GSOE9820 | Group 52 | 20T2

Metamorphic Manufacturing Cell Project

Project Management Plan

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

Group Member	zID	Key Contributions	Declaration
Liam Flynn	z5244712	• Project Charter • WBS • Scope Statement • Project Integration	
Samer AlHaddad	z5245663	• Project Charter • Time-Phased Budget • Project Integration • Scope Statement	
Con Tieu-Vinh	z5245136	• Project Charter • Network Diagram • Est. Time & Cost • Strategy and Success • Project Integration • Risk Mgmt. Plan	
Keshuo Lin	z5244677	• WBS • Project Charter	
Yang Fei	z5242906	• Stakeholder Mgmt. Plan • HR Plan	
Wu Yiwei	z5246039	• Risk Mgmt. Plan • Network Diagram	
Minjie Zhu	z5243474	• HR Plan • Est. Time & Cost	
Mingxi Shen		• Risk Mgmt. Plan	

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Project Charter

Identification	
Name	Metamorphic Manufacturing Cell
Description	Design, develop, procure and construct a metamorphic manufacturing cell at UNSW's Kensington campus
Sponsor	Dr Xiao Peng Li (School of Mechanical and Manufacturing Engineering)
Project Team	Group 52: Con Tieu-Vinh, Keshuo Lin, Samer Alhaddad, Minjie Zhu, Liam Flynn, Mingxi Shen, Yiwei Wu, Yang Fei
Key dates	Commencement: Q1 2021 Completion: Q3 2023

Purpose

- To plan and build a small MM Cell at the UNSW Kensington Campus
- This new facility will serve as a basis for technological development and interdisciplinary research between university schools and external research partners
- The cell will allow for production of high precision customisable parts direct from CAD with optimised lead time

Team & Strategy

- The Project Team includes several key project managers with expertise and experience in various disciplines including artificial intelligence, biochemical manufacturing, finance and consulting, legal and regulatory
- Further details of the Project Team's approach to managing the project is provided in the Project Team Strategy and Success document

Objectives

- Support UNSW's researchers to deliver high quality research in the field of metamorphic manufacturing as measured by journal article publications and average number of citations for faculty in the field of digital manufacturing
- Support UNSW's researchers to obtain further grant funding into metamorphic manufacturing research by demonstrating alignment with Australian Gov's Industry 4.0 Taskforce Priorities[1]
- Create a better learning experience for current and future students, and support teaching strategies through new course development
- Encourage growth in applications of current and future students into manufacturing studies at both undergraduate and postgraduate levels commencing early in the project life cycle
- Advance UNSW's competitive position as a top research facility worldwide by providing it with digital manufacturing capabilities beyond that of Australian and other leading universities
- Promote entrepreneurship involving students, external industry collaborators and strategic alliances through discovery and innovation by enabling low cost, rapid prototyping and testing of products
- Promote UNSW as a thought leader in the field of metamorphic manufacturing through policy and practice publications, large forum events and conferences
- Enable UNSW to live up to its commitment to broader social and developmental policy issues by alignment with the UN's Sustainable Development Goals.[2] The project will enable novel research aimed at addressing density and pollution at a global scale by enabling production of high-quality industrial parts at lower cost and scale, with lower environmental footprint

[1] Australian Government Industry 4.0 Taskforce Priorities, Advanced Manufacturing
[2] United Nations Sustainable Development Goals, Industry, Innovation and Infrastructure; Responsible Consumption and Production; Sustainable Cities and Communities

Success Criteria

The project's objectives directly promote the key tenets of UNSW's 2020 Strategic Plan: Academic Excellence, Innovation and Engagement, and Social Impact.[3] Ultimately, success will be determined by the project sponsor, Dr Li, on behalf of UNSW. The project team anticipates that, if met, the following criteria will determine the project to be successful:

- Increase in average number of citations per faculty and Q1 journal articles relating to digital manufacturing by up to 20% within 3 years of project delivery
- Inflow of at least $5-10M of further grant funding for metamorphic manufacturing related research within 2 years after project delivery
- Full or partial integration of MM cell methodologies in one or more UNSW courses by 2023, with course administrators able to deliver or obtain appropriate training for students to safely operate the MM cell as an experimentation tool. Positive student feedback exceeds 80%.
- After the trial operation and tests of Dr Li, it proves beneficial to his course teaching and research projects
- Growth in applications of current and future students in manufacturing by 5-10% per year as early as 6 months prior to project delivery
- Measured improvements in research quality metrics assessed under various world university rankings such as the QS, Times Higher Education and other world university rankings
- Reduced time to prototype and time to market by up to 20% for new metamorphic manufacturing-based ventures compared to past ventures using traditional manufacturing methods
- At least 10 new ventures benefiting from MM cell research through UNSW's Founders programs within 2 years of delivery
- At least 3 new strategic alliances formed with industry members within 2 years of delivery
- Maintain UNSW's position as a leader on the Edu rank engagement scale[4] via new social media publications showcasing metamorphic manufacturing inventions and creative applications

Scope

The project will be carried out in three main phases:

1. Construction Phase - consisting of the design, procurement and construction of the MM Cell, associated fixtures, lab and software.
2. Testing & Safety Phase - consisting of QA Testing of both hardware and software components.
3. Support & Training Phase - consisting of 12 months technical support, training courses, operations manual and emergency protocols.

For detailed scope breakdown, as well as definition of out of scope items, see Scope Statement in the Project Management Plan.

High Level Requirements

The project:

1. Shall deliver the MM cell, including its design, procurement, construction, and commissioning;
2. Shall use existing infrastructure and services at UNSW (Kensington),
3. Or, shall include the provision of any required new infrastructure and services;
4. Shall cost less than AUD 2,000,000 including any contingencies;
5. Should demonstrate alignment between its objectives and the UNSW 2025 Strategy.

The MM Cell:

1. Shall produce a forged part from a CAD model;

[3] UNSW Strategic Plan 2025
[4] Edurank Awards, Australia Category, Top 5

High Level Requirements
2. Shall incorporate real-time quality control and diagnostic instrumentation, which enables control of the dimensions and properties of the forged part; 3. Shall have an integrated, programmable control system, which coordinates all of its functions; 4. Shall produce a range of forged components for a range of industrial applications, without using a specific forging die to shape any component; 5. Should hot forge commercially available Ti alloys; 6. Should hot forge commercially available low alloy steels; 7. Should allow, after conducting further research into and updating of software in (3), that (1) and (4-7) be achieved without operator intervention.

Key Stakeholders
• Project Sponsor: UNSW (Dr Xiao Peng Li) • Research staff • Current and future students of the university • External research collaborators and industry partners • Australian Government via its Industry Taskforce 4.0 Priorities • Broader community

Key Deliverables	
Name	**Description**
Facility Architectural Document	Detailed lab design specification document
MM Cell Blueprint	Detailed MM cell specification document. MM cell to be housed within 'MM Cell Room' of the Lab facility.
Preliminary Approvals	Pre-approval of the lab facility architectural document by UNSW internal compliance as satisfying work health and safety requirements, such approval subject to site inspection after the lab has been built Approval of the MM cell blueprint by the project sponsor or on their behalf as meeting faculty requirements
Q&A Testing Framework	Framework for test-driven development of the software components necessary to operate the MM cell, and functional testing to ensure MM cell operation satisfies the project's requirements
Lab Site Preparation Specification	Detailed breakdown of work required to construct the lab facility, to be issued at the procurement phase for construction contractors
MM Cell Installation Work Specification	Detailed breakdown of work required to install the MM cell, based on the specific robotic components obtained via tender process, to be issued to advanced machinery operators and engineers responsible for installing the MM cell
Lab Facility	Lab site provisioned by UNSW with adequate utilities and waste storage and disposal facilities connected and certified in accordance with the UNSW Waste Management Plan. Includes Staging Area, Testing and Inspection Area, MM Cell Room, Ventilation System, Conveyor Belt, Material Storage Zone, Observer Platform, PPE & First-Aid Zone
MM Cell	Functional MM cell contained in adequately prepared Lab site, comprising a Furnace, Moveable Base, Robotic Arm, Sensors, Actuators and Tooling, Cooling Vat, and Computer System Hardware. Housed within MM Cell Room.
Software Systems	Proprietary software solution comprising a CAD morphology solver, Sensor & Vision System, Thermal & Force Control System, integrated with CAD, LabView and RealSense SDK (subject to change depending on robotic parts supplier).

UNSW WHS Approval	Final lab inspection and approval by UNSW internal compliance
Operation, Safety and Training manual	Specification and manual for operation of the cell
Faculty Training Sessions	Includes Operator Training, Emergency Protocols and Student Training Course
Ongoing support period for 12 months	To be provided by the project team to UNSW Manufacturing senior staff in relation to the operation of the MM cell, subject to the limitations in this Charter

Milestone Dates			
Item	**Major Events / Milestones**	**Estimated Completion Date**	**Dependencies**
1.	Design lab facility and MM Cell Obtain design approvals from UNSW	Q1 2021	
2.	Procure robotic components via market tender and labour via UNSW pre-approved contractors	Q2-3 2021	Project authorisation, UNSW site approval
3.	Stage gate: Procurement Success If conditions not met, sponsor may determine that the project be abandoned early, with design specifications retained for future use.	Q3 2021	Conditions: (1) Robotic parts obtained at reasonable market cost and meet specification (2) Labour access not prevented by COVID-19 restrictions
4.	Lab excavation & construction	Q4 2021 – Q1 2022	UNSW site approval
5.	MM Cell construction	Q1 2022 – Q3 2022	Final lab specifications Power and water connections Waste removal facilities
6.	Computer systems development and integration	Q4 2022 – Q1 2023	Connected MM cell
7.	Quality assurance testing and compliance	Q1 2023 – Q2 2023	Functional MM cell
8.	Training manuals and training program delivery	Q1-2 2023	Functional MM cell
9.	Launch MM cell website and release Research Grant Funding Information Pack to researchers Commence planning of ribbon cutting ceremony	Q2-3 2023	All tests passed and technical requirements met; project can be deemed Early Success as an operational MM cell
10.	Final project handover	Q3 2023	All project requirements satisfied
11.	Ongoing Technical Support	Q3 2023 - Q3 2024	

Budget Overview				
Category	**Details**	**Best Case**	**Worst Case**	**Most Likely**
Human Resources	Project team (6 FTEs) Construction workers (up to 7 FTE depending on intensity of work) Advanced machinery operators (up to 3 FTE) Supervisor / Compliance consultant (UNSW Internal Compliance) Senior Technical Stakeholder (MME) -Senior Lecturer equiv.	45%	55%	50%
Lab site construction	UNSW lab site zoning and preparation	14%	17.5%	15%
MM cell construction	Thermal component (furnace) Precision sensors Forming tools Robotic apertures Computer station	12%	13%	12.5%
Software R&D	CAD and Robotic Arm software integration	6.5%	8%	7.5%
Raw materials	Purchase order for 6-12 months usage of MM cell suitable alloy steel, Ti alloys	2.5%	2.5%	2.5%
Stakeholder engagement	Research Grant Centre Information Pack Ribbon Cutting Ceremony	1.5%	1.5%	1.5%
Technical support	Ongoing technical support for a period of 12 months following completion (1 FTE)	5%	5%	5%
Contingency Reserve	For defects and repairs Risk response contingencies	6%	6%	6%
Total (without Contingency)		**$1,795,000**	**$1,945,000**	**$1,871,551**

Assumptions and constraints

- UNSW will grant appropriate access to Project Team to make use of, or modify existing equipment at UNSW MME School facilities as necessary for carrying out the Project
- Schedule is provided on a best estimate basis and excludes unforeseen events
- UNSW's internal compliance teams will be consulted for regulatory requirements and they will, if necessary, make any applications on behalf of the project team with respect to independently mandated government WHS certifications or requirements, including compliance with Australian Standards[5]
- Metamorphic Manufacturing is a new technology and lacks detailed standards and specifications;[6] as such, all estimates are subject to reasonable variation with any significant change orders to be formally approved by the project sponsor

[5] Standards Australia, CH-026 Safety in Laboratories: Standards Catalogue
[6] The Minerals, Metals & Materials Society, Metamorphic Manufacturing: Shaping the Future of On-Demand Components

Risks
• The Project Team has assessed potential risks to the success of the project and developed appropriate responses to these risks in the Risk Management Plan. Key risks include Financial, Resourcing, Strategic, Legal and Technical risks. • Stage-gating has been deployed at tender selection in the Procurement Phase to ensure that if key components for the MM cell cannot be obtained at reasonable market prices due to lack of tenderers or undue supply chain delay caused by COVID-19, the project can be aborted before any major MM cell components have been procured. • In the event of early termination, the MM cell and lab design specification will be retained by UNSW for potential project restart when market conditions have improved.

Signoff	
Project Sponsor:	Date:

Strategy & Success Definition

Approach	Explanation
Balanced	• The Project Team proposes to take a balanced and conservative approach to managing the project and its risks. • As the project involves new technology, there is a non-trivial risk of overall project failure due to lack of maturity in metamorphic manufacturing cell technology, which may be heightened by the impact of COVID-19 and its economic flow-on effects on supply chain availability.[7]
Rolling Wave Planning	• The Project Team proposes to adopt a 'rolling wave' planning strategy to ensure that critical near-term objectives are defined and achieved as the project progresses.[8] • This will ensure that the project can respond in an agile manner to unforeseen obstacles and take advantage of opportunities as they arise.
Stage gating and risk management	• Stage gating has been employed at a critical junction of the project – the Procurement phase. As specialty or bespoke robotic components may need to be sourced from overseas, uncertainties arise with costs and delays. • Similarly, the labour necessary to construct the lab facility may be impacted if COVID-19 restrictions resurface from Q4 2021. • By implementing a stage gate conditioned upon both parts and labour procurement, the project allows for early exit with all schematics, plans and designs to be retained by UNSW for future projects.
Scope and cost control	• To manage scope and costs, the Project Team intends to utilise UNSW internal human resources for key approvals relating to lab site work health and safety and other regulatory/legal requirements which are mandated by external bodies. • However, due to their importance for a physical lab site, key approvals are considered within scope and are appropriately estimated in terms of cost and time.
Aggressively diversify risk	• Risk is diversified across success outcomes. The Project Team proposes that success be measured across three main stakeholder groups: Research, Students, and Industry.[9]

[7] COVID-19 Managing Supply Chain Risk and Disruption, Deloitte (2020)
[8] A Guide to the Project Management Body of Knowledge (PMBOK Guide), Newtown Square, Project Management Institute (2017), 6.2.2.3
[9] Project Charter, 3.0 Project Objectives

	• By diversifying success outcomes across these three groups, changing appetites or engagement levels impacting one of these groups by the time of project completion will not jeopardize the success of the project.
Early stakeholder engagement	• As project success is dependent on improved engagement outcomes for several key classes of stakeholders, the project team proposes to implement proactive stakeholder engagement strategies to ensure the project's objectives are achieved via its communications plan. • These have been costed and include a researcher-targeted information pack which permits early grant funding applications and a ribbon cutting ceremony seeking engagement from wider industry.[10]
Multilevel definition of success	• Project success is determined not only in terms of project management dimensions such as scope, budget and time, but stakeholder objectives and UNSW 2020 strategic priorities. • The project's success criteria up to 3 years post completion are detailed in the Project Charter.[11] • The Project Team also anticipates that strategic success will be achieved by placing UNSW in a favourable position for future opportunities and by accruing benefits to stakeholders that are not directly involved or targeted by project itself.[12] This will be driven mainly by further research and learnings acquired from use of the MM cell.

Scope Statement

The project will be carried out in three main phases:

1. Construction Phase - consisting of the design, procurement, and construction of the MM Cell, associated fixtures, lab, and software.
2. Testing & Safety Phase - consisting of QA Testing of both hardware and software components.
3. Support & Training Phase consisting of 12 months technical support, training courses, operations manual and emergency protocols

The deliverables along with acceptance criteria and exclusions are listed in table on the following page.

[10] WBS 8.2; 8.3
[11] Project Charter, 4.0 Project Success Criteria
[12] Bannerman, P. L. (2008). Defining project success: a multilevel framework, Project Management Institute.

Deliverable	Acceptance Criteria	Exclusions
Lab facility architectural plans	• Building Certificate from council • Project Sponsor Sign-off • UNSW WHS Approval	Contingency plan for UNSW activities disrupted by construction
MM Cell blueprint	• Project Sponsor Sign-off	Detailed design beyond function and requirements of components which will be procured
MM Cell Tender Package	• Project Sponsor Sign-off • UNSW procurement team Sign-off	Detailed design beyond function and requirements of components which will be procured
Quality & Assurance Testing Framework document for robot outlining the testing regime that the MM Cell will need to pass in order to be accepted	Lead Engineer sign-off on the following items: • Precise specification of MM Cell alloys • Defect rate for each alloy • Production rate • Maximum Force of Hydraulic Press • Maximum/Minimum initial size of object to forge • Minimum heat and pressure tolerance for each component • Allowable robot downtime • Automated changing of arm attachments during operation • Moveable base range of motion and rotation • Remote Sensing error tolerance • Automated changing of hydraulic press head during operation • Cooling Vat for dimensions and durability • Ventilation System specifications • Robot arm can manipulate object in 360 degrees across 2 axes	• MM Cell performance on alloys not in alloy scope list • Performance outside of specified heat and pressure conditions • Further upgrades or replacement parts to the MM cell components as at the date of handover except as covered by any manufacturer warranty provided for those components and only for the period specified therein
Quality & Assurance Testing Framework document for the software outlining unit testing regime that MM Cell software will need to pass in order to be accepted	Lead Engineer sign-off on the following items: • CAD morphology error tolerance • Sensor & Vision System error tolerance • Thermal & Force Control error tolerance • Intel RealSense SDK model accurate to with agreed precision • LABView Software moves robot with precision agreed about above • CAD model processing time • Acceptable GUI for MM Cell	• Functionality of 3rd party software except where it interfaces with software designed as part of the project. • Further revisions or updates to the software solutions as at the date of handover
MM Cell	• Meets all criteria set out in the Requirements Section of the Project Charter • Passes the MM Cell QA Testing Framework • Passes the Software QA Testing • UNSW WHS Approval	• Upgrades/replacement parts to the MM Cell as at the date of handover except as covered by any manufacturer warranty provided • Provision of further raw materials other than as specified
Lab Facility	• Alignment with architectural plans • Ventilation system keeps air quality within acceptable bounds during furnace operation • Conveyor belt successfully moves forging material from work area to dispatch area without human intervention • UNSW WHS Approval	• Ongoing maintenance of the lab following the completion of construction • Disruption plans for neighbouring buildings during the construction of the lab facility
Furnace	• Generates sufficient heat to forge specified alloys • Inert gas protection for heating of Titanium alloys • Waste disposal procedure and guidance document • UNSW WHS Approval	• Removal of waste beyond documentation of procedure which is in line with NSW Waste Standards
Emergency Protocols	• Training course • Evacuation area • Lab signage • Alarm system • UNSW WHS Approval • MM Cell kill-switch	• Integration with broader UNSW Emergency Procedures
MM Cell Website	• Metamorphic Manufacturing explainer and use cases • Feedback and comments section to receive feedback from stakeholders related to Stakeholder Engagement Plan • Content documenting progress of the MM cell construction • Short demonstration videos of the MM Cell capabilities and use cases	• Hosting infrastructure • IT support • Additional content beyond handover period
UNSW RGC Training Pack	• Information pack outlining MM Cell capabilities and benefits in the context of grant applications • Information pack outlining MM Cell capabilities and benefits in the context of industry partnerships	• Hosting infrastructure • IT support • Additional content beyond handover period
Ribbon Cutting Ceremony	• Facility tour • MM Cell demonstration • Software demonstration	• Organization of media coverage • Attendee list
Operations Manual	• Outlines end to end operation from CAD Model to finished product • Outlines safe working practices • Outlines limitations of MM Cell • Outlines full range of capability • Software user manual for proprietary software and location of 3rd party documentation • Project Sponsor Sign-off	• Changes in operation brought about by updates to 3rd party software past the handover date
Operator Training Programme	• Alignment with Operations Manual • UNSW WHS Approval • Project Sponsor Sign-off	• Changes in operation due to 3rd party software updates past the handover date • Technical support for operators other than those chosen/referred by UNSW
Ad-hoc Technical Support for 12 months following installation of MM Cell	• One full time staff member fully trained in MM Cell operation designated to provide support to users of MM Cell • Project Sponsor Sign-off	• Technical support for operators other than those chosen/referred by UNSW

Scope Exclusions

The following exclusions apply in addition to those listed on the table above.

- At the project team's discretion, further work arising which is not reasonably necessary for the stated requirements of this charter
- Any other work not described above resulting from inadequate lab site provision, undue delay resulting from UNSW staff, or external events which cannot reasonably be foreseen and which adversely impact the university or the project team in carrying out the project

Exclusions described above may be performed subject to any further agreement by the project sponsor and the project team.

Work Breakdown Structure

The MM Cell

1. Design & Planning Documents

- **1.1 Facility Architectural Documents**
- **1.2 MM Cell Blueprint**
- **1.3 UNSW Approval Documents**
  - 1.3.1 Project Sponsor Signoff
  - 1.3.2 Internal UNSW WHS Compliance Signoff
- **1.4 QA Testing Documents**
  - 1.4.1. MM Cell Testing Plan
  - 1.4.2. Software Development Plan
  - 1.4.3 Software Unit Testing Plan

2. Procurement

- **2.1 Robot & Raw Materials Procurement**
  - 2.1.1 Legal Tender Documents
  - 2.1.2 Publish Tender Package
  - 2.1.3 Assessment Criteria Document
  - 2.1.4 Award Successful Tender
  - 2.1.5 Final Contract
- **2.2 Labour Procurement**
  - 2.2.1 Lab Site Preparation Specification
  - 2.2.2 MM Cell Installation Work Specification
  - 2.2.3 Contractor Selection
  - 2.2.4 Final Contract

3. Lab Site Construction

- **3.1 Temporary Office for On-Site Workers**
- **3.2 Site Excavation**
- **3.3 Foundations and Enclosure**
  - 3.3.1 Staging Area
  - 3.3.2 Testing & Inspection Area
  - 3.3.3 MM Cell Room
  - 3.3.4 Ventilation System
  - 3.3.5 Conveyor Belt
  - 3.3.6 Material Storage Zone
  - 3.3.7 Observer Platform
  - 3.3.8 PPE & First-Aid Zone

4. MM Cell Installation

- **4.1 Furnace**
  - 4.1.1 Frame Construction
  - 4.1.2 Inert Gas Chamber
- **4.2 Moveable Base**
- **4.3 Robotic Arm**
  - 4.3.1 Primary Robot Arm
  - 4.3.2 Arm Attachment Changer
- **4.4 Sensors**
  - 4.4.1 Depth Camera
  - 4.4.2 Thermal Sensors
  - 4.4.3 Pressure Sensors
- **4.5 Actuators & Tooling**
  - 4.5.1 Hydraulic Press
  - 4.5.2 Press Head Changer
- **4.6 Cooling Vat**
- **4.7 System Hardware**

5. Software Control System

- **5.1 Proprietary Software Control System**
  - 5.1.1 CAD Morphology Solver
  - 5.1.2 Sensor & Vision System
  - 5.1.3 Thermal & Force Control
- **5.2 Software Integration**
  - 5.2.1 CAD
  - 5.2.2 RealSense
  - 5.2.3 LABView

6. Q&A Testing & Safety

- **6.1 Software Unit Tests**
- **6.2 MM Cell Tests**
- **6.3 UNSW WHS Approval**
- **6.4 Emergency Protocols**

7. Training

- **7.1 LabView Training Course**
- **7.2 RealSense Training Course**
- **7.3 Manufacturer Training Course**

8. Stakeholder Engagement

- **8.1 MM Cell Website**
- **8.2 UNSW RGC Information Pack**
- **8.3 Ribbon Cutting Ceremony**

9. Training & Support

- **9.1 Operation & Safety Training**
  - 9.1.1 Operator Training Manual
  - 9.1.2 Emergency Protocols
  - 9.1.3 Student Training Course
- **9.2 On-Going Technical Support**

Estimate of Cost & Time

Category	Code	Work Package	Qty	Labour times and costs by standard grade[8]						Total direct labour cost	With Oncost	Materials and equipment		Estimated total cost	Estimated duration (days)
				Labour and Construction[7]		UNSW Professional and Academic Staff / Project Team									
				Grade 1 - General Construction Labour[1]	Grade 2 - Advanced Machinery Operator[2]	Grade 3 - Supervisor / Facilities[3]	Grade 4 - Internal Compliance / Legal[4]	Grade 5 - Project Team / Engineer[5]	Grade 6 - Senior Technical Stakeholder[6]			Standard or net cost	Materials burden		
				Hours at Rate	Hrs at Rate	Hrs at Rate	Hrs at Rate	Hrs at Rate	Hrs at Rate						
				34.56	**39.42**	**47.75**	**52.1**	**57.56**	**69.91**		**21.51%**				
1. Design & Planning	1.1	Facility Architectural Documents	1					180	20	$11,759	$14,288			$14,288	30
	1.2	MM Cell Blueprint	1					160	20	$10,608	$12,890			$12,890	30
	1.3.1	Project Sponsor Signoff	1						10	$699	$849			$849	15
	1.3.2	UNSW WHS Preliminary Approval	1				40	10		$2,660	$3,232			$3,232	15
	1.4.1	MM Cell Testing Plan	1					80		$4,605	$5,595			$5,595	90
	1.4.2	Software Development Plan	1					40		$2,302	$2,798			$2,798	90
	1.4.3	Software Unit Testing Plan	1					40		$2,302	$2,798			$2,798	90
2. Procurement	2.1.1	Legal Tender Documents	1				80	20		$5,319	$6,463			$6,463	15
	2.1.3	Assessment Criteria Document	1				20	5		$1,330	$1,616			$1,616	7
	2.1.2	Publish Tender	1			20	10			$1,476	$1,793			$1,793	15
	2.1.4	Award Successful Tender	1					40		$2,302	$2,798			$2,798	15
	2.1.5	Final Contract	1				80	20		$5,319	$6,463			$6,463	15
	2.2.1	Lab Site Work Specification	1				60	120		$10,033	$12,191			$12,191	30
	2.2.2	MM Cell Installation Work Specification	1				20	120		$7,949	$9,659			$9,659	30
	2.2.3	Contractor Selection	1				20	5		$1,330	$1,616			$1,616	5
	2.2.4	Final Contract	1				40	10		$2,660	$3,232			$3,232	10
3. Lab Site Construction	3.1	On-site Temporary Office	1	90	45					$4,884	$5,935	$3,500	15%	$9,960	15
	3.2	Site Excavation	1	314	135	45				$18,322	$22,263	$20,000	15%	$45,263	90
	3.3.1	Construct Staging Area	1	471	202	68				$27,488	$33,400	$25,000	15%	$62,150	90
	3.3.2	Construct Testing & Inspection Area	1	314	135	45				$18,322	$22,263	$35,000	15%	$62,513	90
	3.3.3	Construct MM Cell Room	1	752	323	108				$43,879	$53,317	$80,000	15%	$145,317	90
	3.3.4	Ventilation System	1	628	269	64				$35,364	$42,970	$30,000	15%	$77,470	45
	3.3.5	Conveyor Belt	1	388	269	64				$27,069	$32,892	$30,000	15%	$67,392	45
	3.3.6	Material Storage Zone[9]	1	388	269	64				$27,069	$32,892	$80,000	15%	$124,892	90
	3.3.7	Observer Platform	1	388	269	64				$27,069	$32,892	$30,000	15%	$67,392	90
	3.3.8	PPE & First-Aid Zone	1	388	269	64				$27,069	$32,892	$30,000	15%	$67,392	90
	4.1.1	Frame Construction	1		144	64		64		$12,416	$15,087	$20,000	30%	$41,087	30

4. MM Cell Installation	4.1.2	Inert Gas Chamber	1		144	64		64		$12,416	$15,087	$15,000	30%	$34,587	30
	4.2	Moveable Base	1		96	64		64		$10,524	$12,788	$15,000	30%	$32,288	30
	4.3.1	Primary Robot Arm	1		272	64		128		$21,146	$25,694	$50,000	30%	$90,694	30
	4.3.2	Arm Attachment Changer	1		96	48		64		$9,760	$11,860	$7,500	30%	$21,610	15
	4.4.1	Depth Camera	1		64	48		64		$8,499	$10,327	$5,000	30%	$16,827	5
	4.4.2	Thermal Sensors	1		64	48		64		$8,499	$10,327	$7,500	30%	$20,077	5
	4.4.3	Pressure Sensors	1		128	48		64		$11,022	$13,392	$7,500	30%	$23,142	5
	4.5.1	Hydraulic Press	1		192	64		64		$14,308	$17,386	$20,000	30%	$43,386	15
	4.5.2	Press Head Changer	1		64	48		64		$8,499	$10,327	$5,000	30%	$16,827	15
	4.6	Cooling Vat	1		192	56		64		$13,926	$16,922	$12,500	30%	$33,172	60
	4.7	System Hardware	1			72		128	32	$13,043	$15,848	$15,000	30%	$35,348	30
5. Software Control System	5.1.1	CAD Morphology Solver	1					1152	96	$73,020	$88,727			$88,727	180
	5.1.2	Sensor & Vision System	1					1152	96	$73,020	$88,727			$88,727	180
	5.1.3	Thermal & Force Control	1					1152	24	$67,987	$82,611			$82,611	180
	5.2.1	CAD Integration	1					352	64	$24,735	$30,056			$30,056	30
	5.2.2	RealSense Integration	1					352	64	$24,735	$30,056			$30,056	30
	5.2.3	LABView Integration	1					352	64	$24,735	$30,056			$30,056	30
6. Q&A Testing & Safety	6.1	Software Unit Tests	1					352	64	$24,735	$30,056			$30,056	20
	6.2	MM Cell Tests	1					352	64	$24,735	$30,056			$30,056	20
	6.3	UNSW WHS Approval	1			64	64	16		$7,311	$8,884			$8,884	60
	6.4	Emergency Protocols	1					64		$3,684	$4,476			$4,476	20
7. Training	7.2	LabView Training Course	1					96		$5,526	$6,714			$6,714	10
	7.3	RealSense Training Course	1					96		$5,526	$6,714			$6,714	10
	7.4	Manufacturer Training Course	1					96		$5,526	$6,714			$6,714	10
8. Stakeholder Engagement	8.1	MM Cell Website	1					96		$5,526	$6,714			$6,714	60
	8.2	UNSW RGC Information Pack	1				32	128		$9,035	$10,978			$10,978	30
	8.3	Ribbon Cutting Ceremony	1				96			$5,002	$6,077			$6,077	30
9. Training & Support	9.1.1	Operation and Training Manual	1				80	128	32	$13,773	$16,735	$2,000	15%	$19,035	30
	9.1.2	Emergency Protocols	1					80	32	$6,842	$8,314			$8,314	10
	9.1.3	Student Training Course	1					160	64	$13,684	$16,627			$16,627	20
	9.2	Ongoing Technical Support	1					1900		$109,364	$132,888			$132,888	365
Total										**$1,001,750**	**$1,217,226**			**$1,871,551**	

1Reference rate: UNSW General Staff (Casual) Level 1 (Point 1)

2Reference rate: UNSW General Staff (Casual) Level 2 (Point 1)

[3]Reference rate: UNSW General Staff (Casual) Level 4 (Point 1)

[4]Reference rate: UNSW General Staff (Casual) Level 5 (Point 1)

[5]Reference rate: UNSW Academic Staff (Lecturer) Step 1, $109,365 annual converted to hourly

[6]Reference rate: UNSW Academic Staff (Senior Lecturer) Step 1, $132,834 annual converted to hourly

[7]All labour and construction to be sourced by agreement with UNSW pre-approved contractors used in similar construction works on campus, not at market

[8]Labour burden has been included in rate estimates

[9]Includes 6-12mo purchase order for Steel and TI alloys suitable for MM cell obtained in Procurement Phase

Stakeholder Management Plan

Stakeholder	Role/ Relationship	Interest	Influence	What's the stakeholder's most important goal?	How will he/she contribute?	Best way to manage	WBS Item
UNSW Professional Staff	Marketing team/Grant and Funding	Medium/Relatively high	Relatively high	Indirectly and directly Funding the project (Also including keep good relationship with Government because local government also funds that)	Advertising some key information to show how useful the MM cell is, inviting investment and then funding the project	Link the individual salary to the personal investment from personal contribution	1.3, 2.1, 2.2,8.1-8.3
UNSW Academic Staff	The staff with a certainly highly relative in the Graduate Research School Office with responsibility to maintain the relationship with students and advertise the project to current and future students	Medium/Relatively high	Medium	Maintenance relationships and Advertisement	To maintain and advertise by E-mail and in-person meetings.	Weekly E-mail summarise and occasional in-person meetings	1.3, 4 and 7
Project Management Team & Project Sponsor	Project manager	High	High	To guarantee the project frequently starting and ending by technical aspects	To start on time and on budget, and no surprises	Meeting twice a week	All
Current students	A group of indirect stakeholders who obtain some emerging technical knowledge throughout MM cell projects.	Relatively high/Medium	Relatively high/Medium	Get the feedback to improve our educational structure	Utilizing this resource and providing feedback	Relative students daily provide feedback	7
Future students	The MM cell project could affect the future student selection outcomes before they enter UNSW.	Relatively high/Medium	Relatively high/Medium	-	Advertisement and future students would have chances to develop the project further	E-mail and calls	8.1-8.3
Alumni	A potential group who can spread the project content for current and future students.	Low	Low	Explain something about MM cell to new students who are interested	Spreading	E-mail and calls	8.1-8.3
Government	The MM cell will continuously facilitate UNSW to be leadership in a specific area and thus help the government achieve their educational goals. The Department of Industry, Science, Energy and Resources launched the Industry 4.0 initiative along with the Advanced Manufacturing Growth Fund to invest in the future of Australia's manufacturing sector.	Relatively high	Medium	Stable profits could be the annual goal. Although Government need the innovation of these types of projects to obtain income, the financial income of Government with many incomes cannot be easily affected by only one project.	Funding the project and obtaining profits from the MM cell project	E-mail/going to the Bureau to gain a face-to-face service	8.1-8.3
Investors	These people are essential and direct stakeholders by providing abundant funds to support the construction of MM cell completing on time and running well. The financial management is mainly from this group.	High	High	budgets, goals, requirements	Meetings, calls and E-mail	Meetings, calls and E-mail	8.1-8.3
Industry partners (Including the basic information from conventional workers and robot manufacturers)	Robot manufacturers	High	High	Assist to perfectly complete all mechanical equipment in the MM cell installation	Complete the arms construction and then do maintenance per week; Also introduce some information about interaction between computer and robot.	Face to face at any time	2, 4

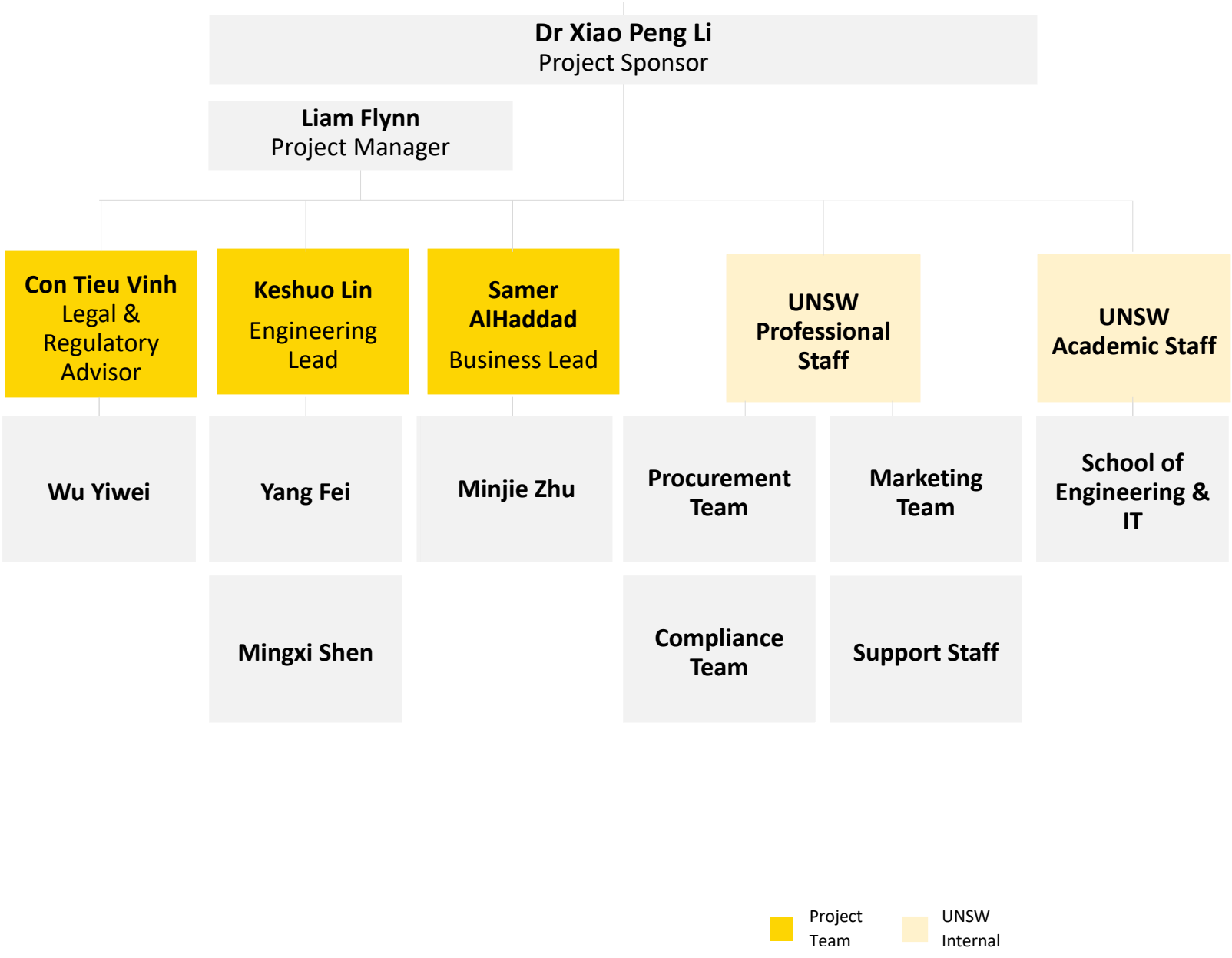
	The whole of the MM cell is based on the conventional industry. These people who could provide a certain technical support for mechanical design and construction is a relative link between the emerging project and conventional industry. But some created sections could be extremely different to the conventional industry.	Relatively low	Low	Keep informed	Seminar meeting, calls and E-mail	Meetings, calls and E-mail	2.2, 3
Research collaborators	The other research organizations could share their high-quality workforce for the MM cell construction, and this also can enhance the MM cell development through collaborations.	Relatively high	Medium	Keep informed	advertisement, email	Meetings, calls and E-mail	1.2, 1.5
Contractor Labour	The people who are related to the construction of MM cell have a responsibility to face and address some problems and hand up on municipal statement and legal documents to Government and keep assign the work to medium contractors. They could also abstract some funds from society and then funding the project.	Medium	Medium	They should be finished the work on time, which has been guaranteed in the MM cell construction contracts.	These people are directly related to the real basic construction work.	Throughout managing the contractors to address the problem which happens from medium contractors	2.2, 3

Stakeholder Engagement Matrix

Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
UNSW staff			C	D	
MM Cell Project Team				D	C
Current students			C	D	
Future students			C	D	
Alumni			C	D	
Government				C D	
Investors				C D	
Industry Partners			C	D	
Research Collaborators				C D	
Contractor Labour			C	D	

Human Resource Plan

Project Organization Chart



Roles & Responsibilities

RACI Matrix detailing varying degrees of responsibility of the key stakeholders in each of the major deliverables.

Role / Task	Project Manager	Business Analyst	Legal Advisors	Procurement Team	Project Sponsor	Industry Partners	Research Collaborators	Technical Support	Academic Staff	Professional Staff	Engineering Team	Contract Labourers
MM Cell Blueprint	R	C	R	C	C	C	C	I	I	I	A	
Facility Architectural Documents	R		R	C	C					I	A	I
UNSW Approval Documents	R	C	A	R	C			R		I		I
QA Testing Documents	R		R	R	C	C	C				A	
Robot Procurement	C	C	R	A	I	C	C	R	C	I	R	I
Labour Procurement	C	C	R	A	I			R	C	I		R
Temporary On-Site Office	I		R		I			I	I	I		A
Site Excavation	R		R		I						I	A
Foundations and Enclosure	R				C						I	A
Furnace	R				C		C		C		A	R
Moveable Base	R				C		C		C		A	R
Robotic Arm	R				C		C		C		A	R
Sensors	R				C		C		C		A	R
Actuators & Tooling	R				C		C		C		A	R
Cooling Vat	R				C		C		C		A	R
System Hardware	R				C		C		C		A	
Software Control System	R				C						A	
Software Integration	R				C		C	R			A	
Software Unit Tests	R				C		C	R	C		A	
MM Cell Tests	R				C		C				A	
UNSW WHS Approval	R	C	R		C			I		A		
Emergency Protocols	R	A	R		I			I		I	C	
3rd Party Software Training Courses	R	C			I		C	R		A	I	
Manufacturer Training Course	R	C	I		I			R		A	I	
MM Cell Website	R	A	R		I	I	I	I		R		
UNSW RGC Information Pack	R	A	R		I	I	I	I		R		
Ribbon Cutting Ceremony	R	C	I	I	I	I	I	I	I	A	I	I
Operation & Safety Training	R		R		C			R		I	A	
On-Going Technical Support	R		A		C			R	C	I	I	R

Training

The three phases of MM Cell construction and operation will require multiple members of the Project Team as well as other stakeholders to undergo upskilling in key areas. The various training courses which people will be enrolled in are listed below:

LabView

LabView is a program development environment developed by National Instrument Company.[13] LabView differs from traditional programming languages in that it has a graphical editing interface with block diagrams. LabView is an ideal choice for CAD manufacturing processes.

RealSense

RealSense is a technology that enables computers to perceive the world.[14] It is equivalent to a computer with a pair of eyes, through the infrared sensor components and the real sense image processing chip, the computer can accurately identify the expression and action of people, so as to better carry out human-computer interaction.

Emergency protocols training

Emergency protocols training can help team members protect their lives in the event of dangerous systems arising within the laboratory environment. The team will develop comprehensive procedures to prepare for and respond to emergencies, including ensuring the safety of team members in the event of a serious accident. This is an essential training for the safety for operators of the MM Cell.

CAD

CAD refers to the use of computers and graphics equipment to help designers carry out design work.[15] All the team members involved in the design should master the ability of CAD design. Some online courses about CAD can be provided for training.

Forging materials

The project team lacks knowledge about material forging. Team member Yang Fei is major in chemistry and can help team in materials. Members should understand the basic knowledge of materials and how to select and forge materials.

[13] National Instruments, LabVIEW, https://www.ni.com/en-au/shop/labview.html
[14] Intel RealSense SDK 2.0, https://www.intelrealsense.com/developers/
[15] Autodesk CAD Software, https://www.autodesk.com.au/solutions/cad-software

Risk Management Plan

Risk Severity Matrix

For each of the identified risks we have estimated the likelihood, impact and detection difficulty on scales of 1-10 with 1 being the least likely, least impactful and least difficult to detect respectively to calculate an overall risk score. We have also documented out risk management strategy for each particular risk as well our response and the related WBS.

Category	Description	Response	Owner	Estimate for Contingency Reserve	Comments	Relevant to WBS Items	Likelihood	Impact	Difficulty to Detect	Score
Technical	MM Cell does not work at all; the technology is insufficiently mature	(Mitigate) Invest additional funds into research; (Accept) Repurpose lab site and/or robotic components into existing MakerSpace technologies	Project Manager	$25,000	Subject to change request and/or additional projects	5, 6	4	9	7	252
Technical	Bespoke software package cannot be integrated with CAD, LabView and/or RealSense as desired	(Accept) Project Team to consult experienced engineer/s with expertise in these software packages to assist in integration.	Technical Team	$15,000	Allocation for hiring consultant	5.1.1, 5.1.2, 5.1.3, 5.2.1, 5.2.2, 5.2.3	6	8	5	240
Legal	Lab site does not pass Work Health and Safety certification by UNSW Compliance	(Accept) Project team to obtain detailed list of site issues from inspecting Compliance Officer, formulate and execute plan to rectify; (Transfer) Transfer cost to contractors where recourse available under contract	Legal and Regulatory Advisor	$12,000	Allocation for rectification works	3, 6.3	6	9	4	216
Legal / Financial	Construction workers cannot be obtained or cannot commence work due to COVID-19 restrictions	(Accept) Impose stage gate at end of Procurement phase; if COVID-19 restrictions show signs of escalation during Q4 2022 and labourers are not permitted on site, the project can be delayed or aborted	Legal and Regulatory Advisor		Already allocated above in (1)	3	7	10	3	210
Technical	The output of the MM Cell does not meet the quality specifications	(Mitigate) As a new technology, certain requirements may not be feasible especially given cost or supply chain constraints. Senior Technical Stakeholder consulted on key Work Packages which require expertise; (Mitigate) Significant QA time allocation and budget	Technical Team		Already priced into Work Packages	5.1.1, 5.1.2, 5.1.3, 5.2.1, 5.2.2, 5.2.3, 6.1, 6.2	5	10	4	200
Strategic	Researchers across UNSW are not aware of the successful launch of the MM Cell or do not know how to incorporate it into their grant applications	(Mitigate) Develop MM Cell website to be published on faculty website; (Mitigate) UNSW Research Grant Centre Information Pack will be distributed to researchers within UNSW to assist them in making grant applications	Project Manager / Business Analyst		Already priced into Stakeholder Engagement Work Packages	8.1,8.2	5	7	5	175
Strategic	Industry members are not aware of the successful launch of the MM Cell or its capabilities	(Mitigate) Project Team to liaise with UNSW Engagement teams to assist with publications via newsletters and emails; (Mitigate) Ribbon Cutting Ceremony to be held with invited industry members upon handover	Project Manager / Business Analyst	$5,000	Allocation for UNSW Engagement	8.3	5	5	7	175
Strategic	Another organization (either Research or in Industry) builds an MM Cell of similar or superior capability, or achieves significant research contributions first, reducing the strategic value of our project	(Avoid) Accelerate project where possible by crashing	Project Manager	$20,000	Initial allocation for overtime loading	3, 4, 5	4	5	7	140

Resourcing	Difficulty in the procurement of materials, equipment, or expertise due to supply chain disruption (COVID-19)	(Accept) Attempt concurrent work on project streams while delay resolved; delay the project	Project Manager	$15,000	Allocation for project delays including human resource costs	3, 4	8	4	4	128
Strategic	Industry partners needs change by the time of project handover; MM Cell technology no longer aligns with needs of our industry partners	(Accept) MM cell's benefits are diversified across research, industry, and student focuses	Project Manager			8.2, 8.3	3	5	8	120
Financial	MM cell components cannot be obtained at reasonably competitive market rates; a premium must be paid for bespoke or specialty parts	(Accept) Impose stage gate at end of Procurement phase; if robotic components cannot be obtained at reasonable market rates and/or delivered within project timeframes, the project can be delayed or aborted	Financial Adviser	$10,000	Allocation for overhead cost associated with winding up the project early	2.1.1, 2,1.2, 2.1.3, 2.1.4, 2.1.5	7	7	2	98
Resourcing	Suitable lab site which supports robot specifications is not found within UNSW Campus	(Avoid) Lab Specification is devised early in the project and allows ample time for UNSW to determine a satisfactory site; (Accept) Modification to an existing site may be required to support MM cell housing and ancillary zone requirements	Project Manager	$15,000	Allocation for modification of existing lab site that is nearly suitable for MM Cell	1.1, 1.2, 3.2	6	8	1	48
Technical	MM Cell cannot forge all required alloys	(Avoid) Robot Specification will ensure that actuators, robotic arm and forge (including inert gas chamber) are capable of forging required alloys	Technical Team		Already priced into QA testing phase	1.2	4	6	2	48
Resourcing	Key project staff member such as software engineer resigns or becomes unable to continue to be engaged on the project partway through	(Accept) Diverse core project team ensures continuity of project; Replace key project staff member by hiring someone with similar knowledge and skillset	Project Manager	$3,000	Allocation for hiring new member	5.1.1, 5.1.2, 5.1.3, 5.2.1, 5.2.2, 5.2.3	3	6	2	36
Technical	The Project Team is unable to design an MM Cell Specification which is approved by Sponsor	(Accept) Diverse core project team including technical experts ensures that, through an iterative process, a design which achieves Project Requirements can be developed	Technical Team			1.3.1	4	3	2	24
Technical	Complicated sensor installation renders adjustment difficult or results in reading errors	(Avoid) Detailed Robot Specification will ensure that sensors are compatible with robotic arm, actuators, and tooling; (Accept) Calibration during QA testing phase	Technical Team		Already priced into QA testing phase	6.1, 6.2	5	2	2	20
Legal	Injury during construction or operation of the MM Cell	(Mitigate) Deploy supervisor on site; (Mitigate) Enforcement of appropriate safety rules and regulations on site; (Transfer) Ensure builders have public liability insurance	Legal and Regulatory Advisor		Supervisor already priced into direct labour costs	3, 4, 5	3	3	1	9
		Total Contingency Reserve		**$120,000**						

Time Phased Budget

WBS	Budget	Duration (Days)	2021												2022												2023								
			21Q1			21Q2			21Q3			21Q4			22Q1			22Q2			22Q3			22Q4			23Q1			23Q2			23Q3		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1.1	$14,288	30	$14,288																																
1.2	$12,890	30		$12,890																															
1.3	$4,081	15			$4,081																														
1.4	$11,191	90			$3,730	$3,730	$3,730																												
2.1	$19,133	67			$4,284	$8,567	$6,283																												
2.2.1	$12,191	30					$3,657	$8,534																											
2.2.2	$9,659	30						$2,898	$6,761																										
2.2.3/4	$4,848	15							$2,909	$1,939																									
3.1	$9,960	15								$9,960																									
3.2	$45,263	90								$4,526	$15,088	$15,088	$10,561																						
3.3.1	$62,150	90											$6,215	$20,717	$20,717	$14,502																			
3.3.2	$62,513	90											$6,251	$20,838	$20,838	$14,586																			
3.3.3	$145,317	90											$14,532	$48,439	$48,439	$33,907																			
3.3.6	$124,892	90											$12,489	$41,631	$41,631	$29,141																			
3.3.7	$67,392	90											$6,739	$22,464	$22,464	$15,725																			
3.3.8	$67,392	90											$6,739	$22,464	$22,464	$15,725																			
6.3	$8,884	60														$1,333	$4,442	$3,109																	
4.1	$75,674	60														$11,351	$37,837	$26,486																	
3.3.4	$77,470	45														$15,494	$51,647	$10,329																	
3.3.5	$67,392	45														$13,478	$44,928	$8,986																	
4.2	$32,288	30														$9,686	$22,602																		
4.6	$33,172	60														$4,976	$16,586	$11,610																	
4.3.1	$90,694	30															$27,208	$63,486																	
4.3.2	$21,610	15															$12,966	$8,644																	
4.5	$60,213	30															$18,064	$42,149																	
4.4	$60,046	15																$36,028	$24,018																
4.7	$35,348	30																	$28,278	$7,070															
7	$20,142	30																		$16,114	$4,028														
5.1.1	$88,727	180																			$11,830	$14,788	$14,788	$14,788	$14,788	$14,788	$2,958								
5.1.2	$88,727	180																			$11,830	$14,788	$14,788	$14,788	$14,788	$14,788	$2,958								
5.1.3	$82,611	180																			$11,015	$13,769	$13,769	$13,769	$13,769	$13,769	$2,754								
5.2	$90,168	90																									$24,045	$30,056	$30,056	$6,011					
6.1/2/4	$64,588	60																												$25,835	$32,294	$6,459			
9.1	$43,976	60																														$17,590	$21,988	$4,398	
8.1	$6,714	60																														$2,686	$3,357	$671	
8.2	$10,978	30																																$8,782	$2,196
8.3	$6,077	30																																$4,862	$1,215
9.2	$132,888	365																																	$132,888
Reserve	$120,000	N/A	$40,000												$60,000												$20,000								
Total (Quarterly)			**$79,273**			**$37,399**			**$41,183**			**$255,167**			**$652,736**			**$286,307**			**$125,392**			**$130,033**			**$112,826**			**$90,875**			**$180,357**		
Total (Annually)			**$413,022**												**$1,194,468**												**$384,058**								
Total			**$1,991,547**																																

Time Phase Budget by Year

Time-Phased Budget (By Year)

WBS	Budget (Annual)	Duration (Days)	2021											
			21Q1			21Q2			21Q3			21Q4		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.1	$14,288	30	$14,288											
1.2	$12,890	30		$12,890										
1.3	$4,081	15			$4,081									
1.4	$11,191	90			$3,730	$3,730	$3,730							
2.1	$19,133	67			$4,284	$8,567	$6,283							
2.2.1	$12,191	30					$3,657	$8,534						
2.2.2	$9,659	30						$2,898	$6,761					
2.2.3, 2.2.4	$4,848	15							$2,909	$1,939				
3.1	$9,960	15								$9,960				
3.2	$45,263	90								$4,526	$15,088	$15,088	$10,561	
3.3.1	$26,932	90											$6,215	$20,717
3.3.2	$27,089	90											$6,251	$20,838
3.3.3	$62,971	90											$14,532	$48,439
3.3.6	$54,120	90											$12,489	$41,631
3.3.7	$29,203	90											$6,739	$22,464
3.3.8	$29,203	90											$6,739	$22,464
Reserve	$40,000	N/A	$40,000											
Total (Quarterly)			$79,273			$37,399			$41,183			$255,167		
Total (Annually)			$413,022											

WBS	Budget (Annual)	Duration (Days)	2022											
			22Q1			22Q2			22Q3			22Q4		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.3.1	$35,218	90	$20,717	$14,502										
3.3.2	$35,424	90	$20,838	$14,586										
3.3.3	$82,346	90	$48,439	$33,907										
3.3.6	$70,772	90	$41,631	$29,141										
3.3.7	$38,189	90	$22,464	$15,725										
3.3.8	$38,189	90	$22,464	$15,725										
6.3	$8,884	60		$1,333	$4,442	$3,109								
4.1	$75,674	60		$11,351	$37,837	$26,486								
3.3.4	$77,470	45		$15,494	$51,647	$10,329								
3.3.5	$67,392	45		$13,478	$44,928	$8,986								
4.2	$32,288	30		$9,686	$22,602									
4.6	$33,172	60		$4,976	$16,586	$11,610								
4.3.1	$90,694	30			$27,208	$63,486								
4.3.2	$21,610	15			$12,966	$8,644								
4.5	$60,213	30			$18,064	$42,149								
4.4	$60,046	15				$36,028	$24,018							
4.7	$35,348	30					$28,278	$7,070						
7	$20,142	30						$16,114	$4,028					
5.1.1	$85,769	180							$11,830	$14,788	$14,788	$14,788	$14,788	$14,788
5.1.2	$85,769	180							$11,830	$14,788	$14,788	$14,788	$14,788	$14,788
5.1.3	$79,857	180							$11,015	$13,769	$13,769	$13,769	$13,769	$13,769
Reserve	$60,000	N/A	$60,000											
Total (Quarterly)			$652,736			$286,307			$125,392			$130,033		
Total (Annually)			$1,194,468											

WBS	Budget (Annual)	Duration (Days)	2023								
			23Q1			23Q2			23Q3		
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5.1.1	$2,958	180	$2,958								
5.1.2	$2,958	180	$2,958								
5.1.3	$2,754	180	$2,754								
5.2	$90,168	90	$24,045	$30,056	$30,056	$6,011					
6.1, 6.2, 6.4	$64,588	60				$25,835	$32,294	$6,459			
9.1	$43,976	60						$17,590	$21,988	$4,398	
8.1	$6,714	60						$2,686	$3,357	$671	
8.2	$10,978	30								$8,782	$2,196
8.3	$6,077	30								$4,862	$1,215
9.2	$132,888	365									$132,888
Reserve	$20,000	N/A	$20,000								
Total (Quarterly)			$112,826			$90,875			$180,357		
Total (Annually)			$384,058								

Total (Incl. Tech Support)	$1,991,547