# PROJECT MANAGEMENT PLAN

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|---|---|---|---|
| • Purpose of Project<br>• Definitions and Abbreviations<br>• Project Charter<br>• Scope Statement<br>• WBS<br>• Cost & Duration Estimates<br>• Schedule<br>• Network Diagram<br>• Human Resource Plan<br>• Time Phased Budget & Contingency Reserve<br>• PMP document template | • Cost & Time estimate<br>• Network Diagram & Schedule<br>• Human Resource Plan | • Purpose of Project<br>• WBS<br>• Estimates of time<br>• Network diagram<br>• Final adjustment | • Risk Identification<br>• RBS<br>• Risk Matrix Response |
| **SHAN CHEN (z5165980)** | **Xinyue Wang (z5169707)** | **Haochen Sun(z5149571)** | **Possawee Chitsombun(z5144641)** |
| • Human Resource Plan<br>• HR project team plan review<br>• Adjust the document | • Human Resource Plan<br>• Stakeholder management and communication plan<br>• Stakeholder list of project charter | • Cost estimate<br>• Stakeholder management and communication plan | • Risk management plan<br>• RMS specification estimation<br>• Material Sensor specification |

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# 1 PURPOSE OF PROJECT

The purpose of the Robot Blacksmith project is to design and build Metamorphic manufacturing (MM) cell that can produce any forged part from a CAD model. It will utilize state of the art technologies in Robotics, Automatic Control and Manufacturing.
The MM cell is the latest generation of the traditional blacksmith's but with higher precision and increased flexibility. It aims to overcome the shortcomings of the additive manufacturing (AM) in terms of low energy efficiency, high cost and increased material waste when dealing with high performance metals with extended fatigue life.
The project will utilize existing infrastructure and services at UNSW and will serve as basis for further research on which the forging process will be completely unattended by means of Artificial Intelligence and Machine learning.
The project brings many benefits to UNSW researchers, academic staff, professional staff, management, and strategic partners. It aims at making UNSW a world leading research institute as per UNSW 2025 vision and strategy.

# 2 DEFINITIONS & ABBREVIATION

| | | | |
|---|---|---|---|
| COTS | Commercial of the Shelf | IFS | Induction Furnace System |
| CDS | CAD Decoding System | DBMS | Database Management System |
| PLC | Programmable Logic Controller | PMP | Project Management Plan |
| PO | Purchase Order | MOM | Minutes of Meeting |
| KOM | Kick Off Meeting | P&C | Procurement and Contracts |

# 3 PROJECT CHARTER

## 3.1 PURPOSE OF PROJECT (Refer to PMP)

## 3.2 PROJECT SCOPE (Refer to PMP)

## 3.3 PROJECT RISKS (Refer to PMP)

## 3.4 SCHEDULE & BUDGET (Refer to PMP)

## 3.5 STAKEHOLDERS

### 3.5.1 Stakeholder List

If a project can be completed on time within budget and cost and satisfied the performance, identified stakeholder is very important in the beginning of project management. It is because this project should align with the foremost expectations of the project owner.

Primary stakeholders:

- **Convener:**
  The project application which apply this project to UNSW is from the convener. Therefore, the convener is leader and is high level stakeholder in this project.

- **Student who directly benefit from the MM cell:**
  o **Future**: Future students at UNSW could consider study about MM cell when choosing a research direction.
  o **Current**: This project provides current students with a unique learning experience as well as the opportunity to pursue cutting-edge research & developing bespoke industry skills. In addition, it also provides a new research area for student to study.
  o **Alumni**: A mount of alumni sustained increase due to graduation from UNSW. Alumni who work on the MM Cell leave the university with unique skills in a potentially budding industry. This feeds back into the university through the alumni community, by providing resources, talks & expert training to university, and thus directly affecting research outcomes.
- **Staff who directly benefit from the MM cell:**
  o **Academic staff**: Academic staff could use equipment of this project to make research collaboration.
  o **Professional staff**: professional staff could make plan to teach an innovation curriculum for student. This project can support equipment and technology in new area.
- **Project team**:
  The project team take charge of the management of the project and make the plan cover the whole project. It includes project management team, design team etc.. This project team develop the project completion which is satisfied the requirement of time, cost and performance from sponsors. In addition, the project team can gain experience and benefit from the project
- **UNSW School of Mechanical and Manufacturing Engineering**
- **UNSW Engineering faculty**
- **UNSW Management** - The stakeholders here to engage are University upper management
- **Sponsor-Strategic partnership organizations** (e.g. corporations who provide scholarships/funding in exchange for access to academic and physical resources afforded by the project)

Secondary stakeholders:

- **Other school** (e.g. student and profession from other school to visit and communication)
  If other school have same project. It can with UNSW become a big community to share information.
- **Research alliances and councils**

Minor stakeholders:

- **General public**, e.g. people who directly benefit from use cases of MM (maybe doctors/patients whose biomedical equipment benefits from MM), or people who indirectly benefit from its impact (social, economic, etc.)
- **Australian government & policy makers**
- **Industrial manufacturing Organizations** who will use this technology for mass production

### 3.5.2 Definition of Success (Project Benefits)

The below table lists some of the benefits of the project and how they are aligned with UNSW 2025 strategy and future vision.

| Benefit | Stakeholders | UNSW 2025 Strategy |
|---|---|---|
| Provide cutting-edge facilities to researchers to carry out leading research & education | Academic Research & Teaching Staff, Students, School of Manufacturing Engineering | UNSW to become world leader in research and education excellence (Section A1, A2) |
| MM can be integrated into coursework | Academic Teaching Staff, Students | UNSW educational excellence (Section A2) |

| | | |
|---|---|---|
| Provide a higher funding stream as well as research citations based on University research funding metrics | UNSW Management, Academic Research Staff | Partnerships that facilitate UNSW strategy (Section C2) |
| Provide unique training and skills | Student, researcher | UNSW educational excellence (Section A2) |
| Provide location & facility for external research and exchange of ideas and research from other universities or research institutions | Student, Other schools | UNSW educational excellence and Knowledge exchange for social progress and economic prosperity (Sections A2,B3) |
| Provide opportunities & integrations with different schools and research groups (e.g. biomedical, CSE). | Researchers, UNSW, Other research staff, Government | Partnerships that facilitate UNSW strategy (Section C2) |
| Enhance economy by contracting work to local manufacturers etc. for building the machine and establishing industry in the field for possible future MM cells | General public, Australian government | contribution to national and global prosperity through innovative, (Section C2,B3) |
| Reducing material waste, energy consumption, production cost, product development time and product distortion | Industrial manufacturing Organizations, UNSW Management, Australian Government | Leading the debate on Grand Challenges and Knowledge exchange for social progress and economic prosperity (Sections B2,B3) |
| Appeal to larger prospective student base, thus increasing enrolments, school funding and University global rank and reputation. | Students, Staff, UNSW Management | Operational Effectiveness & Sustainability (Section D2) |
| Uses numerically controlled processes | Students, Staff, Engineering Faculty | UNSW to become world leader in research and education excellence (Section A1, A2) |

# 4 SCOPE STATEMENT

## 4.1 OBJECTIVES

The objective of the Robot Blacksmith project is to improve the forging process by automating the traditional blacksmith forging methodologies by means of MM cells.
The goal of the Robot Blacksmith Project is to design and build prototype MM cell capable of:

- Flexible forging facility (no hard tooling changes used).
- Producing a forged part from a CAD model.

- Forging small batches of high-performance, sustainable, short lead time components.
- Hot forging commercially available Ti alloys and low alloy steels.
- Allowing for future enhancement to automate forging process without any human intervention.

## 4.2 REQUIREMENTS

- The project team shall be highly capable of carrying out this important project. Team members shall possess diverse qualifications including project management (PMP certified), talented software engineers and professional control systems engineer with proper experience in Industrial Automation.
- The MM cell shall use industrial workstation PC installed with licensed CAD software. The CAD software will allow the operator to design the required shape.
- The workstation PC shall be connected to industrial server that shall run a CAD Decoding System (CDS) that is a software code (programmed in house by competent software engineers within the team).The software code shall decode the CAD design and generate a sequence of operations/movements to the robotic manipulation system.
- The robotic manipulation system (RMS) shall be equipped with mechanical arms and manipulators. The system shall also include at least six different forming tools to allow for wide range of components without the need of forging die.
- During the operation of RMS, continuous real time process monitoring, and control is achieved by using fast action programmable logic control system (PLC).
- The PLC system (programmed in-house by professional control system engineer in the team) shall use feedback control scheme to adjust robot movement if required.
- The PLC system will read the measurements from wide range of vision sensors and ensure quick action is taken to guarantee accuracy of the incremental deformation process.
- The PLC system shall also control the material properties and temperature by using a range of sensors including temperature, oxidation, and carburization to control the laser beam used for heating the raw material. This way, the MM cell shall be able to hot forge different types of materials including Titanium alloy, Thermo Plastic, aluminum, and low alloy steels.
- During the forging process, heating the raw material is required. This is achieved by utilizing Induction Furnace System (IFS). The RMS shall be equipped with heat resistant grippers to withstand the furnace temperature.
- The industrial server connected to the PLC shall also be used to store all data and measurements during the forging process. The data can be used by UNSW researchers in the future by means of artificial intelligence and machine learning analysis software.
- The industrial server memory/storage capacity and the PLC memory capacity shall be sufficient for future expansion without the need to replace or upgrade any component.
- Figure 4-1 shows overview of the Blacksmith Robot system components.

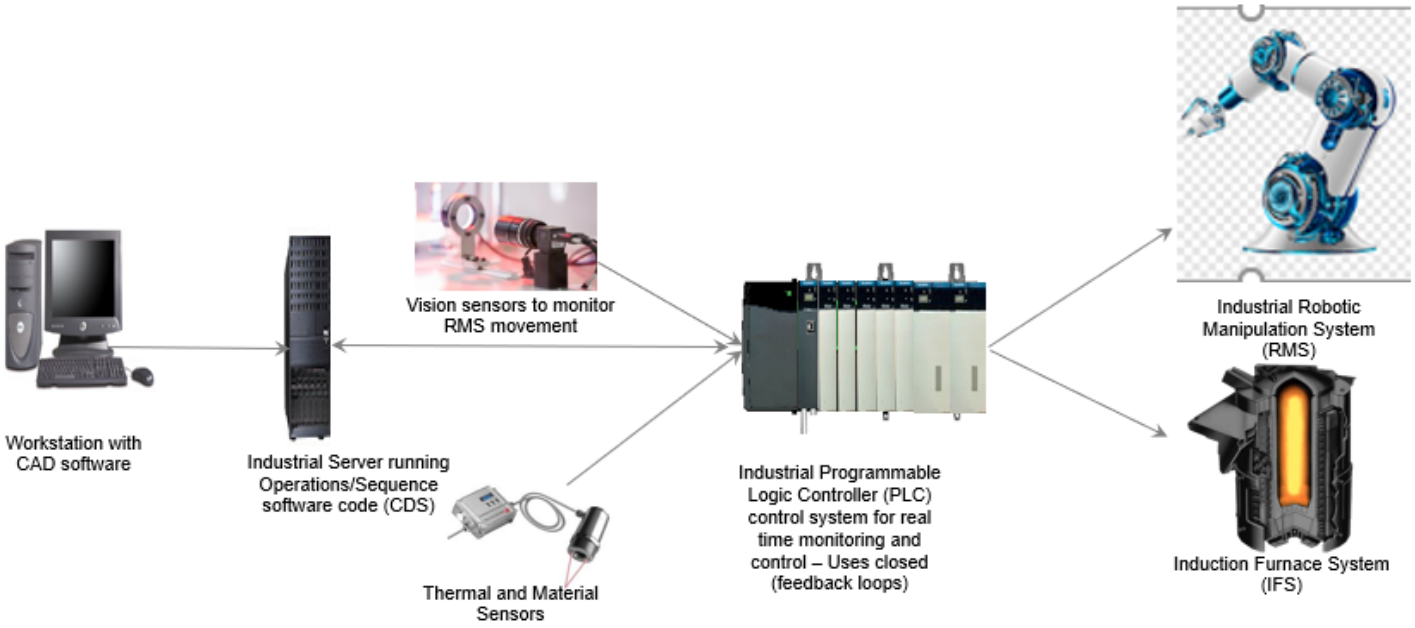



Figure 4-1

## 4.3 DELIVERABLES

### 4.3.1 Design and Engineering

- Integrated System Architecture consisting of high-level diagram of the integrated MM Cell highlighting all different components and their connections. The integrated system architecture shall also include MM Cell Equipment Layout (Lab Layout). To finalize the equipment layout, Lab preparation/renovation must be completed.
- Design and development of CDS including software code (in Python) to include:
  - convert the CAD file to sequence of movements and operations transferred to the robotic manipulation system via the PLC outputs.
  - Contain the database system that will store history data for the RMS and Sensor systems.
- Design and development of PLC control system to include
  - continuous monitoring and control using feedback loops (PID simple loops).
  - Fast action CPU processor of less than 20 MS execution time and 32 MB memory.
  - Equipped with one AI module (8 channels), one AO module (8 channels), one DI module (16 channels) and one DO module (16 channels).
- Design sensor system including vision and material sensors to ensure the forged part meet dimension and material technical specs.
  - Materials Sensors
  - Real-time material dimension detection
  - Stress/Strain estimation
  - Thermal Sensors & real-time thermal monitoring
  - Determine materials deformability
  - Vision & Temperature Sensors

- Inline quality control checks
- Distance-independent measurement for high tolerance on object positioning
- High sensitivity over a small temperature range
- Fast response and easy to use

- Design RMS system consisting of
  - 2 Tending robot arms
  - 1 Polishing/Grinding arm
  - Heat resistant grips
  - 3D-Vision sensors
  - Hydraulic Pressing Machine
  - Jig
  - Rotator
  - Drilling Machine
- Design IFS System consisting of
  - A custom-sized (500mm diameter) chamber to insert forging material into
  - Capable of quickly, reliably, and accurately heating forged materials to ~1000° C

### 4.3.2 Procurement

- Open bid procurement for
  - RMS System
  - PLC System
- Direct procurement for
  - sensor system
  - IFS
  - Raw materials (10 sample sheets of Ti alloys and Lo Alloy Steel)
  - Commercial of the shelf (COTS) IT hardware & Software (Industrial sever, workstation, switches, cables, Windows, CAD and DBMS Licenses etc...)

### 4.3.3 Construction

- Installation of RMS, PLC, Sensor System and IFS.
- Setup CDS System
- Instrument wiring.

### 4.3.4 Commissioning & Handover

- Powering up the RMS and PLC systems.
- Sensors calibration and loop checks.
- On site commissioning.
- Internal testing.
- Site acceptance testing (SAT) signed by customer upon completion of commissioning.
- As-Built Documents.

## 4.4 EXCLUSIONS

- Supply of any hardware or software/licenses not listed in section 4.3.
- Aftersales support and system maintenance are excluded from the scope of this project and shall be quoted separately.
- Training sessions.

## 4.5 ASSUMPTIONS AND CONSTRAINTS

### 4.5.1 Assumptions

- Adequate space is provided in one of UNSW labs with sufficient power and network connections.
- Input feed AC and DC power supply required to power the RMS and PLC shall be provided by UNSW.

### 4.5.2 Constraints

- The design solution shall meet applicable Australian standard safety regulations.
- The PLC logic design shall meet IEC 61131-3 standard for industrial automation.
- The project shall cost less than AUD 2,000,000.

# 5 WBS

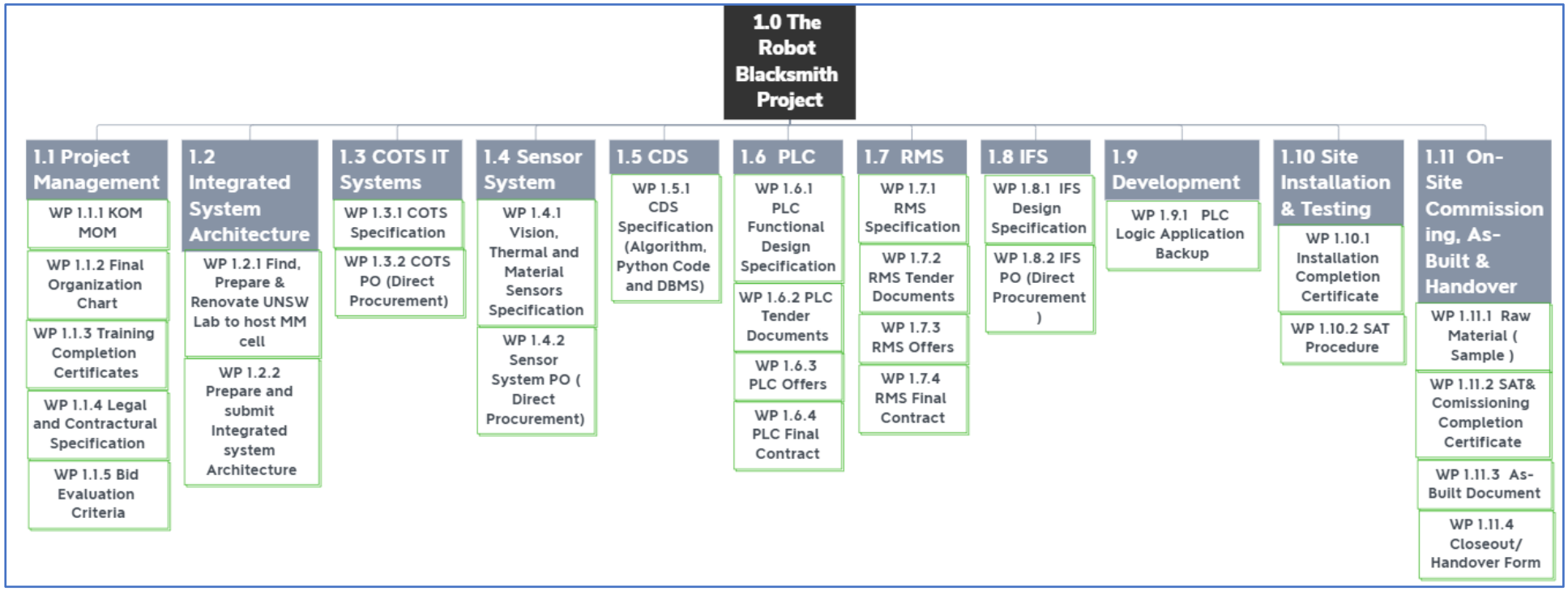



Figure 5-1

Figure 5-1 represents the WBS of the Robot Blacksmith Project. The grey boxes represent the lowest level of deliverables and the green boxes represent the work packages. The work packages were also represented as deliverables (as much as possible), internal sub tasks have been omitted. For example, the final organization chart (WP 1.1.2) has subtasks of (job ad, interviews, recruitment process, etc.) which are not shown in the WBS for simplicity but has been accounted for in the cost and duration estimate in section 6.

# 6 COST & DURATION ESTIMATES

Based on the WBS in section 3 and because this is a fixed price contract, we have used bottom up estimating as represented in table 6-1.

- There are three labor grades considered for this project, UNSW Salary rates and on costs have been used. Technical lead has been added to Grade 1 for simplicity as it should have been included in a grade between 1 & 2.
- Materials and Equipment procurement are either direct procurement for the simple hardware (COTS, Sensors & Furnace) or open bid procurement for the more costly/complicated hardware (PLC & RMS)
- Trainings are either budgeted under their respective tenders (PLC & RMS) or quoted separately.
- Two lump sum contracts have been considered for project work (including all materials and equipment) for the construction work involved in the Lab renovation/preparation and the site installation work.
- Two other lump sum contracts have been considered for training courses/certifications for the Safety Engineer & Software Engineer. Other training courses for the Control System Engineer & Robotics Engineer are budgeted in PLC & RMS tenders, respectively.
- Bottom up (task led) planning has been used to estimate the durations for most of the work packages. Ballpark estimate has been used for the Material sensor specification as more details shall be available during project execution with the help of the academic researcher.

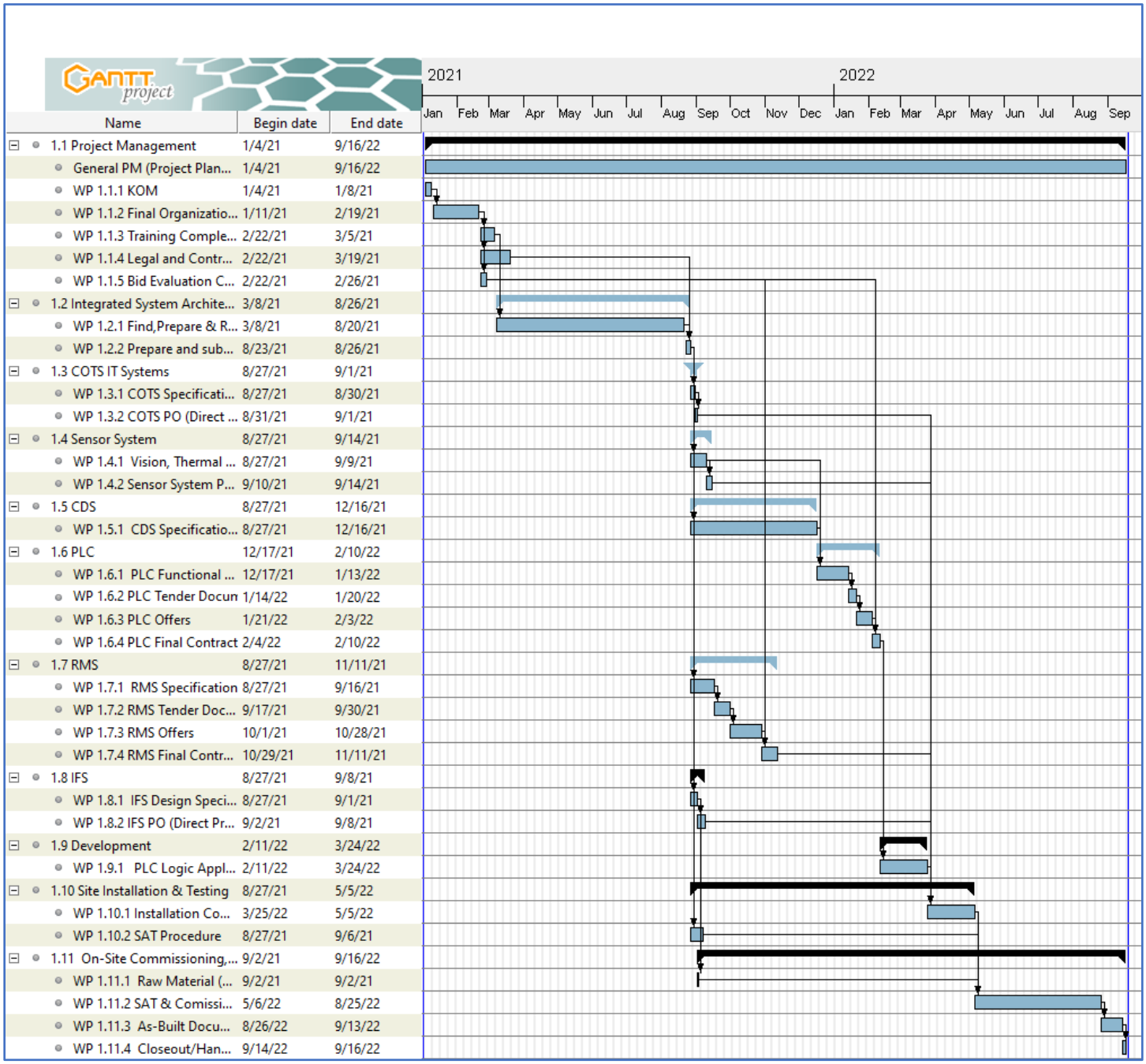
| | Labour | Pay/hour (AUD) |
|---|---|---|
| **Grade 1** | Project Manager / Academic Researcher / Technical Lead | 95 |
| **Grade 2** | Project Engineer(Software/Control System & Robtotics) ,P&C Enginer Contract/Software/Control System Engineers | 70 |
| **Grade 3** | Project Administrator / Document Controller / HR Officer / Instrumentation Technician | 45 |

| WP Code | Item Description | Grade 1 (Hrs) | Grade 2 (Hrs) | Grade 3 (Hrs) | Total Direct Labor Cost | On Cost 21.51% (incl.Super) | Materials & Equipment | Subcontract (Lump Sum) | Duration (Weeks) | Total Cost (AUD) |
|---|---|---|---|---|---|---|---|---|---|---|
| WP 1.1.1 | KOM MOM | 22.5 | 37.5 | 37.5 | $6,450.00 | $1,387.40 | | | 1 | $7,837.40 |
| WP 1.1.2 | Final Organization Chart | 75 | 187.5 | 225 | $30,375.00 | $6,533.66 | | | 6 | $36,908.66 |
| WP 1.1.3 | Training Completion Certificate | | 210 | | $14,700.00 | $3,161.97 | | $30,000.00 | 2 | $47,861.97 |
| WP 1.1.4 | Legal & Contractural Specification | 75 | 150 | 75 | $21,000.00 | $4,517.10 | | | 4 | $25,517.10 |
| WP 1.1.5 | Bid Evaluation Criteria | 15 | 37.5 | 7.5 | $4,387.50 | $943.75 | | | 1 | $5,331.25 |
| WP 1.2.1 | Find,Prepare & Renovate UNSW Lab to host MM cell | 15 | 900 | | $64,425.00 | $13,857.82 | | $85,000.00 | 24 | $163,282.82 |
| WP 1.2.2 | Prepare and submit Integrated system Architecture | 4 | 30 | 7.5 | $2,817.50 | $606.04 | | | 0.8 | $3,423.54 |
| WP 1.3.1 | COTS Specification | 2 | 15 | 7.5 | $1,577.50 | $339.32 | | | 0.4 | $1,916.82 |
| WP 1..3.2 | COTS PO (Direct Procurement) | 2 | 15 | | $1,240.00 | $266.72 | $20,000.00 | | 0.4 | $21,506.72 |
| WP 1.4.1 | Vision, Thermal and Material Sensors Specification | 75 | 75 | 7.5 | $12,712.50 | $2,734.46 | | | 2 | $15,446.96 |
| WP 1.4.2 | Sensor System PO (Direct Procurement) | | 22.5 | | $1,575.00 | $338.78 | $75,000.00 | | 0.6 | $76,913.78 |
| WP 1.5.1 | CDS Specification (Algorithm,Python Code and DBMS) | 22.5 | 600 | 7.5 | $44,475.00 | $9,566.57 | | | 16 | $54,041.57 |
| WP 1.6.1 | PLC Functional Design Specification | 37.5 | 150 | 7.5 | $14,400.00 | $3,097.44 | | | 4 | $17,497.44 |
| WP 1.6.2 | PLC Tender Documents | 15 | 37.5 | 37.5 | $5,737.50 | $1,234.14 | | | 1 | $6,971.64 |
| WP 1.6.3 | PLC Offers | 15 | 75 | | $6,675.00 | $1,435.79 | | | 2 | $8,110.79 |
| WP 1.6.4 | PLC Final Contract | 37.5 | 15 | 37.5 | $6,300.00 | $1,355.13 | $200,000.00 | | 1 | $207,655.13 |
| WP 1.7.1 | RMS Specification | 60 | 112.5 | 7.5 | $13,912.50 | $2,992.58 | | | 3 | $16,905.08 |
| WP 1.7.2 | RMS Tender Documents | 30 | 75 | 30 | $9,450.00 | $2,032.70 | | | 2 | $11,482.70 |
| WP 1.7.3 | RMS Offers | 37.5 | 150 | | $14,062.50 | $3,024.84 | | | 4 | $17,087.34 |
| WP 1.7.4 | RMS Final Contract | 75 | 30 | 75 | $10,725.00 | $2,306.95 | $350,000.00 | | 2 | $363,031.95 |
| WP 1.8.1 | IFS Design Specification | 30 | 30 | 7.5 | $5,287.50 | $1,137.34 | | | 0.8 | $6,424.84 |
| WP 1.8.2 | IFS PO (Direct Procurement) | | 37.5 | | $2,625.00 | $564.64 | $45,000.00 | | 1 | $48,189.64 |
| WP 1.9.1 | PLC Logic Application Backup | 15 | 225 | | $17,175.00 | $3,694.34 | | | 6 | $20,869.34 |
| WP 1.10.1 | Installation Completion Certificate | | 150 | 225 | $20,625.00 | $4,436.44 | $50,000.00 | $40,000.00 | 6 | $115,061.44 |
| WP 1.10.2 | SAT Procedure | 15 | 52.5 | | $5,100.00 | $1,097.01 | $15,000.00 | | 1.4 | $21,197.01 |
| WP 1.11.1 | Raw Materials (Sample) | 2 | 15 | | $1,240.00 | $266.72 | $20,000.00 | | 0.2 | $21,506.72 |
| WP 1.11.2 | SAT & Comissioning Completion Certificate | 75 | 600 | 487.5 | $71,062.50 | $15,285.54 | $15,000.00 | | 16 | $101,348.04 |
| WP 1.11.3 | As-Built Documents | 15 | 97.5 | 7.5 | $8,587.50 | $1,847.17 | | | 2.6 | $10,434.67 |
| WP 1.11.4 | Closeout / Handover Form | 7.5 | 22.5 | 7.5 | $2,625.00 | $564.64 | | | 0.6 | $3,189.64 |
| **TOTAL** | | | | | | | | | | **$1,456,952.01** |

Table 6-1

# 7 SCHEDULE

The project schedule (Figure 7-1) is based on Gantt Chart, the project will start on 4th January 2020 and will end on 16th September 2022.




| Name | Begin date | End date |
|---|---|---|
| 1.1 Project Management | 1/4/21 | 9/16/22 |
| General PM (Project Plan... | 1/4/21 | 9/16/22 |
| WP 1.1.1 KOM | 1/4/21 | 1/8/21 |
| WP 1.1.2 Final Organizatio... | 1/11/21 | 2/19/21 |
| WP 1.1.3 Training Comple... | 2/22/21 | 3/5/21 |
| WP 1.1.4 Legal and Contr... | 2/22/21 | 3/19/21 |
| WP 1.1.5 Bid Evaluation C... | 2/22/21 | 2/26/21 |
| 1.2 Integrated System Archite... | 3/8/21 | 8/26/21 |
| WP 1.2.1 Find,Prepare & R... | 3/8/21 | 8/20/21 |
| WP 1.2.2 Prepare and sub... | 8/23/21 | 8/26/21 |
| 1.3 COTS IT Systems | 8/27/21 | 9/1/21 |
| WP 1.3.1 COTS Specificati... | 8/27/21 | 8/30/21 |
| WP 1.3.2 COTS PO (Direct ... | 8/31/21 | 9/1/21 |
| 1.4 Sensor System | 8/27/21 | 9/14/21 |
| WP 1.4.1 Vision, Thermal ... | 8/27/21 | 9/9/21 |
| WP 1.4.2 Sensor System P... | 9/10/21 | 9/14/21 |
| 1.5 CDS | 8/27/21 | 12/16/21 |
| WP 1.5.1 CDS Specificatio... | 8/27/21 | 12/16/21 |
| 1.6 PLC | 12/17/21 | 2/10/22 |
| WP 1.6.1 PLC Functional ... | 12/17/21 | 1/13/22 |
| WP 1.6.2 PLC Tender Docun | 1/14/22 | 1/20/22 |
| WP 1.6.3 PLC Offers | 1/21/22 | 2/3/22 |
| WP 1.6.4 PLC Final Contract | 2/4/22 | 2/10/22 |
| 1.7 RMS | 8/27/21 | 11/11/21 |
| WP 1.7.1 RMS Specification | 8/27/21 | 9/16/21 |
| WP 1.7.2 RMS Tender Doc... | 9/17/21 | 9/30/21 |
| WP 1.7.3 RMS Offers | 10/1/21 | 10/28/21 |
| WP 1.7.4 RMS Final Contr... | 10/29/21 | 11/11/21 |
| 1.8 IFS | 8/27/21 | 9/8/21 |
| WP 1.8.1 IFS Design Speci... | 8/27/21 | 9/1/21 |
| WP 1.8.2 IFS PO (Direct Pr... | 9/2/21 | 9/8/21 |
| 1.9 Development | 2/11/22 | 3/24/22 |
| WP 1.9.1 PLC Logic Appl... | 2/11/22 | 3/24/22 |
| 1.10 Site Installation & Testing | 8/27/21 | 5/5/22 |
| WP 1.10.1 Installation Co... | 3/25/22 | 5/5/22 |
| WP 1.10.2 SAT Procedure | 8/27/21 | 9/6/21 |
| 1.11 On-Site Commissioning,... | 9/2/21 | 9/16/22 |
| WP 1.11.1 Raw Material (... | 9/2/21 | 9/2/21 |
| WP 1.11.2 SAT & Comissi... | 5/6/22 | 8/25/22 |
| WP 1.11.3 As-Built Docu... | 8/26/22 | 9/13/22 |
| WP 1.11.4 Closeout/Han... | 9/14/22 | 9/16/22 |

Figure 7-1

# 8 NETWORK DIAGRAM

The network diagram (Figure 8-1) is based on Activity on Node (AON), the critical path is highlighted in red and the total duration of the project is 89 weeks.

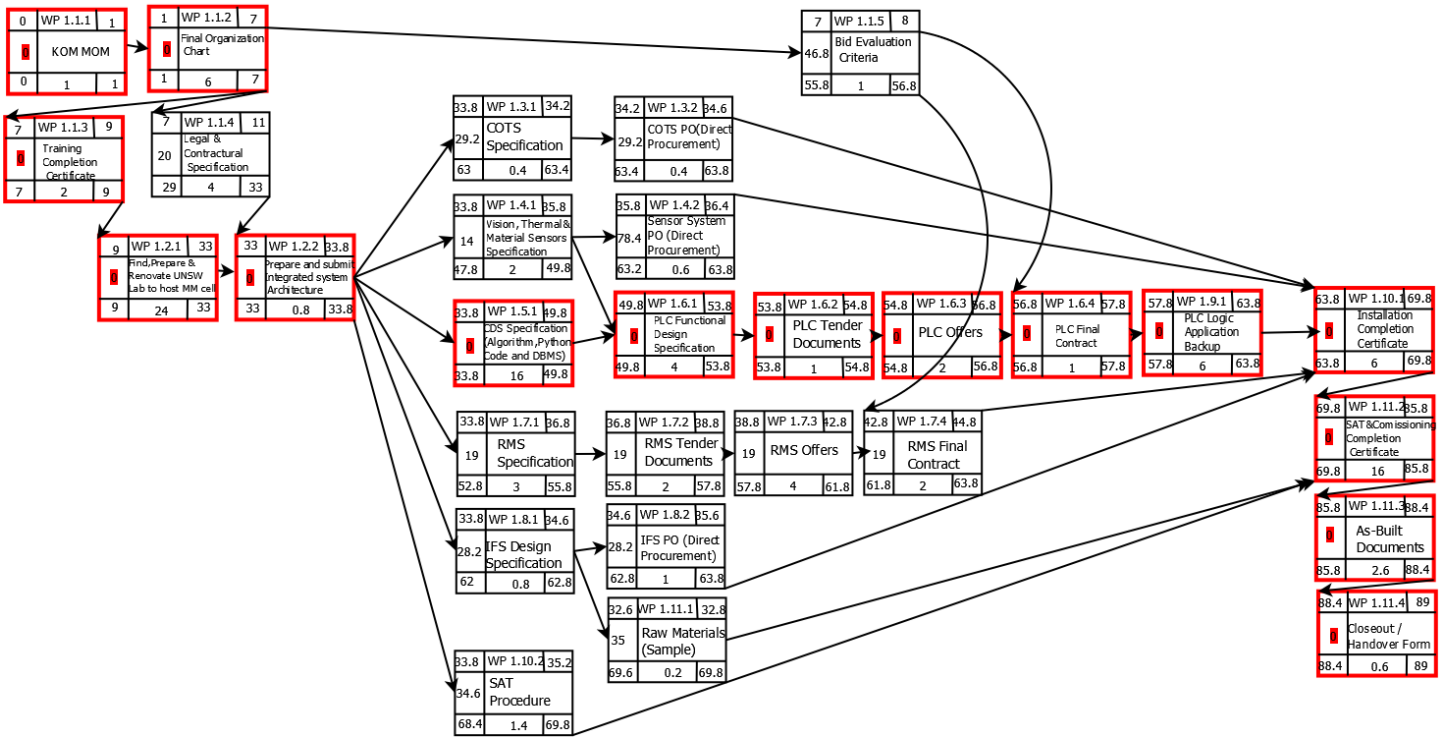



Figure 8-1

# 9 STAKEHOLDER MANAGEMENT & COMMUNICATIONS PLAN

## 9.1 STAKEHOLDER MANAGEMENT:

In this project, objective and benefit is need stakeholder to identified. The engagement level of stakeholders shows below.

| Name | Unaware | Resistant | Neutral | Supportive | Leading |
|---|---|---|---|---|---|
| Convener | | | | C | D |
| Project sponsor | C | | | D | |
| Student & Staff | C | | | D | |
| Project team | | | | CD | |
| UNSW School of Mechanical and Manufacturing Engineering | C | | | D | |
| UNSW Engineering faculty | C | | | D | |
| UNSW management | C | | | D | |
| Other school | C | | D | | |
| Research alliances and councils | C | | D | | |

C = Current position
D = Desire position

In figure 9.1-1 and figure 9.1-2, diagrams illustrate the two distribution of stakeholders: ability to change outcomes and concern about outcomes. Each of them is associated with level of authority. Communication frequency as shown in figure 9.1-3.

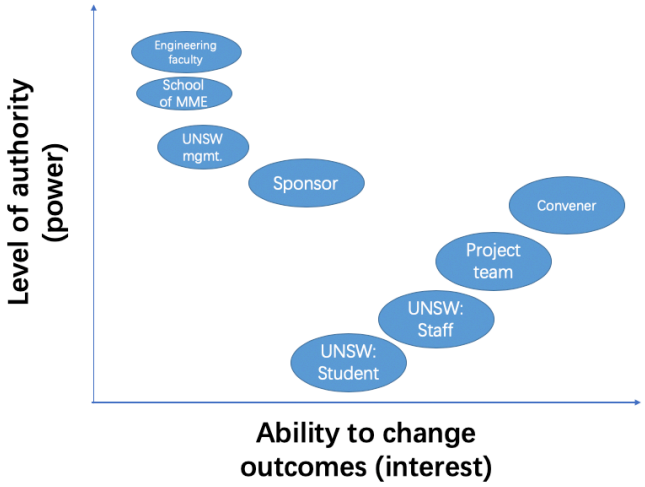



Figure 9.1-1

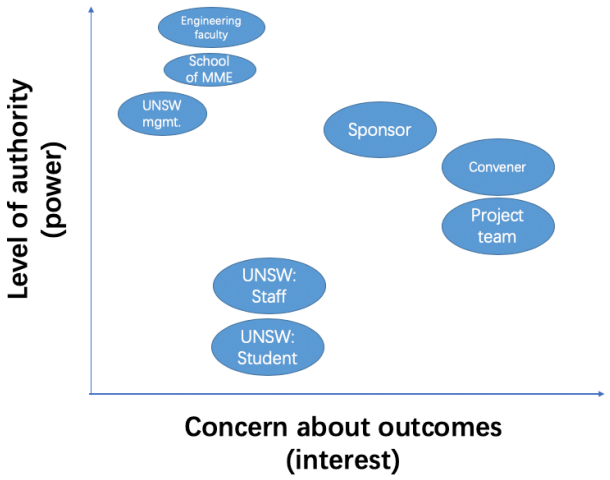



Figure 9.1-2

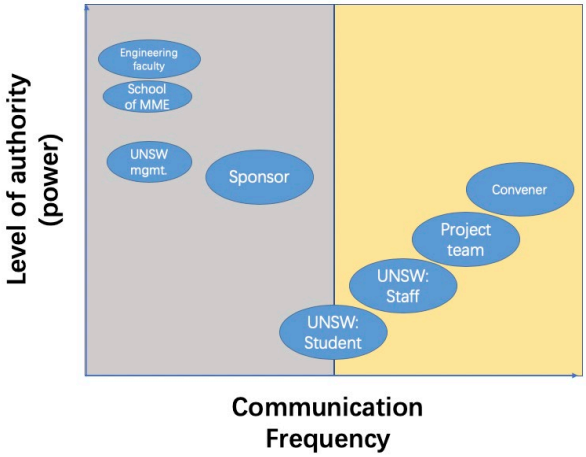



Figure 9.1-3

## 9.2 COMMUNICATION PLAN:

The detail of the community plan shows below.

| Information to be shared | Target individual & team | Date & Frequency | Method of Communication | Provider | The reason of communication | Expected feedback |
|---|---|---|---|---|---|---|
| Project objective and anticipated benefits | UNSW & sponsors | Before the beginning of project management, Once | Online video conference | Convener | Project application | Project approval |
| Requirement & Budget | Project manager | Before the beginning of the project management, Once | Email | Convener & UNSW & Sponsor | Negotiate the budget | Project management plan |

| | | | | | | |
|---|---|---|---|---|---|---|
| Milestone confirmation | Convener | In the early stage of the project management, Once | Online video conference | Project manager | Progress report | Give feedback of milestone |
| Project Charter | UNSW & Sponsor & Convener | In the early stage of the project management, Once | Online video conference | Project manager | Submit preliminary plan | Give feedback |
| Data gathering | Project management team | In the early stage of the project management, Once | Online meeting | All members | Obtain experience from historic project | None |
| Data gathering | Stakeholder & Project manager | In the early stage of the project management, Once | Questionnaire | Stakeholder | Collect ideas from general public | None |
| Project management plan | Convener | In the early stage of the project management, It depends on the statements | Online deliverable | Project manager | To understand the whole project plan | Correct project direction |
| Expert judgment | Project manager | After the completion of the project management plan, Once | Interview & Report | Experts | To know the feasibility and the problem in this project plan | Comments and suggestions |
| Requirement & Restriction | Engineer team | At the beginning of every stage, It depends on the statements | Interview & Online video conference | Project manager | Guide project process | mission report |
| Status Report | Project Manager | After project management plan, Once a week | E-document | Project Team Members | To keep PM handling latest status | Permission of next stage |
| Status Report | Convener | After project management plan, Month a week | Paper & Presentation | Project manager | To keep convener up to date | None |
| Emergency status | Project management | After project management plan, Timely | Phone call | Person in charge | If having some problems in the processing execution | Give solutions |

# 10 HUMAN RESOURCE PLAN

For this project, the human resources will be a combination of in-house competent resources within Group-7 (blue blocks) and external resources that shall be recruited (pink boxes). Recruitment will follow UNSW standard process. Figure 10-1 shows the organization chart.

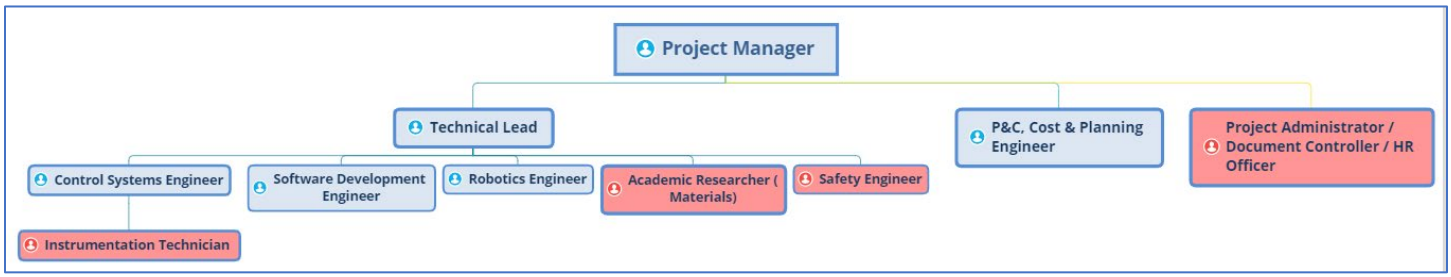



Figure 10-1

The RACI matrix in Figure 9-2 highlights the roles for each team members with respect to project deliverables

| WP Code | Item Description | Project Manager | Technical Lead | Software Development Engineer | Control Systm Engineer | Robotics Engineer | Academic Researcher (Materials) | Safety Engineer | P&C, Cost & Planning Engineer | Project Administrator / Document Controller / HR Officer |
|---|---|---|---|---|---|---|---|---|---|---|
| WP 1.1.1 | KOM MOM | A | C | I | I | I | I | I | I | R |
| WP 1.1.2 | Final Organization Chart | A | R | | | R | | | | R |
| WP 1.1.3 | Training Completion Certificate | | A | R | R | R | | R | | |
| WP 1.1.4 | Legal & Contractural Specification | A,R | C | I | I | I | I | I | R | R |
| WP 1.1.5 | Bid Evaluation Criteria | A | R | | C | C | | | C | R |
| WP 1.2.1 | Find,Prepare & Renovate UNSW Lab to host MM cell | I | A | I | C | R | C | C | | |
| WP 1.2.2 | Prepare and submit Integrated system Architecture | C | A | R | R | R | R | R | I | R |
| WP 1.3.1 | COTS Specification | I | A | R | | | | | | R |
| WP 1..3.2 | COTS PO (Direct Procurement) | C | C | C | | | | | A,R | |
| WP 1.4.1 | Vision, Thermal and Material Sensors Specification | I | A | | C | | R | C | | R |
| WP 1.4.2 | Sensor System PO (Direct Procurement) | I | C | | I | | C | | A,R | |
| WP 1.5.1 | CDS Specification (Algorithm,Python Code and DBMS) | I | A | R | C | C | | | | R |
| WP 1.6.1 | PLC Functional Design Specification | I | A | C | R | C | C | C | | R |
| WP 1.6.2 | PLC Tender Documents | C | C | | C | | | | A,R | R |
| WP 1.6.3 | PLC Offers | I | A | | R | C | C | | R | |
| WP 1.6.4 | PLC Final Contract | A | C | | | | | | R | R |
| WP 1.7.1 | RMS Specification | I | A | I | C | R | R | R | | R |
| WP 1.7.2 | RMS Tender Documents | C | C | | | C | | | A,R | R |
| WP 1.7.3 | RMS Offers | I | A | | C | R | R | R | R | |
| WP 1.7.4 | RMS Final Contract | A | C | | | | | | R | R |
| WP 1.8.1 | IFS Design Specification | I | C | | I | C | R | R | | R |
| WP 1.8.2 | IFS PO (Direct Procurement) | C | C | | | | C | | A,R | |
| WP 1.9.1 | PLC Logic Application Backup | I | C | C | A,R | C | C | C | | |
| WP 1.10.1 | Installation Completion Certificate | A | R | C | C | C | C | C | | R |
| WP 1.10.2 | SAT Procedure | C | A | R | R | R | R | R | | R |
| WP 1.11.1 | Raw Materials (Sample) | I | C | | | | C | C | A,R | |
| WP 1.11.2 | SAT & Comissioning Completion Certificate | A | R | R | R | R | R | R | | R |
| WP 1.11.3 | As-Built Documents | C | A | R | R | R | R | R | | R |
| WP 1.11.4 | Closeout / Handover Form | A,R | C | | | | | | | R |

Figure 9.2

## Position Descriptions

All candidates for these roles will require great oral and communication skills, problem solving and moderate to high level of experience due to the small size of the team.

### Project manager:

*Responsibilities*: Fully responsible for planning project management objectives, formulating team planning and project implementation plan, assisting project bidding, procurement management, construction management (safety, quality, progress, cost control), contract management, information management and coordination and communication. They will also be the primary source of communication to stakeholders.

- *Experience*: Must have extensive previous experience in project management, preferably in an academic setting.
- *Duration*: Full project, 2 years, Full-Time

### Technical lead:

- *Responsibilities*: Will act as the Engineering Team's lead and will accordingly manage all engineers and coordinate the requirements of each post, relaying to and from the PM.
- *Experience*: Must have extensive engineering experience, and some experience in either robotics, software or mechanical engineering. Must have experience managing too
- *Duration*: Full project, 2 years, Full-Time

**Project Administrator / Document Controller / HR Officer**:

- *Responsibilities*: This is a multi-disciplinary role which will take charge of human resources and logistics and organize regular meetings to coordinate and solve problems arising in the project. They will also administrate for the PM and oversee documentation.
- *Experience*: Required for this role is someone with adequate experience in HR in an academic setting as well as experience with general administrative work. Understanding of engineering and project management desirable.
- *Duration*: Full project, 2 years, Full-Time. This role can be a secondment role provided inside the non-academic UNSW staff structure.

**P&C, Cost & Planning Engineer**:

- *Responsibilities*: This engineer will be responsible for procurement, tenders and tracking the associated costs for the PM.
- *Experience*: 3+ years of experience in a well-managed engineering team. Knowledge of PM practices valued.
- *Duration*: Full project, 2 years, Full-Time.

**Control Systems Engineer**:

- *Responsibilities*: Will be the engineer responsible for the PLC system.
- *Experience*: Ability to read and interpret P&IDs, control narratives diagrams and other I&C engineering documentation. Sound technical knowledge and experience working with industrial PLC systems.
- *Duration*: Full project, 2 years, Full-Time

**Robotics engineer**:

- *Responsibilities*: This engineer is responsible for the specification, integration, and installation of the different robotic components.
- *Experience*: Multiple years' experience in cutting-edge robotics labs.
- *Duration*: Full project, 2 years, Full-Time.

**Software Development Engineer**:

- *Responsibilities*: This engineer is responsible for the development of the CAD sequence generation in the CDS System, as well as embedded modular code to robot components. They will also be responsible for logging of historical data from sensors, IFS and RMS.
- *Experience*: Experience with IoT, networking, modular design and test-driven development essential. 4+ Years Experience required
- *Duration*: Full project, 2 years, Full-Time

**Academic Researcher (Material Engineering)**:

- *Responsibilities*: Responsible for keeping the engineering team informed of relevant research opportunities while helping the School of Manufacturing Engineering begin certain high priority research projects.
- *Experience*: Experience as a published researcher leading research projects
- *Duration*: Full project, 1 years, Full-Time. Source directly from the university and from the school

**Safety Engineer**:

- *Responsibilities*: Safety Engineer responsible for all kinds of safety and environmental problems in the process of engineering, such as operation specification, personnel safety, etc.
- *Experience*: Experience designing safety specifications and administering safety advice on multiple industrial projects
- *Duration*: From tender contract handover, 1.5 year, Full-Time.

**Instrumentation Technician**:

- *Responsibilities*: This role involves the wiring of the sensors and other general instrumentation maintenance and installation assistance.
- *Experience*: Setting up robotic components in an industrial setting. 5+ years experience.
- *Duration*: From installation phase onwards, 1 year, Part-Time.

**TRAINING**

The following roles will require training:
Safety engineer:

- RMS safety certificate. This will involve a 5 days training course provided by the RMS system contractor during system handover.
- IFS 1 week safety training course. This must be acquired from a certified training provider

Robotics Engineer

- RMS safety certificate as provided in tender.
- Robotics Technician certification. This must be acquired from a certified training provider.
- UNSW robotics course MTRN 4110. An optional supplementary UNSW course to provide educational help and appeal to prospective applicants

Control Systems engineer

- PLC Design & Engineering course by the PLC Original Equipment Manufacturer (OEM)
- UNSW advanced control systems course ELEC4632. An optional supplementary UNSW course to provide educational help and appeal to prospective applicants.

Software Development engineer

- UNSW IoT security course ZEIT8023. An essential training requirement to ensure the security of the software.
- UNSW Embedded Systems Design course ELEC4601. An essential UNSW course provided to ensure design and architecture practices are in line with current best practices.

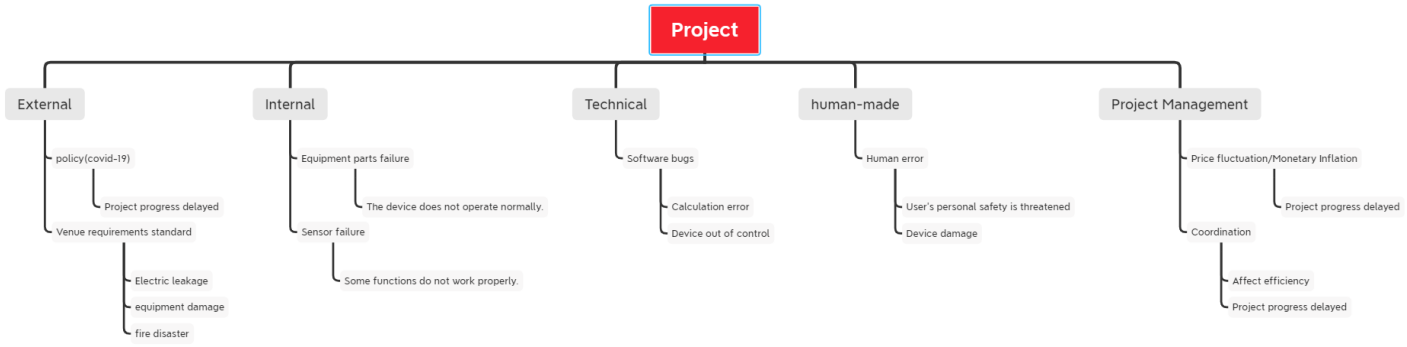
# 11 RISK MANAGEMENT PLAN

## 11.1 ROLES AND RESPONSIBILITIES

Risk Identification: Project Team Members
Risk Registry: Project Manager
Risk Assessment: Project Team Members
Risk Contingency Plan: Project Manager
Risk Response: Project Manager & Project Team Members
Risk Reporting: Project Manager

## 11.2 RISK IDENTIFICATION

RBS Chart:




### Risk 1: Human error

**Description:** If the user does not operate the equipment according to the operation process, it may cause unpredictable safety hazards, such as personal safety and equipment damage, thereby increasing the overall project cost and even affecting the project schedule.

**Solution:** Make operation documents. Before using the equipment, users need to fully understand the entire operation process and operate the equipment according to the process.

### Risk 2: Government Policy Impact (Covid-19)

**Description:** A global influenza outbreak that is an uncontrollable factor will seriously affect the progress of project development, resulting in the failure of the entire project. Because of the outbreak of the global pandemic, the government will impose a strict ban on social isolation, and schools must respond. Therefore, project developers must abide by the social isolation ban and stop all possible face-to-face work.

**Solution:** The person in charge of the project should make timely remedial measures in the face of the isolation ban issued by the government. For example, project participants cannot work offline, so some projects can be carried out online. With the gradual release of the isolation policy, the project manager needs to adjust the priority of some project schedules according to the project time plan.

### Risk 3: Monetary Inflation / Price Fluctuation

**Description**: Since the project duration takes about 2 – 3 years, the money inflation also plays a big part in the budget calculation. The price of many item and materials required on the project can be fluctuate thus, it is crucial to consider about this.

**Solution:** In case of the budget overrun by the inflation. First, the team should reserve contingency budget just in case. reconsider about the procurement of each systems which is not very necessary to the project. To reduce as much cost as possible and make the less impact into the project as possible.

### Risk 4: Venue requirements standard

**Description:** The laboratory site conditions are not up to standard, the equipment electrical is not grounded, and the protection device fails, resulting in the equipment operating under abnormal conditions, which may eventually cause damage to the entire equipment. Affect the project schedule.

**Solution:** Improve the laboratory site conditions, set up protective devices, and regularly check whether the safety device is working properly to prevent equipment damage.

### Risk 5: Project Team Coordination

**Description:** If the project manager cannot effectively coordinate the tasks of each member of the project, it will cause serious consequences for the development of the entire project, and even directly lead to the failure of the project.

**Solution:** In the initial stage of the project team formation, it is necessary to select project personnel with strong collaborative working ability. Good communication and collaborative working ability have a positive effect on the promotion of the entire project.

### Risk 6: Sensor failure

**Description:** The sensor may be damaged by accident. As a result, the equipment cannot operate normally.

**Solution:** Prepare spare sensors. When the sensors on the equipment are damaged due to accidents, replace them in time.

### Risk 7: Software bugs

**Description:** Some software bugs in the computer algorithm may lead to miscalculations and the task cannot operated correctly. Some irreversible operations may even cause damage to the entire device and cause the project to fail.

**Solution:** Install an emergency manual brake button to protect in time when the equipment cannot stop and install a rubber buffer device to protect the safety of the equipment. Prevent equipment damage and economic losses, resulting in project failure.

### Risk 8: Equipment parts failure

**Description:** There will be a heating process during the operation of the equipment, and some parts may be irreversibly deformed during the process of high temperature and thermal expansion and contraction.

**Solution:** Identify the parts that are easily deformed by high temperature and prepare spare parts to be replaced in time when they fail.

### Risk 9: Human Resources Failure

**Description:** On human resources risk aspect. There are many involving risks such as, the position which we were looking for cannot be filled, training for new employee takes too much time, new employee has in appropriate skills.

All of this will greatly impact the project progression.

**Solution:** The team can use a contract worker or freelance while looking for a permanent employee or training new employee. It might increase the budget. However, it can minimize the impact from human resource lacking.

## 11.3 RISK ASSESSMENT MATRIX

This is the assessment for the impact of the risk which might happen into the project. Risks will be rated into each category. Then it will be giving the chance of occurring rating to determine the risk impact.

**Occurring Chance Table.**

| Occurring Chance | Value |
|---|---|
| Very Likely (81-100%) | 5 |
| Likely (61-80%) | 4 |
| Moderately (41-60%) | 3 |
| Unlikely (21-40%) | 2 |
| Very Unlikely (0-20%) | 1 |

| Probability of Occurrence | | Disaster | Critical | Moderate | minor | Negligible |
|---|---|---|---|---|---|---|
| Chance | Value | A | B | C | D | E |
| Very Likely | 5 | 5A | 5B | 5C | 5D | 5E |
| Likely | 4 | 4A | 4B | 4C | 4D | 4E |
| Moderate | 3 | 3A | 3B | 3C | 3D | 3E |
| Unlikely | 2 | 2A | 2B | 2C | 2D | 2E |
| Very Unlikely | 1 | 1A | 1B | 1C | 1D | 1E |

### 11.4 RISK RESPONSE MATRIX

| Risk No. | Risk Code | Risk Event | Likelihood | Impact | Detection difficulty | Risk Management strategies | Response |
|---|---|---|---|---|---|---|---|
| 1 | 3B | Human error | 3 | 4 | 2 | Mitigate | Familiarity with operating documentation is required before operation |
| 2 | 4A | Government Policy Impact (Covid-19) | 4 | 5 | 3 | Accept | Adjust the planning sequence appropriately |
| 3 | 2B | Monetary Infiltration/Price fluctuation | 2 | 4 | 3 | Accept | Contingency budget, reduce unnecessary expenses |
| 4 | 1D | Venue requirements standard | 1 | 2 | 1 | Mitigate | Timely negotiate with venue personnel to upgrade venue conditions |
| 5 | 2C | Project Team Coordination | 2 | 3 | 1 | Mitigate | Screening qualified people in advance |
| 6 | 1E | Sensor failure | 1 | 1 | 1 | Accept | Prepare spare sensors |
| 7 | 2C | Software bugs | 2 | 3 | 3 | Mitigate | Debug and set emergency stop equipment |
| 8 | 1D | Equipment parts failure | 1 | 2 | 1 | Accept | Prepare spare parts |
| 9 | 2C | Human resources failure | 3 | 2 | 1 | Accept | HRs hire qualified people |

In Risk Response Matrix, we outlined how we are going to deal with each of the risks identified. From the analysis of risk response matrix, Risk3, Risk4, Risk5 and Risk6 should we address firstly. Separately, Risk4 and Risk5 are responsible by project manager. They need to select qualified personnel (good communication and coordination ability, etc.) in advance, and then Team members must be trained (equipment usage process, etc.). Risk3 is responsible by team members, they should timely negotiate with suppliers, update venue conditions in time. Risk6 may cause serious consequences. Which is responsible by software developers and testers, they should adequate testing need to be done before the project is delivered.

# 12 TIME PHASED BUDGET (QUARTERLY) AND PROJECT CONTINGENCY RESERVE BUDGET

**Figure 12.1** shows the time phased budget in both tabular and graphical forms, we can see the highest cost is in July 2020 Quarter due to the procurement of the RMS System.

| WP Code | Item Description | Total Cost (AUD) | Jan-20 | Apr-20 | Jul-20 | Oct-20 | Jan-21 | Apr-21 | Jul-21 |
|---|---|---|---|---|---|---|---|---|---|
| WP 1.1.1 | KOM MOM | $7,837.40 | 7,837.40 | | | | | | |
| WP 1.1.2 | Final Organization Chart | $36,908.66 | 36,908.66 | | | | | | |
| WP 1.1.3 | Training Completion Certificate | $47,861.97 | 47,861.97 | | | | | | |
| WP 1.1.4 | Legal & Contractural Specification | $25,517.10 | 25,517.10 | | | | | | |
| WP 1.1.5 | Bid Evaluation Criteria | $5,331.25 | 5,331.25 | | | | | | |
| WP 1.2.1 | Find,Prepare & Renovate UNSW Lab to host MM cell | $163,282.82 | 163,282.82 | | | | | | |
| WP 1.2.2 | Prepare and submit Integrated system Architecture | $3,423.54 | | 3,423.54 | | | | | |
| WP 1.3.1 | COTS Specification | $1,916.82 | | | 1,916.82 | | | | |
| WP 1..3.2 | COTS PO (Direct Procurement) | $21,506.72 | | | 21,506.72 | | | | |
| WP 1.4.1 | Vision, Thermal and Material Sensors Specification | $15,446.96 | | | 15,446.96 | | | | |
| WP 1.4.2 | Sensor System PO (Direct Procurement) | $76,913.78 | | | 76,913.78 | | | | |
| WP 1.5.1 | CDS Specification (Algorithm,Python Code and DBMS) | $54,041.57 | | | 54,041.57 | | | | |
| WP 1.6.1 | PLC Functional Design Specification | $17,497.44 | | | | 17,497.44 | | | |
| WP 1.6.2 | PLC Tender Documents | $6,971.64 | | | | 6,971.64 | | | |
| WP 1.6.3 | PLC Offers | $8,110.79 | | | | 8,110.79 | | | |
| WP 1.6.4 | PLC Final Contract | $207,655.13 | | | | 207,655.13 | | | |
| WP 1.7.1 | RMS Specification | $16,905.08 | | | 16,905.08 | | | | |
| WP 1.7.2 | RMS Tender Documents | $11,482.70 | | | 11,482.70 | | | | |
| WP 1.7.3 | RMS Offers | $17,087.34 | | | 17,087.34 | | | | |
| WP 1.7.4 | RMS Final Contract | $363,031.95 | | | 363,031.95 | | | | |
| WP 1.8.1 | IFS Design Specification | $6,424.84 | | | 6,424.84 | | | | |
| WP 1.8.2 | IFS PO (Direct Procurement) | $48,189.64 | | | 48,189.64 | | | | |
| WP 1.9.1 | PLC Logic Application Backup | $20,869.34 | | | | 20,869.34 | | | |
| WP 1.10.1 | Installation Completion Certificate | $115,061.44 | | | | | 115,061.44 | | |
| WP 1.10.2 | SAT Procedure | $21,197.01 | | | 21,197.01 | | | | |
| WP 1.11.1 | Raw Materials (Sample) | $21,506.72 | | | | | 21,506.72 | | |
| WP 1.11.2 | SAT & Comissioning Completion Certificate | $101,348.04 | | | | | 30,404.41 | 70,943.63 | |
| WP 1.11.3 | As-Built Documents | $10,434.67 | | | | | | | 10,434.67 |
| WP 1.11.4 | Closeout / Handover Form | $3,189.64 | | | | | | | 3,189.64 |
| **TOTAL** | | **$1,456,952.01** | $286,739.20 | $3,423.54 | $654,144.41 | $261,104.34 | $166,972.57 | $70,943.63 | $13,624.31 |

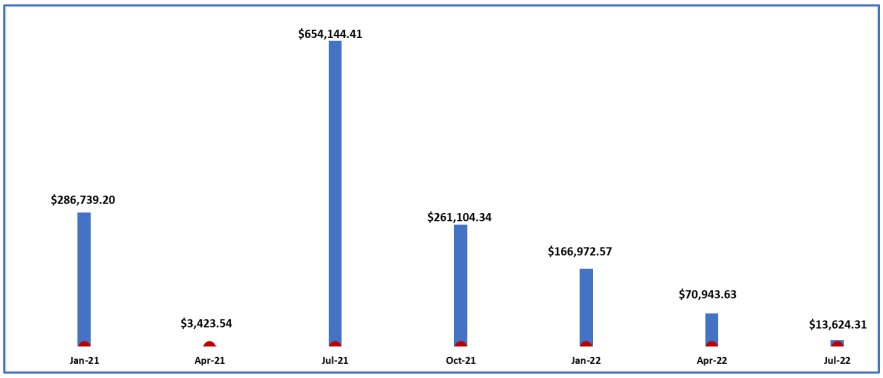



**Figure 12.1**

**Figure 12.2** shows the overall budget of the project considering 20% contingency reserve due to the high risk of this project as this is a new development with no existing prototypes.

| | AUD |
|---|---|
| **Project Cost** | 1,456,952 |
| **20% Contingency Reserve** | 291,390 |
| **Project Budget** | **1,748,342** |

**Figure 12.2**