GSOE9820

Engineering Project Management

Robot Blacksmith Project

Project Management Plan

SUBMITTED BY:

Group 42

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

Group members' name	Ahmed Alghamdi	Yu-Fu Chien	Yuedong Gao	Xiaoyi Jiang	Sachin Krishnamoorthy	Yiran Teng	Wenkang Zhang
zID	z5232346	z5280670	z5232198	z5241550	z5232031	z5241469	z5232665
Key contribution of each group member	• Project Charter • HR plan	• Project Charter • Scope statement	• Project Charter • Time and Cost Estimates	• Project Charter • Definition of Success • Network diagram • Schedule	• Project Charter • WBS • Time phased budget and Contingency budget	• Project Charter • Stakeholder management • Communication plan	• Project Charter • Risk management plan
Declaration	Ahmed Alghamdi	Chien YuFu	Gao Yuedong	JIANG Xiaoyi	Sachin Krishnamoorthy	Teng Yiran	ZHANG, Wenkang

Table of Contents

Introduction

Our proposal is to build a state-of-the-art Metamorphic Manufacturing (MM) laboratory that will bring UNSW closer in line with its 2025 Strategy and attract world-wide scientific and industry attention. The facility itself would use artificial intelligence to forge a range of titanium/low alloy steels for industrial and research applications. The objectives the lab sets out to achieve are listed below.

- Increasing the Capability and Relevancy of UNSW' s Researchers
  As we are building a cutting-edge research facility a core indicator of it being successful would be its benefit to the research community at UNSW. The project will be deemed successful in this case if after completion and use, there is a clear **increase in research papers published** where the MM Lab was used, **an increase in research grants** regarding MM Lab research, or **new research partnerships formed** with other research bodies.

- Enhancing Current Student Quality of Life and Education
  A core objective of the MM Lab will be its accessibility to students. Through the Maker Space students can access university machinery for use in their startups and coursework with relevant training, and it is expected that the same can be done for the MM Lab. Criteria to measure this success will be the **number of courses that** incorporate the MM Lab in its coursework, the **number of forged prototypes** built via Maker Space access.

- Growing the Quality and Quantity of Student Applicants
  In line with UNSW' s objectives, a core objective of the MM Lab is to increase UNSW' s standing amongst prospective domestic and international students. The MM Lab will be the only one of its kind, and as such will attract both undergraduate and postgraduate domestically and around the world. The core measure of our success will be **the number of applicants** UNSW receives to its Material Science and Manufacturing Faculties **(international especially)**, as well as improvement to **UNSW' s standing in the rankings of the Top 100 Universities.**

The team that will lead this project to success is composed of UNSW's own graduates, who have previous knowledge with project management and extensive knowledge in computer systems.

Member	Expertise
Ahmed Alghamdi	Biomedical Engineering
Yu-Fu Chien	Data Science
Yuedong Gao	Internetworking
Xiaoyi Jiang	Telecommunication Internetworking
Sachin Krishnamoorthy	Software Engineering and Architecture
Yiran Teng	Information Technology
Wenkang Zhang	Artificial Intelligence

1 Scope Statement

JUSTIFICATION	
MM lab (cell) is a revolutionary approach to manufacturing that can achieve more complex shapes, reach specific engineering properties. By building this lab at UNSW, the faculties of the school could use the MM lab to forge a range of titanium and steel alloys for industrial and research applications with high accuracy, quality, and efficiency. It will furthermore bring UNSW closer in line with its 2025 Strategy objectives.	
DESCRIPTION	
This project is to build the MM laboratory under AUD 2,000,000 within 12 months. To do this, an integrated software system must be developed for generating toolpaths, data collection and analysis, and precise robot control and decision making. Equipment to be installed in the MM lab includes a sensor system, electronic control system, robotic arm, forging tools, and a furnace without violating building requirements and codes. Finally, we help UNSW transition to full lab ownership through an introduction exhibition, course integration possibilities, and Maker space usage.	
SCOPE	
Lab Space	• **Establish Lab location**: evaluation and approval on existing UNSW building • **Compile Lab Requirement**: define safety, utility demand and space required. • **Build Safety Mechanism**: comply with Australia Health and Safety requirements. • **Build the Lab**
Software System	• **Design of Software Architecture** • **CAD/CAM Integration**: combine a powerful CAM solution with full 3D CAD modelling. • **Sensor System**: real-time sensor data collection and data analytics • **Robot Arm Manipulation Software** • **Forging Control System** • **Artificial Intelligence Algorithm**: collect numerical data from each operation and improve accuracy, quality and efficiency • **Control Interface**
Forging System	• **Sensor system**: 1. Infrared thermal cameras with maximum temperature up to 1950°F (1065°C) and X-ray lasers; 2. Load cells; 3. The Brinell hardness tester; 4. Torque and Torsional Vibration System 5. Ultrasonic testers for Non-Destructive Testing. • **Robotics mechanical arms**: maximum moving speed 10m/sec, maximum lift weight up to 10 kg. • **Forging tools**: different tools are required to forge a multitude of components. • **Furnace**: maximum heating temperature up to 1950°F (1065°C).

Transition of Management	**MML Training:** academic staff training **Course Integration**: implement MML to coursework and Maker Space **Introduction exhibition:** for benefit and accessibility of MM lab **Document**: Manual for manipulating MM cells and Safety Guidelines
Employment	**Engineering team** **Construction team** **Additional contractor**

EXCLUSION
Systems and equipment maintenance and improvement after 12 months.
Provide forging materials (e.g. alloyed steel, Ti alloy)
Forge products with large size (over 10kg) and produce non-metal products.
Remove all equipment are not included in blueprint in the lab
Build research collaboration with other faculties, universities or enterprises.
MM cells operation tutorial for UNSW students.
Show off the outstanding academic performance (related to MM labs) to the worldwide.

CONSTRAINT	
Budget	Build MM laboratory under AUD 2,000,000 budget.
Time	Build MM laboratory within 12 months.
Resources	All the equipment in MM lab should follow the building rules (weight, space and safety).
	The limitation of experts in this field in Australia
	Construction of MM laboratory must comply with Australia safety regulation
	Forging material are limited to Ai alloys and Low-alloy steel.
Technical	Robotics mechanical arms must with maximum moving speed 10m/sec and maximum lift weight up to 10 kg.
	Furnace must with maximum heating temperature up to 1950°F (1065°C).
	Speed hammer must with maximum speed 10m/sec.

ASSUMPTION
All the required materials are delivered on time.
CSE faculty/professors are willing to contribute to AI systems/robotics systems
Hiring the best experts in Metamorphic manufacturing especially intelligent machines and robotic systems.
UNSW utilities is in good condition to extend for our facilities
All staff follow the Safety guidelines.
The equipment of MM labs procured from supplier meet all the specifications.
Preferred location of MM lab is approved.
All the experts will be fully engaged in the project.

2 WBS

2.1 Overview

The MM Lab Work Breakdown Structure is divided into 5 major sub-deliverables, and further broken down into the necessary work pages required for the sub deliverable to succeed. Each sub-deliverable and work package is expanded upon in much greater detail in the rest of the report, but a hierarchal view of each sub-deliverable is available in Appendix B.

2.2 Project Work Breakdown Structure

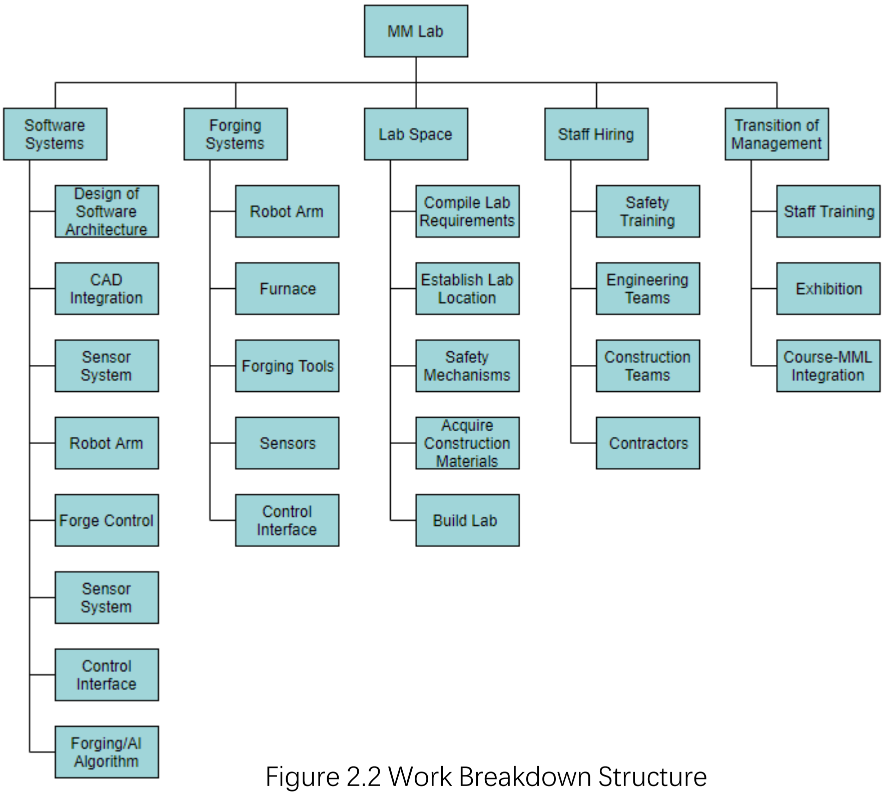


Figure 2.2 Work Breakdown Structure

3 Estimates of Time and Cost

The management of cost and time is one of the most crucial contributors to the successful completion of a project. As proposing and proceeding the project, estimation of time and cost plans were drafted by our management team to ensure the health of our financial circumstance. All work packages were individually assessed to estimate cost along with time estimation.

Utilising the bottom-up approach based on the WBS of this project, our team estimate the cost and duration of different activities in this project. The total cost is 1,751,750 AU$, and the duration of this whole project is 12 months. The detail is in figure 3.1.

Develop and Deliver Lab Space											
description:find a suitable location for this project, and develop a specific design based on the real circumstance,then construct the lab.											
total cost($):											312,730
ID	Acitivity	labour							material		cost/$
		expert		assistant		worker		salary/$	item	cost/$	
		Duration	Number	Duration	Number	Duration	Number				
1.1	Lab Requirements	5	2	5	3	1	0	14300	0	0	14300
1.2	Lab Location	5	1	5	3	5	0	10300	rent	6,000	16,300
1.3	Construction Materials	3	0	3	3	3	3	5850	material	40,000	45,850
1.4	Lab Construction	13	0	13	1	13	6	23400	equipment	160,000	183,400
1.5	Safety Mechanisms	8	2	8	3	8	0	22880	Auxiliary equipment	30,000	52,880
Develop and Deliver Employment Contract											
description:Build different teams for this project and develop communition methods to ensure different part of this project could be done in time.											
total cost($):											35920
ID	Acitivity	labour							material		cost/$
		expert		assistant		worker		salary	item	cost/$	
		Duration	Number	Duration	Number	Duration	Number				
2.1	Engineering Team Contract	5	2	5	3	5	0	14300	0	0	14300
2.2	Construction Team Contract	5	2	5	3	5	0	14300	0	0	14300
2.3	Additional Contractors Contract	3	2	2	3	2	0	7320	0	0	7320
Develop and Deliver Software System											
description:Design and implement Software System with necessary equipment and material											
total cost($):											731,680
ID	Acitivity	labour							material		cost/$
		expert		assistant		worker		salary	item	cost/$	
		Duration	Number	Duration	Number	Duration	Number				
3.1	Design of Software System Architecture	22	1	22	2	22	0	36080	Industry Computers	21,000	57,080
3.2	CAD Integration	12	2	22	3	22	0	46920	equipment	20,000	66,920
3.3	Sensor Systems	18	2	18	3	22	1	56540	Auxiliary equipment	20,000	76,540
3.4	Robot Arm	21	2	21	3	22	3	75240	Robot	240,000	315,240
3.5	Forge Control	23	2	23	3	22	0	65780	Auxiliary equipment	30,000	95,780
3.6	Control Interface	25	2	25	2	25	0	61000	equipment	30,000	91,000
3.7	AI Algorithm	42	2	42	3	42	0	120120	0	0	120120
Develop and Deliver Forging System											
description:merge software and equipment toghther.											
total cost($):											580,400
ID	Acitivity	labour							material		cost
		expert		assistant		worker		salary	item	cost/$	
		Duration	Number	Duration	Number	Duration	Number				
4.1	Robot Arm	22	2	22	3	10	3	69820	Robot	80,000	149,820
4.2	Furnace	21	2	22	3	21	0	61320	Auxiliary equipment	7,000	68,320
4.3	Forging Tools	18	2	18	3	4	3	54240	Auxiliary equipment	14,000	68,240
4.4	Sensors	25	1	25	2	10	3	47900	Robot	160,000	207,900
4.5	Control Interface	23	2	23	2	23	0	56120	Robot	30,000	86,120
Transition of Management											
description: to ensure staffs in teams know what to do and how to do, and design the exhibition to clarify the success of this project											
total cost($):											91,020
ID	Acitivity	labour							material		cost/$
		expert		assistant		worker		salary	item	cost/$	
		Duration	Number	Duration	Number	Duration	Number				
5.1	Staff Training Video	13	1	13	2	13	3	30290	0	0	30290
5.2	Exhibition	9	0	9	3	9	3	17550	rent	6,000	23,550
5.3	Course Integration	13	2	13	3	13	0	37180	0	0	37180
The cost of the whole project($):										1,751,750	
Duration (pre day) Number :the amount of staff take part in this acitivity expert salary:800$ per day assist salary:420$ per day worker salary:230$ per day											

Figure 3.1 Estimate of Time and Cost

4 Network Diagram

Decompose the work packages in WBS (as shown in section 1 and Appendix B) to activities, for the detailed activity list, see Figure 5.2 Schedule.

Use the precedence network diagram (Lock 2007, p.200-203) to analyse time and **precedence order**. List all the main activities on the **critical path** (as shown in figure 4.1 and 4.2), the time units are project working day number.

ID	Description	Duration	Early Start	Early Finish	Late Start	Late Finish	Total Slack
~	Project Start	~	~	~	~	~	~
A	Project Authorization	10	0	10	0	10	0
1.1	Deliver Lab Requirements	5	10	15	10	15	0
1.2	Deliver Lab Location	5	15	20	15	20	0
2.2	Deliver Construction Team Contract	5	20	25	20	25	0
1.3	Deliver Construction Materials	3	25	28	25	28	0
1.4.C	Construct the lab area	5	28	33	28	33	0
1.5	Deliver Safety Mechanisms	8	33	41	33	41	0
4.1.R-I	Deliver Robot Arm	17	41	58	41	58	0
4.1.T	Robot Arm Testing	5	58	63	58	63	0
4.2	Deliver Furnace	21	63	84	63	84	0
4.3	Deliver Forging Tools	18	84	102	84	102	0
4.4	Deliver Sensors	25	102	127	102	127	0
4.5	Deliver Control Interface	23	127	150	127	150	0
3.6	Deliver Control Interface	25	150	175	150	175	0
3.7	Develop and Deliver AI Algorithm	42	175	217	175	217	0
T	Comprehensive Testing	20	217	237	217	237	0
5.3	Deliver Course Integration	13	237	250	237	250	0
R	Review the Project	5	250	255	250	255	0
~	Project Finish	~	~	~	~	~	~

Figure 4.1 Critical Path Sequence

The whole Network Diagram and Detailed Critical Path are shown in Figure 4.2.

5 Schedule

In order to **manage the timely completion** of the project, a detailed schedule is necessary. Use the time analysis table and Gantt chart (Lock 2007, p.78 & 203) to schedule all the activities in the activity list of this project.

List the milestone schedule for the activities of the main deliverables and products.

ID	Description	Duration	Start Date	Finish Date
~	Project Start	~	~	~
A	Project Authorisation	10	1-Jan	16-Jan
1	Develop and Deliver Lab Space	31	16-Jan	2-Mar
2	Develop and Deliver Employment Contract	15	16-Jan	8-Feb
3	Develop and Deliver Software System	199	28-Jan	9-Nov
4	Develop and Deliver Forging System	109	2-Mar	5-Aug
T	Comprehensive Testing	20	9-Nov	6-Dec
5	Transition of Management	13	6-Dec	22-Dec
R	Review the Project	5	22-Dec	30-Dec
~	Project Finish	~	~	~

Figure 5.1 2021-Milestone Schedule (for activities of the main deliverables)

List the Detailed Schedule (as shown in Figure 5.2), including the time analysis table and Gantt chart, to manage the timely completion of the project.

Figure 4.2 Network Diagram

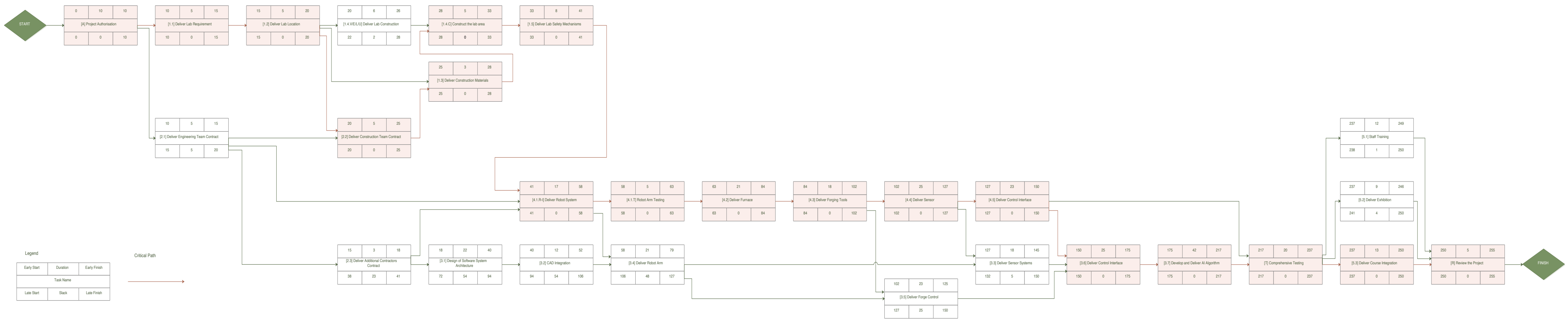
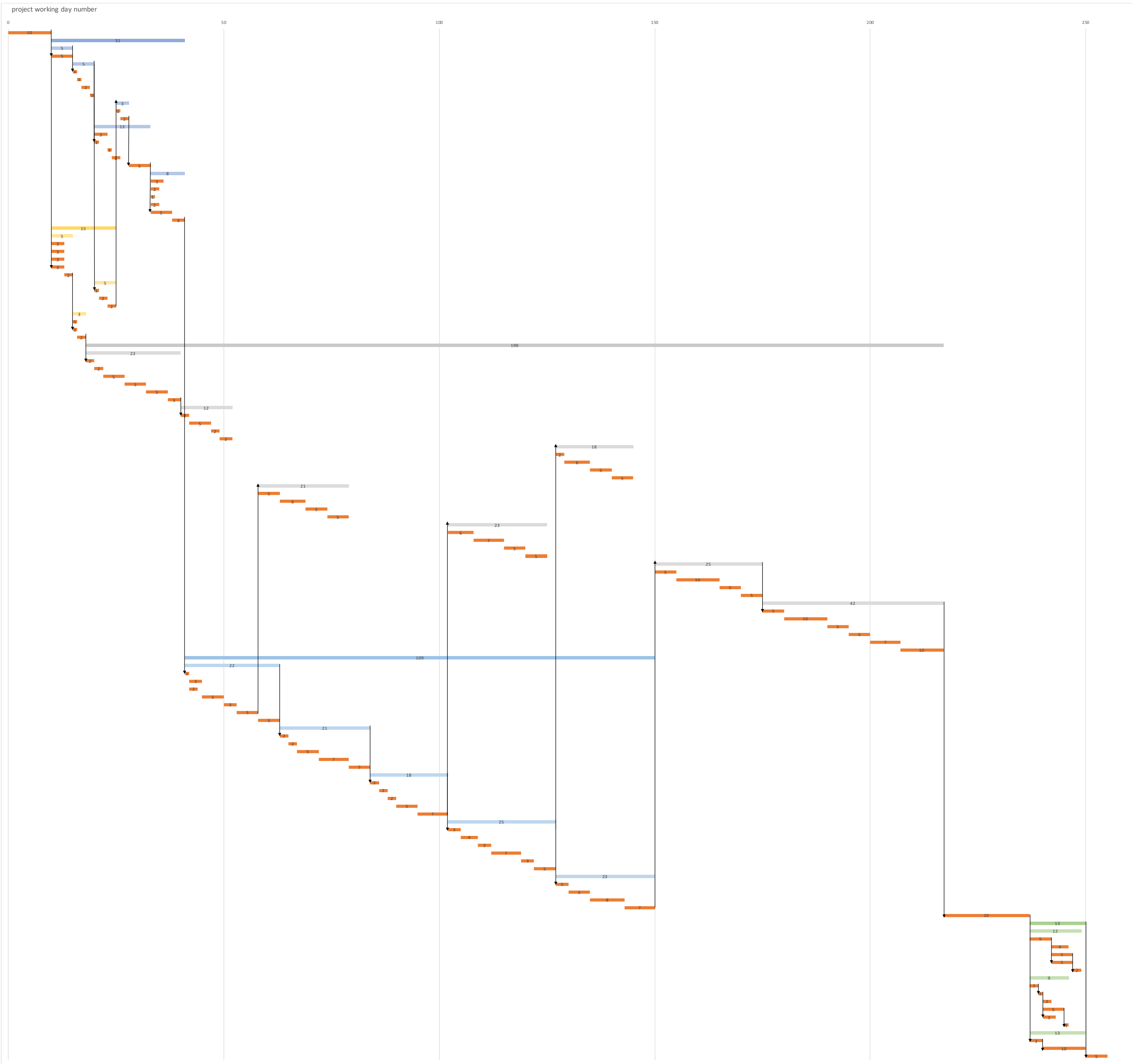


Figure 5.2 Schedule

ID	Description	Preceding Activity	Duration	Early Start	Early Finish	Late Start	Late Finish	Total Slack
~	Project Start	~	~	~	~	~	~	~
A	**Project Authorisation**	**None**	10	0	10	0	10	0
1	**Develop and Deliver Lab Space**		**31**	**10**	**41**	**10**	**41**	**0**
1.1	**Work Package 1: Lab Requirements**		**5**	**10**	**15**	**10**	**15**	**0**
1.1.D	Design Lab Space	A	5	10	15	10	15	0
1.2	**Work Package 2: Lab Location**		**5**	**15**	**20**	**15**	**20**	**0**
1.2.C	Choose Suitable Lab Location	1.1.D	1	15	16	15	16	0
1.2.E	Evaluate Matrix of Available Locations	1.2.C	1	16	17	16	17	0
1.2.D	Design Lab Space	1.2.E	2	17	19	17	19	0
1.2.O	Obtain Permits	1.2.D	1	19	20	19	20	0
1.3	**Work Package 3: Construction Materials**		**3**	**25**	**28**	**25**	**28**	**0**
1.3.E	Evaluate Required Materials	1.2.O, 2.2.C	1	25	26	25	26	0
1.3.S	Establish Storage Areas	1.3.E	2	26	28	26	28	0
1.4	**Work Package 4: Lab Construction**		**13**	**20**	**33**	**22**	**33**	**2**
1.4.V	Vacate Existing Area	1.2.O	3	20	23	22	25	2
1.4.E	Estimate Utility Consumption	1.2.O	1	20	21	24	25	4
1.4.L	Locate Existing Utility Points	1.4.V, 1.4.E	1	23	24	25	26	2
1.4.U	Connect to Utility Points	1.4.L	2	24	26	26	28	2
1.4.C	Construct the lab area	1.3.S, 1.4.U	5	28	33	28	33	0
1.5	**Work Package 5: Safety Mechanisms**		**8**	**33**	**41**	**33**	**41**	**0**
1.5.P	Review and Build Physical Barriers	1.4.C	3	33	36	35	38	2
1.5.H	Review and Build Heating Shielding	1.4.C	2	33	35	36	38	3
1.5.S	Review and Build Sound Insulation	1.4.C	1	33	34	37	38	4
1.5.L	Review and Build Light Shielding	1.4.C	2	33	35	36	38	3
1.5.E	Review and Build Emergency Stop System	1.4.C	5	33	38	33	38	0
1.5.T	Testing	1.5.P, 1.5.H, 1.5.S, 1.5.L, 1.5.E	3	38	41	38	41	0
2	**Develop and Deliver Employment Contract**		**15**	**10**	**25**	**15**	**41**	**5**
2.1	**Work Package 1: Engineering Team Contract**		**5**	**10**	**15**	**15**	**20**	**5**
2.1.S	Building Software Team	A	3	10	13	15	18	5
2.1.H	Building Hardware Team	A	3	10	13	15	18	5
2.1.A	Building Architects/Civil Engineering Team	A	3	10	13	15	18	5
2.1.Q	Building Quality Assurance Team	A	3	10	13	15	18	5
2.1.C	Finalize Contracts	2.1.S, 2.1.H, 2.1.A, 2.1.Q	2	13	15	18	20	5
2.2	**Work Package 2: Construction Team Contract**		**5**	**20**	**25**	**20**	**25**	**0**
2.2.D	Get Design Estimates	1.2.O, 2.1.C	1	20	21	20	21	0
2.2.Q	Get Quotes from Construction Companies	2.2.D	2	21	23	21	23	0
2.2.C	Finalize Contracts	2.2.Q	2	23	25	23	25	0
2.3	**Work Package 3: Additional Contractors Contract**		**3**	**15**	**18**	**38**	**41**	**23**
2.3.C	Consulting Companies	2.1.C	1	15	16	38	39	23
2.3.S	Safety Specialists	2.1.C	1	15	16	38	39	23
2.3.F	Finalize Contracts	2.3.C, 2.3.S	2	16	18	39	41	23
3	**Develop and Deliver Software System**		**199**	**18**	**217**	**77**	**217**	**59**
3.1	**Work Package 1: Design of Software System Architecture**		**22**	**18**	**40**	**77**	**99**	**59**
3.1.P	Identify Primary Systems	2.1.C, 2.3.F	2	18	20	77	79	59
3.1.E	Evaluate External Resources	3.1.P	2	20	22	79	81	59
3.1.C	Establish Communication Pathways	3.1.E	5	22	27	81	86	59
3.1.I	Institute Security Protocols	3.1.C	5	27	32	86	91	59
3.1.B	Build System for Software Patches	3.1.I	5	32	37	91	96	59
3.1.T	Stress Testing	3.1.B	3	37	40	96	99	59
3.2	**Work Package 2: CAD Integration**		**12**	**40**	**52**	**99**	**111**	**59**
3.2.E	Evaluate Existing CAD Systems	3.1.T	2	40	42	99	101	59
3.2.I	Trial Integration with System	3.2.E	5	42	47	101	106	59
3.2.C	Choose CAD Software	3.2.I	2	47	49	106	108	59
3.2.T	Testing	3.2.C	3	49	52	108	111	59
3.3	**Work Package 3: Sensor Systems**		**18**	**127**	**145**	**132**	**150**	**5**
3.3.E	Estimate Data Requirements	4.4.T, 3.4.T	2	127	129	132	134	5
3.3.H	Coordinate with Hardware Team	3.3.E	6	129	135	134	140	5
3.3.D	Collect Sensor Data	3.3.H	5	135	140	140	145	5
3.3.T	Testing	3.3.D	5	140	145	145	150	5
3.4	**Work Package 4: Robot Arm**		**21**	**58**	**79**	**111**	**132**	**53**
3.4.H	Coordinate with Hardware Team	4.1.I, 3.2.T	5	58	63	111	116	53
3.4.M	Map AI Forging to Arm Movements	3.4.H	6	63	69	116	122	53
3.4.I	Institute Motor Controls	3.4.M	5	69	74	122	127	53
3.4.T	Testing	3.4.I	5	74	79	127	132	53
3.5	**Work Package 5: Forge Control**		**23**	**102**	**125**	**127**	**150**	**25**
3.5.H	Coordinate with Hardware Team	4.3.T, 3.4.T	6	102	108	127	133	25
3.5.I	Integrate Forge Controls	3.5.H	7	108	115	133	140	25
3.5.S	Confirm Safety Limits	3.5.I	5	115	120	140	145	25
3.5.T	Testing	3.5.S	5	120	125	145	150	25
3.6	**Work Package 6: Control Interface**		**25**	**150**	**175**	**150**	**175**	**0**
3.6.H	Coordinate with Hardware Team	4.5.T, 3.3.T, 3.5.T	5	150	155	150	155	0
3.6.I	Establish User Interface	3.6.H	10	155	165	155	165	0
3.6.S	Establish Safety Systems	3.6.I	5	165	170	165	170	0
3.6.T	Testing	3.6.S	5	170	175	170	175	0
3.7	**Work Package 7: AI Algorithm**		**42**	**175**	**217**	**175**	**217**	**0**
3.7.H	Coordinate with Hardware Team	3.6.T	5	175	180	175	180	0
3.7.S	Feed Sensor Data to AI Algorithm	3.7.H	10	180	190	180	190	0
3.7.B	Build Action Dataset	3.7.S	5	190	195	190	195	0
3.7.P	Program Training	3.7.B	5	195	200	195	200	0
3.7.M	Map AI Forging to User Display	3.7.P	7	200	207	200	207	0
3.7.T	Testing	3.7.M	10	207	217	207	217	0
4	**Develop and Deliver Forging System**		**109**	**41**	**150**	**41**	**150**	**0**
4.1	**Work Package 1: Robot Arm**		**22**	**41**	**63**	**41**	**63**	**0**
4.1.R	Review Current Arm Models	2.1.C, 1.5.T, 2.3.F	1	41	42	41	42	0
4.1.E	Examine Tool Integration	4.1.R	3	42	45	42	45	0
4.1.C	Consider Software Implications	4.1.R	2	42	44	43	45	1
4.1.D	Forge-Arm Design	4.1.E, 4.1.C	5	45	50	45	50	0
4.1.P	Purchase Arm	4.1.D	3	50	53	50	53	0
4.1.I	Install Arm	4.1.P	5	53	58	53	58	0
4.1.T	Testing	4.1.I	5	58	63	58	63	0
4.2	**Work Package 2: Furnace**		**21**	**63**	**84**	**63**	**84**	**0**
4.2.E	Examine Furnace Specification	4.1.T	2	63	65	63	65	0
4.2.P	Purchase Furnace	4.2.E	2	65	67	65	67	0
4.2.I	Install Furnace	4.2.P	5	67	72	67	72	0
4.2.C	Integrate Furnace Controls	4.2.I	7	72	79	72	79	0
4.2.T	Testing	4.2.C	5	79	84	79	84	0
4.3	**Work Package 3: Forging Tools**		**18**	**84**	**102**	**84**	**102**	**0**
4.3.S	Tool Selection	4.2.T	2	84	86	84	86	0
4.3.C	Create Tool Catalogue	4.3.S	2	86	88	86	88	0
4.3.P	Provision Tools	4.3.C	2	88	90	88	90	0
4.3.I	Robot Arm Integration	4.3.P	5	90	95	90	95	0
4.3.T	Testing	4.3.I	7	95	102	95	102	0
4.4	**Work Package 4: Sensors**		**25**	**102**	**127**	**102**	**127**	**0**
4.4.S	Coordinate with Software Team	4.3.T	3	102	105	102	105	0
4.4.E	Evaluate Sensors	4.4.S	4	105	109	105	109	0
4.4.P	Purchase Sensors	4.4.E	3	109	112	109	112	0
4.4.I	Install Sensors	4.4.P	7	112	119	112	119	0
4.4.C	Connect Sensors to Overall System	4.4.I	3	119	122	119	122	0
4.4.T	Testing	4.4.C	5	122	127	122	127	0
4.5	**Work Package 5: Control Interface**		**23**	**127**	**150**	**127**	**150**	**0**
4.5.S	Coordinate with Software Team	4.4.T	3	127	130	127	130	0
4.5.C	Confirm Safety Limits	4.5.S	5	130	135	130	135	0
4.5.I	Assist with Integration	4.5.C	8	135	143	135	143	0
4.5.T	Testing	4.5.I	7	143	150	143	150	0
T	**Comprehensive Testing**	3.7.T, 4.5.T	20	217	237	217	237	0
5	**Transition of Management**		**13**	**237**	**250**	**237**	**250**	**0**
5.1	**Work Package 1: Staff Training Video**		12	237	249	238	250	1
5.1.S	Preparation of Safety Manual	T	5	237	242	238	243	1
5.1.F	Training of Faculty	5.1.S	4	242	246	244	248	2
5.1.M	Training of Maker Space Admin	5.1.S	5	242	247	243	248	1
5.1.T	Training of Teaching Assistants	5.1.S	5	242	247	243	248	1
5.1.V	Recording Safety Videos	5.1.F, 5.1.M, 5.1.T	2	247	249	248	250	1
5.2	**Work Package 2: Exhibition**		9	237	246	241	250	4
5.2.L	Create List of Attendess	T	2	237	239	241	243	4
5.2.A	Choose Area to Hold Conferenc	5.2.L	1	239	240	243	244	4
5.2.P	Plan for Press	5.2.A	2	240	242	247	249	7
5.2.C	Preparation of Catering	5.2.A	5	240	245	244	249	4
5.2.D	Prepare Demonstration	5.2.A	3	240	243	246	249	6
5.2.E	Complete Exhibition	5.2.P, 5.2.C, 5.2.D	1	245	246	249	250	4
5.3	**Work Package 3: Course Integration**		13	237	250	237	250	0
5.3.M	Hold Faculty Meeting	T	3	237	240	237	240	0
5.3.D	Design Course Integration	5.3.M	10	240	250	240	250	0
R	**Review the Project**	5.1.V, 5.2.E, 5.3.D	5	250	255	250	255	0
~	Project Finish	~	~	~	~	~	~	~



6 Stakeholder Management

6.1 Overview

Stakeholder consideration is a key component when completing the MM lab. The project accomplishes this by identifying the stakeholders and making appropriate communication plans to drive the entire project and build the MM lab.

6.2 Identified Stakeholder List

Sponsor

- Dr. Xiao Peng Li

UNSW Academic staff

- Researchers & Lecturers (MS & CS)
- Engineering Teams (MS & CS)

UNSW Professional staff

- Administrative staff; Student/Career Recruitment
- Competitors

Students Community

- Current students
- Future students

Community/Industry

- Construction/Material Suppliers
- Hardware/Equipment Suppliers
- Contractions & Construction Teams

6.3 Classifying Stakeholders

Stakeholders are those who interests, involves, has influence on the project. Stakeholders should be identified as people rather than some organizations. Not all the stakeholders hold the same attitude, therefore formulating strategy should balance interests of all parties especially the those have more power is a key question to be solved.

Use Interest/Power Grid (PMBOOK 2017, p.512) to analyse stakeholders.

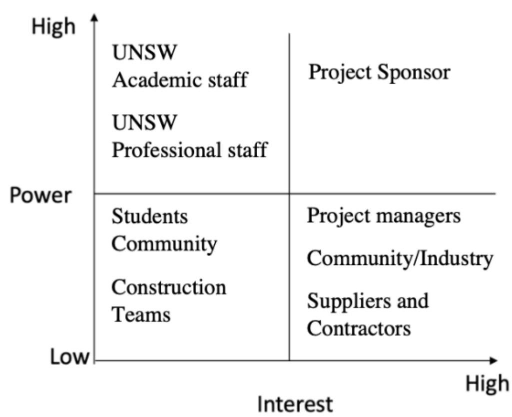


Figure 6.1 Interest/Power Grid

6.4 Stakeholders Engagement Matrix

The stakeholders always have five position: resistant, unaware, neutral, supportive and leading. Below is a diagram listing all possible stakeholders and involving the current and desired engagement levels. See diagram 6.1.
Use the Stakeholder Engagement Assessment Matrix (PMBOOK 2017, p.522) to analyse engagement lever of stakeholders.

Position	Name	Unaware	Resistant	Neutral	Supportive	Leading
Sponsor	Dr. Xiao Peng Li				CD	
UNSW Academic staff	Researchers & Lecturers (MS & CS)				CD	
	Engineering Teams (MS & CS)				C	D
UNSW professional staff	Administrative staff				C	D
	Student/Career Recruitment			C	D	
	Competitors	C	D			
Students Community	Alumni			CD		
	Current students			C	D	
	Future students			C	D	
Community/Industry	Construction/Material Suppliers				CD	
	Hardware/Equipment Suppliers				CD	
	Contractions & Construction Teams				CD	

C=Current position
D=Desired position

Figure 6.2 Stakeholders Engagement Matrix

7 Communications Plan

7.1 Overview

Communications plan is a very important part in building a MM lab since it can not only plan appropriately but also communicate with stakeholders when some intention changes or some risks occurs. The communication plans often include the owner of this meeting, the audience involved, the frequency of the communication, the medium used during the communication, the objective or the benefits for this communication and deliverable.

7.2 Communications Tools and Techniques

There are various of medium that can choose when communicating. Email, phone call, online meeting software such as ZOOM, Teams, face-to-face communication. According to the emergency of the communication, different tools should be applying in different situation. If the lower efficiency tools used in urgent event, some risks may occur. Therefore, choosing a suitable tool to communicate is incredible. Table 7.1 clearly explains who, when, how, what, why information which will be translate to stakeholders.

Person in charge	Audience	Frequency	Medium	Objectives & information received	Deliverable
Project leader	Contractors	Once	Face-to-face	Building Teams Division of labor	✓ Meeting minutes ✓ Proposal of Term Project
Project leader	Contractors	Monthly	Email	Milestones of the project	✓ Meeting minutes ✓ Project milestones
Technical leader in CS & MS	Technicians in CS & MS	Bi-Weekly	Chat Email	Integrating and coordinating CS & MS teams	✓ Meeting minutes
Project leader	Team leader	Monthly	Email Chat	Project status and progress	✓ Report of the Project status and progress
Construction Manager	Construction Teams & contractors & Lab manager in UNSW	Weekly	Face-to-face	Lab construction (obtaining authority & analyzing feasibility) & safety test	✓ Meeting minutes ✓ Project status & progress ✓ Safety performance report
Administrator in UNSW	Lab manager in UNSW	Bi-weekly	Email Chat	Transition of Management (e.g. training, exhibition)	✓ Meeting minutes
Project leader	Leaders in different team	Anytime (urgent)	Online meeting Face-to-face	Any change in the project	✓ Meeting minutes
Project leader	Leaders in different team	Anytime (urgent)	Online meeting Face-to-face	Any problem occurred in the project	✓ Meeting minutes
Project leader	Leaders in different team	Anytime (urgent)	Online meeting Face-to-face	Any decision made in the project	✓ Meeting minutes

Figure 7.1 Engagement lever of stakeholders

8 Human Resource Plan

8.1 Overview

The project team will be hired from UNSW staff. The reason for that is to give the project team an advantage to help the UNSW get the most benefit of the MM lab by their staff which will be a benefit for the long term when the project is ready to be used and therefore the staff will have a better understanding of the lab and its machines, usage and application etc.

By doing this, there will be no need for a special trainer from an external party to train lab users such as researchers or students in the future. Lab construction and lab safety planning and requirements tasks will be accomplished by contractors under the supervision of the project team. More details will be in the following tables (Figure 8.1) (Figure 8.2) (Figure 8.3) (Figure 8.4)

8.2 Role and Responsibilities (RACI)

This chart is designed to distribute responsibilities for each team in the project tasks .

Process Name / Description:	***Metamorphic Manufacturing laboratory Project***
Created On :	*Date*
Revision :	*Date last revised*
Created by:	HR

	Engineering Team	Construction Team	Additional Contractors	Project Management Team
Software Systems integration and Testing	R	C	-	A
Robot Forging and Tooling Systems	R	A	-	A
Building/Lab Construction	A	A	R	A
Safety Requriments	I	A	R	A
Transition of Managments	R	C	C	A

R = Responsible, A = Accountable, C = Consulted, I = Informed

Figure 8.1

8.3 Project Organization Chart

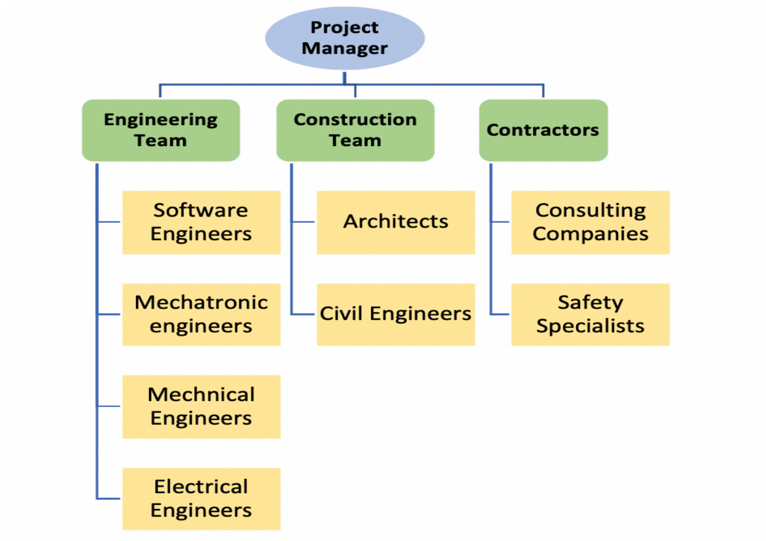


Figure 8.2

8.4 Positions for Project team members and Salary

Name / Title	Required Number	Work Type	Responsibilities	Level	Salary
Software Engineer	2	Fixed term - Full time	Analyse, design, develop and test the software system	3 6-7	$60,589 $88,782 - $97,381
Mechatronic engineer	2	Fixed term - Full time	-Design and build the robot forging and tooling systems by using mechanical and electronic processes and computer technology	3 6	$60,589 $88,782
Mechanical Engineer	2	Fixed term - Full time	-Design, organise and oversee the construction, operation, and installations of the Robot	3 6-7	$60,589 $88,782 - $97,381
Electrical Engineer	1	Fixed term - Full time	-Design, organise and oversee the construction, operation, and installations of the Robot	6-7	$88,782 - $97,381
Architectural Engineer	1	Fixed term - Full time	-Planning, design, construction and operation of the MM lab	6-7	$88,782 - $97,381
Material Science and Manufacturing engineer	2	Fixed term - Full time	-Supervising quality of the forging system materials throughout the construction and production of the project	6	$88,782
Assistant technician	3	Fixed term – Full time	-Manage all on site installation, repair, maintenance and test tasks	2	$57,383
Additional Contractors	-	Contract	-Lab construction -Safety requirements	-	-
Total Project Staff [13]			Total average salary = $903,806		

Figure 8.3

8.5 Training

This table include some recommend training and it can be updated throughout the project if there is any need for more training.

Training Program	**Recommended Recipients**
Safety training course held by the safety specialist contractor for the lab safety requirements and risk associated with this project from the initiation phase to the end of the project and provide personal protective equipment (PPE).	All
Factory tours aim to help the project team to have a clear idea about machines and materials for this project and how they can be manufactured, operated and maintained.	All
Short courses form UNSW lectures specifically designed by experts from different discipline about the project.	All
Special online course for some project team member such as machine learning algorithms that can be taught to the software engineer for example.	Specific
Online Course where can be completed individually such as Linked-In Learning Courses in different development aspects such as personal development and teamwork.	All
Workshops related to the project in different aspects and phases which can hold throughout the project.	All

Figure 8.4

9 Risk Management Plan

9.1 Risk Identification

The team uses Risk Breakdown Structure methodology, to identify and classify risks. We do this by accessing project risk, performing contingency planning, and ranking them in a risk register via a severity matrix.

9.2 Project risk

Technical risk:

- The output of the MM Cell does not meet the quality specifications
- No related personnel follow up the usage and evaluation of the model
- CSE faculty/professors are not willing to contribute to AI systems/robotics systems

External risk:

- All the required materials are not delivered on time
- Equipment accident in workshop
- Possibility to have the disease such as flu, diarrhea and heat stroke during the project
- Project staff member resigns or becomes unable to continue to be engaged on the project

Organizational risk:

- The allocated budget cannot cover the cost of the project
- Changes in the supply of funds

Project Management risk:

- Preparation of the project supplies and workshop content does not complete on time
- Difficulty in the procurement of materials or equipment due to supply chain disruption
- The equipment of MM labs procured from supplier cannot meet all the specification

9.3 Contingency Planning

If some risks are inevitable, some contingency plans should be taken.

1. **Contingency Planning 1:**

Technical risk

If team members cannot protect MM cell which meet the requirements, communicate urgently with UNSW, and add more team members who have related knowledge, which may increase the funding budget.

2. **Contingency Planning 2:**

Contingency Funding

Notify the university in advance that emergency backup funds may be required, if the allocated budget cannot cover the cost of the project, urgently apply to the school for backup funds.

3. **Contingency Planning 3:**

Time Buffers

Plan extra flexible task time and funding when scheduling tasks, if model or workshop does not complete on time, using extra task time and funding to finish task.

9.4 Risk Assessment

Risk Severity Matrix:

Impact classification		Very Low	Low	Medium	High	Very High
impact on the project: $I(y)$		$(0 <= I(y) < = 5\%)$	$(5\% <= I(y) < = 10\%)$	$10\% <= I(y) < = 40\%)$	$(40\% <= I(y) <= 70\%)$	$(70\% <= I(y) <= 100\%)$
Rating $R(z)$	Probability $p(x)$	1	2	3	4	5
1	Rare $(0 <= p(x) < = 5\%)$	Low risk Acceptable $R(z) = 2$	Low risk Acceptable $R(z) = 3$	Moderate risk Tolerable $R(z) = 4$	Moderate risk Tolerable $R(z) = 5$	High Risk Manageable $R(z) = 6$
2	Unlikely $(5\% <= p(x) < = 10\%)$	Low risk Acceptable $R(z) = 3$	Moderate risk Tolerable $R(z) = 4$	Moderate risk Tolerable $R(z) = 5$	High Risk Manageable $R(z) = 6$	High Risk Manageable $R(z) = 7$
3	Possible $(10\% <= p(x) <= 60\%)$	Low risk Acceptable $R(z) = 4$	Moderate risk Tolerable $R(z) = 5$	High Risk Manageable $R(z) = 6$	High Risk Manageable $R(z) = 7$	Critical Risk Requires Control $R(z) = 8$
4	probable $(60\% <= p(x) <= 90\%)$	Moderate risk Tolerable $R(z) = 5$	Moderate risk Tolerable $R(z) = 6$	High Risk Manageable $R(z) = 7$	High Risk Manageable $R(z) = 8$	Critical Risk Requires Control $R(z) = 9$
5	Almost Certain $(90\% <= p(x) <= 100\%)$	Moderate risk Tolerable $R(z) = 6$	High Risk Manageable $R(z) = 7$	High Risk Manageable $R(z) = 8$	Critical Risk Requires Control $R(z) = 9$	Critical Risk Requires Control $R(z) = 10$

Figure 9.1 Risk Severity Matrix

9.5 Risk Register

Figure 9.2

Risk ID	Risk description	Probability $p(x) = 1{\sim}5$	Impact (severity) $I(y) = 1{\sim}5$	Ranking	Mitigating or avoiding action	Action by:
1	The output of the MM Cell does not meet the quality specifications	4	5	9	Daily to ensure that the model development direction is consistent with the requirements and quality	Engineering teams
2	Difficulty in the procurement of materials or equipment due to supply chain disruption	4	5	9	Consider alternative components or design changes to mitigate	Project management team and engineering team
3	The allocated budget cannot cover the cost of the project	3	5	8	Detailed management of funds and daily calculation of funds	Project management team
4	Preparation of the project supplies and workshop content does not complete on time	3	5	8	Update the task progress every day to reduce the probability of risk	All members
5	No related personnel follow up the usage and evaluation of the model	4	4	8	Hire the third part to do the assessment	Project management team
6	Disapproval from UNSW or legal issues with UNSW	3	5	8	After confirming the project, communicate with both parties in time to confirm the feasibility	Project management team
7	CSE faculty/professors are not willing to contribute to AI systems/robotics systems	3	4	7	Try hiring experts from outside but this may cause the increase of cost	Project management team
8	Not all staff follow the Safety guidelines and not all the precautions are well placed.	4	3	7	Offer the health insurance for employees and provide the related training	Safety specialists
9	The equipment of MM labs procured from supplier cannot meet all the specification.	3	4	7	Communicate with the manufacturer in advance	Project management team and engineering team
10	Changes in the supply of funds.	2	5	7	Sign a complete contract with the fund provider (UNSW) in advance	Project management team
11	Equipment accident in workshop	3	4	7	Maintain equipment regularly	Engineering teams
12	Changes in the supply of funds.	2	5	7	Contingency funding	Project management team
13	property loss or damage, including work in progress	3	4	7	employment training and safety guide	Safety Specialists
14	Accidents during the project, which would threaten the personal safety of team members.	3	4	7	Offer the health insurance for employees	Project management team
15	nuisance caused by the works environmental damage.	3	3	6	formulate environmental impact assessment	Project management team
16	Insufficient toxic by-product treatment.	3	3	6	Find a third-party company for waste disposal	Project management team
17	Project staff member resigns or becomes unable to continue to be engaged on the project	1	4	5	Sign a contract and Hiring again	Project management team
18	compensation to persons for bodily harm.	3	2	5	Offer the health insurance for employees	Project management team
19	Possibility to have the disease such as flu, diarrhea and heat stroke during the project	2	2	4	Take precautions against disease in advance	Safety Specialists

Figure 9.2 Risk Register

10 Financial Quarterly Spending and Contingency Reserve

10.1 Budget Overview

In order to address risk concerns it is approspriate to examine our spending across the quarters and to plan for a contingency reserve budget. Considering our spending and timeline (as show in in sections 3, 5 and Figure 5.2) we are able to break our spending down.

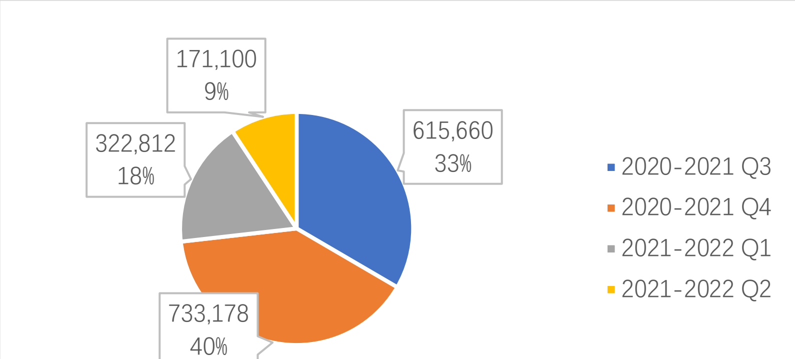


Figure 10.1 Quarterly Spending

As seen in chart 10.1, the bulk of our spending occurs in Q3 and Q4 of the 2020-2021 FY. We are also left with a **reserve of an estimated $157,250**. While it may be appropriate to immediately assign the bulk of our contingency reserve to those quarters we will first reference our risks (section 9) and timeline (section 5) to access when our most critical risks are likely to occur.

10.2 Quarterly Risk Analysis and Contingency

When examining risks to develop a contingency against we consider ranking in the risk register as well as how effective a reserve budget would be in mitigating the issue. As such we believe that issues (Risks 1, 2, 3, and 4 from Figure 9.2) will receive the bulk of the contingency reserve.

Risk ID	Risk	Cash Contingency ($)	Quarters Effected
1	MM Lab output does not meet quality specifications	50,000	2020 Q4, 2021 Q1
2	Procurement/Supply chain disruption	30,000	2020 Q3, 2020 Q4
3	Lab construction delays installing equipment	30,000	Potentially All
4	Price increases in crucial equipment	30,000	2020 Q3, 2020 Q4
N/A	Others	17,250	Potentially All

Figure 10.2 Contingency Reserved

The contingency budget will focus on quarters where the risks revolve around purchasing equipment or contructing the MM Lab itself. As discussed in the risk register, the additional cash would help in faciliating expedited delivery, additional construction teams, and purchasing equipment due to price surges or beating out competition on limited stock.

Conclusion

After the conclusion of the project steps must be taken to measure the scale of its success. Success itself is measured in accordance with our time and funding budgeting, as well as how to each stake holder sees tangible benefits.

In order for the project to be a complete success we hope to meet the following:

- Deliver the MM Lab in accordance to our time requirements
  - Project was delivered before December 30, 2021.
- We are successful in our budgeting (quarterly, total, and contingency)
  - 2020-2021 Q3: $615,660
  - 2020-2021 Q4: $733,178
  - 2021-2022 Q1: $322,812
  - 2021-2022 Q2: $171,100
  - Total Spending: $1,842,750
  - Contingency Reserved Budget: $157250
- Benefiting our stakeholders in line with the UNSW 2025 Strategy.
  - Satisfying our Academic Staff and strengthening UNSW's **Research Excellence**
    - At least 3 new cross-research agreements within the next 5 years
    - Increase the number of related papers published by 5% in the next 5 years.
    - Increase Scientific research funds by 10% in the next 5 years.
  - Attracting future Students in line with our goal of **Educational Excellence** of UNSW.
    - Increase the World University rankings (such as QS) of UNSW.
    - Increase the number of new students by 5% annually.
  - Serving our current Students by improving the **Student Experience** of UNSW and boosting student **Entrepreneurship** of UNSW.
    - Increase the employment rate of graduates from the relevant faculties by 3% in the next 3 years.
    - A 10% increase in student entrepreneur prototypes annually in the next coming 5 years.
  - Recognizing Staff Talent
    - Increase (Material + Manufacturing Faculty/Professional) staff's wages by a minimum of 5% in the next 3 years.
  - Meet the Sponsors' (Dr. Xiao Peng Li) Benefit.
    - Provide technical support for investment enterprises and sponsors.
    - It is expected to increase profits by 3-5% in the next 3 years.
    - Improve work efficiency by 7% in the next 3 years.
  - Provide technical support for the relevant government research and improve the **Innovation and Engagement** of UNSW.

Reference

[1] Lock, D 2007, Project management. 9th ed.

[2] Project Management Institute 2017, A guide to the project management body of knowledge: (PMBOK® guide), Project Management Institute, Newtown Square, Pennsylvania, USA.

[3] The Minerals, Metals & Materials Society (TMS), Metamorphic Manufacturing: Shaping the Future of On-Demand Components (Pittsburgh, PA: TMS, 2019). Electronic copies available at www.tms.org/metamorphicmanufacturing.

Appendix

A. Project Charter

1. Project Purpose

(See Introduction)

2. Objectives and Success Criteria

(See Introduction)

3. Requirements

(See Scope Statement and Risk Analysis)

4. Description and boundaries & Assumption and Constraints

(See Scope Statement)

5. Risk

(See Risk Management Plan)

6. Budget

(See Estimate of Cost, Time Phased Budget and Contingency Reserve Budget)

7. Schedule

(See Schedule)

8. Stakeholder List

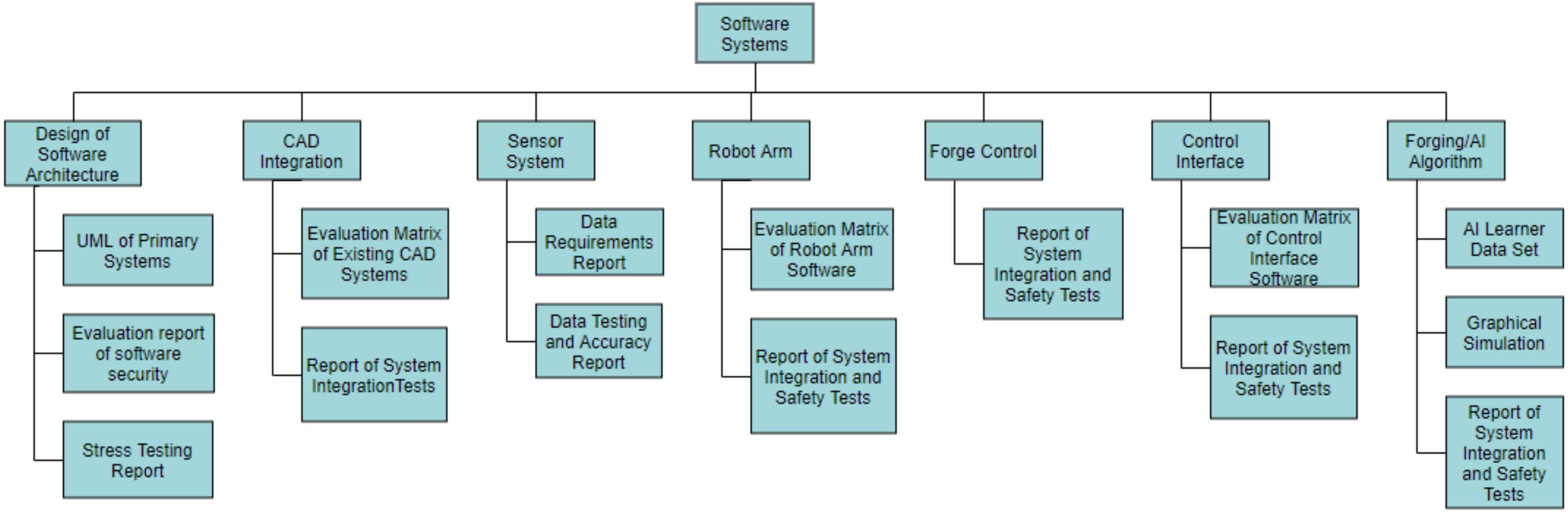
(See Stakeholder Management Plan)

9. Definition of Success:

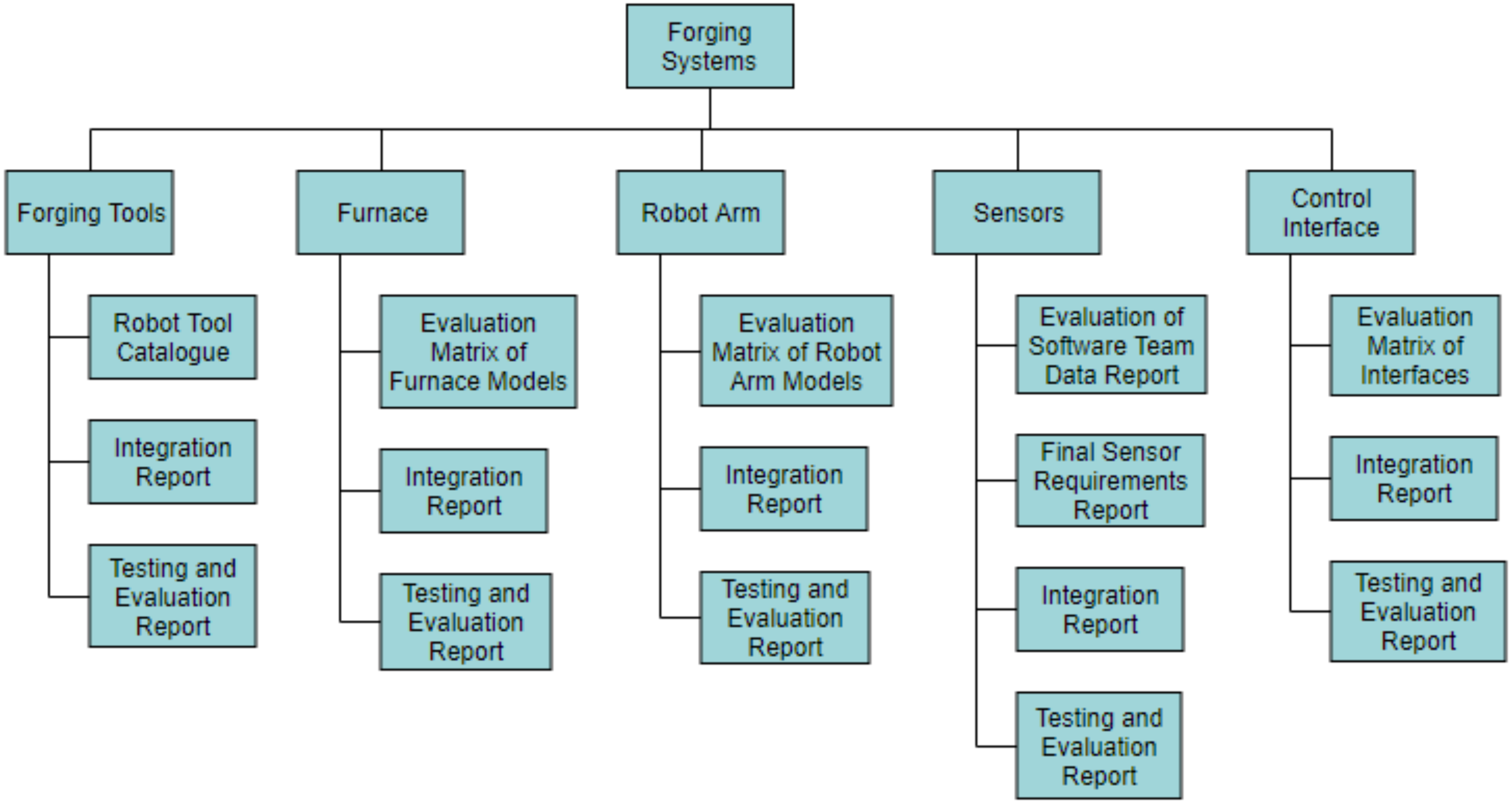
(See Conclusion)

B. WBS Sub-Deliverables

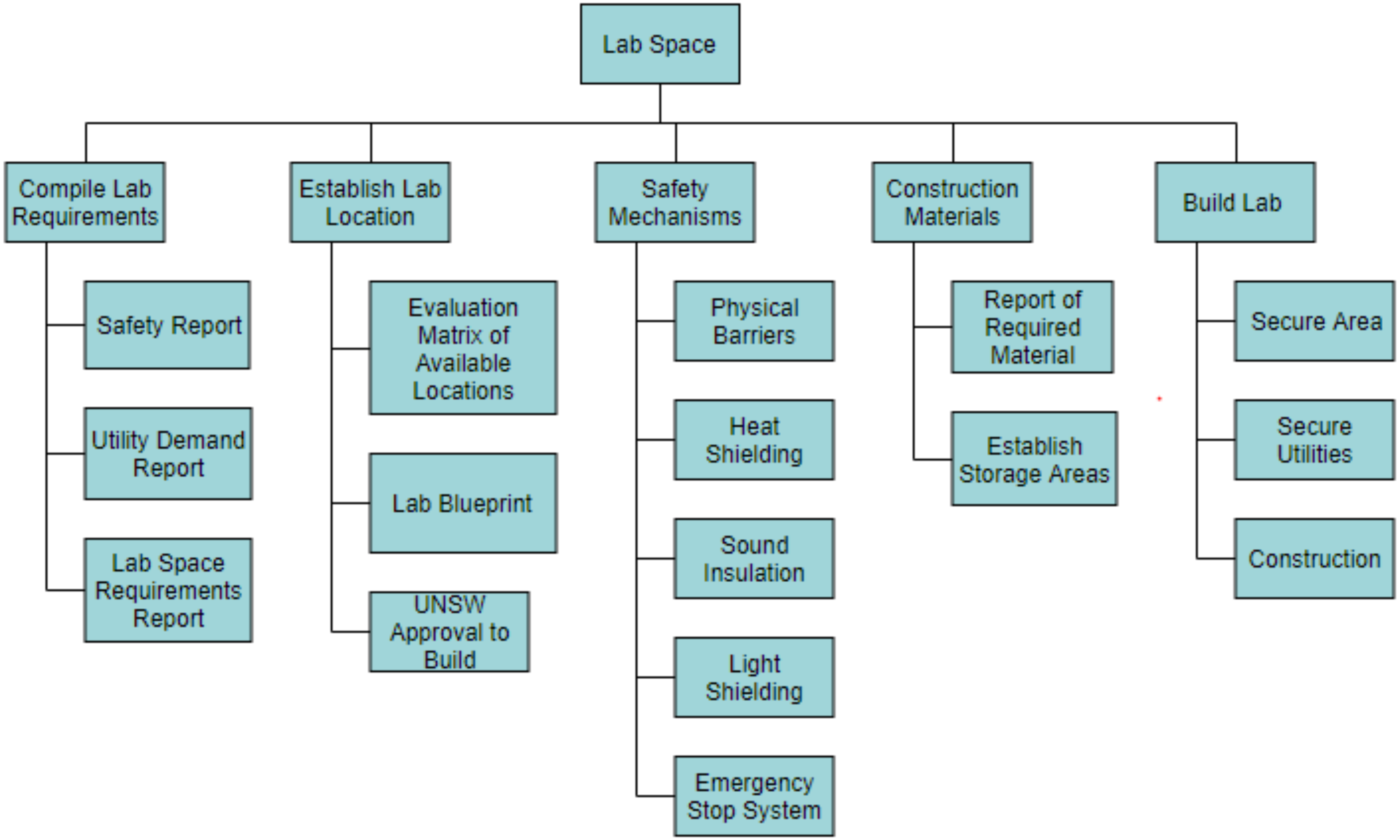
B.1 Software System



B.2 Forging Systems

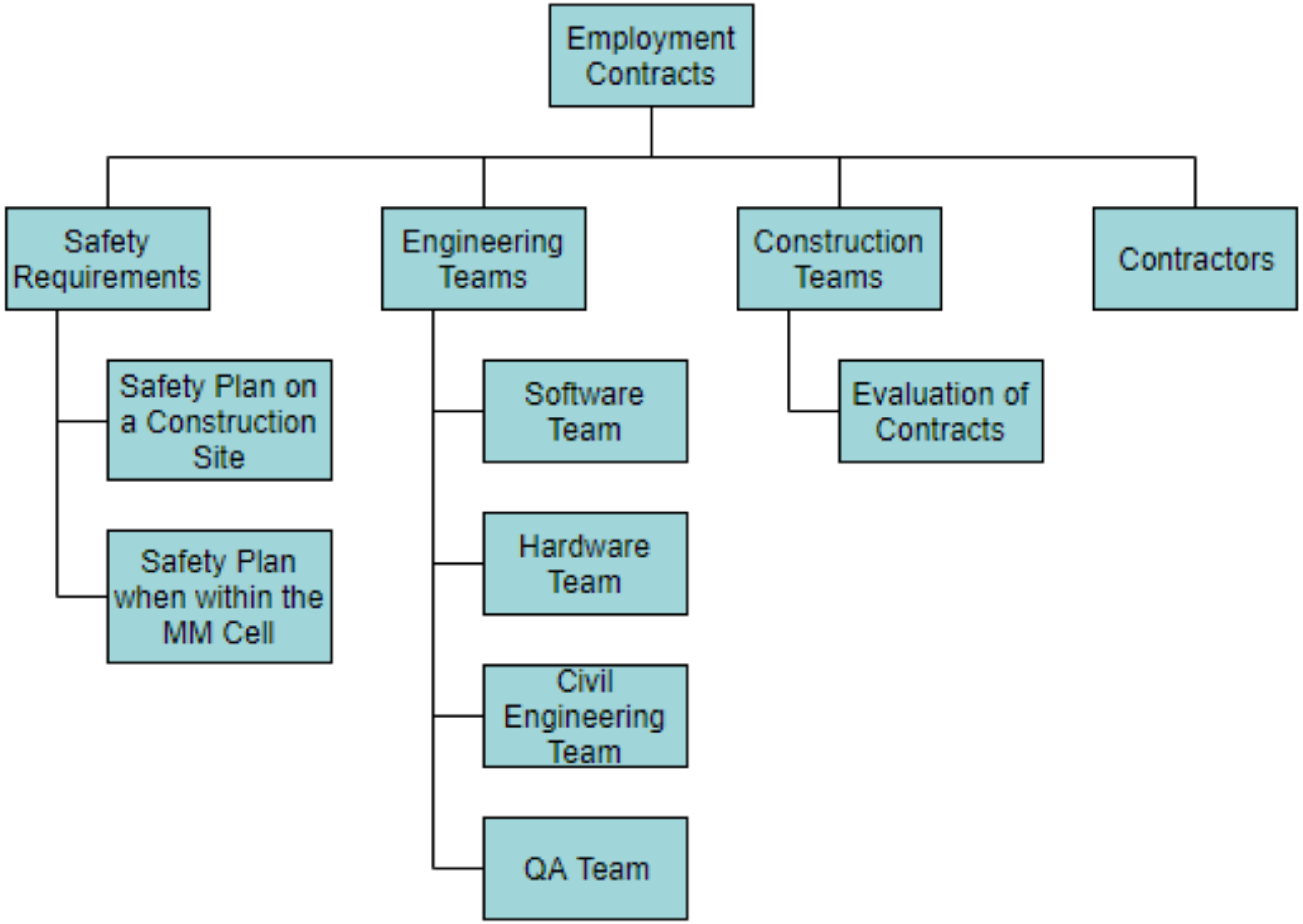


B.3 Lab Space



Lab Space
Compile Lab Requirements
Safety Report
Utility Demand Report
Lab Space Requirements Report
Establish Lab Location
Evaluation Matrix of Available Locations
Lab Blueprint
UNSW Approval to Build
Safety Mechanisms
Physical Barriers
Heat Shielding
Sound Insulation
Light Shielding
Emergency Stop System
Construction Materials
Report of Required Material
Establish Storage Areas
Build Lab
Secure Area
Secure Utilities
Construction

B.4 Staff Hiring



B.5 Transition of Management