DRIVES

Development and Research on Innovative Vocational Education Skills

Sensor Fusion Expert

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 Sensor Fusion Expert 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.

2 ECQA SKILLS DEFINITION MODEL

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

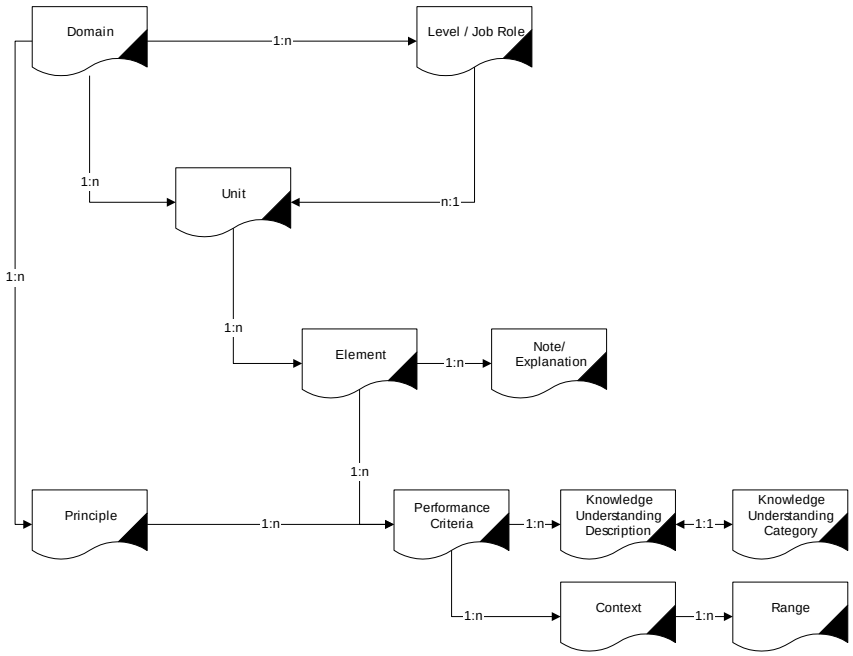

Figure 1 The Skill Definition Model (1:n = one to many relationship)

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 "Sensor Fusion Expert"

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 "Sensor Fusion Expert" has been designed.

Unit ID	Unit Name	Element ID	Element Name
SFE.U1	Electronics and Electricity Principles	SFE.U1.E1	Fundamental Concepts of Electricity
		SFE.U1.E2	Circuit Design and Analysis
		SFE.U1.E3	Important Electrical Components
		SFE.U1.E4	Equipment and Measurements
SFE.U2	Essential Sensor Foundations	SFE.U2.E1	Sensors Basics: Definition, Functions and Features
		SFE.U2.E2	Types of Sensors
		SFE.U2.E3	Handling Sensors
		SFE.U2.E4	Applications
SFE.U3	Introduction to Sensor Fusion	SFE.U3.E1	Sensor Fusion Background and Overview
		SFE.U3.E2	Sensor Fusion Networks
		SFE.U3.E3	Multi Sensor Fusion Architectures, Design and Implementation
SFE.U4	Data and Sensor Fusion Applications, Use Cases and Real-Life Examples	SFE.U4.E1	Sensor Fusion Background and Overview
		SFE.U4.E2	Sensor Fusion Networks
		SFE.U4.E3	Multi Sensor Fusion Architectures, Design and Implementation
		SFE.U4.E4	Data and Sensor Fusion Applications, Use Cases and Real-Life Examples

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Table 1 : The Skills Set for ECQA Certified Sensor Fusion Expert

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE SENSOR FUSION EXPERT

Domain Acronym: Engineering

Domain title: Artificial Intelligence in Automotive

Domain Description:

The field of Artificial Intelligence aims to design computer programs and/or machines which simulate intelligence to mimic human cognitive abilities. Artificial Intelligence is a broad science which includes thinking models, cognitive and knowledge-based systems, problem solving, and decision making. In the automotive industry, the upcoming fully autonomous vehicles will rely heavily on Artificial Intelligence to perceive its environment, reduce the reaction time, and perform the better action according to a rigorous assessment of the consequences of each action and the projection of the different scenarios possible in order to maximize the safety of all interveners, including the driver and passengers inside the car, other human beings in another cars, pedestrians and animals. Artificial Intelligence can also be used to enhance the experience inside the car, enabling a more comfortable, and pleasant ride experience according to user preferences.

Job Role Acronym: SFE

Job Role Title: Sensor Fusion Expert

Description:

The Skill card comprises the following thematic learning units

Unit 1 – Electronics and Electricity Principles

Unit 2 – Essential Sensor Foundations

Unit 3 – Introduction to Sensor Fusion

Unit 4 – Data and Sensor Fusion Applications, Use Cases and Real-Life Examples

3.3 UNIT SFE.U1 ELECTRONICS AND ELECTRICITY PRINCIPLES

Acronym: SFE.U1

Title: Electronics and Electricity Principles

Description:

The first unit is an introduction to electronics and electricity focusing on circuit analysis, important components, equipment and measures. It consists of the following learning elements:

E1 – Fundamental Concepts of Electricity

E2 – Circuit Design and Analysis

E3 – Important Electrical Components

E4 – Equipment and Measurements

3.3.1 Unit SFE.U1 - Element 1: Fundamental Concepts of Electricity

Acronym: SFE.U1.E1

Element Title: Fundamental Concepts of Electricity

Element Note:

This learning element provides an overview of the fundamental concepts in the area of Electricity like current, energy, voltage and power.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U1.E1.PC1	The student is able to represent electrical signals and knows how to perform the Fourier analysis.
SFE.U1.E1.PC2	The student understands and is able to explain Electric Charge, Electric Power, Electric Field and Electric Potential Energy.
SFE.U1.E1.PC3	The student knows the concepts of Voltage, Current, Power, Energy and Yield.
SFE.U1.E1.PC4	The student can distinguish and relate different fundamental concepts of electricity.
SFE.U1.E1.PC5	The student knows and understands rudiments of magnetism.

Table 2: Performance Criteria for the Element SFE.U1.E1

3.3.2 Unit SFE.U1 - Element 2: Circuit Design and Analysis

Acronym: SFE.U1.E2

Element Title: Circuit Design and Analysis

Element Note:

This learning element provides insights on circuit design and analysis, offering students the essential knowledge to explore, manipulate and create different electronic circuits.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U1.E2.PC1	The student knows the notations and symbolic representation of the different elements of a circuit.
SFE.U1.E2.PC2	The student is able to distinguish and perceive series and parallel circuits.
SFE.U1.E2.PC3	The student is able to list and understand the main laws and theorems in circuit analysis and is able to apply the fundamental theorems and laws to analyse series and parallel circuits.
SFE.U1.E2.PC4	The student understands the concept of Impedance, Phasors and Complex Numbers.
SFE.U1.E2.PC5	The student is able to associate phasors to the time domain representation of electrical quantities (voltages and currents) of sinusoidal wave form.
SFE.U1.E2.PC6	The student knows how to calculate electric power in alternating current.
SFE.U1.E2.PC7	The student critically analyses resistor-capacitor (RC) and resistor-inductor (RL) circuits.
SFE.U1.E2.PC8	The student is able to design, integrate and manipulate electric circuits.

Table 3: Performance Criteria for the Element SFE.U1.E2

3.3.3 Unit SFE.U1 - Element 3: Important Electrical Components

Acronym: SFE.U1.E3

Element Title: Important Electrical Components

Element Note:

This learning element is an overview of the most common and important electrical components focusing on their definition, purpose, and characteristics.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U1.E3.PC1	The student is able to define important electrical components and understand their main characteristics.
SFE.U1.E3.PC2	The student can identify each component and know how to distinguish them from each other.
SFE.U1.E3.PC3	The student knows the working principle of some basic electronic components.

Table 4: Performance Criteria for the Element SFE.U1.E3

3.3.4 Unit SFE.U1 - Element 4: Equipment and Measurements

Acronym: SFE.U1.E4

Element Title: Equipment and Measurements

Element Note:

This learning element focus on the most important and commonly used electronic equipment and measurements.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U1.E4.PC1	The student knows the functioning of the different measuring devices.
SFE.U1.E4.PC2	The student is able to critically select and use the appropriate measuring device to measure a specific electrical quantity.

Table 5: Performance Criteria for the Element SFE.U1.E4

3.4 UNIT SFE.U2 ESSENTIAL SENSOR FOUNDATIONS

Acronym: SFE.U2

Title: Essential Sensor Foundations

Description:

The second unit of this job role provides insights on fundamental sensor expertise. It consists of the following learning elements:

E1 – Sensors Basics: Definition, Functions and Features

E2 – Types of Sensors

E3 – Handling Sensors

E4 – Sensor Applications

3.4.1 Unit SFE.U2 - Element 1: Sensors Basics

Acronym: SFE.U2.E1

Element Title: Sensors Basics

Element Note:

This learning element provides a detailed overview of the basic information concerning sensors based on its definition, functioning, and main features.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U2.E1.PC1	The student understands the nature, purpose, and particularities of sensors.
SFE.U2.E1.PC2	The student can list and describe the main functionalities of sensors.
SFE.U2.E1.PC3	The student is able to define the key features of sensors.

Table 6: Performance Criteria for the Element SFE.U2.E1

3.4.2 Unit SFE.U2 - Element 2: Types of Sensors

Acronym: SFE.U2.E2

Element Title: Types of Sensors

Element Note:

This learning element provides insights on the different types of sensors as well as their characteristics and purposes.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U2.E2.PC1	The student understands the different classifications of sensors.

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U2.E2.PC2	The student knows how to properly classify a sensor.

Table 7: Performance Criteria for the Element SFE.U2.E2

3.4.3 Unit SFE.U2 - Element 3: Handling Sensors

Acronym: SFE.U2.E3

Element Title: Handling Sensors

Element Note:

This learning element provides insights and specific instructions on how to properly manipulate sensors.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U2.E3.PC1	The student knows how to perform sensor calibration.
SFE.U2.E3.PC2	The student is able to model common sensors and their measurements.
SFE.U2.E3.PC3	The student can combine and synchronize sensors.

Table 8: Performance Criteria for the Element SFE.U2.E3

3.4.4 Unit SFE.U2 - Element 4: Sensor Applications

Acronym: SFE.U2.E4

Element Title: Sensor Applications

Element Note:

This learning element focus on the different application areas of sensors, focusing on their contributions and impacts on society.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U2.E4.PC1	The student is able to analyse and understand the applications of sensors.
SFE.U2.E4.PC2	The student recognizes the importance and potential of using sensors.

Table 9: Performance Criteria for the Element SFE.U2.E4

3.5 UNIT SFE.U3 INTRODUCTION TO SENSOR FUSION

Acronym: SFE.U3

Title: Introduction to Sensor Fusion

Description:

The third unit of this job role introduces the process of sensor fusion in a clear and simple way to further be explained in more depth and comprehensiveness. It consists of the following learning elements:

E1 – Sensor Fusion Background and Overview

E2 – Sensor Fusion Networks

E3 – Multi Sensor Fusion Architectures, Design and Implementation

E4 – Data and Sensor Fusion Applications, Use Cases and Real-Life Examples

3.5.1 Unit SFE.U3 - Element 1: Sensor Fusion Background and Overview

Acronym: SFE.U3.E1

Element Title: Sensor Fusion Background and Overview

Element Note:

This learning element provides an introduction to sensor fusion, focusing on data fusion and sensor integration, as well as, their purposes and contributions.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E1.PC1	The student is able to define the sensor fusion approach.
SFE.U3.E1.PC2	The student is able to define the key features of data fusion and sensor integration

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E1.PC3	The student is able to identify the motivating factors behind sensor fusion.
SFE.U3.E1.PC4	The student can explain the value proposition of sensor fusion.

Table 10: Performance Criteria for the Element SFE.U3.E1

3.5.2 Unit SFE.U3 - Element 2: Sensor Fusion Networks

Acronym: SFE.U3.E2

Element Title: Sensor Fusion Networks

Element Note:

This learning element offers insights on the sensor fusion networks, focusing on the basic components and principles.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E2.PC1	The student knows how to explain the principles of sensor fusion systems.
SFE.U3.E2.PC2	The student is able to list and understand the basic components of a sensor fusion network.
SFE.U3.E2.PC3	The student can explore sensor fusion networks and critically analyse the possibility of making any changes that may improve their performance.

Table 11: Performance Criteria for the Element SFE.U3.E2

3.5.3 Unit SFE.U3 - Element 3: Multi Sensor Fusion Architectures, Design, and Implementation

Acronym: SFE.U3.E3

Element Title: Multi Sensor Fusion Architectures, Design, and Implementation

Element Note:

This learning element offers a comprehensive overview of the different multi sensor fusion architectures, as well as, their design and implementation.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E3.PC1	The student is able to list the functional requirements of multisensory fusion.
SFE.U3.E3.PC2	The student understands and compares the different types of architectures for sensor fusion systems.
SFE.U3.E3.PC3	The student is able to critically select the architecture that best fits a specific problem or situation.
SFE.U3.E3.PC4	The student can assemble and manage information gathering and integration from a variety of sources.
SFE.U3.E3.PC5	The student is able to design and implement a multi sensor fusion system.

Table 12: Performance Criteria for the Element SFE.U3.E3

3.5.4 Unit SFE.U3 - Element 4: Data and Sensor Fusion Applications, Use Cases and Real-Life Examples

Acronym: SFE.U3.E4

Element Title: Data and Sensor Fusion Applications, Use Cases and Real-Life Examples

Element Note:

This learning element provides a detailed overview of the different purposes and contributions of data and sensor fusion through the analysis of some of their applications, use cases and real-life examples.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E4.PC1	The student can analyse and understand what sensor fusion applications are.
SFE.U3.E4.PC2	The student recognizes and critically understands the challenging problems surrounding sensor fusion approaches.
SFE.U3.E4.PC3	The student is able to discuss and explain some sensor fusion use cases with focus on autonomous driving.

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U3.E4.PC4	The student is able to explore and interpret real life examples of sensor fusion.

Table 13: Performance Criteria for the Element SFE.U3.E4

3.6 UNIT SFE.U4 SENSOR FUSION IN-DEPTH

Acronym: SFE.U4

Title: Sensor Fusion In-Depth

Description:

The last unit of this job role makes a profound and detailed description of sensor fusion and provides insights on important notions and procedures when performing sensor fusion techniques. It consists of the following learning elements:

E1 – Lidar, Radar and Camera

E2 – Measurement Models

E3 – Estimation Theory and Estimation Algorithms

E4 – Filtering

E5 – Fusion Methods

E6 – Feature-Based SLAM (Simultaneous Localization and Mapping) Methods and its EKF (Extended Kalman Filter) Solution

3.6.1 Unit SFE.U4 - Element 1: Lidar, Radar and Camera

Acronym: SFE.U4.E1

Element Title: Lidar, Radar and Camera

Element Note:

This learning element provides a detailed description of the different sensors, namely lidar, radar and camera, as well as their application domains.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E1.PC1	The student can describe Lidar, Radar and Camera and their particularities.
SFE.U4.E1.PC2	The student understands and distinguishes the different sensors.

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E1.PC3	The student knows the different use cases of each type of sensor.
SFE.U4.E1.PC4	The student is able to combine and synchronize different sensors according to specific conditions.

Table 14: Performance Criteria for the Element SFE.U4.E1

3.6.2 Unit SFE.U4 - Element 2: Measurement Models

Acronym: SFE.U4.E2

Element Title: Measurement Models

Element Note:

This learning element provides a comprehensive description of measurement models, namely basic model, vector model, multiple measurements and measurement stacking, and gaussian measurement noise.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E2.PC1	The student understands what measurement models are.
SFE.U4.E2.PC2	The student understands the logic behind each measurement model.
SFE.U4.E2.PC3	The student knows the different use cases of each type of measurement model.
SFE.U4.E2.PC4	The student is able to select an adequate measurement model to a specific situation or problem.
SFE.U4.E2.PC5	The student can employ and evaluate a measurement model.

Table 15: Performance Criteria for the Element SFE.U4.E2

3.6.3 Unit SFE.U4 - Element 3: Estimation Theory and Estimation Algorithms

Acronym: SFE.U4.E3

Element Title: Estimation Theory and Estimation Algorithms

Element Note:

This learning element addresses the fundamental aspects of Estimation Theory and Estimation Algorithms, focusing on Static Linear Models, Static Nonlinear Models, and State Space Models.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E3.PC1	The student understands and demonstrates the need, purpose, and outcomes of estimation theory.
SFE.U4.E3.PC2	The student is able to identify and explain the differences between linear, nonlinear and state space models.
SFE.U4.E3.PC3	The student knows the different use cases of each type of estimation algorithm.
SFE.U4.E3.PC4	The student is able to select the right estimation algorithm to a specific problem or situation.
SFE.U4.E3.PC5	The student can apply estimation algorithms and assess their behaviour.

Table 16: Performance Criteria for the Element SFE.U4.E3

3.6.4 Unit SFE.U4 - Element 4: Filtering

Acronym: SFE.U4.E4

Element Title: Filtering

Element Note:

This learning element addresses the fundamental aspects of filtering, focusing on the Kalman Filter, Linear Kalman filter, Extended Kalman Filter, Unscented Kalman Filter and Particle Filter.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E4.PC1	The student understands and demonstrates the nature and purpose of filtering.
SFE.U4.E4.PC2	The student is able to describe the essential properties of the Kalman filter.
SFE.U4.E4.PC3	The student understands, compares and distinguishes the different types of Kalman filters.

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E4.PC4	The student knows the different use cases of each type of Kalman filter.
SFE.U4.E4.PC5	The student is able to describe the essential properties of Particle filters.
SFE.U4.E4.PC6	The student is able to critically select a suitable filtering technique to a specific problem depending on the type of system dynamics and noise characteristics.
SFE.U4.E4.PC7	The student is able to develop Kalman as well as Particle filtering algorithms for solving sensor fusion problems.

Table 17: Performance Criteria for the Element SFE.U4.E4

3.6.5 Unit SFE.U4 - Element 5: Fusion Methods

Acronym: SFE.U4.E5

Element Title: Fusion Methods

Element Note:

This learning element provides a comprehensive description of the different types of fusion methods with particular emphasis on the Bayesian Methods, the Dempster-Shafer Inference, the Abductive Reasoning and the Semantic Methods.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E5.PC1	The student understands the need and purpose of the fusion methods.
SFE.U4.E5.PC2	The student is able to describe, understand and compare the different fusion methods and their particularities.
SFE.U4.E5.PC3	The student knows the different use cases of each type of fusion method.
SFE.U4.E5.PC4	The student is able to critically select and apply the right sensor fusion method according to the system dynamics and noise characteristics.
SFE.U4.E5.PC5	The student can test, evaluate, and compare different sensor fusion methods.

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E5.PC6	The student can develop algorithms to perceive the world around a vehicle as well as to track, detect, and identify objects and threats over time.

Table 18: Performance Criteria for the Element SFE.U4.E5

3.6.6 Unit SFE.U4 - Element 6: Feature-Based SLAM (Simultaneous Localization and Mapping) Methods and its EKF (Extended Kalman Filter) Solution

Acronym: SFE.U4.E6

Element Title: Feature-Based SLAM (Simultaneous Localization and Mapping) Methods and its EKF (Extended Kalman Filter) Solution

Element Note:

This learning element provides students with a comprehensive description and understanding of the Simultaneous Localization and Mapping (SLAM) problem. In addition, this element presents the Extended Kalman Filter (EKF) as a solution to the problem explaining each step of its operation. Finally, this element briefly explains other SLAM algorithms, UKF SLAM, Fast SLAM, etc.

Performance Criteria:

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

Performance Criterion	Evidence Check: The student can demonstrate
SFE.U4.E6.PC1	The student is able to define and understand SLAM.
SFE.U4.E6.PC2	The student recognizes and critically understands the challenges behind the SLAM problem.
SFE.U4.E6.PC3	The student is able to acknowledge the EKF solution and understand each step of its operation.
SFE.U4.E6.PC4	The student can examine and analyse concrete examples of the application of the EKF to solve the SLAM problem.
SFE.U4.E6.PC5	The student is able to setup an EKF for SLAM.
SFE.U4.E6.PC6	The student recognizes the existence of other SLAM algorithms (UKF SLAM, Fast SLAM, ...) and briefly defines and distinguishes their approaches.

Table 19: Performance Criteria for the Element SFE.U4.E6

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.

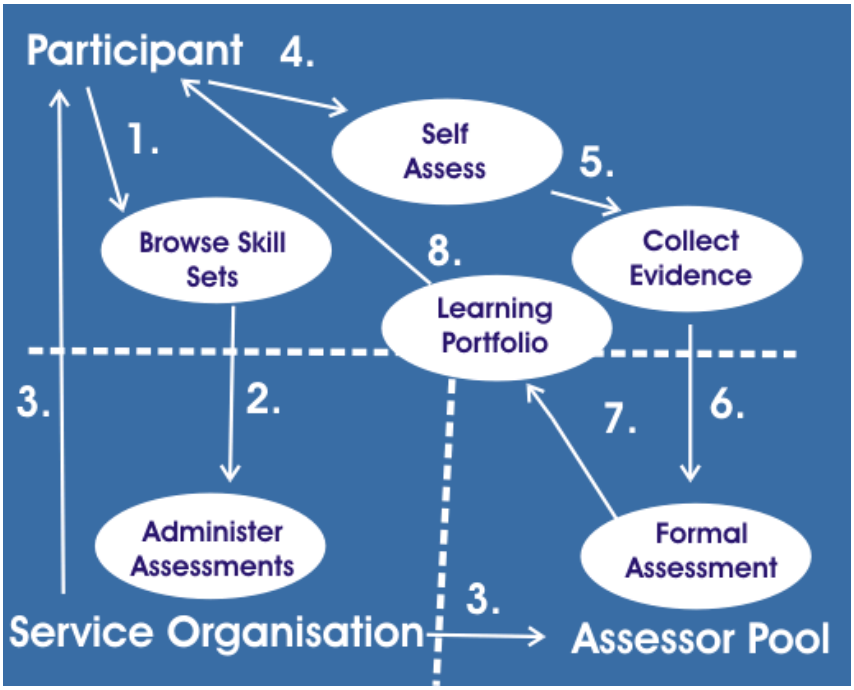
ECQA SKILLS ASSESSMENT MODEL

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

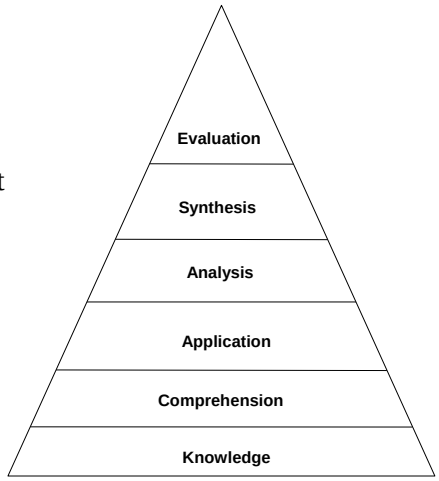
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

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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