



IO2-A1: 3D TECHNOLOGIES COMPETENCE FRAMEWORK



3D2ACT

3D2ACT:

FOSTERING INDUSTRY 4.0 AND 3D TECHNOLOGIES
THROUGH SOCIAL ENTREPRENEURSHIP: AN INNOVATIVE
PROGRAMME FOR A SUSTAINABLE FUTURE

Author (s): UNIVERSITY OF CRETE & A & A EMPHASYS INTERACTIVE SOLUTIONS Ltd

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3D TECHNOLOGIES COMPETENCE FRAMEWORK

PROJECT INFORMATION

PROJECT ACRONYM:

3D2ACT

PROJECT TITLE:

FOSTERING INDUSTRY 4.0 AND 3D TECHNOLOGIES THROUGH SOCIAL
ENTREPRENEURSHIP: AN INNOVATIVE PROGRAMME FOR A SUSTAINABLE FUTURE

PROJECT NUMBER:

2020-1-EL01-KA202-078957

WEBSITE:

<https://3d2act.eu/>

CONSORTIUM: PARTNER LIST

- **NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS" (GREECE)**
- **EUROPEAN DIGITAL LEARNING NETWORK (Italy)**
- **POLITEKNIKA IKASTEGIA TXORIERRI S.COOP (Spain)**
- **A & A EMPHASYS INTERACTIVE SOLUTIONS Ltd (Cyprus)**
- **STICHTING INCUBATOR (Netherlands)**
- **REGIONAL DIRECTORATE EDUCATION OF CRETE (Greece)**
- **UNIVERSITY OF CRETE (Greece)**



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1 INTRODUCTION

The following Competence Framework regarding 3D Technologies (Design, Modelling and Printing) is basically the Syllabus of the 3D2ACT Project.

It is divided into three (3) distinct levels, each of which comprises three (3) chapters. There is also a final chapter related to troubleshooting issues and how to solve them.

The following sections, present the levels and chapters in detail together with their durations for both VET teachers and students.

Finally, the Competence Framework (Syllabus) is presented analytically per level and chapter, analysing the following:

- Topic/Purpose
- Goals/Objectives
- Duration (Teacher/Student)
- Pre-requisites
- Expected outcomes (general and 3D technologies related)
- Knowledge & skills acquired
- Soft skills acquired
- Associated badge



2 LEVELS AND TOPICS OVERVIEW

Level 1: 3D-P-Beginner (Novice Level: Basic Competences)

Chapter 1.1: Introduction to 3D Printing

Chapter 1.2: Designing and acquiring 3D Models

Chapter 1.3: 3D Printer basics and preparation for the first print

Level 2: 3D-P-Competent (Intermediate Level: Mastering the Basics and Beyond)

Chapter 2.1: Creating 3D Designs with CAD Software

Chapter 2.2: Slicing Software in depth tutorial

Chapter 2.3: Hands-on training: customizing and printing simple designs

Level 3: 3D-P-Proficient (Advanced Level: Specialized Competences)

Chapter 3.1: Advanced 3D design topics

Chapter 3.2: Post-processing 3D prints

Chapter 3.3: Working with other materials

Cross level material

Chapter 4.1: 3D Printing Troubleshooting Guide
(Common problems and how to avoid or solve them)

3 LEARNING ACTIVITIES DURATION

As described in the proposal, approximately **50 hours** will be dedicated on blended learning activities (face-to-face or online depending on the Level) including VET trainers in-service training (IO5-A2).

The consortium agreed on the following division:

- 45 hours for IO2 learning activities
- 5 hours for IO3 learning activities

More specifically, IO2 learning activities and their duration are described in the following table:

Lesson plans	Duration (teaching hours)	Notes
Chapter 1.1: Introduction to 3D Printing	3/2	Teacher/Student approx. 3:2 ratio
Chapter 1.2: Getting 3D Models	4/3	
Chapter 1.3: 3D Printer basics and preparation for the first print	4/3	
Chapter 2.1: Creating 3D Designs with CAD Software	6/5	
Chapter 2.2: Slicing Software in depth tutorial	2/1	
Chapter 2.3: Hands-on training: customizing and printing simple designs	6/5	
Chapter 3.1: Advanced 3D design topics	2	Possibly online
Chapter 3.2: Post-processing 3D prints	1	Possibly online
Chapter 3.3: Working with other materials	2	Possibly online
Chapter 4.1: 3D Printing Troubleshooting Guide	1-2	Possibly online
Total	25/19 = 44 + 6-7 possibly online	

4 CHAPTER DESCRIPTIONS


Chapter overview	
Chapter ID	1.1: Introduction to 3D Printing
Level	Level 1: 3D-P-Beginner (Novice Level: Basic Competences)
Topic/Purpose	Introduction to the world of 3D Printing and its' applications. Why learn about 3D Printing
Goals/Objectives	Learn about the basic concepts of 3D Printing, the different 3D printer types and materials, and 3D printing limitations. Environmental and practical aspects of decentralize manufacturing. Example applications of 3D printing in Industry and in other sectors.
Duration (Teacher/Student)	3/2 hours
Pre-requisites	<p>Knowledge: None</p> <p>Software: None</p> <p>Equipment: None</p> <p>Consumables: None</p>
Expected outcomes (general and 3D technologies related)	At the end of this chapter, students must be able to: <ul style="list-style-type: none"> • Identify the different types and methods of 3D printing • Understanding of the basic scientific principles behind 3D printing • Recognize the basic components and functionality of a 3D printer • Realize the potential impact of 3D-P and the possibilities for entrepreneurship and career opportunities from the acquisition of related skills.
Knowledge & skills acquired	<ul style="list-style-type: none"> • Basic principles of (FDM) 3D printing • Benefits, challenges and advantages/disadvantages of 3D-P • 3D-P pipeline, software and additional equipment needed to generate a 3D printed product
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Divergent thinking • Communication (both listening and speaking skills) • Organizational skills • Critical thinking • Flexibility/Adaptability • Situational awareness



	<ul style="list-style-type: none"> • Focus on a specific task • Goal setting
Associated badge	

Chapter overview	
Chapter ID	1.2: Designing and acquiring 3D Models
Level	Level 1: 3D-P-Beginner (Novice Level: Basic Competences)
Topic/Purpose	Different ways of acquiring or creating 3D models for 3D-P
Goals/Objectives	Common functionality of a 3D design software (CAD software), 3D modelling principles and design considerations for 3D-P. Introduction to 3D Scanning (how it works, scanning considerations and applications). 3D models discovery and retrieval (e.g. free online repositories like Thingiverse and Thangs3D), support communities and forums, and other useful resources (e.g. online tutorials, YouTube channels etc.)
Duration (Teacher/Student)	4/3 hours
Pre-requisites	<p>Knowledge: Chapter 1.1</p> <p>Software: Free account to the online CAD software TinkerCAD</p> <p>Equipment: PC with Internet connection, [optional: caliper or other measuring tool]</p> <p>Consumables: None</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Follow and complete the tutorial using 1-2 practical examples/exercises • Produce 1-2 simple (generic) 3D models as practical example/tutorial. • Use applications/tools to design models for 3D printing and make their own creations • Learn to use the online CAD software TinkerCAD




	<ul style="list-style-type: none"> • Understand the principles of photogrammetry and 3D model scanning
Knowledge & skills acquired	<ul style="list-style-type: none"> • Basics of modeling/navigating in TinkerCAD and creation of 3D models using simple geometrical shapes • 3D models acquisition from (free) online repositories • Ability to import, modify and customize existing 3D models using TinkerCAD and export .stl files to be used in a slicer software
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Problem solving • Information discovery and retrieval • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Goal setting • Patience
Associated badge	

Chapter overview	
Chapter ID	1.3: 3D Printer basics and preparation for the first print
Level	Level 1: 3D-P-Beginner (Novice Level: Basic Competences)
Topic/Purpose	How to prepare a 3D model for printing and how to successfully print your first model.




Goals/Objectives	What is the purpose of a Slicing Software and what is GCode. Slicing Software (Cura) quick start guide. How to operate a 3D printer and complete a first print (e.g. “whistle” model).
Duration (Teacher/Student)	4/3 hours
Pre-requisites	<p>Knowledge: Chapter 1.1, 1.2</p> <p>Software: Slicer software (Cura)</p> <p>Equipment: PC, 3D printer</p> <p>Consumables: PLA filament (~10m/50gr)</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Use the open source slicer software Cura to correctly orient a model, identify overhangs and enable support structures, set the printing resolution and infill options • Generate .gcode files • Perform bed leveling (manual/automatic) • Learn about print bed adhesion and the different kinds of printing surfaces • Understand print speed limitations of FDM printers and operational temperatures • Identify simple printing problems and search for possible solutions
Knowledge & skills acquired	<ul style="list-style-type: none"> • Slicer software usage and necessary settings. • Operational principles of a 3D printer • 3D printer calibration • Basic troubleshooting
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task




	<ul style="list-style-type: none"> • Time management • Goal setting • Patience
<p>Associated badge</p>	

Chapter overview	
Chapter ID	2.1: Creating 3D Designs with CAD Software
Level	Level 2: 3D-P-Competent (Intermediate Level: Mastering the Basics and Beyond)
Topic/Purpose	Tinkercad tutorial and practical exercises in using CAD Software.
Goals/Objectives	Produce 2 functional/practical 3D models (that can be used in real life) using the provided worksheets e.g. spinner, balloon car
Duration (Teacher/Student)	6/5 hours
Pre-requisites	<p>Knowledge: Chapter 1.2</p> <p>Software: CAD software (TinkerCAD)</p> <p>Equipment: PC, [optional: caliper or other measuring tool]</p> <p>Consumables: None</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Place a shape to add or remove material • Move, rotate, and adjust shapes freely in space • Group together a set of shapes to create complex models • Produce a 3D model from a 2D design
Knowledge & skills acquired	<ul style="list-style-type: none"> • Adequate familiarity with TinkerCAD • 3D design choices and their implementation • Experimentation, solutions' generation, and problem solving • Ability to export 3D model files from TinkerCAD
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability

	<ul style="list-style-type: none"> • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting • Patience
Associated badge	

Chapter overview	
Chapter ID	2.2: Slicing Software in depth tutorial
Level	Level 2: 3D-P-Competent (Intermediate Level: Mastering the Basics and Beyond)
Topic/Purpose	Full operating knowledge of Cura and slicer software in general. How different settings affect a print job.
Goals/Objectives	Overview and walkthrough of the most important Cura advanced settings. How to modify a print job with Cura plugins and starting/ending G-code. The importance of preview and layer inspection.
Duration (Teacher/Student)	2/1 hours
Pre-requisites	<p>Knowledge: Chapter 1.3</p> <p>Software: Slicer software (Cura)</p> <p>Equipment: PC</p> <p>Consumables: None</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Understand when and where to use support material and how to identify critical overhangs • Produce stronger 3D models using different infill types and wall thickness




	<ul style="list-style-type: none"> • Increase the model quality and resolution
Knowledge & skills acquired	<ul style="list-style-type: none"> • Advanced features and settings in Cura • Scaling and re-orientation of a 3D model • How to preview the print layers and identify possible problems • How to modify a print job with Cura plugins • Understanding the tradeoff between detailed prints, stiffness and overall print time
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Communication (both listening and speaking skills) • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting • Patience
Associated badge	

Chapter overview	
Chapter ID	2.3: Hands-on training: customizing and printing simple designs
Level	Level 2: 3D-P-Competent (Intermediate Level: Mastering the Basics and Beyond)



Topic/Purpose	Gain additional design and printing experience by creating custom 3D objects for practical everyday usage.
Goals/Objectives	Produce 2 functional 3D models that require customization and/or special design considerations e.g. plastic bottle watering spout (or funnel or water bowl for pets), fridge magnet
Duration (Teacher/Student)	6/5 hours
Pre-requisites	<p>Knowledge: Chapter 1.2, 1.3, 2.1, 2.2</p> <p>Software: CAD software, Slicer software</p> <p>Equipment: PC, 3D printer, caliper (digital with 2 decimal digits precision) or other measuring tool</p> <p>Consumables: PLA filament (~150m/100gr)</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Experiment with rapid prototyping and testing techniques • Work fluently with 3D design and 3D printing
Knowledge & skills acquired	<ul style="list-style-type: none"> • How to design and measure with precision • Alignment of objects • Assemble sets of parts • Modification of existing 3D models using TinkerCAD
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting



	<ul style="list-style-type: none"> Patience
<p>Associated badge</p>	


Chapter overview	
Chapter ID	3.1: Advanced 3D design topics
Level	Level 3: 3D-P-Proficient (Advanced Level: Specialized Competences)
Topic/Purpose	Using special purpose or more advanced CAD software (like OnShape or Fusion360) for engineering.
Goals/Objectives	Produce 1-2 engineering related 3D models e.g. print-in-place, compliant mechanisms, articulated parts, gears
Duration (Teacher/Student)	2 hours
Pre-requisites	<p>Knowledge: Chapter 1.2, 2.1</p> <p>Software: CAD software (OnShape/Fusion360)</p> <p>Equipment: PC, caliper measuring tool</p> <p>Consumables: None</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Calculate and employ tolerances and offsets • Experiment, generate solutions, and solve problems • Apply STEM principles
Knowledge & skills acquired	<ul style="list-style-type: none"> • Awareness of geometry and geometrical transformations • Alignment of objects • Design and measure with precision • 3D design tips & tricks • Advanced topics regarding mesh repair and mesh editing
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting



	<ul style="list-style-type: none"> • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting • Patience
Associated badge	

Chapter overview	
Chapter ID	3.2: Post-processing 3D prints
Level	Level 3: 3D-P-Proficient (Advanced Level: Specialized Competences)
Topic/Purpose	Employing common post-processing activities like sanding, filling, priming, gluing, painting. Other tasks that need to be applied on a printed part, or techniques used to further enhance an object.
Goals/Objectives	Provide a finishing touch to treat and refine parts produced from a 3D printer.
Duration (Teacher/Student)	1 hour
Pre-requisites	<p>Knowledge: None</p> <p>Software: None</p> <p>Equipment: [optional: multitool, drill, hot-air gun]</p> <p>Consumables: Sand paper, paint, glue, filler/putty</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Assemble multi-part prints • Use nuts/bolts/screws to combine prints



<p>Knowledge & skills acquired</p>	<ul style="list-style-type: none"> • The most common post-processing activities on printed 3D products • Post-processing tasks on a 3D printed part • Modify the G-Code in Cura (Pause at height, Filament change for multi-colored prints, Time Lapses, etc.)
<p>Soft skills acquired</p>	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting • Patience
<p>Associated badge</p>	

<p>Chapter overview</p>	
<p>Chapter ID</p>	<p>3.3: Working with other materials</p>
<p>Level</p>	<p>Level 3: 3D-P-Proficient (Advanced Level: Specialized Competences)</p>
<p>Topic/Purpose</p>	<p>Using different types of materials depending on their properties. Special issues and 3D printer requirements for using flexible materials (e.g. TPU)</p>
<p>Goals/Objectives</p>	<p>Produce at least one 3D model using flexible materials e.g. cell phone case or anti-shock/vibration rubber feet or anti-slip pads or tires for remote controlled car</p>



Duration (Teacher/Student)	2 hours
Pre-requisites	<p>Knowledge: Chapter 1.1, 1.2, 1.3, 2.1, 2.2</p> <p>Software: CAD software, Slicer software</p> <p>Equipment: PC, 3D printer</p> <p>Consumables: TPU (flexible) filament, PLA filament</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Design and print usable 3D models with other kinds of materials, like TPU (flexible) • Understand the changes required to the 3D model, slicer and 3D printer settings in order to print such materials
Knowledge & skills acquired	<ul style="list-style-type: none"> • Necessary changes to the printing process for handling different materials • Different print temperatures, bed adhesion and speed limitations • Troubleshooting
Soft skills acquired	<ul style="list-style-type: none"> • Imagination • Creativity • Resourcefulness • Divergent thinking • Teamwork • Collaboration skills • Communication (both listening and speaking skills) • Coordination • Organizational skills • Problem solving • Decision making • Critical thinking • Flexibility/Adaptability • Experimenting • Improvisation • Situational awareness • Focus on a specific task • Time management • Goal setting • Patience



Associated badge



Chapter overview	
Chapter ID	4.1: 3D Printing Troubleshooting Guide
Level	Level 4: Cross level material
Topic/Purpose	Common 3D printing problems and how to avoid or fix them
Goals/Objectives	Provide a comprehensive list of resources, tools and information about common problems, and how to troubleshoot a failed 3D print or improve print quality
Duration (Teacher/Student)	1-2 hours (available online)
Pre-requisites	<p>Knowledge: Chapter 1.1, 1.2, 1.3</p> <p>Software: Slicer software, [optional: G-code terminal, Pronterface, Octoprint]</p> <p>Equipment: PC, 3D printer and accompanying tools</p> <p>Consumables: PLA filament, cleaning supplies, replacement nozzle, other spare parts</p>
Expected outcomes (general and 3D technologies related)	<p>At the end of this chapter, students must be able to:</p> <ul style="list-style-type: none"> • Inspect 3D printed parts and recognize/distinguish problems • Make corrections, adjustments or upgrades to the 3D printer • Re-slice a failed print • Ways to recycle and re-use failed 3D prints
Knowledge & skills acquired	<ul style="list-style-type: none"> • Identification of printing errors or problems • Necessary actions to fix the most common problems
Soft skills acquired	<ul style="list-style-type: none"> • Resourcefulness • Collaboration skills • Problem solving • Critical thinking • Flexibility/Adaptability • Experimenting • Situational awareness • Focus on a specific task • Patience