DRIVES

Development and Research on Innovative Vocational Education Skills

Robotic Engineer

Job Role Skill Set

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ROBOTIC ENGINEER JOB ROLE SKILLS DEFINITION

Report Title:	Robotic Engineer Job Role Skills Definition		
Author(s):	Mick Feloy; Darren Clement,(Jaguar Land Rover Standards & Control Dept)		
Responsible Project Partner:	Semta	Contributing Project Partners:	Jaguar Land Rover

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Approved by:	Anke Blume Richard Messnarz		Approval date:	30/04/2020

More information about DRIVES project and contact:

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 Robotic Engineer job role within the ECQA skills definition model. The role of a Robotic Engineer is to install or modify a robot manufacturing system/machine, using pre-established designs and current developments for improving machinery and equipment, which differs from the role of a Robotic Technician which is to diagnose and repair faults on a robot system.

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

2 ECQA SKILLS DEFINITION MODEL

A skills definition contains the following items (see **Chyba! Nenalezen zdroj odkazů.**):

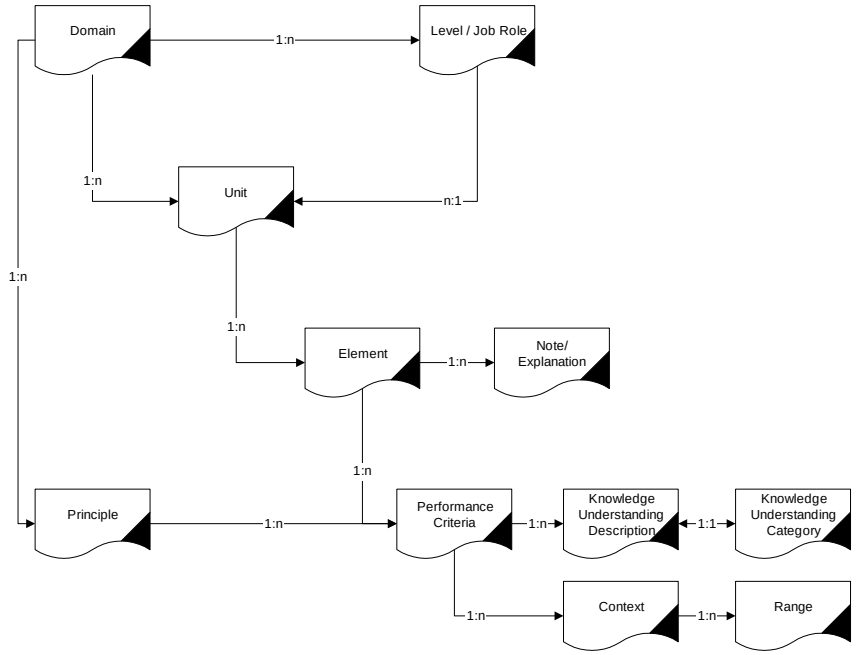


Figure 1 The Skill Definition Model (1:n = one to many relationship)

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.

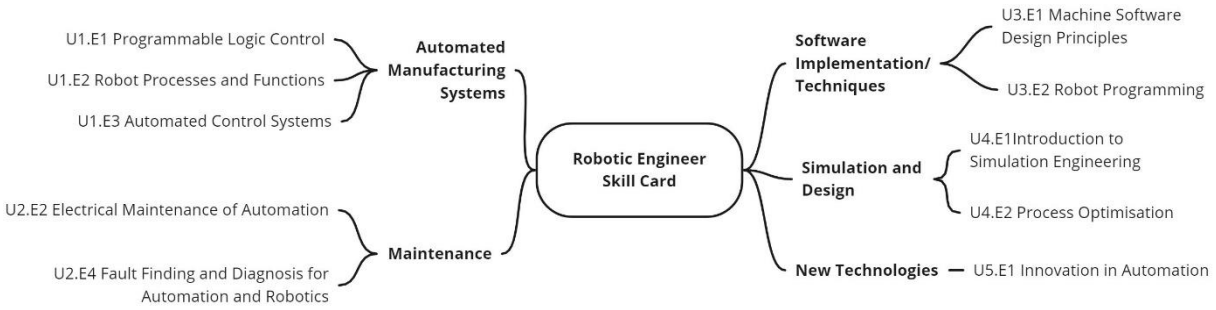
The rationales for developing the ECQA skills definition model is based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they 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 "ROBOTIC ENGINEER"

3.1 THE SKILLS HIERARCHY

Using the terminology and skills identified as part of the development of the SKILLMAN Robotics and Automation Level 3 (UK) EQF Level 4 course the following skills hierarchy for the job role "Robotic Engineer (ROBENG)" has been designed.



Picture 1: The Skills Set for Robotic Engineer

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE EAL CERTIFIED ROBOTICS ENGINEER (ROBENG)

Domain Acronym: R&A

Domain title: Robotics and Automation

Domain Description:

Unprecedented levels of technological change have led to an increased focus on robotics with robotic specialists becoming an increasingly sought after skill set across a wide range of industries. Those industries investing significantly in robotics technology includes automotive, aerospace, manufacturing, agriculture and finance.

As investment in robotics increases the demand for employees to build and maintain robotics technology grows.

Within the Automotive Sector use of Robotics is now commonplace in relation a wide range of shop floor processes from welding to assembly and painting. Robotic Process Automation is also now increasingly used in relation to other areas of the automotive sector including car financing and distribution.

The syllabus and skills set developed for the role of Robotics Engineer have a particular focus on practice. The need for qualified robotics personnel is clear, given the increasing use of robotics technology, as is the need for a commonly agreed skills set for a Robotics Engineer

This skill set has drawn on information developed as part of the SKILLMAN Robotics and Automation course which is a Level 3 (UK) EQF Level 4 course designed as a modular course, with sub-set of the entire set of modules covering the skill sets needed for a Robotic Engineer.

Completion of the entire course leads to a Level 3 (UK) (Level 4 EQF) certification in Robotic Engineering

Job Role Acronym: ROBENG

Job Role Title: EAL Certified Robotic Engineer

Description:

The Skill card comprises the following thematic learning units

1. Automated Manufacturing Systems
2. Maintenance
3. Software Implementation/Techniques
4. Simulation and Design
5. New Technologies

3.3 UNIT ROBENG U1.AUTOMATED MANUFACTURING SYSTEMS

Acronym: ROBENG.U1

Title: Automated Manufacturing Systems

Description:

This unit enables learners to acquire the essential knowledge required in order to consolidate and extend their knowledge and understanding of robotic programmable logic control and also enables learners to understand industrial robot processes and functions and how to operate a robot.

3.3.1 Unit ROBENG.U1 Element 1: Programmable Logic Control

Acronym: ROBENG.U1.E1

Title: Programmable Logic Controllers

Element Note:

This element enables learners to acquire the essential knowledge required in order to consolidate and extend their knowledge and understanding of robotic programmable logic control. This includes Understanding PLC systems and associated communication methodology and the creation and editing of PLC programmes

Performance Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U1.E1.PC1	The student can describe the development of PLCs and how they differ from PC-based control systems.
ROBENG.U1.E1.PC2	The student can explain commonalities/differences between different systems
ROBENG.U1.E1.PC3	The student can explain health and safety implications of PLC-controlled equipment.
ROBENG.U1.E1.PC4	The student can demonstrate understanding and use of the different types of inputs/ outputs commonly used on PLC-based equipment.
ROBENG.U1.E1.PC5	The student can investigate the different methods of communication systems commonly used.
ROBENG.U1.E1.PC6	The student can describe the potential security issues with networked PLC systems.
ROBENG.U1.E1.PC7	The student can utilise PLC programming languages
ROBENG.U1.E1.PC8	The student can explain Boolean logic and its relationship to PLC programming
ROBENG.U1.E1.PC9	The student can explain the number systems used in digital systems: Binary, Hex.
ROBENG.U1.E1.PC10	The student can demonstrate the ability to read, develop and

Performance Criterion	Evidence Check: The student can demonstrate:
	debug PLC Ladder Logic programs.
ROBENG.U1.E1.PC11	The student can produce programmes that operate the equipment in an energy efficient manner.
ROBENG.U1.E1.PC12	The student can demonstrate the ability to use PLC programming software.
ROBENG.U1.E1.PC13	The student can demonstrate documentation, archiving and restoration techniques for programmes.

Table 1: Performance Criteria Example for the Delivery Unit ROBENG.U1.E1

3.3.2 Unit ROBENG.U1 Element 2: Robot Processes and Functions

Acronym: ROBENG.U1.E2
Title: Robot Processes and Functions
Element Note:
This element enables learners to understand industrial control systems and the application of control theory.

Performance Criteria:
The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U1.E2.PC1	The student can describe health and safety risks involved with industrial robots.
ROBENG.U1.E2.PC2	The student can describe the generic structure and functions of an industrial robot.
ROBENG.U1.E2.PC3	The student can describe the technology used in a chosen manufacturer's equipment.
ROBENG.U1.E2.PC4	The student can explain how industrial robots are integrated into production cells/lines.
ROBENG.U1.E2.PC5	The student can explain common applications of industrial robots.
ROBENG.U1.E2.PC6	The student can identify the energy usage of robots: • in its various operational states: standby drives-on etc. • dependant on robot manufacturer • suitability of the robot for a task.
ROBENG.U1.E2.PC7	The student can operate an industrial robot in a safe manner to execute a pre-existing programme.

Table 2: Performance Criteria Example for the Delivery Unit ROBENG.U1.E2

3.3.3 Unit ROBENG.U1 Element 3: Automated Control Systems

Acronym: ROBENG.U1.E3

Title: Automated Control Systems

Element Note:
This element enables learners to understand industrial control systems and the application of control theory.

Performance Criteria:
The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U1.E3.PC1	The student can identify types of control systems.
ROBENG.U1.E3.PC2	The student can describe the importance of integrating safety into automatic control systems.
ROBENG.U1.E3.PC3	The student can critically appraise the types of automatic control and their suitability for different applications.
ROBENG.U1.E3.PC4	The student can describe and relate control theory to a modern industrial robot.
ROBENG.U1.E3.PC5	The student can explain how manufacturer specifications may be used to determine machine characteristics for: • optimal performance • energy efficiency.

Table 3: Performance Criteria Example for the Delivery Unit ROBENG.U1.E3

3.4 UNIT ROBENG U2.MAINTENANCE

Acronym: ROBENG.U2

Title: Maintenance

Description:

This unit enables learners to understand the procedures involved with the safe mechanical and electrical maintenance on industrial automation systems; maintenance support activities for industrial automation systems and the procedures involved with diagnosing faults-on industrial automation and robots.

3.4.1 Unit ROBENG.U2 Element 2: Electrical Maintenance of Automation

Acronym: ROBENG.U2.E2

Title: Electrical Maintenance of Automation

Element Note:

This element enables learners to understand the procedures involved with the safe electrical maintenance on industrial automation systems.

Performance Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U2.E2.PC1	The student can describe the electrical hazards associated with industrial automation.
ROBENG.U2 E2.PC2	The student can read, design and evaluate basic electrical circuits.
ROBENG.U2.E2.PC3	The student can explain common problems with electrical systems.
ROBENG.U2.E2.PC4	The student can perform maintenance on automated systems and ancillary components.
ROBENG.U2.E2.PC5	The student can state the operating principles and wiring of a.c. and d.c. motors.

Table 4: Performance Criteria Example for the Delivery Unit ROBENG.U2.E2

3.4.2 Unit ROBENG.U2.Element 4: Fault Finding and Diagnosis for Automation and Robotics

Acronym: ROBENG.U2.E4

Title: Fault Finding and Diagnosis for Automation and Robotics

Element Note:

This element enables learners to carry out fault-finding techniques and understand the procedures involved with diagnosing faults-on industrial automation and robots.

Performance Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U2.E4.PC1	The student can explain how to devise a generic, logical process for identifying faults.
ROBENG.U2.E4.PC2	The student can explain fault diagnosis methods.
ROBENG.U2.E4.PC3	The student can describe how to select suitable data-capture methods to aid in fault diagnosis and rectification, where the automation system itself does not provide such a function.
ROBENG.U2.E4.PC4	The student can describe how progressive failure of equipment may lead to increased energy usage.
ROBENG.U2.E4.PC5	The student can identify specific fault-finding techniques applicable to particular manufacturers / models of equipment.
ROBENG.U2.E4.PC6	The student can interpret machine error logs to aid fault-diagnosis.
ROBENG.U2.E4.PC7	The student can identify correctly a series of fault conditions using a particular make/ model of robot.
ROBENG.U2.E4.PC8	The student can put the robot into a safe condition for maintenance, undertaking the corrective action(s) and restorative techniques.

Table 5: Performance Criteria Example for the Delivery Unit ROBENG.U2.E4

3.5 UNIT ROBENG U3. SOFTWARE IMPLEMENTATION/TECHNIQUES

Acronym: ROBENG.U3

Title: Software Implementation/Techniques

Description:

This unit enables learners to safely manipulate an industrial robot and program an industrial robot.

3.5.1 Unit ROBENG.U3 Element 1: Machine Software Design Principles

Acronym: ROBENG.U3.E1

Title: Machine Software Design Principles

Element Note:

This element enables learners to understand software design in order to create a program to correctly perform a specific function.

Assessment Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U3.E1.PC1	The student can describe generic programming terminology and philosophy
ROBENG.U3.E1.PC2	The student can explain instruction sets, variables, numbering systems.
ROBENG.U3.E1.PC3	The student can explain the basic syntax rules of a high level programming language.
ROBENG.U3.E1.PC4	The student can programme design principles.
ROBENG.U3.E1.PC5	The student can describe how efficient code can lead to reduced energy usage.
ROBENG.U3.E1.PC6	The student can create a programme using a high level language that satisfies a given set of criteria.
ROBENG.U3.E1.PC6	The student can apply de-bugging techniques to identify and correct errors in programmes.

Table 6: Performance Criteria Example for the Delivery Unit ROBENG.U3.E1

3.5.2 Unit ROBENG.U3 Element 2: Robot Programming

Acronym: ROBENG.U3.E2

Title: Robot Programming

Element Note:

This element enables learners to understand how to use industrial robots including how to safely manipulate an industrial robot and program an industrial robot

Performance Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U3.E2.PC1	The student can program an industrial robot in a safe manner.
ROBENG.U3.E2.PC2	The student can describe the generic structure and functions of an industrial robot.
ROBENG.U3.E2.PC3	The student can manipulate an industrial robot competently.
ROBENG.U3.E2.PC4	The student can interpret a typical program used to control a modern industrial robot.
ROBENG.U3.E2.PC5	The student can describe the generic structure and functions of an industrial robot.
ROBENG.U3.E2.PC6	The student can identify data types and system parameters/configurations.
ROBENG.U3.E2.PC7	The student can develop and safely modify a given program to achieve a specific task, test, and upload this program to a robot and demonstrate its function.
ROBENG.U3.E2.PC8	The student can demonstrate knowledge of robot logic and interfaces.
ROBENG.U3.E2.PC9	The student can describe the common communication protocols used in robotic installations.
ROBENG.U3.E2.PC10	The student can create robot programs to perform tasks.
ROBENG.U3.E2.PC11	The student can document the programmes created.

Table 7: Performance Criteria Example for the Delivery Unit ROBENG.U3.E2

3.6 UNIT ROBENG U4. SIMULATION AND DESIGN

Acronym: ROBENG.U5

Title: New Technologies

Description:
This unit enables learners to understand and appreciate simulation engineering in relation to automated systems and robotics and understand process optimisation in relation to industrial robotic systems.

3.6.1 Unit ROBENG.U4 Element 1: Introduction to Simulation Engineering

Acronym: ROBENG.U4.E1

Title: Introduction to Simulation Engineering

Element Note:
This element enables learners to understand and appreciate simulation engineering in relation to automated systems and robotics.

Performance Criteria:
The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U4.E1.PC1	Identify simulation packages available and their purpose.
ROBENG.U4.E1.PC2	Make modifications to a production cell model to meet a revised specification using a chosen simulation system.
ROBENG.U4.E1.PC3	Model a simple production cell from given data using a chosen simulation system.
ROBENG.U4.E1.PC4	Demonstrate FMEA techniques relating to an automation process.
ROBENG.U4.E1.PC5	Explain the advantages and limitations of simulation engineering in the design of robotic manufacturing systems such as: • modelling energy usage of the equipment in real time to realise an energy efficient process

Performance Criterion	Evidence Check: The student can demonstrate:
	• skills, costs incurred benefits, time saved, and design mistakes.

Table 8: Performance Criteria Example for the Delivery Unit ROBENG.U4.E1

3.6.2 Unit ROBENG.U4 Element 2: Process Optimisation

Acronym: ROBENG.U4.E2

Title: Process Optimisation

Element Note:

This element enables learners to understand process optimisation in relation to industrial robotic systems.

Assessment Criteria:

The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can:
ROBENG.U4.E2.PC1	Identify the main methods used to optimise a process.
ROBENG.U4.E2.PC2	Apply optimisation techniques to a given process, and suggest ways that the process could be improved.
ROBENG.U4.E2.PC3	Calculate the costs incurred for introducing potential improvements.
ROBENG.U4.E2.PC4	Explain how optimisation techniques can be applied to industrial robots systems.
ROBENG.U4.E2.PC5	Optimise software to achieve optimum operation.
ROBENG.U4.E2.PC6	Describe how machine-specific limitations may limit optimum operation in certain circumstances, and how these may be mitigated or overcome.
ROBENG.U4.E2.PC7	Measure existing energy usage and compare to an optimised process.

Table 9: Performance Criteria Example for the Delivery Unit ROBENG.U4.E2

3.7 UNIT ROBENG U5. NEW TECHNOLOGIES

Acronym: ROBENG.U5

Title: New Technologies

Description:
This unit enables provides learners with an understanding of decision-making in relation to the automation of processes.

3.7.1 Unit ROBENG.U5 Element 1: Innovation in Automation

Acronym: ROBENG.U5.E1

Title: Innovation in Automation

Element Note:
This element enables learners to understand the considerations that influence the decision whether or not to automate a process.

Performance Criteria:
The student must be able to show evidence of competencies based on the following performance criteria:

Performance Criterion	Evidence Check: The student can demonstrate:
ROBENG.U5.E1.PC1	State the technical and financial factors that determine the effectiveness of automation
ROBENG.U5.E1.PC2	Describe the financial factors that may be used to guide the decision to introduce an automated process such as: • capital cost • improvements to the manufacturing process • energy usage • maintenance costs.
ROBENG.U5.E1.PC3	Examine a production process and evaluate if automation is appropriate

Table 10: Performance Criteria Example for the Delivery Unit ROBENG.U5.E1

4 CONFIGURATION FOR ROBOTIC ENGINEER (RE) AND ROBOTIC TECHNICIAN (RT)

This skill set is the result of a 'bottom up' approach involving more than 30 Jaguar LandRover supply chain employers to identify the core skills and knowledge of a robotics engineer and technicain .

This was the basis to then develop learning materials and a syllabus, with each syllabus unit then piloted and tested. Once tested with employers this syllabus was then converted into a qualification.

The process has resulted in the identification of a clear set of skills needed for 2 job roles, these being that of Robotic Engineer and Robotic Technician.

Content Units of the Training and Skill card	Robotics Engineer	Robotics Technician
Delivery Unit ROBENG.U1.E1 Programmable Logic Control	Essential	Optional
Unit ROBENG.U1.E2 – Robot Processes and Functions	Essential	Optional
Unit ROBENG.U1.E3 – Automated Control Systems	Essential	
Unit ROBENG.U2.E1 – Mechanical Maintenance of Automation		Essential
Unit ROBENG.U2.E2 – Electrical Maintenance of Automation	Optional	Essential
Unit ROBENG.U2.E3 – Maintenance support activities for Automation		Essential
Unit ROBENG.U2.E4 – Fault Finding and Diagnosis for Automation and Robotics	Essential	Essential
Unit ROBENG.U3.E1 – Machine Software Design Principles	Essential	
Unit ROBENG.U3.E2 – Robot Programming	Essential	Essential
Unit ROBENG.U4.E1 – Introduction to Simulation Engineering	Essential	
Unit ROBENG.U4.E2 – Process Optimisation	Essential	
Unit ROBENG.U5.E1 – Innovation in Automation	Essential	

Table 11: ROBENG and ROBTECH Skill Set with Robotics Engineer and Robotics Technician Scope

The role of a Robotic Engineer is to install or modify a robotic manufacturing system/machine. They use pre-established designs and current developments for improving machinery and equipment. They combine several knowledge fields such as computing, engineering, and electronics.

In addition to the above the specific job roles Robotics and Automation training is also relevant for a wide range of engineering related functions including:

- Safety Engineer
- Fault Finding Engineer
- Environmental Engineer

- Process Engineer
- Joining Engineer
- Layout Engineer
- Controls Engineer
- Mechanical Engineer
- Design Engineer
- Virtual Engineer

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.

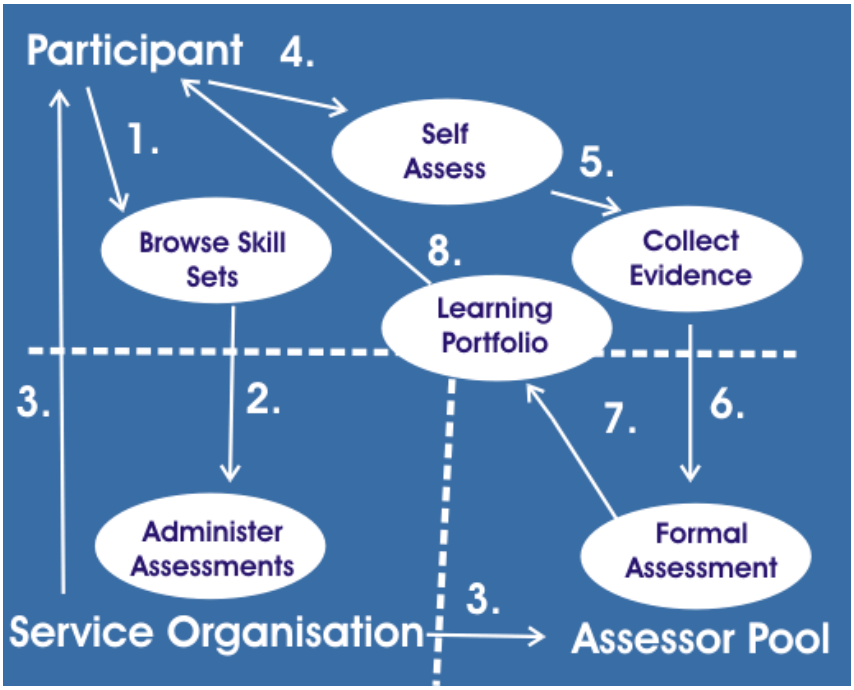
ECQA SKILLS ASSESSMENT MODEL

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 2: 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

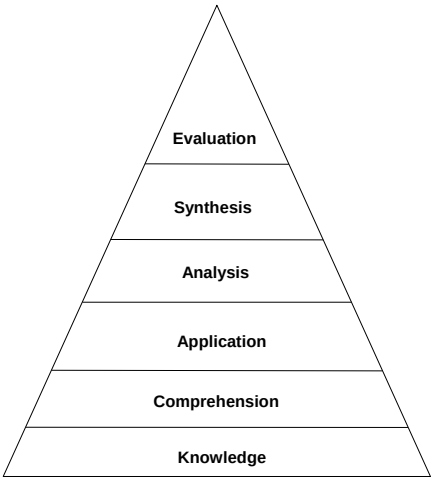
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

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.

EAL

EAL is the awarding body for the SKILLMAN Robotics and Automation course in the UK. EAL is the specialist skills partner and awarding organisation for industry in the UK. Over the last ten years, 1.3 million people in the UK embarked on an EAL qualification in schools, academies, university technical colleges (UTCs), colleges, universities, private training facilities and workplaces.

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