



VACIDE – Vocational Action Competence in Digital Environments

2nd Transnational Project Meeting

Hosted by ŠC Škofja Loka, MS Teams, 26. – 27. May 2021



ŠOLSKI  CENTER
ŠKOFJA LOKA

VIŠJA STROKOVNA ŠOLA

PROJECT VACIDE ROBOT THOR

Igor Hanc, Principle
Vocational College

Project

Mentors

- Igor Hanc
- Alojz Zupančič
- Aleksander Kustec

Students

- Luka Flego
- Aljaž Pivk
- Matic Jovanovič
- Matej Meglič
- Miha Prezelj
- Urban Tratnik
- Urban Verbič

3D printing

- Matej Praprotnik
- Iztok Jože Basaj

CNC programming & manufacturing

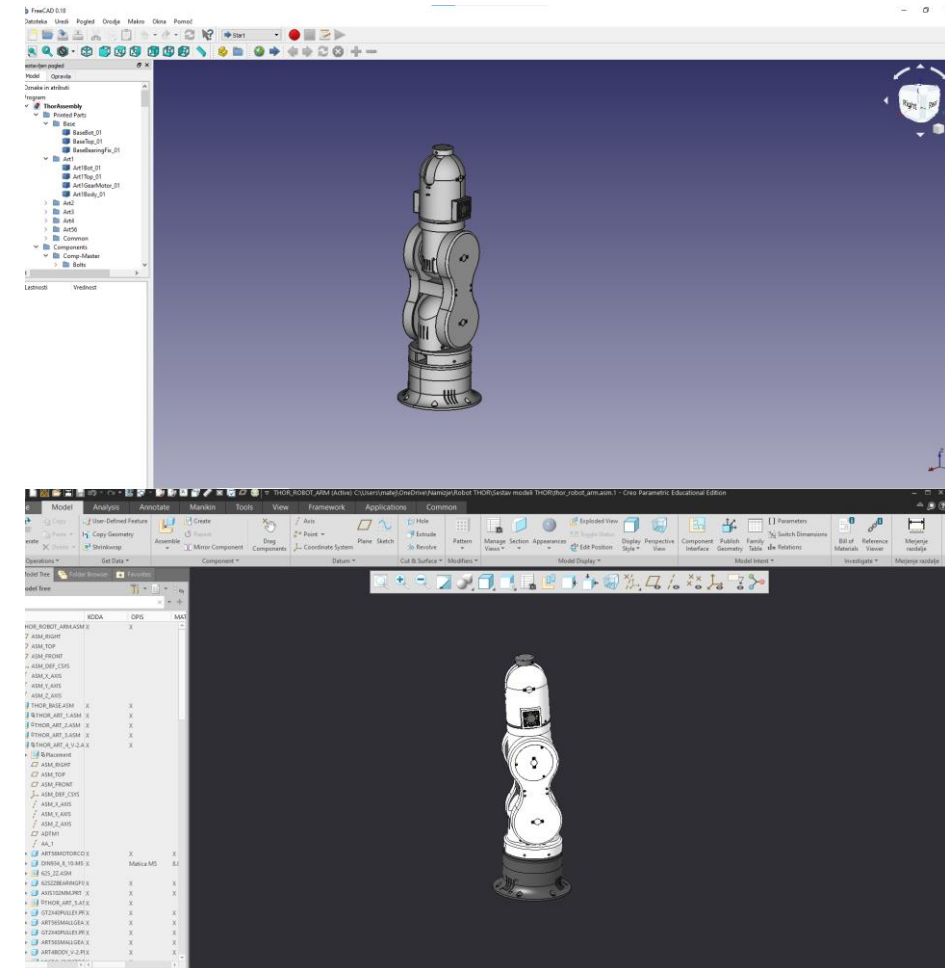
- Primuž Šturm
- Matjaž Luznar

Coordination, planning, purchasing

- Ivan Štrukelj

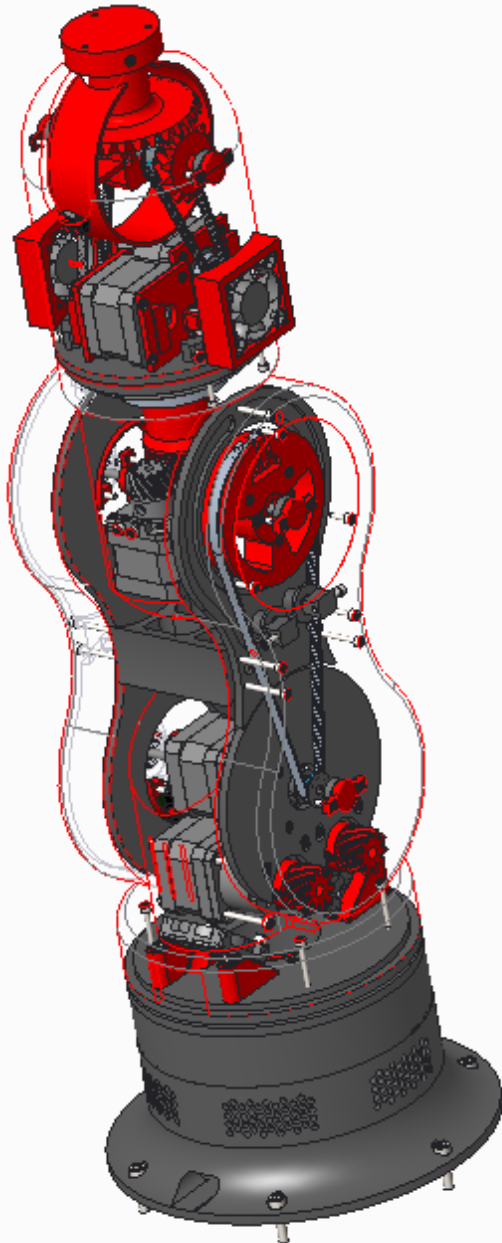
Design review

- Original design in FreeCAD
 - Including STL files for 3D printing
- Transfer of design to Creo 5.0
 - Using STEP files
- Design review:
 - At least 30 % of all parts must be machined!
- To find out how others approached of making and assembling a robot!



Design and redesign of robot

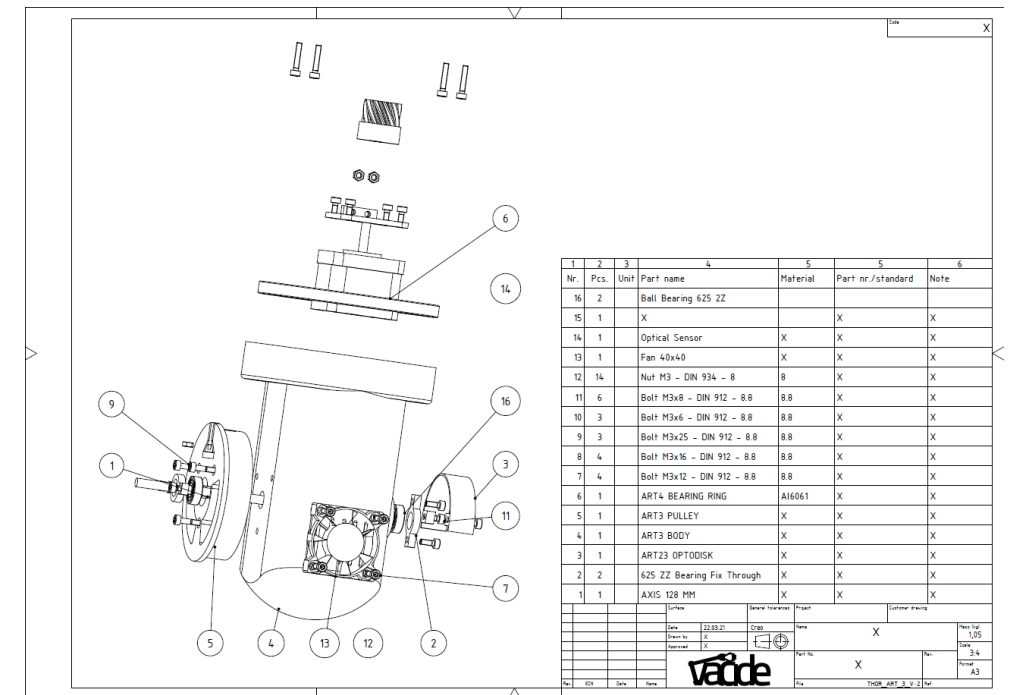
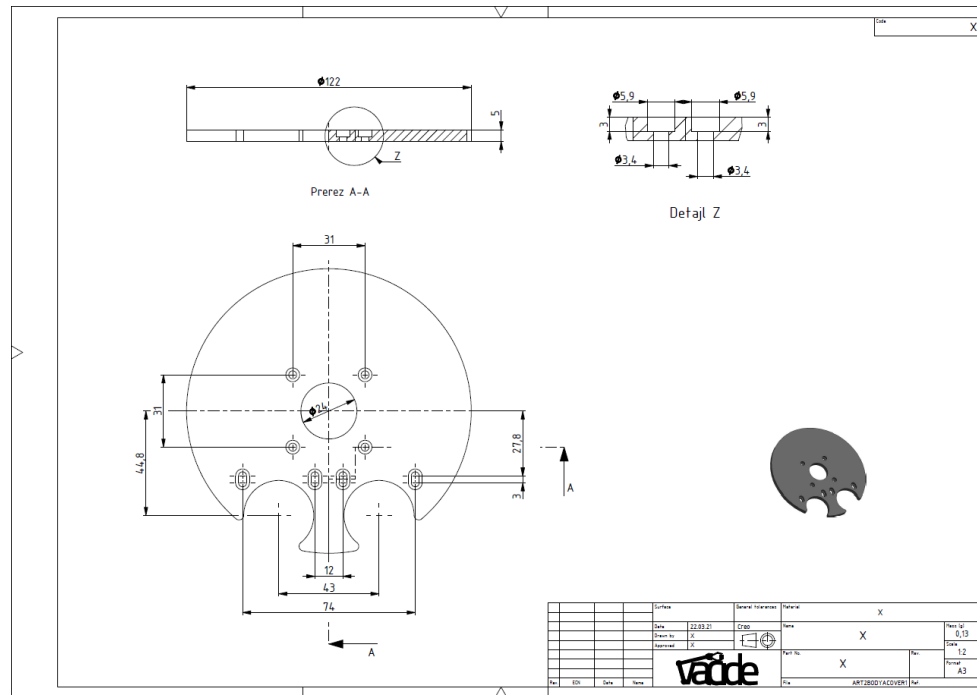
- Research how others approached of making and assembling a robot
- Inspected where everything could get into trouble
- Design for manufacturing and assembly?
 - How to make parts? Printing, turning, milling ...
 - How to put parts together?
 - Would they fit?



Redesign of robot

- 3D printed parts (red):
 - PLA
- Machined parts (grey)
 - Aluminium

Drawings



Bill of Materials

- Make or Buy?
- Make:
 - 3D printed parts,
 - Machined parts
- Buy:
 - Bearings
 - Fasteners (bolts, nuts ...)
 - Electric motors
 - Wires, sensors ...
 - Controller components

No.	Component name	Quantity	make/buy	provider	Costs
1	Barrel Jack Connector Control PCB	1	PP	VHS BW	0.57 €
2	Female Pins Control PCB	112	PP	VHS BW	2.34 €
3	3 Wire female connectors Sensor PCBs	5	PP	VHS BW	2.02 €
5	Motor Nema 17; L=40mm; Holding torque: 39.22 N.cm	1	PP	VHS BW	124.99 €
6	Motor Nema 17; L=34mm; 5.18:1 mechanical reduction; Holding torque: 121.2 N.cm	3	PP	VHS BW	
7	Motor Nema 17 L=34mm; Holding torque: 21.57 N.cm	3	PP	VHS BW	
13	Cooper Plate 36x16mm Sensor PCBs	4	PP	VHS BW	4.98 €
24	Bus Wire 2x36 Control PCB	1	PP	VHS BW	29.90 €
35	40mm Fan Control PCB	6	PP	VHS BW	10.15 €
40	Arduino Mega	1	PP	VHS BW	7.84 €
41	Micro Endstop (Straight type)	1	PP	VHS BW	1.66 €
42	Cooper Plate 120x91mm Control PCB (9x15)	1	PP	VHS BW	1.10 €
43	A4988 Stepper Motor Driver Control PCB	7	PP	VHS BW	19.95 €
44	25V 100uF Capacitor Control PCB	7	PP	VHS BW	0.53 €
45	10kΩ Resistor Control PCB	7	PP	VHS BW	0.38 €
46	Male angled pin Sensor PCBs	12	PP	VHS BW	78.00 €
47	Male Pins Control PCB	97	PP	VHS BW	11.05 €
48	10kΩ Resisto Sensor PCBs	4	PP	VHS BW	0.83 €
49	220Ω Resistor Sensor PCBs	4	PP	VHS BW	0.79 €
50	Optocoupler Sensor PCBs	4	PP	VHS BW	0.88 €
51	Metters of wire Sensor PCBs	3	PP	VHS BW	55.50 €
					353.46 €

Purchasing of parts and materials

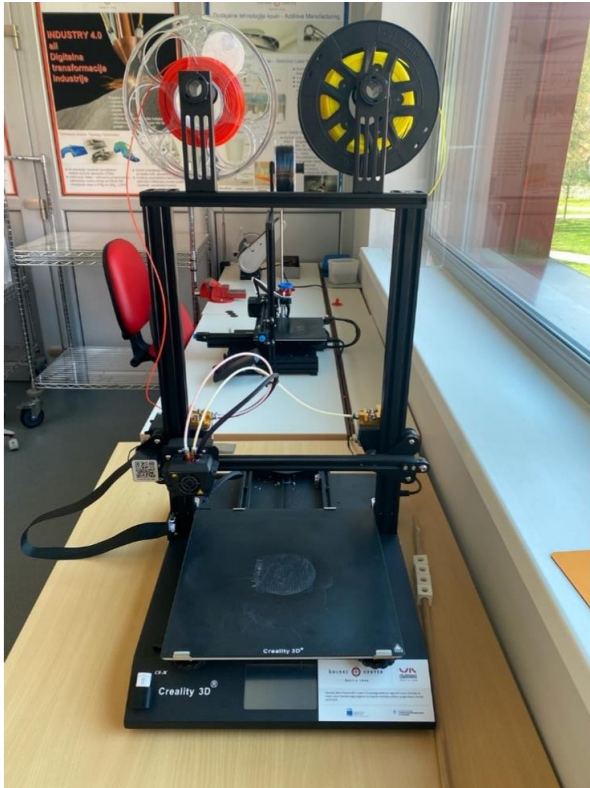
- Finding raw materials
 - Filaments,
 - Al profiles
- Purchasing components:
 - EU or world wide
 - Finding matching parts
- Searching for pulleys and belts in EU
 - Checking the length

Manufacturing process

Overview of 3D Printing Models:

- Selection of filament: PLA
 - Possibilities of using other materials (ABS, ACE)
- Material consumption estimates
- Overview of printing settings:
 - Temperature,
 - Speed,
 - Wall thickness,
 - Consumption of filament

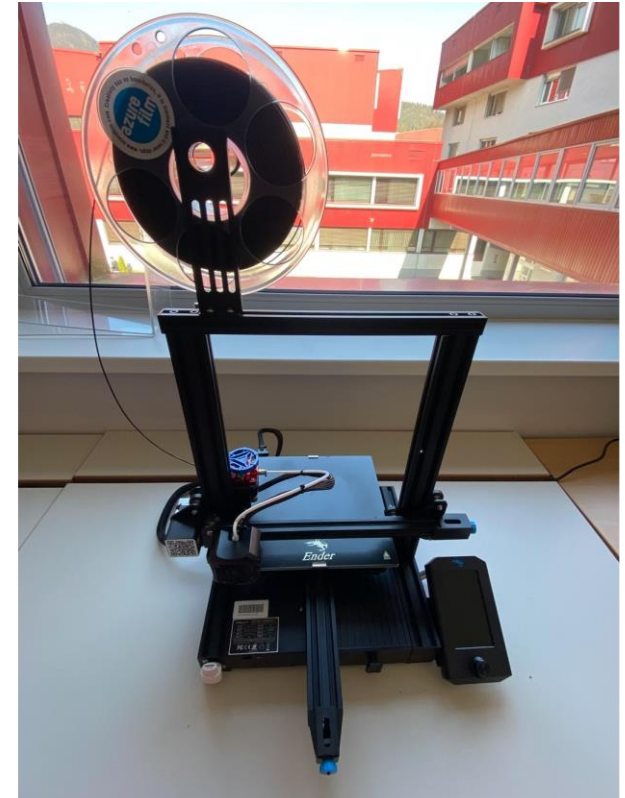
3D Print



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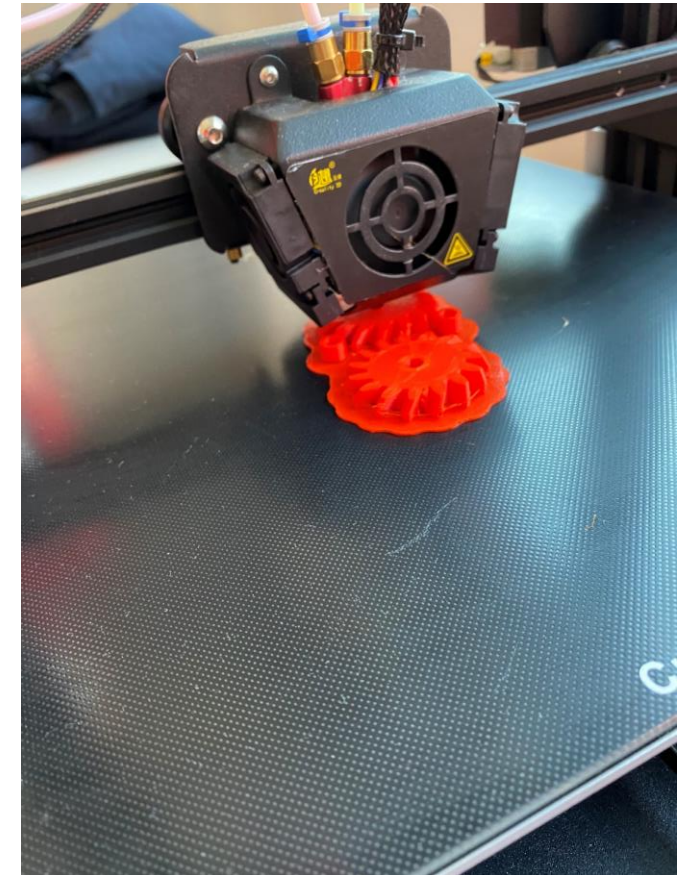
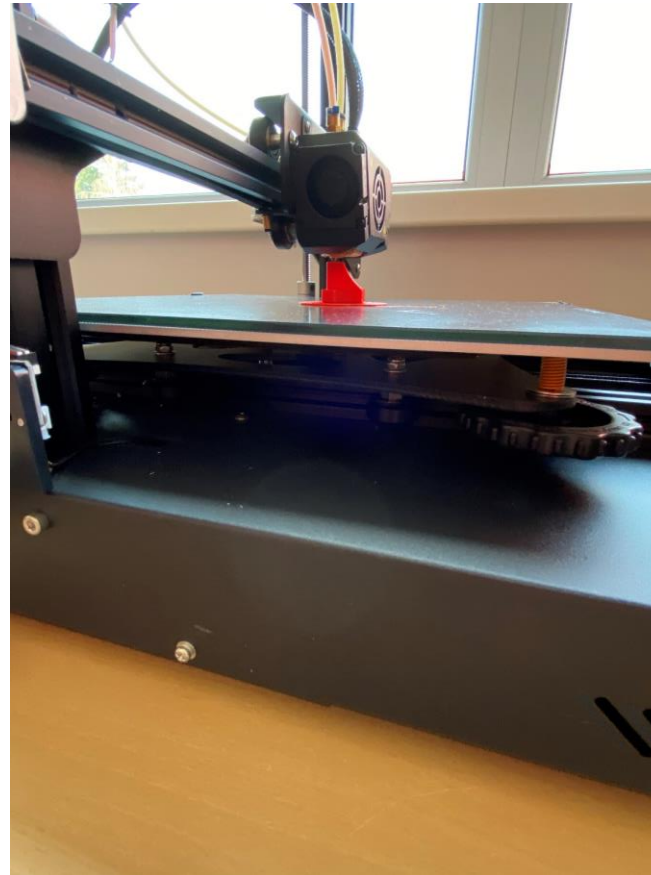
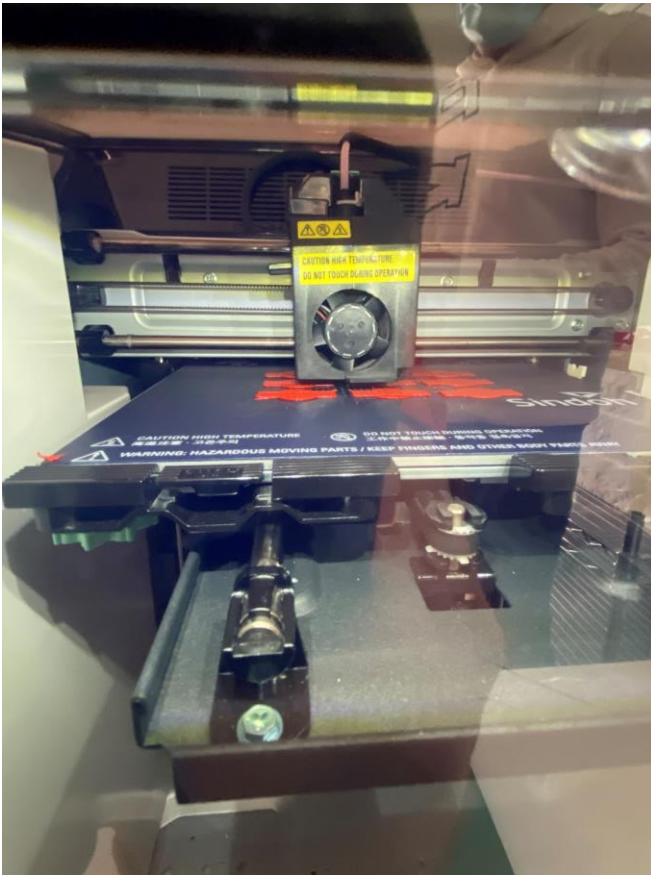


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3D Print





3D Print

3D printing process:

- 3D modelling in Creo,
- Preparing STL files
- Creating G code for printer
- Transferring G code to printer

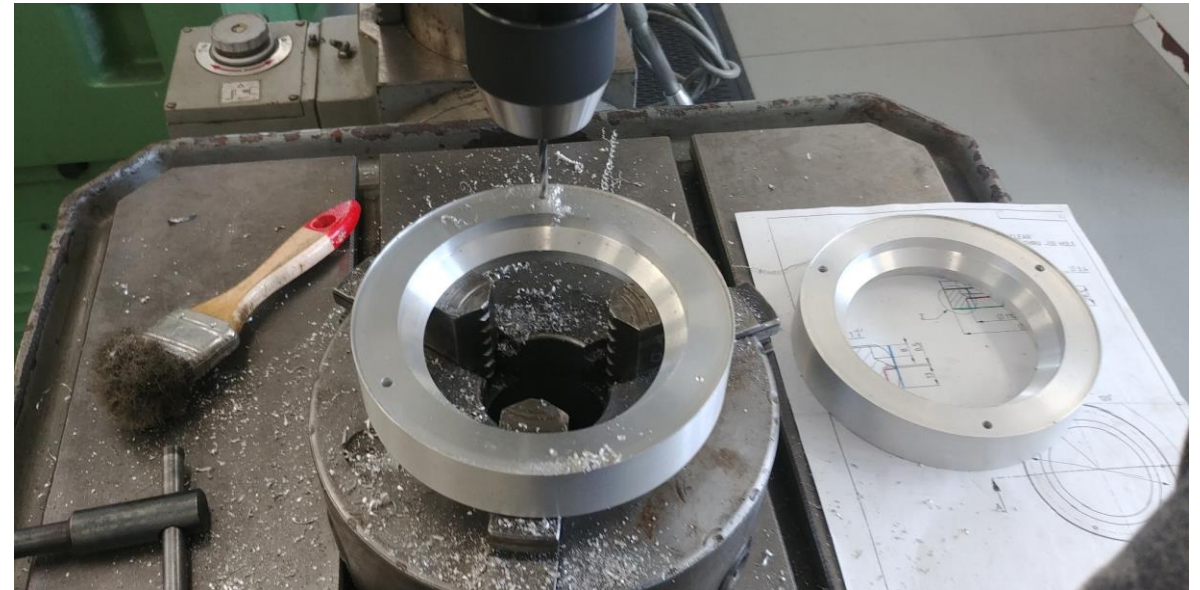
Production of aluminium pieces

Manufacturing process:

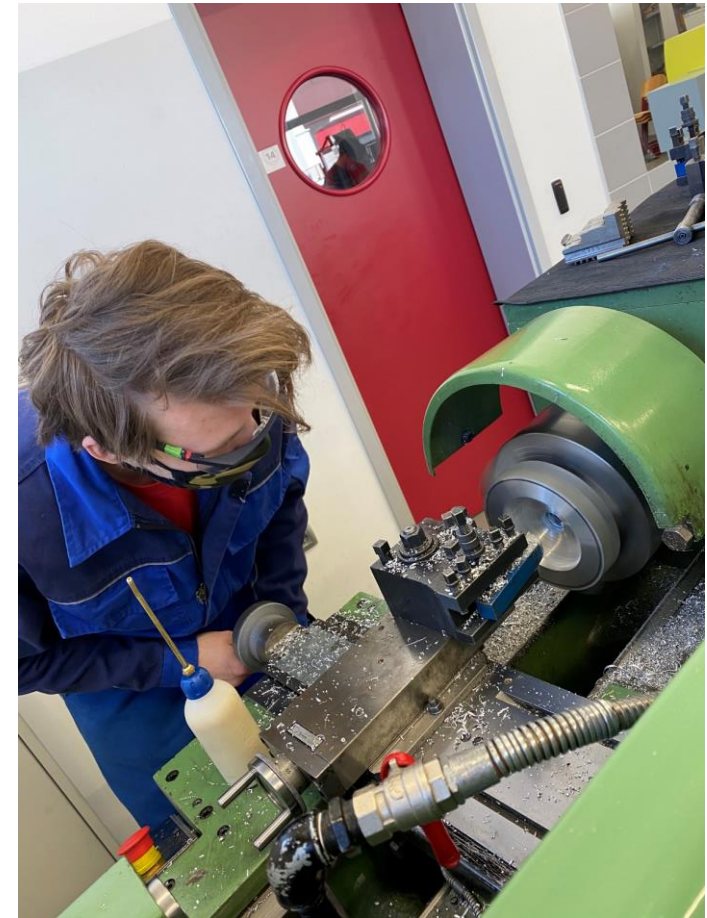
- Preparing workpieces
- Processing with classical machines:
 - turning,
 - milling,
 - Drilling
- CNC machining:
 - Modelling,
 - CNC programming,
 - Machining.



Production of aluminium pieces



Production of aluminum pieces



Production of aluminum pieces



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Assembling the robot

- Approx. 90 % of all parts is finished
 - Some smaller parts are still in production
 - To be finished by the end of May
- Wireing of EM and sensors is completed
- Most of the subbassemblies have been (pre) assembled/tested for fit
 - We revised and modified some part for better fit
 - Have to pay attention to warpage and shrinkage of 3D printed parts

Assembling the robot



Manufacturing and assembly instructions

First draft of instructions:


- Description of mfg process/operation
- List of machines and tools used in operation,
- Working procedure,
- Measuring procedure

Postopek izdelave poz. 1:

Vrsta naloge :	Koda naloge: Črna Koda/ QR koda delovne operacije
<u>Struženje Art4Optodisk</u>	Naziv/ime naloge:
Količina: (navedi št. Kosov) : 1	Art4Optodisk
Material: Al 6060	Risba: (številka risbe): ART2BODYACOVER1

Usmeritve za delo:

- Operacija:
 - Struženje plošče na CNC stružnici
 - Režkanje plošče na CNC rezkalnem stroju
- Pripomočki:
 - CNC stružnica z gnanim orodjem
 - Stružni nož
 - CNC Režkalni stroj
 - Svedri
 - Navojni svedri
 - Frezalo
 - Pomično merilo
- Obdelovanec:
 - Surovec: fi 122*5 (!)
 - Fazna risba
- Priprava:
 - Izdelava CNC programa (sinumeric 840d)
 - Pregled tehnologije obdelave na stroju in priprava orodja za obdelavo z vstavljanjem v zalogovnik orodij na stroju.
- Opis postopka:
 - Vpenjanje obdelovanca v stružno glavo
 - Programiranje, generiranje CNC kode in izvedba simulacije obdelav
 - Poravnava
 - Struženje notranje luknje
 - Ponovno vpenjanje kosa
 - Struženje zunanje oblike
 - Vpenjanje v CNC rezkalni stroj
 - Pred vrtanje lukenj
 - Vrtanje lukenj
 - Obdelava utorov
 - Vrezovanje navoja
- Merjenje
 - Merjenje premera lukenj
 - Merjenje globine lukenj
- Risba



Project summary

What was OK?

- First student project in vocational college.
- Great cooperation and enthusiasm of students
- Good cooperation between college and middle school

Not so OK?

- COVID19
- Occasional work overload of participants
- Production planning – workshop occupancy

What is next?

- Assembling and testing of the robot
 - With VHS
- Working instructions for students:
 - 3D models,
 - Drawings,
 - Operations instructions,
- Didactic material:
 - Manual for teachers

