GSOE9820

Engineering Project Management

Robot Blacksmith Project

Project Management Plan

SUBMITTED BY:

DREAM TEAM

BY SIGNING THE BELOW DECLARATION, I AGREE WITH THE CONTRIBUTION LIST PROVIDED FOR THE PROJECT AND THAT I HAVE NOT INCLUDED ANY PLAGIARIZED CONTENT FOR MY INDIVIDUAL CONTRIBUTIONS.

Group members' name	Mark Saturnino	Rafael Formoso	Joel Lawrence	Jessica Leau	Ramon	Ningye Zhang
zID						
Key contribution of each group member	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5 • Point 6 • Point 7	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5 • Point 6 • Point 7	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5 • Point 6 • Point 7	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5 • Point 6	• Point 1 • Point 2 • Point 3 • Point 4 • Point 5 • Point 6
Declaration						

1 Project Charter – *Needs a cleanup*

1.1 Project Background

The global manufacturing industry was revolutionized by the invention of Computer Numerical Control machine many years ago. It allows the manufacturing industry to build items with high precision and consistency, increased production rate and minimal disruption. Later, the industry was disrupted with the introduction of additive manufacturing process (3D printing). It is a completely different process of manufacturing compared to CNC by creating the items by depositing polymer over a building platform in a layered fashion. However, there are significant drawbacks that are posed by these two techniques i.e. CNC manufacturing left huge amount of wasted materials due to the cutting process, while the purity of material from items constructed using additive manufacturing can't be guaranteed due to the exposure of open air during forming. Accordingly, metamorphic manufacturing is suggested to tackle these two major problems. The idea is to create a facility that can mimic the work of a blacksmith with excellent precision using robotic manipulation systems and computer-controlled forming tools which allows the creation of highly complex shapes of geometries from a predetermined amount of material consistently without the need of a die [1]. This project charter will serve as a guideline towards implementing the development of metamorphic manufacturing cell in UNSW.

1.2 Project Objectives

The objective of the project is to build a shared MM cell at UNSW which will be used as a foundation for the technological development and interdisciplinary research between universities and external research associates that has the potential to create new job opportunities. The project will deliver benefits aligned to UNSW's 2025 Strategy which is to improve lives globally through innovative research, transformative education, and commitment to a just society. The project should address the three main UNSW's strategy in the following ways:

A. Academic Excellence:
    a. Deliver a facility capable of sustaining high quality research and encouraging academic excellence in order to contribute to the University Research quality strategy to sustain UNSW within the top 50 research-intensive universities worldwide [2];
    b. Contribute to Educational Excellence by enabling lecturers to use it for their course as a practical side;
    c. Deliver a facility that offer hands-on experience to over 500 students and researchers each year across the engineering and science disciplines;
    d. Design a facility that enables at least 5 articles published in the Q1 journals each year;
B. Innovation and Engagement:
    a. Collaborate with other faculties within UNSW (School of Computer Science and Engineering) and foster research opportunities with universities from the Group of 8 and industry projects,
    b. Attract one new international research collaboration,
    c. Develop entrepreneurship by developing an innovation start-up culture and therefore increase the numbers of startups that the UNSW Founders Program supports to 1100 by 2025.
        i. Social Impact:

d. Enable the opportunity to increase research funding for a further $5 million within the following five years after the project completion from knowledge exchange and other contract works with external organizations (E5);
e. Provide a facility that enhances UNSW's campus and be featured in some form of media nationally or internationally; and
f. Help the local manufacturing industry by developing techniques and improve products in a sustainable way.

1.3 Project Stakeholders and Benefits

1.3.1 Academic community

- Student
  - Current Student – The MM cell will be accessible for current postgraduate students interested in research or for students taking the UNSW course of additive manufacturing currently being offered, offer some extracurricular activities which can be an advantage on the CV and benefit their future employment (have access to State-of-the-art Education). For PhD students, this will enable them to carry some innovative research and collaborate with other researchers from other universities and therefore enable them to publish more research papers and getting research grants and funding,
  - Alumni – Encourages alumni pride, financial donations, and potential industry connections. Alumni could also be interested in being a course intervenor,
  - Future – Improve the quality of the student community and therefore attract future students by proposing extracurricular activities and offering unique facilities.
- Academic:
  - Research – Faculty & School-led. Enables collaboration and innovation. Attract research collaboration with other research institution which will lead to the publication of more research papers in reputable journals,
  - Teaching – This will contribute to the Educational Excellence by providing a facility and have a practical side to the course (transformative education),
  - Research Companies – Provide grants, entrepreneurship and establish partnership (wider social engagement), potential candidate to join company to conduct further research,
  - Other Universities – Strengthen the Group of 8 by having collaborative research (knowledge exchange) and enable new partnerships between universities.
- UNSW Executive – enhance our facilities, support systems, services, and processes. Promotes University as a 'model'. Financial sustainability through profile.
- Project Sponsor (Dr. Xiaopeng Li) – personal reputation (project champion), ability to conduct further research into area of interest, increasing personal knowledge, responsible for additional funding.

1.3.2 External Community

- Australian government
  - Develop partnership with UNSW to conduct some research which will benefit the community,
  - Greater university profile which will attract a higher international student numbers.
- Industry partnership

    - Have a collaborative research, have access to scholarship funds and get students involved in competitions organized by the company.
- Local Outreach
    - High School excursions, resident engagement, local businesses benefit from stronger university attendance, media profile,
    - Develop techniques and improve products for the industry which will help the local community and benefit the whole world in a sustainable way by reducing the material waste and the energy consumption and carbon footprint.

The benefits to the following stakeholders can be considered similar for all. They have the opportunity to be a part of an innovative and ground-breaking project. This allows for future self-promotion when bidding for new projects. They also have the financial benefit of being a part of the project.

2 Scope Statement

This project aims to deliver a metamorphic manufacturing cell (MM cell) within the UNSW campus. This includes the renovation of a room on campus to accommodate all the necessary equipment. Given the rapidly evolving nature of the field, the cell will be designed with modularity in mind, such that components may be added, removed, or swapped out as needs arise and as paradigms change within the broader research community. Each component of the MM cell has been chosen to cover some aspect of the five fundamental elements of metamorphic manufacturing (STARC).

2.1 Acceptance Criteria

The project will be considered complete once all sub-deliverables have been fulfilled. The MM cell will undergo a final test, wherein it will be required to transform a bar of titanium into a 3D shape, given through a CAD model designed by the project sponsor. The project will be considered closed once all deliverables have been turned over to the project sponsor

2.2 Deliverables

The primary deliverable for this project will be a fully functional metamorphic manufacturing cell, equipped with the tools necessary to reshape a one (1) kilogram bar of titanium or low alloy steel based on a given CAD model.

The MM cell can be decomposed into the following major sub-deliverables:

2.2.1 Facility Renovation

The chosen facility will be renovated to fit the electrical and safety requirements of the MM cell. The project will include the development of a layout design, and a request for proposal will be developed to solicit contractors to perform the renovation.

2.2.2 Staging Area

The staging area refers to a location separate from the rest of the MM cell in which researchers may place their material inputs prior to the manufacturing process. To ensure the researchers' safety, a plexiglass shield will be installed, and materials must be fed through a conveyor belt. Light curtains will be installed to ensure that any machinery remains off while there are people within the cell.

2.2.3 Robotic Deformation System

The robotic deformation system will consist of a robotic arm and a power hammer. The robotic arm will be used as a workpiece manipulation unit, adjusting the pose of the material over the power hammer, while the power hammer will be used to apply force to the material to deform it.

2.2.4 Induction Furnace

A furnace will be installed to apply heat to the material prior to forging. An induction furnace was chosen over other types of furnaces because of its portability and its lowered impact on the environment compared to alternatives such as gasoline or coal-powered furnaces.

2.2.5 Sensor Array

The sensor array will consist of six depth cameras, which will be used to monitor the dimensions and geometry of the material in real-time, as well as the current state of the workpiece manipulation unit and power hammer. Its data will be fed into the materials deformation simulator. In addition, the sensor array will include an infrared sensor to measure the temperature of the material.

2.2.6 Central Control System

The central control system refers to the computer that will be used to process the sensor data, simulate the material, and send commands to the robotic deformation system and induction furnace. It will also have all the standard amenities available to university computers, such as intranet access.

2.2.7 Deformation Simulator

The deformation simulator will be a software application designed to model the physical properties of the material and accurately simulate its deformation given stress. An application programming interface (API) will be provided to allow other applications to feed it sensor data, manipulate its simulated actuators, and extract data for further processing.

2.2.8 Morphology Solver

This will consist of a software application which utilizes artificial intelligence to develop a sequence of actions to morph the material into a given goal state. The application will interface with the deformation simulator and robotic deformation system. Users will interact with this system by loading a predefined CAD file and specifying parameters to control the solver (e.g. maximum action sequence length)

2.2.9 Project Documentation and Training

The project documentation will describe all the information necessary to properly operate, maintain, and extend the system's hardware or software components. A series of training sessions will be provided to academics and technicians at the end of the project regarding these aspects of the MM cell.

2.3 Exclusions

The project deliverables are limited to the components specified above. Though the facility will provide capacity for possible extensions to the cell, the development, maintenance, and installation of such extensions are beyond the scope of this project.

During the renovation, the project team will not be responsible for the removal of any structures found during the construction of the facility that were not present in UNSW's provided blueprints.

2.4 Constraints

This project will operate under a fixed budget of $2,000,000.00, including any contingencies. Project funding will be provided by the project sponsor.

2.5 Assumptions

This project will operate under the assumption that a room has been provided prior to the commencement of this project. In addition, it is assumed that the selection process for any software engineers will be conducted by the project sponsor and will be outside of the project team's responsibilities.

3 Work Breakdown Structure

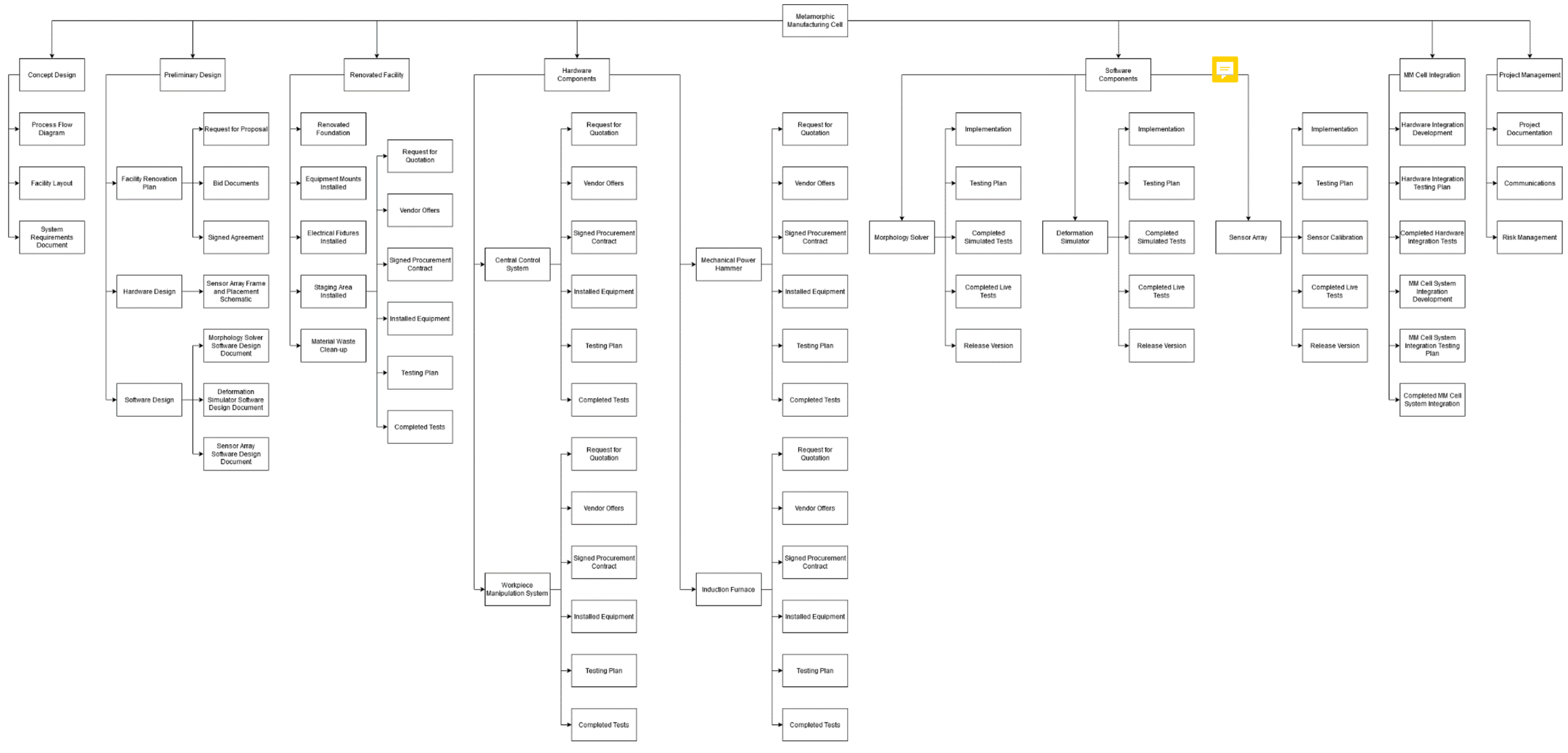


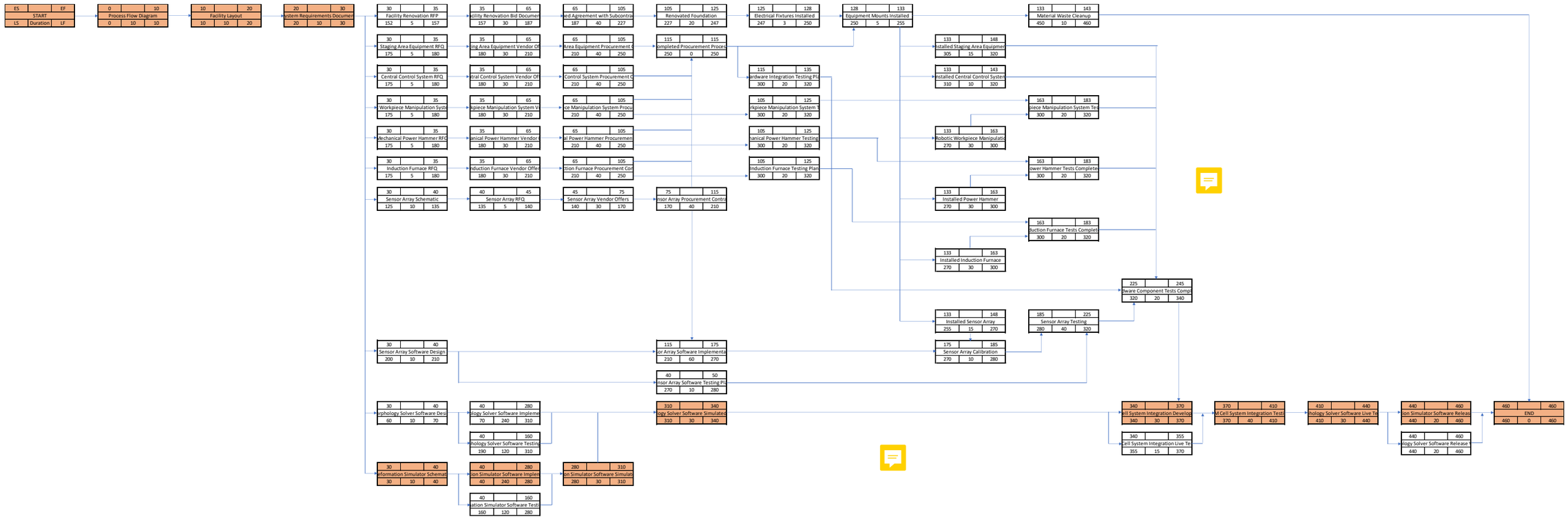
Figure 1 : Work breakdown structure

4 Cost & Time Estimation

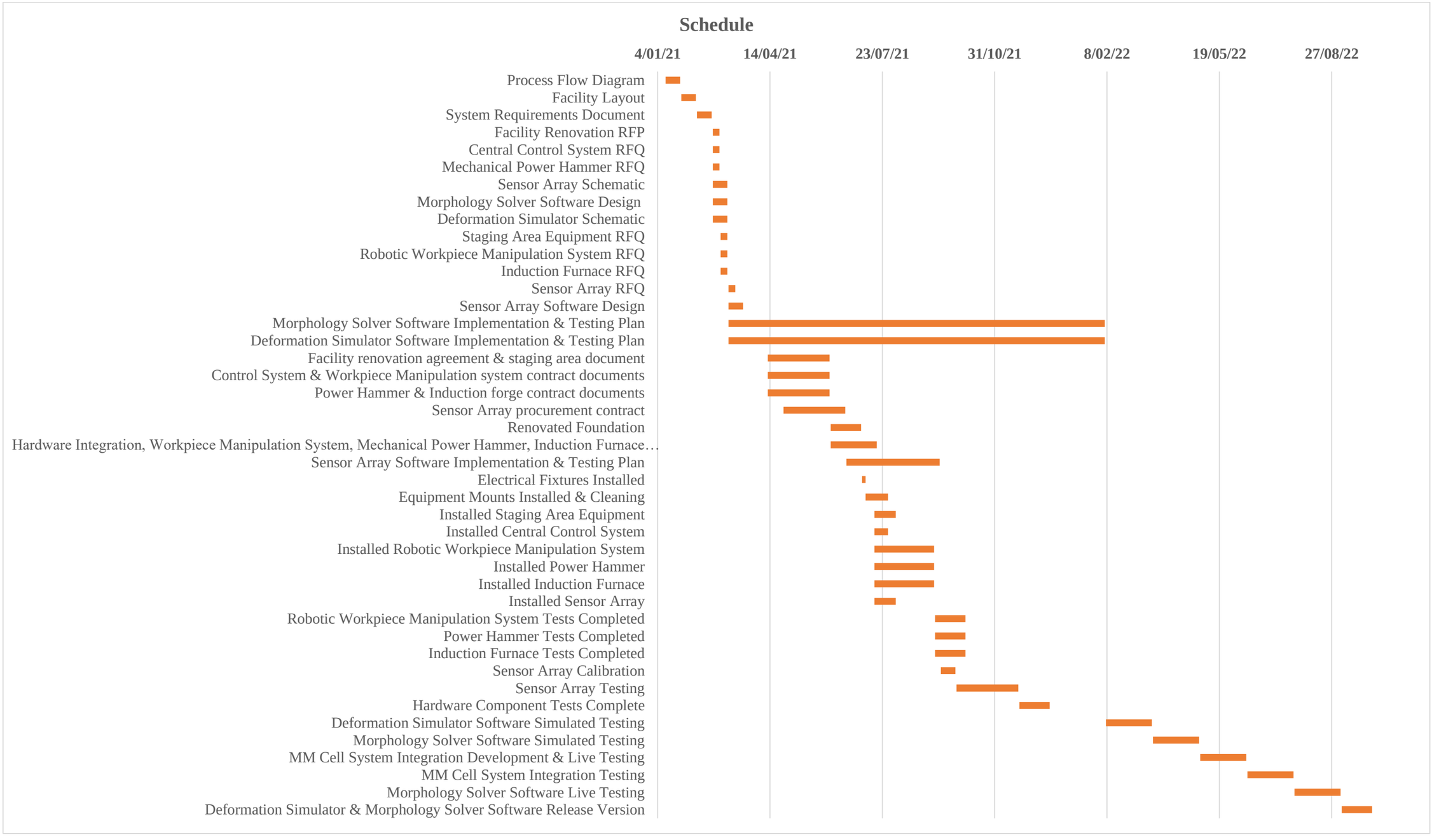
Work Packages	Done by	Scheduled days	Actual working days	Duration in hours	Hourly pay	Number of workers	Salary cost	Material cost	Salary + Material cost
Process Flow Diagram	Lead engineer	0 - 10	10	80	66.83	1	$5,346.66		$5,346.66
Facility Layout	Architect / Interior designer	10 - 20					$5,000.00		$5,000.00
System Requirements Document	PM Team member 1, 2 & 3	20 - 30	10	80	53.75	3	$12,899.85		$12,899.85
Facility Renovation RFP	PM Team 1	30 - 35	5	40	53.75	1	$2,149.97		$2,149.97
Staging Area Equipment RFQ	PM Team 1	35 - 40	5	40	53.75	1	$2,149.97		$2,149.97
Central Control System RFQ	PM Team 2	30 - 35	5	40	53.75	1	$2,149.97		$2,149.97
Robotic Workpiece Manipulation System RFQ	PM Team 2	35 - 40	5	40	53.75	1	$2,149.97		$2,149.97
Mechanical Power Hammer RFQ	PM Team 3	30 - 35	5	40	53.75	1	$2,149.97		$2,149.97
Induction Furnace RFQ	PM Team 3	35 - 40	5	40	53.75	1	$2,149.97		$2,149.97
Sensor Array Schematic	Sensor & software engineer	30 - 40	10	80	60.93	1	$4,874.29		$4,874.29
Sensor Array RFQ	PM Team 2	40 - 45	5	40	53.75	1	$2,149.97		$2,149.97
Facility renovation agreement & staging area document	PM Team 1	65 - 105	10	80	53.75	1	$4,299.95		$4,299.95
Control System & Workpiece Manipulation system contract documents	PM Team 2	65 - 105	10	80	53.75	1	$4,299.95		$4,299.95
Power Hammer & Induction forge contract documents	PM Team 3	65 - 105	10	80	53.75	1	$4,299.95		$4,299.95
Sensor Array procurement contract	PM Team 2	75 - 115	10	80	53.75	1	$4,299.95		$4,299.95
Sensor Array Software Design	Sensor & software engineer	40 - 50	10	80	60.93	1	$4,874.29		$4,874.29
Sensor Array Software Implementation & Testing Plan	Sensor & software engineer	115 - 175	60	480	60.93	1	$29,245.75		$29,245.75
Morphology Solver Software Design	Software engineer 1	30 - 40	10	80	60.93	1	$4,874.29		$4,874.29
Deformation Simulator Schematic	Software engineer 2	30 - 40	10	80	60.93	1	$4,874.29		$4,874.29
Morphology Solver Software Implementation & Testing Plan	Software engineer 1	40 - 280	240	1920	60.93	1	$116,983.00		$116,983.00
Deformation Simulator Software Implementation & Testing Plan	Software engineer 2	40 - 280	240	1920	60.93	1	$116,983.00		$116,983.00
Deformation Simulator Software Simulated Testing	Software engineer 2	280 - 310	30	240	60.93	1	$14,622.87		$14,622.87
Morphology Solver Software Simulated Testing	Software engineer 1	310 - 340	30	240	60.93	1	$14,622.87		$14,622.87
Renovated Foundation	Subcontractor	105 - 125					$10,000.00	$4,000.00	$14,000.00
Electrical Fixtures Installed	Subcontractor	125 - 128					$2,500.00		$2,500.00
Equipment Mounts Installed & Cleaning	Subcontractor	128 - 143					$1,500.00		$1,500.00
Hardware Integration, Workpiece Manipulation System, Mechanical Power Hammer	PM Team 1, 2, & 3	105 - 135	20	160	43.00	3	$20,639.76		$20,639.76
Installed Staging Area Equipment	Subcontractor	133 - 148					$3,000.00	$10,700.00	$13,700.00
Installed Central Control System	Lead engineer	133 - 143	10	80	66.83	1	$5,346.66	$25,000.00	$30,346.66
Installed Robotic Workpiece Manipulation System	PM Team 1	133 - 163	30	240	53.75	1	$12,899.85	$150,000.00	$162,899.85
Installed Power Hammer	PM Team 2	133 - 163	30	240	53.75	1	$12,899.85	$80,000.00	$92,899.85
Installed Induction Furnace	PM Team 3	133 -163	30	240	53.75	1	$12,899.85	$12,000.00	$24,899.85
Installed Sensor Array	Sensor & software engineer	133 - 148	15	120	60.93	1	$7,311.44	$2,500.00	$9,811.44
Sensor Array Calibration	Sensor & software engineer	175 - 185	10	80	60.93	1	$4,874.29		$4,874.29
Robotic Workpiece Manipulation System Tests Completed	PM Team 1	163 - 183	20	160	53.75	1	$8,599.90		$8,599.90
Power Hammer Tests Completed	PM Team 2	163 - 183	20	160	53.75	1	$8,599.90		$8,599.90
Induction Furnace Tests Completed	PM Team 3	163 - 183	20	160	53.75	1	$8,599.90		$8,599.90
Sensor Array Testing	Sensor & software engineer	185 - 225	40	320	60.93	1	$19,497.17		$19,497.17
Hardware Component Tests Complete	PM Team 1,2,3 & sensor en	225 - 245	20	160		4	$35,548.28		$35,548.28
MM Cell System Integration Development & Live Testing	PM Team 1,2,3 & sensor en	340 -370	30	240		5	$69,362.40		$69,362.40
MM Cell System Integration Testing	PM Team 1,2,3 & sensor en	370 - 400	30	240		5	$69,362.40		$69,362.40
Morphology Solver Software Live Testing	Software engineer 1	400 - 430	30	240	60.93	1	$14,622.87		$14,622.87
Deformation Simulator & Morphology Solver Software Release Version	Software engineer 1 & 2	430 -450	20	160	60.93	2	$19,497.17		$19,497.17
Salary of Project Manager	PM	0 - 450	450	3600	59.78	1	$215,202.02		$215,202.02
							$930,214.48	$284,200.00	
					Total cost	1214414.48			

Table 1 : Cost and time estimation

5 Network Diagram



6 Schedule


Schedule
4/01/21
14/04/21
23/07/21
31/10/21
8/02/22
19/05/22
27/08/22
Process Flow Diagram
Facility Layout
System Requirements Document
Facility Renovation RFP
Central Control System RFQ
Mechanical Power Hammer RFQ
Sensor Array Schematic
Morphology Solver Software Design
Deformation Simulator Schematic
Staging Area Equipment RFQ
Robotic Workpiece Manipulation System RFQ
Induction Furnace RFQ
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Sensor Array procurement contract
Renovated Foundation
Hardware Integration, Workpiece Manipulation System, Mechanical Power Hammer, Induction Furnace…
Sensor Array Software Implementation & Testing Plan
Electrical Fixtures Installed
Equipment Mounts Installed & Cleaning
Installed Staging Area Equipment
Installed Central Control System
Installed Robotic Workpiece Manipulation System
Installed Power Hammer
Installed Induction Furnace
Installed Sensor Array
Robotic Workpiece Manipulation System Tests Completed
Power Hammer Tests Completed
Induction Furnace Tests Completed
Sensor Array Calibration
Sensor Array Testing
Hardware Component Tests Complete
Deformation Simulator Software Simulated Testing
Morphology Solver Software Simulated Testing
MM Cell System Integration Development & Live Testing
MM Cell System Integration Testing
Morphology Solver Software Live Testing
Deformation Simulator & Morphology Solver Software Release Version

7 Stakeholder Management and Communication Plan

7.1 Stakeholders Register

STAKEHOLDERS REGISTER

Stakeholder Name	Role or Job Title	Classification	UNSW Association	Organisation or Group	Contact Details			Additional Notes	Communications sent to date	Date of Next Communications
					Email	Phone	Preferred Method			
Dr. Xiaopeng Li	Project Sponsor	Primary	Internal	UNSW	xiaopeng.li@unsw.edu.au	+61 2 9385 6784	Email	By appointment through email	*(enter date)*	*(enter date)*
Professor Chun Hui Wang	Head of MME School	Primary	Internal	UNSW	chun.h.wang@unsw.edu.au	+61 2 93853232	Email	By appointment through email	*(enter date)*	*(enter date)*
Dr. Tamsin Peters	MME Laboratory Manager	Primary	Internal	UNSW	tamsin.peters@unsw.edu.au	+61 413 565 722	Email	Contact during work hours only	*(enter date)*	*(enter date)*
Greg Kaplan	Director, Facilities Management Director	Primary	Internal	UNSW	greg.kaplan@unsw.edu.au	+61 2 9385 5111	Email	By appointment through email	*(enter date)*	*(enter date)*
Jessica Leau	Project Manager / PM Team Lead	Primary	Internal	UNSW	jessica.leau@unsw.edu.au	+61 xxx xxx xxx	Mobile and Email	Contact mobile no. for urgent matters	*(enter date)*	*(enter date)*
PM Team Members	See Below	Primary	Internal	UNSW	See Below	See Below	Mobile and Email	Contact mobile no. for urgent matters	*(enter date)*	*(enter date)*
Tim Neems	Finance Business Partner (Procurement)	Primary	Internal	UNSW	tim.neems@unsw.edu.au	+61 435 200 335	Mobile and Email	Contact mobile no. for urgent matters	*(enter date)*	*(enter date)*
Suppliers	Contractual - To be Tendered	Primary	External	Private Companies	Contact details to be added after Tender Process				*(enter date)*	*(enter date)*
Construction Team	Contractual - To be Tendered	Primary	External	Private Companies	Contact details to be added after Tender Process				*(enter date)*	*(enter date)*
Design Team	Contractual - To be Tendered	Primary	External	Private Companies	Contact details to be added after Tender Process				*(enter date)*	*(enter date)*
Current Students		Secondary	Internal	UNSW	Contact through UNSW Alumni and Engagement (Jane Miller - jane.miller@unsw.edu.au)				*(enter date)*	*(enter date)*
Future Students		Secondary	Internal	UNSW	Contact through UNSW Alumni and Engagement (Jane Miller - jane.miller@unsw.edu.au)				*(enter date)*	*(enter date)*
Research Staff		Secondary	Internal	UNSW	Contact through UNSW Alumni and Engagement (Jane Miller - jane.miller@unsw.edu.au) or directly via UNSW mail				*(enter date)*	*(enter date)*
Teaching Staff		Secondary	Internal	UNSW	Contact through UNSW Alumni and Engagement (Jane Miller - jane.miller@unsw.edu.au) or directly via UNSW mail				*(enter date)*	*(enter date)*
Alumni		Secondary	External	UNSW (Affilliated)	Contact through UNSW Alumni and Engagement (Jane Miller - jane.miller@unsw.edu.au)				*(enter date)*	*(enter date)*
Manufacturing Industry		Secondary	External	Private Companies	Contact through UNSW Media & Content (Monica Melki - m.melki@unsw.edu.au) or directly throught their websites				*(enter date)*	*(enter date)*
Partner Universities		Secondary	External	Academic Community	Contact through UNSW Media & Content (Monica Melki - m.melki@unsw.edu.au) or directly throught their websites				*(enter date)*	*(enter date)*
Government Agencies		Secondary	External	Australian Government	Contact through UNSW Media & Content (Monica Melki - m.melki@unsw.edu.au) or directly throught their websites				*(enter date)*	*(enter date)*
Local Community		Secondary	External	Public Sector	Contact through UNSW Media & Content (Monica Melki - m.melki@unsw.edu.au) or directly throught their websites				*(enter date)*	*(enter date)*
Media Consultants		Secondary	External	Media Companies	Contact through UNSW Media & Content (Monica Melki - m.melki@unsw.edu.au) or directly throught their websites				*(enter date)*	*(enter date)*

The names, roles, affiliations and contact information that appear in this table are used for academic purspose only and not to be contacted for this Project.

PROJECT MANAGEMENT TEAM

Team Members	Project Role	Organisations / Affiliations	Contact Details		
			Email	Phone	Preferred Method
Jessica Leau	Project Manager / PM Lead	University of New South Wales (UNSW)	jessica.leau@unsw.edu.au	+61 xxx xxx xxx	Mobile for urgent matters
Mark Saturnino	Process Engineer	University of New South Wales (UNSW)	mark.saturnino@unsw.edu.au	+61 xxx xxx xxx	Email if outside PM Team
Rafael Formoso	Sensors and Software Delivery Lead	University of New South Wales (UNSW)	rafael.Formoso@unsw.edu.au	+61 xxx xxx xxx	Email if outside PM Team
Joel Lawrence	Site and Procurement Manager	University of New South Wales (UNSW)	joel.Lawrence@unsw.edu.au	+61 xxx xxx xxx	Email if outside PM Team
Ramon	Mechatronic Engineer	University of New South Wales (UNSW)	ramon@unsw.edu.au	+61 xxx xxx xxx	Email if outside PM Team
Ningye Zhang	Project Safety and Risk Assessor	University of New South Wales (UNSW)	ningye.Zhang@unsw.edu.au	+61 xxx xxx xxx	Email if outside PM Team

The names, roles, affiliations and contact information that appear in this table are for used academic purspose only and not to be contacted for this Project.

7.2 Stakeholder Analysis and Management

PROJECT STAKEHOLDER ANALYSIS and MANAGEMENT							
Stakeholder Analysis	Power	Interest	Project Goals	Stakeholder Contribution	Engagement Strategy	Organisational Capabilities	Action Plan
Project Sponsor	5	4	Steer the Scope and provide Resources	Authorise changes to scope	Empower	Maintain Engagement	Progress reports and daily project health status
Head of MME School	3	5	Objectives are satisified	Assist the PM in decision-making	Collaborate	Maintain Engagement	Always keep in the loop and engage for solutions
MME Laboratory Manager	2	3	Meet UNSW Laboratory Standards	Work with the Project Team for the Standards	Consult	Meet their Needs	Get in-depth input up front and check from time to time
Director, Facilities Management Director	2	3	Meet UNSW Facilities Development Guideline	Work with the Project Team for the Guidelines	Consult	Meet their Needs	Get in-depth input up front and check from time to time
Project Manager / PM Team Lead	4	5	Project in control - Budget, Schedule, Deliverables	Lead Project Team and liaise with other Stakeholders	Empower	Maintain Engagement	First Point of Contact for all Project-related concerns
Project Management Team	3	5	Complete Milestones and ensure PM is always satisfied	Remove barriers, escalate concerns, reporting duties	Collaborate	Maintain Engagement	Provide resources, check dynamics, and track project status regularly
Procurement Team (Finance)	3	2	Procure per specification on time and within budget	Assist Project Team with Procurement Process	Consult	Meet Their Needs	Get in-depth input up front and check from time to time
Partner Suppliers	2	3	Tender to meet the required specification, duration, budget	Support sponsor in decision-making	Consult	Meet Their Needs	Get in-depth input up front and check from time to time
Construction Workers	2	2	Complete the Work Packages as specified	Provide progress, escalate concerns and required resources	Inform	Manage Expectations	Align goals and manage understanding up front and track WP status regularly
Contracted Designers	2	2	Complete the Work Packages as specified	Provide progress, escalate concerns and required resources	Inform	Manage Expectations	Align goals and manage understanding up front and track WP status regularly
Current Students	1	2	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Future Students	1	2	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Research Staff	2	3	Interested with the Project Outcomes	Involvement in some low risk areas	Consult	Meet Their Needs	Consult on key interest areas and project expectations
Teaching Staff	1	2	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
UNSW Alumni	1	1	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Manufacturing Industry	1	1	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Partner Universities	1	2	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Government Agencies	2	2	Interested with the Project Outcomes	Involvement in some low risk areas	Inform	Manage Expectations	Keep informed and engageon their interest areas
Local Community	1	1	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project
Media Consultants	1	1	no direct goal associated with this stakeholder	Potential Project Supporter	Monitor	Monitor Perception	Inform via general communications and monitor general perception of Project

RATING	POWER	DEFINITION
5	Very High	This stakeholder can direct (or have a massive impact on) the course of the project
4	High	This stakeholder can have a major impact on the project's schedule and/or budget, and/or a minor impact on the project's scope
3	Moderate	This stakeholder can have a minor impact on the project's schedule and/or budget
2	Low	This stakeholder cannot impact the project, but may know (or have access to) someone who can
1	Very Low	This stakeholder cannot directly impact the project

RATING	INTEREST	DEFINITION
5	Very High	This stakeholder is passionately advocating for the project and its outcomes, and will be devastated if the project fails.
4	High	This stakeholder is highly supportive and its benefits and will be angry if the project fails
3	Moderate	This stakeholder sees benefit to themself and/or to others in the project and will be annoyed if the project fails.
2	Low	This stakeholder sees benefit to others in the project and prefer the project to succeed, but does not feel strongly either way.
1	Very Low	This stakeholder either have no interest at all or some reservations about the project and would push for reconsideration or project termination.

STRATEGY	CAPABILITIES	DEFINITIONS
Empower	Maintain	Authorise this stakeholder to make specific decisions about the project
Collaborate		Partner with this stakeholder to develop alternatives and arrive at solutions that are acceptable to the collaboration group
Involve	Meet	Rely on this stakeholder's expert advice when making decisions about the project
Consult		Obtain this stakeholder's feedback on key project decisions that are relevent to them
Inform	Manage	Provide this stakeholder with relevant, high-level information about the project at regular intervals / milestones
Monitor	Monitor	Track this stakeholder's commentary in traditional and social media to see if their level of interest (or access to power) changes

RATING	1	2	3	4	5
5	Consult	Involve	Collaborate	Empower	Empower
4	Inform	Consult	Involve	Collaborate	Empower
3	Inform	Consult	Consult	Involve	Collaborate
2	Monitor	Inform	Consult	Consult	Involve
1	Monitor	Monitor	Inform	Inform	Consult

ENGAGEMENT LEVEL (Power x Interest)					
1	Monitor	6	Consult	15	Collaborate
2	Monitor	8	Consult	16	Collaborate
3	Inform	9	Consult	20	Empower
4	Inform	10	Involve	25	Empower
5	Consult	12	Involve		

7.3 Stakeholder Management Review

In conjunction to the communication plan, each stakeholder's level of engagement and contribution will be reviewed at least every milestone completed to ensure their expectations are met, their needs are satisfied, and their authority are maximised. Through a regular review, required modifications will be implemented and reduce the number of negative risks and their likelihood associated with miscommunication throughout the project duration. Risks that can be exploited to become project opportunities will also be captured.

7.4 Project Communication Governance and Strategies

The Project Manager will be the main and central point of all communications within and outside the Project Team throughout the Project Duration in order to establish an effective and efficient communication trail. This control measure in the way stakeholders communicate across the network would allow efficient and effective use of resources to pass the relevant information to the right people and secure necessary permissions to conduct the required preventive/corrective/informative actions in a timely manner, to meet Project Deliverables and satisfy the Project Objectives. A series of reporting activities developed to accomplish each of the stakeholder's requirements and expectations. The reporting activities and report documents will cover several aspects of the project involving the progress status, risks, concerns, challenges, and the team members' welfare that could impact the budget, the schedule, the deliverables.

PRIMARY COMMUNICATION DOCUMENTS						
Reporting Document	Document Description	Document Type	When	How	From	To
Agenda and Meeting Minutes	Use Agenda and Meeting Template with a control number format A-XX DD-MM entry #. Template includes action items, WP affected, by who, completed and update provided by when, any support required). A-PM - Project Team Meeting Minutes A-SU - Supplier Meeting Minutes A-SP - Sponsor Meeting Minutes A-ST - Internal and External Stakeholders Meeting Minutes A-EX - External Stakeholder Meeting Minutes A-PR - Procurement Team Meeting Minutes	Semi-Live Document (allowed to add missed item or making corrections to the details)	Agenda: At least 1 day before the Meeting Minutes: No later than 1 day after the meeting	Email	Project Manager	Relevant Team/s
Action Items List	Summary Log of all Action Items throughout the Duration of the Project with reference to the Meeting Minutes control number.	Live Document. New versions for every update and log update history.	Daily	Email	Project Manager	Relevant Team/s
Progress Report	Project Progress Status in terms of Budget Spending and Schedule Tracking. Any corrective or mitigate plan is added as comment for the relevant milestone.	Live Document. New versions for every update and log update history.	Beginning and End of a Milelstone (0%, 100%) or different frequency depending on measurable criteria.	Email	Project Manager	Relevant Teams
Sponsor Dashboard (Executive Summary)	Sponsor Dashboard that includes summary of progress status (milestone checklist, cost and time variance analysis) and any project detail to highlight, including completed, on-going, and next milestons to deliver.	Live Document. New versions for every update and log update history.	Daily	Email	Project Manager	Sponsor
Training and Support Plan	Training Plan of the Team Member needing Support for Performance Development and/or necessary to accomplish a Work Package.	Permanent Document	To be arranged internally	Email	Project Manager	Relevant Team members
Scope Change Requests	For scope Change Request and Approval	Permanent Document	Immediate submission of Request and its Approval/Rejection/Modification	Email	Project Manager (support from relevant Teams)	Sponsor Teams

PRPOJECT COMMUNICATION PLAN

Communication Type	Objective	Medium	Frequency	Audience	Owner	Deliverable	Format
Kick off Meeting	Introduction of Project and its Management to key stakeholders	• Email Agenda • Face to Face • Email Minutes	• Once	• Sponsor • PM Team • Primary Stakeholders	Project Manager	• Agenda and Minutes • Action Items List	Final Copy saved in Project Folder
Sponsor Meeting	Highlight previous and upcomign week activities to assess project performance and integrate any learning in future activities.	• Email Agenda • Face to Face • Email Minutes	• Weekly	• Sponsor	Project Manager	• Agenda and Minutes • Action Items List	Final Copy saved in Project Folder
PM Team Meetings	Review project progress to identify risks, opportunities, additional resources, learnings	• Email Agenda • Face to Face / Dial-in • Email Minutes	• Daily (Agile Approach) • Weekly (In-depth Review)	• PM Team Members	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Design Team Meetings	Review design team progress to understand and escalate design and integration risks/opportunities, additional resources or support, learnings	• Email Agenda • Face to Face / Dial-in • Email Minutes	• At least 2x per week (Designing Period) • As needed thereafter	• Relevant PM Team member/s • Design Team	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Supplier Meetings	Review supplier offer, discuss resolutions, make clarifications and among other things relating to this particular supplier of machine/equipment/materials.	• Email Agenda • Face to Face / Dial-in • Email Minutes	• At least 1x per week (Procurement Period) • As needed thereafter	• Procurement Team • Relevant PM Team member/s • Design Team Lead • Construction Team Lead	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Construction Team Meetings	Review construction team progress to identify and escalate risks/opportunities, additional resources or support, learnings	• Email Agenda • Face to Face / Dial-in • Email Minutes	• At least 2x per week (Renovation Period) • As needed thereafter	• Relevant PM Team member/s • Construction Team	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Emergency Meetings	Immediate escalation and/or discussion of a certain critical aspect of the Project	• Phone Call • Face to Face • Email	• As needed	• Relevant Stakeholder/s	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Training and Support Meetings	Specific discussion around training plan and support needed to enable the work force progress the project and see its completion.	• Email Agenda • Face to Face / Dial-in • Email Minutes	• As needed *Part of stakeholder meetings will be escalation of any support or training needed. If any is required, a specific meeting will be conducted for it.*	• Relevant Stakeholder/s	Project Manager	• Agenda and Minutes • Learnings and Opportunities • Risk Register Update • Action Items List	Final Copy saved in Project Folder
Bulletin Boards	One for the Project Team and other Stakeholders for quick view of Project Progress and another in university Bulleting Board for informing UNSW community	• Print Media	• Before or At Go Live • Daily Review and Updating (Project Bulletin) • As needed thereafter (University Bulletin)	• UNSW Community	Project Manager	Progress Update and Team Memebr Recognition Bulletin Board	Printed Copy posted and Digital Copy saved in Project Folder
Website Announcement / Updates	Informing the Public and other Secondary Stakeholders and Project and its Status.	• Digital Media	• Before or At Go Live • As needed thereafter	• Open to Public	Project Manager	Project Beneifts and Project Milestones Summary Document	Final Copy of Webpage Contents saved in Project Folder
Control Check Reports	Documents that contains a summary or synthesis of project details obtained from the face to face or virtual interactions of PM with different stakeholders in meetings, phone calls, or email exchanges, organised for documentation, reporting, escalation and/or inforkation dissemination to relecant audience.	• Email	See Reporting Documents	See Reporting Documents	Project Manager	See Reporting Documents	Final Copy saved in Project Folder

8 Human Resource Plan

The Human Resource Plan was developed using Resource Management planning within PMBOK.

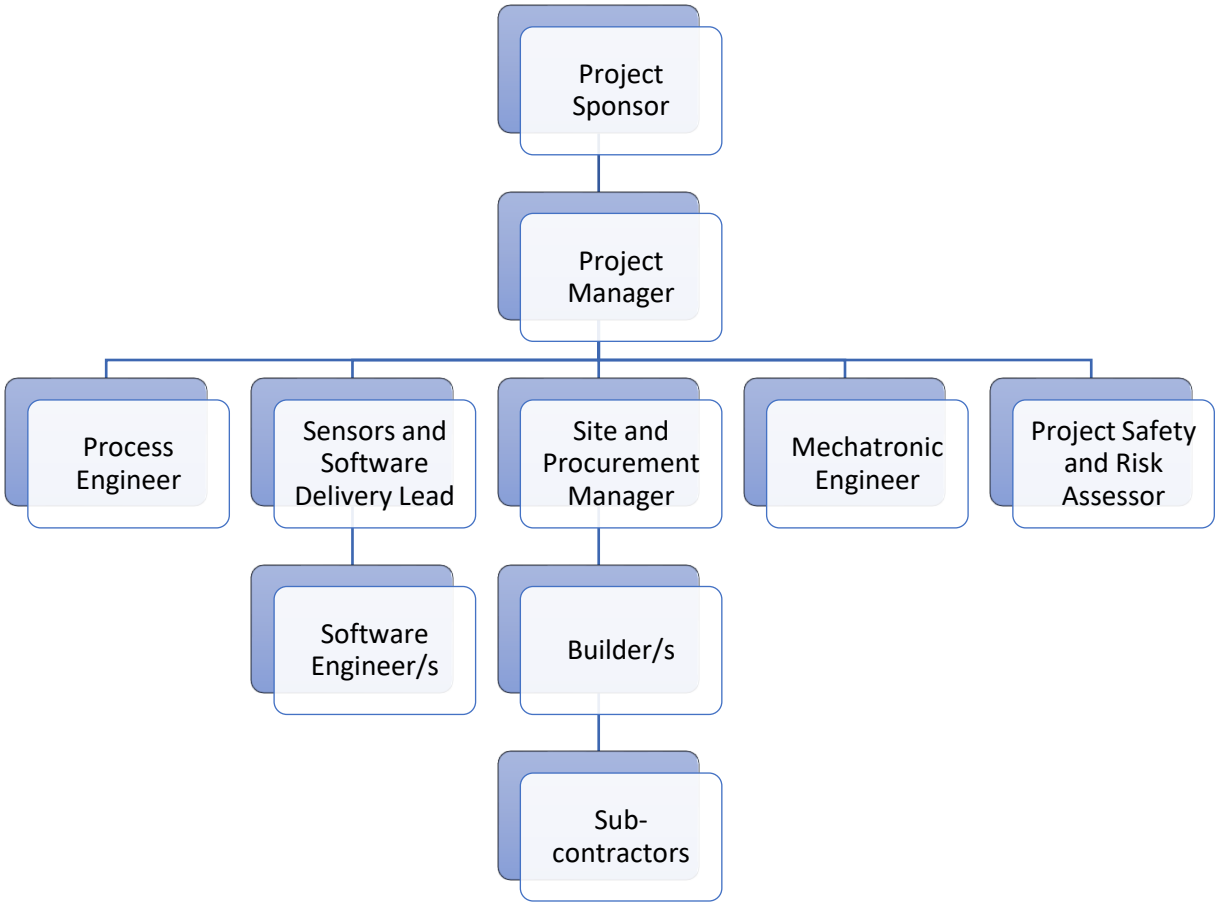
8.1 Identification of resources

The project will use a 6-person project management team for coordination. This will enable all design development, software development and construction management to occur internally. Further to this team, software engineers will also be hired for delivery of the software systems.

8.2 Acquiring resources

The project team is already in place from the design and delivery of this plan. Construction and procurement will make use of tenders to obtain the necessary resources. This means work will need to be put out for bidding while acquiring resources will require vendors to prepare offers. This reduces risk of workforce sourcing issues however there is room for risk of under-budgeting potential tenders. The only hiring will be software engineers which does create a small sourcing risk.

8.3 Organisation Chart



8.4 Roles and responsibilities

8.4.1 Process Engineer

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions over $1000 need approval from the Project Manager.
- Responsibilities:
  - Developing, configuring, and optimizing industrial processes related to the MM Cell from inception through to start up and certification.
  - Design, run, test and upgrade systems and processes.
  - Manage cost and time constraints for previous point.
  - Provide process documentation and instructions.
- Competence:
  - Excellent technical skills.
  - Knowledge of process related standards.
  - Experience in process simulations.
  - Familiarity with Health and Safety Regulations.
  - Analytical thinker who is degree qualified.

8.4.2 Sensors and Software Delivery Lead

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions over $1000 need approval from the Project Manager.
- Responsibility:
  - Coordinate and Manages the software development process.
  - Coordinate and Manages the sensor development and installation process.
- Competence:
  - Excellent technical skills.
  - Knowledge of agile project management practice.
  - Experience in software delivery projects.
  - Familiarity with Health and Safety Regulations.
  - Analytical thinker who is degree qualified.
  - Relevant Agile qualifications.

8.4.3 Site and Procurement Manager

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions over $1000 need approval from the Project Manager.
- Responsibility:
  - Ensure that construction is completed on time and within budget.
  - Overseeing direction of the project.
  - Ensuring that specifications and requirements are being met.
  - Coordinating and supervising construction workers.
  - Maintaining quality control procedures.
  - Assist project manager to negotiate contracts and secure necessary permits and leases.
  - Devising and using fruitful procurement and sourcing strategies.
  - Discovering profitable suppliers and initiate procurement partnerships.
- Competence:
  - Knowledge of sourcing and procurement techniques as well as a dexterity in “reading” the market.
  - Talent in negotiations and networking.
  - Good knowledge of supplier or third-party management software.
  - Aptitude in decision-making and working with numbers.
  - Strong leadership capabilities.
  - Experience in collecting and analysing data.
  - Experienced in construction management.

8.4.4 Project Manager

- Authority:
  - Complete oversight and authority on all decisions.
  - Reports directly to project sponsor.
- Responsibility:
  - Leading project planning sessions.

- Coordinating staff and internal resources.
- Managing project progress and adapt work as required.
- Ensuring projects meet deadlines.
- Managing relationships with clients and stakeholders.
- Designing and signing off on contracts.
- Overseeing all incoming and outgoing project documentation.
- Optimising and improving processes and the overall approach where necessary.
- Conducting project review and creating detailed reports for executive staff.

- Competence:
  - Written and verbal communication skills.
  - Capacity to manage high stress situations.
  - Ability to multi-task and manage various project elements simultaneously.
  - Leadership skills.
  - Big picture thinking and vision.
  - Attention to detail.
  - Conflict resolution skills.
  - Project Management Certifications.
  - Previous experience with innovative projects.

8.4.5 Mechatronic Engineer

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions over $1000 need approval from the Project Manager.
- Responsibility:
  - Design, develop, and enhance electro-mechanical systems and mechatronic devices.
  - Creating automated systems and the software to control them.
  - Developing design documents for mechanical parts and final products.
  - Selecting the required tools and materials for the manufacturing process.
- Competence:
  - BE in Mechatronics Engineering or similar.
  - Strong mathematical, analytical, and creative thinking skills.
  - Ability to work in a team or alone.
  - Attention to detail.
  - Excellent technical skills.

8.4.6 Project Safety and Risk Assessor

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions over $1000 need approval from the Project Manager.
- Responsibility:
  - Continuous inspection of project sites, to ensure a hazard-free environment.
  - Assessment and approval of subcontractor safety plans.
  - Verification of tools and equipment to ensure good quality.
  - Promote safe practices on site.
  - Create and enforce safety guidelines and programs.
  - Carry out drills and exercises on managing emergency situations.
  - Conduct investigations on accidents.
  - Verify that all safety reports are submitted to related government institutions.
  - Respond to workers' safety concerns.
  - Manage all communications with government departments in regards of safety.
  - Arrange OSHA-mandated evaluations of the site.
  - Coordinate all issues regarding hazardous materials or waste.
  - Assist with the preparation of a construction health and safety plan.
  - Establish and maintain health and safety communication structures.
  - Test effectiveness of site emergency response plans.
  - Continuous monitoring of all safety related documents, reports and issues to keep them updated.
- Competence:
  - Strong project management experience on large commercial projects.

- Experience and competencies in hazard Identification, and risk management.
- Experienced in the running of high level OH&S Management systems.
- Familiar with the requirements of maintaining an accredited system in line with ISO 90001 Quality and ISO 14001 Environmental Standard.

8.4.7 Software Engineer

- Authority:
  - Authority to choose appropriate methods to complete assigned activities and setting relative acceptance criteria.
  - All monetary decisions need approval from the Sensors and Software Delivery Lead.
- Responsibility:
  - Improving system quality by identifying issues and common patterns, and developing standard operating procedures
  - Enhancing systems applications by identifying opportunities for improvement, making recommendations, and designing and implementing systems
  - Maintaining and improving existing codebases and peer review code changes
  - Liaising with colleagues to implement technical designs
  - Investigating and using new technologies where relevant
  - Providing written knowledge transfer material
- Competence:
  - Degree qualified or relevant certifications
  - A passion for solving problems and providing workable solutions
  - Knowledge of algorithms and data structures
  - Strong analytical and reasoning skills with an ability to visualise processes and outcomes
  - Proficiency in troubleshooting software issues and debugging a large codebase
  - Outstanding all-round communication skills and ability to work collaboratively

8.5 RACI Chart

Deliverable	Project Manager	Process Engineer	Sensors and Software Delivery Lead	Site and Procurement Manager	Mechatronic Engineer	Project Safety and Risk Assessor	Software Engineer
Concept Design	**A**	**R**	**R**	**R**	**R**	**R**	**I**
Preliminary Design	**A**	**R**	**R**	**R**	**R**	**R**	**I**
Hardware Components	**A**	**R**	**R**	**I**	**R**	**I**	**I**
Software Components	**A**	**C**	**R**	**I**	**C**	**I**	**R**
MM Cell Integrations	**A**	**A**	**A**	**R**	**A**	**A**	**I**
Project Management	**R**	**R**	**R**	**R**	**R**	**R**	**I**

Key:
R – Responsible for completing the work
A – Accountable for ensuring task completion/sign off
C – Consulted before any decisions are made
I – Informed of when an action/decision has been made

8.6 Training

There is currently no training scheduled with regards to the Project as all adequate staff with required skill sets are available or will be acquired. However, if crucial training requirements are identified, funding will be provided from the project reserve.

8.7 Team development

The core of the project team has been formed during the creation of this PMP. It is recognised they have now successfully transitioned through the forming and storming stages of team development. At the completion of this plan it is important to note the team will be finishing the norming stage.

This is advantageous for execution with the team set for the performing stage. It is therefore relevant to focus team development opportunities on navigating and dealing with the adjourning stage as the execution draws towards closure. The project manager will be responsible for ensuring no drop off of performance by providing adequate recognition and feedback throughout the execution phase. They will also ensure adequate time is set aside at the end for celebration of the team's success to ensure there is an end goal for all project team members to keep focus of.

8.8 Recognition plan

The scope of this project does not allow for ample time to provide cross-training or potential for monetary rewards other than standard award remuneration rates. The objective of this project is to deliver an innovative technological facility and as such, successful completion allows for increased notoriety of project team members.

As an added incentive the following will be made available by the project sponsor:

- Upon successful completion of the project, any team member who satisfactorily completed all assigned work packages on time will receive a certificate of thanks from the UNSW Executive team.
- Team members who successfully complete all of their assigned tasks will have their photo taken for inclusion in external and internal UNSW publications.
- All media communication upon the launch of the facility will reference the project team and their success.

9 Risk Management Plan

9.1 Overview

For most of the projects, having tasks that are not completed in the planned duration and budgets are almost inevitable (Lock, 2013). Hence it is critical to develop a risk management plan in order to "identify, evaluate, respond to, monitor and report of the risks" Khatta (2008). This Risk Management Plan will follow the process recommended in the PMBOK to outline how risks will be assessed and managed for the MM cell project.

9.2 Risk Management Planning

9.2.1 Existing Document Review

As recommended by Lock (2013), existing checklists and history of similar projects will be able to assist in highlighting potential problems. The following information available to the team were considered during the development of this risk management plan:

i. Interview with the project sponsor Dr. Xiaoping Li on his previous experience in developing the world first Addictive Manufacturing (AM) cell & the UNSW AM cell.
ii. Interview with external expert Stephen Kuhle (MME Senior Technical Officer) on his experience on procuring, installing, commissioning and running robots.
iii. Approved project Charter from UNSW project steering committee as included in Section 1 of this report.

9.2.2 Internal and External Context

The internal context analysis revealed that the team conducting the projects is newly formed. However, all team members have demonstrated existing project management knowledge and experiences. The project team were also equipped with multi-disciplinary academic backgrounds and are all willing to contribute into the final project delivery.

The project is determined as the world first MM cell for research purpose and for potential future commercializing. It is considered as one of the key projects in line with the UNSW 2025 organizational strategy. Detailed project objectives and work scopes are included in the approved Project Charter in Section 1.

9.3 Risk Identification

PMBOK (PMI, 2017) recommended to use expert judgment, data gathering and analysis, interpersonal and team skills, prompt lists and meetings for the risk identification. In addition, brainstorming was also highly accredited by Lock (2013). The identified risks presented in the Risk Register (shown in Appendix ??) are the results of existing information review, research, interview with internal and external experts, and group brainstorming.

9.4 Risk Assessment

Risk analysis are carried out in order to quantify and qualify:

i. the likelihood of occurrence of each individual risk;
ii. the possible impact on the overall project outcome should they occurred; and
iii. potential measurements on risk responses.

Reference was made to the University of Queensland (2019) Enterprise Risk Matrix in performing the risk qualitative analysis.

9.4.1 Risk Likelihood

The risk probability levels in terms of likelihood applied to the risk assessment is provided in as below:

i. Very low probability (<10%): highly unlikely to occur except under minor conditions.
ii. Low probability (10%-39%): not expected, but inadequate precautionary measurements could lead to a slight chance of occurring.
iii. Medium probability (40%-59%): May occur and have occurred in the known history of similar projects.
iv. High probability (60%-90%): most likely to happen and have frequently happened in similar project history record.
v. Almost Certain (>90%): the risk is expected to occur in most of the circumstances.

9.4.2 Risk Severity

The risk severity levels applied to the risk assessment is provided in as below:

vi. Trivial: no or minor impact to the final project outcome
vii. Minor: slight effort is required for managing risks to minimize impact to project outcome
viii. Moderate: the risk, if not addressed, will lead to a moderate consequence
ix. Major: Impact to project is considered significant
x. Critical: A severe consequence will happen

9.4.3 Risk Assessment Rating

The severity and likelihood of each risk will are assigned with a number from 1 to 5 to represent its level of concerns. 1 represents “concern not warranted”, where 5 indicates alarming concerns.

Risk rating (1 to 25) was then calculated by: Likelihood (1 to 5) x Severity (1 to 5)

9.4.4 Risk Evaluation

A matrix was hence developed from the above mentioned categorizes and is demonstrated in Figure x below, with risks being classified into four levels as shown in the risk matrix developed by University of Queensland, taking consideration to project specifications.

Risk Evaluation		Severity				
		Critical (5)	Major (4)	Moderate (3)	Minor (2)	Insignificant (1)
Likelihood	Very High (5)	E (25)	E (20)	E (15)	H (10)	M (5)
	High (4)	E (20)	E (16)	H (12)	M (8)	L (4)
	Medium (3)	E (15)	H (12)	H (9)	M (6)	L (3)

	Low (2)	H (10)	M (8)	M (6)	L (4)	L (2)
	Very Low (1)	M (5)	M (4)	L (3)	L (2)	L (1)

Notes: E (15-25): Extreme, immediate action is required

H (9-14): High, additional research and measurements required as soon as possible

M (5-8): Medium, review and mitigation required

L (<5): Low risk, minor control and monitoring required

9.5 Risk Response Development

Responses to risks identified include:

i. **Avoid** the risk by changing the plan and abandon the possible causes.
ii. **Mitigate** the risk by reducing likelihood or impact level.
iii. **Accept** some of the risks with low risk rating.
iv. **Transfer** the risk to insurance.

The designed risk responses are also included in the Project Risk Register.

9.6 Risk Response Control

Key risk response controls include constant monitoring, control and improvement. New, changing, and outdated risks should be continuously recorded and reported (PMI, 2017). It is hence recommended to:

i. Conduct internal risk audits every fortnight, or when proposed by project key stakeholders.
ii. Conduct external risk audits at key milestones or when steering committee believe necessary.
iii. Update Project Risk Register accordingly.
iv. Process Project Change Order Request, if necessary, in order to set up corrective and preventive measures as part of the Performance Integrated Change Control process (PMI, 2017).

Reference for Risk Management Part

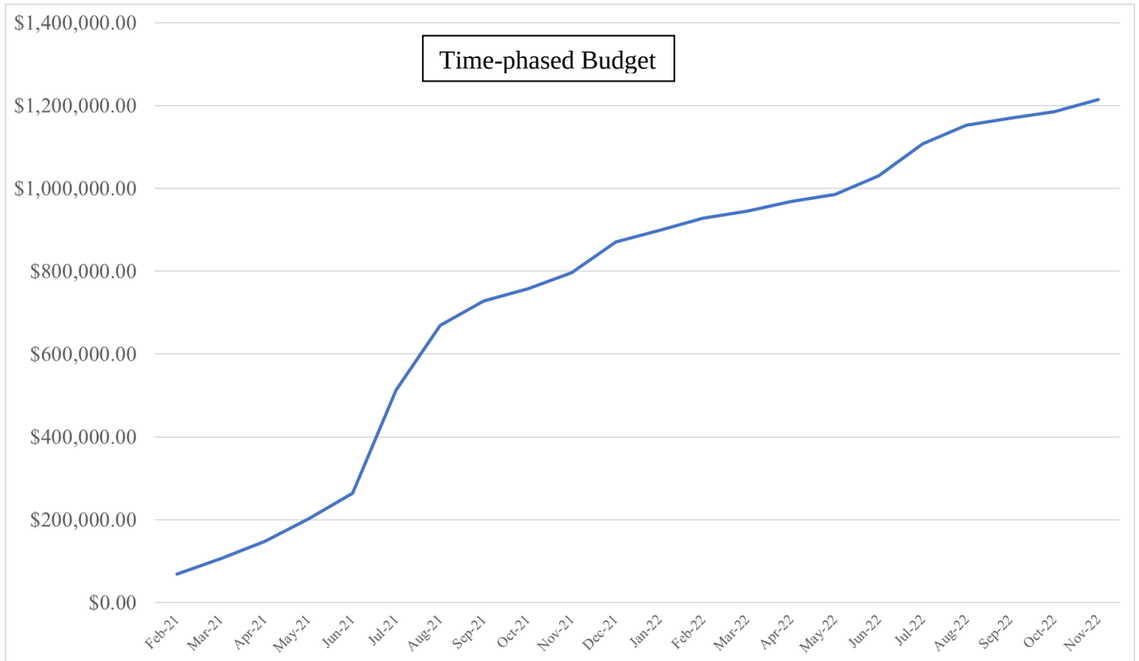
Khatta, R. S. (2008) Risk Management. s.l.:Global India Publications.

Lock, D (2013) Project Management, 10th Edition, Burlington VT.

University of Queensland Australia (2019) Enterprise Risk Matrix, Retrieved from https://ppl.app.uq.edu.au/sites/default/files/Enterprise%20Risk%20Matrix%20A3.pdf

10 Budget

Work Packages	Cost	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22
Process Flow Diagram	$5,346.66	$5,346.66																						
Facility Layout	$5,000.00	$5,000.00																						
System Requirements Document	$12,899.85		$12,899.85																					
Facility Renovation RFP	$2,149.97		$2,149.97																					
Staging Area Equipment RFQ	$2,149.97		$2,149.97																					
Central Control System RFQ	$2,149.97		$2,149.97																					
Robotic Workpiece Manipulation System RFQ	$2,149.97		$2,149.97																					
Mechanical Power Hammer RFQ	$2,149.97		$2,149.97																					
Induction Furnace RFQ	$2,149.97		$2,149.97																					
Sensor Array Schematic	$4,874.29		$4,874.29																					
Sensor Array RFQ	$2,149.97			$2,149.97																				
Facility renovation agreement & staging area document	$4,299.95				$2,149.97	$2,149.97																		
Control System & Workpiece Manipulation system contract documents	$4,299.95				$2,149.97	$2,149.97																		
Power Hammer & Induction forge contract documents	$4,299.95				$2,149.97	$2,149.97																		
Sensor Array procurement contract	$4,299.95					$2,149.97	$2,149.97																	
Sensor Array Software Design	$4,874.29			$4,874.29																				
Sensor Array Software Implementation & Testing Plan	$29,245.75						$9,748.58	$9,748.58	$9,748.58															
Morphology Solver Software Design	$4,874.29		$4,874.29																					
Deformation Simulator Schematic	$4,874.29		$4,874.29																					
Morphology Solver Software Implementation & Testing Plan	$116,983.00			$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58									
Deformation Simulator Software Implementation & Testing Plan	$116,983.00			$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58	$9,748.58									
Deformation Simulator Software Simulated Testing	$14,622.87															$7,311.44	$7,311.44							
Morphology Solver Software Simulated Testing	$14,622.87																$7,311.44	$7,311.44						
Renovated Foundation	$14,000.00				$7,000.00	$7,000.00																		
Electrical Fixtures Installed	$2,500.00						$2,500.00																	
Equipment Mounts Installed & Cleaning	$1,500.00						$1,500.00																	
Hardware Integration, Workpiece Manipulation System, Mechanical Power Hammer, Induction Furnace Testing Plan	$20,639.76					$10,319.88	$10,319.88																	
Installed Staging Area Equipment	$13,700.00						$6,850.00	$6,850.00																
Installed Central Control System	$30,346.66							$30,346.66																
Installed Robotic Workpiece Manipulation System	$162,899.85							$162,899.85																
Installed Power Hammer	$92,899.85								$92,899.85															
Installed Induction Furnace	$24,899.85								$24,899.85															
Installed Sensor Array	$9,811.44							$9,811.44																
Sensor Array Calibration	$4,874.29									$4,874.29														
Robotic Workpiece Manipulation System Tests Completed	$8,599.90									$8,599.90														
Power Hammer Tests Completed	$8,599.90									$8,599.90														
Induction Furnace Tests Completed	$8,599.90									$8,599.90														
Sensor Array Testing	$19,497.17											$9,748.58	$9,748.58											
Hardware Component Tests Complete	$35,548.28												$35,548.28											
MM Cell System Integration Development & Live Testing	$69,362.40																		$34,681.20	$34,681.20				
MM Cell System Integration Testing	$69,362.40																			$34,681.20	$34,681.20			
Morphology Solver Software Live Testing	$14,622.87																					$7,311.44	$7,311.44	
Deformation Simulator & Morphology Solver Software Release Version	$19,497.17																							$19,497.17
Salary of Project Manager	$215,202.02	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61	$9,356.61
Total	$1,214,414.48	$19,703.27	$49,779.18	$35,878.04	$42,303.70	$54,773.55	$61,922.21	$248,510.30	$156,402.06	$59,527.76	$28,853.78	$38,602.36	$74,150.64	$28,853.78	$28,853.78	$16,668.05	$23,979.48	$16,668.05	$44,037.81	$78,719.01	$44,037.81	$16,668.05	$16,668.05	$28,853.78
Cumulative		$19,703.27	$69,482.45	$105,360.49	$147,664.19	$202,437.75	$264,359.96	$512,870.26	$669,272.32	$728,800.08	$757,653.86	$796,256.21	$870,406.85	$899,260.63	$928,114.40	$944,782.45	$968,761.94	$985,429.98	$1,029,467.79	$1,108,186.80	$1,152,224.61	$1,168,892.66	$1,185,560.70	$1,214,414.48



11 Bibliography

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12 Appendix (This counts towards page limit)

Appendix 1: Risks and opportunities register

No.	Risk/Opportunities	Risk event	Risk owner	Impact	Likelihood	Severity	Risk value	Response management strategies	Mitigation	Contingency plan
1	Risk	Laboratory room not available	Project team	Project delays	1	3	3	Accept	Review other possible laboratory locations as back-up	Room relocation and inform project sponsor
2	Risk	Robot, furnace and power hammer breakdown	Project team	Project delays	1	5	5	Transfer	Ensure equipment is under warranty and buy guarantee extensions if necessary	Escalate to the PM and contact the supplier for the replacement or repairment of the equipment under warranty. Inform the project sponsor if any project delays
3	Risk	Faulty sensors	Project team	Project delays	3	1	3	Transfer	Ensure equipment is under warranty and buy guarantee extensions if necessary	Escalate to PM and contact the supplier for the replacement or repairment of the equipment under warranty. Inform the project sponsor if any project delays
4	Risk	Robot fails commissioning tests	Project team	Project delays	2	5	10	Accept	Add time buffers	
5	Risk	Delays in procurement of robotic arms, furnace, power hammer or sensors	Project team	Project delays	3	4	12	Transfer	Add time buffers and order at an early stage Include late penalties in the supplier's contract	Escalate to the project sponsor with estimated delay in project delivery if any and its impact on the project cost
6	Risk	Incorrect delivery of robotic arms, furnace, power hammer or sensors	Project team	Project delays	1	3	3	Transfer	Add time buffers and order at an early stage Include late penalties in the supplier's contract if delivery is delayed of the equipment	Escalate to the project sponsor with estimated delay in project delivery if any and its impact on the project cost
7	Risk	Robotic arms, furnace, power hammer or sensors are damaged during shipping	Project team	Project delays	1	3	3	Transfer	Add time buffers and order at an early stage Include supplier is liable for any damage to the equipment during shipment in the contract	Escalate to the project sponsor with estimated delay in project delivery if any and its impact on the project cost
8	Risk	Robotic arms, furnace, power hammer or sensors are damaged during installation process	Project team	Project delays	1	3	3	Transfer	Safely store the equipment in a secure storage area Include in the contract that the contractor is liable for any damage to the equipment during the installation process	Escalate to the project sponsor with estimated delay in project delivery and put in place a new purchase order
9	Risk	Process flow diagram is inaccurate	Project team	Project delays and affects project quality	1	5	5	Mitigate	Strong process flow diagram requirements which should be reviewed by the expert committee	Escalate to the project sponsor and provide the sponsor with updated flow diagram
10	Risk	Facility layout is not detailed enough	Project team	Project delays and affects project quality	1	5	5	Mitigate	Strong facility layout and site blueprints which should be reviewed by the expert committee	Escalate to the project sponsor and provide the sponsor with updated layout
11	Risk	System requirements documents not detailed enough	Project team	Project delays and affects project quality	2	5	10	Mitigate	Comprehensive system requirements which should be reviewed by the expert committee	Escalate to the project sponsor and provide the sponsor with updated requirements
12	Risk	Missing key specification requirements in request for proposal (RFP) for facility renovation	Project team	Affects project quality, scope, and delays project	2	5	10	Mitigate	Strong specification requirements facility renovation RFP which should be reviewed by expert committee	Escalate to the project sponsor and provide details of scope changes if any

13	Risk	Bid documents received does not meet the requirements of the renovation project in terms of cost or specification	Project team and sponsor	Affects project quality, scope, and delays project	2	5	10	Accept	Review renovation RFP and work on contract terms with the short-listed tenderers	Escalate to the project sponsor
14	Risk	Sensor array frame and placement schematic may be inaccurate and are not compatible with the sensors	Project team	Delays the project	1	4	4	Mitigate	Sensor array schematic should be reviewed by the expert committee	Escalate to the project sponsor and provide the sponsor with updated schematics
15	Risk	Morphology solver, sensor array and deformation simulator software design documents are missing key specification requirements	Project team	Affects project quality and delays project	1	4	4	Mitigate	Comprehensive design documents are written which should be reviewed by the expert committee	Escalate to the project sponsor and provide the sponsor with design documents
16	Risk	Facility renovation is more complex than expected requiring additional resources	Project team	Affects project quality and delays project	2	5	10	Transfer	Contractor should be allowed to do a comprehensive site assessment before their bid submission and include that contractor shall bear the cost of any additional materials or equipment required to complete the renovation in the contract	Escalate to the project sponsor
17	Risk	Poor installation of equipment mounts, electrical fixtures, and staging area by contractors during facility renovation	Project team	Project delays	1	4	4	Transfer	Strong contractor selection process based on previous project completion track record Inspection after installation to be carried out by an independent contractor	Escalate to PM and have it fixed by the contractor. Inform the project sponsor for any project delays
18	Risk	Additional electrical fixtures and equipment mounts may need to be installed	Project team	Delays the project	1	3	3	Mitigate	A well-designed electrical layout and renovation plan need to be prepared pre-renovation which is reviewed by the expert committee	Escalate to the project sponsor
19	Risk	Vendor offers are higher than expected	Project team	Affects project scope	4	5	20	Mitigate	More than two cost estimating methods are used for accurate estimation and contingencies are included in the project budget	Escalate to the project sponsor and provide details of scope changes if any are required
20	Risk	Procurement specification for central control system, staging area equipment is missing key specifications	Project team	Affects project quality, scope and delays the project	1	4	4	Mitigate	Comprehensive procurement document is developed which should be reviewed by the expert committee	Escalate to the project sponsor with updated specification requirements
21	Risk	Critical bugs and system errors are found during the implementation of morphology solver, deformation simulation and sensor array	Project team	Delays the project	2	4	8	Mitigate	Time buffers are included, and a thorough software test plan is drafted which is reviewed by the expert committee	Escalate to the project sponsor and provide estimated delay in the project
22	Risk	Morphology solver, sensor array and deformation simulator fails the test	Project team	Delays the project	3	2	6	Mitigate	Time buffers are included in the schedule for any test fails	Escalate to the project sponsor and provide estimated delay in the project
23	Risk	MM cell system fails the test	Project team	Delays the project	3	2	6	Mitigate	Time buffers are included in the schedule for any test fails	Escalate to the project sponsor and provide estimated delay in the project
24	Risk	Unforseen material waste clean-up cost	Project team	Affects project scope and budget	3	3	9	Transfer	Include the clean-up cost as part of contractor's bid submission	Escalate to the project sponsor
25	Risk	Architecture drawing (fit-out plan) does not meet UNSW facility requirements	Project team	Project delays	1	5	5	Mitigate	Provide design team with UNSW construction checklist. The final drawing is reviewed and approved by UNSW	Escalate to the project sponsor
26	Risk	Unaware of "hidden cost" during the tendering review from contractors	Project Sponsor	Unnecessary cost	4	3	12	Mitigate	Prepare clear tendering document Thoroughly analyse the fee proposal submitted and ask for statement on cost inclusions/exclusions.	Escalate to the project sponsor
27	Risk	Project team and contractor fail to come to an agreement on signing contract	Project Sponsor	Project delays and affects project quality	1	5	5	Mitigate	Work on contract terms with the contractor	Escalate to the project sponsor
28	Risk	Team member may be replaced during the project	Project team	Project delays and affects project quality	3	1	3	Accept	Regular report Frequent internal communications Better documentation on project progress	Escalate to the PM and inform project sponsor of any project delays
29	Opportunity	Renovation work is easier than predicted	Project team	Reduced project duration	2	3	6	Enhance	Allows more time and resources in planning stage; encourage frequent communications	

30	Opportunity	The equipment may not require any additional mounts for the robotic arms, hammer, furnace operation of MM cell	Project team	Reduced cost and duration	1	4	4	Accept	Unlikely to occur but will accept if it does occur	
31	Opportunity	Discount on parts required	Project sponsor	Reduced project cost	1	3	3	Accept	Unlikely for new technologies but can accept if does occur	

Appendix 2: Contingency budget

Risk No.	Probability	Impact	EV (Probability x Impact)	Comments
1	10%	-$5,000.00	-$500.00	New facility layout plan will need to be formulated
2	5%	-$38,697.00	-$1,934.85	The project will be delayed as the equipment will need to be repaired or new equipment will need to be shipped and installed
3	15%	-$7,311.44	-$1,096.72	The project will be delayed as the equipment will need to be repaired or new equipment will need to be shipped and installed
4	30%	-$8,599.90	-$2,579.97	The project will be delayed as modifications will be required to the robotic arms and the test taken again
5	25%	$0	$0	The cost of delay will be covered by including late penalties in the supplier's contract
6	5%	$	$	The project will be delayed
7	2%	-$4,300.00	-$86.00	Unlikely, however contingency has been included to cover the cost of delay
8	10%	$0	$0	The cost will be covered by the contractor
9	5%	-$1,603.92	-$80.20	The flow diagram will need to be updated and reviewed again
10	10%	-$5,000.00	-$500.00	The layout will need to be updated and reviewed again
11	20%	-$3,870.00	-$774.00	The system requirements will need to be updated and reviewed again
12	20%	-$1,290.00	-$258.00	The specification requirements will need to be updated and reviewed again
13	25%	-$15,049.79	-$3,762.45	The RFP and RFQs will need to be reviewed again
14	5%	-$1,290.00	-$64.50	The schematic will need to be updated and reviewed again
15	20%	-$4,386.96	-$877.39	The software design is highly experimental and specification requirements might change over time
16	10%	$0	$0	The cost will be covered by the contractor
17	5%	$0	$0	Any amendments due to poor installations will be carried out by the contractor at their expense
18	15%	-$2,500.00	-$375.00	Additional fixtures and equipment mount may be required after the renovation as MM is a new technology
19	40%	-$284,200.00	-$113,680.00	Equipment prices may vary from the estimated cost as MM is a new technology
20	10%	-$2,580.00	-$258.00	The procurement document will need to be updated and reviewed again
21	40%	-$12,900.00	-$5,160.00	Since MM cell is a new innovative project, it is highly probable that bugs and errors will be found in the system development process which will need to be resolved
22	30%	-$116,100.00	-$34,830.00	MM cell is a new innovative project, it is highly probable that initial tests of its various components might fail and modifications will be required
23	50%	-$69,362.40	-$34,681.20	MM is a new innovative manufacturing technology; it is likely that MM cell might fail its initial tests and require retrials after modifications
24	5%	$0	$0	Material clean-up cost will be covered by the contractor
25	5%	-$5,000.00	-$250.00	New facility layout plan will need to be formulated
26	5%	-$31,700.00	-$1,585.00	
27	5%	-$12,899.85	-$644.99	
28	10%	-$3,010.00	-$301.00	
Total expected value			-$ 204,279.26	