DRIVES

Development and Research on Innovative Vocational Education Skills

Computer Vision 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 Computer Vision 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.

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2 ECQA SKILLS DEFINITION MODEL

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

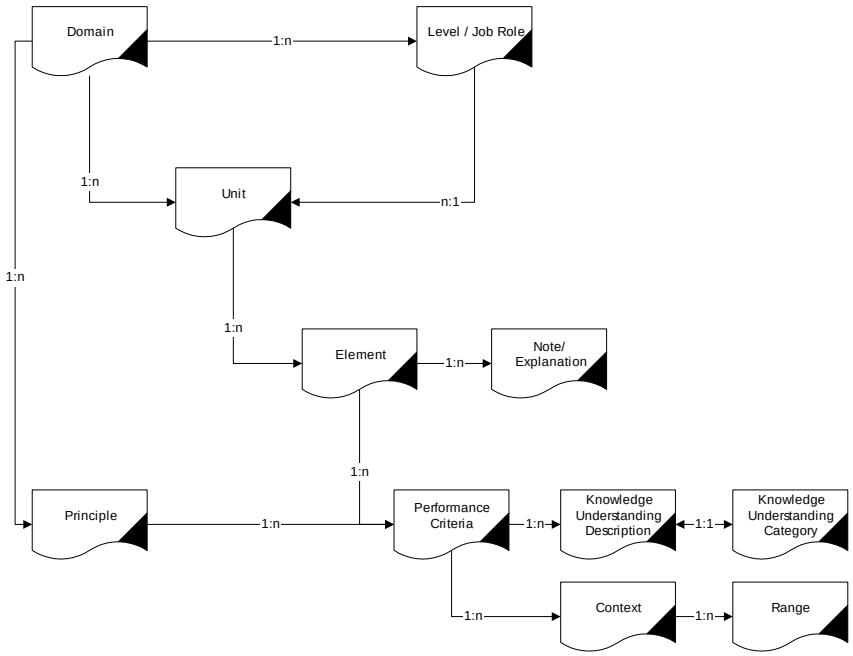


Figure 1 The Skill Definition Model (1:n = one to many relationship)

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 "COMPUTER VISION 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 "Computer Vision Expert" has been designed.

Unit ID	Unit Name	Element ID	Element Name
CVE.U1	Artificial Intelligence Overview	CVE.U1.E1	Artificial Intelligence Fundamentals
		CVE.U1.E2	Machine Learning Basics
		CVE.U1.E3	Underpinnings of Deep Learning
		CVE.U1.E4	Artificial Intelligence Applications, Use Cases and Real-Life Examples
		CVE.U1.E5	The Philosophical Problems Surrounding Artificial Intelligence: Issues, Concerns and Ethical Considerations
CVE.U2	Computer Vision Fundamentals	CVE.U2.E1	Computer Vision Overview
		CVE.U2.E2	State-of-the-art Vision Techniques
		CVE.U2.E3	Image Formation
		CVE.U2.E4	Image Processing and Manipulation
		CVE.U2.E5	Dimensionality Reduction: Feature Selection and Extraction
		CVE.U2.E6	Image Segmentation
		CVE.U2.E7	Image Classification
		CVE.U2.E8	Video Basics
		CVE.U2.E9	Feature Detection and Matching

		CVE.U2.E10	Object Detection and Tracking, Motion Estimation, Facial Recognition, Scene Understanding and 3D Reconstruction
CVE.U3	Computer Vision in Practice	CVE.U3.E1	Familiarization with Well-Known Computer Vision Tools (OpenCV, TensorFlow, NumPy, etc.)
		CVE.U3.E2	Analysis and Exploration of Typical Problems or Tasks Pursued in Computer Vision
		CVE.U3.E3	Resolution of common computer vision problems

Table 1 : The Skills Set for ECQA Certified Computer Vision Expert

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE COMPUTER VISION 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: CVE

Job Role Title: Computer Vision Expert

Description:

The Skill card comprises the following thematic learning units

Unit 1 – Artificial Intelligence Overview

Unit 2 – Computer Vision Fundamentals

Unit 3 – Computer Vision in Practice

3.3 UNIT CVE.U1 ARTIFICIAL INTELLIGENCE OVERVIEW

Acronym: CVE.U1

Title: Artificial Intelligence Overview

Description:

The first unit is an introduction to artificial intelligence and related concepts such as machine learning and deep learning that provides learners a broad overview of artificial intelligence and its main particularities. It consists of the following learning elements:

E1 – Artificial Intelligence Fundamentals

E2 – Machine Learning Basics

E3 – Underpinnings of Deep Learning

E4 – Artificial Intelligence Applications, Use Cases and Real-Life Examples

E5 – The Philosophical Problems Surrounding Artificial Intelligence: Issues, Concerns and Ethical Considerations

3.3.1 Unit CVE.U1 - Element 1: Artificial Intelligence Fundamentals

Acronym: CVE.U1.E1

Element Title: Artificial Intelligence Fundamentals

Element Note:

This learning element describes the concept of Artificial Intelligence based on its definition, origin, contributions and, also, constraints.

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
CVE.U1.E1.PC1	The student understands the differences between data, information, knowledge, understanding/insight and wisdom.
CVE.U1.E1.PC2	The student is able to define artificial intelligence.
CVE.U1.E1.PC3	The student understands the need, purpose and impacts of artificial intelligence.

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

3.3.2 Unit CVE.U1 - Element 2: Machine Learning Basics

Acronym: CVE.U1.E2

Element Title: Machine Learning Basics

Element Note:

This learning element is an introduction to machine learning, a particular branch of artificial intelligence, and focus on the essential aspects of machine learning, providing students a broad overview of this area.

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
CVE.U1.E2.PC1	The student understands the connection between artificial intelligence and machine learning.
CVE.U1.E2.PC2	The student is able to define and characterize machine learning.
CVE.U1.E2.PC3	The student is able to list and explain the different types of machine learning methods.

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

3.3.3 Unit CVE.U1 - Element 3: Underpinnings of Deep Learning

Acronym: CVE.U1.E3

Element Title: Underpinnings of Deep Learning

Element Note:

This learning element is an overview of deep learning, a particular branch of artificial intelligence. This element briefly addresses the fundamental knowledge about deep learning required to perform computer vision techniques, providing students a broad overview of this area.

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
CVE.U1.E3.PC1	The student is able to define deep learning.
CVE.U1.E3.PC2	The student understands the connection and the differences between artificial intelligence, machine learning and deep learning.
CVE.U1.E3.PC3	The student understands the nature, purpose and applications of an artificial neuron.

Performance Criterion	Evidence Check: The student can demonstrate
CVE.U1.E3.PC4	The student recognizes and understands the similarities between a computational neuron and a human neuron.
CVE.U1.E3.PC5	The student knows the most commonly used activation functions for artificial neurons.
CVE.U1.E3.PC6	The student is able to define and explain what an artificial neural network is.
CVE.U1.E3.PC7	The student knows some of the most common neural networks like perceptron, multi-layer perceptron, feed-forward, backpropagation, etc.
CVE.U1.E3.PC8	The student is able to define Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN) and explain their differences.

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

3.3.4 Unit CVE.U1 - Element 4: Artificial Intelligence Applications, Use Cases and Real-Life Examples

Acronym: CVE.U1.E4

Element Title: Artificial Intelligence Applications, Use Cases and Real-Life Examples

Element Note:

This learning element focus on the applicability of Artificial Intelligence, offering an elaborated overview of the main areas of knowledge and applications of AI through real-life examples and use cases.

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
CVE.U1.E4.PC1	The student knows the different application domains of artificial intelligence.
CVE.U1.E4.PC2	The student is able to explore, analyse and discuss several examples and applications of artificial intelligence, machine learning and deep learning.
CVE.U1.E4.PC3	The student recognizes the challenges surrounding artificial intelligence approaches.

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

3.3.5 Unit CVE.U1 - Element 5: The Philosophical Problems Surrounding Artificial Intelligence: Issues, Concerns and Ethical Considerations

Acronym: CVE.U1.E5

Element Title: The Philosophical Problems Surrounding AI: Issues, Concerns and Ethical Considerations

Element Note:

This learning element focus on the challenges and ethical questions surrounding the field of Artificial Intelligence, while enhancing students' problem-solving attitude by challenging them to find solutions to mitigate such problems.

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
CVE.U1.E5.PC1	The student is able to recognize and critically understand the issues and ethical concerns surrounding artificial intelligence.
CVE.U1.E5.PC2	The student can think of ways to solve or diminish those issues and ethical concerns.

Table 6: Performance Criteria for the Element CVE.U1.E5

3.4 UNIT CVE.U2 COMPUTER VISION FUNDAMENTALS

Acronym: CVE.U2

Title: Computer Vision Fundamentals

Description:

The second unit of this job role provides insights on the underlying principles of computer vision as well as its main characteristics. It consists of the following learning elements:

E1 – Computer Vision Overview

E2 – State-of-the-art Vision Techniques

E3 – Image Formation

E4 – Image Processing and Manipulation

E5 – Dimensionality Reduction: Feature Selection and Extraction

E6 – Image Segmentation

E7 – Image Classification

E8 – Video Basics

E9 – Feature Detection and Matching

E10 – Object Detection and Tracking, Motion Estimation, Facial Recognition, Scene Understanding and 3D Reconstruction

3.4.1 Unit CVE.U2 - Element 1: Computer Vision Overview

Acronym: CVE.U2.E1

Element Title: Computer Vision Overview

Element Note:

This learning element provides an introduction to Computer Vision based on its definition, functioning, areas of application 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
CVE.U2.E1.PC1	The student is able to define computer vision.
CVE.U2.E1.PC2	The student understands the functioning of the human visual system.
CVE.U2.E1.PC3	The student understands the origin, need and purpose of computer vision.
CVE.U2.E1.PC4	The student understands the digital imaging process.
CVE.U2.E1.PC5	The student understands how computer vision fits into artificial intelligence.
CVE.U2.E1.PC6	The student knows different application domains of computer vision.

Table 7: Performance Criteria for the Element CVE.U2.E1

3.4.2 Unit CVE.U2 - Element 2: State-of-the-art Vision Techniques

Acronym: CVE.U2.E2

Element Title: State-of-the-art Vision Techniques

Element Note:

This learning element provides insights on the different types of computer vision techniques as well as their 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
CVE.U2.E2.PC1	The student understands what computer vision techniques are and what are their purposes.
CVE.U2.E2.PC2	The student is able to list and understand the most commonly used state-of-the-art vision techniques.

Table 8: Performance Criteria for the Element CVE.U2.E2

3.4.3 Unit CVE.U2 - Element 3: Image Formation

Acronym: CVE.U2.E3

Element Title: Image Formation

Element Note:

This learning element focus on the different aspects of image formation, focusing on the human and digital process of image formation.

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
CVE.U2.E3.PC1	The student understands what an image is.
CVE.U2.E3.PC2	The student knows the different types of images.
CVE.U2.E3.PC3	The student is able to arrange an image as a matrix.
CVE.U2.E3.PC4	The student knows the process of image formation in the eye.
CVE.U2.E3.PC5	The student understands the process of digital image formation.
CVE.U2.E3.PC6	The student understands the steps behind image formation.
CVE.U2.E3.PC7	The student is able to list, define and understand the factors in image formation: geometry, radiometry, photometry and digitization.
CVE.U2.E3.PC8	The student can recognize and comprehend the challenges behind image formation.

Table 9: Performance Criteria for the Element CVE.U2.E3

3.4.4 Unit CVE.U2 - Element 4: Image Processing and Manipulation

Acronym: CVE.U2.E4

Element Title: Image Processing and Manipulation

Element Note:

This learning element focus on the different aspects of image processing and manipulation, addressing important practices like image interpolation, aliasing, image enhancement, singular value decomposition, singular value equalization, filtering and many other.

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
CVE.U2.E4.PC1	The student is able to understand and distinguish the different types of image processing methods, namely, analogue and digital image processing.
CVE.U2.E4.PC2	The student comprehends what sampling, quantization, and image interpolation are.
CVE.U2.E4.PC3	The student understands the differences between image resize and remapping.
CVE.U2.E4.PC4	The student understands what aliasing is and is able to distinguish between spatial aliasing and anti-aliasing.
CVE.U2.E4.PC5	The student understands and defines spatial domain methods and frequency domain methods.
CVE.U2.E4.PC6	The student knows important concepts for image enhancement in spatial domain like point processing and mask processing.
CVE.U2.E4.PC7	The student understands what contrast stretching is.
CVE.U2.E4.PC8	The student knows some commonly used transformation functions used in contrast enhancement.
CVE.U2.E4.PC9	The student understands what histogram and histogram processing is and knows how histogram equalization works.
CVE.U2.E4.PC10	The student understands how Singular Value Decomposition (SVD) and Singular Value Equalization (SVE) works.
CVE.U2.E4.PC11	The student knows arithmetic and logic operations and understands their differences.
CVE.U2.E4.PC12	The student understands image subtraction and image averaging process.
CVE.U2.E4.PC13	The student understands the differences between linear and nonlinear spatial filtering.

Performance Criterion	Evidence Check: The student can demonstrate
CVE.U2.E4.PC14	The student is able to define and differentiate convolution and correlation.
CVE.U2.E4.PC15	The student understands the differences between linear and nonlinear smoothing filters as well as statistical filters.
CVE.U2.E4.PC16	The student is able to define and understand Laplacian, gradient and sobel operator.

Table 10: Performance Criteria for the Element CVE.U2.E4

3.4.5 Unit CVE.U2 - Element 5: Dimensionality Reduction: Feature Selection and Extraction

Acronym: CVE.U2.E5

Element Title: Dimensionality Reduction: Feature Selection and Extraction

Element Note:

This learning element focus on the dimensionality reduction, focusing on feature selection and extraction.

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
CVE.U2.E5.PC1	The student understands the need, definition, and purpose of dimensionality reduction.
CVE.U2.E5.PC2	The student is able to list the different types of dimensionality reduction.
CVE.U2.E5.PC3	The student can define feature selection and understand its particularities.
CVE.U2.E5.PC4	The student knows the different feature selection strategies.
CVE.U2.E5.PC5	The student is able to define feature extraction and understand its particularities.
CVE.U2.E5.PC6	The student knows the different feature extraction strategies.
CVE.U2.E5.PC7	The student is able to identify and understand the differences between feature selection and feature extraction.

Table 11: Performance Criteria for the Element CVE.U2.E5

3.4.6 Unit CVE.U2 - Element 6: Image Segmentation

Acronym: CVE.U2.E6

Element Title: Image Segmentation

Element Note:

This learning element focus on the fundamental aspects of image segmentation, focusing on the different types of image segmentation and their domain of application.

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
CVE.U2.E6.PC1	The student understands the definition, purpose and need of image segmentation.
CVE.U2.E6.PC2	The student knows the different types of image segmentation algorithms.
CVE.U2.E6.PC3	The student can define region-based segmentation.
CVE.U2.E6.PC4	The student knows the differences between threshold segmentation and regional growth segmentation.
CVE.U2.E6.PC5	The student defines edge detection segmentation.
CVE.U2.E6.PC6	The student knows and differentiates the sobel and Laplacian operators.
CVE.U2.E6.PC7	The student is able to define segmentation based on clustering.
CVE.U2.E6.PC8	The student knows the different use-cases of each image segmentation algorithm.
CVE.U2.E6.PC9	The student is able to select the most fitting image segmentation algorithm and assess its behaviour.

Table 12: Performance Criteria for the Element CVE.U2.E6

3.4.7 Unit CVE.U2 - Element 7: Image Classification

Acronym: CVE.U2.E7

Element Title: Image Classification

Element Note:

This learning element focus on the fundamental aspects of image classification, focusing on its definition, different types of models and practical applications.

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
CVE.U2.E7.PC1	The student can define and understand image classification.
CVE.U2.E7.PC2	The student is able to analyse and explore practical applications of image classification.
CVE.U2.E7.PC3	The student knows different image classification models.
CVE.U2.E7.PC4	The student is able to select the image classification model that best fits a specific situation or problem.
CVE.U2.E7.PC5	The student is able to assess the performance of the classification model and proceed with the necessary measures.

Table 13: Performance Criteria for the Element CVE.U2.E7

3.4.8 Unit CVE.U2 - Element 8: Video Basics

Acronym: CVE.U2.E8

Element Title: Video Basics

Element Note:

This learning element provides an overview of performing computer vision in videos, focusing on the challenges of performing video analysis and manipulation.

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
CVE.U2.E8.PC1	The student knows the differences between working with image and video.
CVE.U2.E8.PC2	The student understands video capturing.
CVE.U2.E8.PC3	The student knows how to perform video analysis and manipulation.

Table 14: Performance Criteria for the Element CVE.U2.E8

3.4.9 Unit CVE.U2 - Element 9: Feature Detection and Matching

Acronym: CVE.U2.E9

Element Title: Feature Detection and Matching

Element Note:

This learning element provides insights on the fundamental aspects of feature detection and matching.

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
CVE.U2.E9.PC1	The student is able to define a feature.
CVE.U2.E9.PC2	The student knows the different types of image features.
CVE.U2.E9.PC3	The student is able to define feature detection and matching and understand their purposes.
CVE.U2.E9.PC4	The student knows some commonly used feature detectors and their classification.

Table 15: Performance Criteria for the Element CVE.U2.E9

3.4.10 Unit CVE.U2 - Element 10: Object Detection and Tracking, Motion Estimation, Facial Recognition, Scene Understanding and 3D Reconstruction

Acronym: CVE.U2.E10

Element Title: Object Detection and Tracking, Motion Estimation, Facial Recognition, Scene Understanding and 3D Reconstruction

Element Note:

This learning element provides insights on the fundamental aspects of object detection and tracking, motion estimation, facial recognition, scene understanding and 3D reconstruction.

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
CVE.U2.E10.PC1	The student understands the machine learning and deep learning approaches for object detection and is able to select the best approach according to a specific problem or situation.
CVE.U2.E10.PC2	The student understands the process of object tracking and knows the classification of traditional methods for tracking objects.
CVE.U2.E10.PC3	The student is able to define target representation and localization algorithms and list some examples.

Performance Criterion	Evidence Check: The student can demonstrate
CVE.U2.E10.PC4	The student is able to define filtering and data association algorithms and list some examples
CVE.U2.E10.PC5	The student understands the differences between target representation and localization algorithms and filtering and data association algorithms.
CVE.U2.E10.PC6	The student is able to define and understand what facial recognition systems are as well as identify the applications of these systems.
CVE.U2.E10.PC7	The student knows the different techniques for face acquisition.
CVE.U2.E10.PC8	The student understands the motion estimation problem and knows the different methods and algorithms for finding motion vectors.
CVE.U2.E10.PC9	The student is able to define the need and purposes of scene understanding in typical computer vision problems.
CVE.U2.E10.PC10	The student understands the need, definition, and applications of 3D reconstruction.
CVE.U2.E10.PC11	The student knows the active and passive methods for 3D reconstruction and understand their differences.

Table 16: Performance Criteria for the Element CVE.U2.E10

3.5 UNIT CVE.U3 COMPUTER VISION IN PRACTICE

Acronym: CVE.U3

Title: Computer Vision in Practice

Description:

The last unit of this job role aims to transform all the theoretical information taught until now into practical instructions in order to educate the student on how to develop computer vision techniques for problem solving. It consists of the following learning elements:

E1 – Familiarization with Well-Known Computer Vision Tools (OpenCV, TensorFlow, NumPy, etc.)

E2 – Analysis and Exploration of Typical Problems or Tasks Pursued in Computer Vision

E3 – Resolution of Common Computer Vision Problems

3.5.1 Unit CVE.U3 - Element 1: Familiarization with Well-Known Computer Vision Tools

Acronym: CVE.U3.E1

Element Title: Familiarization with Well-Known Computer Vision Tools

Element Note:

This learning element aims the understanding and manipulation of some state-of-the-art tools in the area of computer vision.

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
CVE.U3.E1.PC1	The student knows some of the most commonly used computer vision tools.
CVE.U3.E1.PC2	The student is able to correctly install the mentioned programs.
CVE.U3.E1.PC3	The student knows the operation of each program and its main functionalities.
CVE.U3.E1.PC4	The student handles programs easily and intuitively.

Table 17: Performance Criteria for the Element CVE.U3.E1

3.5.2 Unit CVE.U3 - Element 2: Analysis and Exploration of Typical Problems or Tasks Pursued in Computer Vision

Acronym: CVE.U3.E2

Element Title: Analysis and Exploration of Typical Problems or Tasks Pursued in Computer Vision

Element Note:

This learning element offers insights on the different areas of application and intervention of computer vision techniques through the exploration of some examples and the encouraging of critical analysis and critical thinking.

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
CVE.U3.E2.PC1	The student knows the different application domains of computer vision.
CVE.U3.E2.PC2	The student is able to explore and analyse several examples and applications of computer vision.
CVE.U3.E2.PC3	The student recognizes the challenges surrounding computer vision approaches.

Performance Criterion	Evidence Check: The student can demonstrate
CVE.U3.E2.PC4	The student is able to identify and recognize computer vision intervention areas.

Table 18: Performance Criteria for the Element CVE.U3.E2

3.5.3 Unit CVE.U3 - Element 3: Resolution of common computer vision problems

Acronym: CVE.U3.E3

Element Title: Resolution of common computer vision problems

Element Note:

This learning element aims to evaluate and apply the knowledge acquired so far through the analysis of the problem, the structuring of its resolution and, finally, solving it.

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
CVE.U3.E3.PC1	The student is able to Realize the differences between the various state-of-the-art tools studied and select the best tool given a specific situation or problem.
CVE.U3.E3.PC2	The student uses state-of-the-art tools to develop solutions for computer vision problems.
CVE.U3.E3.PC3	The student is able to carefully test and evaluate the solutions developed and make the necessary changes to achieve the best solution possible.

Table 19: Performance Criteria for the Element CVE.U3.E3

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.

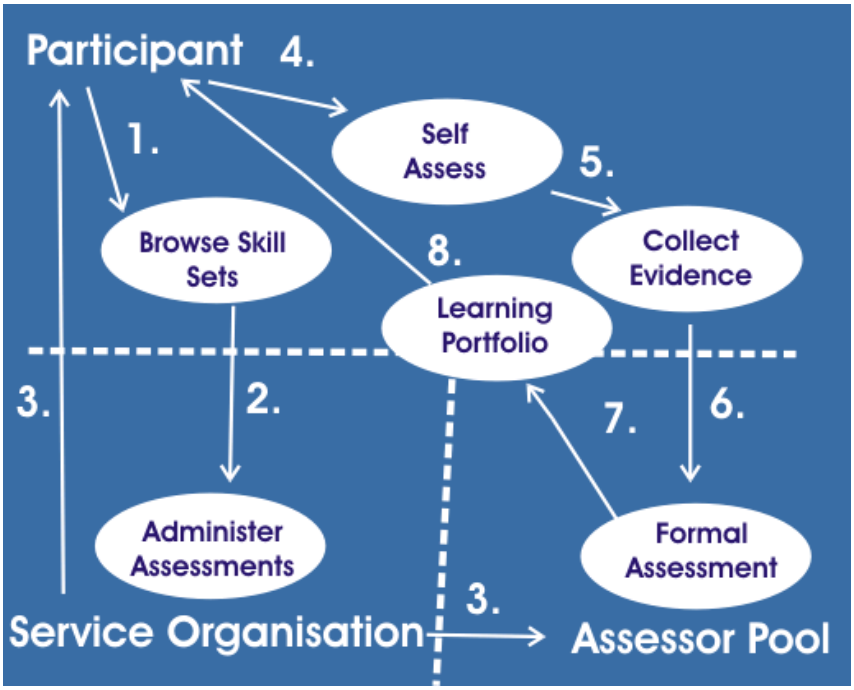
ECQA SKILLS ASSESSMENT MODEL

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

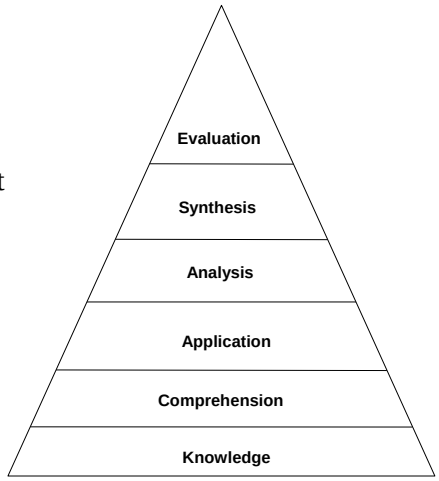
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

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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