RMIT University

Engineering Capstone Project Part A - OENG1183

OENG1185/COSC2503 - Capstone Project Part B/Programming Project 2

Professional Practice and Contribution

Smart Watering System for a Community Garden

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WEEK 1 – 2

1/7/2024 – 13/7/2024

The Capstone Project Part B course began in early July, and the team is now approaching the phase of building the project prototype. This semester, I have continued the role of the team leader and manager, despite Dr. Alexandre's recommendation to rotate leadership biweekly to provide other team members with leadership opportunities. Unfortunately, the team has not strictly followed the initial Gantt chart plan, which included purchasing the necessary components during the semester break to speed up the progress. This delay was partly due to difficulties I encountered in contacting the course coordinator to clarify the component procurement process—a matter that was clearly explained in previous semester meetings. My teammates and I were negligent in acknowledging this issue until our first weekly meeting with the supervisors at the start of this semester.

In these first two weeks, the team had discussions and held two meetings with the supervisor to finalize of the bill of materials, along with a short meeting with RMIT Sustainability team to ask for permission to use soil for project showcase and to address any potential design changes. Initially, the list of components was prepared as reference, with items only briefly selected. However, the team made a change to the project design as only a small-scale version of the project is required. The team reassessed the specific components and suppliers to ensure compliance with the project budget. After several days of careful selection, we prepared the first official bill of materials for submission to the course coordinator for procurement.

WEEK 3 – 4

15/7/2024 – 27/7/2024

During Week 3, the team aimed to complete the Completion plan assignment and prepare for the next stage but encountered an unexpected problem. After submitting the bill of materials and receiving approval, the quotation from vendors verified by RMIT price exceeded the budget limit, reaching 12 million VND, whereas the team calculation had estimated around 8 million VND. The discrepancy arose because RMIT does not purchase the components directly from the team proposed vendors, such as Shopee or other online platforms, but instead from a verified vendor of RMIT, leading to additional cost. These include delivery fee and Value Added Tax (VAT) is also included, which collectively inflated the total cost of the components. In some cases, prices were nearly double what the team had anticipated. To address this, I needed to downscale certain components, such as the water shooting range and both the small and large tanks, to reduce material costs. Additionally, unnecessary components were removed from the list, as some could be sourced from home or substituted with tools available on the RMIT campus. Furthermore, during one of the weekly meetings, the supervisors informed us that certain components, including the Raspberry Pi 4, water pipes, and pumps, were available on campus from previous projects. Since these items were no longer in use, we could borrow them, which significantly reduced the bill of materials' total cost. Another cost-saving measure involved the materials for the water shooting range and tanks. Initially, the team intended to use laser-cut acrylic sheets from an external supplier, but since RMIT does not support external fabrication vendors, we were permitted to use the university's manufacturing workshop to cut the acrylic sheets at no cost. However, a limitation arose: the sheets available were only 3mm thick, which was weaker than expected for building a high-volume water tank, potentially leading to deformation

By Week 4, the acrylic sheets were quickly fabricated, and the team first meeting to build the water tanks. The initial design proved suboptimal, so super glue and silicone sealant were used for assembly. The sheets were first bonded with super glue, followed by silicone sealant to prevent water leakage. By the end of the week, a small water tank was completed, alongside progress on the software functionality. Another weekly meeting with the supervisors provided first look and feedback on improving the design for weather protection of the electronic equipment.

WEEK 5 – 6

29/7/2024 – 10/8/2024

After more than one week since submitting the bill of materials, all components finally arrived, and the team gathered to identify solutions for the key tasks. As the team leader, I evaluated each member's strengths and areas of expertise to assign specific responsibilities. For instance, one member was tasked with designing and constructing the water shooting range mechanism, another focused on researching water sprinklers, while another worked on software development and so on. My role as project manager involved overseeing the timely completion of tasks, while providing support to team members as they encountered challenges, whether related to hardware or software. Additionally, I am responsible for assembling the components, such as attaching the water tanks, as I am meticulous in my action and tend to put everything in perfect shape.

The team spent the whole Week 5 just for discussion as the project presented more challenges than anticipated. Since the project is designed for outdoor use, all equipment must be safeguarded against environmental factors, requiring weatherproofing measures. For instance, the team started to research and purchase water-resistance containers to store all electrical equipment inside as well as electrical conduit adapter to put the wires through, acting as water plug and prevent external impact such as someone accidentally step on or pull the wire, causing them to unplug from the circuit board. In addition, I designed the support structure for the big water tank and shooting range, as the acrylic sheets are thinner than initial plan, and simply using glue for attachment would not provide sufficient strength. This support structure ensures the components can withstand external impacts without collapsing. Moreover, another problem arose when Tung who was responsible for purchasing springs for the shooting range’s target reset mechanism, did not follow my instructions and instead bought springs with much greater tension and elasticity than required. As a result, the target reset mechanism failed to function as intended. To address this, the team developed an alternative solution by implementing a counterweight reset mechanism. This simply adds a small weight beneath the target, causing the center of mass to shift when the target is knocked down, allowing it to automatically return to its original position, much like a pendulum.

WEEK 7 – 8

12/8/2024 – 24/8/2024

In Week 7, despite it being the self-learning week for most students, the team continued to work without interruption, utilizing this period to accelerate progress. T team purchased a few more electrical components that were not covered in the original bill of materials provided by RMIT. Once they arrived, I intended to solder them onto a perfboard. However, I realized that this method is quite risky since the pin holes are relatively close to each other, and the team soldering skill is limited, which could potentially create short circuit or unstable connections. Therefore, I decided to design a custom PCB, which would not only provide a more professional appearance but also ensure stronger and more reliable connections between components. Earlier in the semester, the team had tested the system with the provided components from the supervisor, and everything works flawlessly. However, the provided water pump was too weak and can only generate a 0.7bar of pressure, meanwhile the sprinklers require 1-1.5bar of pressure to function. Although the team had a stronger pump purchased from the bill of materials, it requires 12V-4A adapter to operate while the purchased adapter was the wrong one with only 12V-3A output. So, my teammate went outside and bought another suitable adapter for this pump. After purchasing, the irrigation system was checked again but this time, the higher pump pressure - up to 7 bar - caused leaks at some pipe connections. Lowering the pump pressure is necessary and I proposed a few methods such as using pressure relief valve, divide the pipe layout or implement divider circuit. At the end of the week, the team had a meeting with the supervisors to check the validity of my PCB design before sending it for fabrication.

The PCB was approved by the supervisors; however, I have not sent it for fabrication yet since there might be a slight change in the component position. The irrigation system was tested again with a buck converter which lowers the voltage input of the pump and generates lower water pressure; thus, leakage no longer occurs. I also sourced ABS water-resistant boxes and electrical conduits, preparing for the final setup. In week 8, the school requested for the project showcase setup as well as project banner, so Tuan and I worked on designing a closed-loop control system diagram to include in the banner, while I assigned Nhan to complete the overall banner design due to her artistic skills. I finalized the PCB design and sent it to a local fabrication shop in Ho Chi Minh City, hoping for a quick turnaround. I sent the design on Monday, but I waited until the end of the week, contacted the store and realized that I need to pay them in advance to fabricate the PCB. The team had a huge delay in the workflow, and I had to send the PCB to a fabrication service in China, incurring higher costs and extending the delivery time.

WEEK 9 – 10

26/8/2024 – 7/9/2024

In Week 9, the team encountered a huge workflow delay due to the late arrival of the PCB. During this time, the team could only partially assemble the system for testing all at once and took demo videos with some photos for the school showcase website, RMIT Impact. However, the setup was incomplete and looked unprofessional, relying on jumper wires, breadboards, and alligator clips. The project would have appeared much better with the PCB, but with the deadline approaching, we had no choice but to accept its bad appearance. During one test, the Raspberry Pi 4 malfunctioned due to a short circuit that no one noticed at first, since in the user manual, the user should not touch the GPIO pins barehand. At this time, it was too late to request a replacement from RMIT, so the team had to purchase a new Raspberry Pi at personal expense. Until the end of Week 9, the PCB finally arrived, I worked extended hours on campus to make up for lost time, connecting and soldering all the electrical components and running tests. Once the PCB was confirmed functional, the team moved on to drafting the final report.

Another unfortunate challenge arose when Mr. Thien – an RMIT technician announced that all capstone project components stored inside the lab must be removed by the end of September since the room will be cleaned and renovated. Because the team mostly put all components in the lab instead of bringing home to for convenience and minimizing the risk of damage since some components such as the big water tank or shooting range are oversized and nearly impossible to carry by bike. With no other option, the team booked taxis to transport the materials home, bringing only essential parts back to campus for testing. In the final week before the showcase, the team worked quickly to perfect the entire setup. The team replaced the temporary jumper wires and alligator clips with stronger, more durable electrical wiring, drilled holes in the ABS boxes for wiring and drainage, managed cables, and optimized the placement of equipment inside the boxes. Moreover, the software is still unreliable at this time because there are still some bugs remain that mess up with the watering mechanism. Week 10 concluded with a meeting with the supervisors to show them demo videos of the system before showcase for any further improvements.

WEEK 11

9/9/2024 – 13/9/2024

On Thursday, 12th of September, we participated in the Capstone Project showcase, with our project 99% complete and ready for demonstration. The team gathered to conduct a final system check, ensuring no error occurs and all components stay intact the day before. I also prepared a brief script for my teammates to use when describing the project to attendees and lecturers during the event. On the morning of the showcase, the team arrived on campus at 7:30 AM to set up in our designated area, with two hours to get everything ready. I took the lead in setting up the components in the correct place and ensuring everything is intact and operational. Tuan and Tung and I connected various parts, while Minh verified the electrical circuit and software. Nhan brought 15kg of soil with some plants to fill in the garden box to enhance the display, giving the project a more engaging and lively appearance. The showcase began with a lot of students, lecturers and industry partners coming to check at the projects. Each capstone team is provided with three stickers to vote for the project they consider the best, and the team with the most stickers will win the People Choice Award. The lecturers and industry partners are the ones judging the project to vote for the best project receiving school and industry award after the showcase. The showcase started at 9:30 AM, coinciding with the school's Career Fair, which featured over 40 companies and industries. This was a valuable opportunity for students since we will attend the internship program in the upcoming semester. So, my team organized 2 shifts, each shift has 2 to 3 students stay at the project booth to present while the others explored the Career Fair. After the morning showcase, all students attended the Award ceremony for their projects. Luckily, my team was honored with the School award for the best project of RMIT Sustainability Department. The week concluded with us preparing the final report and gearing up for our presentation.

Student Self-Evaluation and Reflection

Please briefly respond to the following questions:

1. What are your main tasks and responsibilities within this Capstone project?

After completing Engineering Capstone Project Part A course, I continued as the Calico team leader and project manager in this semester. Drawing from my previous experience, I was able to better manage the team's workload and offer necessary technical support, particularly in areas such as soldering, assembling, and wiring.

- Technical Contributions: Once all components were available, I pretty much involved in every aspect from designing and assembling the water tanks, shooting range, doing practical jobs such as piping, soldering electrical components, purchasing additional equipment, and ensuring that each part of the system was correctly implemented.
- Academic Contributions: I was responsible for assigning sections for my teammates, writing detailed description of the water tanks, result analysis and discussion, and format editing for the Final Report.

2. What are your completed works and contributions to the project until this point? From 0 to 10 (the higher the better), how would you rate your works and contributions?

In Project Capstone Part B, I effectively managed both the project workflow and my teammates' workloads. This course holds greater significance compared to Capstone Project Part A, as it involves the actual implementation and construction of the prototype we previously proposed. Based on our timetable, I had the most available time among my teammates and my house is relatively near the school, I dedicated as much time and effort as possible to completing the essential tasks, aiming to achieve the highest quality outcomes. The specific responsibilities I undertook included:

- Creating report templates for my team.
- Assigning tasks for team members based on their current status.
- Contacting, purchasing and collecting components from RMIT Technician.
- Designing support structures for big water tank and shooting range.
- Assembling the water tanks, shooting range and irrigation system.
- Designing the PCB to install on the Raspberry Pi with other components.
- Connecting and soldering all electrical wires.
- Arranging weekly meetings and leading these meetings with the supervisors.
- Observing and checking teammates' work, ensuring they complete them without any error.

I would rate my performance as a 9. Overall, I believe I fulfilled my responsibilities as a team leader and project manager, ensuring everything stayed on track. I learned from my mistake from the previous semester and became a better leader, managing the team more efficiently. Most of my work is considered more well-prepared and professional. However, one of the issues I encountered was I could not provide the most optimal solution in the beginning or could not think of it yet, which resulted in several mistakes during the development process. I was also indecisive in choosing the appropriate components for the project and did not utilize the semester break to boost the team's progress, which the team could improve

the project further with a lot more time. Additionally, while I made more efforts to communicate with our supervisors, I had minimal interaction with our client - the RMIT Sustainability Team - as I planned to present the final prototype at the end of the semester, which in hindsight could have been managed differently.

3. Briefly describe the main tasks and responsibilities of other student members in your project team. From 0 to 10 (the higher the better), how would you rate their work and contributions?

Table 1: Teammate contribution rating

Student Name	Student ID	Main tasks and responsibilities	Rating
Nguyen Bao Tuan	S3713061	***Water Shooting Target Designers, Advisor for Irrigation System Setup, Problem solver*** - Tuan is the one to propose the alternative solution for the auto-reset mechanism of the targets. - He assists Nhan with the irrigation setup and pipe plan. - He usually works with me with the practical works and propose solutions for the project.	9
Nguyen *Mau* Tung	S3755518	***Water Storage Designers, Advisor for Accessories Solution*** - Tung is responsible for refilling mechanism and piping. - Tung also gives ideas and advice for the target reset mechanism and finding accessories.	7
Nguyen Tri Nhan	S3826381	***Irrigation System Designer, Graphic Designer*** - Nhan is responsible for the design of the irrigation system that includes water pipes, nozzles and sprinklers along the garden. - She designed the team banner and wallpaper for the showcase	9
Nguyen Tuan Minh	S3877477	***Software Developer, Electrical Engineer*** - Minh is responsible for all the software aspects of the systems,	9

		including the irrigation system watering timer, UI through an IP address to adjust all the system parameters that change the watering schedule, recording water and sensors data. - He developed the electronic circuits with all necessary equipment to control the whole irrigation system.	

The team has developed a stronger bond and cooperated much better with each other, increasing the work quality. We consistently completed tasks well and on time, demonstrated mutual respect, actively contributed ideas, and ensured punctual attendance at all meetings. Each member is well-prepared and fully understands their responsibilities. However, Tung has shown some challenges in this course. He lacks experience in practical work such as attaching components or soldering electrical parts, therefore I am the one to take care of all those works. Furthermore, Tung's approach lacks the mindset of a professional engineer, as his proposed solutions often resemble those suited for DIY or non-professional projects, rather than the more rigorous standards of industry-based projects. He has also struggled with following my instructions, often deviating from them, which frequently leads to errors. Although my teammates and I did give him feedback and advice on improving these issues, he did not open-heartedly accept it and shown unpleasant attitude.

4. Briefly describe critical issues, if any, that need to be addressed to further support the progression and completion of your project.

As mentioned above, my team did not utilize the extra time during the semester break, so our workflow is different from the initial plan, and the team had to work harder during this semester. The limited availability of certain team members has compounded this issue as well. For instance, Tung and Tuan enrolled in another course while it is recommended to solely focus on Capstone course in this semester, so they could not fully contribute to the project. Nhan, as a staff member of the RMIT Sustainability Department, also has strict availability constraints, often able to contribute only 1-2 hours on select days. Nevertheless, she is highly responsible with her tasks and always completes them well on time. These factors have collectively impacted on the team's overall performance.

Furthermore, the delayed arrival of the PCB has had a significant effect on the project. As a result, the quality of the demonstration materials - photos and videos - intended for the showcase were not reflective of the team's best potential, which could negatively influence recruiters and industry partners reviewing our project.