Professional Qualification: MANAGEMENT AND SUPERVISION OF DESIGNING SYSTEM OF 3D MODELS, IN PROFESSIONAL ENVIRONMENTS.

Related professional groups: (Electricity-Electronics, Computing, Mechanical manufacturing)
Level 3
ESDEI3D Code_1
Version 1
Situation: Review

General Competence
Carry out the processes of Management and Supervision of Designing Systems, monitoring the obtained 3D models, with quality, safety and respect to environment criteria

Units of competence
UC0001_3: Design and repair 3D models meshes through fast prototyping.
UC0002_3: Elaborate the technical documents of 3D designing models.

Professional Environment

Professional field
Its activity deals with the designing and supervision of fast prototyping 3D models as well as with the elaboration of the appropriate technical documents.

Productive sectors
This qualification is located in the subsector related to designing and development of 3D models, placed in industrial, architectonical, civil engineering, clinical, food and agriculture, artistic, educative, sports, domestic and other scientific-technological sectors.
Machinery construction, mechanical equipment and industrial products in the different production sectors.

Employment and relevant job positions
3D models designer.
Researcher of mechanical topology of 3D models.
Technical consultant in 3D designs.
Assistant for technical documents in 3D designs Projects.
Related Education (... h)

Formative Modules
MF0001_3: Designing of 3D models (... h)
MF0002_3: Technical documents in 3D design (... h)

UNIT OF COMPETENCE 1: Design and repair 3D models meshes through fast prototyping

Level 3
Code UC0001_3

Professional achievements and carrying out criteria

RP 1: Define fast prototyping 3D models, providing constructive solutions and stating specifications, characteristics, materials and costs, complying the regulations for occupational hazards prevention as well as environmental protection rules.

CR1.1 3D models are designed considering the features, limitations of the processes, means used to obtain results and criteria to optimize their output and economy of the post process of the prototypes.
CR1.2 3D models definitions will be determined taking into account the amount of material used, the needed supports, their functionality, and the costs for their manufacture.
CR1.3 The base materials, for the design of these 3D products, are chosen guaranteeing their resistance, terminations, costs and established quality.
CR1.4 The parameters for 3D printing equipment's must be linked to the prototypes of the designs according to their technical specifications.
CR1.5 The design of the 3D models are corrected considering the results of the tests, simulations, experimentations and post processing of the prototypes.
CR1.6 The features of the final product will be decided regarding its specifications and, in particular, its official approval.

RP2: Measure the elements designed in 3D from the established data and according to the results obtained from the required technical calculations.

CR2.1 The requirements of effort or load are determined analyzing the phenomenon that cause them.
CR2.2 The resistance of the product to torsion, flexion, shear, compression, break, among others, is established dealing with the requirements the product is subjected to.
CR2.3 The safety coefficient (break, life, among others) applied to the calculation of the elements are decided due to the technical specifications.
CR2.4 The shape and dimension of the designed elements are set depending on the results of the calculus.

RP3: Establish the verification and assurance procedure of the quality of the design of the product, guaranteeing its reliability, the fulfilling of the technical specifications and the applicable regulations for occupational hazards prevention as well as environmental protection rules.

CR3.1 The verification and assurance procedure of the quality of the product is determined focusing on the aspects dealing with quality of the product, specific regulations, functionality, safety and occupational hazards prevention, costs, tools, manufacturing viability, human resources and available material, as well as design and updating of AMFE, rules and quality management systems and CE regulations.
CR3.2 The types of tests and analysis (breaking resistance, fatigue, among others) are established knowing the degree of compliance of the product regarding to the applicable regulation or to the demand of the customers.
CR3.3 The testing or essay parameters are decided in relation to the services conditions (life, environmental, among others) which the product must bear.
CR3.4 The limit of the designs and meshes is compared with the technical features or with the representations of the product as a whole, checking the 3D printing process the component must be complied with have been taken into account.
CR3.5 The production of the prototype is supervised to verify the feasibility of the manufacture and to propose changes in the design.

Professional context

Means of production

Specific computer assisted 3D design, CAD applications.
Specific computer applications for calculus and simulation of mechanisms and tests of the 3D models physical properties.

Product and results

Constructive solutions for products obtained by 3D printing (industrial, architectonical, civil engineering, clinical, food and agriculture, artistic, educative, sports, domestic, other scientific-technological sectors elements, among others). Lists of materials. Guidelines for control.

Product manufacturing viability reports. Verification procedure.

Used or generated information

Digital files of elements or 3D sets that form the 3D printing draft blueprint. Technical specifications. Design manual.

Technical documents of standard components. Commercial catalogues. AMFE of the product and the design. 3D printing procedures. Homologations specifications. Regulations for occupational hazards prevention as well as environmental protection rules.

UNIT OF COMPETENCE 2: Elaborate the technical documents for the 3D design models.

Level 3
Code UC0002_3

RP1: Obtain the digital maps of the product designed in 3D, from the files of the elements or sets, taking into account the 3D printing process and respecting the applicable regulations for occupational hazards prevention as well as environmental protection rules.

CR1.1 The designed product is defined guaranteeing its printing, maintenance, assembly and dismantling (easiness, accessibility, and use of standardized tools, among others).
CR1.2 The designs are made in any kind of file that permits import its meshes to 3D printing models in order to accomplish the drawing rules (blueprint drafts, drawing lines, dimension, tolerances, views, sections, tooling symbology, among others)
CR1.3 The adjustments and tolerances are established according to the function of the different parts and to the type of the expected manufacture.
CR1.4 The element will be defined allowing its safety printing and handling, determining the maximum dimensions of printing, among others.

RP2: Definition of 3D printing operative parameters depending on the equipment and the materials used in the process.

CR2.1 The documents are made implementing the characteristics and variable parameters of the printing equipments (Parameters tables and features of the equipments according to the manufacturer, among others).

RP3: Elaborate the technical dossier of the Printing product, gathering instructions for use, assembly drawings, outlines, list of spare parts, among others.

CR3.1 The documents dealing with the product (reports, list of spare parts, manual, outlines, overall drawings, manufacturing drawings, installation drawings, among others) are organised and completed guaranteeing the disponibility of the information.
CR3.2 The technical reports dealing with the feasibility of the design of the product are written adding the modifications occurred during the process.
CR3.3 The conclusions achieved during the steps of the design, process automatization, manufacture of the prototype and tests are gathered in the reports, easying later designs.

RP4: Keep up-to-date and organised the technical documents needed for the development of the 3D design final product.

CR4.1 The designs are revised and updated complying the established guidelines needed for the impletion of amendments in the final product.
CR4.2 The technical dossier is updated and ordered addind systematically the amendments, assuring its force.
CR4.3 The technical documents are classified according to the established rules allowing its easy location and access.
CR4.4 The guidelines for the revision and updating of the designs and documentation are set describing the impletion of amendments, responsibility and management, among others.

Professional context

Means of production

Specific computer assisted 3D design applications, (CAD) and specific computer applications in the Office environment.

Products and results

Sets of designs and 3D products sawing. List of materials. Technical dossier and technical reports and users manuals.

Used or generated information

Drawing rules. Technical documentation of standard components. Design of draft parts. Technical specifications. Design manual. Commercial catalogues. Design and product AMFE.

Procedures and printing techniques. Outlines and sketches. Applicable regulations for occupational hazards prevention as well as environmental protection rules.

FORMATIVE MODULE 1: Design of 3D models.

Level 3
Code: MF0001_3
Associated to UC: Design and repair 3D models meshes through fast prototyping.
Duration: hours

Capacities and evaluation criteria

C1: Design sets and 3D elements through fast prototyping, on the basis of the required specifications and requests of drafts phases.

CE1.1 Relate the different printing techniques to the shapes and qualities that ca be obtained.
CE1.2 Identify and determine the parameters to consider in the different 3D printing procedures.
CE1.3 Describe the limitations of the different techniques and 3D printing procedures.
CE1.4 Relate the different prototypes to build with the different 3D printing equipments.
CE1.5 Select the best type of material according to the required different specifications and requests.
CE1.6 3D design software, types, scad source files, stl 3D type dimensional files and gcode file generation, through laminators.
CE1.7 3D design, by additive manufacturing, through the use of topological optimization.
CE1.8 A practical example in which 3D printing parts has to be designed and with the required specifications information, must:

- Identify the technical specifications to guarantee the building of the prototype.
- Propose various constructive solutions for the parts that have to be designed, depending on the different demands, taking into account the limits of the 3D printing process.
- Size the different 3D prototypes, applying calculations, rules, tables, considering the safety coefficients of the design.
- Determine the necessary information for the calculus and simulation of specific computer applications and interpret the results.
- Represent in an outline the stress the different 3D prototypes undergo.

C2: Determine the adjustments, geometrical and dimensional tolerances and superficial qualities, linking the different 3D parts to their functioning.

CE 2.1 Relate the adjustments-types to the various demands of the 3D printing parts in accordance with the stresses they are subjected to.
CE 2.2 Calculate the tolerance fields for the adjustments, according to rules, from the nominal dimension and specific tolerance.
CE 2.3 Evaluate the choice of the kind of adjustment and its effect regarding the manufacturing cost, based on the printing process.
CE 2.4 Relate the geometrical tolerances to the required accuracy in the different 3D prototypes.
CE 2.5 Represent, through standardized symbology, different types of adjustments and geometrical tolerances

C3: Analyse the impact of the different materials used in the 3D parts prototyping, in order to determine the specifications of their design and finish.

CE 3.1 Describe the different behaviours of the 3D prototypes according to the materials used in their design.
CE 3.2 Identify the materials to be used in the 3D printing as well as in the finish treatments, which improve the behavoiour and look of the designed items.

C4: Verify and guarantee the quality of the design of the 3D printing prototypes.

CE 4.1 Describe the procedure of assurance of the quality in the design.
CE 4.2 Describe the AMFE design technique.
CE 4.3 Describe the standards and quality management systems from the point of view of the Product Design Process.
CE 4.4 Describe the CE regulation for 3D printed products.

Capacities whose adquisition must be completed in a real working environment

C1, C2 y C3

Other capacities:

Be responsible for the job he/she is carrying out and for the fulfillment of objectives.
Demonstrate creativity in the development of the job which is being delivered.
Propose alternatives with the aim of improve the results.
End the work attending to suitability, quickness, economy, and effectiveness criteria.
Demonstrate certain grade of autonomy in the resolution of contingencies related to his/her activity.
Learn new concepts or procedures and make effective use of the training using the acquired knowledge.

Contents:

1. - CNC introduction. Numerical Control Machines.

- **1.1. -** Components and Architecture.
- **1.2. -** Classification.
- **1.3. -** Operating Principle.
- **1.4. -** CAD / CAM system (Computer assisted Design and Manufacture).

2. - 3D Printers:

- **2.1. - 3D Printing Technologies: (Printing by addition).**
- **2.2. - Evolution and type of 3D Printers.**
- **2.3. - 3D Printers applications: Application Areas:**
- **2.4. - 3D printing Process and Steps.** STL attainment:
  - **2.4.1. -** 3D Design.
  - **2.4.2. -** Design Shceduled 3D design. SCAD**.**
  - **2.4.3. -** 3D scanning.
  - **2.4.4. -** From STL to G-Code. Mills.
  - **2.4.5. -** G-Code 3D printing.
- **2.5. - STL fixing.**
  - **2.5.1. -** Introduction to repair of meshes.
  - **2.5.2. -** Netfabb basic.
  - **2.5.3. -** MeshMixer.
  - **2.5.4. -**3D models design advices.

3. - Software of 3D Modules Designs.

- **3.1. -** CAD: Software Actual Design.
  - **3.1.1. -** Openscad. Parts design, through programming; parameterable Designs. Source files. *.scad
  - **3.1.2. -** Freecad.
  - **3.1.3. -** Tinkercad.
  - **3.1.4. -** Google Sketchup.
  - **3.1.5.-**Autodesk applications: 123D Design; 123D Make**;** ThingMaker (TinkerPlay).
  - **3.1.6. -** Others: IntelliCAD, LibreCAD, DraftSight, Blender, 3Dtin, etc.
- **3.2. -** Other applications of 3D design: Autodesk, SolidWorks, Sketchup, etc.
- **3.3. -** 3D Graphic files standards: *.SCAD**;** *.STL: Standard Tessellation Language. (Standard Patchwork language)**; ***.AMF: Additive Manufacturing Format.
- **3.4. -** Software of topological optimization of the complex parts of 3D models, through the improvement of the design according to its physical properties, lightening the final product.

4. - Geometry and 3D settings:

- **4.1. -** Geometric and Dimensional regulation; Settings and tolerances
- **4.2. -** Dimensional accuracy in 3D printing:
  - **4.2.1. -** 3D printer resolution. (Layer thickness). (ppp)
  - **4.2.2. -** Printing tolerance.

5. - 3D Printing Materials:

5.1. - Materials: characteristics and typology.

5.1.1. - Suitability and selection of the type of material according to its design.

6. - Verification and Quality of 3D products:

6.1. - Considerations to be taken into account:

6.1.1. - Cost of the printer.

6.1.2. - Cost of the printing materials. Price per Kg.

6.1.3. - Printing Speed.

6.1.4. - Cost of the printed prototype.

6.1.5. - Colour printing.

6.1.6. - Post-printing work.

6.1.6.1. - Support material removal.

6.1.6.2. - Hardening of materials with waxes and with thermoplastic polymers.

6.1.6.3. - In ABS, use of acetone.

6.1.6.4. - Sanding, Polishing by abrasion (Bronze), varnish (wood), etc.

6.2. - Endings.

6.3. - Additives.

6.4. - Other physicochemical characteristics: Hardness, Flexibility, Resistance, Opacity, Transparency, Rigidity, high temperature, de colours. Etc.

7. - Applicable regulations for occupational hazards prevention as well as environmental protection rules.

7.1. - Applicable regulations for occupational hazards dealing with the products design.

7.2. - Applicable regulations for environmental protection rules dealing with the products design.

Parameters of training context

Areas and facilities

The areas and facilities will respond, in the form of a classroom, classroom workshop, training workshop, laboratory or similar area, to the formative needs, according to the Professional Context detailed in the associated Unit of Competence, taking into account the applicable regulation of the productive sector, hazards prevention, occupational health, universal accessibility and environmental protection.

Professional profile of the trainer:

1. Command of the knowledge and techniques dealing with the design of 3D printed products, which will be certified by one of these two ways:

- Level 3 academic education, Technical Engineering, higher studies in Design, or others of a higher level related to the professional field.
- Minimum 3 years professional experience in the area of the competences of this formative module.

2. Pedagogical Competence in accordance with what the competent Administrations establishes.

FORMATIVE MODULE 2: Technical documentation in 3D design

Level 3
Code: MF0002_3
Linked to UC: Elaborate the technical documentation of the 3D Design Models.
Duration: hours

Capacities and evaluation criteria

C1: Design in the appropiate format with IT mediums the 3D sets and parts, gathering the necessary technical information for its later printing.

CE 1.1 Choose the graphic design system for each of the sets or parts.
CE 1.2 Represent according to the applicable regulation, the elevations, units, sections and details, that take part in the graphic information the plans contain.
CE 1.3 Limit the dimensions of the designed parts depending on their procurement process and applying the proper regulation.
CE 1.4 Specify in the designs the technological data of the sets or developed parts (materials, standard components, superficial qualities, applicable rules, among others).

C2: Elaborate the technical dossier of the design of 3D prototypes.

CE 2.1 Elaborate the instructions and manuals needed for the use and maintenance of the printed product.
CE 2.2 Elaborate the dossier of the project incorporating the files, memories, plans, outlines, installation drawings, maintenance instructions, among others.
CE 2.3 Describe the updating procedures of the graphic information of the project, as well as the document management.

Capacities whose adquisition must be completed in a real working environment

C1 complete.

Other capacities:

Be responsible for the job he/she is carrying out and for the fulfillment of objectives.
Demonstrate certain grade of autonomy in the resolution of contingencies related to his/her activity.
Propose alternatives with the aim of improve the results.
Prove being flexible to understand changes.
Ability to adapt to new situations or contexts.
Learn new concepts or procedures and make effective use of the training using the acquired knowledge.

Contents:

1. - Representation of 3D prototyping parts.

- **1.1. -** Graphic representation regulations.
- **1.2. -** Sights, cuts and sections.
- **1.3. -** Limits according to the manufacturing process.
- **1.4. -** Surface state.
- **1.5. -** Dimensional tolerances.
- **1.6. -** Form and position tolerances.
- **1.7. -** Sketching.
- **1.8. -** Sets.
- **1.9. -** Standardization.
- **1.10. -** Representation of standard components.

2. - General representation system

- **2.1. -** Representation perspective.

3. - Office automation

3.1. - Word processor.
3.2. - Publishers.
3.3. - Databases.
3.4. - Spreadsheets.
3.5. - Presentations.

4. - Document management

4.1. - Organization of the information dealing with the projects management.
4.2. - Procedure of updating of documents.

5. - Plans computer-aided design

5.1. - Specific computer applications of 2D and 3D design.

Context parameter of the training

Areas and facilities

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2. Pedagogical Competence in accordance with what the competent Administrations establishes.