



Trainers **for Visually Impaired Students Introduce **3D** Printing**

MANUAL FOR ASSESSMENT

Modul of the Curriculum for the T4VIS-In3D Trainer Course
Training of visually impaired participants in 3D printing

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The T4VIS-In3D project consortium:

Berufsförderungswerk Düren gGmbH (project coordination)

Karl-Arnold-Str. 132-134, D52349 Düren, Germany, <http://www.bfw-dueren.de>

Fundacion ASPAYM Castilla Y Leon

C/ Severo Ochoa 33, Las Piedras 000, 47130, Simancas Valladolid, Spain, <https://www.aspaymcyl.org/>

Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs

Jägerstraße 36 - 1200, Vienna, Austria, <https://www.hilfsgemeinschaft.at>

Instituttet for Blinde og Svagsynede, IBOS

Rymarksvej 1, 2900, Hellerup, Denmark, <https://www.ibos.dk>

Istituto Regionale Rittmeyer per i ciechi di Trieste

Viale Miramare 119, 34136 Trieste, Italy, <http://www.istitutorittmeyer.it/>

NRCB

24 Landos Str., Plovdiv, 4006, P. Box 11, Bulgaria, <http://www.rehcenter.org>

1 Content

1	Content.....	3
1	Objective	4
2	Structure and sequence of this assessment module:	4
1.1	Topic block 1 (Checking the optical skills)	4
2.1	Topic block 2 (Checking the optical skills)	4
2.2	Topic block 3 (Review of technical skills)	5
3	Resources required	5
3.1	Staff.....	5
3.2	Devices, work equipment and PPE	5
3.3	Time required	6
4	Section A.....	7
4.1	Chapter 1: Activities of an Additive Manufacturing (AF) Specialist	7
4.2	Chapter 2: Professional requirements, professional qualification or professional experience	7
4.3	Chapter 3: Medical reasons for exclusion.....	8
4.4	Chapter 4: Requirements for residual vision.....	8
4.5	Chapter 5: Requirements for the implementation of this assessment module 8	
5	Section B - Review of optical skills	9
5.1	Part 1: Operability of the design software.....	9
6	Section B - Part 1.2 Moving the three axes	12
7	Section B - Part 1.3 Drawing four surfaces with size specification and the "Sketch" function	12
8	Section B - Part 1.4 Drawing three solids with given dimensions and the "Create" function.....	14
8.1	Part 2: Operability of an FDM Printer and LCD Control Panel	16
9	Section C - Review of technical skills	18
9.1	Identify at least 5 sources of danger.....	19
9.2	Commissioning the FDM printer	19
9.3	Carrying out maintenance work on an FDM printer	20
10	Assessment checklist	21
11	Evaluation.....	25

1 Objective

This module is intended to give an indication of whether the assessment participant (AP) is suitable as part of the aptitude assessment:

1. successfully complete the qualification measure "Specialist for Additive Manufacturing Processes".
2. To be able to be productively employed in a company as a specialist in additive manufacturing processes.

2 Structure and sequence of this assessment module:

1.1 Topic block 1 (Checking the optical skills)

Ability to operate the design software Autodesk Fusion 360 or Autodesk ThinkerCAD

1. Operation of the GUI with mouse, trackball or alternative optical pointing device
2. Movement of the three axes of the software, Incl. zoom functions
3. Draw 4 surfaces with given dimensions
 - a) Rectangle
 - b) Square
 - c) Circle
 - d) Trapezium
4. Draw 3 solids with given dimensions
 - a) Sphere
 - b) Cube c) Cylinder

2.1 Topic block 2 (Checking the optical skills)

FDM printer operability and LCD user interface

1. Operating the LCD user interface according to verbal instructions
Load filament into the extruder opening (as instructed),
2. Filament flow control
3. Optical control of the production result (with visual aid and opt. aids)
4. Checking the distance between print bed and extruder nozzle

2.2 Topic block 3 (Review of technical skills)

Technical understanding, ability to remember technical processes, analytical understanding, practical skill

3 Resources required

3.1 Staff

A staff member as Assessment Implementer (AI) with a secure knowledge of the:

- Operation of the CAD programme Autodesk Fusion360 and Autodesk ThinkerCAD used.
- Commissioning of the FDM printer used
- Procedure of the assessment

3.2 Devices, work equipment and PPE

- A room for conducting the assessment. **Lighting and equipment is to be supplemented if necessary according to the results of the counselling optical and electronic aids!**
- 1 computer workstation (Windows or MacOS operating system), with mouse or trackball connected.
- At least one 21" monitor
- Enlargement software installed (If required)
- Installed CAD software Autodesk Fusion360 Alternatively: online software Autodesk ThinkerCAD. **Access data must be available at** the assessment workplace.
- An FDM printer with **open** space and minimum print area 150x150x150 mm.
- 1 roll of PLA filament in the colour of the filament holder of the machine and the appropriate size (1.75 or 2.83 mm)
- 1 Feeler gauge 0.3mm
- 1 tweezers
- 1 optical or electronic magnifying glass (alternatively: smartphone with magnifying glass app)
- 1 torch small (alternatively: smartphone with lamp/flash)
- One DIN A4 sheet each in the colour black, white, red and blue for possible contrast design of the printer rear wall
- Double-sided adhesive tape for fixing the contrast sheets
- For AI and AP: safety goggles for spectacle wearers, EN 166, EN 170 , class 2-1,2 - 1F
- For AI and AP : Respirator class FFP2
- For AP: Gloves EN407, class 1111

3.3 Time required

Activity	Duration
Preparation of the workplace and the equipment	30 minutes
Possibly prepare the workplace according to the results of the consultations.	60 minutes
Final documentation	30 minutes
Conducting thematic block 1 (incl. 5 minutes break)	90 minutes
Conduct thematic block 2 (incl. 5 minutes break)	45 minutes
Implementation of thematic block 3	45 minutes
Time required to carry out thematic blocks 1-3: 180 minutes	
Total time required for implementation (incl. preparation of documentation):	300 minutes/ 5 hrs.

4 Section A

4.1 Chapter 1: *Activities of an Additive Manufacturing (AF) Specialist*

Additive manufacturing specialists are able to operate the machines in the manufacturing processes [FDM](#), [SLA](#) and [SLS](#) prepare and correct design files for production and manufacture and rework components. The employment of the AF specialist can take place at a service provider for AF or in a small or medium-sized company in the metal or plastics processing industry.

4.2 Chapter 2: *Professional requirements, professional qualification or professional experience*

Participants should have the following professional qualifications:

1. Technical vocational qualification, e.g.: -
CNC lathe operator
- CNC miller - CNC
specialist -
fitter -
lathe operator -
cutting machine operator -
technical draughtsman - technical
product
designer - technical
model
maker
2. Possible exceptional occupations with special aptitude e.g.
Mechatronics
Welder
Technician
Goldsmith
Orthopaedic technician
3. Academic professional qualifications Bachelor's/Master's/Diploma
- Engineering sciences Mechanical engineering, Electrical engineering,
Civil engineering
- Business informatics

4.3 Chapter 3: ***Medical reasons for exclusion***

Mandatory medical reasons for exclusion from this integration measure are:

1. Illness or drug therapy that precludes driving/operating machinery.
2. Allergy to plastic (ICD-10 L23.5)

4.4 Chapter 4: ***Requirements for residual vision***

1. Residual vision in the central visual field that
- requires max. 3-fold magnification on the screen
allows
optical tracking of the mouse pointer and secure mouse positioning.
2. Stable ophthalmological findings in the last 6 months, prognosis stable

4.5 Chapter 5: ***Requirements for the implementation of this assessment module***

1. Determination of the formal requirements Professional qualification or equivalent professional experience has been obtained
2. Determination that there **are no** reason for exclusion has been made
3. A trial of optical aids has taken place. Recommended aids/visual aids are available and will be brought to the assessment
4. A test of the necessary technical aids has been carried out. Recommended aids and lighting are available

5 Section B - Review of optical skills

5.1 Part 1: Operability of the design software

Section B - Part 1.1 Operating the GUI with mouse or alternative optical pointing device

Aim of this task:

The AP shall demonstrate that:

1. the mouse pointer can be tracked visually. **Note: The mouse pointer** may be adapted to the requirements of the AP. (E.g.: enlarged pointer, crosshairs, colour changed pointer, mouse track).
2. with the optical pointing device, the control surfaces of the GUI can be effectively controlled, recognised and operated according to specification
3. the pop-up information and menu bars of the controlled controls can be read
4. he/she can memorise the position of the main controls

Execution instruction for the AI:

Verbal explanation of the GUI of Autodesk Fusion360. The AI explains the position in the order of the numbering shown below. This can be done with classical directional indications or by applying the position indications on a dial. The AP guides the mouse to the object addressed. The function areas are explained coherently. The functions of the individual objects and commands are not yet discussed in detail. Only the main functions of the elements are named. When controlling the control elements, the AP can give verbal assistance to reach the position.

Afterwards, the command for independent control of the control surfaces is given by requesting the AI. The order of control is arbitrary. Verbal assistance and corrections should be avoided as far as possible.

Intended duration of this part: (30 minutes)

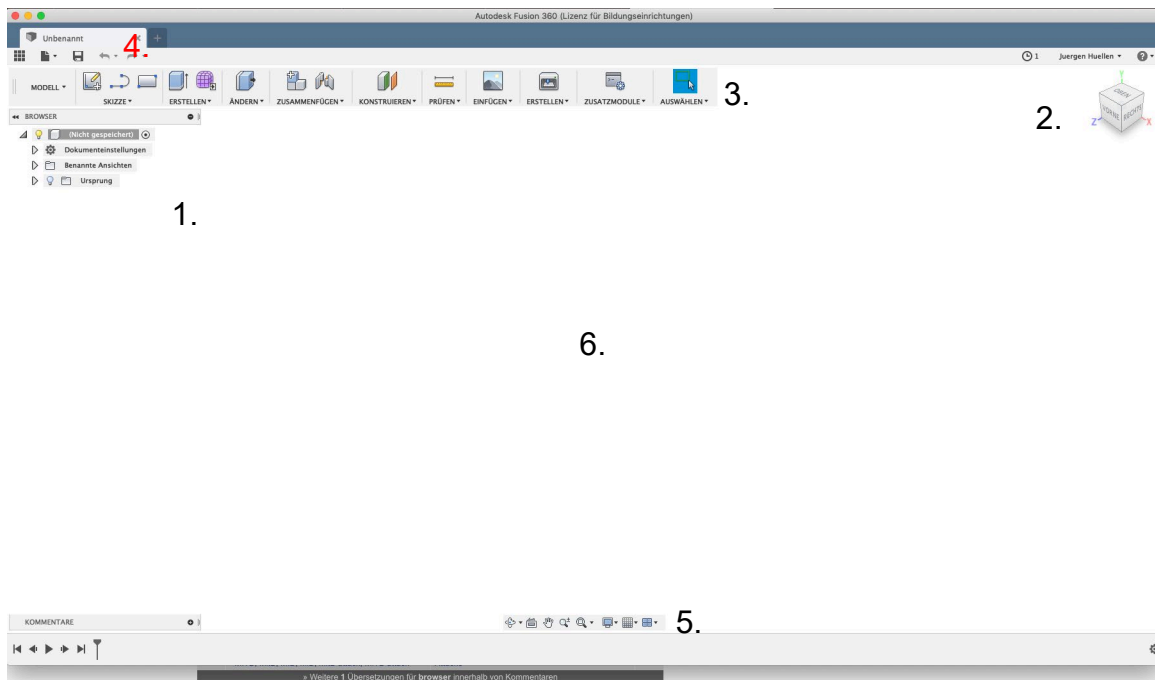


Figure 1 GUI of Autodesk Fusion360

1. (Object) Browser (Top Left/ 10 o'clock)



2. Perspective/ View Cube (top right/ 1 o'clock)



Figure 2 Perspective of the model

3. toolbar (Top / 12 o'clock)



Illustration 4 Toolbar with various functions

4. Menu bar (Via tool bar/ 11 o'clock)



Illustration 5 Menu bar

5. View Settings Bar (Bottom Centre/ 6 o'clock)



Figure 6 View settings bar

6. Working area

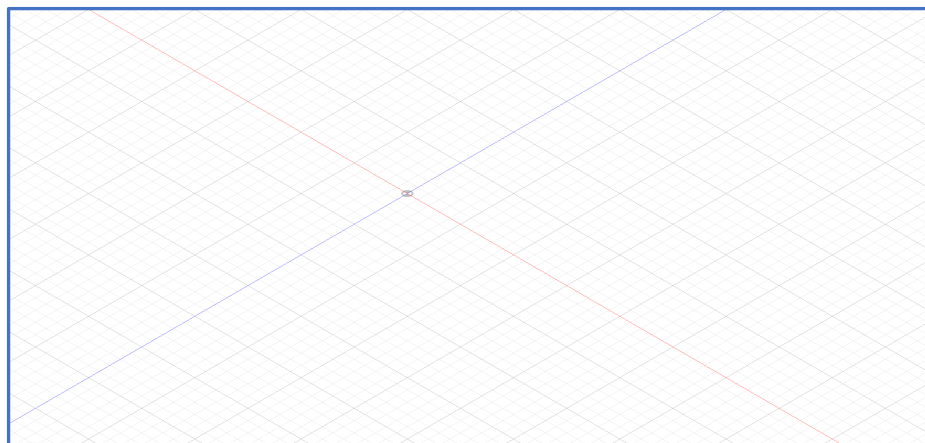
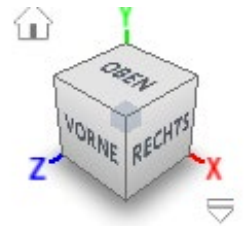


Figure 7 Working area

6 Section B - Part 1.2 Moving the three axes

1. moving the view with the pointing device using the perspective button

1. Front view
2. Top view
3. View right
4. Rotating the machining area with rotation arrows
5. Zooming in and out of the editing area with the scroll wheel

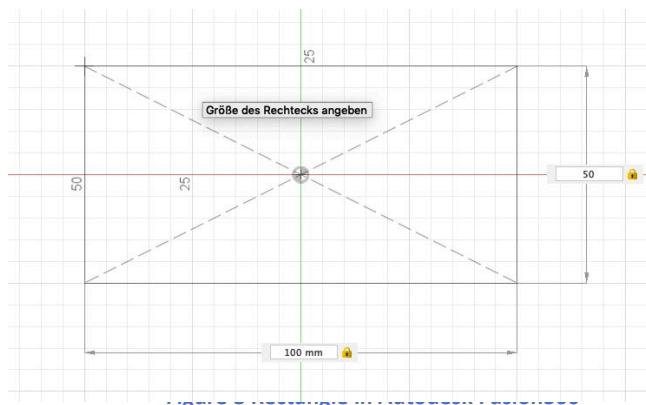


2. move the view with the pointing device using the buttons on the View Adjustment bar.

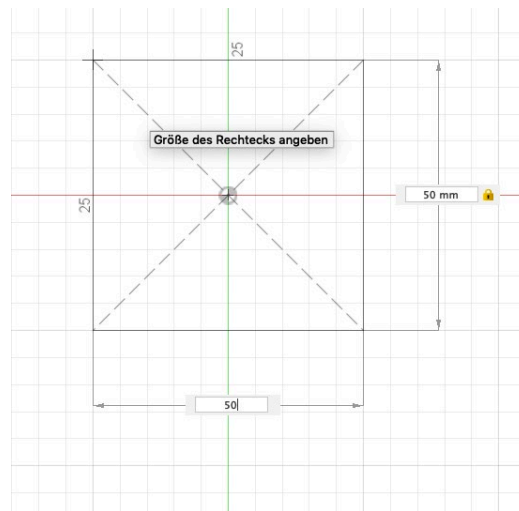
1. Rotating the machining area with the "Rotate" function
2. Shifting the editing area with the "Pan" function

7 Section B - Part 1.3 Drawing four surfaces with size specification and the "Sketch" function

A) Draw a rectangle with the function Sketch-> Rectangle -> Centre Rectangle. Centre point XYZ 0,0,0, dimension 100x50 mm



- B) Draw a square with the function Sketch-> Rectangle -> Centre Rectangle. Centre point XYZ 0,0,0, dimension 50x50 mm



- C) Draw a circle with the function Sketch-> Circle -> Centre Diameter Circle, Centre XYZ 0,0,0, Diameter 50mm

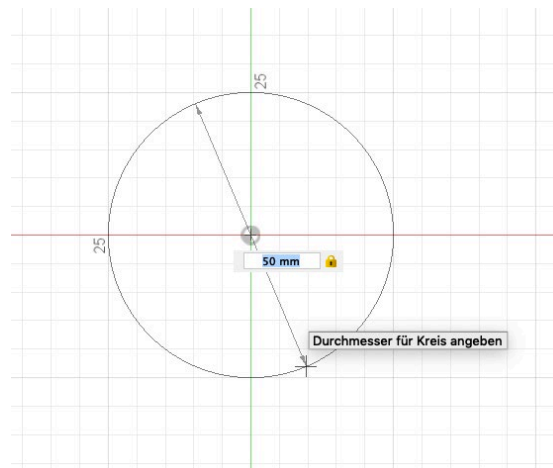


Figure 10 Circle in Autodesk Fusion360

D) Draw an isosceles and symmetrical trapezoid with the function Sketch-> Line, centre XYZ 0,0,0, dimension 50x50x20 mm

Note for AP: Use the "Top" view. Using the grid as a reference for dimensioning

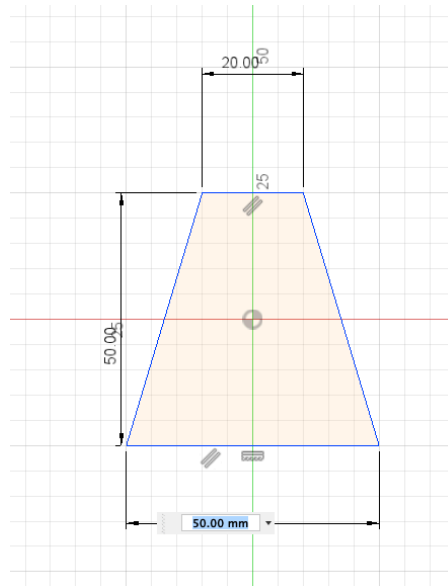


Figure 11 Trapezoid in Autodesk Fusion360

Intended duration of this part: (30 minutes)

8 Section B - Part 1.4 Drawing three solids with given dimensions and the "Create" function

A) Drawing a sphere with the function "Sphere"
" Centre XYZ 0,0,0, diameter 50mm

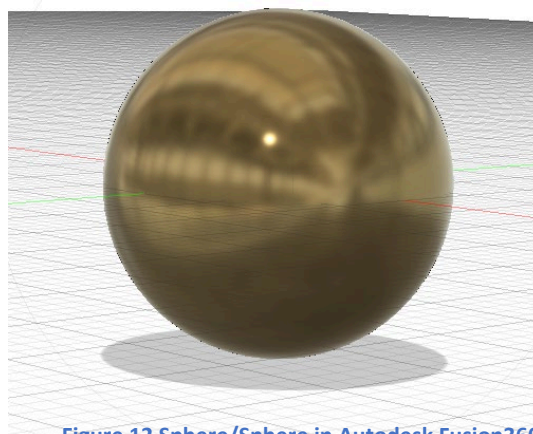


Figure 12 Sphere/Sphere in Autodesk Fusion360

B) Draw a cube with the function "cuboid"
" Centre XYZ 0,0,0, edge length 75mm

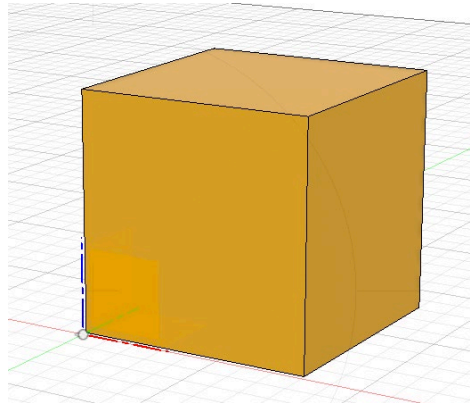


Figure 13 Cube in Autodesk Fusion360

C) Draw a cylinder with the function "Cylinder"
" Centre XYZ 0,0,0, diameter 30mm Height 80mm

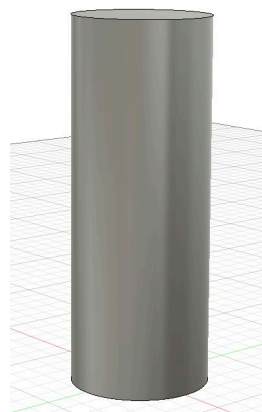


Figure 14 Cylinder in Autodesk Fusion360

Intended duration of this part: (30 minutes)

8.1 Part 2: Operability of an FDM Printer and LCD Control Panel ¹

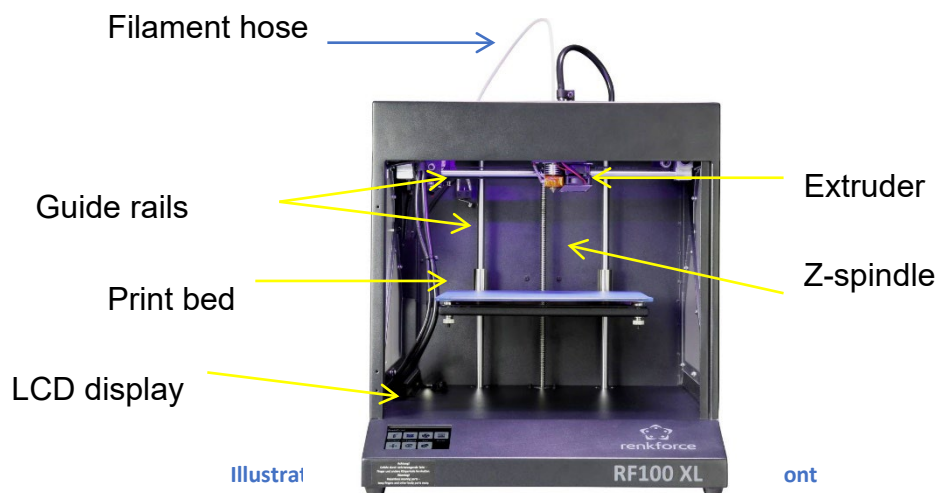
Aim of this task:

The AP shall demonstrate that:

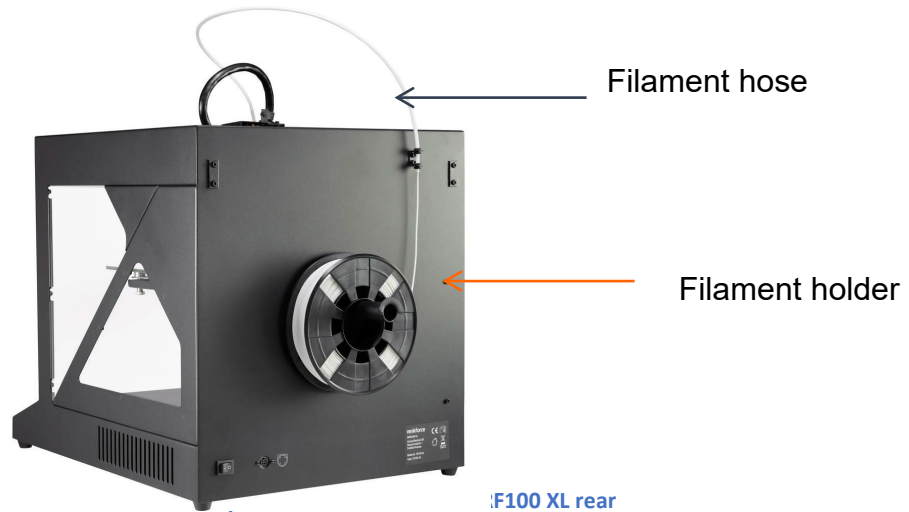
1. Safe, material-friendly and proper operation of the printer is ensured.
2. The printer can be operated properly via the LCD displays of the printer, even with the aid of aids.
3. The control and assessment of the printing processes, with and without aids, is possible
4. It is possible to check the construction elements with and without aids.

Execution instruction for the AI:

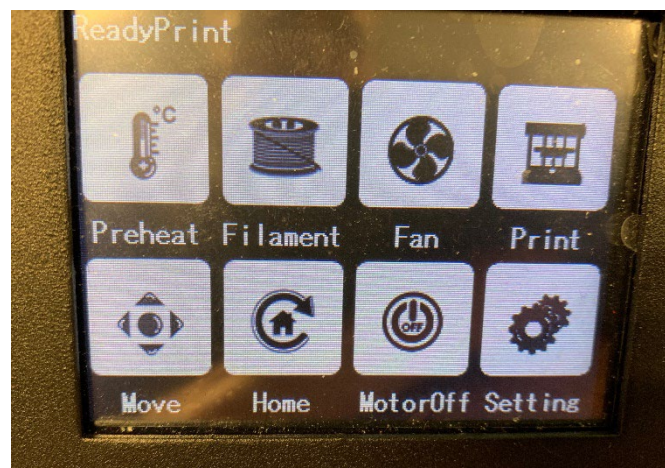
The main components of an FDM printer are named to the AP and shown on the device. Only the components that are important in the assessment are discussed. This is followed by verbal instructions on how to carry out the work steps. Verbal assistance may be given. Manual The AI should only intervene manually for reasons of accident and equipment protection.



¹ It is recommended to use an FDM printer with open installation space for the assessment. The following illustrations therefore refer to the Renkforce RF100 XL. If the Ultimaker 3+ Extended or other models are used, the corresponding instruction manuals should be consulted for familiarisation.



The following explanations are based in content and sequence on the steps for commissioning the FDM printer used. These steps are controlled via the CD display. **Before starting the work, the operator is asked to put on the respiratory mask and protective goggles.**



The following procedures are explained by the AI and carried out by the AP:

1. Preheat extruder (and print bed, if applicable) to temperature 205 - 215° (print bed 60°C).
2. Attach the filament roll to the filament holder and insert the filament into the filament tube until the filament protrudes by approx. 10cm.
3. When the extruder temperature is reached, insert the filament into the filament guide on the extruder unit.

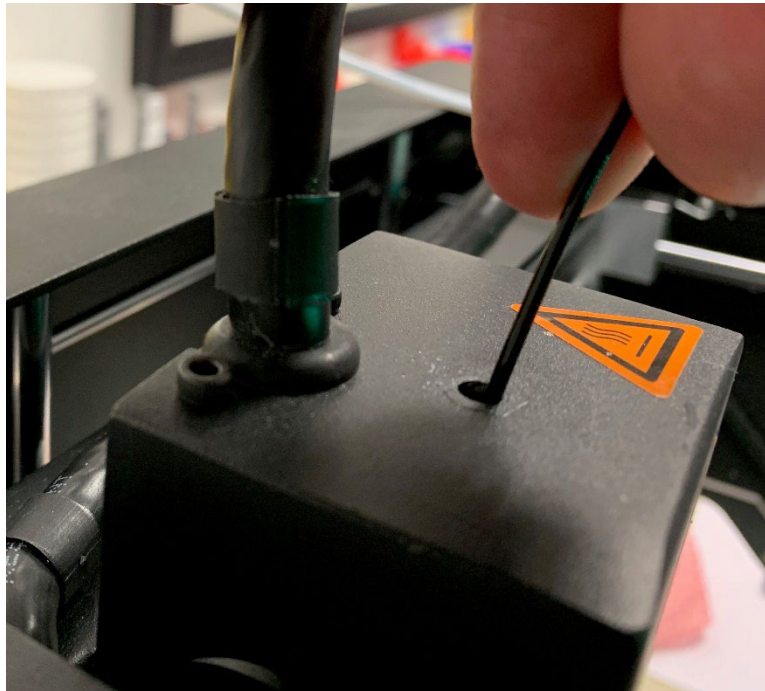


Figure 18 Inserting the filament

4. When the extruder temperature is reached: Activate the "Load Filament" menu.
5. As soon as filament comes out of the extruder in the same colour as the filament, activate the "Stop" menu. Then remove any protruding filament at the nozzle with tweezers.
6. Carry out print bed adjustment using the setup menu at at least 3 measuring points with a feeler gauge. **AP put on protective gloves for this.**
7. Running a proof print
8. Visual inspection of the proof print

Intended duration of this part: (45 minutes)

9 Section C - Review of technical skills

Aim of this task:

The AP shall demonstrate that:

1. He can name the potential accident risks when handling an FDM printer. This can be easily deduced from the hazard labels and the PPE used.

2. He has the technical understanding to start up the device independently according to the previous section.
3. He is able to adjust the print bed according to verbal instruction of the AI
4. He is able to carry out the usual maintenance work

Execution instruction for the AI:

In the final section of the assessment, the AP should act mainly independently and without assistance from the AI. To avoid creating an examination atmosphere, the tasks are completed in dialogue. In this way, the AP can first talk about his next actions and then carry them out. In this way, the risk of injury and operating errors can be avoided.

9.1 Identify at least 5 sources of danger

"What dangers can occur when dealing with 3D printers and 3D printing? "

1. Combustion through hot nozzle
2. Risk of hand crushing due to moving print bed
3. Danger of drawing in at the feed knurls and drive belts
4. Irritating emissions in the ambient air due to hot plastics
5. Injury to the eyes from liquid plastic
6. Injury to the eyes due to plastic particles flying off during reworking

9.2 Commissioning the FDM printer

"Start up the printer and print the model <Test.gcode> . Address your next steps!"

1. Preheat extruder (and print bed, if applicable) to temperature 205 - 215° (print bed 60°C).
2. Attach the filament roll to the filament holder and insert the filament into the filament tube until the filament protrudes by approx. 10cm.
3. AP put on respirator and safety goggles. When the extruder temperature is reached: Activate the "Load Filament" menu.
4. As soon as filament comes out of the extruder in the same colour as the filament, activate the "Stop" menu. Then remove any protruding filament at the nozzle with tweezers.
5. Carry out print bed adjustment using the setup menu at at least 3 measuring points with a feeler gauge. AP put **on** protective gloves for this.
6. Execute the test print by activating the "Print" menu and selecting the file <Test.gcode>.
7. Checking the pressure and removing the model with spatula. Before doing this, AP puts on safety gloves.

9.3 Carrying out maintenance work on an FDM printer

"When you see the components of the printer, what necessary maintenance steps can you think of and where are they described?"

1. Maintenance work is described in the manual
2. Oiling/greasing the guide rails
3. Greasing the Z spindle

The following maintenance tasks are now carried out on the instructions of the AI. The aim is to check whether the AP has fine motor skills to perform the maintenance tasks.

1. Grease the Z spindle. Apply the grease using a tube or spatula. Remove the old grease with a cloth beforehand.
2. Oil the guide rails with a pipette. Application from above and avoidance of dripping on printing plate

Final feedback

1. **AP's impression of the** course and own performance, Difficult and easy tasks
2. **AI's impression of the** course and difficulties of the AP

Intended duration of this part: (45 minutes)

10 Assessment checklist²

Family Name:	First name:
Profession:	Counselling on assistive devices: <input type="checkbox"/> Optics <input type="checkbox"/> Technical
Recommended optical devices:	Recommended assistive devices are available for assessment: <input type="checkbox"/>
Prerequisites residual vision complied : <input type="checkbox"/>	No medical reasons for exclusion: <input type="checkbox"/>
Date:	Implementer:
3D printer used:	Design software used:

Magnification used:		Remark:
Mouse pointer setting:		Remark:

Evaluation scheme:

- 1 = No difficulties
- 2 = Slight difficulties (in locating the mouse pointer, finding and identifying the objects, executing the functions).
- 3 = Significant difficulties (mouse pointer is not recognised several times, objects are not located and/or identified more often, multiple incorrect execution of functions)
- 4 = Considerable difficulties (number of errors predominates)

² This section will be issued separately as a form once this draft has been released

Section: Checking the optical abilities

Part 1 Operation Software

Orientation and operation with optical pointing device

Activity	Rating 1-4	Comment
Navigation with the mouse: <ul style="list-style-type: none"> - Object browser - Perspective - Toolbar - Menu bar - View setting 	0	
Moving the three axes with perspective button <ul style="list-style-type: none"> - Front - Top - Right - Rotate with rotation arrow - Zoom in Zoom out 	0	
Moving the three axes with view adjustment <ul style="list-style-type: none"> - Rotate the display 360° horizontally - Rotate the display 180° Vertical - Moving the control surface to the right 	0	
Mean value:	0,0	

Drawing surfaces

Activity	Rating 1-4	Comment
Draw a rectangle from the centre. Dimensions 100x50mm	0	
Drawing a square from the centre. Dimensions 50x50mm	0	
Drawing a circle from the centre. Diameter 50mm	0	
Draw an isosceles triangle. Side length 50mm each	0	
Drawing a trapezoid from the centre. Dimensions 50x50x20mm	0	
Mean value:	0,0	

Drawing bodies

Activity	Rating 1-4	Comment
Drawing a sphere. Diameter 50mm	0	
Drawing a cube with an edge length of 75mm	0	
Drawing a cylinder diameter 30mm, height 80mm	0	
Mean value:	0,0	

Part 2 Guided Operation FDM Printer

Proper and safe operation and handling

Commissioning and printing

Activity	Rating 1-4	Comment
Setting the extruder temperature	0	
Attaching the filament roll and inserting filament into filament tube	0	
Loading the filament into the extruder via control panel	0	
Remove excess filament from the nozzle	0	
Performing a test print	0	
Removing the proof from the build plate	0	
Evaluation of the printed object	0	
Adjustment of the build plate	0	
Mean value:	0,0	

Section: Review of technical skills

Identification of at least 5 Hazardous sources

1. Burnings through hot nozzle
2. Risk of hand crushing due to moving print bed
3. Danger of drawing in at the feed knurls and drive belts
4. Irritating emissions in the ambient air due to hot plastics
5. Injury to the eyes from liquid plastic
6. Injury to the eyes due to plastic splinters during post-processing

Of the above-mentioned Hazardous sources mentioned:

Evaluation Result:

Scoring formula: 5 / number of correct answers

Independent commissioning and printing

Activity	Rating 1-4	Comment
Setting the extruder temperature	0	
Attaching the filament roll and inserting filament into filament tube	0	
Loading the filament into the extruder via control panel	0	
Remove excess filament from the nozzle	0	
Performing a test print	0	
Removing the proof from the build plate	0	
Evaluation of the printed object	0	
Correct use of protective equipment	0	
Maintenance guide rails	0	
Maintenance Z spindle	0	
Mean value:	0,0	

11 Evaluation

Evaluation

Orientation and movement	
Drawing surfaces	
Drawing bodies	
Guided operation FDM printer	
Hazardous sources	
Independent operation and maintenance	

The following clarification is still needed:

Comment