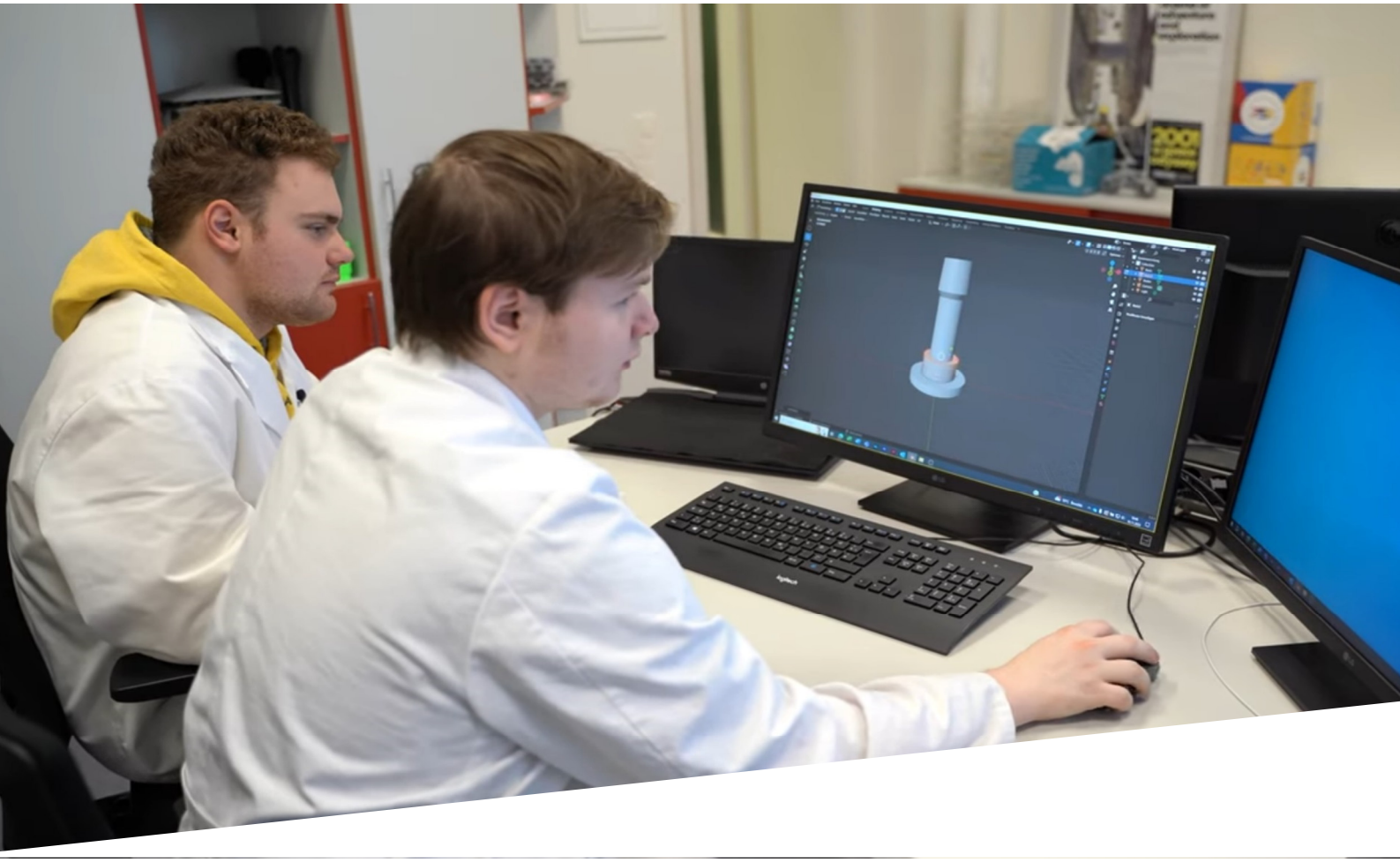

# BEST PRACTICE GUIDE

on easy and no-code 3D Scanning, 3D Printing and WebVR

FASTER3D

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# Structure

# 1. Introduction

The impact of new technology might be overestimated in the short run but underestimated in the long run. Therefore, it is necessary to evaluate realistic fields of application today and future use cases.

The ongoing developments in hard- and software point to an easy to create and easy to use generation of 3D objects. This is FASTER 3D. These developments will foster the use of no-code and low-threshold applications in vocational education training to ensure tailor-made teaching and learning scenarios to suit individual learning needs.

This best practice guide is all about which hard- and software in the fields of 3D scanning, 3D printing and WebVR come in handy, to ensure an easy and pedagogical-sound use in practical training. This guide includes several practical examples in text and video to support you to try it also by yourselves. After reading this guide you will understand the technical and pedagogical possibilities of 3D scanning, 3D printing and WebVR in training.


Faster 3D in a nutshell

## 2. Why – the importance of no-code educational technologies

Educational technology is central to support reaching specific learning goals. The tailor-made use and creation of contents strengthens the learning with and about a technology.

It is a challenge to keep up with technological developments. They key is easy to create and easy to use teaching and learning content. Currently available hard- and software can help with it. It is therefore important to ask:

1. What it needs to use the hardware: Selecting right model and get to know to work with it?
2. Which software comes in handy: Selecting a compatible software and being able to work with it?
3. How easy is to create tailor-made content?
4. Is it easy to create learning content fast?
5. How do I determine the pedagogic added value?

The industry specific questions for a use in practical training during the Faster3D project were:

CHEMISTRY:

1. How to easily create a 3D model with a tablet or 3D hand scanner?
2. Which 3D Printer and printing material (filament) to use for it?

IT:

1. How to easily create a 3D model with a smartphone scan?
2. Which software is required for an engaging WebVR experience?

## 3. What - educational technology for integration in practical training

The selected and applied core Faster 3D technologies were:

**3D scanning,** which is the process of capturing the shape, size, and geometry of a physical object using specialized equipment such as a 3D scanner to create a digital 3D model.

**3D printing** (or additive manufacturing), which is the computer-controlled layer by layer printing of material (e. g. plastic) with the aim of creating a physical representation of a 3D model.

**WebVR**, which allows to experience Virtual Reality (VR) in a common web browser, e. g. Mozilla, without the use of a special VR headset.

**3D Scanning**

Decisive factors for purchasing a 3D scanning device (hand scanner) were:

- Quality of scan (resolution)
- Effort of post processing
- Price of scanning device
- Handling (lightning, turntable required)

We started off with a hand scanner (Revopoint range), which worked out only for bigger objects (turntable required). For smaller objects we used an iPad 11 Pro (with LiDAR sensor) and with relevant scanning software (“AR Code Object Capture 3D Scan” app).

**3D Printing**

Decisive factors for purchasing a 3D printer (for chemistry) were:

- Printing temperature (up to 300 °C)
- Materials or filaments available (e.g. special co-polymer PC/PTFE)
- Price
- Dual extrusion
- Speed of printing
- Available 3D design and slicing software

We bought the Raise 3D Pro 2 Plus Dual Extrusion.

**WebVR**

Decisive factors for purchasing a WEBVR software were:

- Usability software
- Portability of scanned 3D model

The software used for 3D scanning with the smartphone was the WIDAR APP. For the WebVR experience FECTAR was used.

# 4. How to - practical examples

Before starting to use 3D scanning, 3D printing and WebVR it is central to formulate one or more **pedagogical problems**. The application of the selected educational technologies should support solving them, e. g. by improving the level media competences as well as increasing the intensity of collaboration and communication within a small group of apprentices.

In the next step the relevant technology use is projected within the process of lesson planning. This will help to plan the learning phases, learning content, learners' activities as well teacher/trainers' activities as well as suitable communication and collaboration forms. The process involves also steps and methods to instruct, guide, and assess the carried-out activities.

Below are examples from for practical training in the fields of chemistry and IT. Central were the low-threshold and pedagogical versatile use of 3D scanning (hand scanner, iPad, scanning app) and 3D printing for repair and maintenance tasks in a chemical training plant. In addition, the no-code 3D scanning (with a smartphone app) and the transfer as an interactive 3D object (WebVR) was successfully tested and evaluated in the field of IT training.

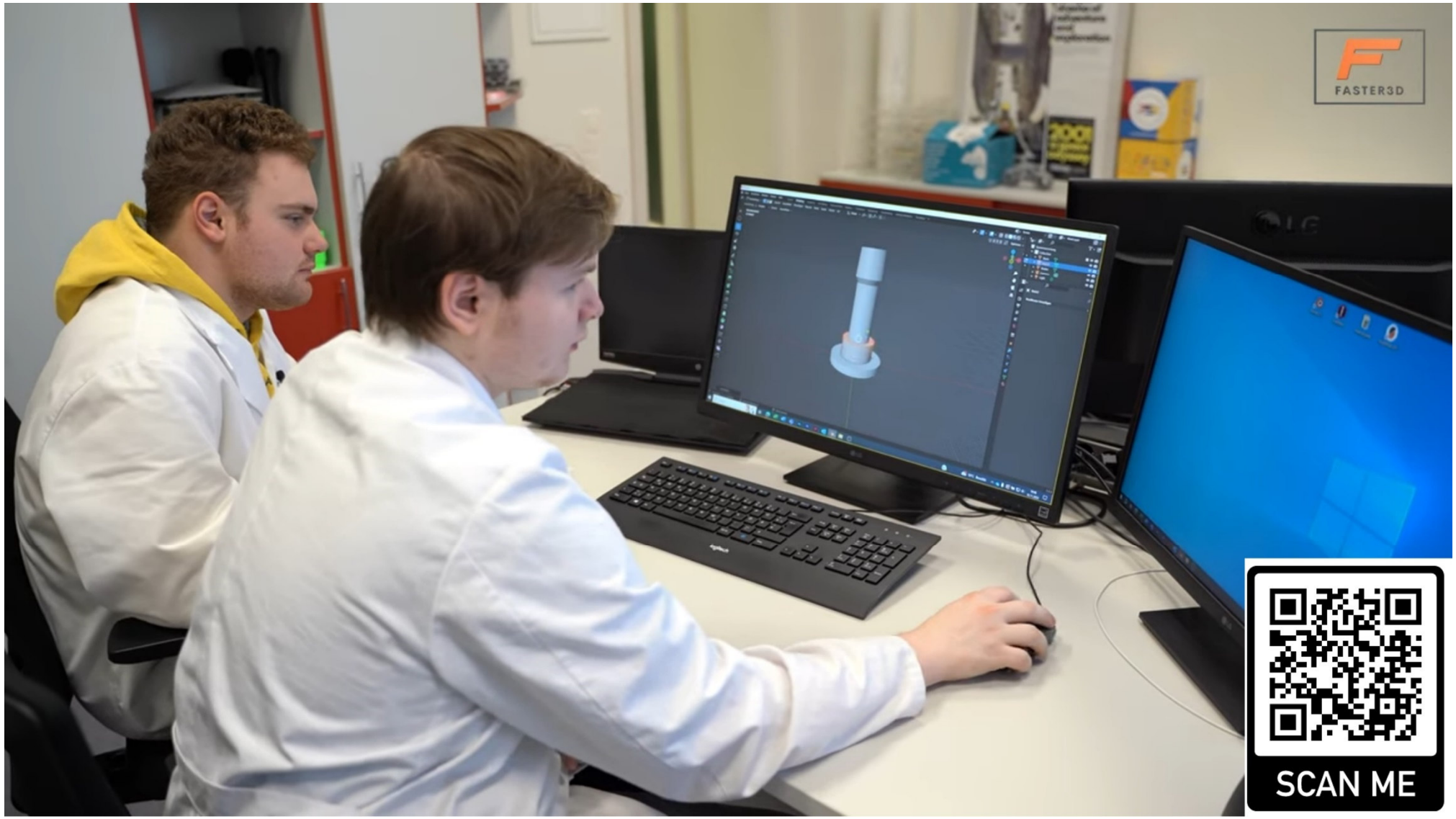
Scenario 1 (chemistry): Hose connection replacing by 3D scanning (hand scanner) and 3D printing

Scenario 2 (chemistry): Blind plug replacement by 3D design and 3D printing

Scenario 3 (chemistry): Flange ring replacement by 3D scanning (Tablet) and 3D printing

Scenario 1 (IT): Router – 3D scanning (smartphone app) and WebVR

Below are for each scenario the lesson plan and QR code to the relevant learning video.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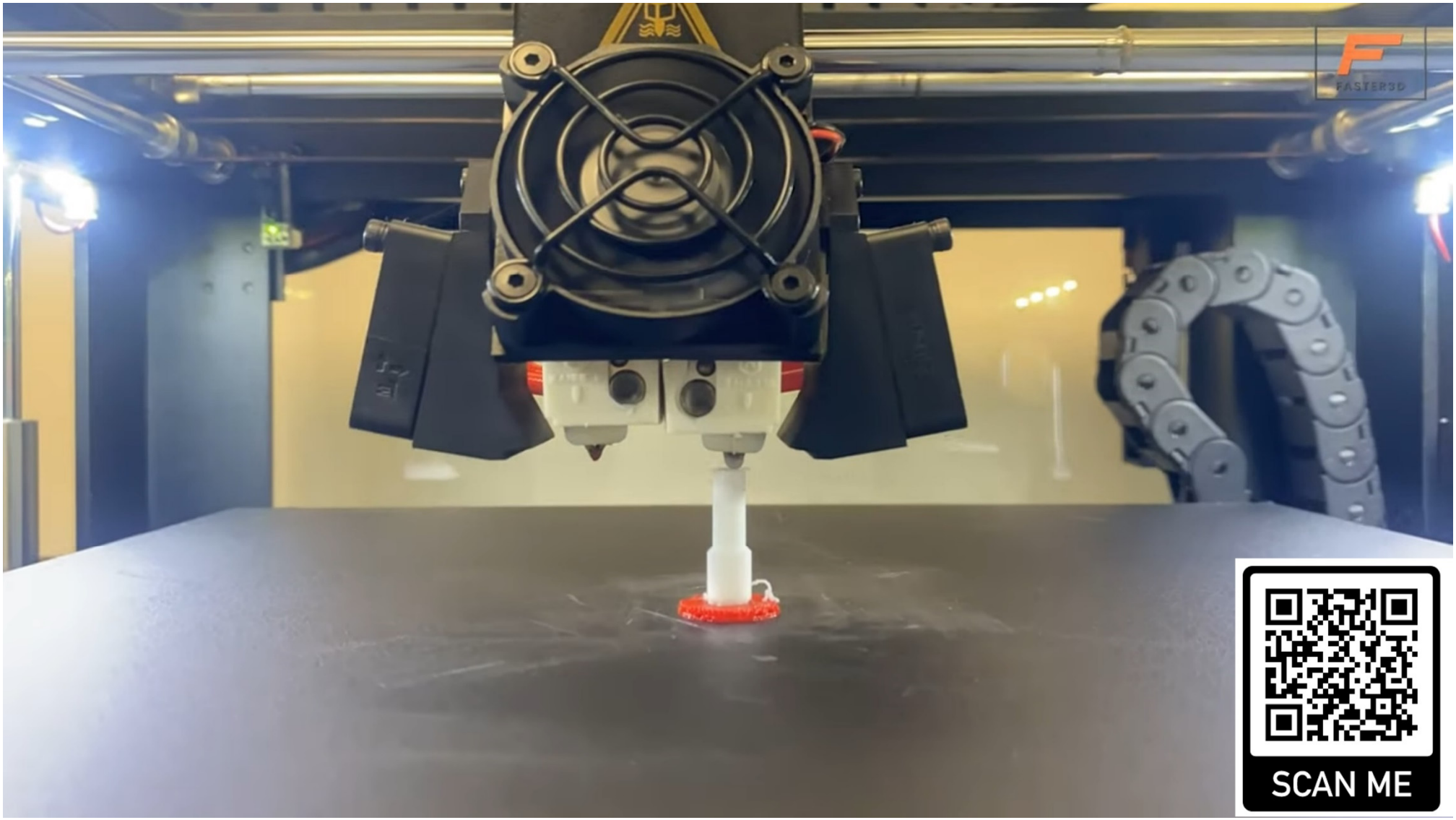
# Chemical plant: Participations in maintenance and repair with 3D scanning and 3D printing of a hose connection

| Dura -tion | Learning phase | Learning content<br>**(What should the apprentice learn?)** | Learning activities<br>**(Apprentice actions to meet the objectives?)** | Teacher/trainer activities<br>**(What is the role of the teacher/trainer and what is he/she going to do?)** | Communication and collaboration forms | Resources, tools and media<br>**(Which tools or media are used and how are they used?)** |
|---|---|---|---|---|---|---|
| 60 min. | **Intro-duction and Orien-tation** | • Providing working task: Production of spare part (hose connection)<br>• **3D scanner (Revopoint Range) or iPad 11**: How to do it? Advantages and disadvantages: safety rules, using technical equipment | • Work in small groups (2 person) on a learning station<br>• Apprentices familiarize with the task of 3D scanning<br>• Learn to use the 3D scanner by verbal and written instruction | • Providing safety rules<br>• Providing introduction to 3D scanner<br>• Evaluating short report | • Trainer-apprentices (verbal instruction, report)<br>• Collaboration in apprentice group at the learning station | • 3D scanner (hardware and software)<br>• Manual 3D scanner<br>• Written instructions |
| 120 min. | **Execution of the task** | • **Scanning hose connection**<br>• Load scan in scanning software and change size of needed | • Learn functioning of the equipment<br>• Learn to prepare scanning setting<br>• Learn to scan | • Observe implementation and provide support if needed | • Apprentices – apprentice (group discussion)<br>• Trainer - apprentice | • 3D scanner and 3D scanning software or iPad (with Polycam app) |
| 30 min. | **Assess-ment /Check** | • **Operate the scanner or iPad according to the safety rules**<br>• Check the quality of the scan data | • Active participation in the group discussion moderate by the trainer | • Moderating discussion and evaluating the results | • Trainer-apprentices | • Computer |

| Dura -tion | Learning phase | Learning content<br>**(What should the apprentice learn?)** | Learning activities<br>**(Apprentice actions to meet the objectives?)** | Teacher/trainer activities<br>**(What is the role of the teacher/trainer and what is he/she going to do?)** | Communication and collaboration forms | Resources, tools and media<br>**(Which tools or media are used and how are they used?)** |
|---|---|---|---|---|---|---|
| 30 min. | **Intro-duction and Orien-tation** | • Providing working task: Printing of hose connection<br>• 3D printer: How to do it? Advantages and disadvantages: safety rules, using technical equipment, filament (PC/PTFE) | • Work in small groups (2 person) on a learning station<br>• Apprentices familiarize with the task of 3D printing<br>• Learn to use the 3D printer by verbal and written instruction | • Providing safety rules<br>• Providing introduction to 3D printing<br>• Evaluating short report | • Trainer-apprentices (verbal instruction, report)<br>• Collaboration in apprentice group at the learning station | • 3D printer (hardware and software)<br>• Filaments for 3D printing<br>• Manual 3D printer<br>• Writing instruction |
| 90 min. | **Execution of the task** | • Select filament for printing (PC/PTFE<br>• Load hose connection scan in 3D slicer software<br>• Printing hose connection | • Learn functioning of the 3D slicer program<br>• Learn to prepare 3D scanning setting<br>• Learn to 3D print | • Observe implementation and provide support if needed | • Apprentices – apprentice (group discussion)<br>• Trainer - apprentice | • Slicer software and 3D printing software |
| 30 min. | **Assess-ment /Check** | • Operate the 3D printer according to the safety rules<br>• Check the quality of the 3D print<br>• Installation of the 3D printed hose connection in the chemical plant | • Active participation in the group discussion moderate by the trainer | • Moderating discussion and evaluating the results | • Trainer-apprentices | • Printed hose connection |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# Chemical plant: Participations in maintenance and repair with 3D scanning and 3D printing of a blind plug

| Dura-tion | Learning phase | Learning content<br>**(What should the apprentice learn?)** | Learning activities<br>**(Apprentice actions to meet the objectives?)** | Teacher/trainer activities<br>**(What is the role of the teacher/trainer and what is he/she going to do?)** | Communication and collaboration forms | Resources, tools and media<br>**(Which tools or media are used and how are they used?)** |
|---|---|---|---|---|---|---|
| 60 min. | **Introduction and Orientation** | • Providing working task: Production of spare part (bling plug)<br>• **3D scanner (Revopoint Range) or iPad 11**: How to do it? Advantages and disadvantages: safety rules, using technical equipment | • Work in small groups (2 person) on a learning station<br>• Apprentices familiarize with the task of 3D scanning<br>• Learn to use the 3D scanner by verbal and written instruction | • Providing safety rules<br>• Providing introduction to 3D scanner<br>• Evaluating short report | • Trainer-apprentices (verbal instruction, report)<br>• Collaboration in apprentice group at the learning station | • 3D scanner (hardware and software)<br>• Manual 3D scanner<br>• Written instructions |
| 120 min. | **Execution of the task** | • **Blind plug**<br>• Load scan in scanning software and change size if needed | • Learn functioning of the equipment<br>• Learn to prepare scanning setting<br>• Learn to scan | • Observe implementation and provide support if needed | • Apprentices – apprentice (group discussion)<br>• Trainer - apprentice | • 3D scanner and 3D scanning software (Revopoint) and single pictures by |
| 30 min. | **Assessment /Check** | • **Operate the scanner or iPad according to the safety rules**<br>• Check the quality of the scan data | • Active participation in the group discussion moderate by the trainer | • Moderating discussion and evaluating the results | • Trainer-apprentices | • Computer |


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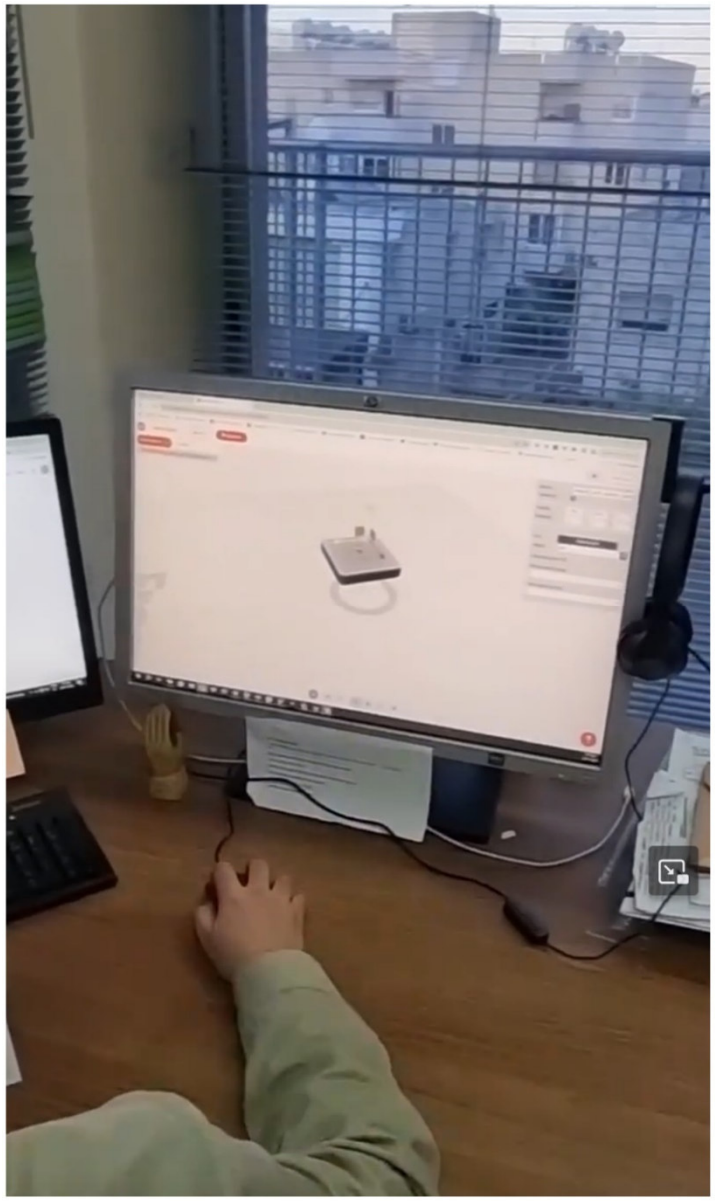
# Chemical plant: Flange ring replacement by 3D scan & 3D printing

| Dura-tion | Learning phase | Learning content<br>(What should the apprentice learn?) | Learning activities<br>(Apprentice actions to meet the objectives?) | Teacher/trainer activities<br>(What is the role of the teacher/trainer and what is he/she going to do?) | Communication and collaboration forms | Resources, tools and media<br>(Which tools or media are used and how are they used?) |
|---|---|---|---|---|---|---|
| 30 min. | **Introduction and Orientation** | • Providing working task: Printing of flange ring<br>• 3D Scan: How to operate the 3D Scan app on the iPad<br>• 3D printer: How to do it? Advantages and disadvantages: safety rules, using technical equipment, filament (PETG) | • Work in small groups (2 person) on a learning station<br>• Apprentices familiarize with the task of 3D scanning and 3D printing<br>• Learn to use the 3D Scanner and the 3D printer by verbal and written instruction | • Providing safety rules<br>• Providing introduction to 3D scanning and 3D printing<br>• Evaluating short report | • Trainer-apprentices (verbal instruction, report)<br>• Collaboration in apprentice group at the learning station | • 3D scanner (iPad 11, free AR Code Object Capture 3D Scan app)<br>• 3D printer (hardware and software)<br>• Filament for 3D printing (PETG)<br>• Manual 3D printer<br>• Writing instruction |
| 90 min. | **Execution of the task** | • Select scan app and scan<br>• Select filament for printing (PETG)<br>• Load flange ring scan in 3D slicer software<br>• Printing flange ring | • Learn functioning of the 3D slicer program<br>• Learn to prepare 3D scanning setting<br>• Learn to 3D print | • Observe implementation and provide support if needed | • Apprentices – apprentice (group discussion)<br>• Trainer - apprentice | • 3D scanning app<br>• Slicer software and 3D printing software |
| 30 min. | **Assessment /Check** | • Operate the 3D scanning app and 3D printer according to the safety rules<br>• Check the quality of the 3D print<br>• Installation of the 3D printed flange ring in the chemical plant | • Active participation in the group discussion moderate by the trainer | • Moderating discussion and evaluating the results | • Trainer-apprentices | • Printed flange ring |



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# IT: 3D Scanning and WebVR Router/Firewall

| Duration | Learning Phase | Learning Content | Learning Activities | Teacher/Trainer Activities | Communication and Collaboration Forms | Resources, Tools, and Media |
|---|---|---|---|---|---|---|
| 30 min. | **Introduction and Orientation** | - Inform on working task to 3D scan the router/firewall<br>- Usage of Advantages and disadvantages of 3D scanning | - Work in small groups on a learning station<br>- Apprentices familiarize with the task of 3D scanning<br>- Learn to use the 3D scanner by video and written instructions | - Provide introduction to 3D scanning with phone<br>- Provide information and best practices when 3D scanning | - Trainer/apprentices (verbal instruction, report) | - Phone for 3D scanning<br>- 3D scanner (WIDAR app)<br>- Video<br>- Written instruction |
| 90 min. | **Execution of the Task** | - Scanning process<br>- Using 3D scanner and software<br>- Use the webvr platform<br>- Adjusting settings | - Learn functioning of the phone app<br>- Learn to prepare scanning settings<br>- Learn to scan<br>- Learn to upload to webvr platform | - Observe implementation and provide support if needed | - Apprentices – apprentice (group discussion)<br>- Trainer / apprentice | - Phone for 3D scanning<br>- 3D scanner software and hardware<br>-Webvr platform (FECTAR) |
| 30 min. | **Assessment/Check** | - Operating scanner on phone<br>- Check quality of scan object | - Operate scanner following best practices<br>– Evaluate scan quality | - Moderating discussion and evaluating the results | - Trainer/apprentices (verbal instruction, report) | - Computer<br>- Phone |

# 4. Summary: Learnings and recommendations

The creation of fast 3D scans is possible with existing hard- and software. We recommend the following:

1. Ask the **PEDGAOGICAL QUESTION** first: What problem is solved? (provision of professional skills by modern technology, more self-directed and exploratory learning, increase of motivation among learners etc.)

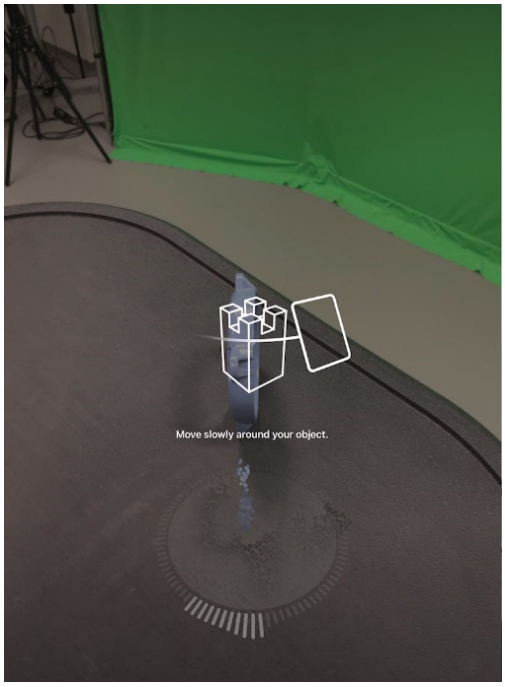
2. 3D SCANNING:

a) Select scanning hardware according to your needs: Smartphone or Tablet (e. g. iPhone or iPad) for smaller objects, hand scanner (like Revopoint Range) for bigger objects. Plan some time for post-processing to add a ground, colour etc.)

b) When scanning use sufficient as well as constant lighting. To ease up the scanning process further use an anti-reflective spray.

c) **Design it: smaller and simpler objects under 50cm in size, Scan it: objects of >50cm in size**

d) Good 3D scanning app (for Apple iPad with LiDAR sensor) is the free app "**AR Code Object Capture 3D Scan**"[1]. The scanning process takes for a simple object around 5 min. The app creates a 3D image by scanning 3 levels (from the front, diagonally below and diagonally above). The use has to move around the object physically (a turntable is here not needed).




Subsequently the AI in the app creates the 3D Model. The3D model is saved as in the usdz- format. By using an online file converter the file is converted into a .stl-file, which can be read by e.g. the free CAD program Blender.

[1] State: 31.01.2024

The scan might require some post-process steps. Small object sscans are very accurate. An advantage of the app is that only the scanned object is provided. A scan of the surrounding environment will not take place.

**The use of that app is very easy and saves much of time.**

**3. 3D PRINTING:**

a) The selection of the 3D printer should be tailored to your needs. For the chemistry scenario, we needed higher printing temperature (up to 300°C) to apply special filament PC/PTFE, which is more thermic stable, when used in the chemical plant.

b) A good 3D design software is FreeCad or Blender. We made good experiences with the slicer software ideaMaker from Raise. Common are also PrusaSlicer (for Prusa 3D printers) and Ultimaker Cura.

c) Select the printing material (filament) according to your needs. Common are PLA (polylactic acid), a biodegradable and eco-friendly material that is easy to print and comes in a wide range of colours, as well as ABS (acrylonitrile-butadiene-styrene), which is a durable and impact-resistant material commonly used for making toys, automotive parts, and electronic housings.

d) Optimize the printing condition like temperature, printing speed, ventilation speed etc.

**4. WEBVR**

a) Higher quality scans ensure easier to use as WebVR. We made good experiences with the smartphone app “WIDAR” and the subsequent integration by FECTAR in a web browser.

The above presented learnings are the result of active technology scouting to solve real pedagogical problems in practical training. To continue and improve this rather incremental process it has to be perceived as a habit to continuously select, integrate and evaluate suitable educational technologies in practical training, in the industry and beyond. This will be a contribution to the digital transformation process of educational institutions as well as the digital skills competence development of teachers/trainers and apprentices.

## 5. Contact

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# 6. Appendices

**LEARNER: SELF-EVALUATION FORM**

**3D scanning and 3D printing use for scenario …**

Please tick relevant answers.

| **Questions** | Very much | Yes | Rather Yes | Probably not | Not |
|---|---|---|---|---|---|
| Was it easy to carry out 3D scanning? | | | | | |
| Was it easy to operate the 3D printer? | | | | | |
| Were the 3d scanned and printed objects easy to integrate in the chemical training plant? | | | | | |
| Was it easy to prepare the file for 3D printing? | | | | | |
| Was it easy to change during 3D printing from one step to another? | | | | | |
| Did you think that your understanding of 3D scanning and 3D printing has improved? | | | | | |
| Did you find it easy to overcome mistakes and misunderstandings? | | | | | |
| How satisfied are you with the accomplishment of the work carried out by 3D scanning and 3D printing? | | | | | |
| Do you feel that your understanding of the working tasks has improved? | | | | | |
| Do you feel that your understanding of the operation of the mill has improved? | | | | | |
| Did you find the working task motivating? | | | | | |

Further comments: