NTNU

Faculty of Engineering (IV)
Department of Mechanical and Industrial Engineering (MTP)

Date created 18.11.2020 Last Revision 23.09.2022

RISK ASSESSMENT

ONLY VALID FOR DETAILED ACTIVITIES LISTED IN SECTION 5

1. Identification

Laboratory name: Mesanin/Ubåten/M43	**Room number:**
User's name: Jenny Marie Fristad	☒Master ☐PhD ☐Post-Doc ☐SINTEF ☐Other:
User's e-mail: jennymf@stud.ntnu.no	**User's Phone:** 97073360
Supervisor: Amund Skavhaug	**Supervisor's phone:** 91897296
Project number: 70443325	
Period: 10.10.22 – 30.06.23	

Description of the project and needs:
Give an overall description of **your** project and be specific as possible. Making of a mechatronic playtoy for specialization project and master thesis. The specifics of the project isn't decided yet, but most likely it will include the use of additive manufacturing, electronics (Arduino, resistors, capacitors, wires etc.), soldering and cardboard prototyping.

2. Signatures

The user and the supervisor are aware of all the risks involved in the lab activities that are going to be performed. Additionally, the user confirms that they will follow the preventive measures described in this form to minimize all the risks that have been identified.

User's signature	Supervisor's signature
Signature: Jenny Marie Fristad	Signature: Amund Skavhaug
Name: Jenny Marie Fristad	Name: Amund Skavhaug
Date: 20/10/22	Date: 20/10/22

Approved by:

	Signature:	Name:	Date:
Room responsible:	Håvard Vestad	Håvard Vestad	31.10.22

Lab manager:		Arve Skorstad	

Note: a pdf copy with all signatures shall be sent to everyone who has signed above.

3. Team (write "NR" if not relevant)

Project manager and organization (Student)	Jenny Marie Fristad	Responsible for instrumentation	NR
Laboratory responsible	Håvard Vestad	Operator	Jenny Marie Fristad
Auditor for safety check		Responsible for running the experiment	Jenny Marie Fristad
Responsible for experimental and scientific content (Advisor)	Amund Skavhaug	Responsible for logging and storing experimental data	NR
Responsible for dimensioning load bearing and pressurized components	NR	Responsible for building the rig	NR

4. Administration

Answer: Yes, No or NR (Not relevant)

Is the work order signed? (only for external work)	NR
Has the operator the required courses/training on the equipment?	Yes
Has the operator followed the safety courses? **(Mandatory)**	Yes
Can the work be done alone?	Yes
- If not, the work may have to be done under special conditions (evaluated in section **5**)	
Does an expert have to check the start of the experiment?	No
- If yes, who?	

5. Description of the Activity

Additive manufacturing (3D-printing)

For each activity performed in the lab, health risks affecting the user or others need to be identified. For each risk identified, a preventive measure must be performed, and the final risk value calculated with the "risk matrix". Explanation of the "risk matrix" can be found in the last page of this form.

This page must be replicated for each different activity performed in the lab. Activities involving the use of chemicals must be filled out in the page titled "Chemical Risk Assessment" in section 5.2.

Activity: Describe all **your** activities, and be as specific as possible

3D-printing designs (a capsule for the embedded systems within) for the mechatronic playtoy. Also, printing different shapes in 3D to be used with the playtoy as well.

All printing will be used for the mechatronic system and as a part of the project.

Risk overview: (mark with X the risk that applies for the activity)

Big loads		Danger of fire	x
Heavy lifting		Working at heights	
Hanging load		Hydraulic pressure	
Gas pressure		Water pressure	
High temperature	x	Low temperature	
Parts at high velocity		Chemicals, if yes; fill in sect. 5.2	
Sudden acceleration at fracture/failure		Pre-tensioned components	
Dangerous dust		Severe noise	
Danger of pinching		Rotating parts	

Detailed risk evaluation:

Risks
1. Heating up with PLA in machine for printing. Very high temperatures can cause burns if heated areas are touched.
2. Failure during printing because of the geometry of the model, can cause damage to the machine
3. Sharp edges on finished printed model can cause cuts.

Risk	**Probability (P) (1-5)**	**Consequence (C)**				**Risk value (P x C)**
		Health (1-5)	**Material values (1-5)**	**Environment (1-5)**	**Reputation (1-5)**	
1	2	2				4
1	2				2	4
1	2		1			2
2	2		2			4
2	2			2		4

3	2	2				4
3	2				1	2

Risk matrix of the activity before any safety measures has been applied (Include corresponding color):

Required safety equipment (mark with X the risk that applies for the activity)**:**

Glasses		Safety shoes	
Helmet		Gloves	
Screen	x	Lifting equipment	
Ear protection		Hazard suit	
Harness ropes, other measures to prevent falling		Fume hood	
Lab coat			

Description of other safety measurements:

- Screen around the printer prevents the risk of someone touching the parts of the printer that is hot.
- Gloves can prevent for cutting on sharp edges on finished model.
- Watching the machine print for the first few minutes and keeping an eye on it during the rest of the print can prevent big machine failure as you can physically stop the print as soon as something goes wrong.

Risk after preventative and corrective measures:

Risks	Preventative and corrective measures
1. *Heating up/printing with PLA in machine for printing. Very high temperatures can cause burns if heated areas are touched.*	By using a screen protector around the machine and waiting a little while after the printing is done you should be able to completely avoid the risk of burn.
2. *Failure during printing because of the geometry of the model, can cause damage to the machine.*	By double checking the model in the software beforehand, as well as keeping an eye on the machine reduces the risk of any big machine failures to happen during printing.
3. *Sharp edges on finished printed model can cause cuts.*	By using gloves, you could avoid getting cut on sharp edges. Also, by sanding down the model a bit afterward can erase sharp edges from the model completely.

Risk matrix of the activity <u>after</u> safety measures has been applied:

Risk	Probability (P) (1-5)	Consequence (C)				Risk value (P x C)
		Health (1-5)	Material values (1-5)	Environment (1-5)	Reputation (1-5)	
1	1	1				1
1	1		1			1
1	1				1	1
2	1		2			2
2	1			1		1
3	1	1				1
3	1				1	1

Electronics

For each activity performed in the lab, health risks affecting the user or others need to be identified. For each risk identified, a preventive measure must be performed, and the final risk value calculated with the "risk matrix". Explanation of the "risk matrix" can be found in the last page of this form.

This page must be replicated for each different activity performed in the lab. Activities involving the use of chemicals must be filled out in the page titled "Chemical Risk Assessment" in section 5.2.

Activity: Describe all **your** activities, and be as specific as possible

For the "product"/prototype in my master's degree to be a mechatronic/embedded system I will need to use wires, microcontrollers, resistors, capacitors etc. and connect them together to make an electronic system. Because of this I will not be using very high voltages in the project. I will be using some form of lighting (LED's etc.), and a sound system (Speakers) and a LED display.

Risk overview: (mark with X the risk that applies for the activity)

Big loads		Danger of fire	x
Heavy lifting		Working at heights	
Hanging load		Hydraulic pressure	
Gas pressure		Water pressure	
High temperature	x	Low temperature	
Parts at high velocity		Chemicals, if yes; fill in sect. 5.2	
Sudden acceleration at fracture/failure		Pre-tensioned components	
Dangerous dust		Severe noise	

Danger of pinching		Rotating parts	

Detailed risk evaluation:

Risks
1. Wrong wiring can cause shock injuries.
2. Wrong wiring can cause components to be ruined. Ruined equipment
3. Bad wiring can cause components to heat up, and then cause a fire.
4. Interruption of power supply

Risk matrix of the activity before any safety measures has been applied (Include corresponding color):

Risk	Probability (P) (1-5)	Consequence (C)				Risk value (P x C)
		Health (1-5)	Material values (1-5)	Environment (1-5)	Reputation (1-5)	
1	1	1				1
2	1		2			2
2	1			1		1
3	1		2			2
3	1			1		1
4	1		1			1
4	1			1		1

Required safety equipment (mark with X the risk that applies for the activity)**:**

Glasses		Safety shoes	
Helmet		Gloves	
Screen		Lifting equipment	
Ear protection		Hazard suit	
Harness ropes, other measures to prevent falling		Fume hood	
Lab coat			

Description of other safety measurements:

- Having a good understanding of basic electronics can prevent most of the risks associated with electronics.

- By having a fire extinguisher nearby, you can prevent a fire from spreading.
- By having multiple power supplies, components ets. You can easily switch to those and report the faulty ones to get fixed. Sudden interruption in the supply and/or components will then not interfere with the workflow.
-

Soldering

For each activity performed in the lab, health risks affecting the user or others need to be identified. For each risk identified, a preventive measure must be performed, and the final risk value calculated with the "risk matrix". Explanation of the "risk matrix" can be found in the last page of this form.

This page must be replicated for each different activity performed in the lab. Activities involving the use of chemicals must be filled out in the page titled "Chemical Risk Assessment" in section 5.2.

Activity: Describe all **your** activities, and be as specific as possible

Solder wires(etc.) in place for there to be any problems with loose wires.

Risk overview: (mark with X the risk that applies for the activity)

Big loads		Danger of fire	x
Heavy lifting		Working at heights	
Hanging load		Hydraulic pressure	
Gas pressure		Water pressure	
High temperature	x	Low temperature	
Parts at high velocity		Chemicals, if yes; fill in sect. 5.2	x
Sudden acceleration at fracture/failure		Pre-tensioned components	
Dangerous dust	x	Severe noise	
Danger of pinching		Rotating parts	

Detailed risk evaluation:

Risks
1. Contact with the equipment and/or the melted solder will cause burn damage
2. Danger of fire if soldering tools are not looked after.
3. Inhalation of toxins

Risk	Probability (P) (1-5)	Consequence (C)	Risk value (P x C)

		Health (1-5)	Material values (1-5)	Environment (1-5)	Reputation (1-5)	
1	1	2				2
1	1		1			1
2	1		2			2
2	1			2		2
2	1	2				2
3	1	2				2

Risk matrix of the activity before any safety measures has been applied (Include corresponding color):

Required safety equipment (mark with X the risk that applies for the activity)**:**

Glasses		Safety shoes	
Helmet		Gloves	
Screen		Lifting equipment	
Ear protection		Hazard suit	
Harness ropes, other measures to prevent falling		Fume hood	x
Lab coat			

Description of other safety measurements:

- A fume hood of sorts is installed in the lab so that the fumes from soldering goes away
- Having fire extinguisher nearby, so that potential flames will be put out fast.

Crafting

For each activity performed in the lab, health risks affecting the user or others need to be identified. For each risk identified, a preventive measure must be performed, and the final risk value calculated with the "risk matrix". Explanation of the "risk matrix" can be found in the last page of this form.

This page must be replicated for each different activity performed in the lab. Activities involving the use of chemicals must be filled out in the page titled "Chemical Risk Assessment" in section 5.2.

Activity: Describe all **your** activities, and be as specific as possible

Assembling the 3D-printed designs.

Using cardboard for prototyping before using 3D-printers.

Using other tools for making the “product”/prototype for my masters degree.

Risk overview: (mark with X the risk that applies for the activity)

Big loads		Danger of fire	
Heavy lifting		Working at heights	
Hanging load		Hydraulic pressure	
Gas pressure		Water pressure	
High temperature		Low temperature	
Parts at high velocity		Chemicals, if yes; fill in sect. 5.2	
Sudden acceleration at fracture/failure		Pre-tensioned components	
Dangerous dust		Severe noise	
Danger of pinching		Rotating parts	

Detailed risk evaluation:

Risks
1. By using basic tools (hammers, nails, cardboard, scissors etc.) there can be a risk of cuts, or other minor injuries.
2.
3.

Risk matrix of the activity <u>before</u> any safety measures has been applied (Include corresponding color):

Risk	**Probability (P) (1-5)**	**Consequence (C)**				**Risk value (P x C)**
		Health (1-5)	**Material values (1-5)**	**Environment (1-5)**	**Reputation (1-5)**	
1	1	2				2
1	1		1			1

Required safety equipment (mark with X the risk that applies for the activity)**:**

Glasses		Safety shoes	
Helmet		Gloves	
Screen		Lifting equipment	
Ear protection		Hazard suit	
Harness ropes, other measures to prevent falling		Fume hood	

Lab coat			

Description of other safety measurements:

- By using common sense and thinking before acting no major injuries should occur
- If injuries should occur, by having medical equipment nearby (band-aid etc.) it can lessen the injuries.
- Using glasses and gloves could be useful in certain situations where the possibility of injuries is bigger. For instance, if wood is used it could be useful with gloves to avoid splinters.

5.2. Chemical Risk Assessment:

Only for activities involving the use of chemicals (except ethanol and acetone for cleaning).

This page **must be replicated** for each different chemical activity performed in the lab. Include all H-sentence and numbers for chemicals used. This can be found in the Safety Data Sheet og the specific chemical(SDS).

Activity: Include specification of **your** work, name of chemicals, composition of alloy, concentration, max volume etc.

Soldering with lead-free solder (Flux)

Chemicals used:	Full name – Include concentration etc. Deca-Flux Pincel Ecogel
Mixture:	If yes, include amount and/or concentration – if known. Otherwise, state roughly max amount <20%
Will the mixture be stored in the cabinet for several uses?	

Risk	Prevention Measures
1. H319 – Eye irritation	P101 – Keep label on chemical close in case there is need for medical help. P102 – Stored unavailable for children P264 – Wash hands thoroughly after use. P337+P313 – With prolonged eye irritation, seek medical help.
2.H302 - Swallowing	P101

	P102 P301 – If swallowed – Contact immediately poison control / medical personnel
3.	
4.	

Note: All H-sentences must be included as a risk, together with "general" risks when using the specific chemical.

Chemical disposal procedure: Not dangerous waste because of chemicals in product**.** Waste will be thrown away in designated places.
Dangerous waste or not? If not, why? Etc. How are you going to store the waste?

Risk matrix of the chemical activity before safety measures:

Risk	**Probability (P) (1-5)**	**Consequence (C)**				**Risk value (P x C)**
		Health (1-5)	**Material values (1-5)**	**Environment (1-5)**	**Reputation (1-5)**	
1	1	2				2
2	1	1				1
3						

Required safety equipment: (mark with X the risk that applies for the activity)

Glasses		Safety shoes	
Helmet		Gloves	
Screen		Lifting equipment	
Ear protection		Hazard suit	
Harness ropes, other measures to prevent falling		Fume hood	x
Lab coat			

Description of other safety measurements:

6. Sources for mistakes/errors

Is the following considered? Answer: Yes, No or NR (Not relevant)

Loss of electricity	Yes	Voltage surge	Yes
Electrical earth failure	Yes	Insufficient power of the machine	Yes
Climate control in the room (temperature, humidity, etc…)	NR	Water jet	NR
Unstable pressure or hydraulic force	NR	Unintended interruption of power supply	Yes
Are load and displacement limits established?	NR	Leakage of pipes, hoses, joints, etc…	NR
Possible interference from other activities	Yes	Possible interference towards other activities	Yes
Troubles in acquisition and storage	Yes	Fire in the laboratory	Yes

7. Calibration of equipment

If a calibration of the equipment is performed during the activity, please indicate the date:

Equipment	Date (dd.mm.yy)

8. Traceability

Answer: Yes, No or NR (Not relevant)

Are all experimental materials known and traceable?	Yes
Is there a plan for marking all specimens?	Yes
Is the data acquisition equipment identified?	Yes
Are the original data stored safely without modification?	Yes
Is there a back-up procedure for the data (hard disk crash)?	Yes
Is there a plan for storing samples after testing?	Yes
Is there a plan for disposing of old samples?	Yes

9. Conclusion

Summary and conclusion of your project

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Date created 18.11.2020 Last Revision 23.09.2022

Risk matrix explanation

		Health	Material values	Reputation	Environment
Grade	1	Minor injury/strain that requires simple treatment. Reversible injury. Short recovery time.	Operational shutdown, or shutdown of activities <1 day.	Little effect on credibility and respect.	Negligible injury and short recovery time.
	2	Injury/strain that requires medical treatment. Reversible injury/strain. Short recovery time.	Operational shutdown, or shutdown of activities <1 week.	Negative effect on credibility and respect.	Minor injury and short recovery time.
	3	Serious injury/strain that requires medical treatment. Lengthy recovery time.	Operational shutdown, or shutdown of activities <1 month.	Reduced credibility and respect.	Minor injury and lengthy recovery time.
	4	Serious injury/strain that requires medical treatment. Possible disability /permanent disability.	Operational shutdown > 1/2 year. Shutdown of activities up to 1 year.	Credibility and respect considerably reduced.	Long-lasting injury. Lengthy recovery time.
	5	Death or disability / permanent disability.	Operational shutdown, or shutdown of activities >1 year.	Credibility and respect considerably and permanently reduced.	Very long-lasting and irreversible injury.

Consequence (C)						
	Very serious	5	10	15	20	25
	Serious	4	8	12	16	20
	Moderate	3	6	9	12	15
	Little	2	4	6	8	10
	Very little	1	2	3	4	5
		Very little	**Little**	**Medium**	**Big**	**Very big**
		Probability (P)				

Red	Unacceptable risk. Measures need to be implemented.
Yellow	Medium risk. Measures need to be considered.
Green	Acceptable risk. Measures can be considered.

Add the color of the risk matrix that corresponds with the value you have placed in your personal risk matrix.