C-VET CURRICULUM FOR THE 3DSPEC COURSE

Contents

1. Introduction

The main **objective of the 3DSPEC** project is to develop an on-line, freely available **course on 3D printing** for users who work professionally in one or more of the following areas: **education, design, health care** and **SMEs**. For each of these areas there are **specific needs and expectations** regarding knowledge and skills in 3D printing, which is strictly related with activities done in work practice.

The course is expected:

1. to provide **theoretical content** regarding 3D printing technology,
2. to present **examples** of use of 3D printing in particular professional activities,
3. to give opportunity of **practical use** of the technology.

It will include two **main elements**:

- **training platform**, the content of which will meet the 1st and 2nd requirements indicated above,
- **3D printing** centre along with internet platform for hands-on 3D printing, which meets the 3rd requirement.

To develop a training platform that meets actual needs of future users, a **properly developed curriculum is necessary**. In this document the curriculum will be described and defined.

2. Structure of the 3DSPEC course

The 3DSPEC **course will consist of**:

- modules - they will be the main units in the course
- final exam.

Each **module will include** the following **parts**:

- objectives – a short description regarding knowledge and/or skills to be acquired by a trainee who has completed the module
- topics – to each topic there will be training materials linked
- self-assessment – a task, e.g. a test that enables a trainee to assess how well they assimilated knowledge/skills.

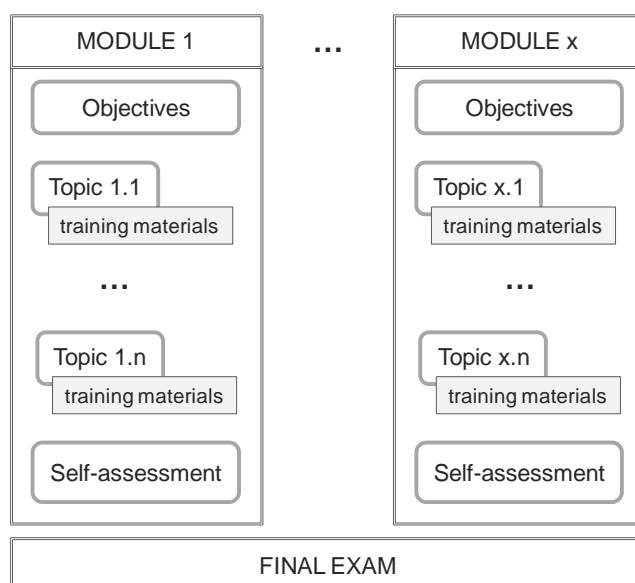Structure of the course is presented in the figure below.

Fig. 2.2-1. Structure of the 3DSPEC course

As it was mentioned before, the course is addressed to trainees who work professionally in at least one of the following areas: education, health care, design and SMEs. To properly meet their needs there will be two types of topics in the course:

- general topics – they will be available for all trainees regardless area of professional activity declared by them
- profiled topics – their content will cover only one area of professional activity, and will be visible and accessible only for trainees who declared given area.

Each type of topic will has individual structure.

General topics will include **theory** and **downloadable materials**.

Profiled topics will include **theory** (optionally – if necessary) and **examples**. All **examples will have the same structure** to make them consistent – see Fig. 2.2-2. The aim of **examples** is to demonstrate how 3D printing can be used in particular professional activities. Each example will be relevantly **entitled**. To give a trainee some introductory information regarding a given example, first a **short description** is shown. Also final result to be achieved is presented in a graphical way – in the section **final object**. Next a **procedure** to follow is presented in a step-by-step mode. To facilitate hands-on carrying out of the procedure, all necessary additional materials should be provided to a trainee – they are included in the section **downloadable materials**. These materials are e.g. stl files, 3D models, source files for 3D printer, photos and other.
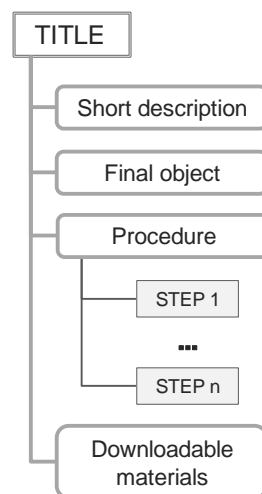

Fig. 2.2-2. Structure of an example in a profiled topic

To correctly understand examples and exercise them some additional knowledge (not included in general topics) might be necessary. In such case relevant **theory** will be added/included in a given profiled topic, which was mentioned earlier.

3. The 3DSPEC course curriculum

The 3DSPEC course will include the following thematic modules:

Module 1. Introduction: general view of the 3D printing technology.
Module 2. Making input file for 3D printer.
Module 3. Materials used in 3D printing
Module 4. Examples of use of 3D printing in activities conducted in your profession
Module 5. Self-designing and assembling of 3D printer.

Each module consists of topics, accessibility of which depends on trainees' professional activities and interest.

There are four main groups of course users – hereinafter called target groups - to which the course is addressed:

- education
- design
- healthcare
- SMEs.

Each trainee will declare belonging to one or more target group. Each topic in a module is assigned to one or more target groups, which assures that all relevant and necessary content will be provided to a trainee. The assignment might be diverse – obligatory or optional. There are general topics which are obligatory for trainees from all target groups and profiled topics which are obligatory for one target group. Regarding profiled topics it is taken into consideration that they might be of interest also for other target groups. So the topics will be optional for these target groups.

Rules regarding availability of topics described above will assure that presenting of content which is beyond interest and needs of a given trainee will be avoided.

Structure of the whole curriculum is presented in the Fig. 3-1. All considerations described above are included. Accessibility of topics for target groups is marked as follows:

- mark "X" - topic obligatory for a given target group
- mark "O" - topic optional for a given target group (their content will not be included in final exam)
- mark "-" - topic not accessible for a given target group (due to its specialized content).

Apart from target groups there is also another group of course users included in the curriculum – trainees who wish to acquire knowledge and skills necessary for building 3D printers on one's own. In the Fig. 4-1 they are represented under „3D Printer Assembly & Development" column. These trainees will be provided with:

- obligatory access to MODUELS 1 to 3 with general topics to acquire:
  o basic knowledge regarding 3D printing technology,
  o knowledge necessary for design of 3D printer components and preparing relevant input files for a 3D printer to print the components
- obligatory access to MODULE 5 content of which is focused on building of 3D printers on one's own
- optional access to selected topics in MODULE 4 – to enhance knowledge regarding design of technical objects, example of which are components of a 3D printer.

Module 5 will be optionally available for all target groups to extend content provided by Modules 1 - 4 by adding issues regarding building 3D printers. This way, trainees from all target groups will have opportunity to acquire ability to build a 3D printer. Surveys carried out to identify needs of potential course users revealed that in all target groups knowledge of practical issues regarding 3D printing is low. Therefore it is justified to assume that after acquiring basic theoretical and practical knowledge regarding preparing and making of 3D printouts, a part of trainees will become interested to gain knowledge and skills in building of 3D printers.

Contents	Target group				3D Printer Assembly & Development
	Education	Design	Healthcare	SMEs	
Module 1. Introduction: General view of the 3D printing technology	X	X	X	X	X
1.1. How the additive technologies work	X	X	X	X	X
1.1.1. 3D printers – overall information about structure and principle of operation.	X	X	X	X	X
1.1.2. 3D printers – properties and usability	X	X	X	X	X
1.1.3. 3D printers – relation between properties and possible applications	X	X	X	X	X
1.2. Possibilities and limitations of application - Main advantages and disadvantages	X	X	X	X	X
1.3. State of the art of the additive technology - available solutions, other methods	X	X	X	X	X
Module 2. Preparing of input file for 3D printer	X	X	X	X	X
2.1. Introduction to 3D modelling	X	X	X	X	X
2.2. Review of software for 3D modelling	X	X	X	X	X
2.2.1. Free software	X	X	X	X	X
2.2.2. Commercial software	X	X	X	X	X
2.2.3. Examples of commonly used software and its application - functionality and application	X	X	X	X	X
2.3. 3D modelling for 3D printing - design recommendations	X	X	X	X	X
2.4 Preparing data from 3D scanning for 3D printing purposes	X	X	X	X	X
2.5. Conversion of patient's body-data into a three - dimensional model	X	X	X	X	X
2.6. Free repositories of 3D models for 3D printing	X	X	X	X	X
2.7. Work in slicer software - transforming of 3D model for a 3D printer	X	X	X	X	X
Module 3. Materials used in 3D printing	X	X	X	X	X
3.1. Description of the most often used materials.	X	X	X	X	X
3.2. Mechanical properties of 3D printed objects	X	X	X	X	X
Module 4. Examples of use of 3D printing in activities conducted in your profession	X	X	X	X	O
4.1. Additive 3D printing applications in the healtcare area	O	O	X	O	-
4.1.1. 3D printouts for informing a patient about their disease, pathological changes of organs, therapy/surgery	-	O	X	O	-
4.1.2. 3D printouts for preparing a patient for surgery	-	-	X	O	-
4.1.3. 3D printouts to help the surgeon in the surgery	-	-	X	O	-
4.1.4. 3D printouts as prototypes of implants (custom made and standard)	-	-	X	O	-
4.2. Additive 3D printing applications in the SMEs area	O	O	O	X	-
4.2.1. Making large-size 3D printouts	O	O	O	X	-
4.2.2. Application of 3D printing in usability tests of new solutions	O	O	O	X	-
4.2.3. 3D printouts for marketing of new solutions	O	O	O	X	-
4.2.4. Development of 3D printed company promotional gadgets and accessories	O	O	O	X	-
4.3. Additive 3D printing applications in the Education area	X	O	O	O	-
4.3.1. 3D printing of teaching aids for improvement of teaching process	X	O	O	O	-
4.3.2. Parametric 3D models for self-adaptation by students	X	O	O	O	-
4.3.3. Curricula of lessons including 3D printouts as part of the teaching process	X	O	O	O	-
4.4. Additive 3D printing applications in the Design area	O	X	O	O	O
4.4.1. Methods for adjustment of 3D models of technical objects for 3D printing	O	X	O	O	O
4.4.2. Fast prototyping for design assessment	O	X	O	O	O
Module 5. Self designing and assembling of 3D printers	O	O	O	O	X
5.1. 3D printers – properties and usability	O	O	O	O	X
5.2. Design of 3D printer - case study 1	O	O	O	O	X
5.3. Design of 3D printer - case study 2	O	O	O	O	X
5.4. Assembly 3D printer - case study	O	O	O	O	X

Fig. 3-1. Structure of 3DSPEC course curriculum

Detailed description of the course modules is below.

Module 1. Introduction: General view of the 3D printing technology.

Objectives

In this module a trainee will be provided with structured knowledge that describes the basics of 3D printing technology, will become aware of how the whole process works, and will learn the advantages and disadvantages of different solutions.

Topics

- How the additive technologies work
    - 3D printers – overall information about structure and principle of operation.
    - 3D printers – properties and usability
    - 3D printers – relation between properties and possible applications
- Possibilities and limitations of application - main advantages and disadvantages
- State of the art of the additive technology – available solutions, other methods

Module 2. Preparing of input file for 3D printer.

Objectives

In this part of the course a trainee will learn how to prepare an input file for a 3D printer. Different ways of preparing a computer 3D model of an object are presented. Also examples how to adjust models obtained e.g. from 3D scanning process to make 3D printouts. Work in specialist software dedicated for preparing input files for 3D printers (files in GCODE format) will be described.

Topics

- Introduction to 3D modelling
- Review of software for 3D modelling
    - Free Software
    - Commercial Software
    - Examples of commonly used software and its application – functionality and application
- 3D modelling for 3D printing - design recommendations
- Preparing data from 3D scanning for 3D printing purposes
- Conversion of patient's body-data into a three - dimensional model
- Free repositories of 3D models for 3D printing
- Work in slicer software - transforming of 3D model for a 3D printer

Module 3. Materials used in 3D printing.

Objectives

Use of proper material for 3D printing is very important in terms of future use of a 3D printed object. In this module physical properties of most often used materials will be presented. Results of research that characterize the strength properties of 3D printouts will be also shown.

Topics

- Description of the most often used materials.
- Mechanical properties of 3D printed objects

Module 4. Examples of use of 3D printing in activities conducted in your profession

Objectives

Examples of application of 3D printing in a trainee's area/s of operation and relevant theory (if necessary) is presented in the module. Procedures to be followed to produce a given, sample 3D printout are presented. In each topic a trainee gains access to downloadable additional materials – 3D models of an object.

Topics

- Additive 3D printing applications in the healtcare area
  - o 3D printouts for informing a patient about their disease, pathological changes of organs, therapy/surgery
  - o 3D printouts for preparing a patient for surgery
  - o 3D printouts to help the surgeon in the surgery
  - o 3D printouts as prototypes of implants (custom made and standard)
- Additive 3D printing applications in the SMEs area
  - o Making large-size 3D printouts
  - o Application of 3D printing in usability tests of new solutions
  - o 3D printouts for marketing of new solutions
  - o Development of 3D printed company promotional gadgets and accessories
- Additive 3D printing applications in the Education area
  - o 3D printing of teaching aids for improvement of teaching process
  - o Parametric 3D models for self-adaptation by students
  - o Curricula of lessons including 3D printouts as part of the teaching process
- Additive 3D printing applications in the Design area
  - o Methods for adjustment of 3D models of technical objects for 3D printing
  - o Fast prototyping for design assessment

Module 5: Self designing and assembling of 3D printers.

Objectives

After description of 3D printers in terms of their features and possible use, two modes of building a 3D printer are presented. First is a detailed description of use of a 3D printer kit (components ready for assembling). The second is description how to build on one's own a 3D printer which meets required technical properties and within a set budget.

Topics

- 3D printers – properties and usability
- Design of 3D printer - case study
- Assembly 3D printer – case study.