DRIVES

Development and Research on Innovative Vocational Education Skills

Automotive Engineer in Quality and Metrology (AEQM)

Job Role Skill Set

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www.project-drives.eu

TABLE OF CONTENTS

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 Engineer in Quality and Metrology 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):

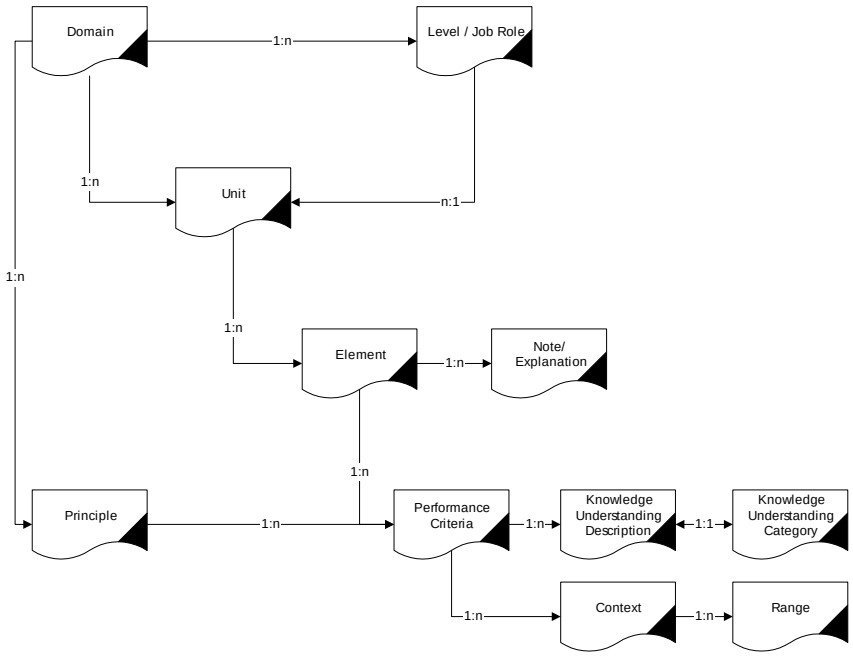

Figure 1 The Skill Definition Model (1:n = one to many relationship)

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 IN QUALITY AND METROLOGY"

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 in quality and metrology" has been designed.

Unit ID	Unit Name	Element ID	Element Name
AEQM.U1	FOUNDATIONS to QUALITY AND METROLOGY	AEQM.U1.E1	Introduction. Why Metrology?
		AEQM.U1.E2	Physics for Metrology
		AEQM.U1.E3	Data, information, knowledge and uncertainty. Mathematical foundations of metrology
AEQM.U2	STANDARDS, CERTIFICATION AND UNCERTAINTY	AEQM.U2.E1	Standards and traceability
		AEQM.U2.E2	Assessing Uncertainty in Dimensional Measurement
AEQM.U3	METROLOGY IN PRODUCT-PROCESS QUALITY ENGINEERING	AEQM.U3.E1	Lean Six Sigma
		AEQM.U3.E2	Capability and Stability Processes
		AEQM.U3.E3	Production Part Approval Process
AEQM.U4	METROLOGY RESOURCES, PLANNING AND EXECUTION	AEQM.U4.E1	Checking fixtures
		AEQM.U4.E2	Measurement resources and tools for Dimensional Metrology
		AEQM.U4.E3	Metrological information representation and drawing interpretation
		AEQM.U4.E4	Measurement planning and execution

Figure 2: The Skills Set for Automotive engineer in quality and metrology

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3.2 THE SKILLS DESCRIPTIONS – JOB ROLE AUTOMOTIVE ENGINEER IN QUALITY AND METROLOGY (AEQM)

Domain Acronym: Engineering

Domain title: Automotive Engineering in Quality and Metrology

Domain Description:

The training project presented here aims to equip students and future workers with the knowledge required to meet the new challenges of 4.0 metrology 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 AEQM UNIT 1: FOUNDATIONS TO QUALITY AND METROLOGY

Acronym: AEQM.U1

Title: Foundations to Quality and Metrology

Description:

The first training unit introduces the subject of Metrology, with a particular focus on issues related to the Quality data and information available, for which the concept of “Uncertainty” is key and never completely divisible from the very same act of measurement, but can be put under control if both directly controllable and external conditions are known and its influence properly analysed.

3.3.1 AEQM Unit 1 - Element 1: Introduction. Why Metrology?

Acronym: AEQM.U1.E1

Element Title: Introduction. Why Metrology?

Element Note:

This element gives an overview about the concept of ideal factory provided by the Industry 4.0 approach, in every aspect: Design, Manufacturing Processes, Management and Business.

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
AEQM.U1.E1.PC1	The student has a basic understanding on which is the approach towards Industry 4.0.
AEQM.U1.E1.PC2	The student is able to relate the importance of metrology for a 4.0 company, integrally.

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

3.3.2 AEQM Unit 1 - Element 2: Physics for Metrology

Acronym: AEQM.U1.E2

Element Title: Physics for Metrology

Element Note:

This element introduces aspects to combat Uncertainty in the Industry, first of all by refreshing the fundamental units of the International System, and then by presenting the Destructive (e.g. tensile, torsion or hardness testing) and Non-Destructive Test methods such as Ultrasonic, X-Ray Computerized Tomography, or even Optical techniques for surface inspection. An introduction to the physical principles of measurement and transformation is given finally; again, by stressing the correspondent error sources in each of the cases.

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
AEQM.U1.E2.PC1	The student knows what Uncertainty is: something unavoidable and linked to the knowledge about something, and not intrinsic to any particular method, tool or machine.
AEQM.U1.E2.PC2	The student knows the most important Destructive and Non-Destructive Testing methods.
AEQM.U1.E2.PC3	The student understands the basic principles of measurement and transformation.
AEQM.U1.E2.PC4	The student comprehends the importance of identifying the error sources in each case, and how to minimise and them under control.

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

3.3.3 AEQM Unit U1 - Element 3: Data, information, knowledge and uncertainty. Mathematical foundations of metrology

Acronym: AEQM.U1.E3

Element Title: Data, information, knowledge and uncertainty. Mathematical foundations of metrology

Element Note:

This last part of the first block deals with data properties (variability, precision, accuracy, repeatability, reproducibility, etc.) applied to Dimensional Metrology, as well as explaining the difference between explicit and tacit, objective and subjective knowledge, and the relationship between data, information and knowledge. More specifically applied to Coordinate Measuring Machines, and apart from these key concepts explained above, this Element collects clues about errors and uncertainties and mathematical foundations for measuring (probability, statistics, data regression).

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
AEQM.U1.E3.PC1	The student, once she/he has understood the concept of Uncertainty in Metrology, is able to distinguish between some of the properties about data, namely: variability, repeatability, reproducibility, and, especially, precision and accuracy.
AEQM.U1.E3.PC2	The student understands the concepts of data, information and knowledge.
AEQM.U1.E3.PC3	
AEQM.U1.E3.PC4	

Table 3: Performance Criteria for the Element AEQM.U1.E3

3.4 AEQM UNIT 2: STANDARDS, CERTIFICATION AND UNCERTAINTY

Acronym: AEQM.U2

Title: Standards, Certification and Uncertainty

Description:

This unit investigates into Standardization in the field of Metrology from both the theoretical point of view, the one around units and international organizations and standards who govern the field itself,

as well as from the practical one, with focus on the measurement system and the uncertainty and "translation" problems to overcome, such as working on different coordinate systems or even software based on different languages.

3.4.1 AEQM Unit U2 - Element 1: Standards and traceability

Acronym: AEQM.U2.E1

Element Title: Standards and traceability

Element Note:

This Element includes skills regarding the basic Standards in use in Dimensional Metrology, from the international organizations who manage the International Metric System to Certification Agents such as AENOR in Spain. Based on this, a more deep approach into metrology is performed, defining types of metrology and making an introduction to measurement software (parameters to take into account, coordinate reference system, and standard languages like DMIS and I++/DME, the latter for automotive industry). Some other characteristics of CMMs (Coordinate Measuring Machines) are explained, for example, dimensions and architectures. All these topics are linked with Uncertainty and traceability of the measurement.

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
AEQM.U2.E1.PC1	The student is able to recognise the importance of and requirements in safety culture to achieve systematic, high level safety awareness and responsibility in the whole organisation
AEQM.U2.E1.PC2	The student is able to recognise elements in organisational safety system management and identify the role of safety manager in achieving that.
AEQM.U2.E1.PC3	The student is able to set requirements for project / product / system level safety management
AEQM.U2.E1.PC4	The student is able to establish necessary (safety and quality) assurance for project / product / system level safety engineering work

Performance Criterion	Evidence Check: The student can demonstrate
AEQM.U2.E1.PC5	The student is able to create and develop necessary documentation for organisational and project / product / system level safety management

Table 4: Performance Criteria for the Element AEQM.U2.E1

3.4.2 AEQM Unit U2 - Element 2: Assessing Uncertainty in Dimensional Measurement

Acronym: AEQM.U2.E2

Element Title: Assessing Uncertainty in Dimensional Measurement

Element Note:

This Element deepens into the concept of Uncertainty, which is something intrinsic to the knowledge got at the time of measuring. However, it may be mitigated through Calibration, which can be performed with another instrument, certified artifacts or master parts.

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
AEQM.U2.E2.PC1	The student is able to identity main elements of safety case, based on standards (e.g. ISO26262, EN50129) and related concepts (assurance case, ISO/IEC 15026)
AEQM.U2.E2.PC2	The student is able to establish requirements for evidence collection to construct a safety case
AEQM.U2.E2.PC3	The student is able to create necessary arguments and modular safety cases
AEQM.U2.E2.PC4	The student is able to explain a safety case for organisational management and other stakeholders (customer, regulator etc.)
AEQM.U2.E2.PC5	The student is able to review safety case developed by suppliers or third parties

Table 5: Performance Criteria for the Element AEQM.U2.E2

3.5 AEQM UNIT 3: METROLOGY IN PRODUCT-PROCESS QUALITY ENGINEERING

Acronym: AEQM.U3

Title: Metrology in Product-Process Quality Engineering

Description:

The present unit provides clues for Metrology and Quality Management for the Automotive Industry, with a double direction: generic tools are presented first of all, tools such as ANPQP, PPAP and SPC, and, then, description of measuring conditions follows, with a special focus on part fixing, alignment, etc.

3.5.1 AEQM Unit U3 - Element 1: Lean Six Sigma

Acronym: AEQM.U3.E1

Element Title: Lean Six Sigma

Element Note:

This Element provides a global overview of Quality in a company whose goal is to achieve Zero Defect Manufacturing, as it is the case of the Automotive industry. It presents a holistic vision about the sector, with current tendencies and strategies. After this, it investigates in detail into the Body-In-White, its materials and unions through the different sheet metal forming and welding techniques that exist and associated parameters and part inspection and testing. More specifically into Quality Management, the Element also explains the tools for the Continuous Improvement of Quality, such as Kaizen, Lean or/and Six Sigma, as well as presenting some key APQP tools.

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
AEQM.U3.E1.PC1	The student is able to select the right engineering and, validation and verification approaches based on the provided method tables, the identified safety integrity level and the product architecture.
AEQM.U3.E1.PC2	The student is able to set up a V&V Plan which covers all necessary validation and verification activities during the design and test phases, and evidences of 100% functional safety coverage /compliance.

Performance Criterion	Evidence Check: The student can demonstrate
AEQM.U3.E1.PC3	The student is able to practically understand and implement safety related testing, such as fault injection testing, diagnostic coverage testing, equivalence class testing, load testing, branch coverage in testing, and more.
AEQM.U3.E1.PC4	The student is able to draw up a compliance map demonstrating the use of qualified tools and qualified engineering methods as part of the safety plan.

Table 6: Performance Criteria for the Element AEQM.U3.E1

3.5.2 AEQM Unit U3 - Element 2: Capability and Stability Processes

Acronym: AEQM.U3.E2

Element Title: Statistical Process Control

Element Note:

This Element explains Quality approaches (preventive vs. corrective), performing, as well, an analysis of statistics as an important part to keep processes under control and guarantee Quality. It also underlines the usefulness of control graphics and sampling etc., establishing the relationship of the productive process with the Stability vs. Capability diagram, as always, from a Quality point of view.

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
AEQM.U3.E2.PC1	The student is able to explain the differences between the standards IEC 61508, ISO 26262 and ISO 13849 regarding their hazard- and risk-analysis.
AEQM.U3.E2.PC2	The student is able to explain the terms harm, hazard, hazardous event, severity, exposure, controlability, risk, safety goal, hazard analysis and risk assessment, reasonably foreseeable event. The student can give examples of his/her own domain.
AEQM.U3.E2.PC3	The student is able to explain an environment in which his system runs and can describe his item definition.
AEQM.U3.E2.PC4	The student is able to explain the difference of functional and non-functional behaviour of his system.

Performance Criterion	Evidence Check: The student can demonstrate
AEQM.U3.E2.PC5	The student is able to moderate a system analysis and hazard identification. The student is able to provide a template for a development department to give guidelines for the discussion.

Table 7: Performance Criteria for the Element AEQM.U3.E3

3.5.3 AEQM Unit U3 - Element 3: Production Part Approval Process

Acronym: AEQM.U3.E3

Element Title: Production Part Approval Process

Element Note:

This element presents the tools provided by the Standard governing Quality applied to Automotive Industry, namely, ISO/TS 16949, and its associated elements such as ANPQP (Alliance New Product Quality Procedure) and tools like PPAP, PSW, Design records, process Flow Diagrams, FMEA, Control Plan, MSA, SPC and 8D.

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
AEQM.U3.E3.PC1	The student is able to explain the terms availability, reliability, safe state, verification criteria
AEQM.U3.E3.PC2	The student is able to understand and show the allocation of subsystems to his systems requirements and system design.
AEQM.U3.E3.PC3	The student is able to explain the difference between system requirements and system design, and functional safety requirements and technical safety requirements. Student is able to explain the link between system requirements and system test.
AEQM.U3.E3.PC4	The student is able to show a signal path and its influence on his system design. He can show the link between system design and system integration test.
AEQM.U3.E3.PC5	The student is able to describe a state machine on system level and allocate time slots for the subsystems on the safety critical path for the identified system reaction time.

Table 8: Performance Criteria for the Element AEQM.U3.E3

3.6 AEQM UNIT 4: METROLOGY RESOURCES, PLANNING AND EXECUTION

Acronym: AEQM.U4

Title: Metrology resources, planning and execution

Description:

This unit is specific to software for Dimensional Metrology, centred in lessons and exercises taken from Multi-Sensor Massive Measurement, or M3, which is the solution developed by Innovalia Metrology for this purpose. Basic-to-medium competence will be given about the utilization and resources of this platform, including Alignment of different coordinate systems, dimension measuring from point clouds and report visualization and interpretation.

3.6.1 AEQM Unit U4 – Element 1: Checking fixtures

Acronym: AEQM.U4.E1

Element Title: Checking fixtures

Element Note:

After the global overview of Quality provided previously, this Element is much more specific about Dimensional Metrology, focusing on control and positioning of parts for subsequent measurements: tools and procedures for alignment, part fixing, etc.

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
AEQM.U4.E1.PC1	The student is able to explain the terms Failure, Fault, Error, Reliability, failure rate. The student can give examples of his/her own domain.
AEQM.U4.E1.PC2	The student is able to allocate safety goals with (A)SIL levels to the elements of a hardware architecture.
AEQM.U4.E1.PC3	The student is able to to explain the basic terms of modelling HW fault tolerance (Reliability, failure rate – FIT, MTTF, etc.) and select the right modelling strategy for hardware fault tolerance.
AEQM.U4.E1.PC4	The student is able to calculate and evaluate hardware safety metrics: architectural (Single-Point Failure Metric, Latent Failure Metric) and random hardware failure metrics

Performance Criterion	Evidence Check: The student can demonstrate
AEQM.U4.E1.PC5	The student is able to devise the appropriate hardware tests based of the chosen hardware design.

Table 9: Performance Criteria for the Element AEQM.U4.E2

3.6.2 AEQM Unit U4 – Element 2: Measurement resources and tools for Dimensional Metrology

Acronym: AEQM.U4.E2

Element Title: Measurement resources and tools for Dimensional Metrology

Element Note:

This Element focuses on and underlines not only the necessity of Checking fixtures, but also of gauge alignment, fixing systems and tools, Validation in supplier and in plant, packing and maintenance.

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
AEQM.U4.E2.PC1	The student is able to identify all necessary roles and activities, required for safety planning.
AEQM.U4.E2.PC2	The student is able to analyse the topics, needed for an integrated safety plan.
AEQM.U4.E2.PC3	The student is able to create and adjust an integrated safety plan.
AEQM.U4.E2.PC4	The student is able to identify the dependencies of the safety plan to other relevant plans (Quality, V&V, etc.).
AEQM.U4.E2.PC5	The student is able to maintain the safety plan during the whole project life cycle.

Table 10: Performance Criteria for the Element AEQM.U4.E1

3.6.3 AEQM Unit U4 - Element 3: Metrological information representation and drawing interpretation

Acronym: AEQM.U4.E3

Element Title: Metrological information representation and drawing interpretation

Element Note:

This Element focuses on software which is specific to visualize results and tolerances of measurements taken by Coordinate Measuring Machines (CMMs) (with both contact probes or optical scanners based

on laser triangulation) through the example given by M3, the metrological interface and data processing solution by Innovalia Metrology. Management of M3 is acknowledged here: how to import, export and edit point clouds, the way to calculate dimensional tolerances, how to visualize reports and statistics, and even the way to align the reference system with a CNC system, a feature that permits to interact with, for example, a machine tool.

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
AEQM.U4.E3.PC1	The student knows the steps to define the chain of the reliability in design and the needed actors to intervene in this chain
AEQM.U4.E3.PC2	The student can define the links between the top events and the elementary design parameters for a given problem
AEQM.U4.E3.PC3	The student knows the link between the modelling of the physical behaviour of the system and the modelling of the design parameters

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

3.6.4 AEQM Unit U4 - Element 4: Measurement planning and execution

Acronym: AEQM.U4.E4

Element Title: Measurement planning and execution

Element Note:

This Element includes more information about M3 possibilities, such as Calibration, Alignment with CAD, Manual or Automatic Measurement and Sensor Management and Exchange.

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
AEQM.U4.E4.PC1	The student knows the different states proposed in the guide for the study of the starts and stops modes for a production system
AEQM.U4.E4.PC2	The student knows how to build the specification for the safety control of a production system

Performance Criterion	Evidence Check: The student can demonstrate
AEQM.U4.E4.PC3	The student knows the limits of the guide for the study of starts and stops modes
AEQM.U4.E4.PC4	The student knows how to take into account the consequence of human action in production steps which relate to safety critical components.

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

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.

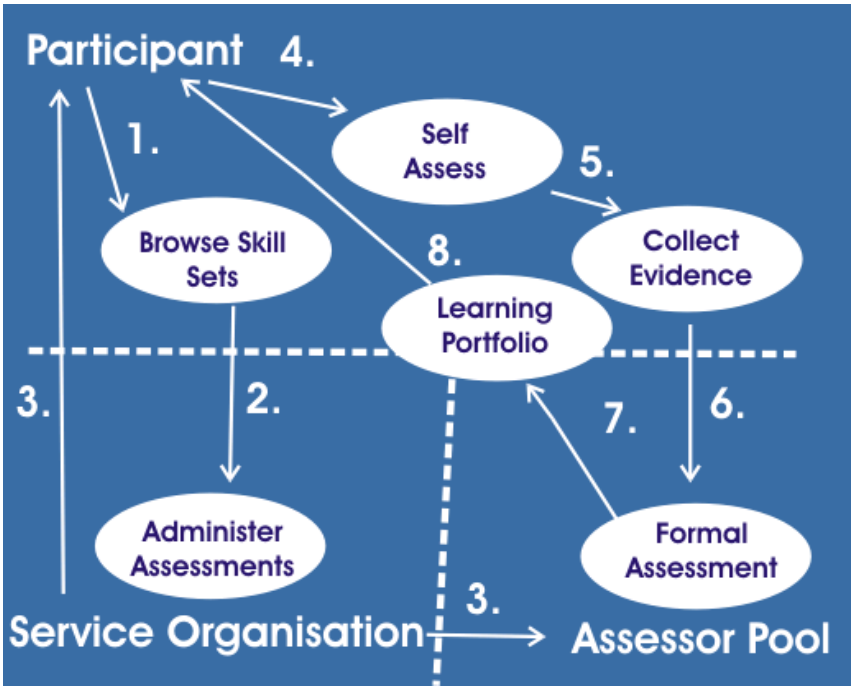
ECQA SKILLS ASSESSMENT MODEL

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

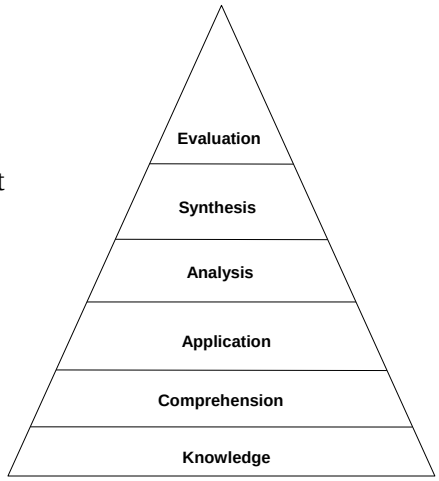
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

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.

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