DRIVES

Development and Research on Innovative Vocational Education Skills

Automotive Engineering CAD, CAE, CAM

Job Role Skill Set

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www.project-drives.eu

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INTRODUCTION

1.1 OBJECTIVE

The objective of this deliverable is to provide an introduction to described Job Role within the applied skills definition model.

1.2 PURPOSE OF THE DELIVERABLE

The purpose of this deliverable is to define skills definitions of the Automotive Engineering CAD, CAE, CAM job role within the ECQA skills definition model.

1.3 SCOPE OF THE DELIVERABLE

The deliverable contains

- Description of the content of the Job Role
- Description of used Skill Sets and skills definitions, coverage of Qualification Schemas

The deliverable does not cover:

- Course development, as this will be done after the skill definitions clearly outlined the set of required courses.

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2 ECQA SKILLS DEFINITION MODEL

A skills definition contains the following items (see Fig.1):

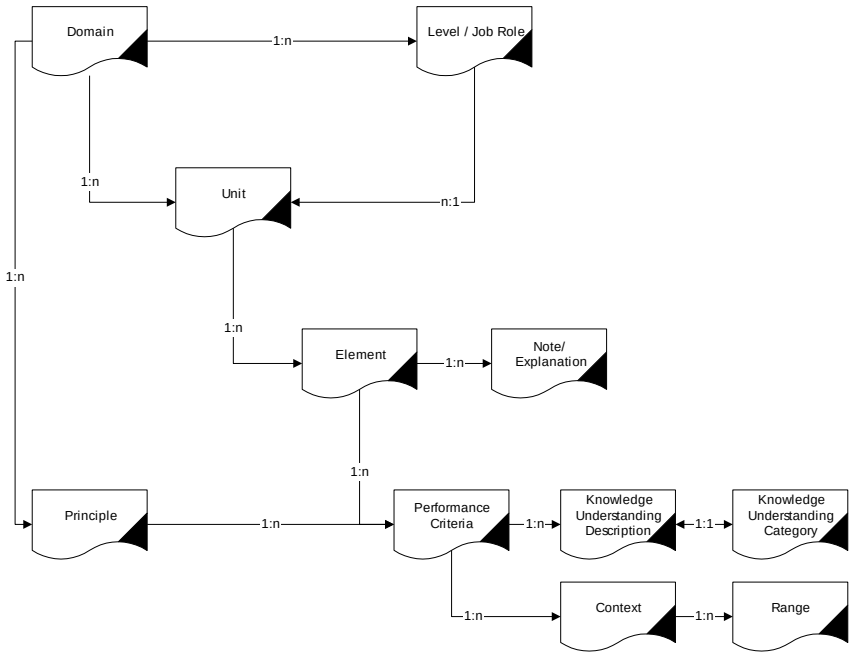

Figure 1 The Skill Definition Model (1:n = one to many relationship)

Context: A category of ranges; it represents some terminology used in a performance criterion that consists of different context, conditions or circumstances. A participant must be able to prove competence in all the different circumstances covered by the context.

Domain: An occupational category, e.g. childcare, first level management or software engineering.

Element: Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.

Evidence: Proof of competence.

Knowledge and understanding category: A category of knowledge and understanding descriptions.

Knowledge and understanding description: A description of certain knowledge and understanding. To be judged competent in a unit a participant must prove to have and to be able to apply all the knowledge and understanding attached to it.

NVQ (UK based): The National Vocational Qualification standard of England, Wales and N. Ireland.

Performance criterion: Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent. A performance criterion may have relevant contexts.

Principle: A statement of good intentions; it underpins all competent domain practice.

Range: Description of a specific circumstance and condition of a performance criterion statement.

Qualification: The requirements for an individual to enter, or progress within a certain occupation.

Job Role: A certain profession that covers part of the domain knowledge. E.g. domain = Functional Safety, job role = Functional Safety Manager.

Unit: A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the UK qualification standard hierarchy and each unit consists of a number of elements.

The rationales for developing the ECQA skills definition model is based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they started employing skill cards [1], [2].

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). Further description and rationales are attached in annexes of this document. The ECQA structure was mapped in DRIVES project to DRIVES Reference and Recognition Framework with the links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

3 SKILLS DEFINITION FOR THE JOB ROLE "AUTOMOTIVE ENGINEER (CAD, CAE, CAM)"

3.1 THE SKILLS HIERARCHY

Using the terminology outlined in the skills definition model and including the skills identified during the demand analysis at the beginning of the project, the following skills hierarchy for the job role "Automotive Engineer CAD CAE CAM " has been designed.

Unit ID	Unit Name	Element ID	Element Name
AECAD_CAE_CAM.U1	UNDERPINNING KNOWLEDGE	AECAD_CAE_CAM.U1.E1	Advanced Processing Technologies
		AECAD_CAE_CAM.U1.E2	Materials Technology
AECAD_CAE_CAM.U2	CAD DESIGN	AECAD_CAE_CAM.U2.E1	Catia V5
		AECAD_CAE_CAM.U2.E2	Unigraphics NX
		AECAD_CAE_CAM.U2.E3	Catia V5 Advanced
		AECAD_CAE_CAM.U2.E4	Unigraphics Nx Advanced
AECAD_CAE_CAM.U3	4.0 TECHNOLOGIES	AECAD_CAE_CAM.U3.E1	Additive Manufacturing
		AECAD_CAE_CAM.U3.E2	Augmented Reality
AECAD_CAE_CAM.U4	PRESS ADVANCED	AECAD_CAE_CAM.U4.E1	Materials Resistance
		AECAD_CAE_CAM.U4.E2	Ls Dyna
		AECAD_CAE_CAM.U4.E3	Abaqus
		AECAD_CAE_CAM.U4.E4	The Basis Of Experimental Research
AECAD_CAE_CAM.U5	PROCESSES & MANUFACTURING	AECAD_CAE_CAM.U5.E1	Modelling & Simulation Of Processes
		AECAD_CAE_CAM.U5.E2	Assisted Manufacturing. CAM, CNC
		AECAD_CAE_CAM.U5.E3	Process Management
AECAD_CAE_CAM.U6	PROJECT MANAGEMENT	AECAD_CAE_CAM.U6.E1	Modelling & Simulation Of Processes
		AECAD_CAE_CAM.U6.E2	Tolerances
		AECAD_CAE_CAM.U6.E3	3D Scanning & Reverse Engineering

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		AECAD_CAE_CAM.U6.E4	Project management

Figure 2 The Skills Set for Automotive Engineer CAD CAE CAM

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE FUNCTIONAL AUTOMOTIVE ENGINEERING (CAD, CAE, CAM)

Domain Acronym: Engineering

Domain title: Automotive Engineering CAD, CAE, CAM Skills Award

Domain Description:

The training project presented here aims to equip students and future workers with the knowledge required to meet the new challenges of CAD, CAE, CAM technologies that in the coming years will play a fundamental role in ensuring the requirements that the new manufacturing Smart requires. In addition, although the European system of education is of superior quality, it is obsolete with respect to the needs of industrial digitalization because it was designed for different industrial needs. The program pays special attention to eliminating the lack of young digital talents.

3.3 AECAD_CAE_CAM UNIT 1: UNDERPINNING KNOWLEDGE

Acronym: AECAD_CAE_CAM.U1

Title: Underpinning Knowledge

Description:

This first training unit introduces us to the area of knowledge of materials, their classification and applications and the different processes to which they can be submitted for die design.

3.3.1 AECAD_CAE_CAM Unit 1 - Element 1: Advanced processing technologies

Acronym: AECAD_CAE_CAM.U1.E1

Element Title: Advanced processing technologies.

Element Note:

This element gives an overview about general knowledge of different types of forming, stamping dies, dies or tools used in forming processes and considerations for die design.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U1.E1.PC1	The student is able to describe different metal forming processes: deep drawing, stamping, blanking, fine blanking, bulk metal forming, bending, hydroforming referred to the manufactured components
AECAD_CAE_CAM.U1.E1.PC2	Given a specific metal forming process, the student is able to choose the appropriate presses, distinguishing the advantages and disadvantages of using different presses in terms of speed, available force, kinematics, transfer, feeding.
AECAD_CAE_CAM.U1.E1.PC3	Given a tooling assembly, the student is able to identify what kind of process is, main parts of the assembly and their function as well as the main properties in different parts of the assembly.
AECAD_CAE_CAM.U1.E1.PC4	Given a metal forming process, the student is able to identify the main parameters influencing it such a) blank material, b)temperature, c) used press, d)material flow, e) fiction and lubrication f) production speed
AECAD_CAE_CAM.U1.E1.PC5	Given a metal formed component to be able to identify the process used to its manufacture, the features of the part linked with the process (dimensional tolerances, surface aspects, shapes, dimensions) and the possible defects.

Table 1: Performance Criteria for the Element AECAD_CAE_CAM.U1.E1

3.3.2 AECAD_CAE_CAM Unit 1 - Element 2: Materials Technology

Acronym: AECAD_CAE_CAM.U1.E2

Element Title: Materials Technology

Element Note:

This element introduces aspects to know different steel classifications, types of foundries and also acquire basic notions of heat treatment such as time, temperature... and their influence on the microstructures of materials.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U1.E2.PC1	The student is able to determine different engineering parameter related to materials properties: elasticity, tensile and yield strength, elongation, hardness
AECAD_CAE_CAM.U1.E2.PC2	Given specific information about phase transitions, composition and phases, the student is able to determine the binary phase diagram.

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U1.E2.PC3	Given a binary phase diagram, the composition of an alloy, its temperature, and assuming that the alloy is at equilibrium, the student is able to determine: what phase(s) is (are) present, the composition(s) of the phase(s), and the mass fraction(s) of the phase(s)
AECAD_CAE_CAM.U1.E2.PC4	Given the isothermal transformation (or continuous cooling transformation) diagram for some iron–carbon alloy, the student is able to design a heat treatment that will produce a specified microstructure.

Table 2: Performance Criteria for the Element AECAD_CAE_CAM.U1.E2

3.4 AECAD_CAE_CAM UNIT 2: CAD DESIGN

Acronym: AECAD_CAE_CAM.U2

Title: CAD Design

Description:

This unit introduces us to the area of the design of products and die assemblies in two and three dimensions in digital format with a computer aided drafting program (CAD/CAM).

3.4.1 AECAD_CAE_CAM Unit U2 - Element 1: CATIA V5

Acronym: AECAD_CAE_CAM.U2.E1

Element Title: CATIA V5

Element Note:

This Element includes skills to become familiar and operate the design program CATIA V5 to generate auxiliary and complex surfaces to obtain spatial geometry for subsequent use.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E1.PC1	Knowledge of representation systems and generating adequate sketches.
AECAD_CAE_CAM.U2.E1.PC2	Managing the display of elements and several selection tools
AECAD_CAE_CAM.U2.E1.PC3	Being able to use 2D design tools.
AECAD_CAE_CAM.U2.E1.PC4	Being able to use 3D design tools.
AECAD_CAE_CAM.U2.E1.PC5	Design of parts using appropriate surface commands.

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E1.PC6	Acquire precise knowledge for edition and modification of curves and surfaces.
AECAD_CAE_CAM.U2.E1.PC7	Being able to process information and resolve various setbacks resulting from a possible defective model.

Table 3: Performance Criteria for the Element AECAD_CAE_CAM.U2.E1

3.4.2 AECAD_CAE_CAM Unit U2 - Element 2: Unigraphics NX

Acronym: AECAD_CAE_CAM.U2.E2

Element Title: Unigraphics NX

Element Note:

This Element includes skills to become familiar and operate the design program NX to generate auxiliary and complex surfaces to obtain spatial geometry for subsequent use.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E2.PC1	Knowledge of representation systems and generating adequate sketches.
AECAD_CAE_CAM.U2.E2.PC2	Managing the display of elements and several selection tools.
AECAD_CAE_CAM.U2.E2.PC3	Being able to use 2D design tools.
AECAD_CAE_CAM.U2.E2.PC4	Being able to use 3D design tools
AECAD_CAE_CAM.U2.E2.PC5	Design of parts using appropriate surface commands
AECAD_CAE_CAM.U2.E2.PC6	Acquire precise knowledge for edition and modification of curves and surfaces.
AECAD_CAE_CAM.U2.E2.PC7	Being able to process information and resolve various setbacks resulting from a possible defective model.

Table 4: Performance Criteria for the Element AECAD_CAE_CAM.U2.E2

3.4.3 AECAD_CAE_CAM Unit U2 - Element 3: CATIA V5 Advanced

Acronym: AECAD_CAE_CAM.U2.E3

Element Title: CATIA V5 Advanced

Element Note:

This Element deepens into specific knowledge for the design of parametric Solids and operation, concepts in the field of dies and knowledge and skill in operation, handling and redesign of a Plane Method.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E3.PC1	Knowing methodology for designing solids
AECAD_CAE_CAM.U2.E3.PC2	Knowing the operability of a specification tree
AECAD_CAE_CAM.U2.E3.PC3	Knowing how to operate, use and interact with a Plane Method.
AECAD_CAE_CAM.U2.E3.PC4	Knowing the relationship and operability between the Plane Method and the creation of specific solids for stamping dies
AECAD_CAE_CAM.U2.E3.PC5	Knowing the different types of restraints to apply between solid components

Table 5: Performance Criteria for the Element AECAD_CAE_CAM.U2.E3

3.4.4 AECAD_CAE_CAM Unit U2 - Element 4: Unigraphics NX Advanced

Acronym: AECAD_CAE_CAM.U2.E4

Element Title: Unigraphics NX Advanced

Element Note:

This Element deepens into specific knowledge for the design of parametric Solids and operation, concepts in the field of dies and knowledge and skill in operation, handling and redesign of a Plane Method.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E4.PC1	Knowing methodology for designing solids
AECAD_CAE_CAM.U2.E4.PC2	Knowing the operability of a specification tree
AECAD_CAE_CAM.U2.E4.PC3	Knowing how to operate, use and interact with a Plane Method.
AECAD_CAE_CAM.U2.E4.PC4	Knowing the relationship and operability between the Plane Method and the creation of specific solids for stamping dies

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U2.E4.PC5	Knowing the different types of restraints to apply between solid components

Table 6: Performance Criteria for the Element AECAD_CAE_CAM.U2.E4

3.5 AECAD_CAE_CAM UNIT U3: 4.0 TECHNOLOGIES

Acronym: AECAD_CAE_CAM.U3

Title: 4.0 Technologies

Description:

This training unit introduces us to the area of 4.0 Technologies, such as Additive Manufacturing and Augmented reality and its influence in the automotive sector.

3.5.1 AECAD_CAE_CAM Unit U3 - Element 1: Additive Manufacturing

Acronym: AECAD_CAE_CAM.U3.E1

Element Title: Additive Manufacturing

Element Note:

This Element provides a global overview of fundamentals of additive manufacturing understanding the operating principles, capabilities, and limitations of AM

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U3.E1.PC1	The student is able to Knowing Additive manufacturing.
AECAD_CAE_CAM.U3.E1.PC2	The student is able to Knowing the AM workflow.
AECAD_CAE_CAM.U3.E1.PC3	The student is able to Knowing the AM technologies.
AECAD_CAE_CAM.U3.E1.PC4	The student is able to Knowing materials y design rules for AM.

Table 7: Performance Criteria for the Element AECAD_CAE_CAM.U3.E1

3.5.2 AECAD_CAE_CAM Unit U3 - Element 2: Augmented Reality

Acronym: AECAD_CAE_CAM.U3.E2

Element Title: Augmented Reality

Element Note:

This Element provides a global overview to know the main ideas about Augmented Reality and acquire knowledge about the different applications that Augmented Reality has in the Automotive sector.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U3.E2.PC1	The student is able to detect different needs in which the Augmented Reality can be implemented.
AECAD_CAE_CAM.U3.E2.PC2	The student is able to use software and applications in the field of Augmented Reality.
AECAD_CAE_CAM.U3.E2.PC3	The student is able to appropriately use different devices and display technologies.

Table 8: Performance Criteria for the Element AECAD_CAE_CAM.U3.E2

3.6 AECAD_CAE_CAM UNIT U4: SIMULATION AND PROTOTYPING

Acronym: AECAD_CAE_CAM.U4

Title: Simulation and prototyping

Description:

This unit provides us with knowledge on strength of materials to subsequently perform on structural components, simulations of behaviour, using the method of the finite elements (FEM), to subsequently generate suitable prototypes

3.6.1 AECAD_CAE_CAM Unit U4 – Element 1: Materials resistance

Acronym: AECAD_CAE_CAM.U4.E1

Element Title: Materials resistance

Element Note:

This Element provides a global overview to acquire knowledges of fundamental concepts of strength of materials learning fundamental concepts of FEM, and understanding the characteristics of test and simulation results.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U4.E1.PC1	The student is able to acquire Knowledge of fundamental concepts of strength of materials
AECAD_CAE_CAM.U4.E1.PC2	The student is able to acquire Knowledge of fundamental concepts of FEM
AECAD_CAE_CAM.U4.E1.PC3	The student is able to acquire Knowledge of FEM methodology
AECAD_CAE_CAM.U4.E1.PC4	The student is able to acquire Knowledge of classify structural calculations
AECAD_CAE_CAM.U4.E1.PC5	The student is able to acquire Knowledge of the characteristics of test and simulation results

Table 9: Performance Criteria for the Element AECAD_CAE_CAM.U4.E1

3.6.2 AECAD_CAE_CAM Unit U4 – Element 2: LS Dyna

Acronym: AECAD_CAE_CAM.U4.E2

Element Title: LS Dyna

Element Note:

This Element provides knowledges to become familiar and operate Ls-Dyna, and learn specific concepts and dynamic behaviour of materials, for later, be able to create impact models.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U4.E2.PC1	The student is able to acquire Knowledge of Ls-Dyna.
AECAD_CAE_CAM.U4.E2.PC2	The student is able to acquire Knowledge of explicit concepts.
AECAD_CAE_CAM.U4.E2.PC3	The student is able to acquire Knowledge of material behavior.
AECAD_CAE_CAM.U4.E2.PC4	The student is able to acquire Knowledge of ls-dyna input files.
AECAD_CAE_CAM.U4.E2.PC5	The student is able to acquire Knowledge of contacts.
AECAD_CAE_CAM.U4.E2.PC6	The student is able to acquire Knowledge General skillsCE.

Table 10: Performance Criteria for the Element AECAD_CAE_CAM.U4.E2

3.6.3 AECAD_CAE_CAM Unit U4 – Element 3: Abaqus

Acronym: AECAD_CAE_CAM.U4.E3

Element Title: Abaqus

Element Note:

This Element provides knowledges to become familiar and operate the design program Abaqus, and generate 3D mechanical analysis, meshing operations and more, to be able to study dynamics, buckling, fatigue and nonlinear designs.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U4.E3.PC1	The student is able to acquire Knowledge of generating geometries.
AECAD_CAE_CAM.U4.E3.PC2	The student is able to acquire Knowledge of Meshing different models using the most suitable mode.
AECAD_CAE_CAM.U4.E3.PC3	The student is able analyse mechanical components. Extract results.
AECAD_CAE_CAM.U4.E3.PC4	The student is able to design components under thermal situations.
AECAD_CAE_CAM.U4.E3.PC5	The student is able to design components under dynamic situations.
AECAD_CAE_CAM.U4.E3.PC6	The student is able to analysis components under fatigue process.

Table 11: Performance Criteria for the Element AECAD_CAE_CAM.U4.E3

3.6.4 AECAD_CAE_CAM Unit U4 – Element 4: The basis of experimental research

Acronym: AECAD_CAE_CAM.U4.E4

Element Title: The basis of experimental research

Element Note:

This Element provides to know the basis of the experimental research knowing the use of them and interpret the data of the research.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U4.E4.PC1	The student knows Know the basis of the experimental research.

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U4.E4.PC2	The student knows how to Learn to use the bibliographical sources.
AECAD_CAE_CAM.U4.E4.PC3	The student knows how to use the research variables.
AECAD_CAE_CAM.U4.E4.PC4	The student knows how to Interpret the data of the research.
AECAD_CAE_CAM.U4.E4.PC5	The student knows how to do a little experimental research.

Table 12: Performance Criteria for the Element AECAD_CAE_CAM.U4.E4

3.7 AECAD_CAE_CAM UNIT U5: PROCESSES & MANUFACTURING.

Acronym: AECAD_CAE_CAM.U5

Title: Processes & Manufacturing.

Description:

This unit is specific for software to perform simulation and validation of a sheet metal forming process to later define the corresponding manufacturing process and thus obtain the desired components, with good planning and control of the project.

3.7.1 AECAD_CAE_CAM Unit U5 – Element 1: Modelling & simulation of processes

Acronym: AECAD_CAE_CAM.U5.E1

Element Title: Modelling & simulation of processes

Element Note:

This Element provides a global overview to acquire knowledges and work the environment of the Autoform program, generating different processes to study and perform the subsequent analysis

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U5.E1.PC1	The student is able to Know the interface and work environment of the Autoform program.
AECAD_CAE_CAM.U5.E1.PC2	The student is able to acquire Knowledge of different types of Autoform files.
AECAD_CAE_CAM.U5.E1.PC3	The student is able to Know the process of creating studies in Autoform.

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U5.E1.PC4	The student is able to Interpret the results of the analysis in Autoform.
AECAD_CAE_CAM.U5.E1.PC5	The student is able to Make modifications in the process and geometry to improve the results of the analysis.

Table 13: Performance Criteria for the Element AECAD_CAE_CAM.U5.E1

3.7.2 AECAD_CAE_CAM Unit U5 – Element 2: Assisted manufacturing. CAM, CNC

Acronym: AECAD_CAE_CAM.U5.E2

Element Title: Assisted manufacturing. CAM, CNC

Element Note:

This Element provides the student the necessary knowledge to perform the design of basic and complex surfaces, which will form part of the final design of the part to be machined later, using TEBIS software, and also will be able to check fundamental parts of the CNC code generated automatically by the system.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U5.E2.PC1	The student is able to acquire Knowledge about the systems of axes and working planes in TEBIS.
AECAD_CAE_CAM.U5.E2.PC2	The student is able learn how to draw basic entities to design complex surfaces.
AECAD_CAE_CAM.U5.E2.PC3	The student is able to acquire ability to manipulate and edit entities.
AECAD_CAE_CAM.U5.E2.PC4	The student is able to acquire Knowledge about machining in 2 ½ EJES.
AECAD_CAE_CAM.U5.E2.PC5	The student is able to acquire Knowledge about machining in 3 EJES.
AECAD_CAE_CAM.U5.E2.PC6	The student is able to acquire Knowledge to interpret de generated CNC code.

Table 14: Performance Criteria for the Element AECAD_CAE_CAM.U5.E2

3.7.3 AECAD_CAE_CAM Unit U5 – Element 3: PROCESS MANAGEMENT

Acronym: AECAD_CAE_CAM.U5.E3

Element Title: Process management

Element Note:

This Element focuses on software which is specific to plan and control projects that allow you to organize and follow tasks efficiently.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U5.E3.PC1	The student is able to know the different phases of a project.
AECAD_CAE_CAM.U5.E3.PC2	The student is able to make a work plane
AECAD_CAE_CAM.U5.E3.PC3	The student is able to know the systems of assignment of tasks
AECAD_CAE_CAM.U5.E3.PC4	The student is able to link tasks and their management
AECAD_CAE_CAM.U5.E3.PC5	The student is able to analyse resource costs.
AECAD_CAE_CAM.U5.E3.PC6	The student is able to optimize the times.

Table 15: Performance Criteria for the Element AECAD_CAE_CAM.U5.E3

3.8 AECAD_CAE_CAM UNIT U6: PROJECT MANAGEMENT

Acronym: AECAD_CAE_CAM.U6

Title: Project management

Description:

This unit provides a global overview to acquire knowledges on the management and follow-up of projects that are to be carried out within a certain period of time and with certain specific “hitos” (milestones).

3.8.1 AECAD_CAE_CAM Unit U6 – Element 1: Modelling & simulation of processes

Acronym: AECAD_CAE_CAM.U6.E1

Element Title: Modelling & simulation of processes

Element Note:

This Element provides a global overview to acquire knowledges and work the environment of the Autoform program, generating different processes to study and perform the subsequent analysis

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U6.E1.PC1	The student is able to Know the interface and work environment of the Autoform program.
AECAD_CAE_CAM.U6.E1.PC2	The student is able to acquire Knowledge of different types of Autoform files.
AECAD_CAE_CAM.U6.E1.PC3	The student is able to Know the process of creating studies in Autoform.
AECAD_CAE_CAM.U6.E1.PC4	The student is able to Interpret the results of the analysis in Autoform.
AECAD_CAE_CAM.U6.E1.PC5	The student is able to Make modifications in the process and geometry to improve the results of the analysis.

Table 16: Performance Criteria for the Element AECAD_CAE_CAM.U6.E1

3.8.2 AECAD_CAE_CAM Unit U6 – Element 2: Tolerances

Acronym: AECAD_CAE_CAM.U6.E2

Element Title: Tolerances

Element Note:

This Element provides a global overview to acquire knowledges to understand the principles of the tolerances and become familiar with the dimensional tolerances surface roughness, symbology and geometrical tolerances.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U6.E2.PC1	The student is able to Know the principles of Tolerances.
AECAD_CAE_CAM.U6.E2.PC2	The student is able to Know dimensional tolerances
AECAD_CAE_CAM.U6.E2.PC3	The student is able to Know surface roughness.
AECAD_CAE_CAM.U6.E2.PC4	The student is able to Know geometrical tolerances

Table 17: Performance Criteria for the Element AECAD_CAE_CAM.U6.E2

3.8.3 AECAD_CAE_CAM Unit U6 – Element 3: 3D scanning & reverse engineering

Acronym: AECAD_CAE_CAM.U6.E3

Element Title: 3D scanning & reverse engineering

Element Note:

This Element includes skills to become familiar with the scan process and points of clouds and provides knowledges about reverse engineering, programs and procedure.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U6.E3.PC1	The student is able to Know the fundamentals 3D scanners
AECAD_CAE_CAM.U6.E3.PC2	The student is able to Know the different types of scanners.
AECAD_CAE_CAM.U6.E3.PC3	The student is able to Know the scan process.
AECAD_CAE_CAM.U6.E3.PC4	The student is able to Know reverse engineering programs and procedures.

Table 18: Performance Criteria for the Element AECAD_CAE_CAM.U6.E3

3.8.4 AECAD_CAE_CAM Unit U6 – Element 4: Project management

Acronym: AECAD_CAE_CAM.U6.E4

Element Title: Project management

Element Note:

This Element focuses on software which is specific to plan and control projects that allow you to organize and follow tasks efficiently.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria (PC):

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U6.E4.PC1	The student is able to know the different phases of a project.
AECAD_CAE_CAM.U6.E4.PC2	The student is able to make a work plane
AECAD_CAE_CAM.U6.E4.PC3	The student is able to know the systems of assignment of tasks
AECAD_CAE_CAM.U6.E4.PC4	The student is able to link tasks and their management
AECAD_CAE_CAM.U6.E4.PC5	The student is able to analyse resource costs.

Performance Criterion	Evidence Check: The student can demonstrate
AECAD_CAE_CAM.U6.E4.PC6	The student is able to optimize the times.

Table 19: Performance Criteria for the Element AECAD_CAE_CAM.U6.E4

4 CONFIGURATION FOR AUTOMOTIVE ENGINEER CAD CAE CAM

GTI is committed to the development of all Gestamp employees' professional skills through the design and delivery of innovative learning programs regarding our global business' technologies, processes, systems and rich portfolio of products. All these skills were taught and applied inside GTI's CAD CAM CAE certification program.

Since 2015 Gestamp is performing this certification program at GTI which leaded to generate talented pool of candidates with CAD CAM CAE skills. The industry feedback showed that the skills provided by the training modules fulfils the criteria of Automotive CAD CAM CAE engineer. Inside Automotive industry these skills are required for the several roles. Such as,

- **Research and Development Teams –** Dealing with CAD Product Design and CAE Process.
- **Forming Technologies Teams –** Dealing with Process & Simulation Engineering.
- **Tool and Die Teams –** For Tooling and Die Design and Production.

In general the feedback was positive because all the contents supported by real automotive examples and best practices used in lead projects.

520 Hours	**Training Modules**
60	**Underpinning Knowledge**
40	Advanced Processing Technologies
20	Materials Technology
300	**CAD Design**
60	Design with CATIA V5
90	Design with CATIA V5 Advanced
60	Design with Unigraphics-Siemens NX
90	Advanced Design with Unigraphics-Siemens NX
20	**4.0 Technologies**
10	Additive Manufacturing
10	Augmented Reality
140	**Processes & Manufacturing**
50	Modelling & Simulation of processes AUTOFORM
40	Assisted manufacturing CAM CNC (28h TEBIS, 12h CNC)
50	Process Management

Table20: AE CAD_CAE_CAM Skill Set applied for the certification program

The role of the Automotive CAD_CAE_CAM Engineer relates to the creation of complex design, complex design analysis using Computer Aided Engineering (CAD/CAE/CAM) software. With these skills one can be able to understand the customer basic requirements and expectations for new product design and improved designs using these software's. Moreover, they can provide timely design guidance and support to the team to guarantee the customer needs.

The role of the Automotive CAD_CAE_CAM Engineer relates to the design and analysis of the vehicle body parts. With the advent of computers inside Automotive industry the software's for computer aided applications (CAD/CAE/CAM) are widely being used for advanced design with accuracy, speed, versatility and engineering convenience.

Thus Automotive CAD CAE CAM engineer involves detailed study of various components related to the vehicle industry such as Chassis Design, Die Design, Body in White parts, Stamping technologies, Materials technology, etc. Also, to prepare and generate the design processes the machine design is necessary where parts of any machine are designed and implemented using computer aided manufacturing (CAM) like CNC, other applications.

Therefore, we can conclude that the skills required for the Automotive CAD_CAE_CAM Engineer are interrelated to each other. For the AE CAD_CAM_CAE project this results in a concept where two or more roles are covered by one skills set, and depending on the roles, different levels of detail in the skills elements and training units can be selected.

ANNEXES

The annex provides overview of used skills set, coverage of Qualification Schemas and Legal background for Certification

ANNEX A ECQA DESCRIPTION

ECQA – EUROPEAN CERTIFICATION AND QUALIFICATION ASSOCIATION

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). ECQA is the pilot Certification body, which structure is mapped to DRIVES Reference and Recognition Framework providing the EU-wide overview of training courses and possible certifications, and micro-credentials. DRIVES Reference and Recognition Framework provides links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

Europe Wide Certification

The ECQA is the result of a number of EU supported initiatives in the last ten years where in the European Union Life Long Learning Programme different educational developments decided to follow a joint process for the certification of persons in the industry.

Through the ECQA it becomes possible that you attend courses for a specific profession in e.g. Spain and perform a Europe wide agreed test at the end of the course.

Access to a Vast Pool of Knowledge

ECQA currently supports 27 professions in Europe and with the continuous support until 2012 by the European Commission the pool is growing to 30 certified professions in Europe. ECQA offers certification for professions like IT Security Manager, Innovation Manager, EU project manager, E-security Manager, E-Business Manager, E-Strategy Manager, SW Architect, SW Project Manager, IT Consultant for COTS selection, Internal Financial Control Assessor (COSO/COBIT based), Interpersonal Skills, Scope Manager (Estimation Processes), Configuration Manager, Safety Manager, and so forth.

The ECQA guide can be downloaded at www.ecqa.org -> Guidelines.

Defined procedures are applied for:

- Self assessment and learning
- http://www.ecqa.org/fileadmin/documents/Self_Assessment/eucert-users-self-assessment-learning-guide-v5-doc.pdf
- Exam performance
- http://www.ecqa.org/fileadmin/documents/ECQA_Exam_Guide_Participant_v2.pdf

ECQA SKILLS DEFINITION MODEL

The ECQA skills definition model, used for Job Role definition, is described in section 2 of this document.

ECQA SKILL SET STRATEGY

Imagine that in the future Europeans will have a skill set like a card with a chip which stores your skill profile to fulfil specific professions, job roles, and tasks. It's working like an ID card. This future scenario requires -

- A standard way to describe a skill set for a profession, job, or specific task.
- A standard procedure to assess the skill and to calculate and display skill profiles.

Such a common set of skill sets in Europe is needed due to the free mobility of workers. European countries such as UK, The Netherlands, and France already have well established open universities which support APL (Accreditation of Prior Learning). In APL the skills of students are assessed, already gained skills are recognised, and only for the skill gaps a learning plan is established. The skill assessment bases on defined skill units and a skill profile displaying how much of the skill units are covered.

In a previous project CREDIT (Accreditation of Skills via the Internet) [1] in which some of the project partners were involved such an Internet based skills assessment system has been built. Therefore another possible scenario of the future is that representative educational bodies per country in Europe maintain skill profiles in databases which can be accessed via defined ID codes for people.

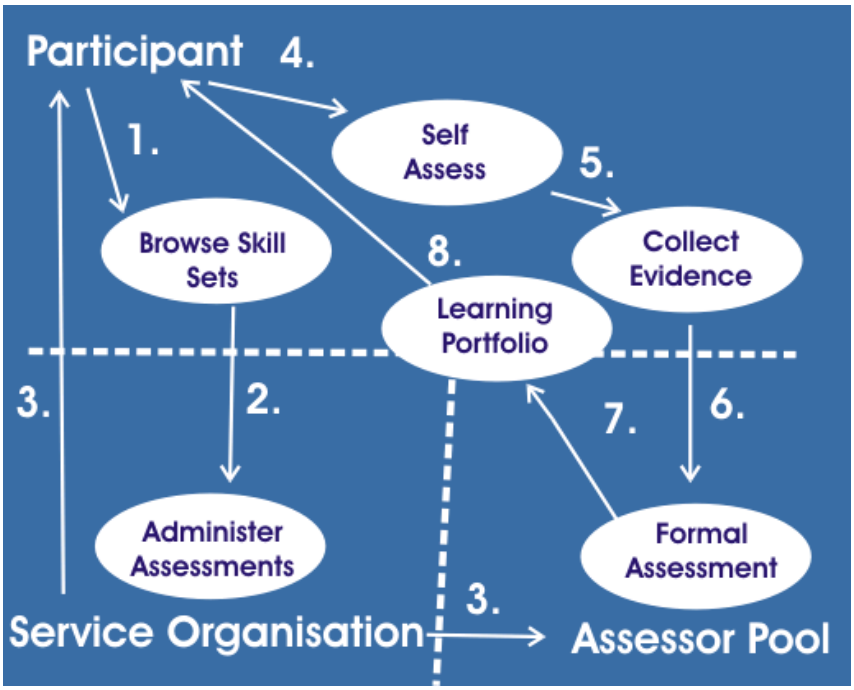
ECQA SKILLS ASSESSMENT MODEL

Step 1 – Browse a Skills Set: You select a set of skills or competencies, which are required by your profession or job using national standards or your company standards. You browse different skills cards and select a job role you would like to achieve.

Step 2 – Register for Self Assessment with a Service Unit : This can be a service unit inside your own company (e.g. a personnel development department) or a skills card and assessment provider outside your company which offers skills assessment services. In case of the Safety Manager Project the registration will automatically assign a predefined service unit.

Step 3 – Receive an Account for Self-Assessment and Evidence Collection : With the registration you automatically received an account to login to the working space in which you can go through the steps

of online self assessment and the collection of evidences to prove that you are capable of certain performance criteria.



Picture 1: Basic steps of the skills assessment model

Step 4 – Perform Self Assessment: You log into the system , browse through the skills required and self assess performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. A skills gaps profile can be generated and printed illustrating in which areas your self assessment shows improvement potentials.

Testing of Skills (Addition to Step 4) – The system provides a multiple-choice test for each performance criteria so that you can check your capabilities as realistically as possible.

Step 5 – Collect Evidences: Before you want to enter any formal assessment you need to prove your skills by evidences. Evidences can be any electronic files (sample documents, sample graphics, results of some analysis, etc.) or any references with details (e.g. a certificate received from a certain institution). Evidences you can then link to specific performance criteria or whole elements of skills units.

Testing of Skills (Addition to Step 5) – In traditional learning schemes people have always needed to go to a learning institution (university, accreditation body, professional body, etc.) to take exams and they received a certificate if they pass. This traditional approach however is insufficient when it comes to

measuring experience and (soft) skills learned on the job and fails to give recognition to skills gathered on the job. The APL (Accreditation of Prior Learning) approach, by contrast, collects so called evidences. Evidences can be certificates obtained in the traditional way, but also references from previous employers, materials from previous projects in which the person took ownership of results (e.g. a test plan) to prove their capability, as well as any kind of proof of competence gathered on the job. The assessors will then evaluate the evidences provided and not only rely on certificates and exams.

Step 6 – Receive Formal Assessment: Formal assessors are assigned by the service unit to the skills assessment. Once formal assessors log into the system they automatically see all assigned assessments. They select the corresponding one and can see the uploaded evidences. They then formally assess the evidences and assess the formal fulfilment of performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. In case of missing competencies they enter improvement recommendations, a well as learning options.

Step 7 – Receive Advise on Learning / Improvement Options: After the formal assessment the participants log into the system and can see the formal assessment results from the assessors, can print skills gaps profiles based on the assessor results, and can receive and print the improvement recommendations and learning options. If required, the generation of learning options can also be automated through the system (independent from assessor advises).

ECQA CERTIFICATE TYPES

In the standard test and examination procedures for levels of certificates are offered:

- Course Attendance Certificate
  - Received after course attendance
  - Modular per Element
- Course / Test Certificate
  - Test in a test system (European pool of test questions)
  - 67% satisfaction per element
- Summary Certificate
  - Overview of covered elements where the student passed the test, all elements shall be covered
  - Generation of certificate
- Professional Certificate

- Uploading applied experiences for review by assessors
- Rating by assessors
- Observation of 2 years

The certificates show credited elements in comparison to all required.

ANNEX B ECQA COVERAGE OF QUALIFICATION SCHEMAS

MAPPING BASED ON NVQ QUALIFICATION LEVELS

Qualification / training levels: Five levels of qualification / training are defined by European legislation and this structure can be used for comparability of vocational qualifications from the different European countries.

- Level 1: semi-skilled assistant performing simple work
- Level 2: basic employee performing complex routines and standard procedures
- Level 3: skilled professional with responsibility for others and performing independent implementation of procedures
- Level 4: middle management & specialist performing tactical an strategic thinking
- Level 5: professional / university level

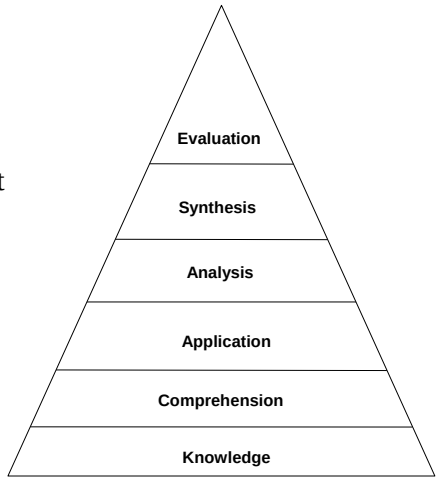
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

- Six level taxonomy:

  Level 0: I never heard of it

  1. Knowledge (I can define it):
  2. Comprehension (I can explain how it works)
  3. Application (I have limited experience using it in simple situations)
  4. Analysis (I have extensive experience using it in complex situations)
  5. Synthesis (I can adapt it to other uses)
  6. Evaluation (I am recognized as an expert by my peers)



Picture 3: Blooms Learning levels

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Six Sigma Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Six Sigma Green Belt
Level 7	• Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields	Six Sigma Black Belt

Level	Knowledge	Example
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Six Sigma Master Black Belt

Picture 4 : EQF Learning levels

MAPPING BASED ON ECTS AND ECVET SCHEMA

ECQA has established a procedure to map ECQA skills sets onto the ECTS (European Credit Transfer System) and the ECVET framework n the European Union.

A job role is assigned ECTS and ECVET points using a defined framework.

ECTS Mapping

Each element of the skills set is assigned hours of lecturing and exercises. These hours determine the ECTS points which are then agreed among a cluster on different universities in Europe.

Level	Knowledge	AQUA	ECTS	Safety Manager	ECTS
Level 1	Basic general knowledge	-		-	
Level 2	Basic factual knowledge of a field of work or study	-		-	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study				
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study				
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge				
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	AQUA - Automotive Quality Integrated Skills - presentations / theory	3	AQUA - Automotive Quality Integrated Skills - presentations / theory	3
Level 7	- Highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - Critical awareness of knowledge issues in a field and at the interface between different fields	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5

Picture 5 : Example Automotive Quality Engineer and Safety Manager

The 2 job roles illustrated in the picture above have been assigned to ECTS and are taught using the same skills set at industry and also universities.

ECVET Mapping

Also ECQA provides a framework to assign ECVET points onto elements of the skills set. The ECQA guidance recommends to offer the ECQA course (which is offered as a lecture at university) as a short course (2 weeks with exercises) in industry to retrain for a job role in industry. The recommended size is 30 ECVET points in total. The lecturing time and exercise per element determine how many ECVET points ae assigned to an element of the skills set.

Automotive Quality Engineer			
			ECVET L7&8
U1	4	U1.E1: Introduction	2
		U1.E2: Organisational Readiness	2
U2	32	U2.E1 Life Cycle	8
		U2.E2 Requirements	8
		U2.E3 Design	8
		U2.E4 Test and Integration	8
U3	12	U3.E1: Capability	2
		U3.E2: Hazard and Risk Management	8
		U3.E3 Assessment and Audit	2
U4	12	U4.E1: Measurement	6
		U4.E2: Reliability	6
		ECVET Points Total	60

Picture 6 : ECVET Mapping example - Automotive Quality Engineer

Functional Safety Manager / Engineer			
			ECVET L7&8
U1	2	U1.E1 International Standards	1
		U1.E2 Product Life Cycle	1
		U1.E3 Terminology	
U2	4	Safety management on organisational	1
		Safety Case Definition	1
		Overview of Required Engineering an	1
		Establish and Maintain Safety Plannin	1
U3	16	System Hazard Analysis and Safety Co	4
		Integrating Safety in System Design &	4
		Integrating Safety in Hardware Design	4
		Integrating Safety in Software Design	4
U4	4	Integration of Reliability in Design to I	2
		Safety in the Production,Operation an	2
U5	4	Legal aspects and Liabilities	2
		Regulatory & Qualification Requireme	2
		ECVET Points Total	30

Picture 7 : ECVET Mapping example – Functional Safety Manager / Engineer

ANNEX C ECQA LEGAL BACKGROUND FOR CERTIFICATION

ISO/IEC 17024 STANDARD FOR PERSONNEL CERTIFICATION PROGRAMMES

The ISO/IEC 17024 standard describes standard processes for the examination and certification of people. Some of the basic principles described include:

- Standard exam procedure
- Standard certification procedure
- Identification of persons receiving the certificate
- Independence of examiner and trainer
- Certification system that allows to log the exam to keep a record/proof that the examinee passed the exam
- Mapping of processes towards ISO 17024

ECQA AND ISO/IEC 17024 STANDARD

- ECQA defined standard exam processes
- ECQA defined standard certification processes
- ECQA developed an exam system that generates random exams and corrects exams.
- ECQA developed a certification database to identify persons and map them to exam results
- ECQA established a mapping onto the ISO 17024 norm and published that in form of a self declaration.

LIASION WITH NATIONAL UNIVERSITIES

ECQA established cooperation with national universities who teach job roles with ECTS. The same job roles are offered with ECVET on the market by training bodies.

ANNEX D REFERENCES

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