



MANTA

Job Safety Analysis

MATE ROV Competition 2019

Chief Executive Officer

David Sun Year 2 Computer Science

Chief Financial Officer

Yat Wing Cheung Year 2 Dual Degree Program

Chief Technical Officer

Amanda Alodia Guito Year 1 Dual Degree Program

Software Engineers

Riwandy Year 2 Computer Science
 Clyde Wesley Ang Year 2 Data Science
 Pak Long Pang Year 1 Dual Degree Program
 Kelvin Leonardo Year 1 School of Engineering

Mechanical Engineers

Tsz Ho Wong
 Jung Eun Ahn
 Chi Shing Yeung
 Bryan Suryaraso Gani
 Kai Ching Chong
 Chih-an Chou

Electronics Engineers

Calvin Chee Hau Cheng
 Yi-hsuan Ho
 Ting-kai Cheng
 Cheuk Chee Chan
 Jozsef Maximillian Adiguna

Year 2 Dual Degree Program
 Year 2 Mechanical Engineering
 Year 2 Mechanical Engineering
 Year 1 School of Engineering
 Year 1 School of Engineering
 Year 1 School of Engineering

Year 3 Computer Engineering
 Year 2 Dual Degree Program
 Year 1 School of Science
 Year 1 School of Engineering
 Year 1 School of Engineering

Job Safety Analysis

General ROV Development

Tasks	Potential Consequence	Risk				Risk Reducing Measures	
		S	O	D	RPN		
Accessing tools	Tripping on miscellaneous tools, cables, and/or rubbish	4	9	1	36	Place all tools back after using as well as lab housekeeping periodically	
Mechanical Development							
Using heavy machinery	Hearing damage	7	2	7	98	Wear earmuffs to prevent noise-induced hearing loss.	
	Eye injury	8	4	3	96	Wear safety goggles to prevent flying debris from causing eye injury.	
	Scalp injury		6	5	3	90	Keep a safe distance from moving blades or drill bits
							Touch heavy machineries only when they are fully stopped
							Turn off machines when not in use
	Burns		6	4	3	72	Avoid touching the cut pieces right after cutting or drilling, wear protective gloves when touching hot metallic pieces.
	Respiratory irritation and damage		8	2	7	112	Wear particulate respirators to filter out airborne particulate matter.
Skin Irritation		4	7	3	84	Wear protective gloves and wash hand after dealing with chemicals	
Using 3D printer	Burns	5	7	4	140	Do not touch the extruder at all times, wait until the bed cool down to collect the print.	
	Scalp injury	6	5	3	90	Keep away from stepper motor when in printing.	
	Respiratory irritation	8	2	7	112	Keep a safety distance from the extruder when printing to avoid toxic foam.	
	Foot injury	3	3	2	18	Keep the printer in a safe and secure location.	
	Eye injury	8	2	3	48	Wear safety goggles to prevent from snapped 3D print material to get into the eyes.	
Electrical Development							
Soldering circuit board and other electronic components	Fire hazard	10	4	4	160	Turn off soldering irons when not in use, never leave hot soldering irons unattended, remove combustible materials from work area.	
	Skin burnt	5	5	3	75	Place soldering iron on its holder after each use.	
	Chemical inhalation	3	7	7	147	Perform work under a fume hood or in a well-ventilated area.	
Potting / Waterproofing electronic components	Irritation	3	9	3	81	Wear protective gloves when dealing with epoxy.	

General Operation

Tasks	Potential Consequence	Risk				Risk Reducing Measures
		S	O	D	RPN	
Transportation						
Transporting the ROV	Foot injury	3	8	3	72	Wear close-toed shoes when pushing transportation cart Secure all loose / moving parts on the transportation cart with cable ties
	Impact with the transportation cart	6	5	3	90	Avoid walking in front of the transportation cart Keep transported objects inside the cart
Pre - launch						
Loading/unloading the ROV into or from the transportation cart	Back injury	8	4	3	96	Picking up heavy equipment with a neutral lower back to prevent spinal disc injury, lift heavy objects together, avoid lifting anything above the shoulder level.
	Hand injury	3	6	3	54	Ensure all handles are strong and safe and there is no sharp object around handles.
	Foot injury	3	5	3	45	Wear close-toed shoes.
	Slipping	2	8	1	16	Wear non-slip shoes near the pool, ban running near the pool.
Setting up power supply	Overvoltage	9	3	2	54	Check the voltage reading showing nominal 48V every time we set up the power supply.
Setting up air pump	Over-pressurized	9	3	3	81	Set pressure regulator to 275 kPa, ensure no air leaks in the pneumatic fittings, depressurize the compressor tank after using.
Setting up the tether	Loose tether	6	7	7	294	Secure the tether with carabiner strain reliefs on the ROV side and the control box side.
	Tangled tether	5	7	3	105	Stow the tether into the tether cart roll after every use
Managing the tether	Tether damage	9	5	9	405	Supply enough tether to ROV to prevent excessive tension on the tether and hold the tether up to prevent friction with the pool edge.
	Tripping over tether	5	6	3	90	Ensure the tether is neatly laid on the floor.
Checking buoyancy	Water Leakage	5	7	8	280	Check all connections before water system operation test.
	Back, shoulder and forearm strain	4	6	3	72	Carry the ROV with at least two people, keep a neutral lower back position when picking up ROV from the pool to prevent straining.
Dry System Operation Test	Damaging the frame or manipulators	6	6	3	108	Place the ROV on the stand to prevent any physical damage.

Launch						
Water System Operation Test	Back, shoulder and forearm strain	4	3	3	36	Carry the ROV with at least two people, keep a neutral lower back position when picking up ROV from the pool to prevent straining, avoid twisting motions when retrieving ROV or reaching too far into the water.
	Scalp injury	6	5	7	210	Yell "Contact!" when someone needs to touch the ROV so as to signal the pilot to stop any manoeuvres, keep hands at a safe distance from the thrusters
	Electrical shock	10	3	3	90	Keep electronic components away from splashes, check and secure all connections, ensure no wire is exposed and loose, kill power immediately whenever an indication of electrical problems emerge.

Failure Modes and Effects Analysis (FMEA) is applied in safety analysis to evaluate the severity, occurrence and detection of risks to prioritize which ones are the most urgent. Each category has a scoring matrix with a 1-10 scale.

- Severity (S) of 1 denotes low risk to end user, and a score of 10 denotes high risk to the customer.
- Occurrence (O) of 1 denotes low probability of the risk happening, and a 10 denotes a very high probability of the risk happening.
- Detection (D) of 1 denotes a process that WILL likely catch a failure, and a 10 means the process will likely NOT catch a failure.
- Risk Priority Number (RPN) = Severity x Occurrence x Detection. The RPNs are sorted from largest to smallest, Risk reducing measures are taken on the top risks in order to reduce the overall risk.

Risk Priority Numbers (RPN)	Description
225 and higher	Intolerable
175 – 224	Unacceptable
125 – 174	Permissible
50 – 124	Acceptable
5 – 49	Negligible