LTTA – Learning Trainig and Teaching Activity

Kofinanziert durch das Programm Erasmus+ der Europäischen Union

Higher vocational college for mechanical engineering and woodworking

Principal:

Igor Hanc, MSc

Kofinanziert durch das Programm Erasmus+ der Europäischen Union

PROJECT VACIDE
ROBOT THOR

Project

Mentors
- Igor Hanc
- Alojz Zupančič
- Aleksander Kustec

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

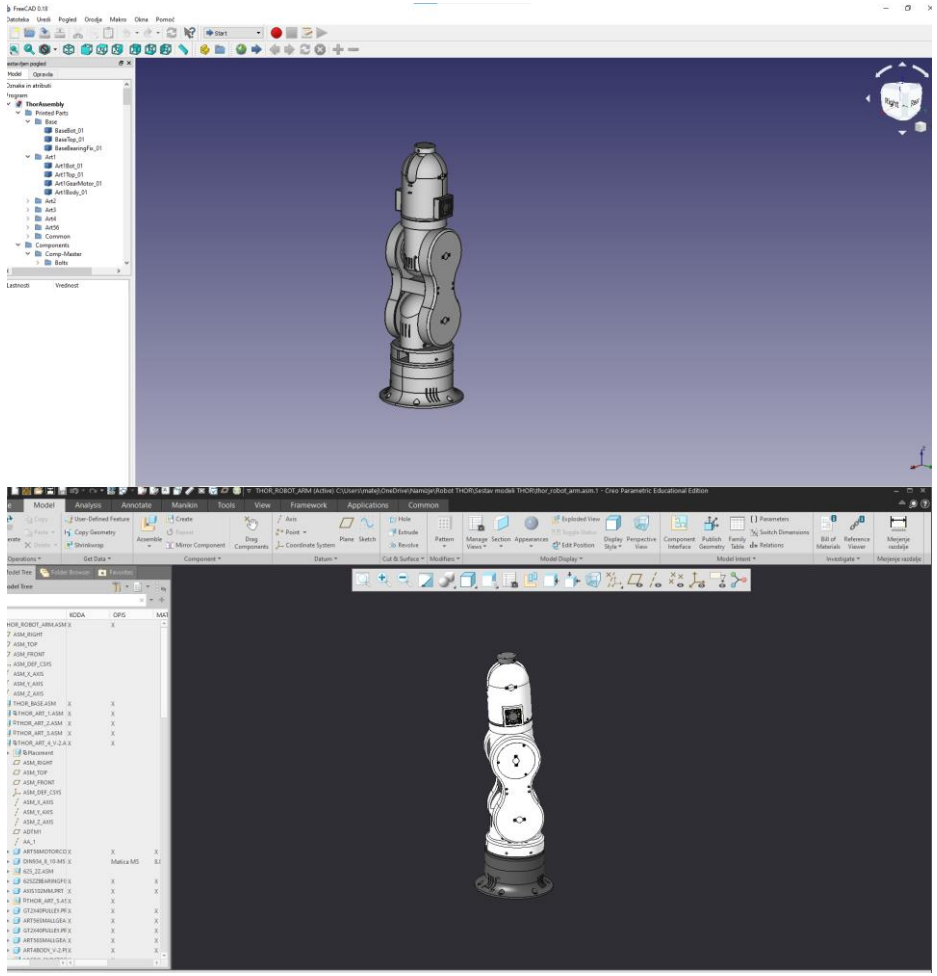
3D printing
- Matej Praprotnik
- Iztok Jože Basaj

CNC programming & manufacturing
- Primuž Šturm
- Matjaž Luznar

Coordination, planning, purchasing
- Ivan Štrukelj

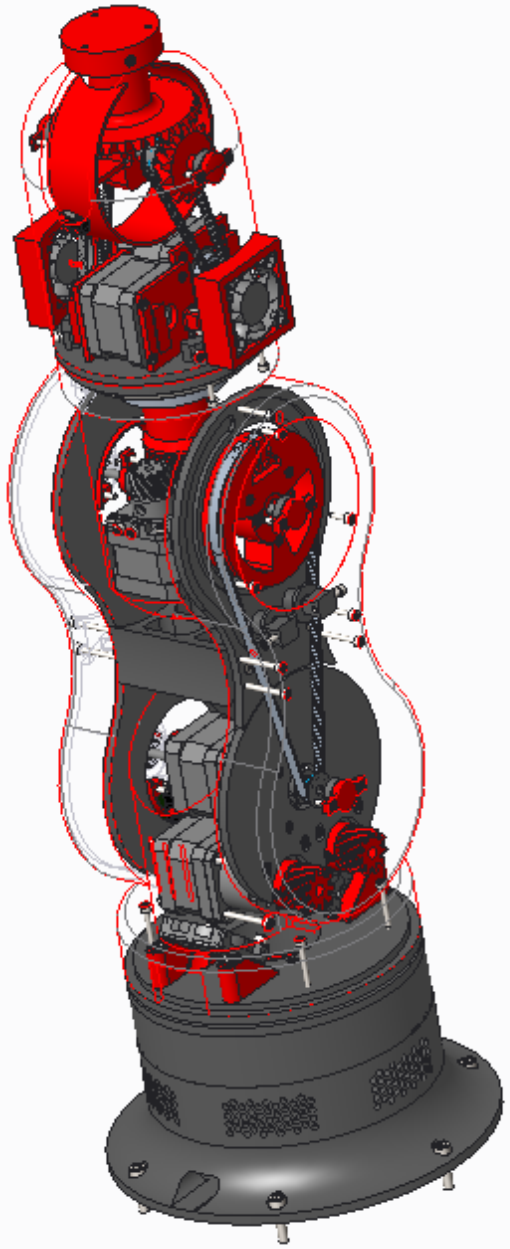
Design review

- 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

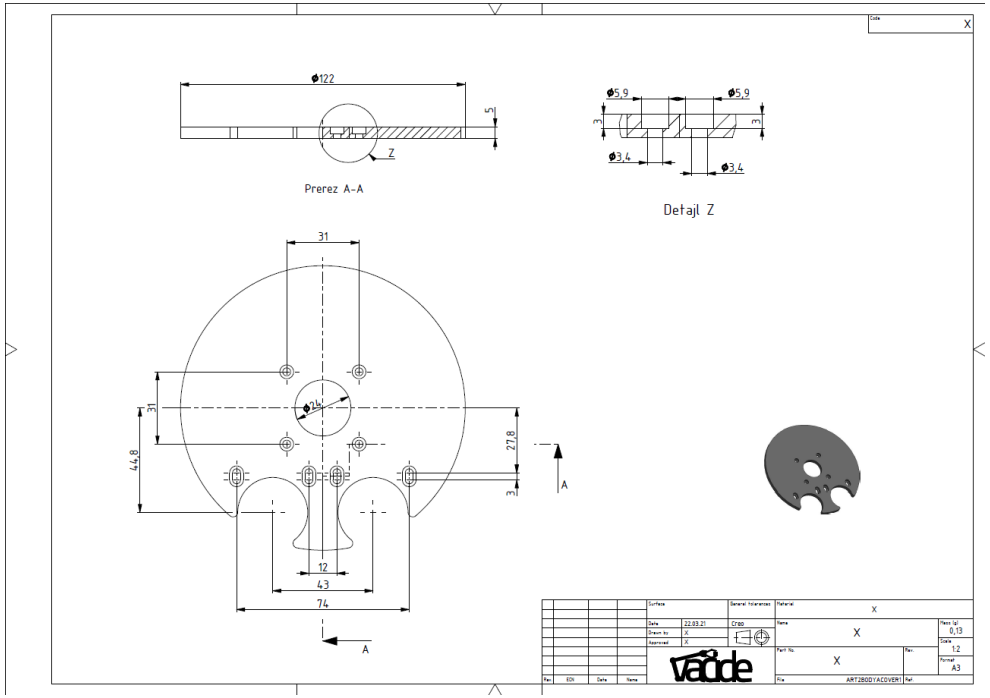
- Research how others approached of making and assembling a robot
- Inspected where everything could get into trouble
- Design for manufacturing and assembly?
  - How to make parts? Printing, turning, milling …
  - How to put parts together?
  - Would they fit?

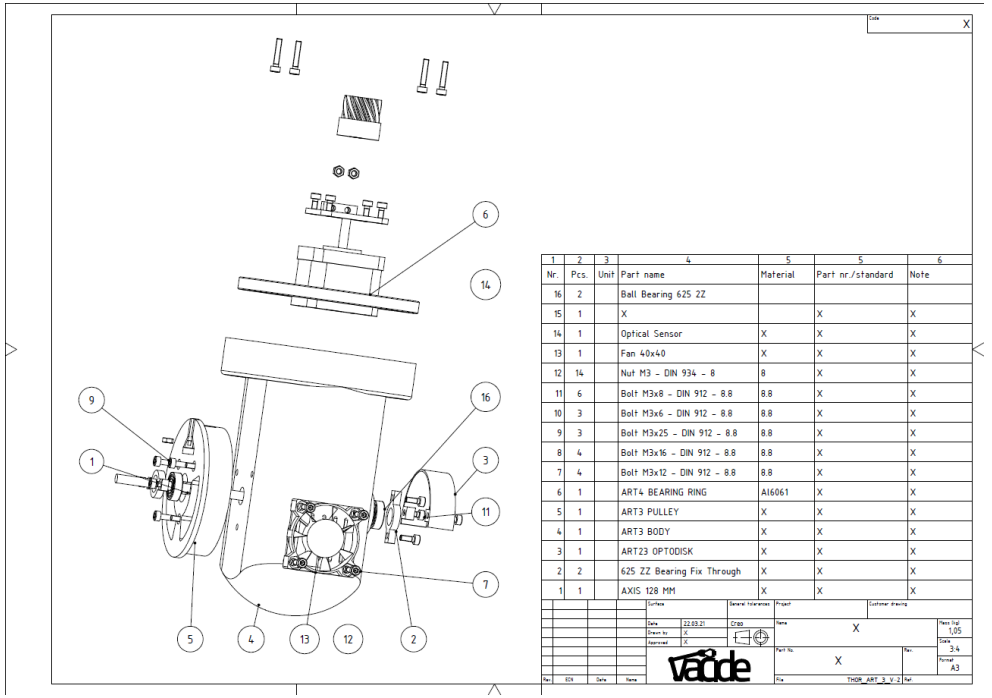


Redesign of robot

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

Drawings


Prerez A-A
Detajl Z


Nr. | Pcs. | Unit | Part name | Material | Part nr./standard | Note
16 | 2 | | Ball Bearing 625 2Z
15 | 1 | | X | | X | X
14 | 1 | | Optical Sensor | X | X | X
13 | 1 | | Fan 40x40 | X | X | X
12 | 14 | | Nut M3 - DIN 934 - 8 | 8 | X | X
11 | 6 | | Bolt M3x8 - DIN 912 - 8.8 | 8.8 | X | X
10 | 3 | | Bolt M3x6 - DIN 912 - 8.8 | 8.8 | X | X
9 | 3 | | Bolt M3x25 - DIN 912 - 8.8 | 8.8 | X | X
8 | 4 | | Bolt M3x16 - DIN 912 - 8.8 | 8.8 | X | X
7 | 4 | | Bolt M3x12 - DIN 912 - 8.8 | 8.8 | X | X
6 | 1 | | ART4 BEARING RING | Al6061 | X | X
5 | 1 | | ART3 PULLEY | X | X | X
4 | 1 | | ART3 BODY | X | X | X
3 | 1 | | ART23 OPTODISK | X | X | X
2 | 2 | | 625 ZZ Bearing Fix Through | X | X | X
1 | 1 | | AXIS 128 MM | X | X | X

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

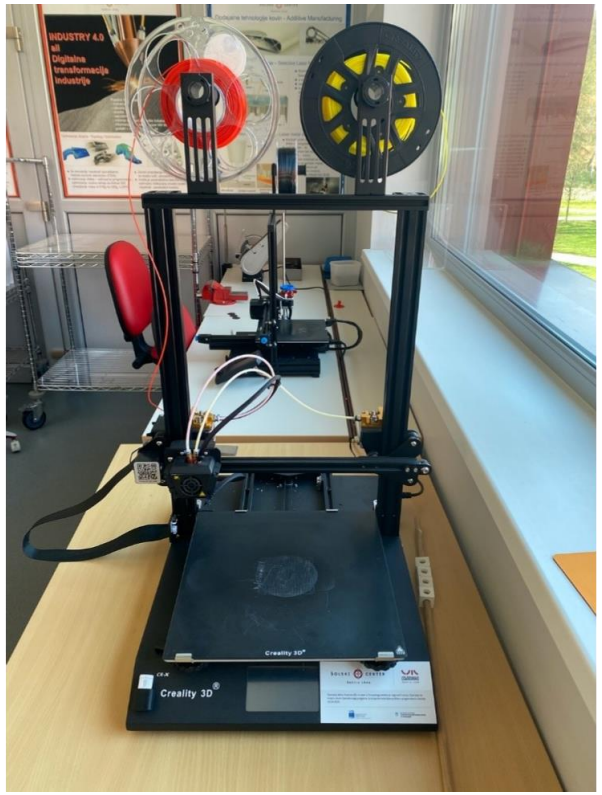
- Finding raw materials
  - Filaments,
  - Al profiles
- Purchasing components:
  - EU or world wide
  - Finding matching parts
- Searching for pulleys and belts in EU
  - Checking the length

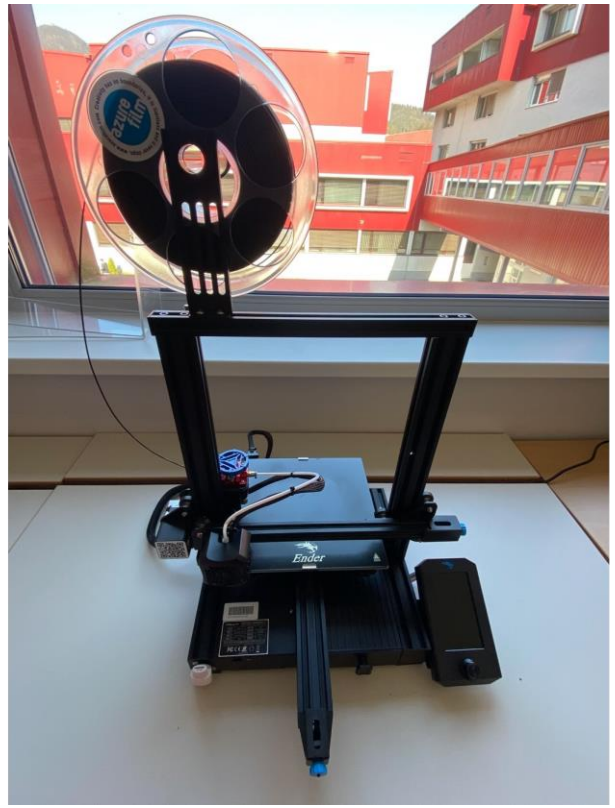
Manufacturing process

Overview of 3D Printing Models:

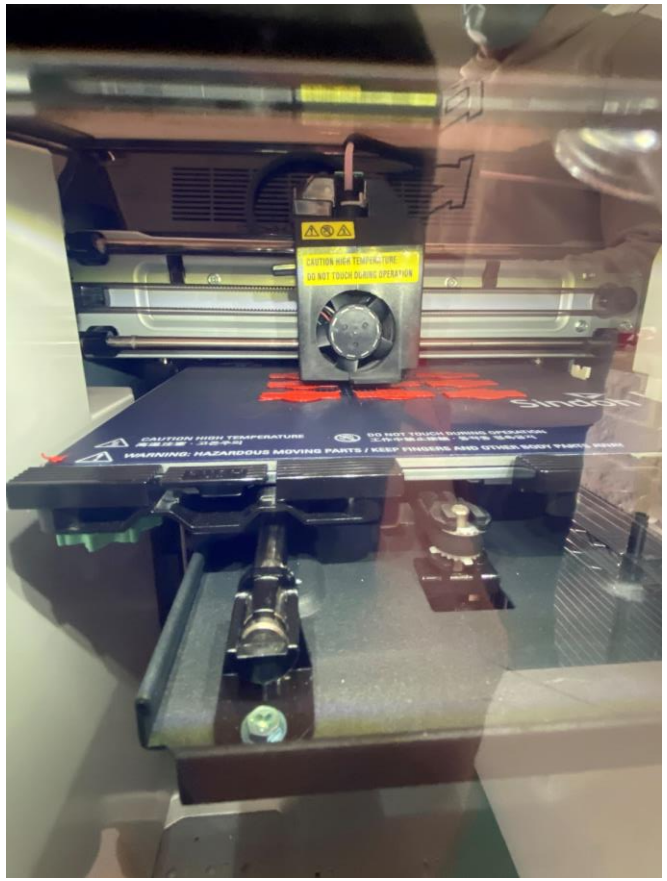
- Selection of filament: PLA
  - Possibilities of using other materials (ABS, ACE)
- Material consumption estimates
- Overview of printing settings:
  - Temperature,
  - Speed,
  - Wall thickness,
  - Consumption of filament

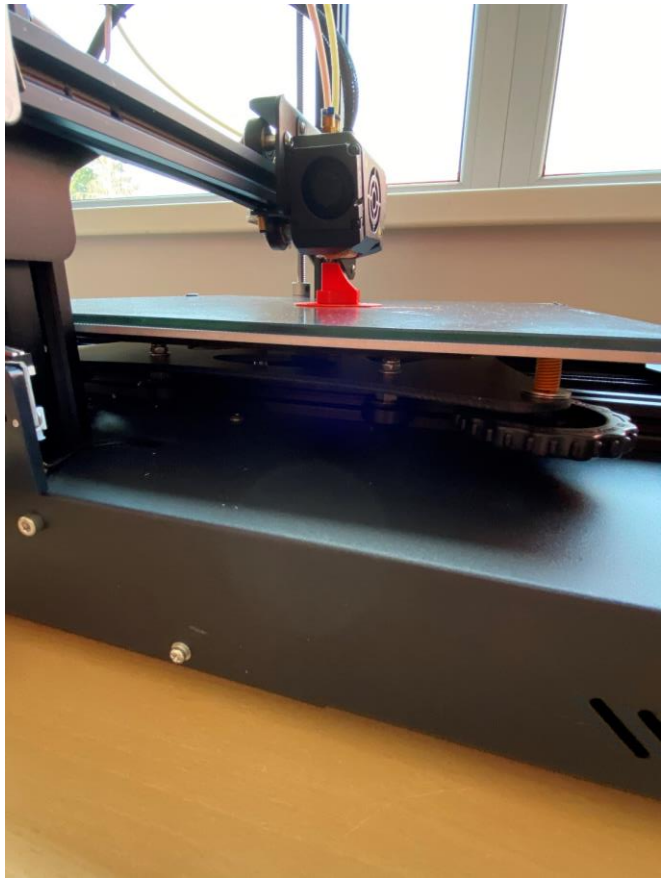
3D Print

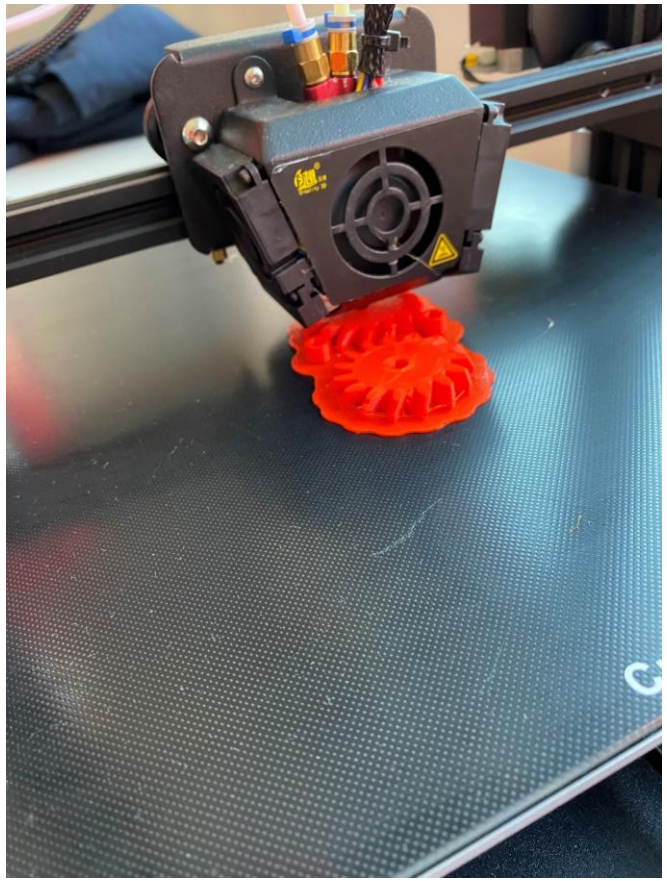




3D Print







3D Print

3D printing process:

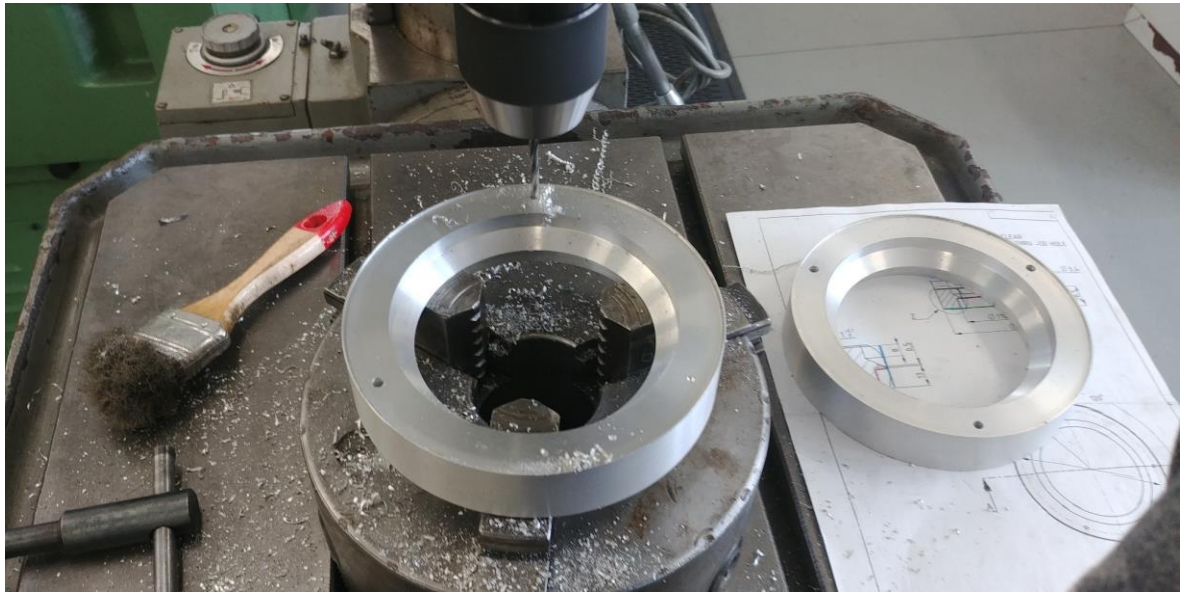
- 3D modelling in Creo,
- Preparing STL files
- Creating G code for printer
- Transfering G code to printer

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



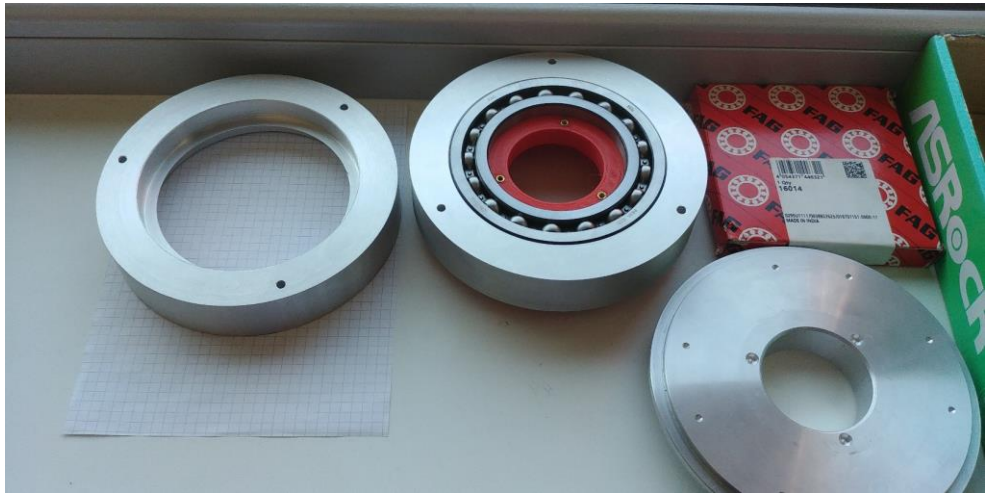
Production of aluminum pieces

Production of aluminum pieces

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 subbasemblies 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:** *Črtna Koda/ QR koda delovne operacije*
Struženje Art4Optodisk	**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
  - Rezkanje plošče na CNC rezkalnem stroju
- Pripomočki:
  - CNC stružnica z gnanim orodjem
  - Stružni nož
  - CNC Rezkalni 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


INDUSTRY 4.0
Digitalna
transformacija
industrije