



Erasmus+

Erasmus+ KA2 - 2016-1-ES01-KA202-025688

Project acronym: CARDEMY

Project title:

**Improving knowledge and competencies of automotive workers for the
factories of the future**

**IO1: Design of a transnational curriculum for
automotive industry**

European desk study

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1. National qualifications frameworks

European Qualifications Framework (EQF) is a common frame of reference established by the European Union that links qualifications systems of countries to improve the interpretation and understanding of the qualifications of different countries and systems in Europe. Further information is given in Annex 1.

As National Qualifications Framework vary significantly across European countries, this paragraph aims to compare following National Qualifications Framework (NQF) to this EQF:

- Spanish NQF: *Marco español de cualificaciones* (MECU)
- German NQF: *Deutscher Qualifikationsrahmen* (DQR)
- Czech NQF: *Národní soustava kvalifikací* (NSK)
- French NQF: *Répertoire national des certifications professionnelles* (RNCP)

Spanish, German and Czech NQF are literal transcription of the European model. There is thus no difference between their model and the European one.

In France, the National Qualification Framework has a limited scope and does not include primary and lower education (< 16 years old) and general secondary qualifications (Baccalauréat général). French NQF is based on a five level structure which can be still compared to EQF.

EQF	Spanish NQF: MECU	German NQF: DQR	Czech NQF: NSK	French NQF: RNCP
1	1	1	1	Not applicable
2	2	2	2	Not applicable
3	3	3	3	V
4	4	4	4	IV
5	5	5	5	III
6	6	6	6	II
7	7	7	7	I
8		8	8	I

Table 1: Comparison of NQF with EQF

2. Specialized qualifications systems

Specialized qualifications systems, presenting superior education and vocational education training, are very specific for each country studied. In the same way, this paragraph will compare each specialized qualifications to the European Qualification Framework and will present national particularities.

2.1 Specialized qualifications system: Spain

EU	SPAIN					
EQF	NQF	SQF		EDUCATION SYSTEM		
	MECU	MECES	CNCP	University	VET official education	Longlife learning
1	1		1		FP basica	
2	2				FP grado medio	Certificados de profesionalidad
3	3		2			
4	4		2		FP grado superior	
5	5	1	3	Former diplomado		
6	6	2	4	Grado	No offer for CNCP 4 & 5 levels today	
7	7	3	5	Master		
8	8	4		Doctor		

Table 2: Spanish Specialized Qualifications System

Previous table shows a comparison of Spanish educational system and presents both of specialized systems:

- MECES: *Marco español de cualificaciones en la educación superior*. This frame regulates professional education in Spain and is adapted to superior educative model from Bologna process.
- CNCP: *Catalogo nacional de cualificaciones profesionales*. This frame regulates Vocational Education and Training (VET) in Spain. This model is divided into two systems:
 - Derivative from educative system, through **Professional Training** provided by public and private centers (regulated by Ministry of Education) and Education Councils of autonomous communities. This includes professional training of basic (*grado básico*), intermediate (*grado medio*) and superior (*grado superior*) levels.
 - Derivative from continuing and professional (longlife learning) education, provided by various public and private centers, regulated by numerous public entities: ministries, labor and economic councils of autonomous communities, autonomous institutes or official corporate entities, trough professional certificates or specialties.

2.2 Specialized qualification system: Germany

Following table shows the actual vocational education training system for the automotive industry in Germany.

EU	GERMANY			
EQF	NQF	EDUCATION SYSTEM		
	DQR	University / university of applied sciences / Berufsakademie	Dual vocational training	Lifelong Learning / Berufskolleg
1	1			
2	2			
3	3		Specialized staff in the metal industry / industrial electrician	
4	4		Skilled craftsmen	
5	5			
6	6	Bachelor + skilled craftsment (like EQF4)		Foreman / technician / engineer accountant
7	7			Strategic professionals: business management graduate / business administrator
8	8			

Table 3: German Specialized Qualifications System

Berufsakademie: a specific combination for apprentices with a company contract and a simultaneous part time studies (university of cooperative education).

Berufskolleg: vocational school.

Dual vocational training: on-the-job training at a company and vocational education at a vocational school.

2.3 Specialized qualifications system: Czech Republic

EU	CZECH REPUBLIC				
EQF	NQF	EDUCATION SYSTEM			
	NSK	GENERAL	VET (GENERAL)	VET (SPECIALIZED)	VET profiles
1	1				
2	2				
3	3		Apprenticeship certificate		
4	4	Maturita exam	Vocational education - maturita exam - apprenticeship certificate		
5	5				
6	6	Bachelor		Tertiary vocational education DiS. (diplomovaný specialista)	
7	7	Master			
8	8	Doctoral			

Table 4: Czech Specialized Qualifications System

Each qualification which can be awarded under the act 179/2006, on the VNFIL, i.e. qualifications awarded outside of initial education, is listed as a vocational qualification in the NSK (the National Register of Qualifications) and has a qualification level described by competences. The level descriptors of the NSK were developed in close connection with the eight levels of the EQF. They describe the activities required at each level for employment. Despite formal differences, a comparison of the level descriptors of the NSK to those of the EQF showed that the eight qualification levels of the NSK correspond well to those of the EQF. Nowadays, National Register of Qualifications has 1,160 fields.

2.4 Specialized qualification system: France

The French NQF does not have clear distinction between VET and higher education, according to the wish of French Ministry of Higher Education to promote vocational and professional qualifications at all level. Vocational courses are now an integrated part of traditional universities.

Moreover, it exists vocational schools offering courses at a high level, training *ingénieurs*. These graduates have qualifications at a high level, equivalent to a master degree.

All of these qualifications are presented in the following table.

EU	FRANCE			
EQF	NQF	EDUCATION SYSTEM		
	RNCP	GENERAL	VET (GENERAL)	VET (SPECIALIZED)
1				
2				
3	V			CAP/BEP
4	IV	BAC Technologique	BAC Professionnel	BREVET Professionnel
5	III		DUT	BTS BREVET de maitrise
6	II	LICENCE	LICENCE Professionnelle	
7	I	MASTER	Titre d'ingénieur	
8	I	DOCTORAT		

Table 5 - French Specialized Qualifications System

3. Degree program analysis

It has been decided, according to industrial needs, to focus our project on EQF levels 3, 4 and 5, corresponding to **specialized operator interacting with complex machines and tools in advanced production systems**. Educational program analysis was made in each country to identify existing training corresponding to these levels.

3.1 Program analysis: Spain

In Spain, two types of diplomas provide training for levels targeted by Cardemy project.

- **Intermediate and superior professional training (EQF 3 and 5)**

Professional training degrees are divided in 26 professional families, which meet needs demanded by the productive system and by a productive activity. Within each professional family is included a set of training cycles, composed of theoretical and practical knowledge on various professional fields. These training cycles have duration of two academic courses and can be:

- Training cycles of Basic Professional Training (EQF 1)
- Training cycles of Intermediate Level (EQF 3)
- Training cycles of Superior Level (EQF 5)

In Spain, competencies in education field are transferred to the 17 regional governments, named autonomous communities. Supply of diplomas is determined by each autonomous government, taking into account economic reality of each community.

- **Professional certificates**

Professional certificates are the official accreditation instruments of professional qualifications of the National Catalog of Professional Qualifications in the field of labour administration. These certificates accredit set of professional competencies that enable the development of an identifiable work activity in the production system. They are official and are valid throughout the Spanish territory. They can be EQF 3 level (CNCP 2) or EQF 5 level (CNCP 3).

Professional certificates are obtained through two means:

- Pass all modules composing the professional certificate.
- Follow established procedures for the evaluation and accreditation of professional skills acquired with work experience and non-formal training.

Many entities offer professional certificates, mainly provided by training centers approved by regional governments, labour representatives, training institutes, non-profit organizations, private and public universities, etc.

Listing all certificates is excessive for this project, but all of them are indexed in the following website: <http://certificadosprofesionalidad.com/>

- **Official degrees offered with Cardemy techs and EQF levels**

Referring to professional families and degrees offered in Aragón that are subject of this analysis, the following table lists codes of intermediate and superior levels offered by the Spanish system.

SPANISH	ENGLISH	GRADO MEDIO (EQF 3-CNCP 2)	GRADO SUPERIOR (EQF 5-CNCP 3)
mecanizado cnc	cnc machining	FME202	
instalación y mantenimiento electromecánico	electromechanical installation and maintenance	MSP201 MSP203 IMA202 IMA203 IMA201	MSP302 IMA301
mecatrónica	mechatronics		IMA302
automatización y robótica	automation and robotics		ELE302 ELE303
programación de la producción en fabricación mecánica	production programming in mechanical manufacturing	FME203	FME304
programación de producción en moldeo de metales y polímeros	Production scheduling in metal and polymer molding	<i>FME205</i> (Este grado está en fase de implantación experimental en formación DUAL con la participación de empresas del CAAR)	FME305

Table 6 - Degrees related to Cardemy technologies and levels

3.2 Program analysis: Germany

One special characteristic of the German education system is the formal division between academic education in universities and universities of applied sciences on the one side and vocational education and professional development in terms of dual vocational training which takes places predominantly on company level on the other side. That is the case in general for the automotive industry. Universities of cooperative education (*Berufsakademien*) which allow part time studies including an academic degree accompanying a vocational initial education are a relatively recent development (combination EQF6 and EQF4). However, this opportunity is almost entirely offered by larger companies as to find in the automotive industry.

In addition to that the system of vocational education and further education is determined by certifications. Especially the professional development leading to qualifications of promotion is linked to the preceding level of qualification.

The entire system both of vocational initial education and of further education is essentially organized on operational level or controlled by organizations like chambers of industry and commerce, as well as institutionally regulated through participation of the state and the role of the social partners. Thus works councils have extensive competences and rights when it comes to codetermination in the field of vocational education in general. That means management in German Automobile Companies are not able to introduce training concept without respecting the co-determination rights of independent works councils in all personal topics.

In the Cardemy target group, following profiles are concerned by the project:

DUAL VOCATIONAL TRAINING	
EQF 3	Specialized staff in the metal industry
EQF 3	Industrial electrician
EQF 4	Skilled craftsmen

Table 7 - Targeted German profiles

3.3 Program analysis: Czech Republic

Currently, in Czech Republic, in CARDEMY target level EQF 3-5 is not offered any kind VET degree. First VET degree is in EQF level 6 called DiS.

However, there is a huge database of VET profiles which are directly linked to the EQF. Concerned by this analysis are focused on the following qualifications.

- Mechanical Engineering and Mechanical Production
- Electrical Engineering, Telecommunication and IT
- Transport and Communication
- Informatics

National Register of Qualifications has 189 VET profiles corresponding to these qualifications. Of these 189 profiles, only 5 are EQF 5, the rest are EQF 3 and EQF 4.

For instance, VET profiles most corresponding to the Cardemy target are:

- Automotive mechanical technician / diagnostician
- Autotronics engineer (hybrid and electric road vehicles)
- Information technology security system electrical engineer
- System administrator for small and medium enterprises

3.4 Program analysis: France

The project target levels will focus on six French diplomas, detailed in the following paragraphs.

CAP (Certificat d'aptitude professionnelle)

This diploma provides a skilled worker qualification in a specific trade. CAP diplomas concerned by Cardemy's field of study are:

- Machining in cutting and stamping tools
- Manufacture of vehicle bodywork
- Manufacture in metalworking
- Machining in metal molds

- Material forming tools
- Operator, setter in undercutting
- Preparation and completion of electrical structures

BEP (Brevet d'études professionnelles)

BEP is an intermediate diploma, which prepare to the graduation of a BAC Professionnel.

- Mechanical production
- Computerized representation of industrial products
- Maintenance of industrial products and equipments
- Plastics and composites

BAC Professionnel

BAC professionnel degree provides a skilled worker qualification in a specific area.

- Machining technician
- Modeller technician
- Mechanical production
- Production of vehicle bodywork
- Maintenance of industrial equipments
- Microtechnology
- Digital electronic systems
- Industrial boiler work technician
- Production line pilot
- Maintenance of vehicles
- Plastics and composites

Brevet Professionnel

This diploma certifies high qualification in a specific professional activity.

- Production processes pilot

BTS (Brevet de technicien supérieur)

BTS diploma is a two-year vocational diploma, which train to a specific professional sector.

- Design and production of vehicle bodywork
- Metal construction
- Design and industrialization in microtechnology
- Electrotechnical
- Process design of products manufacturing
- Material forming by forging
- Numerical systems
- Industrial control and automatic regulation
- Design and production in industrial boiler making
- System maintenance

- Design and manufacture of automatic systems
- Europlastics and composites

DUT (Diplôme universitaire technologique)

It's a two-year vocational diploma, more generalist than a BTS which covers a large panel of technological fields.

- Mechanical engineering and production automation
- Electrical engineering and industrial computing
- Industrial engineering and maintenance

4. Industry 4.0 studies offers

This paragraph aims to give an overview of official and unofficial training related to Industry 4.0 in levels targeted by the project.

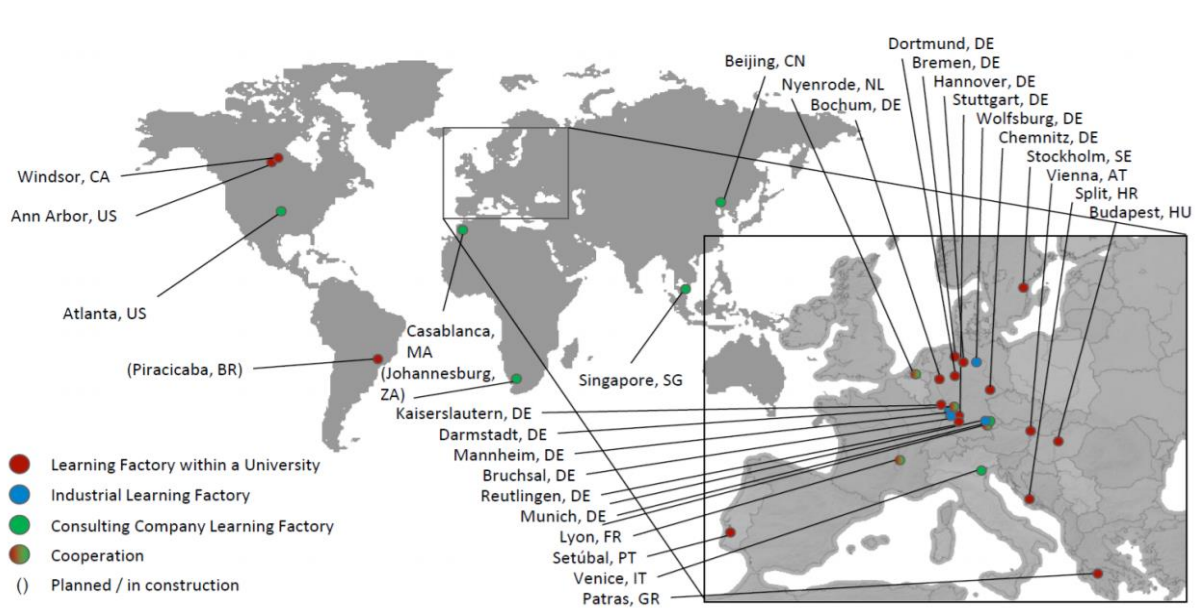
4.1 Industry 4.0 training: Spain

The educational system, at least in Spain, does not offer official titles under the name or with the indication of Industry 4.0. Private training offer is diversified with a variable quality, cost and approach. From study of these private training, it can be concluded that:

- All trainings are recent.
- Costs are very variable: from 7€/h to 60€/h. Quality is also notably different.
- Public institutions of regional governments provide one of these trainings, as a consequence of problematic of implementation of these technologies.
- These courses provide training for higher profile than those targeted by this project.
- There is two approaches. One is very technical, the other is dedicated to manager and marketing profiles.
- Some of them are allowing delivery of ECTS credits.

4.2 Industry 4.0 training: Germany

Since several years mainly German automobile companies have built up future labs (Stuttgart) or Learning Factories (for example Wolfsburg and Munich) to offer further education for different target groups in the broad field of Industry 4.0. The following chart gives an overview over the development of Learning Factories worldwide, especially in Germany on the right side..



Quelle: Institute of Production Management, Technology and Machine Tools | Prof. Dr.-Ing. E. Abele / Prof. Dr.-Ing. J. Metternich | 231027Se1 | 25

Since 2016 also the German automobile union (IG Metall) has developed special training modules only for more than 400 members of work councils of all German automobile companies to enable them to participate actively in the configuration of the digitalization process of production and work. These training modules are developed with the financial support the European Social Fond (ESF) and offered in the Learning Factory of the Ruhr-University Bochum. The following table shows the main topics and the different target groups of Industry 4.0 trainings in German automobile industry:

Target Groups / Training Modules	CEOs & board members	Middle managers	Specialists and Work Councils	Production team leaders	Operators
Big Data analysis for predictive maintenance and other productive applications: 6 sigma, quality		X	X	X	X
Cloud computing for data production storage			X	X	
Cybersecurity in the production area		X	X	X	
Internet of things: tablets, smart phones on the job, personal data capture systems, RFID products control, internet connected machines	X	X	X	X	X
3D printing for Prototyping		X	X		
3D printing for Additive manufacturing		X	X	X	
Augmented reality and smart glasses		X	X	X	
Cobots: collaborative robots		X	X	X	X

4.3 Industry 4.0 training: Czech Republic

In Czech Republic, there is not any official VET training related to Industry 4.0. Nowadays, there are more conferences and other meetings related to Industry 4.0 than practical workshops or studies.

4.4 Industry 4.0 training: France

On the target level (EQF 3, 4 and 5), most of the current degrees offer little or no training in technologies related to Industry 4.0. High level diplomas (DUT, BTS degrees) offer some awareness to their graduates, due to the needs of multidisciplinary workforce. However, this training is still slight. Current courses related to the automotive industry are thus evolving to adapt themselves to Industry 4.0 needs. It's a long process: training experts have to change national reference of their vocational training and to form their trainers.

However, various universities offer courses on subjects related on Industry 4.0. These courses are mostly specializations in engineering courses or specialized master degrees. Some examples of these offers are detailed below.

5. Training needs: conclusions from the companies questionnaire

Following conclusions are the results of interviews carried out in Spain, Germany, Czech Republic and France from February 2017 to May 2017. Profiles of interviewed companies are both small and large companies. They are representative of most activities in the automotive sector and all the production processes are used.

In Spain, 15 companies have been interviewed, in Czech Republic, 12 and 13 in France. Conclusions for Germany are the result of a survey of experts concerning the state of vocational further education in the automotive industry, divided into areas of activity and levels of qualification.

Interviewed companies were asked to study importance of following technologies for their current and future activity.

- Big Data analysis (for predictive maintenance, 6 sigma, quality, ...)
- Cloud computing
- Cybersecurity
- Internet of things
- 3D printing for prototyping
- 3D printing for Additive manufacturing
- Augmented reality and smart glasses
- Collaborative robots
- Drones

Most of companies are already using some of these technologies, such as Internet of things, 3D printing (for prototyping), Big Data or Cloud Computing, which are today widespread used.

For their future, companies consider that following technologies are the most important:

- Internet of Things
- 3D printing (prototyping)
- Collaborative robots
- Cybersecurity

Most companies planned training in Industry 4.0, but training are not always adapted to needs raised by companies. Moreover, companies tend to favour training to team leaders and superior profiles and operators are generally little concerned.

Companies noted importance of soft skills in their transition to Industry 4.0: capacity of leadership, interpersonal skills, solving problem and communication are considered as the most useful.

6. Conclusions

Qualifications and competences in the context of Industry 4.0 rather concern the handling of IT systems, the usage of data for error diagnosis and problem solving than mechanical aspects and their action patterns. They include a software centered perspective. The ability to act autonomously and to communicate and work in a team is required. Other interdisciplinary skills are the ability to cooperate in different spheres of knowledge and to master complex and unpredictable tasks. That also includes the development of a personality that enables a person to intervene proactively.

The synopsis of functional and interdisciplinary competences leads to professional socialization and concomitantly to professional ethics as a critical perspective on activities and products. Knowledge-based and reflexive concepts of action have to be expanded which require a participatory model of vocational initial education and further education (project-based learning). The connection between the development of competences and organizations is important to participatory structures of work.

Employees identifying with their work and the products of it contribute an essential part to Industry 4.0. The work-oriented design of new production systems is the guiding principle of this kind of further education, also when it comes to the protection of employment. The specialized knowledge and experience of employees who have been qualified in the dual vocational system is especially important in the automotive branch where it is relevant to matters of innovation and competition. The high relevance of participation puts a very technology-oriented view on Industry 4.0 into perspective. From the employees' standpoint, "Work 4.0" as a guiding principle for further education programs should contain essential features already found in progressive company agreements:

- Transparency of offers of further education for all employees
- Quick availability of learning offers, as well as support of independent and self-reliant learning
- Didactic structuring regarding topics and time which allows a self-regulated pace of learning

This study shows gaps between educational training and automotive industrial needs in Industry 4.0 field. For studied countries, relationship between vocational education and industry needs to be intensified and courses need to be adapted to new competence needs.

ANNEX 1: European Qualifications Framework

Main objectives:

- Promoting citizens' mobility between different countries.
- Facilitate access to lifelong learning.

The EQF-MEC officially entered into force on 23 April 2008. It sets the year 2010 as the recommended deadline for countries to match their national qualifications systems to the EQF and 2012 for individual qualification certificates to contain a reference to the corresponding EQF-MEC level.

The EQF-MEC links the different systems and national qualifications frameworks by means of a common European reference: its eight reference levels. Levels cover the entire range of qualifications, from the basic level (level 1, such as school education certificates) to the most advanced (level 8, e.g. doctorate). Since it is a tool to promote lifelong learning, the EQF-MEC takes into account all levels of qualification of general education, vocational training, academic education and other types of training. In addition, the framework also covers qualifications gained in initial education and continuing training.

The eight levels of reference are described in terms of learning outcomes. The EQF-MEC recognizes that European education and training systems are so diverse that only learning outcomes allow comparisons and enable cooperation between countries and institutions.

Following table presents the eight reference levels.

EQF – PRESENTATION OF REFERENCE LEVELS ¹			
Level	Knowledge	Skills	Competence
Level 1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context
Level 2	Basic factual knowledge of a field of work or study	Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	Work or study under supervision with some autonomy
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
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	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

¹ “Descriptors defining levels in the European Qualifications Framework (EQF), European Commission.
<https://ec.europa.eu/ploteus/fr/node/1440>