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Project Man. 412 Assignment 3

Group I-2

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Executive Summary

This report is a detailed analysis of the project that successfully developed a pressure vessel for industrial process oil refineries capable of sensing when the vessel is at risk of failure, thereby automatically releasing pressure to prevent catastrophic failure.

The Project Performance Review begins by a thorough analysis of the project performance, by discussing the deviation from the budget as calculated through various project management tools. The actual cost is stated and the tasks that ran over budget is analysed in full. Thereafter the performance of the schedule is analysed and discussed.

The process of hiring and developing the project team is discussed in terms of the initial strategy outlined in the project plan. This section also describes the adaptations that were made to the original plan. The section also explains what the multi-disciplinary team would do in managing and hiring resources in future projects.

During the project the multi-disciplinary team identified potential risks captured in the risk register. Mitigation plans were set in place and each risk was prioritised in terms of the degree of influence it could have on the critical path. The risks that occurred during the simulation were identified and responded to according to this plan. The risk management section in this report is a review of this risk management plan that was developed and how well it was executed.

Throughout the project, the multi-disciplinary team came across some difficulties. Thus, many lessons were learnt. The team reviewed these lessons learnt and discusses what to do in future projects like these. The Real-Life Group Execution Sections is a summary of this and each individual team member added the lessons they learnt from their perspective as an Engineer in their own field.

Finally, the team reached the conclusion that the project could, overall, be considered successful and that the team is satisfied with their performance.

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Nomenclature

Acronyms and abbreviations

AC	Actual Cost
PV	Planned Value
EV	Earned Value
ETC	Estimated Cost To Complete
EAC	Estimated Cost At Completion
CPI	Cost Performance Index
SPI	Schedule Performance Index

Chapter 1

Project Performance Review

1.1. Introduction

This chapter will review the project status and review the full project budget and schedule against the planned baseline.

1.2. General Status Review

As of the completion of period 12 on 2022/02/07 the project has finished before the project deadline of March, however the project is over budget and behind the baseline schedule.

The total cost of the project is calculated to be \$395127,41, \$15127,41 over the baseline budget of \$380000 and \$45127,41 over the adjusted budget of \$350000 due to events (Tab. B.1). As seen in Fig. 1.1 below, the project has been consistently behind schedule and over budget (CPI and SPI < 1), the reasons for which will be discussed in Sec. 1.3 and 1.4.

The project is 34.33 days behind the baseline schedule as seen in Fig. B.1, however this is of secondary importance as no adjustments were made to the project deadline, which was met.

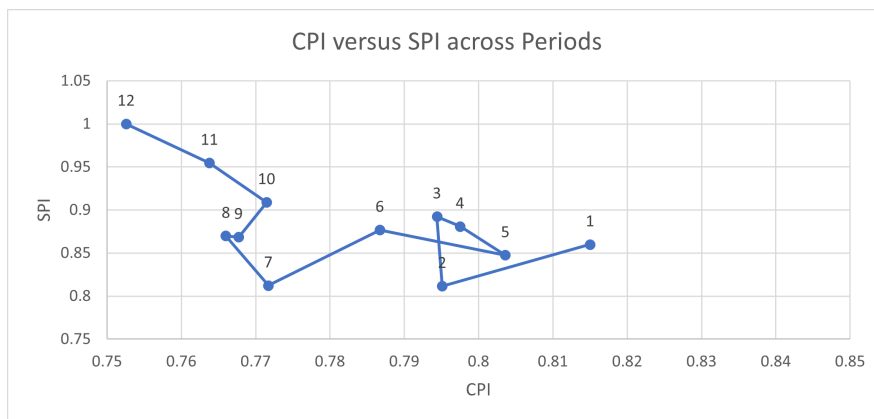


Figure 1.1: CPI and SPI per period

1.3. Budget Analysis & Review

The project has been over budget for the entire project with a downward CPI trend as the project progressed as seen in Fig. 1.1. This is also seen in Fig. 1.2 with the AC being above EV for the entire project with the gap between these values widening.

The gap is due to resources being overbid and as mentioned in Sec. 1.4, the tasks have taken longer than expected due to unplanned resource inefficiencies leading to higher task costs. This gap starts to widen faster after period 6, probably due to the fact that the overbid Engineer Tom Bechur had to complete more work than expected (Fig. B.3). From the same figure it is also seen that the Marketing Manager Yukio Ashida cost \$35791 more than planned, leading to a higher overall AC.

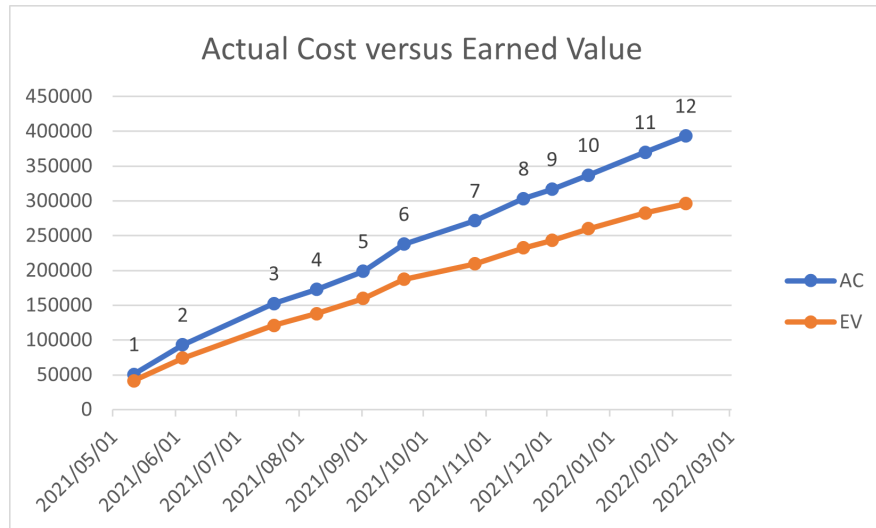


Figure 1.2: AC and EV across Project

1.4. Schedule Analysis & Review

As seen in Fig. 1.1 above, the project has consistently been behind schedule with an upward SPI trend as the project progressed.

This is not necessarily an issue as the baseline plan is very optimistic and does not take into account the inherent inefficiencies of the resources assigned to tasks.

The major variances from the baseline occurred during phase 7-10 as seen in Fig. 1.3, this is due to the fact that an Operations Specialist could not be secured as well as the fact that the Quality Engineer did not perform as well as expected, leading to unplanned delays. This is also clear when looking at Fig. B.2 where the largest relative duration variances can be seen in the work packages where the operations specialist was missing, such as Supplier Quality and Procurement or where the sub-performing Quality Engineer was assigned such as Engineering Quality. Engineering also suffered delays due to resources needing to be reassigned to cover the missing Operations Specialist.

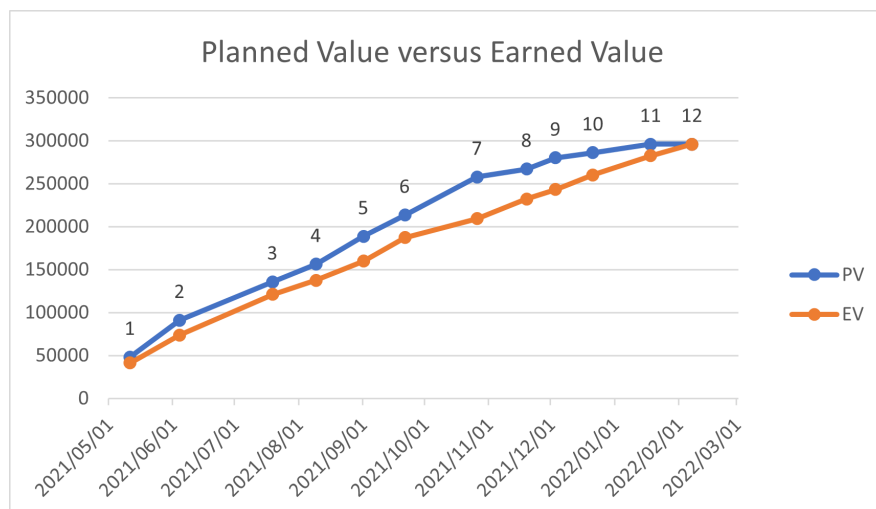


Figure 1.3: PV and EV across Project

Chapter 2

Resource Strategy & Development Review

2.1. Introduction

This chapter will discuss the resource strategy used in the project, where this strategy succeeded or had to be adapted. It will also review the steps taken to develop resources and the efficacy thereof. Lastly it will use the aforementioned review to make recommendations for future projects.

2.2. Resource Strategy Review

At the start of the project, the team came to a decision on the resource strategy for the project, which prioritized saving cost and time, as the team believed these factors posed the greatest threat to the non-completion of the project. The team confirmed this by generating a prioritized risk register, which identified all possible risks to the project in order of highest to lowest priority. Analyzing the results of the risk register, the team concluded the highest priority risk (being a combination of the most likely risks to occur and the risks with the greatest negative impact on the project) were mostly related to going over the planned budget or the planned completion time for the project. This realisation led to the initial resource strategy.

The strategy was first tested in the ‘demo’ run of Sim4Projects. The general strategy for hiring resources was to attempt to acquire at least one of each type of resource (at different phases in the project), by bidding slightly above the standard amount for the specified resource. In general, the team chose resources with attributes such as high skill level, experience, and work ethic, as it was believed that these would contribute to increased efficiency on tasks.

The strategy for bidding on resources for period 1 was relatively basic, the team decided to bid slightly above the standard amount for each required type of resource, hoping to secure at least one Marketing Manager, Junior Marketing Specialist and Engineer, while also bidding on a Project Manager, but for the standard amount (with the expectation that they would likely not be acquired).

The team noticed that the resources with the highest cost were Project Managers, and so the team made a decision not to hire a Project Manager, but to rather hire an additional Engineer to assign to the project management tasks. This was because there were no engineering tasks in the first period, but it was predicted that Engineers would become in high demand from period 2 onward, and so the team wanted to secure a high quality Engineer for the rest of the periods without losing money in period 1 by not assigning the hired Engineer to any task. It was predicted that this strategy would save cost (as Engineers cost less than Project Managers) and improve efficiency in the future (by having a high quality Engineer available for engineering tasks and to cover other).

From period 2 until the last period, the team decided to allocate all the project management tasks to the Marketing Manager that was acquired. It was found that the Marketing Manager was almost as effective as a Project Manager for these tasks (about 95% effective), as well as costing much less.

Contingencies for if the team could not manage to acquire one of each type of resource, is to test the performance of alternative resources in the task which would lack the relevant

resource. For example, when an Operations Specialist was not acquired before period 8, the team allocated additional manufacturing tasks to the Engineers. If an alternative resource is found to be ineffective in a certain task, a different resource would be allocated to those tasks in the following periods.

In all, this strategy seemed to be successful, with only one resource not acquired and the Marketing Manager filling the role of the Project Manager successfully.

2.3. Resource Strategy Adaptation Review

The team had a sound strategy for bidding and hiring resources, as explained in Sec. 2.2. The team quickly realised that the resources were limited to 9 resources per category, leading to high amounts of competition between the different teams. Thus, it was essential to identify the resources on the critical path and bid on these early. It was not always possible to follow the strategy due to the limited resources, and the team had to deviate from this strategy in order to succeed. The team had to over bid on some resources, as seen in Fig. B.4, such as the second engineer in order to secure them as their absence would have negatively influenced the critical path.

During the bidding run of period 5, the original strategy was to hire an Operations Specialist. Unfortunately the resource pool did not have any Operation Specialists left. The team had to implement a mitigation plan as the tasks that required an Operations Specialist were on the critical path. This risk and management plan is outlined in D.1.

The team decided to bid on two Junior Marketing Specialists and assign these resources, in parallel, to the tasks that were planned for the Operation Specialist. There was little competition for these resources and thus the decision was made to make the bids on the standard rate for each resource, George Olmos (\$48,00) and Norman Micheals (\$50,00). Both resources were hired at these rates. In period 6 the resources were assigned to the tasks that were meant for the Operation Specialist. The Junior Marketing Specialists were 90% effective in the tasks handed to them.

For period 7, the group decided that Tom Becher, one of the hired Engineers, would be sufficient to finish the task that were initially planned for the Operation Specialist and him. He did not finish within the estimated time, although he was almost 70% efficient. This meant that the task may have been too much for one resource to manage. The critical path was influenced and the overall budget. The manufacturing tasks that were initially planned for the Operation Specialist was divided between the two hired Engineers. They both were effective in the tasks that were handed to them and showed acceptable efficiency.

In this same period, the team had noticed that the two Junior Product Designers had not been fired two phases earlier as planned and had been incurring unallocated resource penalties. This oversight was rectified by removing the two resources as originally planned.

The rest of the project, in terms of resources, went as planned. The critical path was definitely influenced by the fact that team could not hire an Operations Specialist. It also had a great effect on the budget, as more expensive resources had to be assigned to tasks that were budgeted for the operations specialist. The unallocated resource penalties also contributed to the fact that the project ended over budget.

2.4. Resource Development Review

In the project plan compiled for this project, it was decided that no resource training would take place. Therefore it is unknown how much benefit it would have yielded to send resources to training.

2.5. Recommendations for Future Resource Strategy

For future projects a deeper analysis of the resource pool must be done before the start of the project. This will ensure that the team have great understanding of the number and quality of resources available within the resource pool. Tasks must also be identified which require a very specific resource. This will allow the team to decide on a strategy in which they will hire these resource early to ensure they secure the resources.

Another potential point of improvement could be to cycle in fresh resources as the project progresses to preserve team stamina and prevent the fatigue as seen in Fig. B.5.

Chapter 3

Risk Management Review

3.1. Introduction

This chapter will review both the risks that have occurred during this project as well as the effectiveness of the response strategies deployed for these risks.

3.2. Risk Management Strategy Review

The team had a meeting in the planning phase where the risks associated with the project were identified and each member of the group was expected to identify risks related to their specific engineering field. This risk register compiled at the start of the project identified the majority of the unwanted events that occurred during the simulation, therefore it can be concluded that the register leveraged the multi-disciplinary nature of the team in identifying various sources of risk.

Given that the number of resources in different categories is limited and that other groups hired more than one of a specific resource, a shortage of that resource was created. As our group could not hire an operations specialist during period 8 and the tasks planned for the operations specialist were on the critical path, this was an event that was anticipated and was in the risk register. The response to this event as stated in Tab. D.1 was to assign other resources to the path and review our hiring strategy. Two junior marketing specialists were assigned the task of the operations specialist and later on the engineers took on the tasks. While they were probably not as effective as an Operations Specialist, they did reasonably well and the tasks were completed without catastrophic delays to the project.

In the majority of the events, however, there was little that could have been done in terms of mitigation as the team had no control over external events that occurred and some of the response strategies were not feasible (such as hiring alternative resources when none were available). The contingency fund also only covered the first unwanted event (Tab. B.1), therefore it can be concluded that the original contingency percentage of the budget was insufficient. When looking at team cohesion (Fig. B.5), it is also unclear how much of an effect the managerial actions taken in response to the team conflict had in order to correct this unwanted event.

The project presented a few risks that the group did not anticipate, and the risks were updated accordingly in the new risk registry in App. D for future projects. The group's risk management strategy worked reasonably well for the most part of the project as the events that occurred during the project run were anticipated in the risk registry, however the contingency fund of \$6220,56 was not sufficient to handle all of the unwanted events.

Chapter 4

Real Life Group Review

4.1. Introduction

This chapter outlines the lessons learned as a group during the execution of this project. Individual reviews and lessons learned can be found in App. C.

4.2. Lessons Learned

The group learned the importance of communication between team members while working on a group project. The project required a high degree of planning over an extended period of time. Without good communication and planning between team members the project would definitely have failed.

With this, the team realised the importance of scheduling meetings and deadlines. Since all of the members studied different degrees, we also had vastly different academic timetables and responsibilities. Without scheduling meetings and deadlines, it would have been very hard for the team to work as a consistent unit.

Lastly, the team recognised the importance of accountability. It could be quite easy for individuals to shift blame towards other team members. If each member did not hold themselves accountable for the work that they were responsible for, the team as a whole would have struggled. It is important, while working in a team, that each member takes responsibility for their work.

4.3. Theory Application Review

While the techniques learned in theory were certainly useful, some of these were taught later in the project when they could have been helpful earlier in the project (e.g. CPI and SPI tracking). The simulation is a good sandbox to practice these techniques in a relatively risk free environment. The techniques such as Gantt and Network charts were valuable in planning for this project and there is little doubt that the project would have been as successful without them. EVA theory also ensures that the team is capable of compiling this report and make meaningful reviews and recommendations therein.

4.4. Multi-Disciplinary Aspect Review

Working in a multidisciplinary team posed challenges but also introduced versatility to the contributions made to the project. One of the main challenges faced was with respect to scheduling and time management. Since each team member was from a different engineering discipline, every person had an individual schedule. Considering that, in general, engineering student's schedules are very busy, having five different engineering disciplines in one team (Chemical, Civil, Electrical, Mechanical and Mechatronic) posed an even greater challenge. Of the available time in each person's schedule, there were limited overlaps in the team's individual schedules, which put a restriction on communication and caused difficulties in scheduling meetings.

Despite these challenges, the team overcame them by each being amenable and flexible to last-minute changes in scheduling. Everyone respected each other's limited availability of time, which allowed for a positive team dynamic and good team cohesion. Furthermore, everyone recognized

that each team member had something different and insightful to add to the team, which meant that contributions from each discipline were welcomed. This led to a diverse range of perspectives and contributions when it came to period decision making as well as for the compilation of the final reports.

4.5. Future Recommendations

The simulated project is a tedious process, as it is time consuming. The team would in future projects, like this one, hand out the responsibility of each period to a member to take lead. This would take the weight off the shoulders of the group leader and ultimately include each member much more in the project. This would also allow each member to gain skills in working with software such as MS Projects.

Discussing each other's strengths and weaknesses would give us valuable information about the capabilities of each team member and the type of work that they are suited for. This would ensure that each member could work to his or her strengths and this could improve the standard of work delivered by the team.

4.6. Conclusion

To conclude, group I-2 successfully completed the project but was over budget. The project finished within the deadline but was behind on the baseline schedule.

The risk management strategy put in place at the start of this project proved to be successful in dealing with the unexpected events that have occurred. Suitable responses were ready for the risks.

By completing this project the team has learned valuable experience in the project management field. The group reflected on aspects that they could have changed for an even more successful outcome. Overall group I-2 were satisfied with the results of the project.

Appendix A

Updated MS Project File

The full updated MS Project sheet can be found on the following pages. Note that the image can be zoomed in to read details of the various tasks.

ID	Task Name	Duration	Start	Finish	Resource Names	Baseline Cost	Baseline Estimated Duration	Actual Cost
1	Market Assessment	29.26 days	Wed 21-03-31	Tue 21-05-11		\$32,844.00	25.5 days	\$37,452.80
2	Evaluate market	6.69 days	Wed 21-03-31	Thu 21-04-08	Kurt Zollinger,Yukio Ashida	\$7,728.00	6 days	\$8,563.20
3	Develop Business opportunity	8.06 days	Thu 21-04-08	Tue 21-04-20	Kurt Zollinger,Yukio Ashida	\$9,016.00	7 days	\$10,316.80
4	Customer preference study	12.13 days	Tue 21-04-20	Fri 21-05-07	Kurt Zollinger,Yukio Ashida	\$13,524.00	10.5 days	\$15,526.40
5	Business evaluation (NPV, etc.)	2.38 days	Fri 21-05-07	Tue 21-05-11	Kurt Zollinger,Yukio Ashida	\$2,576.00	2 days	\$3,046.40
6	Procurement	85.58 days	Wed 21-09-01	Wed 21-12-29		\$14,200.00	65.63 days	\$17,978.32
7	Identify vendors	4.5 days	Wed 21-09-01	Tue 21-09-07	George Olmos,Norman Micheal	\$2,800.00	7 days	\$3,528.00
8	Develop and Issue RFQ	3.88 days	Wed 21-09-01	Wed 21-09-15	George Olmos,Norman Micheal	\$2,400.00	6 days	\$3,041.92
9	Issue sample (production equivalent)	7.5 days	Tue 21-09-21	Fri 21-10-01	Jovanna Soto	\$3,000.00	5 days	\$4,500.00
10	Assess RFQ responses and select vendors	6.06 days	Tue 21-12-21	Wed 21-12-29	Jovanna Soto,Tom Bechur	\$6,000.00	10 days	\$6,908.40
11	Supplier Quality	57.14 days	Fri 21-10-01	Tue 21-12-21		\$16,960.00	38 days	\$22,828.20
12	Perform supplier process capability	17.13 days	Fri 21-10-01	Tue 21-10-26	Tom Bechur	\$6,608.00	7 days	\$9,250.20
13	Approve sample parts	10.13 days	Wed 21-10-27	Wed 21-11-10	Jovanna Soto	\$4,352.00	8 days	\$6,078.00
14	Qualify Supplier	12.5 days	Fri 21-12-03	Tue 21-12-21	Jovanna Soto	\$6,000.00	10 days	\$7,500.00
15	Design	54.89 days	Tue 21-05-11	Tue 21-07-27		\$22,344.00	46.5 days	\$34,021.68
16	Design and development plan	3.88 days	Tue 21-05-11	Mon 21-05-17	Kelly Sauseda,Lance Portier	\$2,352.00	3 days	\$3,585.12
17	Design specs.	13.75 days	Mon 21-05-17	Fri 21-06-04	Kelly Sauseda,Lance Portier	\$8,624.00	11 days	\$12,705.00
18	Identify testing requirements	6.25 days	Fri 21-06-04	Mon 21-06-14	Kelly Sauseda,Lance Portier	\$3,920.00	5 days	\$5,775.00
19	Risk analysis	7.06 days	Mon 21-06-14	Wed 21-06-23	Kelly Sauseda,Lance Portier	\$3,920.00	5 days	\$6,523.44
20	Design labeling	3.25 days	Mon 21-07-19	Thu 21-07-22	Kelly Sauseda,Lance Portier	\$1,960.00	2.5 days	\$3,003.00
21	Approve design	2.63 days	Thu 21-07-22	Tue 21-07-27	Kelly Sauseda,Lance Portier	\$1,568.00	2 days	\$2,430.12
22	Engineering	101.02 days	Tue 21-07-27	Wed 21-12-15		\$31,228.00	72.63 days	\$38,626.64
23	Initial engineering specs.	2.88 days	Tue 21-07-27	Fri 21-07-30	Tom Bechur,Darryl Sandefur	\$2,460.00	2.5 days	\$2,828.16
24	Design verification activities	4.19 days	Mon 21-08-09	Fri 21-08-13	Tom Bechur,Darryl Sandefur	\$3,444.00	3.5 days	\$4,114.58
25	Verification design review	2.31 days	Fri 21-08-13	Tue 21-08-17	Tom Bechur,Darryl Sandefur	\$1,968.00	2 days	\$2,268.42
26	Release pre-production specifications	6 days	Tue 21-08-17	Wed 21-08-25	Tom Bechur,Darryl Sandefur	\$4,920.00	5 days	\$5,892.00
27	Build functional model	11.25 days	Wed 21-09-01	Thu 21-09-16	Tom Bechur,Darryl Sandefur	\$8,856.00	9 days	\$11,047.50
28	Design validation activities	3.06 days	Tue 21-10-26	Tue 21-11-16	Darryl Sandefur,Jovanna Soto	\$2,200.00	5 days	\$3,188.52
29	Validation design review	4.75 days	Fri 21-11-19	Thu 21-11-25	Tom Bechur	\$1,968.00	2 days	\$2,565.00
30	Approve model design	5.13 days	Thu 21-11-25	Fri 21-12-03	Darryl Sandefur	\$1,968.00	2 days	\$2,267.46
31	Design transfer activities	8.25 days	Fri 21-12-03	Wed 21-12-15	Tom Bechur	\$3,444.00	3.5 days	\$4,455.00
32	Engineering Quality	78.65 days	Wed 21-09-01	Mon 21-12-20		\$21,472.00	53.63 days	\$26,158.40
33	Evaluate design specifications	14.88 days	Wed 21-09-01	Tue 21-09-21	Jovanna Soto	\$6,000.00	10 days	\$8,928.00
34	Develop testing protocol for prototype	10.25 days	Tue 21-09-21	Wed 21-10-06	Darryl Sandefur	\$3,520.00	8 days	\$4,530.50
35	Test prototype	12.75 days	Tue 21-10-26	Fri 21-11-12	Darryl Sandefur	\$6,000.00	10 days	\$5,635.50
36	Evaluate results of tests and identify weaknesses	7.38 days	Fri 21-11-19	Tue 21-11-30	Jovanna Soto	\$3,600.00	6 days	\$4,428.00
37	Product release meetings	3.38 days	Wed 21-12-15	Mon 21-12-20	Yukio Ashida	\$2,352.00	3 days	\$2,636.40
38	Manufacturing	68.52 days	Tue 21-10-26	Mon 22-01-31		\$22,600.00	66.5 days	\$35,153.32
39	Process engineering plan	17.63 days	Tue 21-10-26	Fri 21-11-19	Tom Bechur	\$6,000.00	15 days	\$9,520.20
40	Develop production plan	8.25 days	Fri 21-12-03	Wed 21-12-15	Darryl Sandefur	\$2,400.00	6 days	\$3,646.50
41	Develop production control plan	11.13 days	Tue 21-12-21	Wed 22-01-05	Darryl Sandefur	\$3,400.00	8.5 days	\$4,919.46
42	Approve production parts	3.31 days	Wed 22-01-05	Mon 22-01-10	Darryl Sandefur,Tom Bechur	\$2,000.00	5 days	\$3,250.42
43	Contracting for deliveries	5.13 days	Mon 22-01-10	Tue 22-01-18	Darryl Sandefur,Tom Bechur	\$3,200.00	8 days	\$5,037.66
44	Submit production purchase order	1.31 days	Tue 22-01-18	Wed 22-01-19	Darryl Sandefur,Tom Bechur	\$800.00	2 days	\$1,286.42
45	Production pilot test	3.19 days	Wed 22-01-19	Mon 22-01-24	Tom Bechur,Darryl Sandefur	\$2,000.00	5 days	\$3,132.58
46	Debugging production system	2.44 days	Mon 22-01-24	Thu 22-01-27	Darryl Sandefur,Tom Bechur	\$1,600.00	4 days	\$2,396.08
47	Production release	2 days	Thu 22-01-27	Mon 22-01-31	Darryl Sandefur,Tom Bechur	\$1,200.00	3 days	\$1,964.00
48	Commercialization	194.49 days	Tue 21-05-11	Mon 22-02-07		\$49,784.00	164.13 days	\$56,487.80
49	Develop preliminary marketing plan	2.81 days	Tue 21-05-11	Fri 21-05-14	Kurt Zollinger,Yukio Ashida	\$3,220.00	2.5 days	\$3,596.80
50	Develop marketing program	8.44 days	Fri 21-05-14	Wed 21-05-26	Kurt Zollinger,Yukio Ashida	\$9,660.00	7.5 days	\$10,803.20
51	Train sales team	24.88 days	Fri 21-06-04	Thu 21-07-08	Kurt Zollinger	\$11,088.00	22 days	\$12,440.00
52	Advertising campaign	31.38 days	Fri 21-06-04	Mon 21-07-19	Yukio Ashida	\$21,952.00	28 days	\$24,476.40

ID	Task Name	Duration	Start	Finish	Resource Names	Baseline Cost	Baseline Estimated Duration	Actual Cost
53	Show functional model at trade show	3.25 days	Mon 21-11-01	Thu 21-11-04	Yukio Ashida	\$2,352.00	3 days	\$2,535.00
54	Product launch	3.38 days	Wed 22-02-02	Mon 22-02-07	Yukio Ashida	\$1,512.00	3 days	\$2,636.40
55	Project Management	220.37 days	Wed 21-03-31	Wed 22-02-02		\$83,236.00	182.63 days	\$110,998.50
56	Project Management Period 1	18.06 days	Wed 21-03-31	Mon 21-04-26	Tom Bechur,Darryl Sandefur	\$12,300.00	12.5 days	\$17,734.92
57	Project Management Period 2	10.06 days	Tue 21-05-11	Tue 21-05-25	Tom Bechur,Darryl Sandefur	\$6,888.00	7 days	\$9,878.92
58	Project Management Period 3	10.13 days	Fri 21-06-04	Fri 21-06-18	Tom Bechur,Darryl Sandefur	\$6,888.00	7 days	\$9,947.66
59	Project Management Period 4	14.63 days	Mon 21-07-19	Mon 21-08-09	Yukio Ashida	\$10,192.00	13 days	\$11,411.40
60	Project Management Period 5	17 days	Mon 21-08-09	Wed 21-09-01	Yukio Ashida	\$11,760.00	15 days	\$13,260.00
61	Project Management Period 6	10.25 days	Wed 21-09-01	Wed 21-09-15	Yukio Ashida	\$7,056.00	9 days	\$7,995.00
62	Project Management Period 7	12.5 days	Tue 21-09-21	Fri 21-10-08	Yukio Ashida	\$8,624.00	11 days	\$9,750.00
63	Project Management Period 8	3.38 days	Tue 21-10-26	Fri 21-10-29	Yukio Ashida	\$2,352.00	3 days	\$2,636.40
64	Project Management Period 9	4.63 days	Fri 21-11-19	Thu 21-11-25	Yukio Ashida	\$3,136.00	4 days	\$3,611.40
65	Project Management Period 10	5.63 days	Fri 21-12-03	Fri 21-12-10	Yukio Ashida	\$3,920.00	5 days	\$4,391.40
66	Project Management Period 11	14.75 days	Tue 21-12-21	Tue 22-01-11	Yukio Ashida	\$5,720.00	13 days	\$11,505.00
67	Project Management Period 12	11.38 days	Tue 22-01-18	Wed 22-02-02	Yukio Ashida	\$4,400.00	10 days	\$8,876.40
68	Milestones	194.49 days	Tue 21-05-11	Mon 22-02-07		\$0.00	164.13 days	\$15,421.75
69	Milestone 1	0 days	Tue 21-05-11	Tue 21-05-11	Period 1 Managerial Action Cos	\$0.00	0 days	\$40.00
70	Milestone 2	0 days	Fri 21-06-04	Fri 21-06-04	Period 2 Managerial Action Cos	\$0.00	0 days	\$360.00
71	Milestone 3	0 days	Mon 21-07-19	Mon 21-07-19	Period 3 Managerial Action Cos	\$0.00	0 days	\$60.00
72	Milestone 4	0 days	Mon 21-08-09	Mon 21-08-09	Period 4 Managerial Action Cos	\$0.00	0 days	\$663.75
73	Milestone 5	0 days	Wed 21-09-01	Wed 21-09-01	Period 5 Managerial Action Cos	\$0.00	0 days	\$4,851.00
74	Milestone 6	0 days	Tue 21-09-21	Tue 21-09-21	Period 6 Managerial Action Cos	\$0.00	0 days	\$4,638.00
75	Milestone 7	0 days	Tue 21-10-26	Tue 21-10-26	Period 7 Managerial Action Cos	\$0.00	0 days	\$4,449.00
76	Milestone 8	0 days	Fri 21-11-19	Fri 21-11-19	Period 8 Managerial Action Cos	\$0.00	0 days	\$40.00
77	Milestone 9	0 days	Fri 21-12-03	Fri 21-12-03	Period 9 Managerial Action Cos	\$0.00	0 days	\$240.00
78	Milestone 10	0 days	Tue 21-12-21	Tue 21-12-21	Period 10 Managerial Action Cc	\$0.00	0 days	\$40.00
79	Milestone 11	0 days	Tue 22-01-18	Tue 22-01-18	Period 11 Managerial Action Cc	\$0.00	0 days	\$40.00
80	Milestone 12	0 days	Mon 22-02-07	Mon 22-02-07	Period 12 Managerial Action Cc	\$0.00	0 days	\$0.00

Appendix B

Additional Figures and Tables

This chapter contains additional figures and tables referenced in this report.

Period	Event	Adjustment
0	Base	380000
2	Mandatory Traing	-5000
4	Budget Increase	50000
5	Design Changes	-15000
6	Community Unrest	0
7	Budget Cuts	-35000
9	Team Conflict	0
10	False Rumours	-10000
12	Emissions Fines	-15000
	Total	350000

Table B.1: Period Events and Budget Adjustments

Name	Finish	Baseline Finish	Start Variance
Milestone 1	Tue 21-05-11	Wed 21-05-05	3.76 days
Milestone 2	Fri 21-06-04	Tue 21-05-25	7.39 days
Milestone 3	Mon 21-07-19	Fri 21-07-02	10.77 days
Milestone 4	Mon 21-08-09	Wed 21-07-21	12.4 days
Milestone 5	Wed 21-09-01	Wed 21-08-11	14.4 days
Milestone 6	Tue 21-09-21	Mon 21-08-30	16.66 days
Milestone 7	Tue 21-10-26	Wed 21-09-15	29.29 days
Milestone 8	Fri 21-11-19	Wed 21-10-06	31.92 days
Milestone 9	Fri 21-12-03	Thu 21-10-14	35.8 days
Milestone 10	Tue 21-12-21	Thu 21-10-28	38.3 days
Milestone 11	Tue 22-01-18	Fri 21-11-26	36.36 days
Milestone 12	Mon 22-02-07	Tue 21-12-21	34.13 days

Figure B.1: Milestone Variances

Name	Actual Cost	Baseline Cost	Cost Variance	Baseline Estimated Duration	Duration	Duration Variance
Market Assessment	\$37,452.80	\$32,844.00	\$4,608.80	25.5 days	29.26 days	3.76 days
Procurement	\$17,978.32	\$14,200.00	\$3,778.32	65.63 days	85.58 days	19.96 days
Supplier Quality	\$22,828.20	\$16,960.00	\$5,868.20	38 days	57.14 days	19.14 days
Design	\$34,021.68	\$22,344.00	\$11,677.68	46.5 days	54.89 days	8.39 days
Engineering	\$38,626.64	\$31,228.00	\$7,398.64	72.63 days	101.02 days	28.4 days
Engineering Quality	\$26,158.40	\$21,472.00	\$4,686.40	53.63 days	78.65 days	25.03 days
Manufacturing	\$35,153.32	\$22,600.00	\$12,553.32	66.5 days	68.52 days	2.02 days
Commercialization	\$56,487.80	\$49,784.00	\$6,703.80	164.13 days	194.49 days	30.37 days
Project Management	\$110,998.50	\$83,236.00	\$27,762.50	182.63 days	220.37 days	37.74 days
Milestones	\$15,421.75	\$0.00	\$15,421.75	164.13 days	194.49 days	30.37 days

Figure B.2: Work Package Cost and Duration Variances

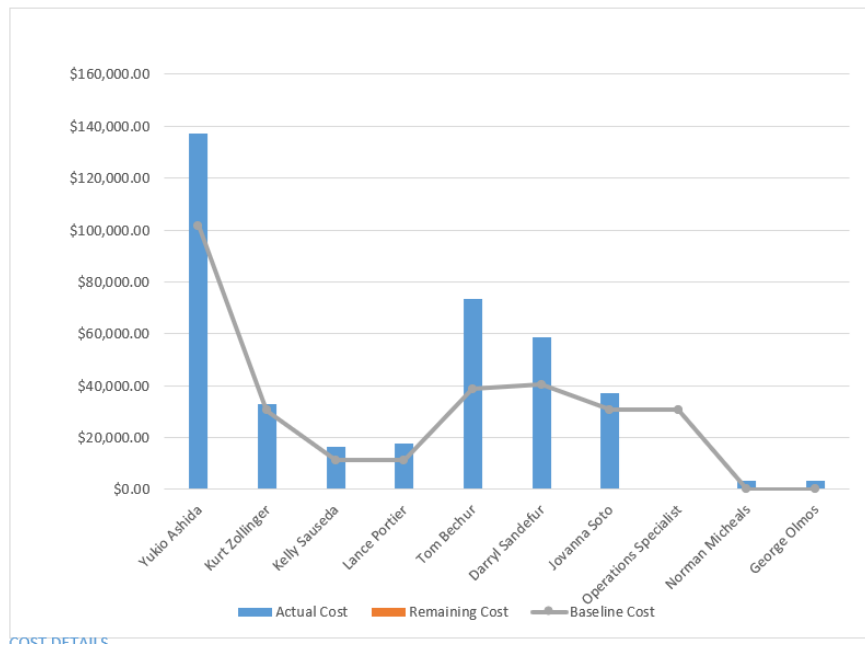


Figure B.3: Resource Baseline and Actual Costs

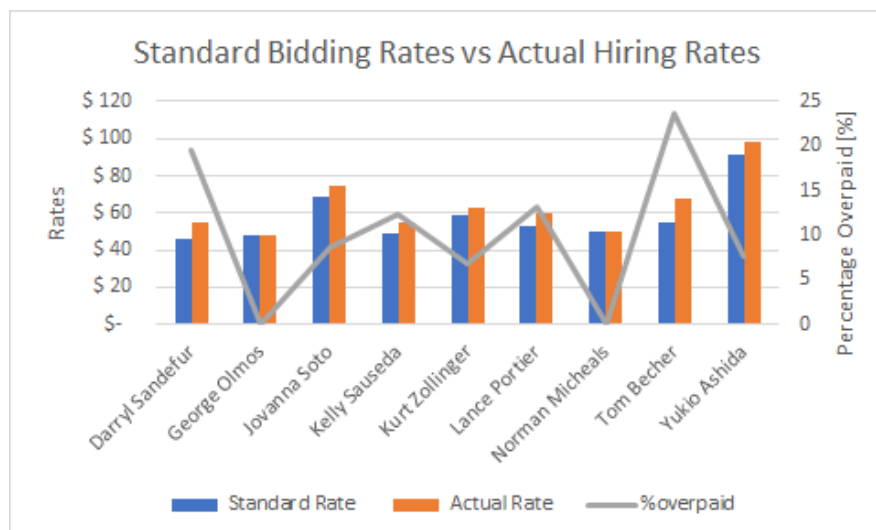


Figure B.4: Standard and Actual Resource Rates

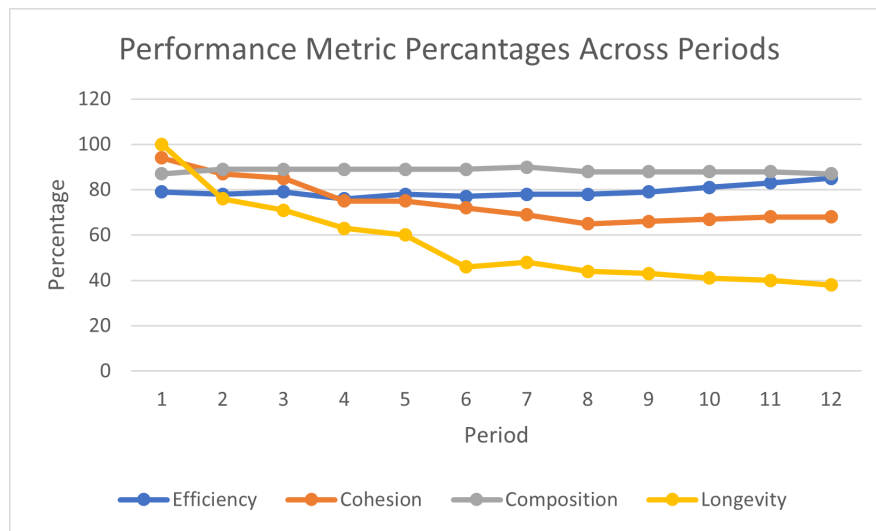


Figure B.5: Team Performance Metrics

Appendix C

Individual Reviews

This appendix contains the individual reviews of all group members.

C.1. Andre David Valkenburg 21670838

This project has been quite different to all of the other projects that I have completed throughout the course of my studies. As a chemical engineering student, the majority of the projects that I have had to complete were focused on understanding complex scientific concepts, analysing and interpreting experimental data and designing process equipment and plants. This project has introduced me to a completely different dimension of engineering.

It was the first time that I have had to work with such a large group of people. All of the students possessed different skills and knowledge. It was interesting, and quite challenging, to work on the project with all of these students. It required good communication skills. Additionally, all of the students had vastly different schedules. It required good communication and planning to work on the project as a team.

It was also the first time that I was formally introduced to the concept of managing a project. I realized that managing a major project from initiation to termination is no easy task. It required extensive planning. The long duration of the project also taught me the importance of keeping all of the information regarding the project and progress organized. I learned that major projects often go astray and that it is the project manager's job to ensure that the team can adapt to these challenges. The project manager can only fulfill his or her duty by consistently reviewing the state of the project and communicating with their team. Furthermore, the project manager is held responsible should the project fail, be delayed or go over budget. This introduced me to another important concept in project management: risk management. I learned the importance of being well prepared for possible risks that might affect the success of a project.

As was expected, I have identified a few mistakes that I have made throughout the project. I realized how easy it is to shift accountability while working on a project with many other individuals. I realized that everybody involved with a project has to keep themselves accountable for their own individual tasks in order for the project to ultimately be a success. I also realized that my communication skills weren't always good enough during meetings. I also did not always manage my time correctly. This caused unnecessary stress to reach certain deadlines that could, at times, have been avoided.

If I could repeat the project, I would be more outspoken about my opinion regarding certain topics. I would manage my time better to ensure that I do not have to rush any tasks to reach deadlines.

I think that our team performed well. We had an acceptable level of communication throughout the duration of the assignment. We could have communicated better. I think we made the assignment a bit harder than it had to be by not always splitting the work evenly. We also did not know each other's strengths and weaknesses. This information could have ensured that each task would be completed by the most capable individual. I think we performed well.

I learned a lot throughout the duration of the assignment. I have definitely learned valu-

able skills that will help me with future complex projects. I think that the project has also prepared me for industry, where working in teams on major projects is commonplace. I also identified personal weaknesses that I should work on. I will look back at the project as a success.

C.2. Bianca Kendall 21682410

This project was my first experience working in and with a multidisciplinary team, and it was an enlightening experience. I learned that every group member has something of value to add to a discussion or to solve a problem. It was interesting and useful to collaborate as a team on certain tasks, where each team member's different perspectives could clearly be seen, and all applied together to produce a successful outcome. I found it especially interesting to collaborate on identifying risks as a team, as each member identified risks relating to their discipline which would not otherwise have been thought. The other difference working with this team is that it was a larger group than I have worked with in the past. I learned, for myself, that this makes communication slightly more challenging, especially due to the limited meetings that could happen in person (due to COVID precautions). Going forward I would prioritize effective communication prior to each project decision being made or task being started. I would dedicate more time to meetings and hopefully having more meetings in person, as I believe people are able to contribute more to the discussion when in a face-to-face situation.

One of the biggest things I would improve in myself when working in a team such as this one (multidisciplinary and more than 5 members), is to have more communication with individuals in the team. I found that the more people present in meetings/discussions, the fewer contributions to decision-making and brainstorming occurred (myself included). I think in future I could add more value to the project if I could collaborate with individual members of the team on certain tasks. I also think it could be useful for each member in the team to work more closely with another member on a task, as I believe this can be more constructive. I think closely working with individuals in this manner allows one to get to know people in the team better (which I believe can boost team morale) and can then assist with identifying the strengths and weaknesses of each member. Then, by assigning tasks to individual members which suits their strengths and skill sets best, the quality of the task may be optimized. I think in the future it could be especially useful to assign tasks to members that have experience in that type of task from their specific discipline (for example if a member has a lot of past experience in research, it may be useful to assign them to a task that uses this skill).

As well as learning from my experience working in a team, I also learned a lot about project management in practice. Being able to apply the concepts learned in theory, to a simulated 'real-life' project, was very insightful. Learning to use MS Project was especially valuable, and I found it is a very useful tool which I will make use of in the future. I learned the importance of making informed and carefully planned decisions when hiring and assigning resources to tasks. At the beginning of the project, I undervalued the importance of assigning specific resources to the task that most suits their skill sets, because I believed it was more important to prioritize saving time and cost. But, after the first few sets of results we realized the importance of functionality for the longevity of the team and project. I also learned the importance of making good decisions at the beginning of the project, through careful planning, since I found that small mistakes made at the beginning of the project can carry through until the end. At the start of the project, I thought that planning and decision-making was purely intuitive, but after applying the concepts learned in the theory classes to the project, my opinion changed, as I saw the noticeable improvement by using the project management tools that were taught. Lastly, I learned that project management is not an easy duty, it requires a lot of dedicated time, detailed work to be done, consistent effort and adaptability. I realized that a good project manager is vital for the success of the final product.

C.3. Emile Visser 21595240

In retrospect, this project has been different from any I have participated in my academic career, not necessarily with respect to content, but to scope. I have not participated in a project that has required this level of consistent, planned and prolonged co-operation between group members. The long-term nature of this project has taught me valuable lessons along with giving me critical exposure in the project management discipline.

This project has run the gamut of project management, from theory and foundational constructs to praxis and tools. This experience has both given me the opportunity to apply concepts taught in this module and increased my confidence in my ability to use the methods to plan, track and analyse projects. As a simulacrum of a real project, it has given me a framework to tackle future projects in academia and beyond.

Completing a project of this scale has strengthened my resolve when approaching large and daunting assignments, something that will prove useful in the next semester when I am faced with my skripsie. The truth found in the words of Decartes has therefore made itself clear to me: “Divide each difficulty into as many parts as is feasible and necessary to resolve it.”

Another enlightening experience has been that of risk management and mitigation. I have been able to see first-hand that identifying risks early mitigates consequences and ensures rapid management strategy deployment.

The mistakes I made personally during this project also serve as valuable lessons for the future, the foremost being that I did not ensure an adequate time buffer for assignments, leading to unnecessary crunch and stress. I was also too stubborn at times, causing me to waste time on a problem that a fellow group member could have assisted with.

If in the future a similar opportunity presents itself, the things I would do differently would include taking more advantage of the differing skill sets of my group members, given that I have a tendency to shoulder more weight than I can handle. I would also conduct more research into similar projects to better anticipate common pitfalls and mistakes.

Working as a multi-disciplinary group has opened my eyes to the value of differing perspectives and approaches. Different sets of eyes can identify both mistakes and risks that others may be blind to, unconsciously or otherwise. Individuals with different academic backgrounds have different skill sets and perform differently when assigned to different tasks. Being in a group with an entwined outcome also serves as a motivating factor, a valuable asset.

Future projects can leverage these advantages of a multi-disciplinary team by ensuring that team composition is diverse and that the strengths and weaknesses are critically examined to make the team self-reinforcing, each team member’s strength covers another’s weakness. Tasks should also be analysed to determine which discipline would be the most effective when assigned.

C.4. Leon Erasmus 20737661

Working in a multi-disciplinary group environment comes with a lot of challenges and a lot is to be learned from yourself and others. Throughout the project, our group communicated exceptionally well, and it was a positive environment to work in. This helped to overcome many challenges of working in a multi-disciplinary group. Having most of our meetings online, increased my confidence in terms of communicating in an online environment. It was difficult for me to communicate online at first, but this group made it very easy, and it will benefit me in future projects.

Engineering students have a lot of group projects and managing our schedule is quite a demanding task. This project forced me to manage my time as effectively as possible due to everyone's schedule clashing, this meant meetings had to be at specific times each day to accommodate everyone. I quickly picked up where I am wasting time and made an effort to stick to my schedule as I have set out for myself, with the help of tools and techniques provided in the theory section of this module.

Our group did each assignment flawlessly and everyone made contributions. I picked up that most of the team were not always aware of the project plan for each period. However, the group leader made an effort to explain the tasks at hand for each period at the start of a meeting. In future projects I would post an agenda a day or so before a meeting so that everyone can prepare. For example, in this project we ran into some problems regarding availability of resources, and we had to come up with solutions to replace these resources with resources that are not 100% capable of doing the task at hand. If everyone knew we had this problem before the meetings, then everyone could have thought of possible solutions and discussed these solutions during meetings. In future projects like these I would give the responsibility of developing the project plan for each period to one or two members, and then combine the individual periods to develop a project plan. The project plan can then be refined by the team to develop a project plan that would have the best possible outcomes.

I observed that some members have exceptional skills with software that makes your life easier in terms of compiling reports. Using software, such as LaTeX, saves plenty of time compiling and thus more time could be spent on the actual content of the report rather than moving figures and tables around to make it neat. I will invest some time to learn to use these software as it will be very beneficial for the final year project report and in future reports I will come across.

I also noticed that some members have outstanding work ethic, and this motivated me to work harder, not only in the project but also in some of my other modules. I grew a few habits from this, and it will help me a lot in the future.

In future projects I would have a pre-project meeting in which each group member should give an indication of what strengths their disciplines have taught them and use this to divide the work in a sense that each group member does a task that best fits their identified strengths. This will benefit the group as a whole and tasks would be done more effectively and efficiently

C.5. Philip Kleynhans 21169713

This group task was very different to any other group task that I was involved in so far because of the time period over which it spanned. Because this task involved students from different faculties, time management within the group became very important since everyone had different time tables. In the past I always liked to take control in group tasks to avoid disappointment, but this group project gave me the understanding that people see and go about things differently. Because the task was multi-disciplinary I have learned that certain engineering fields will perform better in certain tasks than other. Knowing this enables group members to contribute to their strengths and ultimately this leads to great quality of work.

Next time I work on a multi-disciplinary group task I would definitely want voice more of my opinions. I feel that because this was a group task where we worked with people we never met before I can become a bit shy. When working in the engineering field situations like this would come across my path often en this project definitely prepared me for it.

Each different discipline brought a unique pair of skills to the table. In the meetings that we had it was clear that we did not just have different engineering disciplines but also different personalities. When working on projects like this it is also important to know that you are working with people and knowing someone's strength and weaknesses can make greater team work. I feel like every successful team needs a good leader and I think our group had that. I have learned that in a group environment if everyone is prepared and up to date with the theory meetings are more productive and leads to better execution. I learned that having respect for each other and being professional creates a healthy work environment.

In the future when working in a multi-disciplinary group project, I would let individuals that work in the same discipline work on the same task because they will more or less think in the same way. Covid made this project challenging because it made it difficult to have group meetings. In future, if possible, I would encourage some sort of face to face interaction so that group members get a better understanding of each other. I feel that more problems can be resolved in person. I am looking forward to working on multi-disciplinary teams in the future and use the skills that I've learned in this project.

C.6. Rorisang Lekholoane 21192057

This project has been a real eye opener for me and has forced me on multiple occasions to reflect back on past group projects that I have been part of and think of things that I could have done differently then and the ones that could help me do well in the current project. The project was different in that we had to work in groups made up of students from different engineering departments, it's already challenging enough working with student from the same department because of groups having different people with different personal commitments, working with people from different departments with different timetables does not make working together as a group any easier. I have learnt that I have to improve my communication skills in order to better communicate my ideas to my fellow group mates as I have come to realize the importance of communication between groupmates, not to say I did not realize the significance of good communication in group projects, I did, but this project has magnified that fact for me and I am now tasked to improve my communication skills.

As mentioned that working with students from different departments with different timetables made it difficult to set up meetings at a time convenient for everyone, I have learnt that I need to better manage my time and make allowance for meetings with my group. I did attend the meetings but at the cost of missing my other classes. Working in group environment one has to be open to take advice from group mates in order to improve the quality of one's work, I have learnt to appreciate that my group mates are better at some skills than me and for the good of the team I needed to be willing to take any advice I got and apply it to the satisfaction of the whole group. I was lucky enough to be in a group in which all members were willing to work and were always prepared with good attitudes towards the work.

I have learned a lot from project management as a module and this group has helped me take the theory out of the classroom and apply it in real life with the simulated project and the real-life project. Important skills were learned during the project, from my group mates and from general participation in the project. I have learned that planning ahead is really important and have learned to be a project manager in my life as a student generally, with the modules being the tasks I have to complete.

If I was to work in multi-disciplinary team in the future, one of the things I would do differently is to communicate my ideas more with my groupmates, even though we were restricted by COVID during this project and I feel like communication would help a lot in knowing the skills of each individual in the group and as well as exchanging ideas on how to go about certain tasks in our project, I feel like we were denied the opportunity by the current pandemic that is why in future project I feel like better communication between groupmates is one aspect I would change.

One skill that would be of value to me that I noted on this project is presenting information in a professional manner, anyone can do the calculations but what is even more important is presenting your finding or calculations in clear , concise and professional manner, this is a skill I have lacked for the entire length of my academic career and I am definitely noting how my fellow group mates are doing everything and this is one skill that is of great value for me.

In future projects, communication with my group mates would help to better acknowledge the strengths and weaknesses of my group mates and this will help in assigning tasks that people are more comfortable with and this will improve the performance of the group.

Appendix D

Updated Prioritized Risk Registers

The Updated Prioritized Risk Registers can be found on the following pages. Note that the tables can be zoomed in to read details of the various tasks.

Risk	Area Impacted	Impact	Prob	Score	Consequences	Mitigation	Response
Budget cuts	Financial	High	High	16	Project cost may overrun	Add contingency, ensure adequate overhead	Cut costs, review hiring strategy
Going over budget	Financial	Very high	Medium	15	Project may be terminated	Proper planning	Cut costs
Going over time	Financial	Very High	Medium	15	Project may be terminated	Proper planning	Assign more resources
Covid-19 lockdown restrictions	Resources	Medium	Very High	15	Project tasks may be delayed	Define contingency for operating under lockdown conditions	Operate as far as possible under lockdown conditions
Resources contracting Covid-19	Resources	High	Medium	12	Project may be delayed or risk the health of employees	Ensure correct Covid-19 measures are followed.	Infected or exposed individuals must self-isolate
Project purpose not well defined	Financial	Very High	Low	10	Project may be delayed or terminated	Define proper project objectives	Revise project objectives
Scope creep	Financial	Very High	Low	10	Project may be delayed or going over budget	Proper definition of scope	Deviate as little as possible from baseline plan
Cost estimating errors	Financial	Medium	Medium	9	Project may be delayed.	Ensure estimations are done properly, use more accurate methods	Revise and recalculate estimations
Task duration estimate errors	Financial	Medium	Medium	9	Project may go over budget.	Ensure correct project planning.	Redefine project schedule
Bid unsuccessful	Resources	Medium	Medium	9	Project delays	Redundant and reasonable bids	Reassign resources
Design errors	Technical	Medium	Medium	9	Project may be delayed	Add contingency (on time and money)	Assign more designers
Manufacturing errors	Technical	Medium	Medium	9	Project may be delayed or go over budget	Add contingency (on time and money)	Assign more operations specialists
Material supply delays	Procurement	High	Low	8	Project may be delayed	Vet suppliers	Consider alternative supplier
Resource resignation	Resources	High	Low	8	Project may be delayed	Ensure resources receive an appropriate offer	Offer a better package, hire replacement resource
Resources on critical path unavailable	Resources	High	Low	8	Project Delays, Bench cost for other resources	Redundant resources on critical path	Assign another resource to path, review hiring strategy
Ineffective resource assignment	Resources	Low	High	8	Resource not functional to fullest potential	Hire effective resources for each task	Assign more effective resources
Labour strikes	Resource	Very High	Very Low	8	Resources unavailable, project may be delayed	Ensuring employees work under proper conditions. Contingency fund.	Negotiate with employees.
Resource mismanagement	Financial, Legal	High	Low	8	Project may be delayed or budget overrun.	Hire manager with good reputation	Replace manager
Financial mismanagement	Financial, Legal	High	Low	8	Project may be delayed or budget overrun.	Hire manager with good reputation	Replace manager
Resource not available for hire	Resources	Medium	Low	6	Project delay	Good hiring strategy, regular review	Reassign resources
Mandatory training	Resources	Low	Low	4	Resources temporarily unavailable	No mitigation	Check resource availability
Unplanned work that must be accommodated	Financial	High	Very Low	4	Project may be delayed or go over budget.	Contingency funds.	Hire additional resources.
Team conflict	Resources	Low	Low	4	Task delays, cohesion loss	Pre-emptive Managerial actions	Review planned managerial actions
Resource unavailability due to lockdown restrictions	Resources	Low	Low	4	Project may be delayed.	Proper planning	Assign another resource, review hiring strategy
Sick Leave	Resources	Low	Low	4	Project delay	Proper planning for resources	Assign another resource, review hiring strategy
Maternity Leave	Resources	High	Very Low	4	Project may be delayed	Proper planning for resources	Assign another resource, review hiring strategy
Injury at work	Resources	Medium	Very Low	3	Extra costs, task delays	Proper safety protocols	Assign another resource, review hiring strategy
Unskilled Resource	Resources	Low	Low	2	Task delays	Vet hires	Have emergency protocols, reassign resources
Managerial actions ineffective	Resources	Very Low	Low	2	Inefficient spending	No mitigation	Review training strategy
							Review planned managerial actions

Table D.1: Updated Prioritized Internal Risk Register

Risk	Area Impacted	Impact	Prob	Score	Consequences	Mitigation	Response
Community strikes	External	High	Medium	12	Delays in project supply chain	No mitigation	Implement remote working facilities
Plant Emissions Fines	External	High	Medium	12	Fines from the occupational health department	Proper mitigation procedures for plant emissions	Frequent emissions checks on site, pay fine
Structural failure	External	Very high	Low	10	Product destruction, possible loss of life	Ensure good design, develop emergency response	Implement emergency response, investigate failure source
False rumours about the project online	External	Medium	Medium	9	Company image ruined and could lead to possible community strikes	No mitigation	Hire public relations officer
Product becomes obsolete early in lifetime	External	Medium	Medium	9	Product no longer in service	Explore avenues of improvement	Attempt refit/improvement or decommission
Economy shift to greener energy sources	External	Low	High	8	Reduced demand for product	Explore alternative product uses	Reduce production
Product not operating within advertised parameters	External	High	Low	8	Product might operate as it should, Product could be deemed unsafe	Thorough project testing	Retract product for further testing
Tank deformation or failure	Technical	Very high	Very low	5	Product failure	Test tank material and product	Redesign product with improvements
Valve control error	External	Very high	low	5	Product failure	Proper design, testing, and implementation. Add safety valves.	Implement emergency shutdown procedure
Flammable substance ignition	External	High	Low	4	Loss of life or injury, Damage to buildings due to fires.	Follow correct codes and standards for flammable substances.	Implement hazard protocols.
Substance spillage into the environment	External	high	Very Low	4	Loss of productivity for customers, Environmental impacts.	Follow correct codes and standards for pressurized storage vessels, Ensure vessel testing is done correctly.	Implement hazard protocols.
Product sensor failure	External	High	Very Low	4	Loss of customer's product, Loss of control of product, possible product failure	Add redundant sensors	Send technician to replace sensor
Power loss to product	External	High	Very Low	4	Loss of control of product, possible product failure	Add backup generators, design emergency shutdown	Implement emergency shutdown measures
Pressure limit control system failure	External	High	Low	4	Product failure	Proper testing of control system before installation	Add emergency shutdown to the system
Failure to the tank support structure due to fatigue	External	Very high	low	4	Product failure	Proper Maintenance	Frequent checks onsite for possible failures
User interface bugs	External	Low	Low	4	Process delayed	Proper user interface debugging.	Issue software patch
Unfavourable exchange rates	External	Medium	Very Low	3	Product manufacturing may go over budget	No mitigation	Adjust product price
Bad weather delaying product installation	External	Very low	Low	2	Installation delayed	Check weather report before installation	No response

Table D.2: Updated Prioritized External Risk Register

Appendix E

Meeting Minutes

The minutes transcribed at the various meeting preceding this report in given on the following pages.

Minutes of the Meeting 6 of Group I-2

Project Management 412

on 19/04/2021 @13h00-13h30 on MS Teams

1. Attendance

- Present: Andre (AV), Bianca (BK), Emile (EV), Leon (LE), Philip (PK), Rorisang (RL)
- Apologies: N/A

2. Minutes of the previous meeting

Refer to Meeting 5 above.

3. Agenda

The following agenda was approved before the meeting:

- Review assignment 2.
- Discuss period decisions.




4. Discussion according to agenda

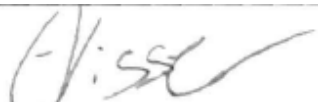
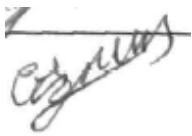
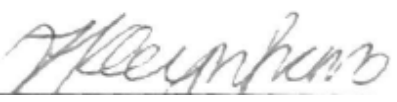
- a. Reviewed the final document draft for assignment 2, each team member having read through the document carefully and identifying any small errors. These errors are to be fixed before handing in the assignment.
- b. Discussed assigning the hired marketing manager to the project management tasks.
- c. We will assign the two hired engineers to the engineering tasks.

5. Next meeting

The next meeting is planned for 10/05/2021 @09h00 on MS teams, to review progress.

6. Signatures

A Valkenburg	
R Lekholoane	
B Kendall	

E Visser	
L Erasmus	
P Kleynhans	

Minutes of the Meeting 7 of Group I-2

Project Management 412

on 10/05/2021 @09h00-09h30 on MS Teams

1. Attendance

- Present: Andre (AV), Bianca (BK), Emile (EV), Leon (LE), Philip (PK), Rorisang (RL)
- Apologies: N/A

2. Minutes of the previous meeting

Refer to Meeting 6 above.

3. Agenda

The following agenda was approved before the meeting:

- Discuss resource hires and assignments for the next few periods (5, 6, 7).

4. Discussion according to agenda



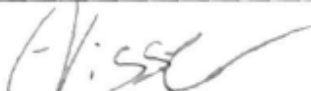
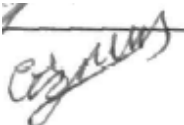

- a. Discussed hiring an operations specialist for the upcoming periods. If no operations specialist is available, one of the currently hired engineers will be assigned to their tasks.
- b. Will assign all current resources to their relevant tasks for the next three periods (5, 6, 7). I.e., The two engineers will be evenly assigned across the engineering tasks (but they will not both be assigned to the same task). In period 6 and 7, the quality engineer will be assigned to their relevant task. In period 7, one of the engineers will be assigned to the supplier quality task.
- c. The marketing manager will be assigned to the project management tasks for period 5, 6 and 7.
- d. Will assign the two junior marketing specialists to the procurement tasks in period 6, but if they are seen to not be suited to those tasks, they will be fired before the start of period 7.

5. Next meeting

The next meeting is planned for 17/05/2021 @17h00 on MS teams, to make next few period decisions.

6. Signatures

A Valkenburg	
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R Lekholoane	
B Kendall	
E Visser	
L Erasmus	
P Kleynhans	

Minutes of the Meeting 8 of Group I-2

Project Management 412

on 17/05/2021 @17h00-18h00 on MS Teams

1. Attendance

- Present: Andre (AV), Bianca (BK), Emile (EV), Leon (LE), Philip (PK), Rorisang (RL)
- Apologies: N/A

2. Minutes of the previous meeting

Refer to Meeting 7 above.

3. Agenda

The following agenda was approved before the meeting:

- Discuss resource hires and allocations for next few periods (8, 9, 10)




4. Discussion according to agenda

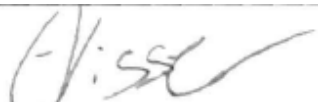
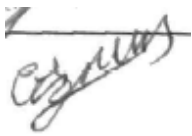
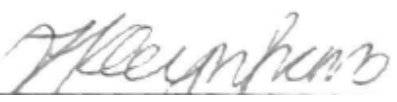
- a. Will assign the marketing manager to the project management tasks for periods 8, 9 and 10. The same resource will be assigned to the commercialization tasks.
- b. The engineers will be evenly allocated to the engineering tasks, with the quality engineer being assigned to the relevant quality engineering tasks and the supplier quality tasks.
- c. If the quality engineer is not effective in their tasks, the engineers and marketing manager will take over the engineering quality tasks.

5. Next meeting

The next meeting is planned for 28/05/2021 @13h00 on MS teams, to have a project post-mortem meeting.

6. Signatures

A Valkenburg	
R Lekholoane	
B Kendall	

E Visser	
L Erasmus	
P Kleynhans	

Minutes of the Meeting 9 (Project Post-Mortem meeting) of Group I-2

Project Management 412

on 28/05/2021 @13h00-14h00 on MS Teams

1. Attendance

- Present: Andre (AV), Bianca (BK), Emile (EV), Leon (LE), Philip (PK), Rorisang (RL)
- Apologies: N/A

2. Minutes of the previous meeting

Refer to Meeting X above.

3. Agenda

The following agenda was approved before the meeting:

- Were initial project objectives met?
- Changes in objectives and reason for that.
- The project team, and its relationship with the vendors and contractors, and the interaction with the organisation.
- Performance and involvement of stakeholders.
- Expenditures, sources of cost and project profitability.
- Identification of good performed and performance areas within the project.
- Identification of poor performed and performance areas within the project.
- Lessons learned and recommendations for future projects.

4. Discussion according to agenda

- a. Were initial project objectives met? Yes, mostly. The project was completed in February 2022, which was before the scheduled termination date of the project (March 2022). But, we did go over budget. But, we did deliver all the deliverables and milestones.
- b. Changes in objectives and reason for that. We did not change our objectives, as we met all our milestones. The only thing that changed was adjusting our budget. We had to adjust our resource strategy due to not acquiring an operations manager, which inhibited our ability to complete certain tasks efficiently.
- c. The project team, and its relationship with the vendors and contractors, and the interaction with the organisation. Did not have interactions with vendors as it was not a real life project.
- d. Performance and involvement of stakeholders. Our resources did not perform as efficiently as planned for, especially the quality engineer (did not perform as we would have hoped). The team

cohesion and longevity declined over the course of the project, which is speculated to be due to fatigue.




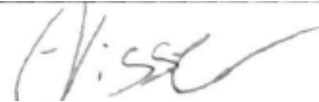
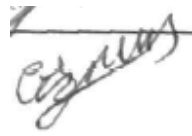

- e. Expenditures, sources of cost and project profitability. We did go over budget. The source of the cost was partially due to overbidding on some resources, for example we overbid by about \$10 on one of the engineers that we subsequently hired for the duration of the project. We also had to adjust our strategy and therefore budget because we did not acquire an operation specialist, this meant we instead assigned quality engineers to the tasks of an operations specialist but the quality engineers were 50% more expensive than an operations specialist would have been. Furthermore, we had the designers for two periods longer than we was necessary before firing them, which resulted in costs due to unallocated resources. When we had to make the adjustments to the budget for the aforementioned reasons, it resulted in the project becoming no longer profitable.
- f. Identification of good performed and performance areas within the project. We saved a lot of money by not hiring a project manager, but instead assigning a marketing manager to the associated tasks. Furthermore, the marketing manager performed more or less the same as a project manager would have. For the first two or three periods we assigned two marketing people (either junior marketing specialists or marketing managers) to every relevant task, which saved a lot of time and kept the project on schedule for the first two periods. Securing the engineering resources early on in the project resulted in successful assigning of resources to the engineering tasks.
- g. Identification of poor performed and performance areas within the project. For the first two periods, we assigned engineers to the project management tasks, and they were only about 70% effective, which possibly resulted in the decreased overall functionality that we observed. For the last few periods, the quality engineer was less effective than we expected, they were only 95% effective for one task and 70-75% effective for the remaining tasks to which they were assigned. This is also expected to have contributed to decreasing the overall project functionality rating. We did not secure the operations specialist early enough, resulting in us not obtaining an operations specialist. This led to problems with increased cost and time as well as decreased functionality.

- h. Lessons learned and recommendations for future projects. Bid for resources earlier, especially if the resource pool is limited, to secure them for critical tasks. Allocate multiple resources to critical tasks to improve efficiency and therefore shorten their duration. Cycle in fresh resources to improve team stamina (and possibly team longevity). Possibly maintain the same project manager throughout the project to potentially improve team cohesion and longevity. We learned that due to overbidding on our resources, there was an increasing gap between the actual cost and earned value, this also caused our CPI to trend downwards as the project went on.

5. Next meeting

The next meeting is planned for 30/05/2021 @11h00 on MS teams, to review progress.

6. Signatures

A Valkenburg	
R Lekholoane	
B Kendall	
E Visser	
L Erasmus	
P Kleynhans	

Minutes of the Meeting 10 of Group I-2

Project Management 412

on 30/05/2021 @11h00-h00 on MS Teams

1. Attendance

- Present: Andre (AV), Bianca (BK), Emile (EV), Leon (LE), Philip (PK), Rorisang (RL)
- Apologies: N/A

2. Minutes of the previous meeting

Refer to Meeting 9 above.

3. Agenda

The following agenda was approved before the meeting:

- Review progress for assignment 3.
- Collaborate on the real life group review.




4. Discussion according to agenda

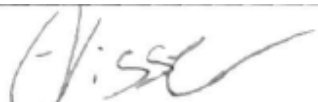
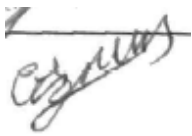
- a. The team collaborated on the lessons learned in the real life group project. Each team member contributed lessons that they felt they had learned while working in a team for the duration of the project.
- b. The team ran through the assignment 3 draft document, taking note of the sections that still needed to be completed.
- c. After completing the real life group review as a team, the only sections remaining to be completed are the executive summary, conclusion, and a few points in the risk management analysis section.

5. Next meeting

No more meetings planned.

6. Signatures

A Valkenburg	
R Lekholoane	
B Kendall	

E Visser	
L Erasmus	
P Kleynhans	