Project Management Plan for the UNSW Metamorphic Manufacturing Cell

GSOE9820 Group 4

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Key:
PC: Project Charter
WBS: Work Breakdown Structure
RMP: Risk Management Plan
SCM: Stakeholder Communication and Management Plan
CE: Cost Estimation and Budget
SE/ND: Schedule Estimation and Network Diagram
HRP: HR Plan
DS: Definition of Success

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Project Charter

Objective

Design and build a small MM facility for fundamental research into incremental forging [1] and communicate these results with the wider community. This will promote interdisciplinary collaboration and stimulate industry interest in the cutting-edge research carried out at UNSW. Within two years of completion, a diverse range of professionals will share ideas in this research workspace.

Requirements

This project will deliver the UNSW MM cell in its entirety, including its design, procurement, construction and commissioning, under a $2M budget. It will use existing infrastructure and services at UNSW and then provide any further infrastructure and services (e.g. training) as required.

The UNSW MM cell will be able to automatically produce a hot-forged part from a CAD model. Sensors and diagnostic instrumentation provide real-time measurements to the central computer, which converts these feedback measurements into the appropriate control input for real-time quality control of the dimensions and properties of the forged part. The overall control system will be able to produce a wide range of hot forged components from commercially available titanium alloys and low-alloy steels, for a range of industrial applications. The tooling used is generic, so no specific forging die is required.

Constraints

Regulatory

On-site workers must comply with the regulations in the NSW WHS, including safe work procedures involving high voltage electrical equipment, high temperature and other workplace hazards. Sustainability regulations (both social and environmental) must also be followed, in particular those regarding labour laws and waste disposal. Additionally, UNSW policy regarding noise restrictions may prevent work from being done in certain areas of campus during certain times of the day to avoid disrupting normal campus activities.

Technical

All groundwork and installation of utilities are to be performed in accordance with the relevant Australian standards (e.g. plumbing, electrical, etc.). Limited stock or restricted delivery options associated with the residual impact of COVID-19 in 2020 will also have to be navigated.

Stakeholder identification, benefits and deliverables

This project shows excellent alignment with UNSW Strategy, particularly by promoting world leading research with high research impact, as well as enabling domestic and international graduates to be optimally prepared for the opportunities and challenges of the 21st century workplace [2].

The project sponsor, Dr. Xiaopeng Li, would be better able to attract fruitful industry partnerships to stimulate financial and technical backing from external companies with greater resources but the lack of research facilities. The existence of the experimental facility would also attract prospective researchers and PhD students to UNSW from all over the world to perform fundamental research into developing novel techniques in MM. The accumulation of global talent at UNSW would lead to an improvement in the quality and impact of research publications and other research outputs [2].

Researchers in MME and external research partners would benefit from the new collaborative workspace, in which they could freely share results to enable the cross-pollination of diverse perspectives and ideas. The new core research infrastructure delivered by this project would promote this, and would serve as a basis for “technological development and interdisciplinary research between university schools and external research partners” [3]. The inclusion of end-user training, short training videos and documentation would streamline the uptake of the new equipment and enable these benefits to be realised sooner.

Students and student project teams would benefit from the experimental apparatus if the MM cell is used during coursework. Although the development of the actual coursework is out of the scope of this project, students in MME could tackle some of the ‘*grand challenges*’ mentioned in the TMS report [1], and then rapidly prototype their solutions using the available technology. Access to world-leading facilities would help students develop advanced knowledge of modern techniques in manufacturing, as well as inspire creativity. This is a crucial trait of “in-demand graduates”, as set out in the UNSW 2025 Strategy [2].

Scope statement

The project will deliver the necessary groundwork at the facility, the robotic hardware and ancillaries, embedded control software and the induction heater, in addition to the human resources and supporting PM activities required for successful completion. It will also deliver project staff and end-user training, documentation of safety procedures and online training videos, as well as communication of results with the wider community.

This project will not include the convening of a technical advisory body associated with the MM cell, nor deliver a set of standards intended for wider use. It also will not include any academic packages such as scholarships, opportunities for undergraduate or postgraduate thesis study or supporting coursework/course material. The project will also not deliver other auxiliaries like a laser welding station.

This project will prioritise the delivery of a quality research environment to assist UNSW in establishing its research competitiveness in a developing field, under a $2M budget. The possibility of further upgrades has been left open, with provisions made for future work.

	Time	**Performance**	**Cost**
Constrain			X
Enhance		X	
Accept	X		

Table 1: Project Priority Matrix

Assumption Log

Human resources

- “All human resources will be sourced within or recruited into UNSW. Salary rates and on cost are based on UNSW salary rates [4]” [3].
- The existing UNSW HR system (PiMs) is used for payroll management and HR will be managed internally inside UNSW.
- Costs of position advertisement and recruitment are borne by UNSW.
- The payment of other technical and professional staff who are already employed by the University is borne by UNSW.

Training

- Training rooms will be available when required.
- Internal training costs will be borne by UNSW.

Existing infrastructure

- Existing locations at UNSW will be able to be used to securely store project materials.
- Existing (functioning) freight elevators in the School of MME will be used and have sufficient load capacity for the movement of heavy project materials.
- Building space allocations will be reasonably convenient (ground floor preferable) with easy road access.
- Existing servers at UNSW can be acquisitioned for project use for secure storage of project files and documents.
- The floor space of the new facility is nominally $200m^2$.
- Existing furniture at UNSW will be used (and thus is ‘free’).

Budget

- Electricity, water and other running costs will be borne by UNSW.
- The project will have access to the entire allocated funding over the duration of the entire project.
- “Indirect overheads and the management reserve budget will be managed outside your project team” [3].

Regulatory

- The project will adhere to UNSW policy and other government guidelines.
- Costs of safety inspections are borne by UNSW.

Project

- Tradespeople will provide their own tools.
- Security will be provided by existing UNSW Security employees.
- General WHS inductions and safety training will be done by the HSE officer in the School of MME.
- The existing UNSW hazard/incident reporting system in HR will be used at no extra cost.
- We will be renovating a lab space within an existing building in the School of MME and not constructing a new building.
- Costs of stakeholder communication and media will be borne by UNSW.
- At most two tons of project waste will be produced.
- Internal auditing is performed bimonthly at no cost.

Component procurement and delivery

- All parts are paid for at the start of the procurement process.
- It takes a minimum of 28 days (4 weeks) for procurement and (international) delivery.
- It costs nominally $1k for insurance and international delivery.

Component installation:

- It nominally takes 75% of the capital cost of the item for installation and commissioning.

Technical

- All robots already have embedded control software. Thus, forward/inverse kinematics and motion control capabilities are already implemented in the robot (the plant model is implemented internally).
- At most 1km of 120A rated cable is required.
- A 50kVA transformer will be capable of delivering more power than what is required.
- The University already has already procured an academic licence for MATLAB.
- The robotic grippers are heat resistant (negotiated in contract) and can withstand billet temperatures over 1000^oC for extended periods of time.


MM Cell
HR
Recruitment
Job advertisement and candidate selection process
Formation of a back-up labour pool
Training
WHS Induction
Project staff technical training and training materials
End-user technical training and training materials
Finances
Payroll (PiMs)
Project management
Ongoing Stakeholder management
Personalised correspondence
Public relations and media
Supporting PM activities
Administrative paperwork
Obtaining insurance
Organisational system and updates to PM documents
Internal auditing
Interviews with other project teams
Building modifications
Facilities and utilities
Surveying, foundational work and structural modifications
Waste management and acquiring secure storage for project materials
Plumbing and fixtures
HVAC
Electrical and installation of a HV power system
Interior
Decoration and furniture
Safety equipment and signage
Furniture
Safety inspection
Main experimental apparatus
Static robot and ancillaries
Delivery, commissioning and installation of robot and ancillaries
Installation of steel-plated mount, robot and ancillaries
Familiarisation with embedded hardware/software and teach pendant
Machine vision development and closed loop testing
Development of safety procedures and signage
Forging press
Procurement, delivery and installation
Device modification to use a generic die
Precise motion control design
Integrated testing with robot
Mobile robot
Component procurement and delivery
Machine vision and autonomous navigation
Chassis, power systems and propulsion design
Power systems design
Prototyping and performance testing
Workstation computer
Workstation procurement, delivery and installation
Alternatives analysis (distributed computing)
License acquisition and software installation
Software development
Consultation with experts
Software design and execution (GUI development and software integration)
Development of user documentation
Code review and optimisation
Regular meetings
Induction heater
Induction heater selection
Installation, commissioning and testing
EMI testing and installation of required shielding
Welding
Feasibility study
Closing the project
End-of-project communication
Project closure documents, including final report
Stakeholder communications and media
Storage of project knowledge
End-of-project tasks
Final testing and commissioning
Clerical work
Excess project material disposal or recycling
External auditing

Project Threat Management

Threats to project completion were ranked using the following risk severity matrix.

		Severity				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Critical (5)
Likelihood	Very High (5)	5	10	15	20	25
	High (4)	4	8	12	16	20
	Medium (3)	3	6	9	12	15
	Low (2)	2	4	6	8	10
	Very Low (1)	1	2	3	4	5

Key:

1-5	Low risk
6-10	Moderate risk
11-15	High risk
16-25	Extremely high unacceptable risk

Human resources

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
1	Delays in recruitment and human resource procurement	PM Team	L	S	R	L	S	R
			3	4	12	2	2	4

Delays in recruitment are mitigated by a public job advertisement campaign (1 month) and a multi-stage interview process (1 month). Job advertisement can also start earlier so that more expressions of interest can be acquired before selection. A list of known employees for nomination is also constructed; should there be delays in the process, prospective employees can be selected from this list to bypass the selection process.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
2	Employees quitting during the project or leaving due to personal injury	PM Team	L	S	R	L	S	R
			2	5	10	2	4	8

Employee turnover is managed by forming a backup labour pool at the start of the project, during recruitment. To facilitate refamiliarisation in the event of turnover, documentation of work done is enforced (which also assists the auditor). An employee from the back-up labour pool is hired and is allocated to the employee’s partner (employees work in teams, as mentioned below); the combination of documentation and support from the work partner reduces the familiarisation time required. Finally, notices of leave/resignation conditions are negotiated in the contract to allow the PM Team to make the necessary arrangements for replacement.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
3	Employees require more training than expected	PM Team	L	S	R	L	S	R
			4	3	12	4	2	8

One month at the start of the project is also dedicated to basic technical training and the WHS induction for contractors and technical staff. While building renovation works are conducted, senior technical staff may continue technical training for up to four months (senior engineer responsibilities start formally in April, when they assist with equipment procurement). This training is a combination of self-study and attending seminars/workshops conducted by professional staff already employed at UNSW. The training time is paid; provisions have been made in the HR plan for this, as all senior technical staff are brought on in January. Further funding ($80k) has been allocated to external training (provisions for airline tickets, accommodation and food services have been made for short international trips). Performance reviews allow for effective two-way dialogue between employee and the PM team, and are conducted monthly; these build a performance development culture within the team.

Material Procurement and Scheduling

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
4	Errors of omission [5]	PM Team	L	S	R	L	S	R
			4	3	12	3	3	9

Bottom-up estimating is more prone to errors-of-omission than top-down estimates [5]. Mitigation strategies include consultation with technical experts, contacting suppliers early to obtain quotations and interviewing other PM teams who have worked on similar projects [6]. Consultations have been slated to specifically occur between Jan and Apr in 2021, and are also ongoing throughout the duration of the project.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
5	Cost & schedule estimation bias	PM Team	L	S	R	L	S	R
			2	3	6	2	2	4

Cost and schedule estimates are always biased [6]. Interviews with experts, related professional and technical staff and other experienced project management teams who have all worked on similar projects will be conducted (in the time scheduled above) in order to refine estimates. Money can be siphoned from the contingency budget to deal with uncertainty.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
6	Delays in procurement, delivery and component replacement	PM Team	L	S	R	L	S	R
			3	3	9	2	3	6

To minimise the likelihood and severity of delays due to delayed delivery, parts can be procured early and stored in secure locations on campus to minimize the chance of delay. The UNSW procurement team is available to assist with this. Time and funding has also been allocated for physical inspection of components; this will ensure that the equipment is fully functional before shipping. Multiple suppliers can also be approached with tenders to mitigate the severity of delays or losses in transit.

Building Modifications

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
7	Improper renovation/structural work or adverse weather phenomena, resulting in catastrophic damage (flooding, building collapse, fire, explosion etc.)	PM Team	L	S	R	L	S	R
			1	5	5	1	4	4

Flooding due to broken piping or heavy rain could interfere with the setting of concrete and/or damage lab equipment. Training of technical staff could be advanced to February to save on HR costs if this is the case. Weather charts can be consulted to minimise this particular risk (however, it is summer, so this event is unlikely). Structural calculations are authorised before being acted on. Existing fire safety procedures (smoke alarms, etc.) in the building are to be adopted by the new facility. A dust extractor has been budgeted for to reduce the risk of dust explosions. The induction heater also reduces the amount of heat in the facility (the only hot component is the billet itself), further reducing the risk of fire. To reduce the risk of electrical fires, surge protection, HV circuit breakers and protection relays have been budgeted for and are slated for installation. Finally, the impact of noise is reduced by scheduling foundational work to occur at the end of 2020 and at the start of 2021 when there is minimal campus activity.

Technical Risks and Project Delivery

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
8	Components requiring maintenance/repairs during project construction and insufficient documentation of parts leading to delays and confusion [5]	PM Team	L	S	R	L	S	R
			3	2	6	1	3	3

Maintenance and repair may be caused by improper control, lack of safety features (i.e. emergency stop buttons), and improper testing procedures. Repair may infeasible, necessitating replacement (both slow and costly). Contingency funding has been allocated for professional repair costs and backup parts. Expensive hardware is also tested in isolation before integrated testing, i.e. the static robot is tested in isolation without the forging press to minimise the change of damage due to collision. Datasheets should also be properly consulted. Schedule slack can be used for the resolution of issues. As a technical solution, a forging press rather than a power hammer has been used to reduce vibration action on the robot joints, which preserves their longevity. Documentation and labelling of component models will be helpful during future maintenance, repair and component upgrade. This enables part interchangeability for future upgrades [5].

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
9	Communication breakdown, resulting in clashing tasks during fast-tracking, stakeholder grievances and out-of-scope activities	PM Team	L	S	R	L	S	R
			4	5	20	2	3	6

To reduce the chance of communication breakdown, mandatory syncing meetings will be conducted. Remote meetings are recorded to preserve meeting ideas, and agendas will be organized in advance to ensure efficient usage of time. Teleconferences are also possible through online platforms like MS Teams.

Over the lifetime of the project, living project documents (such as the risk register, assumption log, budget, and schedule) are frequently updated and proofread to rectify errors and omissions. Relevant staff are required to take ownership of this documentation. A change control system is established at the start of the project. When working with documents, staff will also be required to use the internal coding system provided, use standardised document formats and keep records of work done in each new revision. All correspondence and project files will be stored in a centralised, secure location, provided by UNSW. Stakeholder engagement strategies are discussed further in the Stakeholder Management Plan.

For internal communications between project teams, extra attention is paid to clarity so that only minimal background knowledge is required to understand the content of the correspondence. In the case of confusion, further clarification from the document owner should be sought by the recipient.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
10	Technical uncertainty and design difficulties	Design teams	L	S	R	L	S	R
			5	3	15	2	2	4

To mitigate the effects of uncertainty regarding technical solutions, components not relying on building modification (i.e. the workstation computer) can be obtained earlier in the project. This enables greater time for familiarisation and testing so that as-of-yet unknown technical risks can be identified and dealt with earlier. Digital modelling, simulations and prototyping enables the testing of technical solutions in a safe environment [7]. Negotiating ready-made control software in the sales contract allows for the abstraction of many of the technical details from the design process which allows more focus on crucial system functionality. Consultation with technical experts [8] would also help here.

On the software front, testing software updates on isolated systems before deploying to primary systems, only using stable releases of software and having stable revisions of code handy reduces the risks associated with device instability. Schedule slack allows for further consultation with experts and time to design around the compatibility/integration issues. Finally, time has been allocated for extensively testing both the isolated and the fully integrated system; crashing of the task is also possible as the Robotics 1 team has idle time in Sep 2021. Contingency funding slated for scope extension could also be used to obtain additional components.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
			L	S	R	L	S	R
11	Missing technical details and design errors, resulting from design work overload or negligence	Design team	3	4	12	2	3	6

A large portion of the budget (70%) has been allocated to the procurement of project staff. Assuming some level of technical expertise for the interns employed, collaborative working is beneficial as it will raise team morale, distribute the workload and thus minimise the chance of overwork. Part of the contingency reserve budget has also been allocated to obtain any further software packages required (i.e. those not covered by the UNSW academic licence) to help reduce the technical knowledge required for a high-level engineering task. Frequent backups would also help in recovery from crashes. As mentioned in the previous point, other techniques such as computer modelling and simulation would also be useful here.

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
			L	S	R	L	S	R
12	Loss of project code due to electrical faults or human error	Software team	1	5	5	1	1	1

Surge protection and backup power supplies reduce the risk of large-scale data corruption due to power surges. Regularly backing up code in multiple locations (offline, and in a private repository on a public cloud) and having version control are ways to mitigate human error. As mentioned previously, only using stable versions of software can also be used to reduce the chance of data corruption.

Premature project closure

#	Identified Risk	Risk owner	Current Risk			Residual Risk		
			L	S	R	L	S	R
13	Premature project closure due to cost overruns, technical infeasibility or requested cancellation	PM Team	1	5	5	1	3	3

Funds for project closure are allocated in advance. Project documents are frequently updated to reduce the chance of there being significant clerical work at project closure [5]. To minimise grievances and confusion associated with premature closure, relevant stakeholders should be looped into end-of-project correspondence. Recycling or redistributing unused material could be used to partially recoup losses. Funds from the management reserve are used to deal with this type of risk.

Opportunity Management

#	Identified Opportunity	Management Strategy
1	Extra funding due to an industrial partnership or if parts are cheaper than expected	Accept

Allocate the additional funding as contingency reserve for schedule and budget uncertainty and loop in the external partner in the communication plan, noting that future expansions would be receptive to their input.

#	Identified Opportunity	Management Strategy
2	Components coming earlier than expected	Accept

Store components safely in secure storage, or if all necessary work has been done and staff are idle, begin the task early (if feasible). Project documents should be updated to reflect these changes.

Stakeholder Communication and Management Plan

Stakeholder Assessment

The project sponsor, all project staff and university professional staff (who will act as consultants) should be "aware of the project and its impacts and be actively engaged in ensuring that the project is a success", and thus be desired as the *leading* stakeholders [9]. To this end, direct engagement and participation of these stakeholders is sought during regular (weekly to monthly) meetings. Secondary stakeholders like academics, students and faculty management should at least be made aware of the outcomes and benefits of the project, and thus be desired as *neutral* stakeholders [9]. To this end, they are contacted via email with monthly progress reports or via official UNSW media releases.

Name	Unaware	Resistant	Neutral	Supportive	Leading
PM Team					CD
Sponsor				C	D
Design engineers, tradespeople and professional staff			C		D
Academics	C		D		
Faculty management		C	D		
Students	C		D		

Table 2: Stakeholder engagement assessment matrix for the MM cell project

Key:
C: Current position
D: Desired position

Stakeholder Engagement Strategy

Engagement strategies for the two classes of stakeholders are discussed below.

Currently Neutral or Supportive

All information imparted using these communication strategies are to be acted on. Regular meeting agendas will be distributed at least two days prior to any scheduled meeting. All participants should review these agendas and reserve time prior to attendance.

#	Communication type	Receiver	Owner	Medium	Frequency
1	Internal progress updates	Tech lead/ Design team	Design team	Instant messaging/ in-person	Daily

The purpose of internal progress updates are to clearly articulate what has been done, and to assist in record-keeping and in work-schedule alignment. This information is intended to be used for inter-team communication and also to assist the PM team and tech lead to schedule work packages. Unclear points should be clarified by the staff members who own the communication.

#	Communication type	Receiver	Owner	Medium	Frequency
2	Weekly stand-up meetings	PM Team/ all Design teams	Design team	Formal in-person or remote meeting	Weekly

The purpose of weekly stand-up meetings is to communicate weekly progress. This will give project staff the opportunity to voice any concerns and will assist the PM team to identify issues and risks, especially during fast-tracking [10]. If any issues are raised which may affect the project schedule, schedule slack will be used to make up for the lost time. Crashing may also be employed to reduce the duration of the work (i.e. the Robotics 1 team is idle in Sep of 2021 and is able to help the mobile robotics team) [10].

#	Communication type	Receiver	Owner	Medium	Frequency
3	Monthly project status reports	Sponsor/academics all project staff	PM Team	Email	Monthly

The purpose of monthly status reports is to inform stakeholders of the project status. The objective is to present what has been done in a non-technical manner, so that stakeholders who are currently unaware of the project progress will be aware that it is being performed. In-person meetings with the sponsor are required to seek feedback on project progress, as mentioned below. Any queries about the contents of the report will be handled by the PM Team.

#	Communication type	Receiver	Owner	Medium	Frequency
4	Monthly project and design reviews	Sponsor/academics All project staff	PM Team	In-person meeting	Weekly - Monthly

Monthly project review meetings serve to present details on completed project sections, encourage feedback and discuss further steps required. The dissemination of information regarding construction progress, delivery status of components and staffing concerns will help prevent confusion in cross-group tasks. Input from academics outside of the project allows the discovery of missed requirements early in the project through raised criticisms and expert insight. During these meetings, the PM team will coordinate with all parties to make adjustments to the project schedule, budget and scope afterwards to ensure smooth project progress. The meeting agenda and minutes can be used by project staff to refresh their memory, and will be distributed to attending academics.

#	Communication type	Receiver	Owner	Medium	Frequency
5	Performance reviews	Design team	PM Team	In-person	Monthly

Monthly performance reviews, as mentioned in the HR plan, are an opportunity to establish dialogue between the PM team and project staff regarding job performance and organisational priorities. Personalised feedback will help both the PM team and the employee to find avenues for improvement.

#	Communication type	Receiver	Owner	Medium	Frequency
6	Funding or regulation emergency meeting	Sponsor and relevant project staff	PM team	In-person meeting	As required

The purpose of an emergency meeting is to gain the sponsor’s permission to change the project scope or increase funding to the project, in the case where the allotted contingency funding is insufficient. The sponsor will be required to sign the relevant updated documents. The PM team will also negotiate with other parties to discuss potential solutions to the problem, and further consultation with the sponsor may be required when these solutions are found. The existing two-way dialogue between the PM team and sponsor should be used to further clarify any issues and negotiate a favourable outcome.

Currently Unaware

#	Communication type	Receiver	Owner	Medium	Frequency
1	Official UNSW media and news	Students and staff in MME	School of MME/ media intern	Digital format, sent by email	Twice at project end

The purpose of this communication is to raise awareness of the cell towards the end of the project lifespan. The email is sent to all students and staff in the School of MME and all heads of school in the Faculty of Engineering. The digital brochure contains a clear, non-technical description of the purpose and capabilities of the new MM cell, and highlights the the excitement of the University to have access to such cutting-edge technology. Any queries or expressions of interest for postgraduate study will be handled by the School of MME, with consultation with the PM team as required.

Cost and Schedule Estimation

Aggregated cost and schedule estimates for work packages

The work packages in the WBS were further broken down into activities. Cost and schedule estimates were derived from these activities using a bottom-up estimating approach. Shown below is a summary of the cost and schedule estimates aggregated for each work package. The full details may be found in the Appendix. Note that the asterisk (*) denotes that part of the contingency reserve budget has been included in the estimate.

#	Work package	Aggregated cost (AUD)	Activity start	Activity end	Duration (days)
1	Recruitment	0	01-Sep-20	31-Oct-20	59
2	Training*	80,000	Ongoing		
3	Finances	1,400,000	Ongoing		
4	Stakeholder management	1000	Ongoing		
5	Supporting PM activities	200	Ongoing		
6	Facilities and utilities	101,000	02-Nov-20	28-Feb-21	118
7	Interior	15,300	01-Mar-21	07-May-21	67
8	Static robot and ancillaries*	157,150	29-Mar-21	26-Nov-21	242
9	Mobile robot*	131,000	26-Apr-21	19-Nov-21	207
10	High performance workstation computer*	26,000	04-Jan-21	12-Feb-21	39
11	Software development	5,000	15-Feb-21	26-Nov-21	284
12	Forging press*	26,250	02-Aug-21	26-Nov-21	116
13	Induction heater*	56,500	06-Apr-21	02-Jul-21	87
14	End-of-project tasks	500	29-Nov-21	31-Jan-22	63
15	End-of-project communication	0	03-Jan-22	31-Jan-22	28
	TOTAL	**1,999,900**			**517**

Recruitment

As mentioned in the assumptions section, HR recruitment costs are assumed to be borne by UNSW. This activity includes the formation of a back-up labour pool, as mentioned in the risk management section.

Training

It is assumed that internal training costs are borne by UNSW and this training is a combination of self-study and seminars conducted by professional staff already employed by UNSW. $80k of the budget is allocated to external training conducted by ABB; this allocation includes travel, accommodation and food services (up to $10k per international training session per participant) [11]. Some training may not be international; this offers potential for further training to be obtained. End-user technical training will be held over multiple sessions, but it is once again assumed that costs for internal training will be borne by UNSW.

Finances

All technical staff are brought on in Jan 2021 to begin on-the-job technical training, as part of the risk management strategy for more training being required than expected. Additional interns (one for every senior engineer) are brought on to distribute the workload and to reduce the risk of overload. All human resource costs have been aggregated in the $1.4M sum; the salary rates were calculated with UNSW oncosts applied.

Stakeholder management

Stakeholder management is ongoing throughout the entire course of the project; $1k is allocated to associated costs such as travel and high-quality printing.

Supporting PM activities

Supporting PM activities include managing paperwork, implementing change control procedures and interviews with other project managers who have worked on similar projects. Associated costs are assumed to be managed outside of the project budget, so a nominal $200 for permit applications and stationery has been included instead.

Facilities, utilities and interior

Preliminary work involves surveying, structural design and authorisation ($500) [12] and acquiring waste management ($500) [13]. Foundational work and structural modifications to support the weight of the new equipment were estimated to cost $8k [14]. Utility costs were estimated as follows. For one electrician working for 50 hours ($4k) [15], the installation of 1.5km of new electrical cabling ($4k) [16] and a 250A switchboard ($2k) [17] is estimated to cost $10k. Similarly, the installation of plumbing and HVAC were estimated to cost $12k (worst case) [18] and $10k [19] respectively. An interview with a power systems intern resulted in an estimate of $25k for 50kVA transformer, $25k for 1km of 120A rated cable and approximately $2k ea. for protection relays, bringing the cost estimate for HV power installation to approximately $60k in total. For the interior, windows, doors and fixtures were estimated to cost $5k overall, fire safety measures $5.8k [20] and the dust extractor $3.5k [21]. The schedule for these activities was aggregated to give a total estimate of approximately half a year for all renovation work [8].

Static and mobile robotic platforms

Funds were allocated for international trips, accommodation and food services for manufacturer visits. Robotic arms were costed according with estimates provided in the Dream Team's Laboratory visit [8]; the cost of installation and commissioning has been estimated to be nominally 75% of the capital cost for each item. An additional portion of the budget has been allocated to supporting items, including additional grippers ($3k ea), safety enclosure ($10k), emergency stop button ($200), 3D webcams and backup 3D webcams ($1.5k) [22] and safety signage ($200). An allocation of $41k has been made for insurance, professional repairs and replacement of components, this forms the majority of the $52k allocated for repairs and insurance in the contingency reserve budget. Procurement and delivery has been estimated to take 28 days to occur (as assumed), while installation, commissioning and preliminary testing has been estimated to take another 28 days to allow for the opportunity of any damage during transit to be identified and rectified.

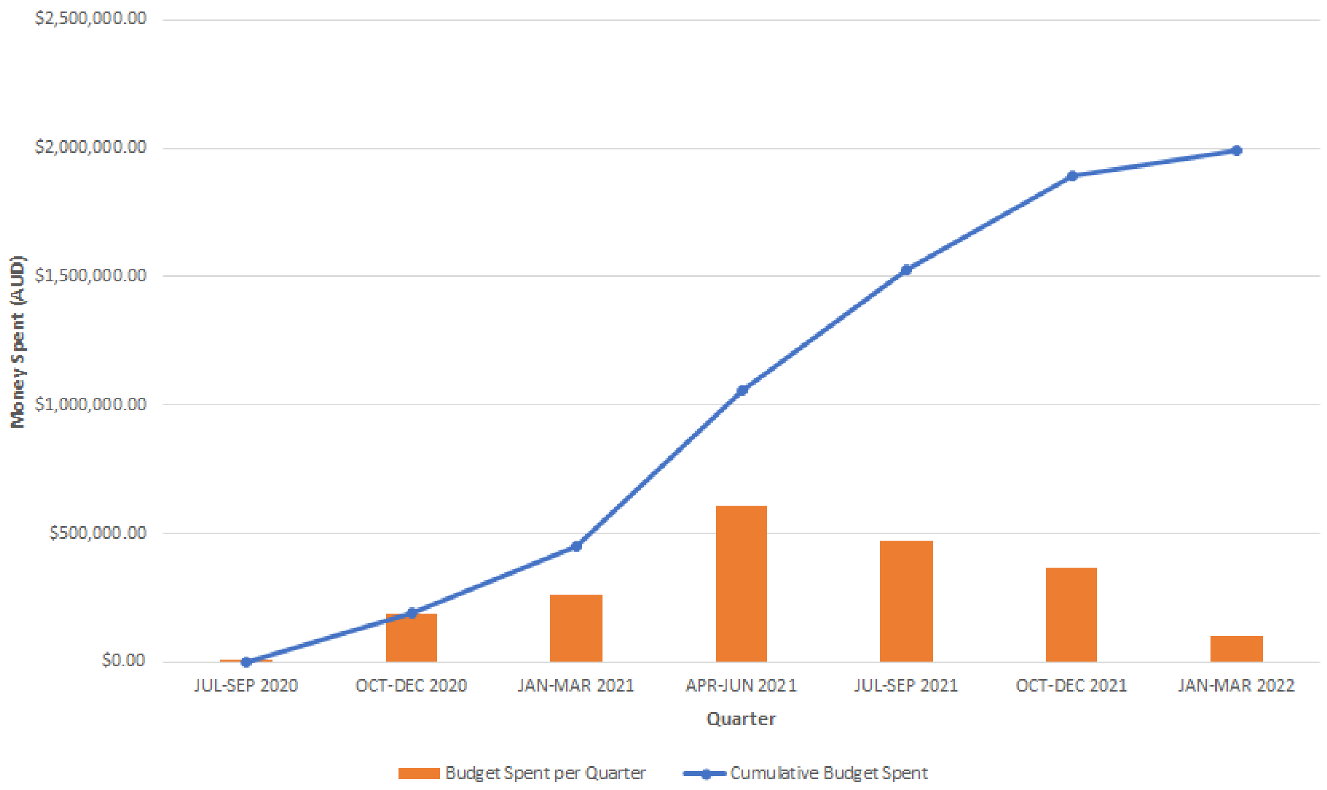
High performance workstation and software development

An allocation of $20k has been made for the procurement of additional software packages which are not covered by the University's academic licence. These software packages are acquired to assist in the project design phase, as they abstract away much of the technical details and allow the engineers to focus on solving problems related to the minimum viable product. A further allocation of $5k has been made for international conferences and consultation with technical staff and experts from outside of the University. In line with the Dream Team's activities, software development takes place over the course of approximately 10 months [8].

Forging press and induction heater

A vacuum induction heater ($30k) [23] is selected to reduce the amount of heat in the lab. A forging press which is more powerful than what is required ($15k) [24] is also selected to enable the possibility of future expansion. Keeping with assumptions, installation time is estimated to be 28 days, including preliminary testing. Installation and commissioning costs are nominally 75% the capital cost (as before). Allocation for a RF shielded enclosure ($4k) has also been made to protect the computer from electromagnetic interference.

Time-Phased Budget (Quarter)



Contingency Reserve Budget

The contingency reserve budget is about $178k, which forms 8.9% of the total project budget.

Activity	Budget Baseline	Budget Reserve	Project Budget	Comment
Technical training	$0	$80k	$80k	For training conducted by external companies
Repair and insurance (total)	$205k	$52k	$257k	For professional repairs done by a licensed technician
Obtaining replacements, backups or additional components/software packages	$50k	$14k	$64k	For backup grippers, batteries, webcams, RF shielding
Bringing on technical staff one month earlier (from Jan 2021 rather than Feb)	$0	$32.4k	$32.4k	Done to allow extra time for on-the-job technical training
TOTAL	**$255k**	**$178.4k**	**$433.4k**	

Gantt Chart and Network Diagram

Some greater detail about the task breakdown has been included in the following Gantt chart, which summarises the schedule estimates derived from the Appendix. The human resource allocations for each body of work have been shown to the right of each bar, and correspond with those shown in the Human Resource plan. A network diagram is shown on the page following the Gantt Chart. There are no activities with zero float, so this project plan can be considered to be fairly robust to project uncertainties [10].

Gantt Chart for the MM Cell Project

Tasks	Sep-20	Oct-20	Nov-20	Dec-20	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
Advertising and recruitment	PM																
Employee induction and training			All staff														
On-the-job technical training					All technical staff												
Surveying, structural calculations, design and foundational work			Struct, Trade														
Facilities, utilities and procurement of workstation computer					Struct, Trade, Power												
Interior (including installation of safety equipment)							Trade										
Industrial computer installation and procurement of third-party software					Software												
Software design and testing							Software										
Procurement of lab equipment (except for forging press and computer)								PM, Tech									
Waiting for delivery									PM								
Installation of lab equipment										Robotics 1 & 2, Mech							
Control system design for static robot											Robotics 1, SP						
Induction heater testing											Mech						
Mobile robot design, assembly and integrated testing											Robotics 2, Power, SP (after Aug)						
Forging press procurement, delivery, installation and commissioning												Mech					
Integrated testing of press with main robot														Robotics 1, Mech			
Final integrated testing																Tech	
Welding station feasibility estimate																Mech	
Project completion, development of documentation, end-user training																All staff	
Ongoing meetings and progress updates										PM, Tech and sponsor							

Staff Coding
PM: Project Management Team
Struct: Structural engineer
Trade: Tradespeople and contractors
Tech: All technical staff
SP: Signal Processing team
Mech: Mechanical engineering team

Note that there are two robotics teams.

Nelson Fu; Group 4

MM Cell Network Diagram

HR Plan

The Human Resource Acquisition shall happen via the UNSW H.R. team, through the UNSW employment policy. The acquisition takes, on average, two to four weeks for the entire process – form submission, advertisement, batches of interviews and final candidate selection. We shall also capture a list of backup candidates which shall be reached out to in case the primary candidates fail to show up. We also have interns who shall be employed during the final stretch of the project to decrease the impact of an employee leaving. In the cases of short-term employment of the Structural Engineer and the interns, the UNSW nomination policy shall be undertaken to reduce overheads. The positions of the interns would namely be: Structural Engineer, Media Intern, Software Integration Developer, UX Developer, Robotics Engineer, Mechanical Engineer, Power Engineer and Signal Processing Engineer.

Possible courses that may be audited by the employees to gain further insight into the MM Cell, managed by UNSW:

- [MECH9420] Composite Materials and Mechanics
- [MTRN9400] Control of Robotic Systems
- [COMP9434] Robotic Software Architecture
- [MATS6001] Fundamentals of Materials Processing

Performance Reviews

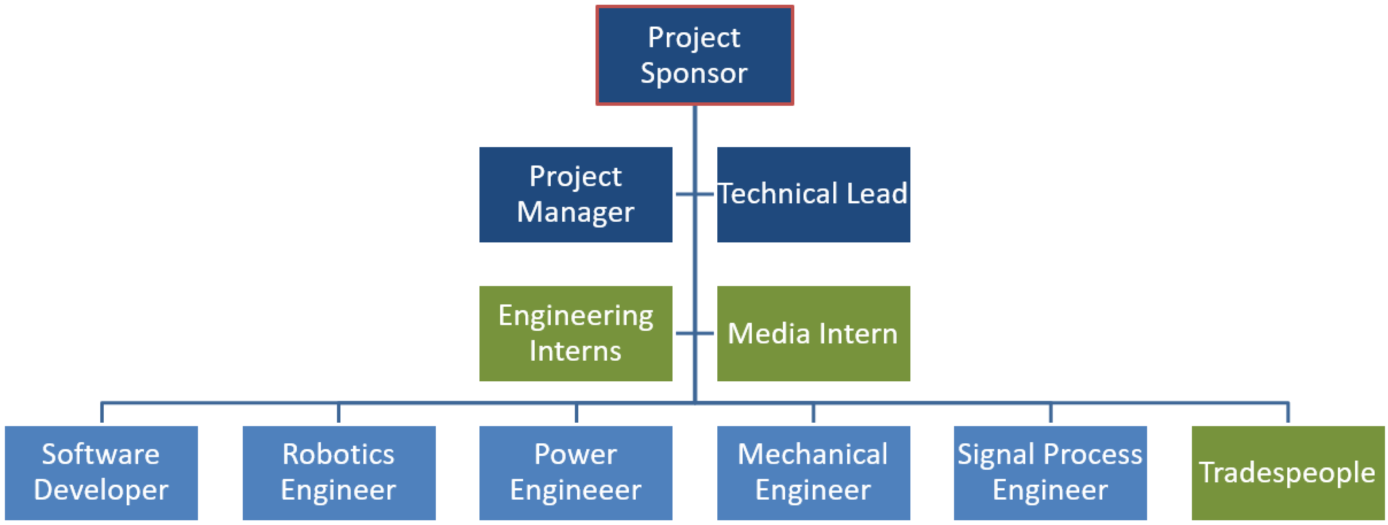
To correctly ascertain the performance of each employee, regular review of their work shall be conducted every month for a maximum of an hour by the Project Manager. Feedback shall be collected from co-workers anonymously and be shared with the employee in question. [a]:

Position	Responsibilities	Required Skills	Education & Experience
Robotics Engineers (x2) and Intern	• Robot configuration and closed-loop testing • Robot path planning • Implementing machine vision and force-feedback control for robot collaboration • System verification and approval • Manufacturer visits (potentially overseas)	• Familiarity with MATLAB, Simulink and robot programming • Excellent understanding of robot modelling and control • Knowledge of RAPID is preferable.	MS/ PhD degree in Robotics, Mechatronics or Computer Science with relevant experience
Software Developer and Intern	• Developing high quality, secure and stable code • Design and implement excellent system extensibility through drivers and APIs • Ensuring that authored code both conforms to established coding style and meets design requirements	• Hands-on experience with industrial robotics • Strong programming skills in C/C++, Python, ROS • Experience with machine vision and machine learning	Master's Degree in Computer Science, Robotics, Hardware Engineering, or related field
Project Management Team	• Develop, organise and update detailed project documents like the schedule and budget • Anticipate risks, employ effective risk management strategies and proactively identify and remove blockers • Manage external vendors and contractors by assigning tasks, communicating requirements, and tracking deliverables	• Familiarity with project management software tools, methodologies, and best practices • Strong interpersonal and written and verbal communication skills • Actively facilitate and participate in project activities, such as safety inductions and technical workshops	Bachelor’s degree in a technical field or equivalent practical experience with 8+ years of experience PMP certification preferred
Technical Lead and Intern	• Engineering decisions in accordance with the necessary rules and regulations pertaining to the creation and management of an MM cell • Liaise and coordinate with project management team and other researchers • Oversee structural design and technical reviews	• Undertake and support the procurement, design, installation, commissioning and testing of the MM Cell facility • Research and prepare formal responses to inquiries regarding the project	MS/ PhD within Electrical Engineering 8+ years of experience
Power Engineer and Intern	• Commissioning of appropriate power system protection measures • Commissioning of appropriate HV power solutions • Oversee the installation of the HV power system and recommend appropriate solutions	• Exposure to High Voltage Systems projects would be advantageous • Working knowledge of PSSE and/or PSCAD • Adept at writing detailed technical reports and formulating concise technical arguments	Educated in Electrical Engineering with 4+ years of experience
Mechanical Engineer and Intern	• Design and test hydraulic control system • CAD design and structural analysis • Experience with hot forging • Collaborate with team	• Demonstrated experience in the repair and operation of mechanical systems, plant and equipment and preparation of mechanical manuals	A Masters/ PhD degree in Mechanical Engineering with 4+ years of experience

Signal Processing Engineer and Intern	• Radar signal processing • Image signal processing • Implementing classification algorithms and robust filters for autonomous navigation • Implementing simple denoising filters	• Familiarity with MATLAB and Simulink • Strong programming skills in C/C++ • Strong mathematical background and knowledge of radar and image processing, robust filtering for pose estimation	Degree in Electrical Engineering with 3+ years of experience
Structural Engineer (Casual)	Excellent technical knowledge of Australian Standards, written and verbal communication skills and the ability to communicate well with senior management and clients	Strong technical capability and understanding to ensure quality service delivery. Knowledge on one or more of the following software packages would be beneficial: Evit, Safe, AutoCAD	A University Degree in Civil Engineering. Minimum 3 years' experience
Tradespeople	We shall need an array of tradespeople from UNSW's side which shall help in the physical set up of the MM Cell. Their responsibilities include setting up and maintaining the: H.V.A.C. / Plumbing / Electrical / Flooring / Windows		
Media Intern	Creating and sending out press releases containing scientific media content across scientific platforms such as journals, conferences, and websites. Follow up conversations with scientists and researchers to build scientific exposure for the project. Design online training courses, to be stored for posterity	• A keen eye for detail and motivation towards furthering your writing and social skills, • Well-developed interpersonal skills and demonstrated experience in building and maintaining social relations	Communications degree. A minimum 2 years of experience in scientific reporting

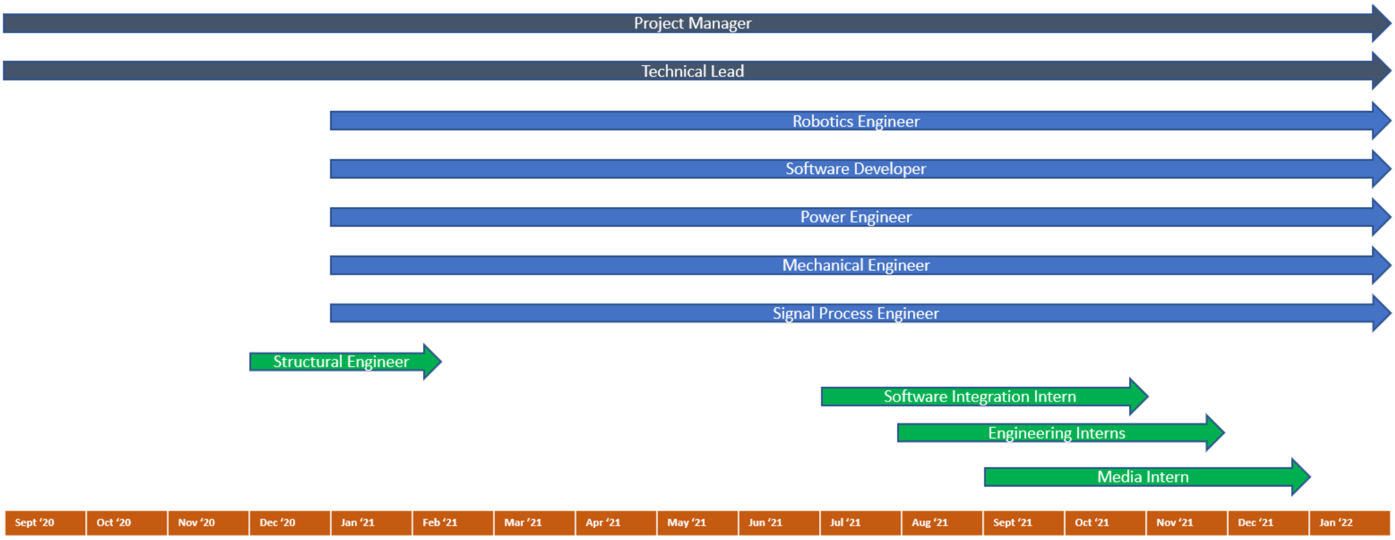
Organizational Chart

The organization chart for the project is as follows. The Project Manager shall manage all members of the team, while the technical lead shall manage all Engineers, Developers and interns from a technical perspective.

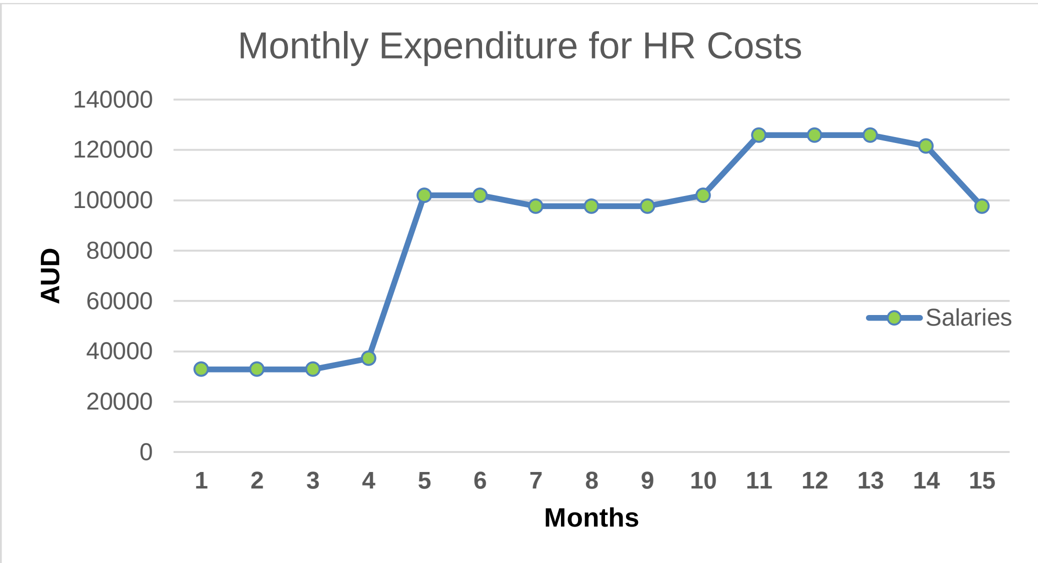


Resource Calendar

The MM Cell project will require the Project Manager and the Technical Lead to be allocated to the project from September of 2020 to January of 2022. We shall then recruit the Structural Engineer for duration of three months, starting from the December of 2020 to the February of 2021. The senior engineering team, composing of two Robotics Engineers, a Software Developer, a Power Engineer, a Mechanical Engineer and a Signal Processing Engineer shall be employed from January of 2021 to the January of 2022. The technical interns shall be employed from Jul to Dec 2021 to assist the senior engineers. The media intern is employed in the last month of the project (this has been omitted in the diagram).



The plot below summarises the monthly human resource cost incurred over the course of this project.



RACI Chart

The following is a RACI chart detailing the roles and responsibilities for each project staff member [25].

	Project Leadership		Project Team Members					Short Term Team Members	
Task	PM Team	Tech Lead	Software Dev.	Robotics Engr.	Power Engr.	Mech. Engr.	SP* Engr.	Structural Engr.	Media Intern
Staff Procurement Form submissions	R	A							
Budget Management	R	C							
Document Management	R, A	C							
Orientation and Induction	R	A							
Procurement of Material	C, A	R, A		C	C	C			
Procurement of Machines	R, A	C, A							
PR and media	R, A	C, A	I	I	I	C	I	I	C
Stakeholder Correspondence	R, A	C, A	I	I	I	I	I	I	I
Project Design	I	R	C, A	C, A	C, A	C, A	C, A	I	I
Process Training	R, A	C, A	I	C	I	C	I	I	I
Incident Identification	C	A	R	R	R	R	R	R	R
Incident Prioritization	C, A	R	I	I	I	I	I	I	I
Incident Escalation	R	A	C	C	C	C	C	C	C
Incident Recovery	C	R, A	R	R	R	R	R	R	I
Risk Analysis	C, A	R	C	C	C	C	C	C	I
Change Management	R	A	C	C	C	C	C	C	I
Disaster Recovery	R, A	R	I	I	I	I	I	I	I
Code Review	I	R, A	C, A	C, A	I	I	I	I	I
Auditing	R, A	C, A	I	I	I	I	I	I	I
Knowledge Management	R	C	C	C	C	C	C	C	A
End User Training	R, A	C	C	C	C	C	C	C	C
Confirming Project Success	R, A	C	I	I	I	I	I	I	I

Note
*SP: Signal Processing
Engr.: Engineer (senior engineer in each team).

Definition of Success

To gauge project success, the following project success criteria were developed [26]. If an overall score of 195 or above is achieved in the following criteria, then the project will be considered a success. This assessment is done from the perspective of the PM team, in the light of the project objectives and scope set out in the Project Charter.

Category	**Criteria**	**Success Rubric**	
Time	Project is completed on time	On time: Up to two weeks of delay: Up to four weeks of delay: Over four weeks of delay:	20 15 10 5
Budget	Project is completed on budget	On or below budget: Over budget by 5%: Over budget by 10%: Over budget by 20%: Over budget by over 20%:	20 15 10 5 5
Scope	Project delivers all items within the agreed scope	Yes: No:	20 5
	Project scope has been reduced over the course of the project	No: Once: Multiple times:	20 15 5
	Project deliverables are fit for purpose	Yes: No:	20 5
Function	Project meets functional requirements	Yes: No:	20 5
	Project meets non-functional requirements (potential for future upgrade, safety signage, etc.)	Yes: No:	10 5
	Project handover was documented and completed appropriately	Yes: No:	10 5
	End-user training was conducted successfully	Yes: No:	30 5
	Staff and student awareness was raised to the desired levels at project-end	Yes: No:	10 5
Policy Considerations	Project satisfies all UNSW policy restrictions	Yes: No:	20 5
	Project meets all regulatory guidelines	Yes: No:	20 5
	Gained Centre of Excellence Certification	Yes: No:	20 10
Liability	No personal injury incurred over the duration of the project	Yes: No:	20 10

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Appendix

The first section contains the full table of the schedule and cost estimates, while the second contains the calculations used to find the total HR cost.

Cost and Schedule Estimates for the MM Cell

Work package	Activity	Cost (AUD)	Activity start	Activity end	Duration (Days)
Recruitment	Develop position descriptions and publicly advertise	-	01-Sep-20	30-Sep-20	30.00
	Select applicants, authorise employment and form a back-up labour pool	-	01-Oct-20	31-Oct-20	31.00
Training	Perform WHS Induction and UNSW policy training	-	02-Nov-20	06-Nov-20	5.00
	Obtain external technical training for senior engineering staff	80,000	04-Jan-21	31-May-21	148.00
	Conduct internal technical training for senior engineering staff	-	04-Jan-21	31-May-21	148.00
	Conduct end-user technical training and develop training materials	-	03-Jan-22	31-Jan-22	29.00
Finances	Manage payroll	1,400,000	01-Sep-20	31-Jan-22	517.00
Ongoing stakeholder management	Send personalised correspondence	-	Ongoing		
	Manage public relations through media	1,000	03-Jan-22	31-Jan-22	29.00
Supporting PM activities	Manage administrative paperwork and permit applications	200	01-Sep-20	30-Sep-20	30.00
	Form a change control board (CCB) and develop change control procedures	-	01-Sep-20	30-Sep-20	30.00
	Develop an official coding system for project documents and obtain secure storage for electronic files and physical project material	-	01-Sep-20	30-Sep-20	30.00
	Interview other project teams and consult with technical experts to continually refine estimates	-	Ongoing		
	Perform internal auditing	-	Quarterly		
	Schedule and attend regular meetings	-	Ongoing		
	Update and proofread 'living' PM documents	-	Ongoing		
Facilities and utilities	Survey the site and perform structural calculations and structural design	500	02-Nov-20	27-Nov-20	26.00
	Acquire waste management services	500	02-Nov-20	13-Nov-20	12.00
	Perform foundational work and structural modifications	8,000	30-Nov-20	15-Jan-21	47.00
	Electrical	10,000	18-Jan-21	28-Feb-21	42.00
	Plumbing and fixtures	12,000	18-Jan-21	28-Feb-21	42.00
	HVAC	10,000	18-Jan-21	28-Feb-21	42.00
	High voltage power system installation	60,000	18-Jan-21	28-Feb-21	42.00
Interior	Paint walls and ceiling and finalise interior plan	1,000	01-Mar-21	31-Mar-21	31.00
	Install fixtures, fittings, windows, doors etc.	5,000	01-Apr-21	30-Apr-21	30.00
	Install fire safety measures (sprinkler, fire extinguisher, alarms, etc.) and signage	5,800	01-Apr-21	30-Apr-21	30.00
	Install and commission a dust extractor	3,500	01-Apr-21	30-Apr-21	30.00
	Obtain furniture	-	01-Apr-21	30-Apr-21	30.00
	Arrange for safety inspection	-	03-May-21	07-May-21	5.00
Static robot and ancillaries	Tender for quotes and physically visit the supplier, for both static and mobile robots	8,000	29-Mar-21	23-Apr-21	26.00
	Procurement and delivery of main robotic arm and ancillaries	55,000	26-Apr-21	28-May-21	33.00
	Webcam procurement and delivery	1,500	26-Apr-21	28-May-21	33.00
	Machine vision algorithm procurement	30,000	26-Apr-21	28-May-21	33.00
	Install and commission the steel plated mount and static robot	41,250	31-May-21	25-Jun-21	26.00
	Install safety barriers, emergency stop button and signs	11,000	07-Jun-21	25-Jun-21	19.00
	Familiarisation with embedded control software and teach-pendant programming	-	05-Jul-21	16-Jul-21	12.00
	Integration of diagnostic instrumentation and closed loop testing		19-Jul-21	20-Aug-21	33.00
	Development of device-specific safety procedures and signage	400	20-Aug-21	27-Aug-21	8.00
	Redesign to work collaboratively with the forging press (obstacle avoidance)	-	18-Oct-21	26-Nov-21	40.00
	Repair or scope extensions	10,000	04-Oct-21	26-Nov-21	54.00
	Procurement and delivery of components	105,000	26-Apr-21	28-May-21	33.00
	Familiarisation with mobile robotics sensors	1,000	31-May-21	04-Jun-21	5.00

Mobile robot	Autonomous navigation and general signal processing (programming)	-	07-Jun-21	02-Jul-21	26.00
	Obtaining backup components (including batteries)	2,000	07-Jun-21	11-Jun-21	5.00
	Propulsion system design and testing	-	15-Jun-21	02-Jul-21	18.00
	Mounting and integrated testing of mobile platform and robot arm	13,000	05-Jul-21	06-Aug-21	33.00
	Implementing closed-loop vision control and robot contact (force-feedback) control for the overall robot (collision avoidance, etc.)		09-Aug-21	17-Sep-21	40.00
	Testing and refinement	10,000	20-Sep-21	12-Nov-21	54.00
	Verification or augmentation of safety features and development of documentation	-	08-Nov-21	19-Nov-21	12.00
High performance workstation computer	Workstation computer procurement and delivery	6,000	04-Jan-21	05-Feb-21	33.00
	Alternatives analysis (investigating distributed computing)	-	04-Jan-21	25-Jan-21	22.00
	Procure additional software licenses and install third-party software	20,000	27-Jan-21	12-Feb-21	17.00
Software development	Familiarise with software and consult with experts to find out how to integrate existing simulation software	5,000	15-Feb-21	16-Apr-21	61.00
	Back-end development	-	01-Mar-21	01-Oct-21	215.00
	Front-end development	-	03-May-21	03-Sep-21	124.00
	Code review and optimisation	-	06-Sep-21	26-Nov-21	82.00
	Code backups	-	Ongoing		
Forging press	Procurement and delivery of the forging press	15,000	02-Aug-21	06-Sep-21	36.00
	Installation, commissioning and modification of the press to use a generic die	11,250	07-Sep-21	17-Sep-21	11.00
	Precise motion control design	-	20-Sep-21	15-Oct-21	26.00
	Integrated testing with robot	-	18-Oct-21	26-Nov-21	40.00
Induction heater	Select a vacuum induction heater with appropriate size and power rating	-	06-Apr-21	14-Apr-21	9.00
	Procure and wait for delivery of the induction heater	30,000	15-Apr-21	28-May-21	44.00
	Install, commission and perform tests	22,500	31-May-21	25-Jun-21	26.00
	Test for EMC compliance and install a shielded enclosure for the industrial computer, if required	4,000	31-May-21	02-Jun-21	3.00
Welding	Feasibility estimate	-	13-Dec-21	23-Dec-21	11.00
End-of-project tasks	Perform final integrated testing and commissioning of the project deliverables	-	29-Nov-21	14-Jan-22	47.00
	Clerical work	-	29-Nov-21	31-Jan-22	64.00
	Disposal, redistribution or recycling of excess project material	500	03-Jan-22	14-Jan-22	12.00
	External auditing	-	03-Jan-22	31-Jan-22	29.00
End-of-project communication	Editing and transmitting project closure documents (i.e. final report)	-	03-Jan-22	31-Jan-22	29.00
	Obtaining confirmation and acceptance from project sponsor	-	03-Jan-22	31-Jan-22	29.00
	Storage of project knowledge and producing the lessons learned register	-	03-Jan-22	31-Jan-22	29.00
	TOTAL	1,999,900			517

Position	Level	Number of weeks	On Cost Rate	Base Rate (hourly)	Number of hours p.w.	Salary Cost	Cost + On Costs rate	monthly	Start Times	End Times
Structural Engineer	5 point 1	12	0.1567	52.1	18	11253.6	13017.03912	**4339.01304**	Dec '20	Feb '21
Media Intern	4 point 1	16	0.1567	47.75	10	7640	8837.188	**2209.297**	Aug	Nov
Software Integration Developer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Jul	Oct
UX Developer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Aug	Nov
Robotics Engineer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Aug	Nov
Mechanical Engineer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Aug	Nov
Power Engineer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Aug	Nov
Signal Processing Engineer	5 point 1	16	0.1567	52.1	18	15004.8	17356.05216	**4339.01304**	Aug	Nov
						total cost	**$125,990.54**			

Position	Level	Number of Years	Base Rate (yearly)	Superannuation rate	On Cost Rate	Salary Cost	Cost + On Costs rate + Super	monthly	Start Times	End Times
Project Manager	7 step 4	1.333333333	115,497	0.095	0.2154	153996	204947.5785	**17078.96488**	Sept '20	Jan '21
Technical Lead	7 step 1	1.333333333	106,707	0.095	0.2154	142276	189349.8642	**15779.15535**	Sept '20	Jan '21
Robotics Engineer (x2)	6 step 1	1	97,279	0.095	0.2154	97279	258930.0436	**21577.50363**	Jan '21	Dec '21
Software Developer	6 step 1	1	97,279	0.095	0.2154	97279	129465.0218	**10788.75181**	Jan '21	Dec '21
Power Engineer	6 step 1	1	97,279	0.095	0.2154	97279	129465.0218	**10788.75181**	Jan '21	Dec '21
Mechanical Engineer	6 step 1	1	97,279	0.095	0.2154	97279	129465.0218	**10788.75181**	Jan '21	Dec '21
Signal Processing Engineer	6 step 1	1	97,279	0.095	0.2154	97279	129465.0218	**10788.75181**	Jan '21	Dec '21
						total cost	**$1,171,087.57**	**97590.63112**		

overall costs **$1,297,078.11**

	Referred Links
On Costs Rate	https://www.hr.unsw.edu.au/services/salaries/oncosts.html
Cost for Casuals	https://www.hr.unsw.edu.au/services/salaries/casgnsal.html
Cost for Employees	https://www.hr.unsw.edu.au/services/salaries/gensal38.html
Superannuation rates	https://www.hr.unsw.edu.au/services/super/super_home.html
	Glassdoor

	Monthly cost
Sept	32858.12023
Oct	32858.12023
Nov	32858.12023
Dec	37197.13327
Jan	101929.6442
Feb	101929.6442
Mar	97590.63112
Apr	97590.63112
Jun	97590.63112
Jul	101929.6442
Aug	125834.0064
Sept	125834.0064
Oct	125834.0064
Nov	121494.9933
Dec	97590.63112
sum	**1330919.963**