacement is caused by a certain amount of force. And kinetic energy ($\frac{1}{2} mv^2$) is how much energy is contained by a body depending on its mass and velocity. This can help us understand forces and energy acting on our prototype and affecting our readings.

For instance we can make a device that measures RPM (**number of rotations per minute**) this device is affected by the work done on the sensor as we can measure the force acting on the device by measuring the torque which is the cross product of the force vectors acting on the object. This helps us understand the amount of work done on the device and make sure it doesn't exceed the safe limits that our device can withstand without malfunctioning due to overheating in the gears.

This device if applied correctly can increase the efficiency in supporting scientific and technological development as it can be used in cars or anything that is affected by the work done on it for example the car if the RPM got higher than a certain point the tires can rupture or the engine can fail due to high work done on the engine and tires. So companies making cars must take care of putting safe limits that cannot be exceeded, by making an automated system that decreases the work done by the engine to reduce the RPM to avoid any dangerous consequences

GREEN

Baraa Ahmed

In ME.2.03, we had studied that the work done by a force equals the force magnitude, multiplied by

its displacement. One of the properties of the work equation, is that the displacement doesn't always have to be linked to the force itself. This concept allows for different values of forces to differ, only according to their magnitude, as long as they're

over the same object. The unit of work is in joules. Given this information, we learn that any prototype with mechanically moving objects has a set of forces acting, as well as a net displacement caused by it. This gives us the chance to measure the efficiency

of the components used from discarded electrical devices, where the input can be compared to the work done inside the component. For example, a recycled DC motor would require a certain number of watts to operate. Multiplying the watts by time of operation,

we get the watt-hours, which can be converted into joules, and compared with the motor's net work done in the same time interval.

GREEN

In your current project, you are asked to design a system where existing materials are disassembled, transported, and then reassembled into new, functional forms. You learned in ES.2.05 that river systems are composed of different parts with different shapes and functions. Explain two points you drew from this similarity for your project

Learning Transfer

Ziad Salah

In ES.2.05, the main points of discussion were about rivers and the way they stream into different shapes and have different functions. When looking at this from the surface, it may seem that river systems and electronics or materials that are recycled aren't similar at all; however, there exist shocking similarities when looking from another viewpoint; and of these similarities are:

1. In rivers, there may exist an infinite number of nodes, but we're concerned with three main parts or essential nodes in a stream – the INITIAL point, the MAIN stream (the path in which a river flows), and the END point (deposition point, which can relate to underground water.) There may exist DISTRIBUTION points in the middle splitting the pathways which are also important and crucial for streamflow and the shape. In recycling, we have an INITIAL point which is the recycled materials we're using, a process of disassembly which can be similar to how a river first starts flowing, and a FLOW or DISTRIBUTION of parts, where it reaches the END point in our prototype. This analogy helped understand different ways that we can even distribute things between materials and the prototype.
2. Similarly to how rivers carve pathways and have different shapes – so does our prototype, where the external transparent layer is transparent – acrylic that has been carved with the laser cutter in the fab lab.
3. Similarly to how rivers have different functionalities like deposition, transportation, and such, so does our prototype, where it goes through multiple stages to achieve the desired voltage reading it wants.

BLUE

Omar Adel

A lot of inspiration is derived from rivers' aspects and used in our project like, in the recycling stage where we took apart and reassembled new parts like river streams splitting and converging at the trunk then splitting again at the distributary stage.

1. Flow regulation, during the trunk part of the river where a lot of water flow is happening, there is risk of overflow and flooding the nearby lands, this is similar to our project where the main wire and circuitry face a risk of electric overflow and burning of components. We found out that engineers construct underwater dams that slow the water flow by making it more turbulent, we have learned from this by using voltage regulators that slow down the electric flow to the needed value so it doesn't get too high and cause damage or too low and stop the circuit.

2. Good distributions, at the end of the trunk part and nearing the distributary part of a river, the water splits into different streams with varying directions and sizes. A bigger size would go to a further area with a higher water intake. We took inspiration from this when splitting the incoming electric signal into the different components, a thicker wire would carry more charge with less resistance while a smaller one less; we connected them wisely to components with high electric intake and vice versa.

At the end I believe that the way a river is didn't only help us learn how to disassemble, collect and reconstruct new parts, but it also helped us learn how to deal with different aspects like electricity regulation and distribution across the circuit.

GREEN

Mazen Askar

In ES.2.05, we studied river systems as networks of streams that form organized pathways for moving water and sediment. Each part of the system, such as headwaters, tributaries, channels, and the final basin. Inputs from many smaller channels are collected and reorganized into a larger, integrated system. I applied two key ideas from this system to the way our capstone project handles disassembly and transport

1. Organized Transport Improves Efficiency: River systems show that flow becomes efficient only when pathways are structured. Streams don't merge randomly; they follow predictable channels that guide water and sediment toward the basin. This helped us design a clearer process for transporting parts after disassembly. Instead of moving all components together, we created "stream-like pathways" by sorting items based on size, fragility, and function. This prevented mixing, reduced loss or damage, and ensured that every component reached the

reassembly stage smoothly, similar to how a river system reliably moves material through its channels.

2. Reassembly requires merging of Inputs: A drainage basin forms when multiple tributaries bring material into one larger system. This idea guided our approach to reassembly. Each stream of sorted components acted like a tributary feeding the final design. If one “stream” was unorganized or incomplete, the final structure lacked stability, just as a river basin cannot develop properly without consistent inputs.

Understanding these parallels helped us coordinate timing, distribution, and integration of all parts in the final build.

GREEN

Malek Sayed

In ES.2.05 we learned about how rivers can be shaped and what is the function of each shape and how it is done. When you look at the learning transfer and our challenge you will notice a lot of similarities between them in how our project focus on disassembling electronic parts recycled from old devices then take them and reassemble them to make a whole new efficient device that works in our labs.

Rivers have different ways of existing like a **tributary** which is the place where the river begins to form then it runs off and collects in a **trunk** which is the place where the water is gathered together. And the last shape is **distributary** which is the river being distributed after gathering in the trunk.

This is similar to our project as we first get the old electronic devices (e-waste) that contains certain parts that we need to build our prototype which is similar to **tributaries** in rivers.

Then collecting the parts that we are going to use in our prototype which is similar to the **trunk** in the river. After that distribute every part we collected in different parts of the circuit to achieve the prototype that we want which is similar to the **distributary**.

To conclude this learning outcome in geology has a lot of similarities with our capsotone challenge which influenced us in building our prototype.

GREEN

Baraa Ahmed

River systems are composed of multiple points, or intervals, with differing properties and functions. A river starts from a point called the river bank, and continues flow, where it subdivides and merges with other flows, until it reaches its final destination where the water ends up in a lake, or an ocean. A very simple analogy can be drawn, between the water cycle of rivers, and the life cycle of electronic devices.

This is prominent in two points: 1. Components start as crude materials, which undergo industrial manufacturing techniques, in order to be sold and used in devices, then thrown away in landfills without recycling. The problem is, the analogy works, until the landfill part, where it doesn't work!! 2. Sweet water, even if mixed with salty ocean water, can evaporate and come back as rain, free of any salts. There's no similar process in landfills, which means that we are ought to do it ourselves. We are obliged to start recycling the electrical components ourselves in order to align with the conventional rule of sustainability in nature. Recycling produced components into new functional forms is the missing part required to ensure sustainability and mitigate effects on the environment. And the best part about all of this? We learn it all from nature!

GREEN

Journal 5

Based on your experience designing a scientific poster for your project, describe at least two main strategies your team employed to create an effective and visually clear poster. In your response, explain how you organized the information, selected visual elements, and ensured that your poster conveyed your ideas to the audience.

Personal Reflection/Team Collaboration

Ziad Salah

In our poster, we tried to link the design and the prototype's main idea; this gives a really nice shape and design, designating what the prototype may be about. Since our prototype analyzes mathematical functions as waves, we added WAVES in the HEADER to convey that main idea. That's concerning the design; however, there are more STRATEGIES and techniques we employed to allow the CONTENT to be clear and organized with nice visual elements, of which are:

1. The ORGANIZATION of information using a method called the FUNNEL METHOD, this method employs a technique where you start off at a wide SCOPE and then zoom down to a specific problem, this allowed for a very ATTRACTIVE INTRODUCTION to be written. This was also used in the ABSTRACT in the poster to be able to CONVEY THE IDEA of the capstone to the AUDIENCE.
2. By using ATTRACTIVE visual elements that are READABLE and distinguishable, we managed to give off a VIBE that an audience would like and have an idea of what may be going on. Our poster is GREEN because it relates to MATH, where GREEN is usually linked to MATH in books. To CONVEY the IDEA.
3. Using CLEAR FIGURES and LABELS that allow the audience to have a clear IDEA of what's going on, where the figures are all labelled with an EXPLANATION under them.
4. In general, the RESULTS and MATERIALS and METHODS sections employed a technique using TABLES and FIGURES to allow the audience to follow what's being explained.

To wrap this up with our capstone: employing a VISUALLY CLEAR poster UTILIZING several elements RELATED TO OUR PROTOTYPE helps gain ATTRACTION.

BLUE

Omar Adel

the poster is complicated, it contains many different sections that are essential to showcase a project idea clearly therefore, it can be very hard to not mix things up or get confused when working on it. The visuality of a poster is really important to achieve two key things; a good way to explain things, and a comforting non distracting environment. These are necessary to make sure that anyone looking at it isn't confused nor distracted. We took on 2 main strategies to make sure we achieve the good design:

1. Peer reflection, as a team we will obviously be familiar with the project and its design therefore we can't really judge it well on our own therefore, we will ask some of our schoolmates and peers to look at it and give us some feedback on where they got confused or their eyes felt disturbed.
2. Old experience, we went up to our alumni from older years and asked them for their posters. We studied them well and wrote down where their designs and formatting were really good. We then were able to use similar techniques while designing our poster.

At the end we reached some conclusions on how to make the design as good as possible; first the color palate of the poster shouldn't have high contrast so it doesn't extract anyone from the important information. Second the description of a figure or table should be at the top where eyes are mostly starting from. Lastly we added more visuals and figures in the presentation since it is on a device near the reader it can be easily examined.

GREEN

Mazen Askar

Designing a scientific poster is a stressful process as the poster needs to balance between being academic and accurate, while also being creative enough to draw in an audience; therefore, to ease this process and ensure its success, our team deployed these two strategies:

1. **Prioritizing Academic Power over Design:** Since our poster had a strong character count, sometimes we had to change up the design, making it less attractive in order to fit in more words and characters.

Following this strategy helped the team be consistent, as it always put academics over comfort, ultimately creating an academically strong poster.

2. **Setting Clear Standards Such as Font Size:** While designing the poster, the team decided on a few standards that cannot be decreased no matter what, for example, font size. We decided that the font size cannot decrease below 18.

Following this strategy helped make the poster visually clear upon printing.

3. **Following the Rubric for Organization:** To be consistent and organized, we had to follow the Poster rubric precisely and make sure that every section, such as the introduction or the analysis, is in its correct place.

Following this strategy caused the poster to be organized and visually appealing.

4. **Reviewing English and Academic writing:** During the writing of the poster's content, the team made sure to follow a strong formal tone in speech, while making sure that it's grammatically sound.

By following these 4 strategies, my team was able to create an effective and visually clear poster that convey our ideas to the audience brightly.

BLUE

Malek Sayed

After working on three different capstone projects, for sure I gained a lot of experience in comparison with the first semester. In the first semester our poster lacked color organization and also couldn't convey our ideas to the evaluator. but now we follow certain strategies to achieve the perfect poster. 1. The first strategy we applied to achieve a good poster, we selected the color palette of the poster to be made with colors with low contrast and to be eye-comforting for instance colors like bright yellow and phosphoric green also crimson, if you see these colors on a poster your eyes will feel discomfort, also colors with high contrast like purple and green for example. These colors can ruin your poster even if the content is scientific. So instead we chose eye-comforting colors in our poster which is a mix of dark blue and white. 2. The second strategy we applied, add a lot of scientific base to our poster especially in results and analysis, also, we organize our information and write it in the order we followed in building the prototype, our capstone project relies heavily on physics especially electrodynamics so we focused on ohm's law and kirchoff's laws in the analysis to make the poster look more scientific 3. The last strategy we applied is to try to add more graphs and figures, this ensures that the audience can see all the results you conducted and understand your project even further. To conclude the poster is the most important thing in our capstone project as it contains all the procedures you made to make the prototype and if it is effective or not.

BLUE

Baraa Ahmed

A scientific poster is a banner-sized sheet including multiple sections of a normal research project in brief, including only the most important detail in the whole project. A poster's rule is to convey as much information as possible clearly upon first glance, which isn't easy. A few helpful strategies made this

more attainable. The first important strategy deals with the visuals. There are four main points to focus on, which are: 1. Choice of color palette: Calm, well-suited colors should be chosen, for better readability and general appeal. 2. Element size: When dividing the poster into the aforementioned sections, it is important to keep the elements appropriately sized, in order to maintain uniformity in the design. 3. Text size: This can be adjusted based on previously printed school posters. Experimenting with different font sizes is the best method for that. 4. Hierarchy of information: Visually separating titles, subtitles, normal text, and indentations from each other is always important for clarity. The second strategy deals with the actual information included within the poster. A proper understanding of the role of each section is fundamental. The most important tip I learnt was from a project outside school. I learnt from my research-paper Ph-D mentor that the most important columns in order are: Abstract, Discussion, Methods, then Introduction. She told me that those four should include all important details of my project, and the rest are repetitions of the same information in other ways. Keeping all these in mind made creating posters much easier!

BLUE

During the capstone project, your team faced a challenge where the model exhibited instability during continuous operation; after some time, its performance began to deteriorate, leading to frequent failures. By utilizing the EDP (Engineering Design Process) steps, explain how your team could identify two potential reasons for this instability and develop an enhanced version of the model that operates efficiently over extended periods.

Using the Engineering Design Process (EDP)

Ziad Salah

When using our MODEL during testing, my team and I have found that in the CODE uploaded and USED in our MODEL has a malfunction and begins to give false readings after approximately 60 minutes of CONTINUOUS OPERATION. This caused a severe DEGRADATION in performance, giving HIGHLY INACCURATE readings. This also occurred when the LAPTOP reading the MODEL's output was linked to the charger, this caused a severe inaccuracy. For these problems, the EDP was the most suitable solution to go by, where:

1. By RESEARCHING the program causing the INACCURATE readings in continuous operation, we found that there exists something called a "STACK OVERFLOW" which causes a break-down of functionality. This was fixed by CONTACTING the DEVELOPER of the PROGRAM and ASKING him directly.

2. For the laptop's inaccuracy, we've found that after extended charger usage, the accuracy DECREASES, using the EDP, I devised a plan because I didn't know what was causing an inaccuracy, where I would try everything and see if it works. After removing the charger, I found that it gave normal readings.
3. In addition to those, we found that AFTER CONTINUOUS RUNTIME, capacitors would get OVERWHELMED and therefore wouldn't allow our PROTOTYPE to run. To avoid this, we researched CAPACITORS and found that capacitors were affected by temperature, our accuracy was off. Looking into PRIOR SOLUTIONS, we found that CERAMIC CAPACITORS were more appropriate as they had a high voltage threshold and a high temperature resilience and this ALLOWED the development of an ENHANCED version.

BLUE

Omar Adel

Any project may be successful as first and then show signs of failure the longer it is used, this is normal, however, it depends on the period of time it took to reach this failure. Since sustainability is an important requirement for us, we knew we had to troubleshoot this when looking at our project.

1. More tests, we started conducting more and every one of our tests for longer time, we did this for every component until we found the problem; the capacitor (an electric component) was getting full quickly and stopping the circuit from running more charge into it.
2. Research, although our project might be unique and modified in some regions but we can recognize parts of our circuit that align with other projects online. This helped us look into what others have faced in similar circumstances and what we could do to fix this.

After using these two troubleshooting methods, we were able to not only determine what the problem was, but also what the potential reasons and solutions are. We found that the resistor we added after the capacitor made it so that the capacitor can't discharge fast enough to equalize with the incoming current, therefore we made a tiny modification where we decreased its resistance.

Finally, we found that the project works better for longer times, however, we kept going on with our methods and kept testing more and more testing more variables to see their effect on our project.

GREEN

Mazen Askar

During our capstone project, our team constructed an absorptiometer, and during testing trials, it exhibited instability, where performance was inconsistent and deteriorating, in order to fix this issue, our team immediately started working on identifying the issue, and the team came out with 3 suspects:

- 1- **Friction:** Our absorptiometer had moving parts, so our team suspected that the friction could be causing strong overheating, causing the deterioration in performance.
- 2- **Light leakage:** Since our prototype depended on the (LDR) light detector resistor, any light hitting the sensor other than the intended light from the LED could cause deterioration in performance.
- 3- **Unstable Voltage:** Our device used a voltage regulator as any changes in voltage would cause the results to fluctuate and become inaccurate; the voltage regulator could be malfunctioning.

Once our Team identified the potential Reasons for the model's deterioration in performance, we immediately worked on fixing them by following these 3 steps:

- 1- **Applying oil and lube over the device:** By doing so, we can ensure the limitation of friction on the device, removing any excess heat, allowing the device to work over extended periods.
- 2- **Painting the prototype Black:** By doing so, no excess light can fall on the sensor other than the light coming from the LED, providing accurate results.
- 3- **Replacing the voltage regulator:** By doing so, our team ensures that no strong or random fluctuation would occur.

After retesting once these issues have been dealt with, our team deemed that the model was now enhanced and operated efficiently over extended periods of time.

BLUE

Malek Sayed

During the capstone project, we face a lot of challenges in constructing the prototype and determining its design requirements, but the most exhausting part is testing the prototype as you face a lot of errors and wrong measurements, for instance we faced a problem which is inaccurate readings and that the device reads different values for the same input measurement. when this happened, we used the EDP to revise what caused the problem. 1. The first strategy we applied to identify the potential reasons for Readings instability, is to research about common reasons that causes this specific problem for example we faced a problem in the circuit that the FTDI didn't apply constant 5V power supply to the circuit, when we researched about this problem we figured out that this problem is caused by the parallel connection of the resistors which causes the variety in potential difference and this results in inaccuracy in the readings. 2. The second strategy we applied to identify potential reasons for instability in the readings, is we looked for external factor that might affect our reading. the circuit was connected well . And the sensor was not burnt, but the problem was in the laptop charger, as we display our readings on the laptop the charger created a magnetic field which caused magnetic field interference this resulted in inaccuracy in the readings. After that we changed the connections of the resistors and

removed the laptop charger then repeated the tests many times over many weeks, and the prototype's error decreased significantly.

BLUE

Baraa Ahmed

Our project is a modified Galvano-multimeter which replaces permanent neodymium magnets with an electromagnet as a means of further control over the induced magnetic field inside the apparatus. It was a successful project, working perfectly upon first glance. However, we had noticed that the multimeter's readings were becoming more inaccurate as it was turned on for longer. When turning off then on again, it would get back to normal. The first strategy was following the Engineering Design Process in reversed order. We re-studied, in order: the testing, construction methods, materials, previous solutions, preliminary research, and even the research question itself. We had found that, while solving the main problem, we created another one. After re-performing preliminary research over the electromagnet apparatus, we had discovered that the electromagnet's copper coil can heat up, which makes the electromagnet weaker and weaker. The first strategy had helped identify the problem, and it's about time that another strategy be employed for finding a solution for it. The copper coil was heating up and we needed a method to cool it down. We researched methods of cooling down of operating devices, and we employed the most appropriate solution, which was adding a heatsink to the back of the electromagnet, to dissipate heat. The main moral learnt from this story is that, studying the EDP steps backwards can help show the project from a different standpoint at a different point in time – a strategy that I am now going to be using for any personal project later on.

GREEN

In CS (2.03), you delved into programming concepts such as variables, branching, repetition, and SQL statements. These concepts will significantly enhance your ability to design and assemble a new instrument for the school lab, utilizing components from older devices. Discuss the role of at least three of these concepts in realizing this idea.

Learning Transfer

Ziad Salah

These programming concepts in CS (2.03) gave an easier way to allow our prototype's construction, where using SQL statements, my team and I found that we could retrieve databases from

online and utilizing SQL and XAMPP, we could filter out the old electronics that had components we needed. Furthermore, we found that:

1. Variables allowed the ease of definition in the program we made to find the RECYCLED components in OLDER DEVICES. We also found that by employing DATABASES of SCHOOL LAB DEVICES, we could easily find a simple lab device to be made. We also UTILIZED variables in the DESIGN of the CODE to run our PROTOTYPE's program. Variables are declared in CODE with a "\$", a name (i.e., Numbers), and a value with a semicolon.
2. SQL statements allowed the RETRIEVAL of data in DATABASES on the server-side of the program, alongside USING IT to code our WEBSITE for finding RECYCLED components. This allowed the boost in productivity for my team and I and easily finding the components we require for our prototype. We used the INSERT, SORT, and UPDATE keywords in SQL.
3. Using REPETITION, we managed to make a SEARCH tool that we could use to find the components we needed. This was also used in the DESIGN of our PROTOTYPE'S CODE, where utilizing the INPUT VARIABLES, we GRAPHED A FUNCTION according to our NEEDS and used it in the POSTER to allow a clear representation.
4. We also utilized BRANCHING in our PROTOTYPE'S CODE, where using BRANCHING, we could SPLIT THE CODE into several if-statements that allowed DIFFERENT CASES to run.

BLUE

Omar Adel

Since a lot of parts can be damaged and not useful when extracted we had to determine if the ones being used are in fact damaged. However, we as beginners didn't know what a fully working component should be like. This why we used SQL along with other languages like Python to help us code a useful mini-tool.

- First, we went on our normal tests, inserting a voltage and current into the component until we noticed it working well (this is our minimum current variable) getting overheated (this is our maximum current variable) and then inserting into a common database using python:

Insert [Input(minimum current?) input(maximum current?)] into database1

- Second, we added an electric components information website that had all the base currents for a functional component as a database (database2) in SQL:

Select * from exampleshopURL Where database1 is equal.

If database1 = database2:

print('component works!')

Else:

Print('component doesn't work')

- After running the previous code and using the databases, we can notice that if we insert our variables into our database¹ they will get compared to those online, if they match then the component is good and can be used, if not then they are damaged and a message appears to branch off into ways that this can be overcome.

At the end we have been able to use these three concepts well to increase our efficiency in recycling and extracting components and we hope we can improve this in the future into a functional app that others can benefit from in their recycling.

BLUE

Mazen Askar

In CS (2.03), we learned several programming concepts that help us control how a system behaves. Three of the most important ideas for building a new laboratory instrument from reused electronic components are variables, branching, and repetition. These concepts make it possible to collect data, react to changing conditions, and automate the device.

- 1- **Variables:** They allow the instrument to store constantly changing readings, such as temperature from an old sensor, voltage from a reused Arduino, or timing intervals for measurements. By assigning these values to variables, the instrument can process and compare data instead of working blindly.
- 2- **Branching (if/else statements):** They let the device make decisions based on those readings. For example, if the temperature variable rises too quickly, the program can activate a fan salvaged from an old computer. If the light intensity drops below a threshold, the device can switch on an LED from another discarded device. Branching turns the instrument into a responsive system that adjusts automatically instead of needing manual control.
- 3- **Repetition (loops):** They keep the instrument running continuously. A loop can take a new sensor reading every second, update the display, save values, or run safety checks using reused components. Without repetition, the device would only take one measurement and stop. With repetition, it becomes a functional monitoring tool capable of supporting real lab experiments.

These 3 concepts helped us turn discarded E-waste into Lab devices.

BLUE

Malek Sayed

In this semester our project is related heavily to computer science and mechatronics, as our project requires taking data and creating a circuit that analyzes it, this made us deal with a lot of variables and

repetition in the readings, so we had to use SQL to organize this all amount of data. 1. The first concept that had a role in our project is variables, our project is a sound analysis system that takes sound signals and measures its frequency, amplitude, and graphs the waveform that the sound signal creates, this inputs a large amount of variables to our device every second, so this made us use a lot of variables in our code to achieve accurate results. 2. The second concept is repetitions, our sound analysis system creates waveforms similar to sine waves which repeats infinitely with a certain amplitude, if the sound signal input stayed on the same frequency al the measures will be the same which means the readings is repeated, some we made our device recognize the repetitions in the frequency calibrated and stop making new waveforms and stay on the same wavelength and amplitude that were inputted in the first time. 3. The third concept is SQL statements, in our project everything is related to each other so we used SQL to link variables in different datasets, for instance frequency changes with wavelength so we made a one-to-one relation between them to make every every frequency reading has a different wavelength reading.

GREEN

Baraa Ahmed

Our Galvano-multimeter project had used the required electronic instruments to be able to store measurement data temporarily. In CS.2.03, topics of variables and repetition are discussed. We had concluded a possible addition to our prototype from this. The project replaced magnets with an electromagnet, and the ohmmeter-conversion circuit requires a constant DC source, all of which require a formal representation of the used current. By measuring the amperage and voltage of a DC at the same time, the power required to run a circuit can be measured in Watts – merely the multiplication of both Amps and Volts. Using repetition, we could create a graph that shows the number of Watts against time, showing the net usage of electricity throughout the time frame of operation, in Watt-hours. The calculation of Watt-hours depends on multiplying the average number of watts (AvgWatt2) in ΔT_2 , by that time itself, then adding it to the previous average wattage (AvgWatt1) multiplied by ΔT_1 . Continuing over this sequence, the actual number of Watt-hours used can be shown as the project is running, and even after it finishes operation. Each of those four attributes is a variable expressed in float architecture, which allows for decimals to be inputted and utilized by the program.

GREEN

In L.O. CH2.04, you explored various experimental techniques for monitoring the kinetics of chemical reactions. Please explain two practical methods for determining the reaction rate, using at least two devices commonly found in your chemistry laboratory.

Learning Transfer

Ziad Salah

In chemical kinetics, we study the internals of a REACTION, most notably its reaction mechanism or its RATE (mathematically) this is called the differential rate law. Which, for a reaction given as $aA + bB \rightarrow cC + dD$ (where the small letters are coefficients and the large ones are reactant molecules) gives: $\text{rate} = -1/a \Delta[A]/\Delta t = -1/b \Delta[B]/\Delta t = 1/c \Delta[C]/\Delta t = 1/d \Delta[D]/\Delta t = k[A]^n [B]^m$ where n and m are both ORDERS of reactants.

Given the previous formulae, we can then employ several PRACTICAL METHODS using either OBSERVATION or PRACTICALITY, where we can construct the following devices:

1. A SPECTROPHOTOMETER which is used to find the CONCENTRATION of a solution using the Beer-Lambert Law. When adding a small CONCENTRATION of a certain SALT or IONIC COMPOUND to study with WATER, we can use a LIGHT-SENSING resistor which gives the ABSORBANCE, which can be used in the Beer-Lambert Law to find the CONCENTRATION. Consecutively, we can then use the pseudo-first-order reactant method to find the GRAPH of the REACTANT CONCENTRATION with time. Allowing the RETRIEVAL of the variable k.
2. A pH-meter where the device (using a PLATINUM lead) can be input into an ACIDIC or BASIC solution, where the hydrogen ($[H^+]$) CONCENTRATION may be identified. This can be then substituted in the RATE LAW while GRAPHING the output to FIND the RATE.
3. A CONDUCTIVITY METER where the device (using two poles of electricity) can be put into a solution to measure its CONDUCTIVITY, and by using the law of CONDUCTIVITY for reactants, we can find their CONCENTRATIONS while measuring TIME.

BLUE

Omar Adel

Knowing a chemical reaction's rate is important to determine the produced materials after a period of time; industrially to compare costs and time consumption materials and educationally to show

different concepts and what affects the rate when a variable is changed. There are many ways to determine the reaction rate:

- Conductivity, using a conductivity-meter we can measure how well a solution can pass electricity. If the product solution conducts electricity differently than the reactant, we can notice that the conductivity throughout the reaction changes. Then we determine how much the conductivity is affected by 1 mole of product and how fast does it change:

Conductivity per mole = $\Sigma \text{conductivity} / \text{number of moles}$

Speed of change = $\Delta \text{conductivity} / \text{time}$

Using these in a relation we can determine the amount of product produced.

- Density, using a density measurer that uses ultrasound waves and a scale to determine the volume and mass we can notice the difference in density caused by the reaction over time; some products have higher density since they are more compressed causing a net change in volume at constant mass. Similar to the previous method we can conclude the amount of produce.

These two methods help us calculate the concentration or amount of the products, to turn this into rate we use the integrated rate law:

$$\ln(1/A) = KT - \ln(1/A_0)$$

Where A_0 is the concentration at the start, A the final concentration, K the rate constant and T the time taken. This can be inserted as a simple coding step in a bigger device that utilizes both methods to increase accuracy.

BLUE

Mazen Askar

In CH2.04, we learned that the reaction rate can be measured by monitoring how the concentration of reactants or products changes over time. Two practical methods rely on the gas syringe and the colorimeter, starting with the Gas syringe:

- 1- **Measuring Gas Volume Using a Gas Syringe:** For reactions that produce a gases such as the reaction between hydrochloric acid and magnesium, the rate can be determined by recording the volume of gas released at regular time intervals. A gas syringe attached to the reaction flask allows us to directly measure the gas produced without losing any to the surroundings.

Plotting a gas volume against time gives us a curve whose slope is delta volume over delta time represents the reaction rate.

- 2- **Using a Colorimeter to Monitor Color Change:** Many reactions involve a visible color change due to the formation or disappearance of colored species, and a colorimeter measures the

absorbance of light passing through the solution. According to Beer–Lambert's Law: which states $A = \epsilon Lc$.

Absorbance is proportional to concentration. By taking absorbance readings every few seconds or minutes, we can track how the concentration changes and calculate the reaction rate from the slope of the absorbance–time graph.

This technique is highly precise and ideal for reactions involving colored ions or indicators.

Both techniques are practical methods that provide reliable kinetic data and are widely used because they rely on simple, well-understood devices present in most school laboratories.

BLUE

Malek Sayed

In CH.2.04 we learned about various techniques for monitoring kinetics in chemical reactions and measuring the rate of chemical reactions, a lot of device can apply these techniques and laws to measure the concentration of chemical reactions and how they change with the speed of the chemical reaction. 1. The first method used for determining the reaction rate. Is to measure how much time taken for the reactants to change to products, this method is used in chemistry labs to measure the reaction rate in the absence of catalysts and in the normal conditions of this specific chemical reaction this mwthod is used with calorimeters in chemistry labs 2. The second method used to measure the reaction rate. Is to track a specific chemical compound and see how fast it disappears through the chemical reaction, for example in the reaction of burning magnesium in presence of oxygen to form magnesium oxide $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ you can track the magnesium as it disappears through the chemical reaction and observe magnesium oxide forming, this is used with colorimeters and spectrophotometers To conclude CH.2.04 teached us a lot in chemical reactions and how to calculate chemical reaction rates, which can be used in chemistry labs, and is conducted with many devices like colorimeters and spectrophotometers

GREEN

Baraa Ahmed

The kinetics of chemical reactions is a big domain under which many applications and methods exist. Starting from thermodynamics, thermochemistry and applications of heat & free energy exchange, to chemical reaction rate and the factors affecting it – all show different aspects of how a chemical reaction occurs, with different theories being possible, such as the very well-known Le Châtelier's principle. The thermodynamic aspect of a chemical reaction can show whether a reaction reaches a more or a less stable state, and how easy or difficult it has to reach that state. Almost all reactions generally require an input of energy, called the activation energy, in order to start. The stable state after

the activation-energy input may exhibit heat absorption, or heat dissipation. The most appropriate instrument which may showcase this thermodynamic aspect is the Calorimeter, that shows the difference in temperature and pressure before and after a reaction, which is quite satisfactory from a thermodynamic standpoint. From a chemical-reaction rate standpoint, in which time taken is important, there isn't a certain law that can definitively measure the chemical rate without some preliminary empirical measurement first, as it follows a rate constant "k", and exponents N and M for the reactants concentrations A and B, as shown: $\text{Rate} = k * [A]^N * [B]^M$ A device that measures the concentration, either using a color indicator and a spectrometer, or any other can do the job well.

GREEN

Grade 11 Semester 2

Journal 1

During the stage of identifying a problem, you discover that one of your teammates has misunderstood an issue. This teammate is known for being stubborn.

Explain two effective methods you would follow to convince them and resolve the misunderstanding.

Ziad Salah

Stubborn people are a major nuisance especially for a team that has chemistry; however, from my experience in the first semester of G10, I would actually start hearing them out.

It seems weird, but despite people being stubborn, they OPEN YOUR EYES to many ASPECTS of the CAPSTONE and how you can APPROACH a PROBLEM – even if it's MISUNDERSTOOD. I had this happen to me in Grade 10 where one of my teammates would always modify the prototype without telling us; however, due to his INSISTENCE, he managed to help us make a PROTOTYPE so STRONG that it LIFTED me personally (the Bridge prototype). We would always DEBATE about what was RIGHT and WRONG, but his FACTS were SOLID.

When I was dealing with this teammate, I saw that there were two important effective methods, which are:

1. Providing SOLID, researched EVIDENCE. When someone misunderstands something, their brain might lead them to THINK that what they're saying is the ONLY CORRECT THING; however, when met with HARD EVIDENCE, they begin to stutter and falter. Something like a **PROBLEM** can be debated because no problem is always correct nor false; it's about **HOW YOU APPROACH THE PROBLEM**.
2. This leads me to my second point, which is **ASSISTING HIM** in their research. Maybe the reason they're being so stubborn is because they're researching from an untrusted source; therefore, I'll **HELP HIM** by LEADING HIM TO TRUSTED WEBSITES.
3. For my last plan, I would arrange a MEETING that would be hosted like a DEBATE – when there's a MISUNDERSTANDING, there's always a FLAW in LOGIC. Therefore, I'll try to find that FLAW using a FRIENDLY DEBATE.

BLUE

Omar Adel

It is common to find stubborn teammates when working in teams to complete projects, so it is almost mandatory to be able to adapt and convince the unconvinced.

Understanding the issue is one of the most important parts of identifying the problem, yet, it is very natural to get confused and mix things up a bit.

- Exemplifying, to understand anything well it is much better to see an example carried out and explained. I will start by showing my teammate where his mix-up may be wrong; there are low resources because there isn't enough production, not because there isn't enough workers. Then I will show him an example; if there are 100 fish in a lake, no matter how many fishermen there are, you will only get 100 fish.
- Give them leadership, I believe the only one capable of convincing someone of anything, is their own conscious, other than that they would be just following orders not genuinely on board with what is going on. That is why I would let them lead the way and explain everything till they face a problem like lack of affirming data, I will then point out that this problem is due to the incorrect mix-up in the beginning. I will let them try everything they could until the only option is to change their mindset and go on the correct path.

I follow the principle of capstone which is growth, so I won't keep away a chance of growth and change from my teammate just so that we can finish work early. No, I will let them take their time and put in the effort to realise what they need to do differently and finally reach a new understanding.

GREEN

Mazen Askar

Throughout 2 years of teamwork, I learnt the hard way that the stubborn people will not obey if they feel forced, or if that obedience even slightly fractures their ego, I have learnt that even if I am correct and they know it, they will still repel against me just to prove a stupid point, and thus I have learnt that the most effective methods to make them cooperate are:

- 1- **Letting them do things their way:** If a stubborn person feels like they are doing what they are supposed to, to their liking, there is a high chance they will cooperate and put aside their childish nature to disobey for nothing's sake.
For example, if you have a task that should be done in 2 weeks, then say that you want it in 1, and they will naturally object and ask for 2, then you agree with them and make it 2, they will feel like they won, but you know the truth.
- 2- **Letting them lead:** While this sounds counterintuitive, most of the time, letting a stubborn person lead the team is successful, as they are literally programmed to want to do things their way, and letting them take charge does exactly that.

- 3- Never Brute Force:** If you try to threaten a stubborn teammate that you will deduct his credits, or take the team's problems to the principal, they will almost always become far more stubborn.

Following these three different methods will help improve communication between my teammate and me, and will fix any misunderstandings of any issues, as they will always be convinced, and thus there will be no misunderstandings to resolve.

GREEN

Malek Sayed

"The smartest humans alive can be wrong sometimes." This saying illustrates why it is not good to be stubborn. Some people mix between self confidence and being stubborn, self confidence is a good and practical trait that helps you be productive and saves a lot of time of questioning yourself if you are right. But you must also listen to the other opinions this what differs a self-confident person from a stubborn person.

As identifying the problem is the most important step in solving any problem, as it carves the path for the rest of the steps leading to solving the problem, so if you took the wrong path you will not reach your destination. As a result, every teammate must identify the problem carefully and fully understand it to make sure the rest of the steps in building our solution is built on a good base.

1. The first strategy I will try to convince him about this misunderstanding, is trying to simplify the problem for him and explain it more explicitly. As there might be something that he misunderstood or didn't know about that is causing this problem. and in most cases that is the reason for misidentifying a problem. but if he continues in his stubborn attitude I will try another strategy
2. Asking our cap leader or supervisor, a lot of times people be stubborn and don't listen because they think that you are not better than them as you are the same age and in the same school so why i am wrong and you are right. So making someone older or someone that has more experience can convince him that he is wrong just because he believes that they have more experience.

GREEN

Baraa Ahmed

Having been in a capstone project four times already, this was an experience I had to go through countless times. A disagreement grows out of nowhere; somebody focuses on the little details instead of the actual whole picture, and our efforts end up being driven off course. I will relate this experience to

one specific scenario I had two semesters ago. We gathered as a team to ANALYZE THE CHALLENGE RUBRIC released by the STEM Unit. A very simple misunderstanding drove us off course very easily: one teammate insisted that the problem to be solved be STATED IN GENERAL TERMS, instead of being SPECIFIC. For example, he insisted that it be “ENERGY IS EXPENSIVE IN EGYPT”, instead of “LACK OF SMALL-SCALE POWER SOLUTIONS”. Both are pretty much the same in their core, but they lead to very different directions of research – something that my teammate didn’t really grasp at first. To solve this, I told THE WHOLE TEAM to do the following: 1. SEARCH UP RESEARCH PAPERS: The goal here is not to gather information, but to recognize whether the problem was TRULY relevant to ours, and actually related to the objectives of the project. 2. COMPARE CONCLUSIONS: This is basically to show that a real conclusion was backed by certain findings, instead of unsupported bias. A discussion can be held to arrive at final conclusions Stubborn teammates cannot argue for too long in front of concrete, backed information from well-known research articles – and they never failed to do so!

GREEN

To identify the problem, you need to clarify many keywords. Explain three **methods** you follow in choosing the keywords that **help** you **identify** your problem and **why you will use them**.

Ziad Salah

Since last semester, I’ve learnt valuable things in research, and that is: don’t OVERCOMPLICATE things. When choosing our keywords for research, we always implement a strategy that has every PART of a PROBLEM.

When implementing this strategy, we find that something like the PROBLEM becomes easy to identify because you gather linked PROBLEMS to this certain KEYWORD. For example, we can say that the “population growth” problem has a keyword that can be derived from it called “famines”, because an increased population causes an increased lack of resources. Therefore, when me and my team implement this, we will:

1. Derive KEYWORDS or more PROBLEMS from a certain KEYWORD in the problem itself, identifying this KEYWORD is by looking at which part of the problem has the MOST IMPACT on HUMAN LIFE. So, “LACK of agricultural AWARENESS” causes FAMINES or a LACK OF FOOD. We can then DERIVE more keywords to cover more PROBLEMS that BRANCH off of this problem. This is so that we can COVER every aspect of the problem and all problems that branch off of it.
2. Look at certain NOUNS or ADJECTIVES, as given in the last example, I said “agricultural AWARENESS” not “agricultural NEED” this means that the problem isn’t about its LACK, it’s about how people PRACTICE IT. I will use this to find a MORE ACCURATE description to the problem itself as without this, the problem can DEVIATE AWAY from the actual one.

3. Start linking KEYWORDS from one problem to those of another. This makes the KEYWORDS be an indicator for the root of all problems. This is to FIND the PROBLEM TO BE SOLVED.

GREEN

Omar Adel

It is important to identify multiple keywords that are relevant to the problem to be able to find the correct sources of information. This doesn't only help you stay on track and organize thoughts, but also find the correct sites that provide the necessary information.

To Pick out the correct keywords I do 3 things:

1. Open conversations, I start chatting with my teammates normally, then I pick out the most recurring word between each dialogue. When we spoke about pollution's negative impacts, or what challenges face population growth in Egypt, the whole conversation revolved around the words "food shortage" and "environmental damage".
2. Blank searching, it is a technique me and my teammates made up to find keywords related to sentences. It is just putting missing sentences in the search engine and letting the most popular results identify the keywords. For example, typing "population growth lacks__" will result in things like "accommodative resources"
3. Synonyms and relations, we look at how the words relate to each other and infer whether they might be the correct ones or not:

"Environmental damage" causes a "food shortage" which in turn leads to a lack of "accommodative resources".

Since this sentence makes sense the Keywords are probably correct, however if we had words that don't fit like "waste water dumping" we can then conclude it isn't a necessary keyword.

Following these three methods ensures the keywords are correct in relation to our topic. This greatly increases the efficiency of research and helps us identify the problem in a correct scientific manner.

GREEN

Mazen Askar

The first step in the Engineering Design Process (EDP) is identifying the problem. To do this accurately, I must extract and clarify the most important keywords in the challenge. I follow three structured methods to select these keywords and understand them clearly:

- 1- **Focused and Analytical Reading:** First, I carefully read the problem statement multiple times and highlighted repeated or emphasized terms. I pay attention to action verbs, such as reduce, design, maintain, constraints, and measurable targets.

Why I use it: Because many problems contain hidden requirements, and without careful reading, I might misinterpret the scope. This method ensures that I fully understand what is required before moving to research or solution brainstorming.

- 2- **Categorizing Keywords into Types:** After identifying the main terms, I classify them into objective keywords (what must be achieved), limitation keywords (constraints), and context keywords (where or for whom the solution applies).

Why I use it: Categorizing prevents confusion between what is the main goal and the restriction. This helps narrow the problem clearly and avoids designing a solution that ignores constraints.

- 3- **Expanding Keywords Through Targeted Research:** Finally, I research the selected keywords to understand their technical meaning, real-world implications, and measurable indicators.

Why I use it: Some keywords may seem simple, but have complex scientific or social dimensions. Research allows me to define the problem precisely instead of relying on assumptions.

By combining careful reading, structured categorization, and focused research, I ensure that the problem is clearly defined before moving to the next stages of the EDP.

BLUE

Malek Sayed

Identifying the problem can be the most important step in the engineering designing process, as it is the first step and every other step relies on the accuracy of this step. You can imagine it like the pillars of skyscraper if the pillar is weak the skyscraper will fall.

To identify the problem accurately I look for three main key words (cause, consequences and solution) which I can find by asking three question:

1. What is causing my problem? this question allows me to research a lot about the problem and find where the origin as “the best solution for a problem is actually avoiding from the first place”. Knowing what is causing the problem can avoid a lot of consequences and can save a lot of effort solving the problem later.

2. What is the effects of my problem? this question can open your eye to a lot of things about the problem that you didn't notice in the first place. For example, if the electricity in your house keeps cutting off back and forth, At first you can be annoyed the the internet is not working or that you can not watch the TV, but if you asked yourself that questions you'll realize that heavy house devices like the refrigerator can actually malfunction costing you a lot of money which is in fact a bigger problem than not watching the TV.
3. How can I solve my problem? now you are trying to find a real solution for your problem and brainstorm for a solution instead of only thinking about the consequences of the problem. you switch your mind "how this can affect me" to "how can I stop these effects"

GREEN

Baraa Ahmed

Identifying the problem in correct TERMINOLOGY and relevant VOCABULARY is paramount for a successful review of literature, and an overall research process – especially at the first stage of EDP; identifying the issue. I used a hundred methods to help myself and my team get a better grasp of the problem in its own language, but I can mention the most useful three; out of personal experience. Having been exposed to research methodologies both INSIDE and OUTSIDE of school, I concluded that the best methods are as follows: 1. EXPOSURE TO LITERATURE: The most significant factor here is reading a LOT OF RESEARCH PAPERS. You will eventually know how the topic is studied in its correct, graduate-level terminology. Over time, you'll know how a word is used, even without searching it up. 2. REVISING CITED LITERATURE: Most people may only read the contents of the research paper, without at least taking a look at the cited literature of the paper itself. My personal research's PhD mentor has told me that this is quite useful to find relevant papers much easier, and to save time on the long run. 3. USE OF LLM'S: Large Language Models are specific types of AI with widespread applications in SCIENTIFIC RESEARCH. This isn't like skipping school assignments – instead, LLMs find you the papers you're looking for, even if described in inappropriate grammar and vocabulary. They do not work as explainers, but just a "Smarter Google Search" – that's how I just call it.

GREEN

In light of what you have studied in CH. 2.08, you need to measure the degree of salinity of the electrolytic solution in your challenge; you need first to calibrate the used sensor. Explain the steps you will follow in your chemistry lab to accurately calibrate the TDS sensor showing the importance of calibration.

Ziad Salah

To CALIBRATE the SENSOR, we need to implement 4 STEPS and 1 CHECKS that assure everything is ACCURATELY DONE in the lab. These steps are:

1. PREPARING an ELECTROLYTIC SOLUTION of a standard salinity using a set amount of electrolytes. The best thing to prepare should be a STANDARD SOLUTION at a regularized temperature and pressure, where the solution should be 1M at 25°C & at 1 atmosphere of pressure. This SOLUTION'S SALINITY should be then MEASURED or CALCULATED accurately using stoichiometry and the ratio of dissolved salts to the volume of water.
2. CHECKING back the RESULTS according to availability, where if the school lab has an accurate TDS sensor, we can use that to CHECK the TDS (Total Dissolved Salts) of the SOLUTION we made and then use our OWN TDS sensor to COMPARE the results. However, if there isn't a TDS sensor at the school, then the CALIBRATION must be done according to the CALCULATED TDS (less accurate, but works.)
3. Make a table of all MEASUREMENTS taken to find the AVERAGE ERROR and see if there were any deviations in MEASUREMENTS that reach a so called "DANGER ZONE" (the zone where the ERROR is way OUTSIDE the RANGE (an OUTLIER)). We can then use this table to find when the DEVIATIONS happened to avoid the same mistakes happening during prototype construction.
4. Use the ERROR SIGNAL in the Arduino Code to correct the readings provided by this sensor by making a REGRESSION EQUATION to check how far the error is from the consistent result.

We can then implement the CHECK, which is to check the TDS of the SOLUTION itself.

GREEN

Omar Adel

Making sure the degree of salinity isn't high is important to make sure the water, solution, and soil are all safe for plants and consumer organisms.

We must use a TDS sensor that shows us the **total dissolved solids**. However, each sensor gives different readings because each manufacturing company uses different units of measurements; some

use ounces and pints while the international system uses litres and m^3 . Thus, we must calibrate the sensors finely and carefully to be able to use these results in our work without room for error.

- Measuring units, we must go into the sensors settings and update the measuring units so that they match the ones used in the rest of the prototype to make sure the conversions and equations used aren't messed up.
- Construct the range from scratch. In our chemistry lab we will prepare two solutions to give the sensor a reference that it can compare to the results acquired in the prototype. The first solution is pure distilled water where there is 0 TDS, this is the ground reference for the sensor. Next up is a solution where 50 grams of salt are dissolved in the water, theoretically this should yield 1,000 TDS. On the sensor it might appear as a different number, we change its settings till it reads approximately 1000.

Now the sensor knows to measure per litre and has an accurate reference, which in turn makes sure it can work with minimal error. This helps us in our calculations of how much more water is needed to decrease the TDS of the original batch. For example, if we had 1000 TDS which is too high, we can add 4 more litres so that it can be approximately 150 TDS which is safer for consumption.

GREEN

Mazen Askar

In CH.2.08, we studied electrolytes, electrolysis, and how the presence of ions in solution allows electric current to pass. Salinity in water is directly related to the concentration of dissolved ions, which makes the solution an electrolyte. A TDS (Total Dissolved Solids) sensor works by measuring electrical conductivity, which depends on ion concentration. Therefore, accurate calibration is essential before using it in our feedback-controlled aquaculture system.

To calibrate the TDS sensor in the chemistry lab, I use these steps:

1. **Prepare Standard Solutions:** Using distilled water and a known mass of sodium chloride, I would prepare standard solutions of known concentrations, for example, 500 ppm and 1000 ppm. Since NaCl dissociates into Na^+ and Cl^- ions, it behaves as a strong electrolyte, ensuring reliable conductivity values.
2. **Rinse and Stabilize the Probe:** The sensor probe must be rinsed with distilled water to avoid contamination. It should then be immersed in each standard solution and allowed to stabilize.
3. **Adjust Calibration Settings:** The sensor reading is compared with the known concentration of the prepared solution. If there is a deviation, the calibration setting is adjusted until the sensor reading matches the actual TDS value.

- 4. Create a Calibration Curve:** By plotting conductivity (or sensor reading) versus known concentration, we verify linearity and accuracy.

Calibration is essential because in our closed-loop control system, incorrect salinity readings would trigger wrong actuator responses, harming aquatic organisms. Proper calibration ensures reliable feedback, system stability, and healthy living conditions

BLUE

Malek Sayed

In CH. 2.08, we learned about electrolytic cells and galvanic cells which mainly function due to chemical reaction that causes releasing ions which moves from a pole to the other opposite pole either from cathode to anode or from anode to cathode depending on the charge of the ion (if it is an anion or a cation) this can help us a lot in our challenge which demands making a 10L water tank suitable for specific fish that live in specific conditions like temperature, PH and salinity which can severely affect the health of the fish living inside and getting out of specific ranges can lead to death of the fish. So to ensure that we avoid this we calibrate the sensor by doing the following steps:

1. first I will search for the range of salinity that the fish I am using can survive, for example clownfish can withstand a range from 500mg to 2000mg as it lives in deep ocean. This step is to see what is the specific range that I need the sensor to be most accurate at as this range is which the actuator will, regulate the salinity to.
2. The second step is in the chemistry lab, I bring pure water the sensor and packs of known salt amount. First I measure the original TDS of the water then start adding 100g of salt each time and checking the readings of the sensor and make sure that it is accurate

GREEN

Baraa Ahmed

Let's first analyze the function of a TDS Sensor: it calculates the concentration of total dissolved salts that form an electrolytic solution as a function of the conductance of a slight electrical current between the two probes of the sensor, with pre-defined potential difference, calculated distance and area of exposure to electrolytes. The concentration of TDS is eventually calculated in units of PPM, PPB (parts per million/billion), or a value of X Molar. In the chemistry lab, there are STANDARD SOLUTIONS – solutions at a well-known concentration, defined at industry-grade accuracy. Information about the concentration can be paired with the degree of ionization of a certain electrolyte, to know exactly the number of ions which contribute to establishing a current between the two poles of a TDS sensor. Moving on to the electronic aspect of the sensor, it will be likely used along with an Arduino or an ESP32

chip. Without calibration, the sensor just spews numbers with no real meaning; just small numbers for low concentration, and the larger the higher. This data can be collected for multiple solutions of different concentrations, and be fitted over a regression line with a defined function, along with statistical data interpolation & extrapolation for the curve-fitting. My personal advice is to always take note of the units being used for all measurements – never replace 1 molar with 1 molal!

GREEN

you have studied the structure and the function of the human reproductive system. Choose one structure that its function will be affected by feedback, and explain how this study can help you **design** the **feedback system** in your Capstone Project.

Ziad Salah

There are actually two examples for this, of which are:

1. The menstrual cycle – here, the hypothalamus releases HORMONES that stimulate the RELEASE of LH and FSH, these two hormones are the most important during the menstrual cycle because it causes the continuity of the cycle and the release of the egg itself. The cycle starts by an increase in FSH as it stimulates the GROWTH of the FOLLICLE which contains the ovum, so long as FSH is being released, the FOLLICLE keeps growing. This is POSITIVE FEEDBACK. When there's a command to release the FOLLICLE, FSH and LH spike rapidly to command it to release it, forming a structure called the CORPUS LUTEUM, which is commanded by LH, its response to LH causes it to either DIE or KEEP RELEASING HORMONES if fertilization happens. An example of NEGATIVE FEEDBACK is the REGULATION of PROGESTERONE and ESTROGEN secretion by the corpus luteum.
2. Birth – here, this is also POSITIVE FEEDBACK, where, as the baby puts pressure onto the cervical wall, the brain releases OXYTOCIN which is a hormone that causes CONTRACTIONS to help release the baby. As more pressure happens, more oxytocin is released and the BABY is PUSHED harder causing a cycle.

From this, we can deduce:

1. For each PASSIVE change that happens in our system, we can utilize a simple method of POSITIVE FEEDBACK to go WITH the change of the system to REDUCE power consumption as the system increases with the actuators.
2. NEGATIVE FEEDBACK is needed for heavily regulated conditions that go against the nature of the system like temperature.

BLUE

Omar Adel

The uterus is a major part of the human reproductive system where most of pregnancy is located. It bears the embryo which later on becomes the child, in its early development stages. These stages require many modifications throughout the process which depend on a natural biological feedback system.

- Some embryos develop faster than others, and their metabolic needs are much higher. In these cases the uterus is able to communicate through the umbilical cord to understand the needs of the embryo sending it the resources it needs. In our prototype we are going to include a similar communication line between the plant and the supporting irrigation system. By measuring the soil moisture we know whether the plant has been using up more water lately so that we can increase the water input.

Another organ is the male reproductive organ which is the penis combined with the testis.

- The penis gets stimulated by movement and neuron activity that tells it to erect and start activity, this feedback is then transferred to the testis which start preparing the semen and sperm for ejaculation into the vaginal cavity for fertilization. This feedback makes sure everything is prepared and in order, a similar thing we are including in our prototype is a solar heat detector. Early in the morning it will measure whether there has been an increase in the heat and solar energy which means the area will be dryer than normal, it will then move on to prepare and store more water which it estimates will be needed so that the soil and plant doesn't dry out and die.

I believe there will be more inspiration for feedback and preparation in other systems of the body which we can improve from.

GREEN

Mazen Askar

One reproductive structure whose function is strongly affected by feedback is the **ovary**, specifically during ovulation. The ovary does not release an egg randomly; its activity is regulated through hormonal feedback involving the hypothalamus and pituitary gland. During the menstrual cycle, follicle-stimulating hormone (FSH) stimulates follicle development in the ovary. As estrogen levels rise, they initially create negative feedback to regulate FSH production. However, when estrogen reaches a certain threshold, it switches to positive feedback, triggering a surge in luteinizing hormone (LH), which causes ovulation. This is a precise biological feedback control system that maintains balance and timing.

Studying this mechanism helps me design the feedback system in my Capstone project. In our smart aquaculture or greenhouse system, sensors measure environmental variables such as salinity, humidity, or temperature. These readings act like hormone levels. When a parameter deviates from the optimal range, the control algorithm (similar to the pituitary gland) activates actuators such as pumps or valves to restore stability.

The hormonal feedback cycle taught me that effective systems require:

1. Continuous monitoring,

2. Threshold-based responses,
3. Adjustment mechanisms to maintain equilibrium.

Just as improper hormonal regulation disrupts ovulation, inaccurate sensor readings or delayed actuator responses can destabilize our farming system. Therefore, understanding biological feedback improves my ability to design a stable, responsive, closed-loop environmental control system.

BLUE

Malek Sayed

In BI.2.08 we learned about human reproductive systems and how some of them acts as a feedback loop either positive or negative. Similar to our challenge this semester which demands making a feedback system that helps either agriculture or aquaculture.

In the human body, the control of the reproductive hormones is maintained by a negative and positive feedback system involving the Hypothalamus, the Pituitary gland, and the gonads (Ovaries in females and Testes in males). The hypothalamus is the biological sensor that detects the conditions in the body and transmits signals to the pituitary gland. The pituitary gland is the control center that transmits hormones to the ovaries or testes, which are the effectors (or actuators) of the system, secreting hormones such as estrogen, progesterone, and testosterone. When the hormone levels are too high or too low, feedback signals are transmitted to decrease or increase their secretion. This negative and positive feedback system ensures that the system stays within a functional range, just like an automated greenhouse system. For instance, in the menstrual cycle, the increasing levels of estrogen at first produce a negative feedback process to avoid the overproduction of hormones. This is similar to an intelligent agricultural system that provides more correction as soon as a certain threshold is crossed by the parameter. For example if the range of temperature that the plant can withstand is crossed the actuator will cool or heat the temperature to bring it back to the safe range for the plant.

BLUE

Baraa Ahmed

From what I learnt in BI.2.08, the physiology of reproductive systems of both the males and females run periodically, in terms of hormonal & neural activity, gland secretion, growth, and overall sexual activity of both the external and internal organs. Upon comparing between the male and female reproductive systems, we find that the male system works at a feedback loop within a daily timeframe. We notice the rise & fall in hormonal activity at certain times of the day, as well as the immediate effects over mood, libido, and even some noticeable effects over the external organs. For example, it is very commonly known that males experience PENILE ERECTION very early in the morning upon waking

up, due to the vasodilatation of arteries & pressure blockage of veins leading to increased blood flow at this part of the abdominal cavity, which leaves the erectile muscles filled up with blood. In contrast, the female reproductive system works at a much larger timeframe – often in three to four weeks, commonly referred to as the MENSTRUAL CYCLE. From ovulation, to the shedding of the lining of the uterus, females experience very drastic effects in libido, physical ability, and most importantly the mood – something that males notice best. The large contrast in structure, function, and even the temporal aspect of both systems shows an important aspect of methodology in feedback loops, that is naturally implemented in us. We learn that it is very important to define THE SPATIAL & TEMPORAL SCALE of constructed models & loops, depending on use and requirement.

BLUE

Journal 2

After completing your first semester project, a team member may have faced a situation where he did not fully understand his assigned role but pretended that he did until the project was finished.

Explain **three disadvantages** of this case and give **two** pieces of **advice** you would offer him/her for working on this semester's project.

Personal Reflection/Team Collaboration

Ziad Salah

Misunderstandings can cause a plethora of issues, especially when it comes to the ASSIGNED ROLE of the team member, this affects us DRASTICALLY throughout the entire project, this was a personal experience I had in GRADE 10 S1, and I concluded that the DISADVANTAGES were:

1. A WEAKER, NON-FUNCTIONING PROTOTYPE is produced based on a FALSE SCIENTIFIC BASE; this was a problem I've faced before when one of my teammates misunderstood a lecture on building bridges. I realized that it also OPPOSED the PANEL REVIEW that we wrote.
2. A NON-CONSISTENT POSTER is produced, filled with opposite sentences where the scientific base is inaccurate/inconsistent.
3. NON-CONSISTENT RESULTS are produced due to a misunderstanding in the researched values of the PROTOTYPE because of INSTABILITY.
4. A BAD EVALUATION EXPERIENCE, where the inconsistency of the STUDENTS' UNDERSTANDINGS creates an environment for MISUNDERSTANDING and INSIGNIFICANT/INCORRECT INFORMATION.

These are DISADVANTAGES that affected me drastically during that project; however, when it was all done, I gave my teammate a FEW PIECES of ADVICE that he used the following semester and does so till now, which are:

1. SUPPORT ALL YOUR IDEAS with correct research and check for the validity of websites, as he may have researched in untrusted sources or misunderstood from the LECTURE.
2. HEAR FROM YOUR TEAMMATES, this is to hear all the constructive CRITICISM provided by your teammates
3. ASK BEFORE YOU DO – this is something I go by all the time, which is to ASK your teammates about something before you do it.

BLUE

Omar Adel

People care about how others view them more than succeeding in life and actually learning.

However, it is still very important to be able to understand and explain every part; if not, many disadvantages arise: 1- Lack of skills: If a teammate doesn't understand a certain point, they wouldn't be able to explain the idea thoroughly and help others understand. This can lead to bad presentations. 2- Chaos: During further work that heavily relies on each teammate understanding their corresponding role, if someone messes up or doesn't complete their work correctly, others will try to step up and take over the work to ensure the best quality, but this causes a disordered and unorganized working environment that may end up ruining everything. 3- Not learning: We work on projects together to improve our teamwork and also understand subjects better by applying them. Therefore, this teammate will lose the cores of CAPSTONE which are helping each other and learning, not just getting grades. These disadvantages prove that this teammate doesn't only negatively affect himself, but also

others. So as a fellow teammate, before any of this happens I usually hold a friendly meeting where I give everyone some advice: A- Reassurance: I advise my teammates to not be embarrassed about asking questions because we should all act as one, and if anything goes wrong we can always ask our seniors for help. B- Researching: Even as a team, we shouldn't heavily rely on each other, I would advise everyone to take responsibility and research about these topics alone as much as they can.

GREEN

Mazen Askar

Sometimes in Capstone teams, a member could fall behind with a misunderstanding and pretend he is fine to avoid embarrassment, which caused a few unnecessary drawbacks:

1. **Wasted Time and Effort:** Since this teammate didn't understand his role properly, this means that he probably completed tasks incorrectly, or even completed tasks that weren't meant to be his.
Why this harmed the team: These tasks had to be repeated taking effort and time that could have been saved.
2. **Lack of Team Harmony During Evaluation:** The member's misunderstanding of his role could lead to different roles crossing into each other, causing chaos during the Evaluation presentation.
Why this harmed the team: This issue could lead to a lower grade or credit deduction.
3. **Personal Disagreements Between Team Members:** These issues already previously mentioned that are caused by his misunderstanding of his role could also lead to Quarles between team members, and escalation into blames and fights.
Why this harmed the team: Such Personal issues could cause issues in co-operation.

Knowing these issues from the first semester, my advice to him for the second semester would be:

- 1- **Honesty in communication:** If you are honest with you team, then everyone will understand each other's problems, which will lead to union and enhanced teamwork.
- 2- **Ignore Peer Pressure:** This whole situation of pretend is likely caused due to peer shaming and pressure, which should be a phenomena we seek to end, not encourage.

GREEN

Malek Sayed

"a dump man is not one who doesn't understand its who pretends he does". Sometimes if someone didn't fully understand something they are afraid to say that they don't as they don't want anyone to say that they are dump or has low IQ. There is a lot of disadvantages that can be caused by this pretending:

the whole project efficiency and functionality can be ruined due to this one action as every part plays a huge role in the final product that we make after a whole semester of hard work.

this team member reputation will be ruined. As every semester there is new capstone teams and every capstone team choose each other as a result if I knew that this member pretends that he understood his role and he doesn't do his work properly no one will choose him in their capstone team

missing deadlines. the portfolio, poster, logbook have submission dates that you cannot cross without submitting your work unless you will face serious problems and can highly affect your grade in the end of the semester.

If I saw someone doing this I will advise him to not be afraid to say that he don't understand his role as the main idea of capstone teams is that we learn teamwork and collaboration wich is understanding each other, also I will advise him to research about his role and how he can excell in this role.

GREEN

Baraa Ahmed

It was most evident that a team member couldn't understand their role well especially when REHEARSING FOR THE CAPSTONE FINAL EVALUATION. It resembles a holistic overview that's representative of all the project steps, it is easy to spot any potential mistakes and/or unnecessary misunderstandings that may arise. Taking Grade 11 First Semester as an example, one team member was assigned to explain the Data Analysis section of the project (and we used placeholder data so we can practice early). We eventually found out that the member hadn't understood his role well, and explained the data in QUALITATIVE TERMS instead. Upon further troubleshooting we found out: 1. He did NOT SPECIFY HIS OWN ROLE, which caused a large portion of the person's efforts spent to branch

into unnecessary parts of the presentation. 2. He did NOT UNDERSTAND EVERYTHING CORRECTLY – obviously, unfocused work meant low quality and improper preparation. 3. His presentation showed a LACK OF CONFIDENCE. He knew something was wrong, but couldn't pinpoint it and tried to cover it up instead. All of these are very common flaws that may cause a decrease in grade. Having learnt this the hard way before, my advice is this: 1. PRACTICE EARLY. Had we not rehearsed early, we would've noticed these flaws mid-evaluation! 2. BE HONEST! Notice that our dear teammate tried to cover up his mistakes instead of admitting something's wrong. That alone would've cut down efforts into half. Having adapted these tips into my projects, we were ready to meet the toughest evaluators like never before!

BLUE

Before designing a smart farm or aquaponics system, what existing technologies and case studies should you research? How will studying them help you improve efficiency, sustainability, and cost-effectiveness? Using the Engineering Design Process (EDP)

Ziad Salah

Before designing anything, the problem itself should be identified, which my team and I found to be a WEAK AGRICULTURAL BASE that doesn't provide enough for the +110 million Egyptian civilians.

After finding out the disadvantages or the WEAK POINTS of the Egyptian agricultural system, it was important to research about those exact WEAK POINTS from a PRIOR SOLUTION called the 100,000 GREENHOUSES INITIATIVE, comparing it to HAVFARM1's ADVANTAGES:

1. The TEMPERATURE-regulating technology, where I had researched about the 100,000 GREENHOUSES INITIATIVE in EGYPT that had built in TEMPERATURE systems that I found were INEFFICIENT in terms of POWER and the TEMPERATURE PROVIDED. For this, I researched more about HAVFARM1's existing TEMPERATURE REGULATING SYSTEMS and found that instead of full COOLERS, they allowed some of the outside AIR to flow in alongside maintaining a proper HUMIDITY to trap the necessary TEMPERATURE. This decreases the time of usage of COOLERS, increases the EFFICIENCY of the system as it UNIFIES two systems in one as well as making maintaining the greenhouse more SUSTAINABLE.
2. The pH-REGULATING technology, where in the same 100,000 GREENHOUSES INITIATIVE, the GREENHOUSES were built on SOIL that was INCOMPATIBLE with the pH-requiring PLANT being planted. This caused an INEFFICIENCY as the GREENHOUSE had to maintain

the buffered soil, which was hard to adapt correctly. Going back to HAVFARM1, it was smartly built on SOIL suitable for the pH of the PLANT being CULTIVATED in that region. This helps the PLANT to be cultivated sustainably, REDUCED POWER USAGE because the pH sensor is no longer needed, and COST-EFFECTIVENESS on CUTTING COSTS.

BLUE

Omar Adel

Researching other technologies that may be different but with the same goal in mind is important, to learn from their mechanisms and what has affected them to not reach utmost efficiency. First, My team and I would research about automatic systems that use electronics, this exists in AC units that automatically change the temperature of air inside a room. This helps us understand how to make the most efficient circuit with the least amount of error.

Second, research on older technologies such as, submarines and metal welding. These technologies are old and simple yet are very strong and able to withstand extreme conditions making them very sustainable and able to stay modernized till today, I would try to learn about how this level of sustainability was achieved and the materials used through historical timelines and development schematics. Third, research on recycle based technologies, some technologies keep recycling in mind by either being made of recycled materials like compacted plastics, or they try to make the design simple to make it easy to recycle when getting disposed. This includes filtration robots made of plastics that help purify water using organic waste. I research about the recycled material used and its sources. This helps by keeping the cost low and making sure the prototype is replicable in many areas with low resources. I believe these technologies are strong inspirations to devising a strong design for a solution and prototype, however, I am sure there are many more that have achieved many more strong results which I must learn from as well

GREEN

Mazen Askar

To design a smart farm or aquaponics system, the research stage of the EDP requires studying existing technologies and real case studies through:

1-Researching automated monitoring and control technologies: In modern agriculture, this includes sensors for temperature, pH, dissolved oxygen, and salinity connected to microcontrollers. Studying these technologies helps me understand how real farms collect environmental data and maintain stable conditions for plants and fish.

How would studying this improve efficiency, sustainability, and cost-effectiveness? This improves efficiency because automated systems reduce manual monitoring and respond quickly to environmental changes.

2-Studying Existing Aquaponics farms and smart greenhouse projects: These case studies show how water circulation, filtration, and nutrient cycling are managed, using them I can identify successful layouts, suitable plant–fish combinations, and how to effectively manage water consumption.

How would studying this improve efficiency, sustainability, and cost-effectiveness? This improves sustainability because aquaponics systems recycle nutrients and reduce water waste.

3-Analyzing renewable energy and resource-efficient technologies: Studying these technologies found in sustainable farms, such as solar-powered pumps or energy-efficient LED grow lights.

How would studying this improve efficiency, sustainability, and cost-effectiveness? Understanding them helps reduce long-term operational costs and environmental impact, improving the cost-effectiveness of the system.

BLUE

Malek Sayed

In this semester capstone project we are told to design a smart farm or an aquaponics system that helps agriculture in Egypt and solves many problems like food insecurity, water scarcity, and lack of automation in Egypt's agricultural systems. So to achieve the perfect design or solution to these problems we must focus on four MAIN stages in the engineering designing process

1. Defining the problem
2. Doing background research
3. Brainstorming for a solution
4. Testing the prototype

After successfully defining the problem, we must do heavy background research about related topics and technologies that we can benefit from in our smart farm system.

1. **FEEDBACK SYSTEMS.** Our projects main idea is that there is some parameters that plants need to grow that is not available in our area, for instance PH, temperature , salinity, moisture etc... these parameters need to be set into specific ranges for the plants to grow, for example passion fruit needs temperatures between 20 and 30 degrees Celsius which the average temperature is often out of this range. The way to set this parameter TAKES us to the next topic(technology).

2. ACTUATORS. Actuators acts like an AUTO correction for the environment, for example it measures the temperature using a sensor and checks if the temperature is in the specified range or not if less than the range, the temperature actuator rises the temperature again to the specified range. Deeply understanding actuators and how they function and how you can use them effectively can significantly improve your prototypes efficiency and sustainability

BLUE

Baraa Ahmed

Our main role before starting in the later parts of the project was performing the most conclusive review of existing literature, including systematic reviews, research theses, project proposals, and even going as far as reading pre-publish research manuscripts! Our project is an enhanced smart farm to promote growth of licorice & cotton, therefore the simplest objective is to look for previous smart-farm projects. The research process started in very general terms (starting off with literature reviews first), then branched into deeper subtopics slowly. Among these subtopics were: 1. PARAMETERS MOST INFLUENTIAL ON PLANT GROWTH: This is a very direct research trajectory. Many reviews have agreed on certain soil parameters including pH, temperature, moisture & composition, as well as climate parameters as air temperature, moisture, daylight integral, and CO₂. 2. PARAMETERS MOST REPRESENTATIVE OF PLANT GROWTH: This is yet another direct research trajectory. After studying what affects plant growth the most, we now need to assess it directly as an output. The parameters are either structural & cumulative (as basal area, height, plant allometric properties) OR functional & state-defined (as net primary productivity & gross primary productivity). Studying these tells us what is REQUIRED, what is EFFICIENT, which directly tells us how an efficient, cost-effective system can be made.

BLUE

You studied in (ES.2.09) that the evolution of Earth's spheres shows how major Earth processes are connected and depend on one another. You also worked on the smart farm project. Both topics require understanding systems thinking (how different parts connect, influence each other, and respond to changes).

Explain two points that show how both topics involve connected parts

that affect one another. Then explain one way they are different. Learning Transfer

Ziad Salah

- They're different because one is LOCALIZED and the other is GLOBALIZED (geologic event)

In old geologic times, Earth's spheres underwent many changes, and these changes were influenced by the factors happening outside of the Earth (such as the sun, the existence of life, and such.) Two examples that clearly show the TWO POINTS of ANALOGY are:

1. The start of life of photosynthesizing bacteria. This bacteria initiated a CYCLE called the CARBON CYCLE, where the bacteria would intake any CO₂ in the atmosphere, and convert it to O₂, this was due to the incubation of Earth during its "hothouse" period, where it would trap heat; however, as the sun got brighter, the Earth needed less temperature, and therefore, these photosynthesizing bacteria connected the CARBON CYCLE by decreasing CO₂, and therefore, decreasing the GLOBAL TEMPERATURE of Earth. This is quite similar to how a GREENHOUSE adapts to a TEMPERATURE change, as things get too HOT, the GREENHOUSE starts cooling the system down compared to the temperature outside, causing a LOCALIZED EVENT, this is also SUPPORTED BY THE PLANTS. This is also why the increase of CO₂ is called the GREENHOUSE EFFECT.
 2. The second point being that SIMILAR to how in a GREENHOUSE SYSTEM, the TEMPERATURE changes in response to HUMIDITY, so does it in the ATMOSPHERE. In the Hadean eon, when there was a lack of a hydrosphere because the conditions were unmet, the TEMPERATURE was extremely HIGH; however, during the EVOLUTION OF EARTH, H₂O was released into the PRELIMINARY ATMOSPHERE, causing a MASSIVE SHIFT in TEMPERATURE GLOBALLY. Similarly, in a GREENHOUSE, a change in HUMIDITY changes the TEMPERATURE LOCALLY.
- One thing we can deduce from these as a DIFFERENCE is that the changes happening are LOCAL on the GREENHOUSE level and GLOBAL on the Earth's level.

GREEN

Omar Adel

In geology we learned about the Earth's history, tectonic plate interaction and crust formation. Although it may seem crust formation is the only concept that is helpful, we can still learn from tectonic plate interactions and how they resulted in the changes of Earth throughout history. Induced changes and reactions: We learned about subduction zones and how the increased pressure and heat from the core can lead to tectonic plate movement and sometimes leakage of magma. This change causes some plates to move up and down changing the rock formation, something similar happens with a smart

greenhouse; if the humidity is low and the temperature is high, the top layer of soil dries up and increases in density, it can sink and form a hard infertile layer that impairs plant development. This led us to believe that an automatic humidifier and irrigation system should be implemented to prevent this. valuable resources and materials: We learned that matter on earth is conserved and cycles through and through, with organisms dying and decomposing they construct a nutrient rich soil layer becoming minerals like apatite and coal then become molten at the core. We learned that although these rocks may be infertile and hard, the process can be reversed with water and heat. This releases the condensed nutrients and will substitute as a cheap and nice soil enhancer for plant growth or aquatic feed. In conclusion, geology doesn't only helps us know the location and properties of resources, but also how they formed so that we can replicate or reverse certain processes towards our benefit.

GREEN

Mazen Askar

Both topics involve systems thinking, meaning different parts interact and influence each other:

The first similarity is interdependence between components. In Earth science, the Earth consists of connected spheres: the atmosphere, hydrosphere, biosphere, and geosphere. These spheres interact through processes such as the Hydrologic Cycle, where water evaporates from oceans, moves through the atmosphere, and returns to land to support living organisms. Similarly, in a smart farm or aquaponics system, components such as fish tanks, plants, biofilters, and sensors depend on each other. Fish produce waste that becomes nutrients for plants, while plants help purify the water for fish. Therefore, if water quality changes, it affects both plants and fish, showing how one component influences the entire system.

The second similarity is system response to change. In Earth systems, a change in one sphere can affect others. For example, increased atmospheric carbon dioxide can influence temperature and precipitation patterns. In a smart farm, sensors monitor variables such as temperature, pH, and salinity. When values move outside the optimal range, the system activates pumps or aerators to restore balance.

However, a key difference is scale and control. Earth's spheres operate naturally on a global scale and cannot be directly controlled by humans, while a smart farm is a human-designed system that can be monitored and adjusted to maintain optimally perfect conditions.

GREEN

Malek Sayed

we learned about evolution of Earth's spheres and that Earth has existed as an interconnected, global system containing the geosphere, air (atmosphere), water (hydrosphere), and life (biosphere). these two topics are very connected as our system acts as a MINI EARTH.

1. The idea of earth's systems clearly relates to our project, "Engineering the Living Systems." Our smart greenhouse and aquaculture systems produce mini earth systems. We monitor the environment with sensors, while the actuators fix any deviations from the desired conditions. Just like earth maintains stability through closed loop feedback systems (For example: the WATER CYCLE and the magnetic fields that protect earth's atmosphere), our project uses a closed loop feedback control system to ensure stability for the plants or fish.
2. Initially, earth was made up of one simple (molten object) but over billions of years, earth transformed into a layered composition of different physical systems working together. The same applies to our prototype. We start with simple materials (most of which are recycled) and, by using them to create an integrated system and restore balance every time a variable.

also the two systems differ in many ways first that earth doesn't change its temperature and environmental parameters based on command or actuators like our smart farm system. Sometime the weather is very unpredictable and varies throughout the large land of earth. Also our system can change its atmosphere based on the plant we grow unlike earth which is the exact OPPOSITE the plants grow depending on the atmosphere.

BLUE

Baraa Ahmed

The earth's spheres are all explained in a simple approach: the PROCESS-BASED MODEL. It consists of 2 elements: processes (inputs & outputs) and reserves (as pools). A process can be input to one pool, and output from another. Looking at the hydrosphere & water cycle, we can simply distribute the hydrosphere into processes & pools accordingly: • Pools: Clouds, oceans, rivers, lakes, living organisms, mineral water, and man-made water reserves, and others • Processes: Evaporation, Evapotranspiration, Respiration, Evaporation, Boiling, Condensing (rain, snow, hail, sleet, etc...) and more. Applying this approach to the idea of a smart farm, we find something: • There IS a WATER CYCLE INSIDE A SMART FARM. Plants reserve water inside their structures, and perform evapotranspiration. The soil reserves water & may evaporate due to sunlight exposure. Condensation leads to the returning of water from the air to the soil & therefore to the plant and so on. • The PROCESS-BASED MODEL APPLIES IN A SMART FARM. As described above, the cycle repeats on and on, and can be described in the form of processes & pools. However, a smart farm would obviously NEVER INCLUDE A WHOLE

HYDROSPHERE. This stresses on something fundamental to the idea of processbased models, which is the SPATIAL & TEMPORAL SCALE of the model. While a hydrosphere's model may work at the timescale of months, years, or even decades, the timescale of a smart farm is often at hours, and even minutes. In terms of spatial scale, there's no comparison between a whole planet's reserve of water and a small, hand-held prototype.

BLUE

In what ways can analyzing limits and continuity of functions help engineers predict environmental changes and prevent sudden fluctuations (change) in a smart aquaponics or greenhouse system?
Learning Transfer

Ziad Salah

During the research period, it's common that you'd find mathematical MODELS demonstrating TEMPERATURE changes (for example) in response to HUMIDITY, LIGHT, and EVAPOTRANSPIRATION for GREENHOUSES. It's important to take all these factors into consideration because it can DRASTICALLY affect the plant's lifetime if unconditioned appropriately, it may also cause a severe INEFFICIENCY when PREDICTING ENVIRONMENTAL CHANGES, causing sudden FLUCTUATIONS, this can be shown in the following points:

1. After studying the MODEL and giving it the APPROPRIATE targeted environmental parameter RANGE and the VARIABLES required, the MODEL approximates how the TEMPERATURE (for example) should change in RESPONSE to these changes. We can then use the property of CONTINUITY of this MODEL to approximate how the TEMPERATURE should behave at time x of cooling the system with the given parameters. We can then LIMIT the MODEL where t (time) approaches x to find the PRECISE value of the continuous function $f(t)$ ($\lim_{t \rightarrow x} f(t)$). This can help PREDICT a SUDDEN CHANGE in values for multiple conditions by finding where JUMPS are and avoiding their conditions.
2. Using MODELS of LIGHT INTENSITY, we can EXTRAPOLATE the NEEDED light INTENSITY for the PLANT as well as RELATING this to TEMPERATURE as not to cause a FLUCTUATION in that variable. As the MODEL is graphed, we can FIND the OPERATING RANGE of values, and detect if there are any SUDDEN JUMPS to prevent FLUCTUATIONS. It also helps DETERMINE when the LIGHT should be on, increasing the cost-effectiveness of the system and its EFFICIENCY.

GREEN

Omar Adel

Graphing properties such as limits and continuity help us understand the interactions between multiple values to determine how a system must change and adapt when a value is changed. 1- limits: Using limits we can understand the maximum value that is possible at a certain point. For example, when relating the temperature inside a system with the time that a temperature actuator has been running with a function, we can assume that the temperature won't exceed a certain number at a certain time interval such as 3 minutes as so: $\text{Lim} = (X^2 + 90)/X$, $\text{Lim} = 33^\circ\text{C}$ $X \rightarrow 3$ this means that after 3 minutes of the actuator running, the temperature will reach 33 degrees Celsius if the system started at Zero. This can help us determine how much time we need an actuator to be running for to achieve the optimal environment in a system. 2- continuity: realizing where a function stops working correctly, breaks or just jumps to a different value we can find out which values are impossible to maintain for long times or even just a millisecond. As the last example, in the function $(X^2 + 90)/X$, we would think that the value at 0 when the actuator is not running is 90 but that is impossible in real life and because it isn't continuous, the function breaks at $X=0$ therefore we can never reach that value. In short, we can understand how actuators and sensors will interact in a system without buying or using them at all, this helps us predict results and form new design modifications.

GREEN

Mazen Askar

Analyzing limits and continuity helped us understand how environmental variables change over time and prevent sudden fluctuations that may harm organisms in controlled systems.

First, the concept of Limit in mathematics allows engineers to predict how a variable behaves as it approaches a critical threshold. For example, in a smart aquaponics or greenhouse system, parameters such as temperature, pH, or salinity must stay within safe ranges. By analyzing limits, engineers can estimate how close a variable is to a dangerous level and take corrective action before the system reaches that point.

Second, understanding continuity rather than abruptly. In a well-designed smart farm, adjustments made by pumps, heaters, or ventilation systems should create smooth transitions in environmental conditions. Continuous changes protect plants and aquatic organisms from stress caused by sudden shifts.

Finally, studying Discontinuity helps engineers identify potential risks. A step discontinuity could represent a sudden temperature spike due to equipment failure, while an infinite discontinuity might

indicate a sensor malfunction or system instability. Recognizing these possibilities allows engineers to design monitoring and control systems that detect abnormal changes early.

Therefore, applying limits and continuity helped us maintain stable environmental conditions, predict approaching risks, and prevent sudden fluctuations that could damage the aquaponics or greenhouse system.

GREEN

Malek Sayed

In MA.2.06 we learned about continuity and limits in binomial functions and how can continuity affect the limit of the function at specific points in the function. The limit is what value the function tends to at a specific X value for example if X is actually in the domain of the function so the limit is just $f(x)$ but if the X value is not in the domain of the function so we see what is the value that the graph tends to approaching this X value.

Engineers can use these concepts to predict environmental changes by studying the weather in this specific time range so for instance in Egypt every year in the beginning of may there is strong sand storms this can be visualized as a continuous function that repeats every year so understanding continuity will significantly improve the accuracy of weather predictions.

Also Engineers can use limits to predict environmental changes that happens gradually for instance if the temperature is decreasing by 2 degrees daily in the last few days so if the temperature was 36 degrees for three days you can predict that tomorrow the temperature approaches the value 28 degrees as it acts like a decreasing function even if we do not have the value 'tomorrow' yet we can see what value the graph approaches

Depending on these concepts and predicting environmental changes we can set our greenhouse systems to act depending on these changes for instance if the temperature will decrease tomorrow I will set the actuators in my system to rise the average temperature in the system.

GREEN

Baraa Ahmed

The idea of limits & continuity of functions has a direct link with prediction of environmental changes. Engineers often use mathematical methods to represent data in form of functions, and visualize them into curves & other methods. Among other methods of data analysis are LINEAR and NON-LINEAR REGRESSION, which depends on a set of x - y pairs to generate a curve that is most representative of all data after filtering. There are two key tools used in hand with different types of regression. Oftentimes, the collected data be scarce, which leads to two methods: • Interpolation: A set of data may potentially

include a large gap in the middle. The whole regression function is supposed to fill this gap using information from the rest of the function. • Extrapolation: A set of data may potentially be cut off at the end, or require an extension over the x-axis. A regression function can help with extrapolating in a set of data. The concept of interpolation is analogous to finding the limit of x as it approaches a value excluded from the function's range – which can be done when fitting data on curves. Meanwhile, extrapolation can be done for up to ∞ using limit of function at x approaching ∞ . These two methods can be useful for environmental engineers to predict certain patterns or constant changes over large time intervals, potentially leading for true sustainability of solution; whether it be a smart farm with a slight inconsistency with CO₂ concentration for example, or a very slight increase in water salinity that can be noticed after a large time interval of 10 years or so.

BLUE

Journal 3

Explain how **collaborating** with your team helped you select the design requirements of your prototype, and how this experience improved your **skills, understanding, and readiness** for the next stage of the project.

Personal Reflection/Team Collaboration

Ziad Salah

My team and I are from different governorates, more specifically, 3 dudes from Ismailia and 1 dude from Cairo, you might think this would pose a problem because of the difference in governorates or locations; however, this facilitated finding the design requirements.

Ismailia has an especially diverse climate – here, many types of plants can be cultivated on a yearly basis if the plants are rotated. When I was thinking of how we can possibly mitigate the problem of having a NOT-SO-DIVERSE team, I thought about turning that into a useful thing.

I, as the team leader instructed my friend from Cairo to research about the environmental profile in Ismailia and what plants we're supposed to cultivate and grow. This is so that he can look at the topic from a NEUTRAL POINT OF VIEW, whereas I instructed my friends from Ismailia to research about ENVIRONMENTAL PARAMETERS and their APPLICABILITY.

This team division was quite fruitful at the end because we found that the APPLICABILITY OF ENVIRONMENTAL PARAMETERS matched with the PLANT that our friend from Cairo chose.

This helped GROW MY SKILLS in team communication as I learned the following things:

1. AUTONOMY is better than MONOTONY in work, where working ASYNCHRONOUSLY while establishing proper connection ensures strong team COMMUNICATION and COHESION.
2. PROPER COMMUNICATION of RESULTS; this helps in staying in touch with all the updates.
3. TURNING YOUR WEAKNESSES INTO STRENGTH – there's always a loophole you can exploit which turns your weakness (our non-diversity) into strength (a WELL-FOUNDED RESEARCH).

BLUE

Omar Adel

Diversity is an important property of socializing that is important for people to understand others' respective environments. STEM schools' boarding dormitory lifestyle ensures that everyone meets

people from all around Egypt, connecting, living and laughing together, but how does this influence capstone work?

While selecting the design requirements it was clear that everyone had a specific one in mind they didn't want to abandon. While we almost argued, we decided to listen to everyone's reason. It was made obvious that each member of the team had a design requirement fulfilling their ideologies:

1. Simplicity of design, our teammate from a village with low education pointed out.
2. Low price, our teammate from a poor area added.
3. Reproducibility, our teammate from an area with a huge need for a solution noted.

It was clear that since each member of the team had their own diverse experience, they were able to point out ideas that would have been ignored. This helped my team pick design requirements that fit every possible social group efficiently.

I realized that diversity and satisfaction of every group is mandatory to be successful. I improved not only my leadership skills through reaching a result, but also my critical thinking skills; I now know how to choose a design that fits everyone's needs.

I believe if everything goes well and me and my fellow team members keep working hard in a collaborative manner, we will be able to produce a solution and prototype that truly solves the problem down to its core.

BLUE

Mazen Askar

"Design requirements are necessary criteria that judge the success of the solution and the prototype, so my team came together to decide on what qualities our prototype must possess, and discussions about several requirements arose, where we had to ask if our standards were too high or too low, and once we chose a design requirement, thus this experience made ready for the next stage of the project which is prototyping through the learning of:

1- Skills:

- Teamwork: working with a team to decide on the design requirements helps develop communication skills and improves teamwork, which is always helpful in any stage of the project.
- Working for the long term: When deciding on the we had to think in advance about how we were going to apply a test plan to each design requirement, which forced us to not be reckless.

- 2- Understanding: Correct judgement: Being forced to ask what was right and what was wrong, morally, performatively, and critically, helped me understand what makes a design requirement needed, and what makes one overkill, which is necessary for building a functional prototype.
- 3- Readiness: The experience as keeps us one our toes for any surprises, as with strong design requirements, the prototype should come out strong and healthy, making the next phase easier.

BLUE

Malek Sayed

Selecting the design requirements can be considered the most important stage in constructing the prototype. The most effective way to solve a problem or a challenge you are facing is to follow a process called the EDP. It highlights the main steps you follow to reach a solution. These are the 5 most important steps to solve nearly any problem 1. Identifying the problem 2. Background research 3. Searching for a solution 4. Setting design requirements 5. Constructing a prototype So after we passed the first 3 MAIN stages, we gathered our team and started asking questions like “what are the essential things that must be in our prototype that our prototype will not function without it?”, “how can we achieve the MAX efficiency from our prototype?”. And we decided to do deep research about these questions and how prior solutions was effective and what requirements were set to achieve their advantages. And also what caused their disadvantages. This helped us set specific, strict requirements about how to prevent disadvantages in prior solutions and how to achieve the best functioning prototype we can build. In consequence we understood how we will build our prototype and read what errors and malfunctions can happen. To conclude setting the correct design requirements with the correct ranges can differ a bad prototype from an effective one as the design requirements you set shapes your prototype’s shape, functionality and efficiency. also collaborating with my team to find the right design requirements made us see our prototypes from various perspectives.

BLUE

Baraa Ahmed

A house has hundreds of blueprints and schematics created since the start, and refined slowly until it is finally used for the construction process. A capstone project’s prototype undergoes the same process. We’ve all contributed in all aspects of the project creation since the start – from researching the problem, previous solutions, tradeoffs, and more, up until we have gathered a solid foundation of information. That drove us into re-focusing on our own work again. What materials were to be used? What sizes? What parameters? To satisfy all “whats” and “ifs”, we’ll have to set our own criteria for the greenhouse project. Gathering our cumulative skills as a team, we have arrived at four main categories:

1. SPACE: The prototype should be usable, both indoors and outdoors, without the reliance on a certain location; that is, it should contain its own soil compartment. 2. DIMENSIONS: The prototype's size should be minimal for customer-level use AND be spacious for various plants. 3. COST: The prototype, including its components, should be cost-effective. High expenses will obliterate the purpose of the project. 4. USAGE: The prototype should be prepared for simple usage without prior experience in coding or engineering, i.e. user-friendly. Determining these criteria was a team's process, where a teammate who: 1. Researched common planting practices developed criteria for space. 2. Studied types of greenhouses (which was me) determined dimension constraints. 3.

Evaluated financial effectiveness of each type suggested rules for cost AND usage.

BLUE

Design requirements are considered the cornerstone of the prototyping process. Discuss how these requirements guide the design phase.

Using the Engineering Design Process (EDP)

Ziad Salah

The DESIGN PHASE is extremely DEPENDENT on previous phases, this is OBSERVABLE when we're researching about ENVIRONMENTAL PARAMETERS and their relation to the DESIGN REQUIREMENTS, and which PARAMETER should be used out of temperature, pH or salinity. These kinds of PARAMETERS can only be identified once your PLANT is IDENTIFIED, meaning that this part of the RESEARCH PHASE relies on itself which in its entirety, the DESIGN PHASE relies on it.

For example, during research, we found that our plant of choice – the Chia Plant is excellently grown in HUMID, WARM CONDITIONS. This poses the following questions in the DESIGN PHASE:

1. What parameters and sensors should I use?
2. What ACTUATORS should I use to respond to a change?
3. How should I design the greenhouse to be best fit for these conditions?

These THREE QUESTIONS are extremely essential. By researching sensors and parameters, we found that HUMIDITY, MOISTURE, and TEMPERATURE are extremely suitable for this application, we also found that FANS, and HUMIDIFIERS are EXCELLENT ACTUATORS. For the THIRD QUESTION, we had to RESEARCH prior solutions and different DESIGNS. We concluded that we should use a SLOPED ROOF and TRANSPARENT WALLS.

We found that BY SETTING THESE REQUIREMENTS, during our RESEARCH PHASE, we could find MATHEMATICAL MODELS that could be used ALONGSIDE SENSOR DATA to predict the TRAJECTORY of the PARAMETERS and prepare systems accordingly.

We also found that BY THAT DESIGN REQUIREMENT, we need to use an ONLINE PLANT API to retrieve the best conditions for this plant to adapt the plant to its conditions.

GREEN

Omar Adel

The best map doesn't tell you which road to take, but how to pick a path that suits you. Design requirements are similar to landmarks you see in a map, to make sure you are headed in the right direction you must acknowledge each one.

1- Clear goal creation. Picking the right design requirements, helps you pin point what your goal and result should be. Whether it is a cheap solution, simple, or just effective compared to older ones, depends mainly on the chosen requirements and whether they have been satisfied.

2- Choice making. Choosing specific design requirements makes it much easier to choose materials, method of employment and more. For example, by choosing a cheap requirement, you know that any material bought shouldn't exceed a certain value, I.E. 250 EGP.

3-physical attributes. It helps you have an idea of how a final prototype should be. If your design requires a portable device, then having a light prototype is mandatory so it can be carried around easily.

4- validity testing. By having a design requirement that is quantifiable like "not using more than 40 W of power" you can test this and compare it to other solutions giving you grounds for analysis and improvement.

These points are only the tip of the iceberg compared to the real importance of design requirements. It helps choose final outcomes, materials, construction details, attributes, shape, and scientific base.

I believe that without the correct design requirements, everyone will be lost like a man without a map.

GREEN

Mazen Askar

Design requirements are the foundation of the prototyping process because they define what the solution must achieve and how its success will be evaluated. During the design phase, these requirements act as clear guidelines that shape every design decision.

First, design requirements set clear objectives and constraints. They specify target values such as acceptable temperature ranges, response time, or accuracy, as well as limitations like cost, size, and available materials. This ensures that the design stays focused on solving the problem effectively without exceeding practical limits.

Second, they guide the selection of components and system structure. For example, if a requirement states that the system must respond quickly to environmental changes, the design must include fast sensors and responsive actuators. Similarly, if cost is limited, the team must choose affordable materials and simplify the design. In this way, requirements directly influence how the system is built.

Third, design requirements support decision-making and prioritization. When multiple design ideas are possible, the team can compare them based on how well they meet the requirements. This prevents random or subjective choices and ensures that the final design is justified and efficient.

Finally, design requirements prepare the prototype for testing and evaluation. Since each requirement is measurable, it becomes easier to verify whether the prototype meets the expected performance.

Overall, design requirements guide the design phase by providing direction, limiting unnecessary complexity, and ensuring that the final prototype is functional, efficient, and aligned with the project goals.

BLUE

Malek Sayed

To solve a problem you are facing you must follow a certain protocol or some important steps to reach an effective solution. Besides setting design requirements, the preceding steps must be done correctly to be standing on solid ground when you set your requirements. These are the most important steps in prototyping or solving a problem. 1. Identifying the problem 2. Background research 3. Searching for a solution 4. Setting design requirements 5. Constructing a prototype After identifying the problem carefully to ensure that the right problem is solved effectively a lot of background research has been done to look for the right solution and also gathering information from prior solutions. Then came a critical point in solving the problem which is setting the design requirements for our prototype. This phase can be considered like drawing the line that you will mimic while building the prototype. For instance in this semester's project if you set the wrong temperature or soil moisture range as the design requirement you will build your prototype with the wrong conditions for the plant causing the plant to die. In consequence, specific, strict design requirements must be set and these requirements must be based on a scientific background and specific for your solution to achieve the best results from your prototype. To conclude setting the correct design requirements with the correct ranges can differ a bad prototype from an effective one as the design requirements you set shapes your prototype's shape, functionality and efficiency.

BLUE

Baraa Ahmed

Let's compare two scenarios for building a house. The first house is built haphazardly, randomly, and without coordination between its engineers. From the ground up, every brick is misplaced. There's a balcony hanging without a door on the fourth floor, and a door next to it without a balcony either. The first is nonfunctional and the second's only function is to kill you. The second house is elegantly built, based on tons of prior studying and well-visualized on tons of blueprints and schematics. Every element is placed neatly and all's well. Design requirements are considered the cornerstone of the prototyping process, whether it be for a house, a capstone's prototype, a car, or any systematic process. Scientists did not include it as a step for Engineering Design protocols for nothing. Evaluating the purpose of design requirements, a pre-mortem of NOT FOLLOWING them includes: 1. **UNCLEAN MEASUREMENTS**: Many faults and offsets in the framing of the prototype can mechanistically weaken its structure. 2. **UNCALIBRATED COMPONENTS**: Usage of components without proper regulation and understanding of their purposes introduces amplified errors and faults everywhere. 3. **INCOHERENT PURPOSE**: Having too much problems inside the prototype, turns its job from fixing a certain problem into fixing its own problems, completely destroying the idea. At the same time, the advantages include: 1. **SOLID FOUNDATION**: The prototype is structurally clean and has its own components' compartments prepared in advance. 2. **HARMONY**: All components are compatible with each other.

BLUE

Based on your study (CS.2.07) of different view groups' tools, explain how you could utilize this knowledge to design an interface for monitoring environmental changes in aquaculture, agriculture, or hybrid aquaponics.

Ziad Salah

Utilizing Android Studio, we can construct a UI (User Interface) to guide the user about the ongoing changes in the greenhouse/designed system. This can be done by **DESIGNING A LAYOUT**, whose type can be sequential, linear, or whatever else. I personally prefer a **RELATIVE LAYOUT** because it can easily be designed **RELATIVE TO** screen size and other components present in the **VIEW XML**.

Using the **MICROCONTROLLER (ESP32)** in my agriculture system, I can **UPLOAD SENSOR DATA** to a server hosted on the **PHONE** using the local **PHONE'S** IP Address or use the **BLYNK** IoT app. I can then add different **COMPONENTS** to show the loaded **PLANT'S DATASET** and add an option to **REMOTEY CHANGE THE DATASET**, allowing for quick **SWAPPING** of the plant (this means that the plant can be easily changed by a simple download.)

After the **SENSOR DATA** is uploaded, I can use a Java library using **TENSORS** or **MATPLOTLIB** to **GRAPH THE DATA** and utilize several **MATHEMATICAL** models for the **ENVIRONMENTAL PARAMETERS** and identify the **TRAJECTORY** of the system. This is an excellent way to **ALERT THE USER** of ongoing changes and predicting anything that **MAY HAPPEN**, also **ALERTING THE USER** and sending a notification before it happens.

The **COMPONENTS** in this layout are TextLabel, Button, TextBox, and RadioButton. These are mainly used for **SHOWING THE USER** what's going on and when **COMPONENTS ARE FAULTY**, I can send a **WARNING** to the user to alert them to replace that component (**A BROKEN RELAY FOR EXAMPLE.**)

GREEN

Omar Adel

Creating an interface that is important yet simple may come across as a hard concept. However, when using the right tools and applying different ideas, everything becomes much simpler. Therefore several steps are important to create one that correctly monitors environmental changes.

1. Designing a user-friendly UI. This can be done through XAMPP, and HTML since they run on local servers that don't require internet. This is important for a worker who might not have access to a stable signal.
2. Constructing a dynamic and automatic comparison code. After choosing a plant, a database with this plant's needs is computed. This database is a static one, in code we can go:

Create New database = plant_1

This database will include safe ranges of humidity, temperature and soil moisture. Then the real time data is measured in comparison to this main database:

If real_time_data == plant_1:

Output("safe environment!")

Elif real_time_data < plant_1:

Output("activate humidity actuator")

else:

Output("error")

this is a simple example of how the interface can accomodate the needs of the plant to the worker in a simple.

3. Using View old data. By viewing the real time data across the last two weeks, the worker can determine whether the design is actively failing to accommodate the needs of the plant and whether a change is mandatory.

I believe that a good interface wouldn't only make it easier to help the plant grow, but also make it possible to detect any trend or problems that may occur in the future.

GREEN

Mazen Askar

In CS 2.07, we studied how different view groups' tools can be used to organize and present information clearly to the user. This knowledge can be applied when designing an interface for monitoring environmental changes in an aquaculture or smart farming system.

First, I would use different views to display data based on its importance. For example, a main dashboard view can show real-time readings such as temperature, pH, and salinity, allowing the user to quickly understand the system's condition. Additional views can be used for detailed graphs, showing how each parameter changes over time. This helps the user identify trends instead of only seeing current values.

Second, I would organize the interface so that related data is grouped together. For instance, all water-related parameters can be displayed in one section, while air or environmental factors are shown in another. This makes the interface easier to navigate and reduces confusion when monitoring multiple variables at once.

Finally, I would include visual indicators such as color changes or alerts to highlight abnormal conditions. If a parameter goes outside the safe range, the system can display warnings, helping the user respond quickly.

By applying these ideas, the interface becomes clear, organized, and effective in helping users monitor environmental changes and maintain system stability.

GREEN

Malek Sayed

In Android development, a View is any rectangular area on the screen that the user can see or interact with. Think of it like a Lego brick, you stack different types of "bricks" (Views) to build your app's screen. The Main (Concepts): TextView: Displays text. You use it to show information to the user. ImageView: Displays pictures or icons. Button: A clickable element that performs an action when pressed. XML: The coding language used to "draw" these bricks on the screen and decide where they go. This matches our

project structure. Your ESP32 is the "brain," but the App is the "face" of the project. Here is how you use these concepts: 1. Displaying Sensor Data (TextView) Since your system is a "closed-loop," it is always collecting data. For example: Use a TextView to show the real-time sensor reading ("Current Temperature: 28°C"). This helps the user see if the "feedback" is working. 2. Manual Control (Button) Even though the system is smart and "heals itself," you might need a manual override. Example: Create a Button labeled "Reset System" or "Stop Actuator". When you click it, the app sends a command to the ESP32 to take action. 3. Status Icons (ImageView) Visuals are faster to understand than text. Example: Use an ImageView to show a Green Tick icon when the system is stable, and a Red Warning icon if the sensors detect an error that needs fixing. 4. Organizing the Layout (XML) You use XML to make the app look professional. Example: You can place the ImageView at the top, the TextView in the middle for data, and the Button at the bottom for easy reach.

GREEN

Baraa Ahmed

The knowledge studied in different view groups' tools can be utilized in many aspects of the prototype, from the data inputting process, to the outputs, measurements, and even

extrapolations of data for potential solutions and protocols for future implementation. Recalling the prototype's design requirements, they include: 1. User-friendliness 2. Able to be calibrated for different plant types 3. Able to visualize measured data For all these reasons, it is important to design an interface that will enhance user-friendliness of the prototype for use at consumerlevel scale without prior knowledges about the mechanisms of the project. At the same time, the prototype should be able to accept new data for the feedback loops, ready to be applied into pre-made control algorithms for each parameter. In turn, the data measured should be saved in csv (or other database format) for future referencing and further study of how the prototype operates. Using an IoT-based microcontroller (The ESP32), establishing an internet connection with the device enables it to be used at all scales – from a mobile phone to a laptop. That being said, further evaluation of the prototype can be done against IEEE Standards for IoT-based devices.

GREEN

In CH.2.09, you studied electrochemical cells. Explain two points showing how the knowledge you gained about electrolytic solutions helped you design or improve the solution used in your prototype (aquaculture or agricultural environment).

Learning Transfer

Ziad Salah

Electrolytic solutions are **IONIZED**, whether that'd be half, or almost completely ionized, or slightly ionized – the **MOST IMPORTANT POINT** is that in this solution (whether aqueous or molten), there are **FREE IONS** floating.

In botany, plants absorb **MINERALS**, these **MINERALS** are found freely floating inside of **SOIL PARTICLES** in which the plant is situated in.

Slightly electrolytic solutions with moderate **IONIZATION** can be used as fertilizer for a plant by providing Na^+ , K^+ , Ca^{+2} , and NH_4^+ ions. These are commonly used in **FERTILIZERS**; however, in **fertilizers**, these are in **certain RATIOS at certain CONCENTRATIONS**. This means that in this **electrolytic solution too**, the **RATIOS** must be similar.

To create your own solution, multiple **METHODS** may be utilized to either balance this concentration or help **CALIBRATE** sensors and **ACTUATORS**, of which are:

1. Using **ELECTROLYTIC BATTERIES** and the **Nernst equation**, the **CONCENTRATION** of the electrolytic solutions can be adjusted according to the **EQUILIBRIUM CONSTANT**.
2. Using the **MOLARITY** or **MOLALITY** of the solution to achieve a different concentration by adding different **IONS** or more **WATER** to dilute the solution.
3. Electrolytic solutions can be used to **CALIBRATE pH and salinity sensors** by measuring the base voltage reading on a **DISTILLED NEUTRAL SOLUTION** of pH 7 and measuring an **ELECTROLYTIC SOLUTION** of pH 0 (extremely ACIDIC.)
4. For the **ACTUATOR**, since the soil has a **BUFFERING CAPACITY**, the **MICROCONTROLLER** can calculate the exact **VOLUME** needed to be dispensed into the soil for its **pH** to change.

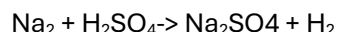
GREEN

Omar Adel

Electrochemical interactions are complicated yet interesting. They can go from consuming energy producing refined and extracted materials, to producing that electricity instead to accommodate any

needs. There are many ways to utilize these ideas, however, only a few stood out as applicable methods:

1. Electroplating. After noticing that a lot of parts in the automatic device are prone to rusting and causing pollution in both water and soil, we decided to plate them with bronze to stop them from rusting. This can be done by adding the component in water and driving a current through a bronze piece, it will become a solution and then precipitate onto the component protecting it from weathering and rust.
2. Electrolysis of water. A major problem with having a stable aquaculture environment is keeping a good amount of dissolved oxygen so that fish can breathe. We were able to do this by driving a current through a small water vial which split the $2\text{H}_2\text{O}$ to 2H_2 and O_2 we can reinsert the oxygen alone to dissolve it in the fish tank.
3. Sustainability and erosion evasion. We learned that some acidic solution from plants or animal waste may corrode metallic components because some metals would replace the Hydrogen:



we decided to use components made of copper which is weaker on the chemical activity series (C.A.S) so it doesn't partake in this reaction.

After applying these things, I noticed that electrochemical solution study didn't only make the solution better, it is the main reason it is possible.

GREEN

Mazen Askar

In CH.2.09, we studied electrochemical cells and how electrolytic solutions conduct electricity due to the presence of mobile ions. This knowledge helped improve both the sensing and stability of the solution used in our aquaculture system.

- 1- Improving measurement and monitoring of water quality:
An electrolytic solution conducts electricity because dissolved salts dissociate into ions. In our prototype, salinity and water quality are critical parameters. Understanding that conductivity depends on ion concentration allowed us to correctly interpret sensor readings and design a more reliable monitoring system.

For example, by ensuring the solution behaves as a proper electrolyte, we improved the accuracy of sensors that depend on electrical conductivity. This made our feedback system more precise when detecting changes in salinity or nutrient levels.

- 2- Enhancing system stability using electrode potentials:
From the study of standard electrode potentials and the redox series, we learned how different

materials react in electrolytic environments. This helped us choose electrode materials that are less reactive and more resistant to corrosion when placed in water.

As a result, the system avoids unwanted redox reactions that could alter water composition or damage components. This improves durability and maintains a stable environment for aquatic organisms.

Overall, understanding electrolytic solutions and electrode behavior allowed us to design a more accurate, stable, and long-lasting system.

GREEN

Malek Sayed

In CH.2.09, we studied electrochemical cells and how they function and switch between converting between chemical energy and electricity and vice versa. The galvanic cell converts spontaneous chemical reactions into electricity on the other hand electrolytic cell converts electricity to facilitate chemical reactions which is considered non-spontaneous because they don't happen on their own they need electricity to start the chemical reaction. Electrolytic solutions can be used for many applications like electroplating and removing impurities from metals by collecting a certain metal you can choose by putting a rod of this metal. 1. As a result we can use electrolytic solutions to remove excess minerals from the soil and water like (iron and mercury) as they are poisonous and can cause plants and fish to die, so we can make an electrolytic cell and put an iron rod at cathode to collect the excess iron in the soil or in the water. 2. We can make electrolytic cell that collects excess water and converts it into hydrogen and oxygen gases $2\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$. As excess water can cause the plants to die or to prevent wasting water. 3. Also some electrolyte solutions contains beneficiary elements and minerals to the plants and fish some solutions can contain salts that facilitate the plant growth and improve their overall health and adds nutrients to the plants that will later benefit humans or animals the consumes it

GREEN

Baraa Ahmed

Understanding the importance of properties of solutions, including the types of solutions, concentrations, volumes, temperature-pressure effects, have had their own applications. More specifically, electrolytic solutions have been extensively studied for the purposes of environmental applications. When studying the constituents of a compartment of soil, we can classify them into their solid and liquid components. The liquid component is mostly water containing a great deal of colloidal particulate matter, as well as dissolved minerals. It contains a wide range of materials in compounds including sodium, potassium, nitrogen, phosphorus, carbonates, bicarbonates and much more. The existence of an electrolytic solution in a greenhouse's prototype is important for two main functions: 1. THE PLANT ITSELF: a plant requires a constant daily intake of minerals for its own processes including

growth, respiration, photosynthesis and carbon sequestration. 2. GREENHOUSE MEASUREMENTS: A great deal of measurements done by the greenhouse depend on the fact that electrolytic solutions are good electrical conductors, hence the amount of conductivity is used for measuring concentrations of electrolytes, humidity, salinity, and much more. For these two reasons, it is important to monitor the kinds of minerals that exist in the soil of a greenhouse – to prevent the aggregation of unhealthy ones (such as too much salt), and to enhance plant health and maintain calibration-appropriate measurements.

GREEN

Journal 4

Every project has a "signature" a specific choice that makes it uniquely yours. Illustrate in details the part of your project that no group else in your school could have created and came by brain storming of your team.

Personal Reflection/Team Collaboration

Ziad Salah

I've generally noticed something during the time I've worked with this team, that all of us have a GOOD BASE of mathematics and research, which gives us a great HEADSTART in terms of COLLABORATING on RESEARCH and connecting ABSTRACT ideas to make a SIGNATURE MODIFICATION or ENHANCEMENT. We wanted to unite our MINDS and RESEARCH SKILLS into making something that distinguishes this agricultural system – something that DISTINGUISHES it from other SYSTEMS.

I also noticed that most my friends were MATH SECTION which gave me an idea to implement MATHEMATICAL MODELLING into the prototype to be a supplement to sensor readings; basically, PREDICTING HOW THE SYSTEM IS GOING TO GO.

Using our strong basis of research, I divided the tasks; one would take research about PARAMETERS and STRESS, one would take research about GRAPH TRAJECTORY AND PREDICTED VALUES, one would research about MATHEMATICAL MODEL DATABASES, and (I) would research about the FUNCTIONS.

We did these tasks around eachother so that any NEW IDEA that was considered SIGNATURE, we would TELL eachother to see how everything fit together; just like a PUZZLE GAME.

Implementing this into our system helped us transform the prototype from a PRIMITIVE/BASIC feedback loop to an ADVANCED MMA (Mathematical Model Approach) feedback loop. The MMA helps PREDICTING events that cause SENSORS to give certain readings. It also helps in KNOWING THE DIRECTION of a variable. For example, temperature may be rising but the PRIMITIVE feedback loop wouldn't know this – it would only know the INSTANTANEOUS READING.) We did this

WARN the user about POTENTIAL events happening that alter the regulated parameters. For example, the TEMPERATURE is RISING with a SLOPE, a STANDARD FEEDBACK LOOP wouldn't know which direction it's going; however, the MATHEMATICAL MODEL graphs it such that IT KNOWS THE TRAJECTORY OF THE GRAPH. We did this by uploading SENSOR DATA to the MODEL DATABASE and PROCESSING the PARAMETERS, then PREDICTING THE OUTPUT.

BLUE

Omar Adel

A solution's impact is the main viewpoint when analyzing different ones. However, for it to stand out and get popular among others to be utilized world-wide, it must have a unique feature that can convince someone that this is some high-level intricate work. Designing a project for a sustainable, self-sufficient, and automated farming system is widely common and explored. The main ways to stand out aren't focusing on how the prototype behaves on its own, but rather how it interacts with the surrounding environment. Our unique trait is that we focus on allocating resources to help out and benefit other areas not depending on this project. Through research we discovered that infiltrated water that drops through the soil and leaves plant irrigation range is a major challenge because around 40% of water is wasted that way. However, what is much worse is that this water dissolves many nutrients such as Nitrogen and Nitrates (NO₂) which are very important protein building blocks for plants. Therefore, instead of recycling this water and wasting money on reinserting it into our crop, we decided to harvest it and associate it into different soil fertilizers increasing their nutrient values. These soil fertilizers can be used to work on new land, projects and fix deserted areas. Through the tuning of runoff and irrigation pathways, we were able to secure 20% of total wasted water into a container that can be later on used. My team and I believe that our project's uniqueness isn't due to applying a new idea, but rather working towards saving other projects and agriculture.

BLUE

Mazen Askar

It is assumed it is easy to stand out, assumed that being unique is for everyone, but in reality, my team worked incredibly hard to be different... to be special.

- Greenhouse functionality expansion:** My Team didn't only implement 3 parameters and 2 actuators, as the challenge proposed, but we are monitoring 5 different parameters, being: temperature, humidity, moisture, light intensity, and PH. And 4 actuators, like LEDs, to regulate the light's intensity and temperature, or the humidifiers and fans to regulate temperature and humidity, or the water pump to regulate the soil's moisture.
Why we did this: This decision wasn't taken just to be special or to stand out, but because, in the process of building a greenhouse, having more parameters allows more variety for plant species, expanding the greenhouse's capabilities, for practically much lower cost than it would take to just build a new greenhouse from scratch.
- Digital monitoring of our parameters and data:** Using the ESP32 chip's capability of running Bluetooth and wifi, we decided to build a mobile app that can utilize them by creating a user interface that connects to the chip via Wifi and retrieves the sensor's readings, allowing any

person with our app to be able to monitor the current state of the greenhouse and the plant at anytime.

Why we did this: Being able to monitor the greenhouse makes human intervention if necessary, much easier and more alert.

In conclusion, by combining the greenhouse's ability to run automatically for long periods of time to grow any plant species, while also being capable of alerting humans for emergencies, guarantees the plant's survival and high yield percentages.

GREEN

Malek Sayed

Every project must have its unique factor, which makes it different from the other projects and make it noticeably better in a specific area or function. For example Apple are unique with their IOS software that make their iPhones and iMacs better than most other devices in some areas like the processor. This unique factor is what differs a functional good project from a phenomenal project that really deserves to get an A+. In our project most of the groups are making an agricultural greenhouse that is so ordinary just soil, any functional housing and their plant. But we have decided to be different from the other teams so every member in our group has done a lot of research and brainstorming to get our "signature.", as a result we decided to make a huge modification. • instead of using regular soil we will instead use nutritious water as the base of our agriculture, this is better because sometimes plants need specific nutrients to grow or can die from the normal levels of minerals in normal soil for example banana trees need more ammonia than regular trees also some plants can die from excess ammonia. So we control the nutrients that get to the plant customized on its preference and the ideal environment for it to grow. To conclude always try to be special don't say I will make like everyone just to pass or think about being normal every great figure you know just wanted to be different, to be special and ended up written in the history books.

GREEN

Baraa Ahmed

Many of the projects in our school and across the STEM network in general share a lot of characteristics in common; primarily because we are bound by the same challenge, and told to work through the solution in a tightly defined area of environmental study. That being said, standing out with our project was a tough job – a feedback-controlled closed greenhouse ecosystem wasn't going to stay memorable to an evaluator. Taking a closer look, we found out we could stand out in quite a lot of areas, as follows:

1. All greenhouses are intended for either INDOORS OR OUTDOORS usage only. We decided to take an interdisciplinary approach – why not do both? By using polycarbonate sheets, paired with LED lighting at

the corners, light availability was never a problem regardless of place. 2. Most greenhouses focus ONLY on PRESENT PROCESSES. Simply put, the project reads measurements and acts upon them right away. This completely ignores the history of the project's functioning, and also gives no insight about how the growth trajectory of a plant will look like in the future. We decided to implement a process-based, individual-plant growth model that uses species-, climate-, and soil-specific properties from the TRY Plant Trait Database, as well as using the past 24h measurements as the reference for future conditions. This gives two advantages: past data is put into use, and insight about the functionality of the prototype in the future can be studied thoroughly.

BLUE

Based on the sensor's results, a feedback loop implemented to improve the performance. Mention **TWO RESULTS** obtained, then explain the actuators actions for each result.

Using the Engineering Design Process (EDP)

Ziad Salah

Before understanding what actuators do, we need to introduce the TYPE of the FEEDBACK LOOP first.

There are multiple types, such as the PRIMITIVE Partial Integral Derivative (PID) and the ADVANCED Mathematical Model Approach (MMA), this is what they do:

PID uses THRESHOLDS to REGULATE a VARIABLE, this generally has many drawbacks and is EXPENSIVE to keep ACCURATE

MMA uses a mathematical MODEL and a PID system COMBINED to give a better feedback loop system.

We used an MMA system that integrates both sides and makes the actuation more EFFICIENT in terms of POWER.

The SENSORS would provide PERIODIC readings, at around 1 reading per 3 MINUTES so that the ESP32 can REST so that it DOESN'T USE A LOT OF POWER. During that READING, the SYSTEM would PREDICT if an ACTUATOR is needed or not depending on the PLANT DATASET. The following are the results:

1. For the TEMPERATURE ACTUATOR, our Salvia Hispanica plant requires 11°C to 32°C, meaning that it requires ADEQUATE COOLING. The temperature sensor would usually read 28°C which is a LITTLE TOO HIGH. We implemented an H-BRIDGE (MODULE used to control ELECTRONICS and their SPEED) to control 2 FANS and a THERMOELECTRIC COOLER. This worked to cool down the atmosphere to 25°C.

2. For the HUMIDITY ACTUATOR, our plant requires 20%-70%, we used an ULTRASONIC HUMIDIFIER that BLOWS IN WATER in small particle sizes. This brought the HUMIDITY to 50% when the SENSOR was reading 30%.

Using the EDP, my team and I managed to fix the TEMPERATURE not working efficiently by using TWO FANS instead of ONE to allow heatflow OUTSIDE.

BLUE

Omar Adel

Through the testing phase we were able to move on from theoretical ideas and look at how the devices, sensors and actuators interact in real conditions. We were able to look at two sensors and their corresponding actuator recently: 1- Temperature. Through a DHT-22 Sensor our board can get inputs for the current chamber temperature. Through research we determined that a range of 20 to 30 degrees Celsius is most optimal. Whenever this temperature was lower, the actuator was a relay module that allowed current to flow through a high resistance coil, in turn heating up and releasing heat into the chamber just like a tea kettle. 2- Humidity. Through both the DHT-22 and DHT-11 sensors, humidity (a measure of percentage of water vapor per volume of air), can be analyzed and studied. This parameter varies according to plant type, however, for Chia (our plant) around 60% was determined. Any deviation from this by a decrease turns on an ultrasound vibrator that shakes water so fast until it evaporates into the air. During the test, early in the morning the temperature dropped to 15C, activating the actuator until it reached 24.7C in 14 minutes to avoid further fluctuations. Similarly, at night the Humidity reached a lower number of 40%, the vibrator turned on and indeed was able to get it back up to 62.4% in a time period of 8 minutes. We rely on these mechanisms importantly because they make sure plants don't experience heat and humidity stress which damage leaves, cause wilting and fruit dropping, all of which decrease produce and efficiency and increase diseases.

BLUE

Mazen Askar

In our project, we implemented a feedback loop where sensor readings are continuously monitored, and actuators respond to maintain optimal environmental conditions. Two key results obtained from the sensors and their corresponding actuator responses are:

- 1- **Increase in temperature above the optimal range:** The DHT 11 (temperature and humidity) sensor detected a rise above the setpoint required for plant growth. This deviation triggered the feedback system to activate cooling mechanisms.
Actuator response: The fan was turned on to increase air circulation, and the LED intensity was

reduced to minimize heat generation. This combination helped lower the temperature gradually and restore it to the optimal range, ensuring stable conditions for plant health.

- 2- **Decrease in soil moisture below the required level:** The soil moisture sensor detected that the water content in the soil had dropped below the minimum threshold. This indicated that the plants were not receiving sufficient water.

Actuator response: The water pump was activated to irrigate the soil until the moisture level returned to the desired range. Once the correct level was reached, the pump was automatically turned off to prevent overwatering.

- 3- **Decrease in light intensity below the optimal level:** The light sensor detected insufficient light.

Actuator response: The LED system was activated to increase light intensity, restoring optimal conditions for photosynthesis and plant growth.

These feedback actions improved the system's performance by ensuring continuous monitoring and automatic correction of environmental conditions, leading to a more stable and efficient growing environment.

BLUE

Malek Sayed

After the prototype was finished and ensured that it met the design and solution requirements, the test was planned to check the sensor's accuracy and the environmental values like the temperature, humidity and light intensity as these are the main parameters that have been chosen to meet the ideal environment for our plants. so a DHT 22 sensor, and a light intensity sensor have been used in our prototype to measure these parameters. 1. First when the temperature was measured, it has been found to be 28 degrees on average, also rising to values up to 35 degrees in the morning. But that was not ideal for the plant the we chose which is chia seeds. Chia seeds needs a temperature between 11 and 20 degrees to grow efficiently without any roots dying in the process. As a result, the actuator which is a fan connected to a thermoelectric peltier operate when the sensor detects a temperature more than 20 degrees. But there is a important twist a H-bridge has been used to reverse the current leading the peltier to cooling instead of heating 2. Then the air humidity was measured, which is very important for the plant for cellular respiration and photosynthesis as water vapor plays a huge role in both of the processes that is vital from the plant. Chia seeds needs a minimum of 60% water vapor in the air. Although when it was measure it was found to be 40 %. As a result when the DHT 22 sensor detects the humidity less than 60 %, an ultrasonic air humidifier turns liquid water into water vapor until it reaches the desirable percentage

GREEN

Baraa Ahmed

Based on our current studies of feedback-loop control algorithms, we decided to simply use ON-OFF actuator algorithm that depends on threshold intervals, and actuators designed for above and below the threshold. This idea came from the conclusion that a plant will not be simply affected by perturbations or inconsistencies of actuation or measurement with the small temporal scale; typically from between one second to a few minutes. Our plant, the loquat, is a moderate-low temperature plant with medium shade tolerance. That means – it must be kept at a low temperature. Several studies show that the optimal growth trajectory for the plant lies in temperatures between 10 & 20 degrees Celsius. The sensors are a simple air temperature sensor, as well as cooling and heating hubs for actuation. Upon testing the system with a temperature of $5.5(\pm 0.1)$ degrees, the heating actuation would work for a continuous 20 seconds to increase that to up to $17(\pm 0.1)$ degrees. On the other hand, measuring a temperature of $25(\pm 0.1)$ degrees led the cooling hub to work for a whole minute, bringing it down to $15.25(\pm 0.1)$ degrees. These results have proven the prototype to be quite effective at maintaining low-temperature plants in high-temperature climates.

BLUE

How can the concept of exponential growth be applied to monitor bacterial growth and fish population growth in a smart aquaculture system in order to prevent dangerous rapid growth?

Learning Transfer

Ziad Salah

Animals are generally smart enough to know when to breed and increase their population, it's based off of a set of criteria that the system itself can regulate as not to have a population get too out of control. the only problem is with the bacteria, whose population growth is:

All of these can be **MONITORED** by implementing **MATHEMATICAL MODELS** and using **DERIVATIVES** to predict the **TRAJECTORY OF THE POPULATION**. For example, bacterial colonies grow in accordance to:

$$number = 2^n$$

Where n is the number of **reproductions**.

We can find the **derivative** to see how fast this rises:

$$\frac{d}{dn} = 2^n \ln 2$$

However, the factors for fish are:

1. The introduction of prey – in an aquaculture system, we can't just introduce a prey directly, this would just kill the fish or organism being cultured and would be unethical. This factor is completely **DISREGARDED**.
2. The suspension of nutrients – this is a **great way** – if done in a **regulated manner** – to downregulate breeding of organisms. This would generally cause the fish to either **CONSUME SOME OF HER EGGS**, or cut down on **BREEDING**, leading to a **CONTROLLED POPULATION**. (The ethicality of this is QUESTIONABLE.)
3. Manual intervention – let's say for example, a fish LAYS a dozen (12) eggs. We can control the species by TAKING OUT 11 eggs and leaving 1 EGG. (ETHICAL).

If we talk about bacteria, there are many countering methods that are all ethical; however, they must be done in consideration.

1. Elimination of bacterial conditions
2. Introducing an anti-bacterial plant (algae for example.)

BLUE

Omar Adel

Exponential growth is a common phenomenon in nature and is much more dangerous than linear growth because changes happen much faster and could be detrimental to the environment, however, it can be studied well enough to combat these issues. 1- modeling for analysis. A typical function of exponential growth is $X * (1+P)^T$ X is the current number or population; P is percentage of increase or decrease written in decimals. And T is the time needed for each change. Through this function we can model a graph on the current bacterial or fish population if we know how much they increase per period. For example, for bacteria there is around 30% population increase per day due to mitotic division. If we started with a population of 100 cells, we would get 130 after one day, and 169 for the next. This modelling helps us keep track of populations and resource-based needs. 2- Making changes. By understanding and analyzing these changes, we can determine whether we would need to decrease feeding or procreation stimulus. These would usually make it so that bacterial growth or fish is at a higher rate, but since there is a specific population per volume that is safe to stop disease propagation and suffocation (1 per 4 liters for salmon), these must be decreased to control fast increases. This helps ensure stability and safety of organisms while cutting down on resource usage. I believe Exponential growth isn't only helpful to analyze and understand results or the current status of the chamber, but also help us stabilize and protect everything.

BLUE

Mazen Askar

In MA.2.08, we studied exponential functions and derivatives, which describe how quantities grow and how fast they change over time. These concepts can be applied in a smart aquaculture system to monitor bacterial and fish population growth and prevent dangerous rapid increases.

- 1- bacterial growth can be modeled using an exponential function such as

$$N(t) = N_0 * e^{(k t)}$$

where $N(t)$ is the population at time t , N_0 is the initial amount, and k is the growth constant. This shows that bacteria grow faster as their population increases. The rate of growth is given by the derivative:

$$dN/dt = k * N$$

This means the growth rate increases as N increases. In practice, sensors measure bacterial concentration over time, and the system estimates how fast it is growing. If the rate becomes too high, the system can activate filtration or reduce nutrients before harmful levels are reached.

- 2- Fish population growth can also be monitored using a similar model. By taking the natural logarithm:

$$\ln(N) = \ln(N_0) + k t$$

The data becomes linear, making it easier to detect sudden increases in growth rate. If the slope increases quickly, the system can reduce feeding or adjust stocking levels.

Therefore, using exponential models and derivatives allows the system to predict growth trends and respond early, preventing unsafe conditions.

BLUE

Malek Sayed

In a smart aquaculture system bacterial and fish population must be controlled to prevent any invasion or disturbance in the food chain as a sudden growth in the fish population can severely lower the food available which can lead to the extinction of the fish species. In MA.2.03 we learned about rates of change and exponential functions; Rates of change: A rate of change is a measure of how one quantity changes in relation to another, typically time. In an aquaculture system, the rate of change is essential for monitoring environmental parameters, as it allows to detect how quickly fish or bacteria grow as it can affect the environment severely. This helps the system determine the urgency of the corrective action needed to restore stability. Exponential and logarithmic functions: Exponential functions describe processes that grow or decay at a constant percentage rate. We can use these concepts to prevent dangerous rapid growth, by studying the relation between fish and bacterial population, and

death rates and lifetime of fish. We will notice that life time decreases severely as fish population and bacteria increases, also some bacteria can infect the fish leading in further decline in their lifetime and an increase in their death rates. We can notice that the relation between death rates and population growth acts like an exponential function($y=x^n$), while the lifetime relation acts like an inverse function($y= 1/x$). To conclude by monitoring these functions we can prevent sudden dangerous growth of fish and bacteria.

GREEN

Baraa Ahmed

In an aquaculture system, the population of fishes and bacteria can be readily measure – the former being possible by eyesight, and the latter through chemical testing of bacterial byproducts in water, giving an estimate of the number of bacteria per cm³ of tank water. The rapid growth of bacteria is unhealthy for the whole closed system and can lead to infection, disease of living organisms and other unwanted results. The same goes for fishes –

overpopulation can lead to fierce competition over food and oxygen availability inside a closed system, as well as harder control of ion concentrations and temperatures inside the water. Studying the exponential growth trajectories, we aim to seek two objectives: 1. Find a measurable & highly reliable safety setpoint for population numbers, either for fishes or bacteria or both 2. This setpoint should give a brief safety threshold enough for intervention to occur before further complication occurs In a feedback-controlled system, proper measurement of fishes/bacteria populations can be used to initiate actuators at the given setpoint, to decrease the population to 60-70% of the original value pre-setpoint. In the case of fishes, actuation may rely on mechanically isolating extra numbers elsewhere, whereas bacteria can be controlled through standard methods of water filtration

GREEN

Explain how can the principles of energy storage in inductive elements of a DC circuit be applied to enhance the design of feedback control systems in aquaculture or greenhouse agriculture, particularly in managing time-dependent responses to variable environmental conditions?

Learning Transfer

Ziad Salah

Inductors are TIME-SENSITIVE COMPONENTS that also provide a relation to time in a DC CIRCUIT. This can be used in accordance to a circuit to control its TIME CARDINALITY and RESPONSE to a change in the **SYSTEM**. Inductors are basically the SAME WORKING PRINCIPLE of FEEDBACK LOOP ACTUATION MECHANISMS.

Inductors work by **RESISTING** a change in a system; when a POSITIVE VOLTAGE is provided to it, it tries to resist that by inducing a **BACK-EMF**, which **GRADUALLY DECREASES** over TIME as it adapts to a change. Notice how I said over TIME, meaning that an inductor causes a TIME-DEPENDENT COMPONENT to occur in a circuit. An inductor is also similar to how a feedback system tries to COUNTER a change in the ENVIRONMENT, conserving its PREVIOUS STATE.

Inductors store electric energy in the form of a MAGNETIC FIELD, this MAGNETIC FIELD is what RESISTS that change, this is its PRINCIPLE of ENERGY STORAGE, and the MAGNETIC FIELD is induced by current according to the equation:

$$E = \frac{1}{2}LI^2$$

Where E is the energy stored in joules, L is the **INDUCTANCE** and I^2 is the **SQUARE OF CURRENT**.

An inductor can then be used to PERIODICALLY ACTUATE something according to TIME CONSTANTS in relation to a circuit using a RESISTOR and an INDUCTOR. For example, in my AGRICULTURAL PROTOTYPE, I require PERIODIC actuation of a GROW LIGHT, an INDUCTOR can be used with a RESISTOR to get a TIME CONSTANT OF 100 seconds according to the equation:

$$\tau = \frac{L}{R}$$

Inductors are also themselves the SCIENTIFIC BASE of the working of a RELAY MODULE (which turns ON and OFF on command, just like an INDUCTOR.)

BLUE

Omar Adel

Inductive elements of a DC circuit can be utilized for several uses; however, they all agree on a specific goal: keeping the device safe, stable and functional using inductors. We have used inductors in 2 very similar and important ways. 1- sudden fluctuation and sensor instability. Sensors can get a sudden increase in their data, for instance if something heats up, it will be detected and activate the corresponding actuator, however, this signal might happen for only 2 seconds, wasting the actuator usage. Since sensors communicate data through voltage and current we used an inductor after its output node and before the computing board's input node. Using the Laws: $EMF_{back} = EMF_0 * (1 - e^{-(\pi/T)})$ This is the EMF that counteracts any sudden voltage or increase, e is Euler's constant, π is the time constant which is equal to $\frac{1}{2} A * L$ (A is current intensity and L is inductance of inductor) T is the time taken. This ensures that if the current and voltage rises due to a random short signal, it won't register until a specific time passes of around 5 to 10 seconds depending on the inductor. This makes it so that the actuator only activates when the signal is surely not a random error. 2- Sensor safety and stability. By making sure a sudden spike and rush of current doesn't hit the sensor we ensure that it doesn't get damaged or burned easily and can withstand specific ranges for higher amounts of time. This time the inductor is placed before the sensor's input. This helps us keep readings precise without fluctuations and ensures components stay safe for more sustainable use.

BLUE

Mazen Askar

In electrical circuits, inductive elements such as coils store energy in a magnetic field when current flows through them. A key property of an inductor is that it resists sudden changes in current, meaning that current increases and decreases gradually over time rather than instantly. This principle is important in designing stable feedback control systems in aquaculture or greenhouse agriculture.

1. Inductors help smooth time-dependent responses in control systems. In a smart farm, actuators such as pumps, fans, or motors are used to adjust environmental conditions like temperature, water flow, or oxygen levels. If these devices respond too quickly, they can cause sudden changes that stress plants or aquatic organisms. By incorporating inductive elements in the circuit, the current supplied to these actuators changes gradually, leading to smoother operation. This prevents abrupt environmental fluctuations and improves system stability.
2. Inductors enhance the performance of devices such as DC motors, which are commonly used as actuators in automated systems. The gradual change in current ensures controlled acceleration and deceleration of motors, allowing precise adjustment of airflow, irrigation, or

circulation. This is especially important in feedback systems where continuous correction is needed.

Therefore, the energy storage behavior of inductors helps create more stable and controlled responses, ensuring that environmental changes occur gradually and safely within the system.

BLUE

Malek Sayed

An inductor is a component that stores energy in a magnetic field when electric current flows through it. In the smart farm or aquaculture prototype, inductors are important because they protect sensors, controllers, and actuators from sudden current changes. They smooth power fluctuations, ensuring devices like pumps and fans operate safely and reliably. Understanding inductors helps the team design circuits that maintain stable current flow, improving the efficiency and durability of the automated system. Inductors gradually store energy when current starts flowing (charging) and release it when current stops (discharging). By understanding charging and discharging, the team can predict how circuits respond over time, ensuring stable and efficient operation of the control system. Inductors store energy in the form of a magnetic field. In the project, this energy storage maintains current flow briefly during power changes, helping keep sensors and actuators stable. Understanding energy storage helps the team design a reliable automated system that continues working efficiently even with short power fluctuations. The time constant of an inductor circuit determines how quickly current increases or decreases. Current changes follow an exponential pattern. In the prototype, this helps predict how quickly actuators respond to changes, improving timing and control of devices. Understanding these concepts allows the team to manage time-independent responses to variable environmental conditions.

GREEN

Baraa Ahmed

Inductor energy storage is a time-dependent principle, governed by other characteristics of the said inductor. The rule governing current running in a conductor is $i = (\epsilon/R)(1 - e^{-t/\tau})$, with τ equal to the inductance divided by the resistance, in seconds. This time factor τ is a static variable that defines exactly how the current inside a circuit runs through time. Analogous to function of a control algorithm inside a feedback loop, many properties are time-dependent to a great extent. Light availability, for example, is a time-dependent property, varying from one plant species to another. Plants are generally divided by their degree of shade tolerance into tolerant, moderately tolerant and completely intolerant. Based on this information, light availability (separate from the heating effect of sunlight) is one of the most important parameters to be controlled. Inside a feedback-loop system, light availability is best

controlled in indoor environments where full control over light intensity and availability is paramount. For this reason, light becomes time-dependent – each plant would prefer a preset number of hours of lighting, to satisfy its needs of a full day cycle, including the time given in darkness to perform respiration. This is commonly referred to in scientific literature as the Daily Light Interval DLI

GREEN

Grade 10 Semester 1

JOURNAL 1

It's your first time to work in group to make a project. Illustrate two things you will do to be sure your group will be effective, showing the benefit of each of them (Personal reflection)

MALEK

Teamwork and collaboration between team members is very important to be a good and effective team.

Of course arguments between members can make the group, and the project fail because there is no connection, and chemistry between the team members.

As it is the first time for me to work in groups, it is quite hard to get along fast with this new way of education. Of course first we divide the roles of the members to: Leader, Time manager, Presenter and Researcher. The time manager manage the time of working and give deadlines to submit a certain task. The leader divide tasks between the members and helps anyone if he has a problem in his work. The presenter is the person who present the work and the solution that the team made. And the researcher search for the suitable materials and the information for the team.

As a leader the first thing I will do is to make sure that all the team members have no problems with each other then we will distribute the tasks and every member has a deadline to end the task before it and of course if one cant do a certain thing all the team will help him because we are all on the same team.

The second thing we will do is to make someone to evaluate our work to check the effectiveness of our work and check the mistakes for us to correct it and make our project better.

OMAR ADEL

Working with a group so far was a good experience, I learned many ways to communicate with my fellow team members to make sure that our progress is going well while maintaining a good friendship.

This could be done in many ways for example, we voted and chose a good team leader that will motivate us and make sure everyone is up to date with the calendar, we worked together and discussed our work to ensure that everyone is caught up with the rest of the team.

Of course there is still many steps to take to increase our effectiveness, firstly we as a team will discuss what we learned from our classes that could be used in the project, portfolio, and capstone, so that everyone is on the same level of information and could work well together.

Secondly, we will view all opinions and criticize them equally and fairly to reach an appropriate solution and project that suits everyone for instance, when choosing a type of truss bridge and its mechanism of opening and unlocking, we will go over all the data we collected such as advantages and disadvantages

of such bridge design, then we will choose one that is most compatible with our requirements and goal of solving the solution.

In conclusion, it is very good to work as a group, but for it to go smoothly we must all work together to achieve to best results possible.

ZIAD SALAH

The group working part is a really fun thing, it allows you to communicate easily and be powerful as they say “Power in numbers” especially when working together. There are many points that are important for something like this, like having team communication skills with your members, proper communication, maintaining a good relationship with your other team members and actually working together.

The team communication skills amongst team members are really important because if you get into a fight with a team member, you should be able to handle the situation and prevent escalation, it happened to me once! One of my team members was regularly using AI which harms us and him, I had to tell him to stop but he refused, I talked to the Cap teacher and he explained to my team member that it’s wrong to do and is straight up plagiarism, he listened and stopped using AI. This also allows the team to be open minded and actively listen for criticism and feedback where when I was the leader, I was over-manipulative and my team members told me about it.

The other part which is actually working together and not letting your team down, you should provide tasks for your team regularly, as a team leader, I use a website to put our tasks in a board, all of my team members claim their respective tasks and prepare them, this is especially useful for writing the portfolio and preparing presentations.

Mazen Askar

First: I make sure each member of my group has a voice during any debate that the group has in any problem we face, and that everyone is up to date on what is happening, for example, during one of our math sessions we were given a problem to solve, I started by making sure everybody understands the question, after that, we all solved the question, then we collected our answers to compare them and decided on which one is correct, by doing that I make sure that everyone in my group is keeping up and that further strengthens our teamwork.

Secondly: in the making of the project we like to disagree and be different, because that helps us collect a variety of data that we otherwise wouldn’t have collected, which in general benefits our team, for example when my team was deciding on the location of our bridge, we all had different opinions, that led to us debating on which one is the best through looking at each one’s opinion pros and cons, that led to us realizing that there are even better options than what we all initially picked out, ultimately this caused us to choose the ideal location for our project, which we all think is better than anything we had selected at first.

In conclusion, by following these two steps, our teams become more effective and efficient. We can vary our thoughts and opinions, keep the entire team concentrated and up to date on the situation.

RESULTS

MALEK: BLUE

OMAR ADEL: GREEN

ZIAD SALAH: BLUE

Mazen Askar: GREEN

In Egypt's STEM education system, the engineering design process (EDP) is a thinking process used to learn and apply concepts and skills in an integrated manner. The first step of the EDP is defining the problem. Identify two reasons that make defining the right problem to solve important to the success of and project. Alternative: "Explain how a poorly defined problem could negatively impact two later steps in the engineering design process." *

Using the Engineering Design Process (EDP)

MALEK

The EDP is thinking process used to learn and apply concepts and skills to solve any problem that faces you in general. The first step is defining the problem. Of course a bad defined problem can make all the solution wrong.

For example a poorly defined problem can make you research for wrong information and materials also will make you specify wrong requirements because you didn't understand the problem and it's disadvantages well. For example if I didn't understand that the urban congestion is a big problem that cause many other problems like useless arid areas and I made a random bridge not linking between a congested area and an arid one I didn't solve the problem because I defined it incorrectly and didn't know why I need to solve this problem.

Also if you defined the problem poorly you will go very far away from the main problem you are trying to solve , like you are trying to solve population growth you can define it like it is only causes urban congestion so u make a prototype for solving urban congestion and you didn't solve the main problem which is the population growth.

OMAR ADEL

The EDP is a set of steps we as a team follow during our capstone, realizing what step you are on and what to do in such step is an important part. Identifying the problem is one of the earliest steps in the EDP, it might seem simple to finish this step, but you still shouldn't take it lightly and work on it without much precision, as it will affect further steps and could cause the failure of the project.

By not noticing the correct problem, for example, if you think a problem in Egypt is its economic deals with other countries then it is an incorrect problem, as it is almost impossible to solve such a problem

with building our bridge and so in the research and prior solutions phases you will find that your bridge is a wrong solution or not solving the problem you intended for it. This will affect the research phase because when looking for an area that suffers from the problem, you will find that the bridge or prototype may not fit and not be of much help in that area. In the prior solutions for the problem phase, you will realize that many old solutions don't correlate with your project and can't be applied to the bridge.

Each and every step in the EDP is important even the simplest ones, so it is important to take everything into consideration to achieve success.

ZIAD SALAH

Defining the problem is an extremely crucial step because what would you be even doing if you don't know what problem you're solving? It can be extremely useful to find the problem so you can know what happens and properly observe the problem, write notes about it and see how the problem progresses if it's complicated.

We can find that by doing this we're able to see the core issue and try to fix it, we can take care of it, for example: Egypt suffers from a lot of crowded streets and urban congestion, people who have treated this made new roads, bridges and pedestrian pavements which allowed Egypt to gain enough knowledge to make a bridge that distributes traffic and eases travel, learning from other countries' mistakes and avoiding the flaws they made in their bridges.

We can also find that by defining the problem, we eradicate the confusion of the situation, we can also properly research about our problem because we can provide specific details about the problem. It happened to me too in a toy prototype I made for a bridge that uses a hand mechanism to get lifted up, I saw that when I lifted it up, it kept stopping at a certain angle, I tried dismantling the toy and found the real problem which was that it was really short and at the brink of being cut.

Mazen Askar

Correctly defining the problem and knowing what is required to solve this problem is very important as if a problem is misunderstood, the information that will be collected to attempt to solve it will all be either trying to solve another problem or incorrect, which will render all that information useless or unhelpful because they are trying to solve another matter, for example, if I was to solve a problem such as urban congestion and I misunderstood urban congestion this means that I might research population growth instead, this will turn all research I did on urban congestion useless because I didn't correctly define the problem from the very start.

The second reason that it is very important to correctly understand and define the problem is that understanding the problem helps in learning about prior solutions that attempted to solve the problem, what were their advantages and disadvantages, why they didn't ultimately succeed, and how can we improve them, this, in general, helps us in our personal trial and error attempts because we already

know what to try to achieve during solving the problem, and which mistakes these previous solutions have done that I should avoid repeating.

RESULTS

MALEK: GREEN

OMAR ADEL: GREEN

ZIAD SALAH: GREEN

Mazen Askar: BLUE

(Lo 1.01) You have studied SketchUp program. Select two most important tools in your opinion and explain how you can benefit from them in your Capstone project.

MALEK

We have studied a lot of subjects in STEM one of them is computer science and it's connection with the capstone.

Of course we will use sketch up in a lot of things in designing. There are two types of designs 2D and 3D

I will use 2D to design the flat parts in my capstone project like the road and the triangles in the truss design.

Also there are very important tools in SketchUp like split and merge this is used mainly to merge different parts that you have designed this will help a lot in designing the bridge because of course you will design every part alone so you can merge these parts to see your final design.

Then converting the designs to other formats is very important because if I want to communicate my designs I can convert it to other formats also to print it because machines need certain formats.

Also the line tool will help me a lot to draw perfect lines that will save a lot of time in designing our prototype.

OMAR ADEL

The SketchUp program is an important program that benefits our team and will benefit us even more in the future in working with the prototype in the capstone project. The program has many useful tools that can ease our use of the program and improve our work.

For example, the insert tool which can upload pictures and files and allows editing them to your liking and benefit, this would help by letting you upload files that are similar to what you intend on making from the internet and improving them and changing them to the requirements you need, so that they can be cut out or manufactured in the fab lab and use the models you created in the prototype to ensure

maximum certainty in measures such that your experiment would be successful or unsuccessful, but has accurate results that help you make an observation for later improvement.

The line and arc tools , they let you draw and make shapes that aren't always mathematically symmetric, this is purely just to make shapes, that are later on cut out using the laser cutter, to better the design of the prototype and make it aesthetically pleasing and look better because even if practicality is our main priority in constructing the bridge or prototype it is still necessary to make it good looking, for instance the Tower Bridge in London is made in a beautiful neo gothic style similar to a nearby tower to make it blend in and not stick out.

ZIAD SALAH

SketchUp is a really fun utility that allows me to make 3D models on my device and see them, it can be especially useful for when I want to make a visual representation for my project or for when I want to make a 3D printable object, it's like Blender (the 3D modelling app) but for more architectural use, where it can be used for visualizing apartments and furniture layouts in a new house.

I, with the help of my team members and my CS teacher were able to make a 3D visual representation of our bridge, my CS teacher helped me use the app and properly taught it to me, it has many tools that help you to build stuff, two tools I found extremely interesting were the arc tool, where you can make an arc using a pencil like cursor, it's called a Bezier curve which has many points, I was able to use it to make the truss like an arc while also using the normal line tool to make connections to the base of the bridge.

The other most important and fundamental tool is the workshop, you can find many pre-built prefabs on there that you can directly use in your representation, my team used this to get two nice looking pillars for support and we connected them to our bridge, we could also animate the bridge and make it open and close for a representation that we used in our portfolio.

Mazen Askar

SketchUp program is generally very helpful in Capstone projects as it facilitates the process of making 2D designs that are used very frequently in our capstone project, in this year's project, in particular, I found two tools in SketchUp to be very useful, the first one being the ability to create any geometrical shape, regular or irregular ones, this tool helps in designing the prototype and makes it easier to use the Fab-Lab, by helping us imagine what a shape might look like once cut in or printed onto the prototype, another helpful tool that is crucial for our capstone project is the line tool as this tool makes creating lines very easy which is very important during designing the prototype because during its design we need to draw a lot of lines because they are later used as indicators for where to carve in the lines on the prototype.

These two tools are generally very important and helpful to our capstone project as they make the designing process much easier as well as the process of using the fab-lab to bring the prototype to reality.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

Mazen Askar: Green

JOURNAL 2:

In your school all students are classified into groups for capstone. Explain how this calcification helps you to deal with your new educational life in two points. *

Personal Reflection/Team Collaboration

MALEK

Teamwork is very important in our school and is one of the key goals of the STEM education system. To be productive, we must work in teams to prevent work overload and improve each other's work.

In my new educational life, I'm very satisfied because of this new system. The first thing that helps me is that studying and working in groups is a lot easier. The collaboration between the team is so good and useful. For instance, last week we didn't understand the second learning outcome of biology, so we distributed the learning outcome into concepts and set every member to study and understand one of them then everyone taught the rest of the group his concept, and that made the learning outcome a lot easier to understand.

The second thing that helped me a lot is that our capstone is too hard. So, to be in groups is better to understand how to work on your project and the workload will not be all on one person, for example finding an idea to solve the challenge and choosing the design and the place is so difficult and frustrating to do alone.

OMAR ADEL

In STEM schools all students were classified into groups for capstone, projects and school work in general. Being classified into groups is helpful in many ways, but it can be hard to agree with everyone.

I'm discussing why and how I benefit from working in a group for our schoolwork;

1. Task distribution, being split into groups we are able to split tasks that are usually hard for one person to complete on his own or time-consuming, for example, when the biology teacher asked us to make a presentation about the second learning outcome which revolves mainly about cells, we decided to split the task into different parts that are almost equal in size and difficulty

and then distributed it among the group so we can finish faster and have better results.

2. As a team we decided to help each other with our studies; since most of our work and curriculum relies on research and acquiring information from sources on the internet, it has been apparent that sometimes we don't get all the information intended for us to study and memorize so we exchange information and split subjects. For example, last week we wanted to study chemistry, physics, and biology so we made one of our members study chemistry, another two study physics, and I studied biology, and at the end of the day, we discussed our topics and exchanged everything.

As a deduction, I think the system in which we are split into groups is very beneficial and eases our studies.

ZIAD SALAH

This classification is smart. For a new educational life, it feels weird as I barely knew anybody around me when the teams were divided, I felt nervous because I didn't know how to deal with a lot of people or be a leader of 5 people, these things that the STEM system is based off of is a great thing, it has helped me in many points, but two of them are:

1. The classification helped me deal with my new life because it introduced me to new people I never knew, it allowed me to know their personalities, it also helps people who are somewhat introverted (like me) understand people more and talk to them freely, as a group we always talk to each other about everything that bothers us.
2. Collaboration and working with other people, as all of us work with each other in groups and make presentations we get to know and help one another during studying as well, especially when you get to a higher level and have to work as an engineer for example, you must have the ability to work with other people.

The team classification system allows the students to break the barrier between them and come to communicate, personally, when I came to the school for the first time, I felt nervous and scared, I was thinking of pulling out and converting to regular high schools, but when I came to communicate with my friends and team, it felt much better to stay.

Mazen Askar

STEM is built on teamwork as it is a main part of its education system. The fact that teamwork was included in almost everything not just the capstone project has forced me to quickly adapt to working in a team by becoming cooperative, sharing my thought process, and in some cases assertive to be able to force others to react and focus on our objective this in general has impacted my educational life through:

- 1- Taking away lots of stress, while working in a team could sometimes be difficult due to communication issues and disagreements, it also buys me a lot of time which in turn makes my ability to focus on education much easier, because I need to direct less attention to working on my capstone project as each member in the team has a role to play, for example, when each member does their job correctly, having a team becomes a large contribution to easing my new educational life.
- 2- Secondly, working as a unit and learning from each other, I realized teaching the capstone team to cooperate and help each other in everything had many benefits outside the capstone project, as we help each other understand concepts outside the capstone project, or by sharing materials, for example, yesterday I was helping one of my capstone teammates prepare for the EDP question, and after that, he, in turn, helped me prepare for the connectivity question, which generally helps to ease my educational life.

RESULTS

MALEK: GREEN

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

MAZEN ASKAR: BLUE

You and your team found the solution for your challenge, Explain two ways that helped you to determine this solution.* Using the Engineering Design Process (EDP)

MALEK

Me and my team worked very hard to find a solution for our challenge, and we found a great solution for our challenge, there are a lot of important things that helped us to find this solution there are two examples of what helped us.

The first thing that helped us in finding our solution is according to the engineering designing process we know what to do in simple steps to achieve our solution because if we don't know the way or steps to do, we will take a lot of time trying to only test one thing that we think of. Of course, the engineering designing process helped us a lot. For example, we were stuck on how to define our problem; we didn't know what we must search about to find our solution.

The second thing that helped us was the other instructions about the project and our solution. For instance, after we had defined our problem and done background research, we found many solutions and we thought they were right when we communicated with others and our directors, we found that a lot of our thoughts were wrong because we had done wrong background research in untrustworthy sites, and they told us that a lot of our solutions can't be done on real life. To sum up, the engineering designing process has helped us in a lot of things to generate our solution.

OMAR ADEL

As our team was determining solution we had to follow some steps similar to the EDP and almost as important, these steps included;

1. Reviewing prior solutions, as a team we all researched different solutions that were implemented in the past we studied their composition, idea, and its scientific base, After that we determined its pros and cons of its structure and what difficulties it faced, and so when making our solution we can use its advantages and try to solve its disadvantages. For example, when looking for some prior solutions I found the Tower Bridge in London which is built in the neo-gothic style similar to the Tower of London which is close, this is both an advantage and a disadvantage as the beautiful style assures that it doesn't stick out as an eye sore, however, it makes maintenance difficult to carry out and many technological improvements are hard, so when making my bridge it should be able to have cheap and easy maintenances and stay good looking.

2. Having all solution requirements, of course any solution must have requirements other than the design and tests made on the prototype, those requirements are apparent in any successful solution such as, prone to improvements, cheap maintenances, not cause other problems when fixing the main one, and a cheap material that is still good and resilient overall so it can be implemented in many places.

In conclusion there's many ways to make sure your solution is successful when choosing one or creating a new one.

ZIAD SALAH

To find a proper solution, we had to think of the problem itself and see what we must solve, we found that a particular solution for crowded streets especially in urban congested places require a bridge for easier accessibility across waterways, they prevent traffic at a certain area like another bridge 2 miles away, a bridge over a popular waterway requires to be movable to allow ship movement along the banks.

To find a way to build this bridge, my team and I sat down and did the following to determine a solution:

1. Researched by looking at prior solutions for this same problem, we saw an

Egyptian bridge called the El-Ferdan bridge which is a swing bridge which

isn't particularly supported very well because two counterweights hold it

along the two banks, but from the sides themselves, they were free to rotate.

We saw that this had disadvantages in windy weather and would require a

lot of maintenance to keep working.

2. Consulted older engineers and experts in this field, as one of my teammates'

grand-dad was an engineer and an architect that helped us and described

how the girder should be built and what the best type of truss to be built will

be for our particular use, we also consulted a professor in a university who

precisely described everything we should know.

From all the previous, my team and I were able to determine a solid base and type of mechanism that works for a small region.

MAZEN ASKAR

My team is very fond of discussing any problem in a matter that everyone contributes by finding his own solution before anyone shares his, this allows diversity in thoughts and the solution's general way of facing the problem, we do this when searching for the solution of any problem including our challenge by applying two to three ways/steps, being:

First: discussing the problem as a team without trying to solve it, this allows each one of us to fully understand and define the problem that we are trying to solve, for example when we were selecting the position for our solution to the challenge we first discussed what are the requirements that the chosen position need to pass in order to solve our challenge, this helped us later in choosing the position without any confusion or problems, which ultimately contributed greatly to the determination of our solution.

Secondly: Researching prior solutions that attempted to solve our challenge, as understanding those prior solutions' advantages and disadvantages, and reasons for success or failure greatly contributed to helping us apply their reasons for success, avoid their past mistakes and fatal errors that lead to the prevention of their global/ultimate success, to conclude learning from prior solutions that attempted to solve our challenge helped us determine the best solution to it.

RESULTS

MALEK: GREEN

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

MAZEN ASKAR: BLUE

In your challenge you are asked to construct a bridge with a scale of 1:50 for the constructed prototype. In Math (Ma.1.01) you are studying some concepts such as the unit circle, trigonometric functions, sin law, cos law, angle of elevation and angle of depression. Choose one of the Math concepts that you will depend on for your project, and explain how you can get benefit from that concept in your project. *

Learning Transfer

MALEK

In math, we have studied a lot of important things that will help us in designing and constructing the bridge and also to visualize the relations variables.

Trigonometric functions like sine, cosine, and tangent are used to calculate angles and sides and understand the relation between them for trusses in the bridge to maintain the weight applied to it. To illustrate if we don't know how to design the trusses how long are the sides and how big are the angles to maintain the weight tension and compression, we must measure the sines and cosines of the angles in trusses to see how big the sides should be.

Furthermore, sine law and cosine law are as important as trigonometric functions. Sine and cosine laws are laws used to measure sides or angles when you have only one angle or only one side. To illustrate if we have only one side in a truss and we don't know how big the other angles or sides should be, we use sine or cosine law to measure them.

OMAR ADEL

Math is very important and interesting to use in the construction of our prototype and thinking of the solution in real life because using it correctly makes sure that your work and prototype is scientifically correct so you don't have to make many tests that can also fail many times. All of the concepts we learned are as equally as important to build the prototype these concepts are;

- the unit circle,
- trigonometric functions,

- sin law,
- cos law,
- angle of elevation
- angle of depression

using one of these concepts alone is very difficult as they complete each other and work together, but so far what I am able to benefit from is the angle of elevation and angle of depression and sine cosine laws.

1. By studying the trigonometric functions, and sine and cosine laws we can then calculate the angles of truss structures necessary for a stable bridge to overcome deflection and make sure it is safe.

2. By studying the angle of elevation and angle of depression and using it I can calculate the height of my bridge's truss structures and angles.

For instance, after determining the length of my bridge we can calculate the angle of elevation using sine and cosine laws, that we got from the truss structure calculations, and then use the angle of elevation to determine the height of the truss structures.

Overall we can benefit from math by determining the correct measurements of different structures and parts in the bridge to make sure it is in its most viable state.

ZIAD SALAH

Using math, we are able to identify the proper lengths for our prototype after finding an urban congested spot using the 1:50 scale, we can also especially use trigonometry for identifying the lengths of each truss beam that we're going to build with using the trigonometric functions, as we can use the Sin, Cos, Tan in the right angle triangle of each truss triangular piece, as $\sin \theta = \text{Opposite}/\text{Hypotenuse}$ and $\tan \theta = \text{Opposite}/\text{Hypotenuse}$, we can use these rules to find an angle that we need if we have the side lengths, we also can use it to find the real length between the two banks at which we're going to build our bridge at if we have a map and a scale.

We can also use the sine law which states that $a/\sin(A) = b/\sin(B) = c/\sin(C)$ to find the angles and the sides in our triangular pieces on the main girder if the triangles are acute angled, for precise measurements to write in the portfolio and the poster.

We can use the area rules to find the volume of the palm tree plank we will buy using the (length * width * depth = volume) rule to calculate how much force should be distributed along the wood plank for it to not break, and accurately buy the required depth/thickness that the challenge states, same thing with the reed palm pipes where we can use the cylinder volume rule (height * π * r^2).

MAZEN ASKAR

Math in general with all of its concepts is very important for our capstone project, but I find the trigonometric functions are very important to understand to properly work on our capstone project, and that is because in our project we are working with a truss bridge, and the truss structure includes many right-angled-triangles, by understanding the trigonometric functions such as sin, cos, tan or the Pythagorean theory, we can use them in the necessary calculations required to build the truss structure, which allows us to find out the unknown lengths and angles inside the triangles.

The sin law and cos law are also very important, as during the construction of the movable part of the bridge we will have to work with a lot of non-right-angled triangles, which in turn forces us to use the sin, cos law to find the lengths and angles of those triangles, to conclude the sin law and cos law are very important tools that we are required to be used to get accurate measurements of our bridge, which is very beneficial for our project.

RESULTS

MALEK: GREEN

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

MAZEN ASKAR: GREEN

JOURNAL 3

Two of your team members suggested two prototypes (each member had a design idea), and while the team members were discussing the two models, the two members argued because each one of them was biased towards his design. How will you overcome this situation? 1- as a team leader. 2- as a team member. *

Personal Reflection/Team Collaboration

MALEK

One of the main advantages of the stem education system is the ability to work in teams and collaborate with others.

Firstly, as a team leader, I will study the two design plans accurately keeping in mind the design requirements and study the advantages and disadvantages of the two designing plans, then I will take the opinions of the other team members in addition I will take our cap leader because he saw a lot of other projects so he will help us. Furthermore, I will take the opinions of the two members arguing and why they want their design plan, lastly, I will decide considering all these opinions and the pros and cons of both design plans.

As a team member, The first thing I will do is to take the opinions of both of them to see what is the advantages and disadvantages of each of the designing plans, then I will take our team leader's opinion, I will research about the two designing plans and how the forces is calculated, and the effectiveness of them, lastly I will decide and will give my opinion to the team leader.

To conclude, team collaboration is very important, and we must not to argue or get biased because it will lead to wasting time and hating each other, also we must learn how to deal with these hard situations.

OMAR ADEL

As a member of my team, I also have a say in selecting the prototype design and idea whether it was a vote or a final decision as a team leader. Firstly to overcome the situation I would calm down both of the members, I would then ask them to explain their ideas thoroughly mentioning their strong suits and what the design fails to accomplish or has trouble with, my next action would be different depending on my role; If I was just a member I would also do research on both subjects and collect more data and make a decision and cast in my vote or side with which design I think is suitable.

On the other hand if I was a team leader I would hold an election where the other team members will vote on which design we should go on with and depending on the results we shall start testing the one with more votes, in the case of both designs having equal votes or an obvious bias by the team members I will then make a mini prototype of each and test It and determine the winner.

After choosing the design I will still get use of the other design by extracting its strong suits and implementing them in the chosen design to improve it to achieve better results.

To conclude no design is bad or unimprovable but there some designs that better fit our requirements and needs.

ZIAD SALAH

This happened to me once when I thought a table bridge would've been better than a vertical lift-bridge because it would use hydraulics and work in a better way, but my team denied this after researching that good and reinforced hydraulic systems were relatively too much for our budget.

As a team leader, I should think in an unbiased way, the only reason I would be biased if one is legitimately better than the other. The first thing I would do is ask for each one of them to research their prototypes and explain why it's better than the other, after they're done, the second thing is I'll ask them to speak to me as if I were the evaluator, they'll tell my why their prototype and design idea is better than the other person's and the prototype's advantages for the design requirements, if I feel the information isn't adding up or is wrong, I will choose the other prototype and also check if it's right.

On the other hand, as a team member I would ask my capstone teacher what to do, I would also talk to eleventh grade students and the leader of the team to see what they tell me, I'll try to research and see

which one is better in my opinion then pitch it to the team leader, I would also talk to my cap teacher about the information I concluded from my research and say which one I feel is actually a good choice.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

While constructing your bridge, you test many designs and ratio of material components to make your prototype able to carry at least 10Kg of traffic load, choose two of your tests you did and explain it, then discuss the results you obtained to reach the final design of your prototype *

Using the Engineering Design Process (EDP)

MALEK

In constructing our bridge, we encountered many difficult situations, tested many things, such as designs and truss structures, and researched many materials and mechanisms.

Firstly, we tested the materials, there are a lot of materials we can use, the first thing we tested is arndide; arndide is a sticky glue-like structure that consists of two different tubes when it is added to each other it sticks very well, and it is so hard to break the two things you stuck with it.

The second thing we tested was mechanisms, we decided that we would do a vertical lift bridge, firstly we tested a hydraulic mechanism that depends on water pressure, we used syringes and wires to do this mechanism but it failed because it couldn't handle this weight, furthermore we tested a mechanical mechanism that is lifted with motors and wires, we used a motor called a DC motor and we used steel wires at first we struggled buying the motors and wires but fortunately we found it with a cheap price.

Also, we tested a lot of other things like truss structures like Warren truss and Ktruss and other mechanisms like bascule and swing bridges.

The results of the tests were so good that arndide handled a lot of weight more than 20 Kg and the vertical lift mechanism succeeded and didn't break.

To conclude, we had a hard time but a great experience testing our prototype.

OMAR ADEL

After picking many designs and ideas and discussing them we found that many designs are suitable for our requirements such as swing, and bascule bridge, but then after calculating the forces and ratio of material composition, we found that some may function better and have a better way of handling 10kg worth of traffic load.

First the swing bridge, when testing the prototype of the swing bridge we noticed that some weight is weighed on the pillar in the of the bridge span and by careful testing and research we discovered that a heavy load on this pillar could be bad if the ground beneath the water is unstable or subjective to movements due to water currents this was observable because as we added weight on the middle part we noticed the pillar was sinking a little into the ground and started to bend forming a slope, and such a risk of safety shouldn't be taken.

Second, the bascule bridge, when researching and testing this prototype by first, making a free force diagram and calculating the forces during each stage and then testing the prototype by adding weight gradually, we noticed that some of the weight load on the bridge isn't affecting it or adding any deflection because of the counterweights that support the bridge

At end we decided that the bascule bridge will surely be a better candidate due to its lower ratio of weight of components to the ability to withstand weight, and we decided the swing bridge wouldn't be very applicable to our needs as we require the design to be implemented in many locations without much difficulty.

ZIAD SALAH

One of the tests me and my team did was making a Pratt truss-type bridge using suspension to support it from the ground, for this one, we used palm reed as the main material, we had thought that if we did this, with no girders or support from below as long as it's suspended, it would be fine which turned out not to be the case where the dead load already gave some deflection in the middle as the forces weren't equally distributed, we also realized that the truss diagonals were being bent a little due to pressure, furthermore, when we tried to put some weight on the bridge, the deflection we measured by the vernier caliper was too big for the design requirements, which lead us to reach a second truss type which we made in the second prototype test.

The second test we made had much more success, we researched and found that the K-Truss-Type doesn't bend under pressure as it looks like a triangle, we removed the suspension and added warren girders and a pier (pillar) from below to hold the bridge, the deflection with the dead-load was 0, while with 10kgs it was 3cm.

We managed to get the final prototype by that test, we used a better siliconbased adhesive as the old one was glue that came off due to temperature and water and also reinforced the base by perpendicularly aligning the reeds (4 vertically at the top, 2 horizontally at the bottom).

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

Concerning PH 1.01 in which you deal with measurement. Mention three factors that would affect the accuracy of your measurements negatively, then explain how to overcome one of these factors to make measurements accurately.*

Learning Transfer

MALEK

Physics is one of the most important subjects we will be using in this semester's capstone project. We studied a lot of important things that will help us in our project like accuracy and precision, as well as forces and equilibriums. Measurement errors in building an opening bridge over water are common and can affect our project so badly. And affects bridge safety.

The first factor that can affect the projects negatively is choosing the wrong measurement tools, wrong tools can waste a lot of time and make wrong measurements.

The second factor is choosing a very old or a poor-quality device. Systemic errors from poor-quality devices can ruin your results making it completely wrong. The third thing is human errors, human errors are common and result in wrong results, for example, looking at something with the wrong angle or measuring the observations incorrectly.

To conclude measurement errors are so common and can be so harmful in collecting your results but there are small errors that don't affect the results so negatively.

OMAR ADEL

In physics, we learned to deal with many problems concerning measurements so we can make sure it is correct so further calculations relying on these measurements can be carried out correctly with uncertainty becoming close to zero to ensure that the bridge will be stable

There are many factors that can affect the measurements of anything especially the length

First errors:

1- System error, system error is the error caused by the measuring tool as it

might be set to measure and increase the length by 1m or weight by 1kg. To get past this error we must make sure all our measuring tools are calibrated correctly and with immense precision.

2- Random error, this type of error is defined as the error caused by human

error and miscalculations for instance, a person can measure the length of a wall as 1.87m tall while another person could see it as 1.89m tall, to overcome this we must get the average of many measurements so it can be as close as possible to the real value.

Secondly, measuring units:

The measuring units differ from place to place as there are two main measuring units, the American measuring units that are the; inches, feet and miles. While the other is SI units which are; centimeters, meters and kilometers respectively. To overcome this we must learn the conversion rates between them and apply them when calculating anything.

Thirdly, accuracy concerning prefixes

Sometimes the measurements of something is too small it's written as 0.0005m so calculating anything could be complicated and leads to problems, that's why we should use prefixes such as nanometer, centimeter, and milli meter so we can get a less confusing and more accurate result

ZIAD SALAH

In Physics, we studied the chances of errors, we also studied how errors can happen. Three factors that can affect my measurements negatively are:

1. Systematic errors in an old device, that gives an incorrect reading or a value added/subtracted to/from the true reading. When we were measuring the weight of our test prototype in the fab-lab, the device measured 26KGs and we were baffled as that is over the design requirements, the teacher came in and said the reading was wrong and he said subtract 12 from the given value so it was 14KGs.
2. A parallax error which is a human error generally occurring due to the eye level when looking at the measuring tool, you should be looking directly at the tool's reading with no weird angle.
3. A measurement error where when you use a device its precision might not be high so you'll get an error, an example for that is when my team was measuring the span with a measuring tape in the fab-lab the precision of the tape was in millimeters, but the length looked above the millimeter mark.

We can overcome the third factor by estimating the absolute error which is $\Delta X = |X_0 - X|$ where ΔX : absolute error, X : real value, X_0 : measured value, we can put $\pm \Delta X$ to the measured value to get an estimate that we must use in our poster and portfolio for precision, we can get the relative error by: $r = (\Delta X / X) * 100$.

RESULTS

MALEK: GREEN

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

JOURNAL 4

The team leader distributes the tasks among the team members and one of your teammates doesn't accept his/her task. Explain two pieces of advice for your teammate to persuade him/her to accept his/her task.* Personal Reflection/Team Collaboration

MALEK

In STEM, where we work in teams, team collaboration is very important. We must help each other make a good project and get a good grade.

First I will ask him why he doesn't want to do his task, after that I will see the rest of the tasks if there is a difficulty difference, if his task is very difficult we will distribute the task to two people, if not the first thing I will tell him about to persuade him is that we need to finish our tasks or we will get bad grades so that will affect us so badly, after that I will tell him that we work in teams so we must collaborate and don't make problems and if he didn't do his task the rest of the team will not do their tasks too because they are busy in studying too and if his task is too hard we can help him do it.

Also, if he has other personal reasons like he is sick or his laptop not working properly we will do his task instead of him because we as a team must help each other in hard times.

Also, if he has some mental problems or is not comfortable in our team, we talk to him and know what are the reasons that he does not like our team and help him mentally.

To conclude teamwork is very important and one of the key advantages of the STEM educational system so we must help each other and do our tasks effectively.

OMAR ADEL

The distribution of tasks must rely on each person's skills and abilities that make them able to complete tasks quickly while maintaining its quality, so when the team leader distributes the tasks he must have considered everybody that is fit for such task and so each task is perfect for their corresponding member.

Sometimes some members aren't satisfied with what task they got due to difficulty and time consumption but it is in the team's benefit that they complete whatever they were assigned so we must convince them to do it so we can all have amazing results.

Firstly to convince anyone to take up the task that was assigned I would show them how it is almost the same difficulty or hassle as other tasks, if it is indeed harder I would try and help him in my free time or divide the task between him and another member whose task is easier.

Secondly, I would persuade him by boasting about him and his skills and how they are very helpful, by showing him appreciation and the need for his work he might be convinced to complete the task due to his ego.

Lastly, I would give him more time or leave him out of some work in other criteria such that he feels like he gave the same effort overall. to conclude I think we should accept the tasks we are given no matter what and go through whatever hardships we need to go through to complete and it is also natural to not accept the assigned task at first but what is not natural is not accepting any task or not following the team leader's commands.

ZIAD SALAH

As a team member, I'd persuade them by calmly talking with them and NOT threatening them about telling somebody above us (as that must only happen if they've done something terribly bad).

The two ways I'd persuade him is by telling him that it's only fair that you do your task, much like everyone else who accepted their tasks, if he refuses because the given task was too hard or he can't do it alone, I'll personally assist him and help in performing the task with him if the given task was too hard.

The second way is by inviting him to talk together in private in a noncapstone related topic, try to get things off his chest as he could be stressed and therefore unable to work due to pressure; This happened once where a person from another team broke down crying in the bus as he was given all the stressful tasks while the other team members were relaxed. After his mood becomes better, I'll ask him if he wants to work, if he refuses, I'll ask him to try and talk to the team leader.

This has personally happened to me once where a team member refused to work because he didn't want to do everything, we asked the team leader why he was working alone and he didn't give a clear answer, we went to assist our team member to help complete the part quicker and easier, as tasks were divided in that hard part.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

After constructing your prototype, you tested the results and found that you need to improve your design to get more accurate results. Explain a strategy you will follow to achieve this.* Using the Engineering Design Process (EDP)

MALEK

In STEM we work as teams to solve one of Egypt's grand challenges using materials that don't affect the environment badly and are more effective and with a low cost this term, we are making an opening bridge that is made of palm tree wood.

After defining the problem that we are facing which is urban congestion choosing our solution and how we will solve our problem and specifying the requirements that are necessary to construct our bridge, we started constructing our bridge and testing it, after testing we found that the results is not accurate and doesn't meet our requirements.

The first thing we will do is try to find why the results are not accurate and what is wrong with the design or the mechanism we are using, after we find the error we think and brainstorm our minds to know how to fix this problem, for example, if we found that the bridge cant handles the weight and make a large deflection, we will make stronger trusses and more girders to support the weight without deflection, after that we will retest our prototype if there is another problems. If the results are accurate and the prototype is strong enough, we start communicating our results to experts to see if we need to make any improvements. If the results are not accurate, we will repeat the process and try to improve our design.

To conclude it is common to don't have very accurate results at first, but you must try to improve and make the best that you can.

OMAR ADEL

Testing the results and improving the design later on is very important because as humans we must keep improving and building so we can thrive together in peace and harmony, and so, while constructing the prototype after showcasing the results among the team whether it was good or bad results we must take the necessary steps to improve it.

To improve my design faster and make it better I would first observe the results well. for instance, if one of my results showed major deflection and inaccuracies in measurements I will have to look for the real problem causing this such as, weak substructure, weak trusses or even weak decks, after that I would reinforce the structure that lacks ability to stay stable and make it stronger but adding more materials or adhesive depending on the reason for weakness.

I would also try to get more results more frequently as I construct my prototype to notice more things that I can improve, to showcase my idea I would either make a low-quality prototype and improve it many times or I would make a great-quality prototype and improve it only a few times or as much as needed .

Another way I can I achieve maximum improvement in my prototype is by making it simple and easy to reconstruct if needed to fix the problem because sometimes the problems are in the core of the design and its biggest aspect.

To deduce, I think there are many ways to achieve efficiency in improving the prototype and design and these methods differ from one project to another but I hope to be able to follow as much methods as possible to get the best results possible.

ZIAD SALAH

Our strategy followed is through digging deep into research and seeing the results of previous portfolios and conducted experiments by scientists as that's the most time-efficient method and the most accurate one.

The prototype was built in such a way that the design was incapable of actually lifting the 10KGs required to be lifted, so to combat that, we had to take the design slowly and analyze it to see what went wrong. We saw that the deck looked clean and would lift the weight easily, but we were surprised to see that it caused a deflection of 7.2cm (with the trusses) and reached its plastic point.

We had to modify this based off of scientific bases where the deck palm parts should have their length cut in a constant ratio applied for all lengths as this furthermore strengthens it. This was based off of lab research.

We also saw that the truss pieces had a shear force affecting them where there was a force from above and a force from below which caused them to make an unfavorable deform.

To combat that, perpendicular girders (to the deck and trusses) were added to divide the forces horizontally, therefore eliminating the force from below.

We also saw an inaccuracy in results where in the first design before changing it into the new one, the absolute errors were great, as the 15cm unit palm stalks had an absolute error of $\pm 0.8\text{cm}$.

To combat that, precise tools with high precision were used such as the vernier caliper to measure the lengths, which helped us round down the absolute error to $\pm 0.03\text{cm}$.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

In (ES.1.02) you have studied how atoms are arranged in mineral crystals and how that affects the physical properties of the mineral. In your project, you based on this idea to construct your bridge, Explain two types of arranging of the pieces of palm parts and why you chose one of them for your bridge.*

Learning Transfer

MALEK

In earth science, we have studied a lot of important things like building materials and branches of geology which can help us a lot in our project in the second learning outcome we have learnt about the minerals and their properties.

In our prototype, there are many ways to arrange the palm parts, but every way of arranging will affect the weight it can handle and its stability.

According to the design requirements, each palm part can't exceed 5mm in radius and 15cm in length of course the dimensions can't handle heavy weight so the first idea that will come up to any person is to make many layers.

The first way to arrange the palm parts is to make them both vertical and horizontal on top of each other. This way of arrangement is better and can handle more weight than one layer alone but there is a better option.

The second way to arrange the palm parts is to make the parts on top of each other but alternating between vertical and horizontal like one horizontal layer on top of one vertical layer this will handle more weight with less deflection that is why we chose to arrange our palm parts with this way of arrangement.

To conclude earth science helps us a lot in our bridge so we must get the benefit of it and choose carefully how to arrange the palm parts and where to place our bridge according to earth science.

OMAR ADEL

The arrangement of atoms affects the minerals in many physical properties such as; hardness, shape, colour and cleavage, so by considering each property and the atomic structure I can then conclude what minerals are beneficial for which project.

As we use different palm parts to build our project we considered each and every property it has and how to variate between them and use each one in the most beneficial way. Palm parts such as the wood can be used differently and alternatively for example by making it smooth while cutting it to decrease friction in moving parts or making it rough to increase friction between static parts. In my case I would start with cutting the palm parts into regular moderate size pieces getting use of its almost custom cleavage made in workshops and connecting it using an adhesive, due to their size and atomic arrangements they would have high friction holding them together whilst the adhesive starts working. Another arrangement we are using is to cut the parts into irregular pieces that fit each other well enough to produce a lot of friction like a jigsaw puzzle this would result In using less adhesive and having lower costs.

By understanding the color caused by the atomic arrangement we can notice many things for instance, we can notice whether the part is ready for use in construction or if it is still soft also not use dark or black parts because they absorb a lot of light causing the parts to get hot which may affect the project negatively. In conclusion using the right combination properties of palm parts could be the very reason the project succeeds

ZIAD SALAH

The chemical structure and shape of the mineral crystals is what defines the physical properties, this idea is very similar to how the bridge functions, the bridge is built in a certain structure with substructures, superstructures and a deck all making up the singular prototype, much like how the atoms bond together to form the crystals of minerals.

The first arrangement of the pieces of palm parts in the trusses was thought to be in a way to make a warren truss bridge, for which we used 60° angles (thinking that this was an optimal division). In the main deck we also arranged them in a wrong way, as putting palm parts next to each other and just gluing them puts the forces upon the glue and not the deck itself, the support made under the deck wasn't also all correct as it went coincident to the deck.

After conducting research and experiments, it was found that the K-Truss bridge is a more stable option as the triangle design stabilizes the pressure and separates it, for the angles, we conducted even more research we saw that using all angles as 45° in a right-angled triangle is the better option as it distributes the force equally according to the free-body diagram we formed for the bridge's trusses. For the deck, we found that by dividing the ground into an abstract piece with different length ratios gives it better strength, as well as putting the support perpendicular to the deck.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

JOURNAL 5

The first capstone project in STEM is nearing completion, and it has had a significant impact on shaping certain aspects of your personality. Describe two specific ways in which working on the capstone has influenced you personally. *

Personal Reflection/Team Collaboration

MALEK

One of the main advantages of STEM educational system is the capstone. As we work on the capstone, we learn a lot of good things and it has had a lot of significant impacts on us.

One of the main impacts shaping my personality is that I learned how to work in teams and collaborate. Teamwork is critical, especially in my future life, in college, and in my jobs. Working teams has taught me that I must help other teammates in hard situations for instance when one of our teammates is sick I must do his tasks, and also taught us that my decisions affect other people so I must be critical and make great decisions for example if I do my task with ai or with a bad quality this will affect the grades of everyone in the team

The second impact that shaped my personality is critical thinking, in our capstone project that requires a bridge that handles a minimum of 10kg made from palm trees is so hard that I must think creatively. Also, I must come up with an idea that is different from the other teams to be special and get good grades. For example, in the opening mechanism, all the teams are doing a hydraulic mechanism with syringes, but I thought differently and found a way to do it with motors.

To conclude, the capstone project has taught me a lot of things that impacted my personality.

OMAR ADEL

Working on the Capstone project with my team has influenced my life in many ways. both academic and personal aspects of my life were impacted heavily as I learned problem-solving, communicating with my team, time management and democracy all of which will help me not only in future projects but also in further life achievements like working in a team during college or after I graduate and get offered a job.

Capstone has influenced my life personally in factors that are invaluable to have as experiences;

1. I learned to communicate with others, not one opinion is purely perfect nor

is it purely bad, each idea has its flaws and so I was able to show my point

and understand others' point without any arguments and misunderstanding

but simply discussing everything together.

2. Time management is an obsolete skill that u must acquire, it is not just given

but gained, meaning that u must go through hardships to understand how to

have perfect time management to showcase my point, eventhough at the start

of the semester every older student advised us to have good time

management for our capstone it was still a hard concept to come by and me

specially I wasn't able to fully grasp the idea but after working for a while I

was able to understand that there are priorities in work that differ from;

deadlines, difficulty and time consumption and one must consider all three

factors if not more when managing his time.

All in all I think that despite the capstone being difficult at times, the experience and self growth that occurred due to it cant be neglected.

ZIAD SALAH

The first capstone was exceptionally unique as it helped me and everyone around me, especially my team and whom I helped in their project to gain new abilities and has influenced me personally as a person. It has helped me grow and change as a person for the better, it has also helped me break the ice of talking to people as an introverted person. It has influenced me where:

1. As the team leader I gained leading skills which are skills that were achieved through directing the team and hearing from other people, ignoring all difficulties that faced us when constructing the

prototype. It has given me the ability to be able to talk to people more as an introvert and become more extroverted. It has also helped me in finding a way to persuade people to believe what I believe.

2. It has helped me shape who I am as a person, as it has helped me find my true talent in woodworking and arts & crafts, I didn't know what I liked before experiencing making a prototype this fun.

3. It has improved my writing skills and general analysis skills, where the way I write changed from the worst to the better and I also became better at analyzing different situations to avoid arguments or possible bad outcomes as well as analyzing the prototype's outcomes as well.

These things and the capstone itself allowed me to have an experience where I can improve myself in multiple directions and not in one limited direction.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

As you complete your first capstone project and prepare for the next challenge, reflect on your experience. Based on what you learned, explain two practices or strategies you will apply in your next project and two approaches you will aim to avoid and mention the reasons. *

Using the Engineering Design Process (EDP)

MALEK

In the next capstone project, the first strategy I will apply is to balance between writing and constructing the prototype. In this term, I and my team wrote a lot in the first portfolio without constructing the prototype that much, and this affected us badly as a lot of the writing required information from the prototype, so we had to follow the engineering designing process we must define the problem first then finding a solution and construct the prototype.

The second strategy I will apply that we must brainstorm for a solution from the beginning of this term we came up with a solution after a lot of time and that affected us negatively as we were writing and constructing without a solution which made us edit a lot of things in the portfolio and poster also in the prototype, so we must find a solution after defining the problem directly.

The first approach I will avoid doing in the next term. Is not communicating and discussing our solution, in this term after we finished our solution, we didn't communicate the solution with experts and our capstone teachers which made us change a lot of things in our solution because it was not that efficient

The second approach I will avoid is making our team without certain roles, in this term every team member

doesn't have a certain role which made our team very messy and overwhelmed

OMAR ADEL

Working on my first capstone project has showed me that there many things I can do better and improve upon myself, What I could so better is a lot for instance:

1. I would have better time management, if I was able to create more time to balance between studying and doing work for the capstone not only would I find some free time to do extra research for the capstone, but I would also be working under less pressure im sure everyone knows of the saying pressure makes diamonds but gold is made without any, of course my past hardships taught me a lot but they most importantly taught me that I shouldn't go through them again.

2. I would balance between my team's skills for example some people are good researchers and can express their ideas with ease but aren't really good on hard labor and working on the prototype and some other people are the quite opposite and so I would task my team with work respective to their skills.

There are a few things I mustn't do again in the following project as they were mistakes that could be avoided;

1. I wouldn't argue with any of teammates over any idea as it only spreads roots of hatred between us and so we wont have good chemistry and we wouldn't work in harmony.

2. I wouldn't doubt myself or others, self confidence whether it was confidence of one's own skill or trusting your teams skill is a must, because doing the work on your own or checking everyone's work is very time consuming and wouldn't be of much necessity.

ZIAD SALAH

By the end of the semester, I had learned multiple ways to enhance and further improve my experience with the capstone during all the tasks done and activities during the construction of the prototype. It has also allowed me to learn from my mistakes and practices I've done that were correct and should be followed for maximum efficiency during the research, construction and what else.

The two strategies I'll apply in my next project are based on challenges that faced us during the construction of the prototype. Where:

1. Before constructing the prototype, lay out everything on paper and find a way to achieve maximum efficiency, as this allows you to have a more laid-out structure and a solid plan.
2. During the construction of the prototype, each method and step must be recorded and checked for scientific validity to be able to further endorse the reason you're building the prototype in this way.

The two approaches I aim to avoid to be able to enhance the capstone experience are:

1. To procrastinate where it has affected the team heavily and caused a disruption in the deadline as we didn't work on separate days and decided to do everything in one day which is wrong to do.
2. To argue with your teammates, as you should all work together and try to understand each other rather than fight. Fighting in teammates has especially pushed us back a week due to not understanding each other and me, as a team leader not having the experience to fix the problem.

RESULTS

MALEK: BLUE

OMAR ADEL: BLUE

ZIAD SALAH: BLUE

In (Ch 1.01), you explored the concepts of scientific theories and scientific laws. During the construction of your prototype, you likely applied several related theories and laws. Describe how you used one scientific theory and one scientific law in your project, providing specific examples.*

Learning Transfer

MALEK

In chemistry we studied a lot of important learning outcomes and concepts that helped us a lot in our capstone.

There are a lot of Scientific laws and theories that helped us in our capstone project because our capstone project must have a scientific base to rely on and apply them.

For instance. One of the scientific laws that helped us is newton's second law $F=ma$, newton's second law helped us a lot in calculating the forces affecting the bridge, as in truss structures there is tension and compression forces acting on them on the other hand there is wind force and friction force so we used this law calculating these forces and using them in constructing the bridge to make it handle all

these forces acting on it, for example we used newton's second law in calculating the net force acting on the bridge's piers to build it in way that handles this force.

One of the scientific theories that we used is Pythagoras theorem to calculate the truss' triangles' sides and angles as there is a lot of missing sides in the truss structure that we must calculate for example while we were constructing the truss structure, we used the Pythagoras theorem to calculate these missing sides

To conclude scientific laws and theories are very important and helped us a lot in our project as we used it calculating forces acting on the bridge and the missing sides in the truss structure.

OMAR ADEL

Scientific laws and theories may sound similar, of course they are but they share a ton of differences that help us to differentiate between them for example scientific theories are based of observations that can be rumoured as coincidences or pure chance, they explain phenomena but wouldn't explain it in different circumstances on the other hand scientific law is based of fact $1+1=2$, it is a fact therefore it is a law, they are explain phenomena in different situations and times without wavering more-like a math equation.

In our capstone project concerning the bridge we used many theories some that are world known and some that we observed on our own for example:

When we were constructing the prototype we noticed that many pieces of palm stuck together require more force to break but what we failed to consider is that sometimes the glue could be weak and so it could require less force to disassemble the sticks luckily we used strong glue that helped prove our theory.

We also used many laws that helped our cause for instance:

truss formations, since truss designs solely rely on a scientific base and law that states that the triangle sides fit better to distribute forces such as compression in tension and the net force must be Zero to reach a stable design so there are endless combinations to making truss designs but there are famous ones like Warren, Howe and Pratt designs in our bridge which requires the use of trussed we used this scientific law among many others and concluded that the warren truss bridge fits our design the best.

ZIAD SALAH

Scientific theories, are a way to explain a phenomenon, as mentioned in the question, they're a result of tests, hypotheses and observations you can perform to have a consistent outcome, or in the case of a constant natural phenomenon it's called a scientific law as it implies that this thing always happens in this way.

Post-construction of prototype, during the testing phase, when the minimum load was applied to the bridge, it was apparent that there was no deflection and that the deck itself returned back to its original state after it was de-loaded, this can be best explained by the physics concept showing the stress

(Force affecting an area of the object) and strain (Deformation of the object) of an object, where if the stress divided by strain is less than a certain threshold called the Yield Point then it remains in an elastic state (to return to its original state), but if it doesn't then it surpassed the Yield Point and won't go back to its original state, rather, it might reach the point of breaking. This is a scientific law used.

During the construction of the prototype, when the bridge's deck was being built, its deck length was divided in a certain ratio to assure its rigidity where after many observations it was found that performing this ratio strengthened the deck and allowed it to be ordered correctly, this is best explained by the arrangement of crystals in minerals of which the scientific reasoning was taken from.

RESULTS

MALEK: BLUE

OMAR ADEL: GREEN

ZIAD SALAH: GREEN