SKILLMAN

Sector Skills Alliance
for Advanced Manufacturing
in the Transport Sector

INDUSTRY & PRODUCTION 4.0 SPECIALIST

Curriculum & Teachers methodological guide

This book has been co-ordinated, drafted and produced by Centro Studi "Cultura Sviluppo" (CSCS - IT) and Teknisk Erhvervsskole Center (TEC - DK)

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The European Community publications as the main reference of specific information about the joint policy, the technology roadmaps and about the main European projects on the transport technologies.

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Contents

Innovative curricula: Skillman - Sector Skill Alliance for Advanced Manufacturing in the Transport Sector and the European VET system

Tiziana Chiappelli

Skillman project - Sector Skill Alliance for Advanced Manufacturing in the Transport Sector has provided an effective answer to the constantly and rapidly evolving scenario of new technologies affecting the advanced manufacturing in the transport sector by not only establishing innovative joint European curricula addressing current competencies and skills requirements, but also establishing a structured approach in detecting and sharing information on emerging new needs via the Observatory on Advanced Manufacturing for the Transport Sector.

The design of the innovative curricula has been carried on thanks to the collaboration and the synergies of key players in the field of Advanced Manufacturing in the Transport Sector: VET providers, enterprises, research centres and certification bodies.

THE METHODOLOGY

The Joint European Curricula developed by Skillman project are based on learning outcomes in adherence with ECVET principles and methodology. ECVET is adopted in the delivery of the educational activities and within the transnational mobility initiatives to facilitate the transfer, recognition and accumulation of assessed learning outcomes of individuals.

Skillman Curricula have been developed through the **quality assurance and improvement** cycle of **Planning, Implement, Assess/evaluate and Review/Revise** supported by common quality criteria, indicative descriptors and indicators as requested by the EQAVET INDICATORS' TOOLKIT [http://www.eqavet.eu/Libraries/Working_Groups/EQAVET_Indicators_Toolkit_final.sflb.ashx].

At European level, these common principles are defined in the "Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the "European Qualifications Framework for lifelong learning" , which are listed in Annex III [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:111:0001:0007:EN:PDF].

For instance:

[…]

- quality assurance should include regular evaluation of institutions, their programmes or their quality assurance systems by external monitoring bodies or agencies
- external monitoring bodies or agencies carrying out quality assurance should be subject to regular review,
- quality assurance should include context, input, process and output dimensions, while giving emphasis to outputs and learning outcomes

- quality assurance systems should include the following elements: > clear and measurable objectives and standards, > guidelines for implementation, > including stakeholder involvement, > appropriate resources, > consistent evaluation methods, > associating self-assessment and external review, > feedback mechanisms and procedures for improvement, > widely accessible evaluation results
- quality assurance should be a cooperative process across education and training levels and systems, involving all relevant stakeholders, within Member States and across the Community
- quality assurance orientations at Community level may provide reference points for evaluations and peer learning

All the **Skillman project Curricula** have been **developed to implement** the indicators included in the **"Recommendation on the establishment of a European Quality Assurance Reference Framework for Vocational Education and Training"** of EQAVET [http://www.eqavet.eu/gns/home.aspx], accomplished through common principles for quality assurance.

Quality assurance and improvement cycle

THE PHASES OF THE CURRICULA ELABORATION

In order to design the Curricula, Skillman project has:

a. Conducted a background survey, collecting the main results in a "State of the art on Advanced Manufacturing in the Transport Sector"

b. Produced three Yearly Outlooks of the Observatory on Advanced Manufacturing for the Transport Sector, each of them focused on specific fields: Robotics, Composite Materials, Industry and Production 4.0 and Energy Performance

c. Detected and defined competencies and skills requirements in the selected professional area by the means of accessing and aggregating existing data and research findings on labour market, particularly the research results of the National and European "Skills councils and from EU Skills Panorama"

d. Defined the needs of and requirements for VET programmes, particularly referring to tertiary qualifications for youngsters and the short-cycle qualifications for workers

e. Designed a first draft of the Joint European curricula in line with the sector requirements in the field of Advance Manufacturing conceived on the basis of learning outcomes and units of learning, in compliance with ECVET and EQF

f. Implemented the Joint European Curricula in piloting activities, workshops, trainings a National and International level

g. Assessed and revised the Curricula on the basis of the feedbacks collected during the implementation phase, and produced the final version.

Project teams experts have conducted all the phases in strict collaboration, combining the point of view of the research centers, the companies, the VET providers and the certifying bodies. The delivery of educational programmes has been based upon the reference framework promoted by EQAVET, its procedures and 10 indicators for monitoring the quality and impact of VET programmes.

THE BENEFICIARIES OF SKILLMAN CURRICULA

The main target groups who will benefit from the Curricula are:

- Youngsters: the Skillman Curricula foster tertiary qualifications and higher apprenticeship schemes in the field of Advanced Manufacturing. One of the challenges determining significant unmatched job vacancies within European Advance Manufacturing sector, is, from one side, that youngsters (and their parents) are not well informed about the educational and job opportunities and, from the other side, difficulties on the part of National education systems to offer innovative and attractive training courses based on the latest technologies.

- Workers: many businesses are opting to retain their staff rather than employing youngsters and engaging in apprenticeship schemes and thus, in the short term, they are faced with the need of re-skilling and up-skilling workers. The Skillman Curricula offer short-cycle qualifications, adopting modular and blended learning approach, embedding ICT and Open Educational Resources, ensuring validation of non-formal and informal learning and its recognition

- VET system: the Skillman Curricula support the improvement of the quality of the European VET system, by embedding EQAVET and European transparency tools and measures in the delivery of educational programmes; specific educational resources are offered to VET providers with the aim of updating their technical competencies and fostering their staff's professional profile.

- Businesses: the Skillman Curricula support both large sized as well as small and medium sized companies and those in the supply chains active in the field of Advance Manufacturing for the Transport Sector. The qualifications and educational programmes developed are meant to support businesses in their recruitment and HR activities.

- Decision and policy makers: the Skillman Curricula are also aimed at widening and mainstreaming the qualifications and educational programmes and in this respect they can be a point of reference for public authorities interested in the improvement of the educational systems and labour market policies.

THE CONTENTS

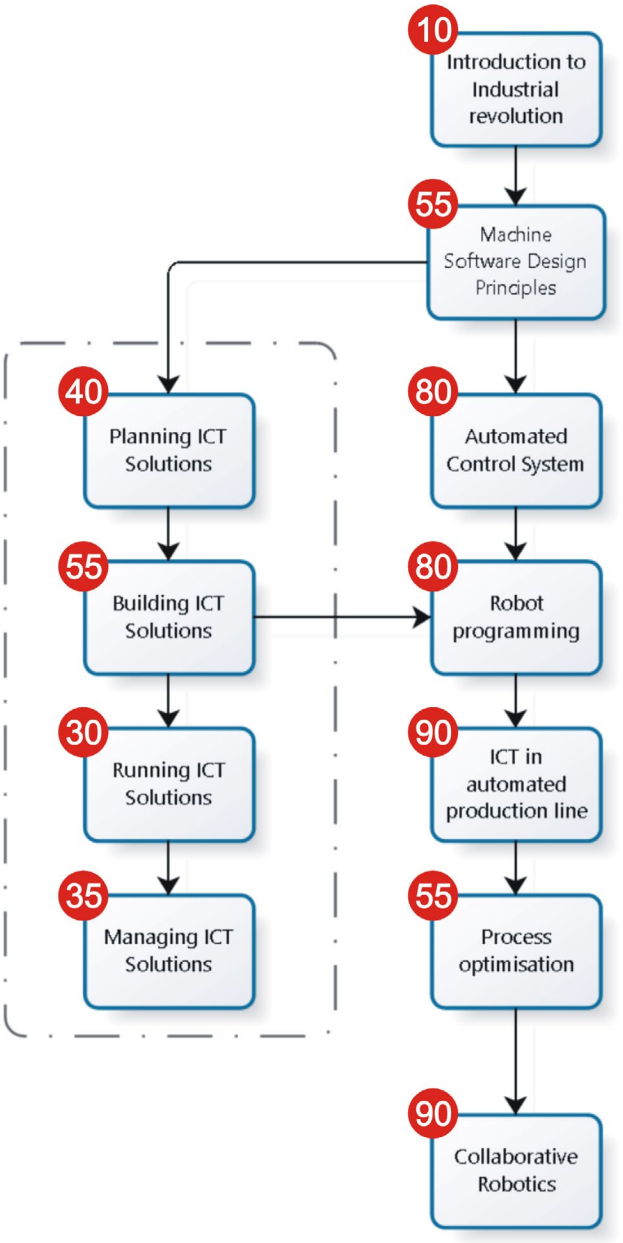
In the next sections you will find:

PART A: the **Methodological guide** for teachers with all the necessary definitions, information and explanations regarding the model applied and how to use Units of learning.

PART B: the **Units of Learning** focused on the competencies, knowledge and skills necessary to operate in the Advanced Manufacturing in the Transport Sector.

All the **Units of learning** are based upon the European Qualification Framework and they are referred to ESCO codes in order to ensure the maximum transparency and applicability in all European countries.

Here the map of the Units of learning with the duration in hours:



Part A
Teachers methodological guide

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21-12-2016

Part A
Teachers methodological guide

1. Introduction

Skillman, the challenges for VET in the EU and the need for cross-national recognition of competences between countries, educational systems and industries

A main purpose in the Skillman project is to take the first steps towards cross-industry training (i.e. advanced production for the transport sector) and national training suitable for recognition by other countries and educational systems in the EU.

The main problem areas that the Sector Skill Alliance aims to address are related to three challenges which are transferable and relevant for the automotive, aerospace and rail sectors of industry, namely the energy performance of production processes and end products, advanced production processes, robotics and advanced combined materials, and information technology wireless technologies and information and communications technology for safety and user purposes.

The working process for the Skillman project, which is lasting three years, ending in 2017, can be described in brief as a process where:

- Training needs, work tasks and future requirements are examined for the three industrial sectors.
- Where training curricula in aviation, car manufacturing and IT support is examined.
- Curricula are developed and common qualifications and competences outlined according to EU standards.

In the new curricula developed in the different industries, learning modules with cross-national and industrial relevance are selected, and syllabuses developed.

The new learning modules as a part of the new curricula are tested, evaluated and adjusted according to feedback from the participants, who may be unskilled workers, experienced workers, leaders or specialists according to the needs in the specific industry.

The new learning modules are supported by, and linked to, an Open Learning Resource.

The purpose of this teacher's methodological guide is to offer a framework for understanding, developing, conducting and evaluating competence-based training across industries and countries according to EU standards. The EU vocabulary, like 'lifelong learning, EQF, NQF, permeability, utilization, stakeholders' interests in education and accreditation', is briefly outlined.

2. The EU's educational vocabulary and context

In the following, the reader will find a brief introduction to the vocabulary the EU uses as the framework within the Skillman project. The purpose is to give trainers, teacher's leaders and other relevant stakeholders with limited knowledge of European educational policy an understanding of how industrial and educational problems are addressed in an EU context.

Lifelong learning

The EU has adopted the so-called Lisbon strategy, which states that in 2010 'Europe must be the most competitive and dynamic knowledge-based economy in the world – with more and better jobs and greater social cohesion'.

The main tool for achieving this goal is to ensure lifelong learning in all its aspects. This means that citizens and employees must constantly be able to continue learning. Seen from the point of view of VET (Vocational Education and Training), it is important that skilled workers can continue their education later on in their working lives and, for example, can attend the junior program or University (HE or higher education).

For unskilled workers, it is important that they can continue learning and become skilled workers later in life. This requires that their skills can be recognized, both informal skills acquired in their work and the retraining they have participated in, so that they have an opportunity to pass an examination and to become a skilled worker.

EQF/NQF (European Qualification Framework and National Qualification Framework)

The EQF for lifelong learning is a common European reference framework which enables European countries to compare and their different qualification systems and link them to one another. The history of the EQF has been one of rapid development. Thirteen years ago, only three countries had this system, namely Ireland, France and the UK – now over 140 countries are currently developing NQFs.

The main aim is to help learners and workers who wish to move between EU countries, change jobs or switch between educational institutions. It also helps to promote the lifelong learning philosophy by opening up pathways for the EU's citizens, and more generally to make the education and training system more transparent and to promote access, transfer and progression into, within and between programmes of learning and lifelong learning.

The EQF works to provide the best possible levels of opportunity by helping promote the mobility of learners and employees between countries. The EQF can only work if NQFs are in place nationally. Apart from purposes of mobility (for a limited number of people), the objectives of NQFs are much broader and wider, namely to foster and enhance access to and participation in lifelong learning and use of qualifications for everyone, including those who are disadvantaged or affected by unemployment.

As a reference structure for qualifications, the NQF is in the first place a tool for classifying qualifications (described in terms of learning outcomes) transparently. To achieve its

various objectives, it needs to be combined with a number of change processes.

An NQF introduces a common language for learning outcomes, levels, types of qualifications (awards), credit transfers etc. This language is used for developing qualification standards (occupation, education, assessment) and needs to be applied and elaborated on the general level down to the individual qualification. It also provides conceptual tools for planning and coordinating learning to make the system more coherent and unified. The common language for learning outcomes supports permeability between VET and HE. The use of levels clarifies where potential overlaps exist between qualifications. Mapping qualifications against the same set of descriptors makes it apparent where two (or more) qualifications lead to comparable learning outcomes and what learners might need to achieve in addition.

Permeability

The adoption and implementation of comprehensive NQFs across Europe influences the relationship between (higher) education and training subsystems.

For both VET and HE outcomes-based qualifications are developed, even though differences exist in the benchmarks on which outcomes are formulated, namely occupational standards in VET qualifications and programs and curricula for HE qualifications. VET and HE qualifications focus on employability and the required knowledge, skills and competence, but in the case of HE they are understood in broader terms than just preparation for a specific profession or group of professions. Improving the links and bridges between levels and types of qualification, eliminating dead-ends and promoting vertical and horizontal progression is considered a key task of most of the new frameworks.

Unitization

In many NQFs, qualifications are structured in units of assessment, with programs being structured accordingly in modules of learning, which can be combined and accumulated in different ways and used for credit transfer and progression. Unitization is claimed to provide opportunities for learners or end-users to exercise choice and increase their power in the learning market. Transfers between VET and HE can be made possible by unitization or modularization, making it easier to identify overlaps and to exempt learners from a module and its assessment. Modules or units also enable the delivery of pathways once the learner has obtained recognition and been exempted from certain units or modules.

Stakeholder engagement and coordination

The process of developing and implementing an NQF, and the institutional arrangements for maintaining and supporting it, are contexts in which different stakeholders in education and training may come together to identify mutual interests and coordinate their activities. Stakeholders include a range of actors, such as ministries, education and VET agencies, providers, employment services, employers, trades unions and civil society. This, it is claimed, enables standards to be updated and made more relevant and the learning system to become more coherent and demand-driven. The involvement of the private sector and social partners is of critical importance for the relevant qualifications. NQFs can provide a platform for social dialogue.

Regulation

An NQF may be an instrument for regulating qualifications and thereby mandate reforms in education and training. Qualifications within a framework may have to meet the requirements for standards development (procedure, content and structure); delivery (provision of programs and rules for access, transfer and progression); and assessment and certification (including the recognition of non-formal/informal learning), all of which are aspects of quality assurance. The formal basis of the NQF thus varies according to the national context and the 'policy-making culture', as well as existing governance arrangements: it can consist of one (integrative) new law, creating new institutions, of a number of laws or of by-laws or orders making reference to the NQF and assigning new tasks to existing institutions. However, the legal basis alone is insufficient – reaching an agreement between key stakeholders on how to implement the framework after adoption is crucial. The most important criterion for deciding whether an NQF has reached the operational stage is whether there is an agreement on sharing responsibilities and roles between the different stakeholders.

A crucial issue to be addressed in implementing an NQF is to decide the roles and responsibilities involved in the management of the framework. An NQF needs national co-ordination, or in EU terminology national coordination point'. In fact, there is a great variety of solutions for this in European countries. While the majority of these 'coordination points' are with institutions of the education system, some countries have chosen institutions which fall under the Ministry of Labour. Most of these institutions are well integrated into the national qualifications structures and, at the minimum, are able to support framework implementation at the technical and administrative levels.

Accreditation of prior learning and recognition of non-formal learning

One of the more important aspects of qualification frameworks is that they encourage and facilitate the validation of non-formal and informal learning. Informal learning is especially important because many unskilled and semi-skilled workers have a lot of qualifications that are not formal, but can be recognized and used as part of an adult VET.

In accordance with the principle of lifelong learning, it should be possible for older workers with no formal qualifications to enter the vocational training system and obtain qualifications, thereby improving their employment prospects and expanding the pool of skilled labour available for industry. Older workers often come with substantial practical experience (non-formal learning) from the sector in which they are now seeking a qualification, and in order to avoid repetitive learning and shorten the time spent in training, most EU countries have now implemented opportunities for the accreditation of prior learning (APL) as part of their VET systems. As well as practical experience, APL also takes into account theoretical learning achieved in other contexts, such as other courses or educational programmes (e.g. evening classes).

In Denmark, older workers may apply to have their skills assessed in order to determine to what extent they already possess the knowledge, skills and competences necessary to obtain a qualification. This process, known as realkompetencevurdering ("assessment of real competences"), takes place at a vocational school and may last up to two weeks. During this period, the worker undergoes a series of theoretical and practical tests, at the

end of which the school issues an assessment of what the worker already knows, understands and can do, and what elements are missing before a full qualification can be obtained. This assessment also indicates what theoretical learning and practical training he or she must undertake to complete the programme. Depending on the nature of the experience, the time required to obtain the qualification may be shortened substantially. As many older workers have families and other obligations, they may also be given financial compensation during their time in training on top of the going apprenticeship stipends to enable them to complete the programme without endangering the welfare of themselves and their dependents.

3. Open Educational Resources or OER

Definition

Open Educational Resources (OER) are teaching, learning and research materials in any medium that reside in the public domain and have been released under an open licence that permits access, use, repurposing, reuse and redistribution by others with no or limited restrictions (Atkins, Brown and Hammond, 2007). The use of open technical standards improves access and reuse potential. OER can include full courses and programmes, course materials, modules, student guides, teaching notes, textbooks, research articles, videos, assessment tools and instruments, interactive materials such as simulations and role plays, databases, software, apps (including mobile apps) and any other educationally useful materials. The term 'OER' is not synonymous with online learning, eLearning or mobile learning. Many OERs, while shareable in a digital format, are also printable.

Skillman's use of Moodle as OER software

Moodle is the OER software used in Skillman. Moodle is a commonly used open-source software in education. The website for Moodle is www.moodle.org. Moodle is compatible with Linux, UNIX, Windows, Mac OS X, FreeBSD and any other system that supports PHP. In 2011 it was downloaded about 500 times a day and contains more than 28,000 registered sites, over a million courses and a learning community of ten million.

The rationale for use of distance education methods

Whether consciously or unconsciously, attempts to make use of distance education methods have generally been driven by a desire to build on some or all of the following lessons emerging from the history of distance education practices:

1. *Providing access to students who, because of work commitments, geographical distance, or poor quality or inadequate prior learning experiences, would be denied access to traditional, full-time contact educational opportunities*. This motivation may have been the key motivating factor behind the use of distance education methods. The drive has been stimulated partly by growing awareness of the importance of lifelong learning and corresponding attempts to respond to market needs. It has also been motivated by dwindling student numbers in some of the more traditional areas of educational provision and a corresponding need to find new educational markets.
2. *Seeking to expand access to educational provision to significantly larger numbers of students*. This motivation is linked to the previous one, but is not the same. Its differ-

ence lies chiefly in the scale of the programmes. Many programmes motivated by a desire to provide access to students who would be denied access to traditional full-time contact education do not really have the goal of reaching significantly larger numbers of students. Indeed, it is notable that large-scale distance education programmes are, in general, confined to very few educational sectors, most notably nursing and teacher training. Most other programmes tend to be small-scale interventions, although there may be a change in this regard as alignment between industry/commerce and programme providers gathers momentum.

3. *Shifting patterns of expenditure to achieve economies of scale by amortizing identified costs (particularly investments in course design and development and in effective administrative systems) over time and large student numbers*. This motivation draws together the above two motivations and has been an underlying economic rationale for many distance education institutions around the world. Its success depends on limiting the number of courses but maximizing enrolments in them. Many distance education programmes simply have neither the intention nor the capacity to exploit these economic benefits. The reasons for this are varied, but most commonly it is because market demand is simply not big enough to create programmes enrolling thousands of students or because institutions or programmes have neither the financial nor the human capacity to make large-scale venture capital investments in course design and development or administrative systems to support the implementation of large-scale distance education. The latter problem is exacerbated by the reality that administrative systems at these institutions have been so narrowly designed to support full-time contact education that the investments necessary to adapt these systems would often exceed what would be necessary to set up new systems from scratch.

4. The components of a well-functioning distance education system

Course design and development

a. Well-designed courses

In good distance education, it is the course rather than the educator that provides an appropriate learning environment for students. Rather than simply referring to a set of materials, however, the course is the structure of learning that is designed into the materials. It has three basic elements:

- Conceptual pathways to command of its knowledge, conceptualizing skills and practical abilities.
- Educational strategies to help the student find his or her way through these pathways.
- Summative and formative assessment, which should be integral to the learning process. The materials and presentation of the course as a whole must excite, engage and reward the student. Courses should be designed so as to involve students actively in their own learning and should allow them quick access and clear pathways through them. Although there is no need for courses to use advanced technologies, most, but not necessarily all, will make use of a variety of media. In designing courses, provision

should also be made for the necessary practical work. In order to be as flexible and open as possible, courses should be organized in modules.

b. Programme and course development in a team

An essential component in the successful design of courses is collaboration. This can be achieved by using an approach where a group of people, each with particular skills and competencies, develop a course as a team. Although there is no golden mean, nor indeed an absolute minimum, a substantial ratio of staff course design time to student study time will be inevitable in developing courses. However, some of the better courses in more challenging subjects might have ratios of fifty to a hundred hours of design time to each hour of student study time. This has clear implications for courses designed for small numbers of students: they are simply not financially viable if collaborative design processes are to be used.

Counselling and support

a. Counselling

Distance education providers should make provision to advise and help individuals who would otherwise be isolated throughout the learning process, and in particular, to help them to make choices before enrolling in educational programmes. It should be made easily available through a variety of devices, including, most importantly, human intervention.

b. Learner support

If students are to adapt to the special requirements of guided self-study, they require various forms of support, for example, satisfactory access to tutors and facilitators, opportunities to interact with other students and access to the necessary facilities.

c. Provision of adequate administrative support to students

This would involve administrative support on a number of levels, including enrolment procedures, payment of fees, delivery of materials and keeping channels of communication open. The aim throughout should be to keep administrative procedures few and simple.

d. Quality Assurance

Quality assurance should be an element of all learning programmes. Several mechanisms need to be established to ensure the quality of learning programmes and their capacity for self-improvement. One of the most critical of these is a mechanism which enables meaningful and reliable feedback from students and tutors into the ongoing performance of the institution.

e. Research, evaluation, and development

As with all aspects of education, continuing research, evaluation and development are necessary for the improvement of distance education provision. Distance education providers also need to have effective research as the basis for improving the quality of their performance.

f. Effectively managed distance learning

Effectively managing distance learning involves establishing performance criteria and targets for the institution, together with mechanisms for publicly and regularly evaluating performance and incorporating lessons learned into improved practices.

5. Validation and OER

EU policy-makers are focusing on how to validate OER, especially in light of the 2013 communication on opening up education, which states that validation should address the challenges linked to the emergence of OER.

Up to now it has been virtually impossible to acquire formal recognition for learning achieved by OER, hence almost no credits are given for learning acquired through OER, in contrast to "formal education" or distance learning courses.

Nonetheless it is possible to establish links between OER and validation. The European Centre for the Development of Vocational Training published a Thematic Report on Validation concerning OER mentions four types of example. These are listed below:

Identification	List of open resources and materials that can give individuals awareness of their knowledge, skills and competences, prevalent standards, level of competence and gaps in their knowledge, skills and competences.
Documentation	OER may support documentation and non-formal learning by means of reference to course material.
Assessment	OER may be linked to various forms of assessment, from self to peer and institutional assessment.
Certification	OER may lead to certification entitling individuals to certain rights: for example, it may have a labour market value or value in the education system (e.g. a value for course entry, waiving the requirements to complete elements of courses or the award of full qualifications).

6. Teachers using OER: some pedagogical considerations

Didactic perspectives

The OER concept is not new, but is based on the principle that educators should select, from the full range of educational provision, those resources and methods that are most appropriate to the context in which they are providing education. The learning materials produced in the Skillman project, this means that teachers can benefit by considering some didactic perspectives.

A didactic framework for VET teachers and educational planners

The central questions a VET teacher or educational planner must consider, to meet the required learning goals and competences described in the curricula, are outlined here. These can be viewed as six perspectives, described by two Norwegian educational VET researchers, Hiim and Hippe (2003 and 2007).

Six didactic perspectives for teacher's didactic considerations

- **Learning prerequisites.** Concerns learner's and teacher's prior knowledge and experience.
- **Evaluation and assessment.** Concerns both formative and summative methods, and requirements that can be referred to learning goals, competences and skills and likewise described in the curricula and other official documents.
- **Planning for learning processes, methods and activities.** Concerns teaching methods, videos apps, task-based work etc., considering the relation and flow in the design of the learning process for the participants.
- **Content.** Selection of content in order of presentation.
- **Learning goals.** Concerns the teacher's considerations of progression and the development of learning goals that VET students must reach. Naturally these goals should also be linked to the overall curriculum and official documents that describe the competences, skills and attitudes that the student must acquire.
- **Frame factors.** Concerns the learning environment. These could be factors such as number of students, time to reach the learning goals etc.

The main point made by the two researchers is that all six perspectives are interrelated. This means that teachers and educational planners should be able to distinguish between the six elements, bearing in mind that change in one aspect affects the other five aspects.

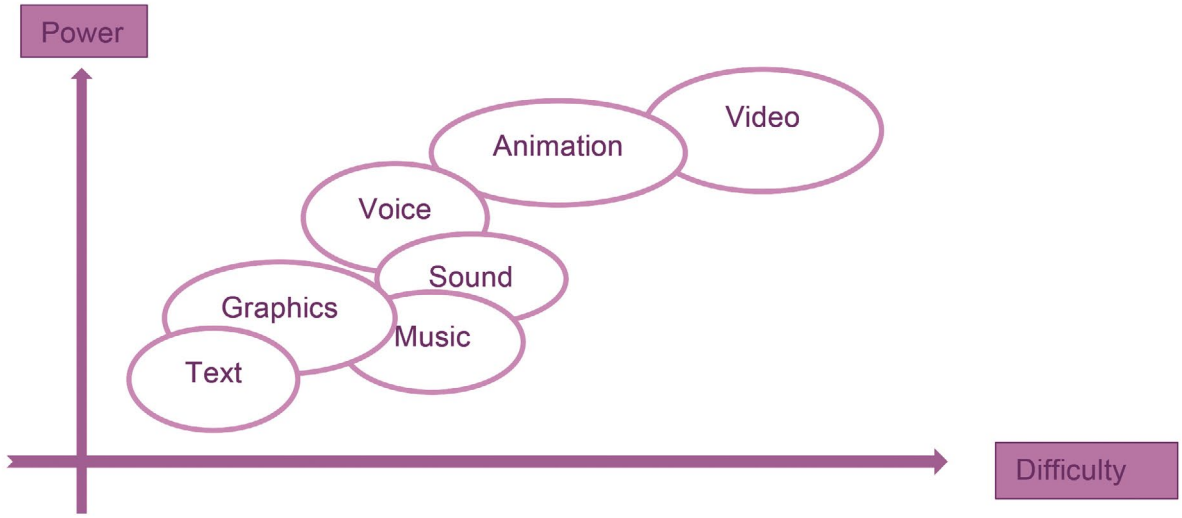
In the following, we will present some models that can help VET teachers and educational planners transform the curricula developed in Skillman into learning activities linking with and using elements from Skillman's OER Platform.

Teacher's choice of media, power and difficulty

When the teacher has considered and described the goals, content, learners and the requirements and activities necessary to achieve the learning goals in the Skillman curricula, it might be useful to specify the media needed to implement the activities and tests.

Each learning object may require a different mix of media. Each medium should be more or less easy to use, and the requirements concerning the teacher's ability to use it, storage space, tools, network speed and so on varies, as does the difficulty of the media. Likewise it will be found that the power of the media – that is, the ability to communicate facts, explain concepts and trigger emotions – can differ.

Though all media are possible, the following figure may be useful in considering which media are most appropriate for particular learning activities.



Technology applications that can be used in OER: a brief overview

This short overview provides a quick guide to some of the technology applications which are available to support education and development initiatives and that are helping to stimulate the creation and use of openly licensed, or at least openly available, educational resources.

- **Social network sites.** These are web-based services that allow people to construct a public or semi-public profile within a bounded system, define a list of other users with whom they share a connection, and view their list of connections and those made by others within the system. The best known of such sites are probably Facebook and MySpace, although many such sites exist. Some also focus on specific dimensions of social networking. For example, social bookmarking sites such as Del.icio.us allow people to save bookmarks to websites and tag them with keywords, generating community-driven, keyword-based classifications known as 'folksonomies'. Likewise, photo-sharing websites such as Flickr allow people to upload, tag, browse and annotate digital photographs, as well as participate in self-organizing topical groups. While social networking sites have massive potential for influencing the ways in which we organize and find information and how we interact with people, it is important to note that the for-profit sector is selling itself as the provider of choice for these Web 2.0 collaboration capabilities, predominantly in an effort to create new platforms to fund consumers and sell advertising.
- **Blogging.** Blogging is remarkable for the speed at which it has grown as an online communication vehicle. 'Blog' is an abbreviated version of 'weblog', a term used to describe websites that maintain an on-going chronicle of information. A blog is a frequently updated, personal website featuring diary-type commentary and links to articles or other websites (and, in the case of video-blogging, video). Given the personal perspectives presented on blogs, they often generate ongoing discourse and a strong sense of community. Blogs provide diverse, alternative sources of information for higher education, as well as supplying tools that can be used by academics and students for a wide range of educational purposes.
- **Wikis.** A wiki enables documents to be written collaboratively in a simple mark-up language using a web browser. A defining characteristic of wiki technology is the ease with

which pages can be created and updated. This ease of interaction and operation makes a wiki an effective tool for mass collaborative authoring. The most famous example is Wikipedia, an online phenomenon that has played a massive role in challenging notions of what constitute 'expertise' and reliability of information. Wikis are already extensively used in many higher education programmes for educational purposes and are one of the authoring tools being used to generate 'open' content (see below).

- **RSS.** Real Simple Syndication (RSS) is a protocol that allows users to subscribe to online content by creating lists of preferred sources of information in a 'reader' or 'aggregator' that automatically retrieves content updates, saving the user's time and effort. RSS feeds can be very helpful in managing information and undertaking ongoing research.
- **Podcasting.** This refers to any combination of hardware, software and connectivity that permits automatic download of (usually free) audio and video files to a computer, smart phone or MP3/MP4 player to be listened to or watched at the user's convenience. This is typically done by subscribing to an RSS feed linked to the specific podcast, so that when new editions of a podcast are made available, they are automatically downloaded by podcasting software. Podcasting has made available a very broad spectrum of educationally useful audio and video material, including radio programmes from around the world, lectures, conference speeches and custom-produced podcasts created by enthusiasts. Growing numbers of universities and academics are making lectures available as podcast series, which are usually freely available to anyone around the world with Internet access.
- **Virtual worlds.** These are immersive online environments whose 'residents' are avatars representing individuals who participate via the Internet. Some, such as the very popular World of Warcraft, are explicitly focused on gaming and entertainment. However, possibly the best known of these from an educational perspective is Second Life, a fully three-dimensional world where users with many varying interests interact, but within which many universities and businesses are now constructing virtual campuses for their students.
- **Voice-Over Internet Protocol (VOIP).** VOIP is a protocol optimized for the transmission of voice through the Internet or other packet-switched networks. VOIP is often used abstractly to refer to the actual transmission of voice, rather than the protocol implementing it. VOIP facilitates applications such as Skype, which allow users to make free telephone calls between computers.
- **Instant messaging (IM).** IM is a form of online communication that allows real-time interaction through computers or mobile devices. It is often bundled into applications such as Skype and social networking sites, so that it can be used seamlessly while within those applications. It has become such an integral part of students' lives that many universities are working to move IM beyond the social sphere into teaching and learning.
- **Online applications.** These are web-based programmes that run in web browsers and typically replicate the functionality currently available on desktop-based applications. A good example is Google Apps, which provides access to office productivity, communication and file storage tools. Another, more specialized example is Lulu, which offers online access to the tools one needs to design, publish and print original material, facilitating inexpensive production of publications. The online nature of such tools is also intended to facilitate collaboration, peer review and the collective generation of knowledge.

Wielding the applications

By drawing on the potential of the above technologies, several new possibilities are emerging that can be useful for teachers using OER.

Mashups are web applications that combine data from more than one source into a single integrated tool. The power of mashups for education lies in the way they help us reach new conclusions or discern new relationships by uniting large amounts of data in a manageable way. Web-based tools for manipulating data are easy to use, usually free, and widely available. Mashups include:

- Digital storytelling, which involves combining narrative with digital content to create a short movie or presentation.
- Data visualization, which is the graphical representation of information to find hidden trends and correlations that can lead to important discoveries.
- Open journaling, which manages the process of publishing peer-reviewed journals online, allowing authors to track submissions through the review process, and creating a sense of openness and transparency unusual in traditional, peer-reviewed publications.
- Google jockeying, which involves a participant in a class surfing the Internet during the class for terms, ideas, websites or resources mentioned by the presenter. These searches are then displayed simultaneously with the presentation.
- Virtual meetings, which are real-time meetings taking place over the Internet using integrated audio and video, chat tools and application sharing.
- Grid computing, which uses middleware to coordinate disparate IT resources across a network, allowing them to function as a virtual whole and providing remote access to IT assets and aggregating processing power.

7. Teacher's choice using OER: linking learning to life, work and future learning

When the teacher plans learning activities in VET programmes, it is useful to ensure that people can apply what they have learned. This is especially emphasised in VET education, European policy and research linked to transfer.

In an OER-supported educational program, it can therefore be useful to consider "connect" activities that can help the learner apply what he or she has learned. Connected activities can make existing knowledge more useful. Connected activities range from a simple stop-and-think questions to a full-scale work project. To design effective "connect" activities, one should start with a clear idea of what one wants to connect.

The figure below is designed to help the planning process.

To connect this	To this	Use this type of Connect activity
Individual principles, concepts, and other bits of learning	The learner's work or studies	Consider activities such as identifying examples
Critical bits of information	Gaps in the learner's current understanding	Questioning activities
Major themes in the OER supported learning environment	The learner's life	Stories told by the learner
Producers and policies	The learner's professional work	Job aids and original work activities
Limited information in the learner's course	The large body of knowledge in a field	The learner's active search for knowledge, problems and answers to a subject. 'Research' activities
Current information	New information that the learner will encounter	The learner's active search for knowledge, problems and answers to a subject. 'Research' activities

8. Teacher's choice using OER: feedback, test evaluation and goals, accessed learning

In this methodological guide, a test is an activity that indicates how well learners are meeting learning objectives. In this understanding, any activity that provides feedback on learners' performance in relation to an object, goal, skill knowledge etc. can serve as at test.

Teachers feedback: an effective tool with three types of feedback

In this guide, we focus on both formal and informal tests. In this understanding, feedback has at central role. According to Hattie, drawing on research on the teacher's impact on students learning, feedback is one of the most effective methods of enhancing students' learning.

Hattie develops the concepts of effective feedback by dividing feedback in to three perspectives and questions that must be answered. The purpose of feedback, in Hattie's view, is to reduce discrepancies between the learner's current understandings and performance on the one hand and the goals that have been set on the other. In the feedback

process, both teacher and the student can address the student's learning process by fulfilling the following tasks.

The teachers task is to provide appropriate challenging and specific goals, or to assist students to reach the goals through effective feedback.

The students task is to increase the effort and employment of more effective strategies, or to abandon, blur or lower the goals.

Effective feedback requires answers to three questions:

1. Question: Feed up: Where am I going? The goals.

2. Question: Feed back: How am I going?

3. Question: Feed forward: Where to next?

In Hattie's view, each question works on four levels that are important for teachers, leaders and educational planners to incorporate into the student's test.

On the task level, the student and teachers will encounter information of how well tasks are being understood and performed. *On the process level*, information concerning the processes needed to understand and perform tasks is revealed. *On the level of self-regulation*, the feedback guides the students and teacher towards the self-monitoring, direction and regulation of actions. And finally, on the *level of the self*, teachers and students receive feedback on their personal behaviour and their ability to perform the task effectively and reach visible goals.

Teacher's choice: a test guide

Before testing the learner's achievement of goals, skills and competences from the curricula developed under the Skillman project, the following should be considered: What is your aim in testing when you decide to test? How important are recorded scores? And what kinds of feedback is it important to give learners in light of the feedback questions and levels mentioned above? These decisions will be crucial and can later be incorporated or used as an training tool in addition to Skillman's OER.

The table below can serve as the first step in deciding and designing the quality of a test.

What do you want to accomplish with your test?

Purpose of testing	How to test	Record scores	Feedback
Measure the progress of learners.	At the end of each topic, lesson and course.	Yes.	Numeric, at end of test.
Help learners measure their own progress.	Frequent, short test.	No.	Descriptive and numeric.
Certify learner's knowledge.	Proctored, legally defensible test.	Yes.	Pass-fail or overall score. May also provide scores for sub-components so learners can study and try again.
Certify learner's skills.	Observed accomplishment of prescribe tasks.	Yes.	Pass-fail or overall score. May also provide scores for sub-components so learners can study and try again.
Motivate learners.	Informal pre-test.	No.	Recommended areas of study.

Purpose of testing	How to test	Record scores	Feedback
Exercise independent learning skills.	'Open-book' test where learners can find answers in available resources.	No.	Recommended search targets and strategies.
Teach new knowledge and skills.	Informal, frequent, before presentation of content.	No.	Presentation of just the content that testing indicates the learner needs.
Diagnosing learner's skills and knowledge.	Comprehensive test.	Yes.	Complete profile of what learners already know and need to learn.
Measure the effectiveness of learning modules.	Comparison of test scores between different modules and between modules before and after revision of pre-and post-test.	Yes.	

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Part B
Industry & Production 4.0 Specialist

Part B
Industry & Production 4.0 Specialist

B. Curriculum template		
Unit of learning	**1. Introduction to Industrial revolution**	
Duration	10	Lessons hours: 4 Self-study hours: 5 Hands-on hours: Other (please specify): Assessment hours: 1
Learning outcomes *Number and title*	**1.1 The industrial revolution**	

Competences
1. Analyses and defines current and target status.
2. Estimates cost effectiveness, points of risk, opportunities, strengths and weaknesses, with a critical approach.
3. Creates structured plans; establishes time scales and milestones, ensuring optimisation of activities and resources.
4. Manages change requests.
5. Defines delivery quantity and provides an overview of additional documentation requirements.
6. Specifies correct handling of products, including legal issues, in accordance with current regulations

Knowledge	**Skills**
1. Effective frameworks and methodologies for governance plans 2. Typical KPI (key performance indicators) 3. Basic decision-making methods 4. IPR principles and regulation 5. Agile techniques 6. Structured Project Management Methodologies (e.g. agile techniques) 7. Optimisation methods (e.g. lean management) 8. New emerging technologies	1. Identify all potential targets for the product or service 2. Define the communication plan; identify key users and create related documentation 3. Manage the change request process

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. At the end of the module the learners are expected to have acquired a clear aspect on the different industrial revolutions over the different industrial ages. Assessment criteria should: • relate closely to the unit Learning Outcomes, describing those aspects of the Learning Outcome which will be assessed • indicate what is required at a pass level, in a positive way • help students know what they need to do • help students understand what you expect at differing levels of achievement • be understandable to all stakeholders • be manageable in number • be distinct from each other • be seen as an indication of achievement .rather than an exact measurement. Learners, in this unit, are expected to be able to clearly describe the main drivers of the past and current industrial revolution, to identify the enabling technologies which have modified and improved the state of the art in each period (industrial age). Assessment method: In the contest of the teaching session, observed by the mentor/teacher, the learners will demonstrate 5 different example of enabling technologies for the current industrial revolution, ranking them on impact on the current SoTA (state of the art), describing them. For each industrial revolution, learners will identify the most relevant drivers, ranking them for importance.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	**Readings:** Industry 4.0: The New Industrial Revolution, Deloitte Study 2015 The Industrie 4.0 transition: How it reshuffles the economic, social and industrial model, Max Blanchet (Roland Berger), April 2016 Shaping the Digital Transformation Plattform Industrie 4.0, Thomas Hahn, Siemens AG | February 8th, 2017 BDC Study: Industry 4.0: The New Industrial Revolution, May 2017 Design Principles for Industrie 4.0 Scenarios: A Literature Review Hermann, Mario Pentek, Tobias* Otto, Boris. Working Paper No. 01 / 2015 Industry 4.0 Digitalization for productivity and growth. Briefing September 2015. Ron Davies, EPRS (European Parliamentary Research Service) Industrie 4.0, Smart manufacturing for the future. William MacDougall, Germany trade and invest, July 2014. 2016 Global Industry 4.0 Survey. Industry 4.0: Building the digital enterprise. Dr. Reinhard Geissbauer, Head of EMEA Industry 4.0 Digital Operations Team (PWC) From Industry 4.0 to Digitising Manufacturing, An End User Perspective, Conference Papers. Manufacturing Technology Centre Pilot Way, Ansty Business Park, Coventry CV7 9JU Industry 4.0 Making your business more competitive, 2017 CGI GROUP INC. Industry 4.0 How to navigate digitization of the manufacturing sector, McKinsey Digital 2015. Industry 4.0, the future of productivity and growth in manufacturing industries, BCG (Boston Consulting Group), April 2015 On the Way to Industrie 4.0 – The Digital Enterprise, Klaus Helmrich, Member of the Managing Board of Siemens AG, 2015 Industry 4.0 – Opportunities and challenges of the industrial internet, Dr. Reinhard Geissbauer, Head of EMEA Industry 4.0 Digital Operations Team (PWC), 2015 **Websites:** www.pwc.com/industry40 https://en.wikipedia.org/wiki/Industrial_Revolution **Videos and tutorials:** Coal, Steam, and The Industrial Revolution: Crash Course World History #32: https://www.youtube.com/watch?v=zhL5DCizj5c The next manufacturing revolution is here | Olivier Scalabre. TED (2016): https://www.youtube.com/watch?v=AyWtIwwEgS0 Documentary | The Fourth Industrial Revolution. World Economic Forum (2016): https://www.youtube.com/watch?v=kpW9JcWxKq0

B. Curriculum template		
Unit of learning	**2. Planning ICT solutions**	
Duration	~~55~~ 40 (20+20)	Lessons hours: 30 Self-study hours: 10 Hands-on hours: 10 Other (please specify): Assessment hours: 5
Learning outcomes *Number and title*	**2.1 Product and project planning**	

Competences
1. Analyses and defines current and target status.
2. Estimates cost effectiveness, points of risk, opportunities, strengths and weaknesses, with a critical approach.
3. Creates structured plans; establishes time scales and milestones, ensuring optimisation of activities and resources.
4. Manages change requests.
5. Defines delivery quantity and provides an overview of additional documentation requirements.
6. Specifies correct handling of products, including legal issues, in accordance with current regulations

Knowledge	**Skills**
1. Effective frameworks and methodologies for governance plans 2. Typical KPI (key performance indicators) 3. Basic decision-making methods 4. IPR principles and regulation 5. Agile techniques 6. Structured Project Management Methodologies (e.g. agile techniques) 7. Optimisation methods (e.g. lean management) 8. New emerging technologies	1. Identify all potential targets for the product or service 2. Define the communication plan; identify key users and create related documentation 3. Manage the change request process

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. Learners, in this unit, could have to be evaluated through a concrete and complete cycle of 'Product and project planning' assignment. the theoretical parts of the learning outcomes can be assessed considering the results and the evidences of the task performances. The whole assignment could be also driven as a continuous formative assessment process starting from the early beginning of the unit implementation. It could be also a good solution to leave the learners to freely select which ICT approach, platform/tools implement, to make their masterpiece. Factors to be taken into account for the assessment: ● quality and comprehensiveness of identified potential targets for the product or service ● quality and comprehensiveness of identified necessary resources ● appropriateness of tasks, milestones, time scheduling and deadline set ● appropriateness of process modeling and workflow management systems solutions adopted ● level of implementation of the process modeling and workflow management systems solutions adopted ● resources allocation / assignment coherence with assignment terms ● clarity and sustainability of the communication plan ● quality of identified key users list ● quality of related information and documentation ● quality of the changes management plan
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	Readings: Project-Management with Gantt-Charts (OpenOffice) Creating Gantt Charts with Excel and Microsoft Project Graphical Project Planning Techniques: An Overview of Gantt, PERT, and CPM Charts Websites: https://en.wikipedia.org/wiki/Project_planning https://en.wikipedia.org/wiki/Gantt_chart https://www.smartsheet.com/blog/how-create-gantt-chart-excel01 Videos and tutorials: Gantter Project Scheduling: https://www.youtube.com/watch?v=ZvGcYo7JLuM Making a Gantt Chart with Google Docs: https://www.youtube.com/watch?v=IGwXQryI2-A Creating a Gantt Chart in Google Sheets: https://www.youtube.com/watch?v=-crraoSMxc0 Gantt Chart Excel Tutorial - How to make a Basic Gantt Chart in Microsoft Excel 2013 https://www.youtube.com/watch?v=-oD50HSBBBI
Activities	

Learning outcomes *Number and title*	**2.2 Technology Trend Monitoring**

Competences
1. Investigates latest ICT technological developments to establish understanding of evolving technologies.
2. Devises innovative solutions for integration of new technology into existing products, applications or services or for the creation of new solutions.

Knowledge	**Skills**
1. Emerging technologies and the relevant market applications 2. Market needs 3. Relevant sources of information (e.g. magazines, conferences and events, news letters, opinion leaders, on-line forums, etc.) 4. The rules of discussions in web communities 5. Applied research programme approaches	1. Monitor sources of information and continuously follow the most promising 2. Identify business advantages and improvements of adopting emerging technologies

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria *Description and timing*	Taking into account unit of learning 1, learners have achieved an overview over the enabling technologies for industrial revolution. According to the different emerging technologies in the current contest, learners will identify the potential improvement of current product with different examples in at least 3 different manufacturing fields (automotive, aeronautic, naval, buildings, …) Learners will apply for a research on appropriate sources of information (papers, conference, press, patents, …) over the web and will prioritize the collection of results on function according to their relevance as appropriate source of information for the selected enabling technologies. Teachers will provide learners with two different technical papers on new and emerging enabling technologies and learners will describe how potentially these technologies would impact on the current SoTA and for which main appropriate technological field.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	Readings: Technology monitoring and analysis, Scott W. Cunningham and Alejandro Sanz, Tech Monitor ● Sep-Oct 2011 Using Indicators for Technology Monitoring Steps toward a proposed framework, Annika Nyberg, Sebastian Palmgren, Chalmers University Of Technology, Göteborg, Sweden, 2011 A new instrument for technology monitoring: novelty in patents measured by semantic patent analysis, Jan M. Gerken, Martin G. Moehrle, June 2012, Volume 91, Issue 3, pp 645–670 Websites: https://www.mycoted.com/Main_Page http://www.fch.europa.eu/project/technology-monitoring-and-assessment https://www.sciencelogic.com/product/technologies/microsoft Videos and tutorials:

B. Curriculum template		
Unit of learning	**3. Building ICT solutions**	
Duration	55 (30+25)	Lessons hours: 30 Self-study hours: 10 Hands-on hours: 10 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**3.1 Solution Deployment**	

Competences
1. Following predefined general standards of practice carries out planned necessary interventions to implement solution, including installing, upgrading or decommissioning
2. Approves hardware, software or network configuration to ensure interoperability of system components and debugs any resultant faults or incompatibilities.
3. Engages additional specialist resources if required, such as third party network providers

Knowledge	**Skills**
1. Performance analysis techniques 2. Techniques related to problem management (operation, performance, compatibility) 3. Software packaging and distribution methods and techniques 4. The impacts of deployment on the current architecture 5. The technologies and standards to be used during the deployment 6. Web, cloud and mobile technologies and environmental requirements	1. Organize population of data bases and manage data migration

Assessment methods *(Click appropriate box/s)*	☐ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. Teachers will provide learners with a specific case study of mechatronic system programming and configuration. The case study will be based on simplified actuators and sensors to be implemented in a system for a simple mission: e.g. a system to detect the temperature of a part, and actuating, when a specific value is reached, the conditioning. In the specific, sensors and actuators will be activated by a simplified code program (visual object, app, or similar), and the main focus will be on the logic scheme level and on the logical flow. It could be, also, used a program code similar to Scratch, based on APP and android language. For advanced level, the basic element of programming can be exploited on Arduino code. There are different Arduino Software which allows learners to write programs and upload them to the Arduino board. In the Arduino It is possible to use the online IDE or it is possible to install the Arduino Desktop IDE. For this purpose, the sensors and actuator guide for Arduino is the reference. An alternative to Arduino language use is the application of scratch programming code to Arduino hardware, as in this example. https://create.arduino.cc/projecthub/kittenbot/graphical-programming-drawing-robot-on-the-wall-dbc75a?ref=platform&ref_id=424_trending___&offset=69
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ■ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	**Readings:** **Find documentation on:** http://www.codebind.com/android-examples/ For advanced level, arduindo documentation Beginning Arduino Programming Writing Code for the Most Popular Microcontroller Board in the World, Brian Evans Arduino programming notebook, Brian Evans Arduino Tutorial Tutorials for Arduino Arduino Starter Kit Manual, A Complete Beginners Guide to the Arduino, ©2009 M.McRoberts - Earthshine Design 30 Arduino™ Projects for the Evil Genius Sensors and actuators for Arduino **Websites:** https://en.wikipedia.org/wiki/Visual_programming_language https://en.wikipedia.org/wiki/Block_(programming) https://education.lego.com/en-us http://snap.berkeley.edu/ https://wiki.scratch.mit.edu/wiki/Alternatives_to_Scratch http://appinventor.mit.edu/explore/ http://www.codebind.com/ **Project tutorial (advanced level)** https://create.arduino.cc/projecthub http://www.instructables.com/id/Controlling-the-Position-of-an-Actuator-with-an-An/ http://learn.robotgeek.com/demo-code/123-arduino-linear-actuator-tutorial-preset-position-button-control.html **Videos and tutorials:** **Scratch tutorial:** https://www.youtube.com/watch?v=VIpmkeqJhmQ **Android studio tutorial** https://www.youtube.com/watch?v=EknEIzswvC0&list=PLS1QulWo1RIbb1cYyzZpLFCKvdYV_yJ-E **Arduino tutorial (advanced level)** http://blog.arduino.cc/2013/07/30/arduino-starter-kit-video-tutorials/ https://www.youtube.com/watch?v=4HqXAmV_Ock https://www.youtube.com/watch?time_continue=1&v=xZ8G4pxnDvM

Learning outcomes *Number and title*	**3.2 Documentation Production**

Competences

1. Produces documents describing products, services, components or applications to establish compliance with relevant documentation requirements.
2. Selects appropriate style and media for presentation materials.
3. Creates templates for document-management systems.
4. Ensures that functions and features are documented in an appropriate way.
5. Ensures that existing documents are valid and up to date.

Knowledge	**Skills**
1. Produces documents describing products, services, components or applications to establish compliance with relevant documentation requirements. 2. Selects appropriate style and media for presentation materials. 3. Creates templates for document-management systems. 4. Ensures that functions and features are documented in an appropriate way. 5. Ensures that existing documents are valid and up to date.	1. Organise and control content management workflow 2. Keep publications aligned to the solution during the entire lifecycle

Assessment methods *(Click appropriate box/s)*	☐ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. Learners, in this unit, could have to be evaluated through the realization of correlated documentation on the previous module activity. In particular, learners will provide the technical documentation related to the system programming logic, and to the mechatronic devices (actuators, sensors) implemented in the system. The information have to be enough detailed and all the correlation and interrelation among different devices under the control system have to be specified. The documentation will be used in the following learning unit.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	**Readings:** **Technical writing tutorial:** https://ocw.mit.edu/courses/mechanical-engineering/2-000-how-and-why-machines-work-spring-2002/tools/technicalwriting_fixed.pdf **Websites:** The 7 Rules for Writing World Class Technical Documentation https://www.developer.com/tech/article.php/3848981/the-7-rules-for-writing-world-class-technical-documentation.htm Introduction to Technical Writing/Documentation http://www.perlmonks.org/?node_id=130249
Activities	

B. Curriculum template

Unit of learning	**4. Running ICT solutions**	
Duration	30	Lessons hours: 20 Self-study hours: 8 Hands-on hours: 7 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**4.1 Problem Management**	

Competences
1. Identifies and resolves the root cause of incidents.
2. Takes a proactive approach to avoidance or identification of root cause of ICT problems.
3. Deploys a knowledge system based on recurrence of common errors.
4. Resolves or escalates incidents.
5. Optimises system or component performance.

Knowledge	**Skills**
1. The organisation's overall ICT infrastructure and key components 2. The organisation's reporting procedures 3. The organisation's critical situation escalation procedures 4. The application and availability of diagnostic tools 5. The link between system infrastructure elements and impact of failure on related business processes	1. Allocate appropriate resources to maintenance activities, balancing cost and risk

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. Learners, in this unit, could have to be evaluated through the identification of proper root failure detection according to the previous learning unit deployment. According to the case study developed in the previous unit learning, learners will analyze, by the adoption of the available technical documentation, the right system running. In particular, they will detect any potential diagnosis system or procedure to be actuated in order to control and monitor the system. They will identify any kind of malfunction roots (on software, hardware, sensors, …model) potentially occurring in the system, and for each of them they will identify the right procedure to avoid or recover the error.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** Corrective Action and Root Cause Analysis, David S. Korcal BSMT (ASCP) Understanding How to Use The 5-Whys for Root Cause Analysis, Mike Sondalini **Websites:** https://en.wikipedia.org/wiki/Root_cause_analysis **Videos and tutorials:** Six Sigma: Root Cause Analysis Examples https://www.youtube.com/watch?v=IX3uQ72-iXs What is Root Cause Analysis? https://www.youtube.com/watch?v=350IpBEqFXU 5 Whys Root Cause Analysis Problem Solving Tool--Video Training https://www.youtube.com/watch?v=350IpBEqFXU

B. Curriculum template		
Unit of learning	**5. Managing ICT solutions**	
Duration *hours*	35	Lessons hours: 15 Self-study hours: 10 Hands-on hours: 5 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**5.2 Risk Management**	
Competences 1. Implements the management of risk across information systems through the application of the enterprise defined risk management policy and procedure. 2. Assesses risk to the organisation's business, including web, cloud and mobile resources. 3. Documents potential risk and containment plans.		
Knowledge 1. Apply risk analysis taking into account corporate values and interests 2. The return on investment compared to risk avoidance 3. Good practices (methodologies) and standards in risk analysis		**Skills** 1. Apply mitigation and contingency actions
Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ■ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly ☐ Other activities (please specify):	

Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. The study assumed that risk management software used in the preparation of course material is available for student use Learning objectives. Different free tools area available on the web. The selection can be done according to the teacher/school experience. http://www.polecat.com/blog/free-grc-tools/ Risk Management is the process of advising organizations of the potential and perceived risks involved in their activities, supervising organization activities, and taking corrective actions and proactive steps to minimize accidental injury and/or loss. In line with the tenets of the tool adopted, teachers seek to guide students with information and resources that empower them to make the most fair, reasonable, and intelligent decisions about their organizational activities and events. Students must first conduct a comprehensive assessment of the physical, reputation, emotional, financial, and facilities risks associated with their organization and its events. Next, they must assess each risk based on its probability of occurrence and severity of consequences. Finally, they must make decisions about accepting, modifying, transferring, and/or eliminating risks based on those assessments. Outcomes: Provide an overview of project risk management; why project risk management, the process involved and definitions of project risk. Students will be able to: • Conduct a comprehensive assessment of associated physical, reputation, emotional, financial, and facilities risks • Provide a realistic assessment of those risks along the risk management matrix (probability and severity) • Conduct a comprehensive exploration and examination of options for mitigating actions • Select the most appropriate mitigating actions for each risk • Develop contingency and crisis response plans • Consult with "campus experts" in planning • Communicate risk management plan to other constituents of event • Implement event according to pre-established risk management plans • Document and evaluate outcomes of risk management plans • Internalize the value of risk management • Articulate the value of risk management According to a specific case study, Learners assessment will be accomplished according to the - Complete risk overview analysis - Provide a risk management matrix - Provide an options examination for mitigating actions - Selection of most appropriate mitigating actions for each risk - Provide an analysis on risk responses (to threats and opportunities, secondary risks), with a post response assessment - Implementing responses; updating plans - Manage the process; keeping the process alive and improving risk management
Qualifications framework *Reference to EQF and NVQ*	Level EQF V

Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** Risk Management Outcomes, Division of Student Affairs, Texas A&M University Objectives and Outcomes in Risk Management, Education Padmavathi Koutha, Purdue University **Websites:** Risk Management: https://www.conted.ox.ac.uk/courses/project-risk-management https://www.theirm.org/training/all-courses/project-risk-management.aspx
Activities	

Learning outcomes *Number and title*	**5.4 Process Improvement**

Competences
1. Measures effectiveness of existing ICT processes.
2. Researches and benchmarks ICT process design from a variety of sources.
3. Follows a systematic methodology to evaluate, design and implement process or technology changes for measurable business benefit.
4. Assesses potential adverse consequences of process change

Knowledge	**Skills**
1. Research methods, benchmarks and measurements methods 2. Evaluation, design and implementation methodologies 3. Existing internal processes 4. Relevant developments in ICT (e.g. virtualisation, open data, etc.), and the potential impact on processes 5. Web, cloud and mobile technologies 6. Resource optimisation and waste reduction	1. Compose, document and catalogue essential processes and procedures 2. Propose process changes to facilitate and rationalise improvements 3. Implement process changes

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing
	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment.
	Learners, in this unit, will be able to
	• Understand the Business Process Improvement (BPI) assessment process
	• Synthetize the information to make decision for organizational initiative on PI
	• Apply analytical techniques for tactical decision in a PI project
	In particular, students will be assessed, on Evaluating the Organization level by:
	• Analyzing the organizational mission and vision adopting at least one of the following instruments:
	  • Pinpointing influences on the business
	  • MOST
	  • Five forces
	  • PESTLE
	  • SWOT
	• Developing a communication plan (Identifying key stakeholder's needs, Defining the phases of communication)
	Further, the Learners will be in charge of Outlining the Current Process by the creation of a process inventory, applying them a prioritization technique, measuring them by the adoption of appropriate KPI (key performance indicators).
	Analyzing and Improving the Process by analyzing process performance (in terms of time, cost, quality, poor process performance,…), leveraging problem analysis criteria on people, technology, materials, investigation root cause (suing problem mapping tools), relating root cause analysis to a business process.

Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** **Websites:** Business Process improvement outlines https://www.learningtree.com/courses/3505/introduction-to-business-process-improvement-bpi-training/ Process Improvement http://www.masetllc.com/training/m-712.shtml Videos and tutorials:

B. Curriculum template		
Unit of learning	**6. Robot programmings**	
Duration	80	Lessons hours: 40 Self-study hours: 20 Hands-on hours: 3 Other (please specify): web academ: 15 Assessment hours: 2
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**6.1 Programs used to control an industrial robot**	

Competences
1. Describe the H&S aspects of industrial robots.
2. Apply the generic structure and functions of an industrial robot.
3. Demonstrate competently manipulate of an industrial robot.
4. Analyse how to interpret a typical program used to control a modern industrial robot
5. Develop and safely modify a given program to achieve a specific task, test, and upload this program to a robot and demonstrate its function.

Knowledge	**Skills**
1. To understand the risks associated with industrial robots 2. To possess a knowledge of the structure and function of a robot system 3. To understand robot co-ordinate systems 4. To understand the structure of a robot program 5. To understand basic instructions/commands	1. Demonstrate adherence to H&S requirements for industrial robots 2. Competently operate an industrial robot 3. Be able to modify an existing program and test against a defined specification 4. To be able to archive/restore programs

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ■ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. **Alternative 1** One path can be done according to the COMAU "robotic licence for high school" program. The program is actuated by the use of a: • COMAU online platform, where multimedia material, exercitation and test for the certification are stored. • Software simulation • Manuals • Hardware simulator (optional) for the • Robotic cell (based on e.Do robot platform) (optional) This path will enable learned to get the robotic licence provided as final examination by COMAU company itself. **Alternative 2** The alternative path can be done by the adoption of open source version of programming code like "Kuka Sim" the simulation and Offline Programming. **Alternative 3** This alternative path is based on the robotic open source https://www.osrfoundation.org/ It is based on The Robot Operating System (ROS), a set of software libraries and tools that help you build robot applications. From drivers to state-of-the-art algorithms, and with powerful developer tools, ROS has what you need for your next robotics project. And it's all open source. **Assessment criteria** Learners over the learning unit will be assessed on a practical exercitation. Different job activity will be provided on student, in the initial phase at group level. A rubric will be developed for each job/project. Learners in their groups will have to complete a project. In the first learning unit the main focus will be on the understanding and adaptation of a given typical program to control a modern robot with respect a different scope from the original software, by the adoption of elements provided over the lessons. Teacher will wander around the room, observing each student at their task, also observing the group dynamic as they plan, build, and program. The observations will be used to assess each individual according to the rubric for their job. This is the individual grade for the project. A rubric to assess the final product will be also developed. This provides a second grade for each individual for the project.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V

Delivery methods	■ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings and website:** **Alternative 1** Sowftare and documentation provided by COMAU on their portal platform **Alternative 2** Kuka Office Lite KUKA.Sim Kuka RoboDK: https://robodk.com/download https://www.allaboutcircuits.com/technical-articles/an-introduction-to-robot-operating-system-ros/ **Alternative 3** http://wiki.ros.org/ Video tutorial ROS introduction https://www.youtube.com/playlist?list=PLDC89965A56E6A8D6
Activities	Practical work using robot programming software (e.g. COMAU e.DO based system, Kuka Office Lite or Robot Operating System (ROS) open source).

Learning outcomes *Number and title*	**6.2 Create new software to safely operate an industrial robot**

Competences

1. Describe the H&S aspects of industrial robots.
2. Describe the generic structure and functions of an industrial robot.
3. Demonstrate Competently manipulate of an industrial robot.
4. Interpret a typical program used to control a modern industrial robot
5. Develop and safely modify a given program to achieve a specific task, test, and upload this program to a robot and demonstrate its function.
6. To create robot programs to perform different tasks.
7. Demonstrate knowledge of robot logic and interfaces.
8. Describe the communication equipment and protocols used.
9. Identify data types and system parameters/configurations.

Knowledge	**Skills**
1. To understand the risks associated with industrial robots 2. To possess a knowledge of the structure and function of a robot system 3. To understand robot co-ordinate systems 4. To understand robot tool, base and load calibration 5. To understand the structure of a robot program 6. To understand logical instructions & commands 7. To understand system variables and parameters	1. Demonstrate adherence to H&S requirements for industrial robots 2. Competently operate an industrial robot 3. Calibrate tool, load and base systems 4. Be able to modify an existing program and test against a defined specification 5. To be able to create new programs and test against a defined specification 6. To be able to archive/restore programs

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. The work accomplished in the previous module will provide the basis to understand and modify a typical robot programming language. In the present module, learners will create a new robot program to perform different tasks properly configuring the parameters. Assessment criteria Learners over the learning unit will be assessed on a practical exercitation. Different job activity will be provided on student. A new will be developed for each job/project. Learners in their groups will have to complete a new project creating a new robot program. Teacher will wander around the room, observing each student at their task, also observing the group dynamic as they plan, build, and program. The observations will be used to assess each individual according to the rubric for their job. This is the individual grade for the project.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V

Delivery methods	■ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings and website** **Alternative 1** Sowftare and documentation provided by COMAU on their portal platform **Alternative 2** Kuka Office Lite KUKA.Sim Kuka RoboDK: https://robodk.com/download https://www.allaboutcircuits.com/technical-articles/an-introduction-to-robot-operating-system-ros/ **Alternative 3** http://wiki.ros.org/ Video tutorial ROS introduction https://www.youtube.com/playlist?list=PLDC89965A56E6A8D6
Activities	Practical work using robot programming software (e.g. COMAU e.DO based system, Kuka Office Lite or Robot Operating System (ROS) open source).

B. Curriculum template		
Unit of learning	**7. Automated Control Systems**	
Duration	55	Lessons hours: 30 Self-study hours: 10 Hands-on hours: 10 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**7.1 Theory and methods of sensing and control**	

Competences
1. Identify the main types of automatic control (discrete, open/closed loop, sequence)
2. Apply Integration of safety into automatic control systems
3. Critically appraise the types of automatic control and their suitability for different applications
4. Explain Control technology – sensors and drives (theory)
5. Perform research on a real application of control theory.

Knowledge	**Skills**
1. To understand methods of automation control 2. To understand the use of robots, PLCs & computer-controlled equipment 3. To understand reporting and data analysis techniques 4. To understand trends in automation technology (Industry 4.0 & The Connected Enterprise)	1. To identify existing methods of automation control 2. To understand the use of robots, PLCs & computer-controlled equipment 3. Deployment of reporting and data analysis techniques 4. To observe and understand trends in automation technology (Industry 4.0 & The Connected Enterprise)

Assessment methods *(Click appropriate box/s)*	☐ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing
	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment.
	The module will be based on NI Labview tool.
	Outcomes:
	a) An ability to apply knowledge of mathematics, science and engineering
	b) An ability to design and conduct experiments, as well as to analyze and interpret data
	c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
	d) An ability to function on multi-disciplinary teams
	e) An ability to identify, formulate and solve engineering problems f) An understanding of professional and ethical responsibility
	g) An ability to communicate effectively
	h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
	i) A recognition of the need for, and an ability to engage in life-long learning
	j) A knowledge of contemporary issues
	k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
	Assessment of Student Outcomes through:
	• Direct Measures:
	  • Specific test questions
	  • Projects, reports
	  • Rubrics
	• Indirect Measures:
	  • Surveys
	Project assessment:
	• Design and build a system for a specific task -> outcome (c)
	• Model the system -> outcome (a)
	• Use of Mechanical components (gears, pulleys, etc.) -> outcome (c)
	• Selection & interface of Sensors / Actuators -> Outcome (e)
	• Data Acquisition System-> outcome (k)
	• Programming -> outcome (k)
	• Testing and data handling -> outcome (b)
	• Team Project-> outcome (d)

Qualifications framework *Reference to EQF and NVQ*	Level EQF V

Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** Labview-Getting Started Labview lessons 1 to 6 **Websites:** Control systems: https://en.wikipedia.org/wiki/Automatic_control https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm **Videos and tutorials:** Tutorial National Instruments: http://www.ni.com/tutorial/6368/en/ LabVIEW Tutorial 1 - Getting Started: https://www.youtube.com/watch?v=Em5R_RM8E08 LabVIEW Course | Lesson 1 (Programming) 2016: https://www.youtube.com/watch?v=mBSB9qCfl54 Lecture - 11 Introduction to Automatic Control: https://www.youtube.com/watch?v=2MRu9SQCU_g
Activities	Classroom-based activity Using a real production process, describe the overall process, the control system used, the method(s) used to control it (discrete, open/closed loop, sequence), the equipment used to both drive and provide feedback to the control system. Include an appraisal of the safety system(s) in place and recommendations for further improvement where necessary

Learning outcomes *Number and title*	**7.2 Application of control theory to industrial automation**

Competences

1. Describe and relate control theory to a modern industrial robot
2. Describe how an industrial robot is driven and controlled – how the sensors, controller and drive interact to produce movement under constant software control.
3. Explain how manufacturer specifications may be used to derive machine performance characteristics in real-world use.
4. Demonstrate knowledge of industry terminology.

Knowledge	**Skills**
1. How control theory relates to industrial robots 2. Understand control topology and terminology 3. To understand how control systems generate and analyse data	1. Demonstrate computer skills 2. Demonstrate data analysis techniques

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. This set of modules focus on control tutorials for MATLAB and Simulink, Control Tutorials for MATLAB and Simulink - Designed to help to learn how to use MATLAB and Simulink for the analysis and design of automatic control systems. They cover the basics of MATLAB and Simulink and introduce the most common classical and modern control design techniques. System Dynamics and Control - Modeling of electrical, mechanical, and electromechanical systems. Analytic solution of open loop and feedback type systems. Root Locus methods in design of systems and evaluation of system performance. Time and frequency domain design of control systems. Learning Outcomes Upon successful completion of the course, students will be able to select, design, analyze, implement, and evaluate effective controllers for a number of different robotics platforms and applications.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	**Readings:** 1. Introduction to Control systems **Websites:** Videos and tutorials: Tutorial Matlab https://uk.mathworks.com/academia/courseware/control-tutorials.html https://uk.mathworks.com/academia/student_center/tutorials.html https://uk.mathworks.com/academia/student_center/tutorials.html The Complete MATLAB Course: Beginner to Advanced!: https://www.youtube.com/watch?v=T_ekAD7U-wU

B. Curriculum template

Unit of learning	**8. Machine Software Design principles**	
Duration	55	Lessons hours: 30 Self-study hours: 10 Hands-on hours: 10 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**8.1 Software design methodologies**	

Competences
1. Describe the basics of generic programming structures.
2. Explain the basic syntax rules of a given programming language.
3. Apply Synthesize programs in a chosen language to demonstrate understanding of program construction: Variables, Loops, Decisions, Branching, Labelling
4. Identify Data types (Binary / Hex)

Knowledge	**Skills**
1. To understand data types (constant & variable, numbering systems) 2. To understand error handling techniques 3. To understand human-machine interfaces 4. To understand program structures 5. To understand program design principles (top-down design / JSP)	1. To demonstrate good Maths, English, ICT skills 2. To demonstrate ability to devise a program using a logical structure 3. To demonstrate data analysis and collection techniques

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. The module will be based on the adoption of LabVIEW Real-Time. LabVIEW Real-Time is a full programming language providing developers numerous options of how to construct a controller and enabling them to create very flexible and complex systems. LabVIEW Real-Time controllers are being used in applications ranging from control of nuclear power plant rods, to hardware in the loop testing for engine ECUs, to adaptive control for oil well drilling, to high speed vibration monitoring for predictive maintenance The architecture will also facilitate implementing features including: • Performing parallel loops and nondeterministic operations such as data logging • Implementing interlocks • Building multirate control applications • Implementing I/O forcing • Performing communications from the real-time controller • Adding an HMI To demonstrate this control architecture, a basic PID control application will be provided (http://www.ni.com/example/6922/en/). This simple application controls a temperature chamber to maintain 350 degrees. The example case study has one analog input from a thermocouple, one analog output (0-10V) that is connected to the input on a heater controller, and will use a PID algorithm for control. This application is overly simplistic and is used here to explain the architecture components without adding the complexity of an intricate control example. More detailed control examples are explored later which demonstrate using this architecture for more complex control applications. Assessment criteria will be based on the following outcome delivering: • Architecture component identification (Basic Controller Architecture) • The initialization routine • Control routine • Shoutdown routine • I/O table definition
Qualifications framework *Reference to EQF and NVQ*	Level EQF V

Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** **Websites:** NI Labview: http://www.ni.com/example/6922/en/ Machine Control Software Design Examples: http://www.ni.com/example/30750/en/

Learning outcomes *Number and title*	**8.2 Modification of programs and the synthesis of new programs**

Competences
1. Use a chosen high-level language produce software that produces a required output from define initial conditions, and any supplied calculations
2. Use a chosen high-level language, identify and correct errors in supplied programmes.

Knowledge	**Skills**
1. To select an appropriate language to use for a particular application 2. To understand fault-finding methods	1. Demonstrate the ability to understand a computer program 2. Demonstrate the ability to change a computer program 3. Demonstrate fault-finding techniques 4. Computer skills, ICT

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria *Description and timing*	In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment. The easiest way to get started with this design is to modify an existing example. Assessment will be based on the modification capability of previous example that used the state chart to build our own application. There are 4 main steps: 1. Modify the I/O Scan Task to read and write to the physical I/O for your application. 2. Modify the Initialization Routine to write the default values for your physical outputs. 3. Modify the Task 1 to map the I/O. 4. Modify /rewrite the StateChart to fit your application Assessment criteria will be based on the following above mentioned steps delivering.
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** **Websites:** http://www.ni.com/example/6922/en/ http://www.ni.com/example/30750/en/ **Videos and tutorials:** **Documents:** **Examples:** machine_ctl_sw_design.zip

B. Curriculum template		
Unit of learning	**9. ICT in automated production lines**	
Duration	90	Lessons hours: 40 Self-study hours: 20 Hands-on hours: 10 Other (please specify): Assessment hours: 10
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**9.1 Analysing data**	
Competences 1. Designs data structures 2. Builds system structure models according to analysis results through modelling languages 3. Collect and analyse data from different production cells also via cloud applications		
Knowledge 1. Statistical theory and applications 2. Techniques for large scale data analysis and data mining		**Skills** 1. Ability to monitor and collect research data 2. Ability to assess accuracy, validity, and integrity of data 3. Ability to analyze statistics and other data 4. Ability to interpret and evaluate results 5. Ability to create reports and/or presentations. 6. Capacity to work with different computing tools in order to address complex problems
Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ■ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):	

<table>
<tr><td>Assessment criteria
Description and timing</td><td>In designing their tests the teachers are suggested to set at least one ‘Performance-based’ assessment.
This module enables learners to understand the importance of data to retrieve business intelligent for decision making process. They will get understanding of Data Analysis, the methodology, the main tools and tests and when to use them and when not. Learners will extend their knowledge of databases and they will develop skills to create data models for business intelligence, combine data from several sources and implement data to produce useful management reports.
Some of the topics will also be illustrated using MS EXCEL.
Other tools and programming: Hadoop/Spark, Python, R, SQL
Learning outcomes
1. Appraise the role of data warehouses for providing business intelligence in decision-making
2. Evaluate all stages of data warehouses life cycle model
3. Design and develop data models for data warehouses
4. Extract, transform and load data from range of source using various available tools and techniques
5. Implement a data warehouse to produce useful management reports
Assessment strategy
● A practical project to design and build a data warehouse to develop a useful report demonstrating business intelligence retrieved for data
● Exam to understanding and theoretical knowledge of learners
<table>
<tr><th>Method of assessment</th><th>Percentage weighting</th><th>Learning outcomes assessed</th></tr>
<tr><td>Project</td><td>50%</td><td>3,4,5</td></tr>
<tr><td>Exam</td><td>50%</td><td>1,2,3</td></tr>
</table>
</td></tr>
<tr><td>Qualifications framework
Reference to EQF and NVQ</td><td>Level EQF V</td></tr>
<tr><td>Delivery methods</td><td>☐ Hands-on
■ Lectures/lessons/presentations
☐ Job-shadowing
☐ Placement
■ Project work
☐ Role-play
☐ Video tutorials
☐ Other activities (please specify):</td></tr>
</table>

Resources	**Readings:** Step-by-Step Guide to Data Analysis & Presentation **Websites:** https://www.ictlounge.com/html/dataanalysis.htm http://edutechwiki.unige.ch/en/Methodology_tutorial_-_quantitative_data_analysis **Videos and tutorials:** IGCSE ICT 2016 Specimen Paper 3 Data Analysis: https://www.youtube.com/watch?v=SXrCYQm-7dw&t=217s Data analysis in Excel, webinar: https://www.youtube.com/watch?v=0dIykabcN-c

Learning outcomes *Number and title*	**9.2 Improving the production**

Competences

1. Design, develop and configure simulation environments to test changes in the production phases to improve production processes
2. Detecting faults in the production cells
3. Identifying improvements through software applications, simulation and reverse engineering
4. Selecting the appropriate self-adaptation systems
5. Implementing auditing of processes and of products
6. Involving other specialists on the basis of improvement requirements

Knowledge	**Skills**
1. Methods and techniques of industrial engineering 2. Auditing techniques and procedures 3. Ishikawa 4. Guidelines ISO 19011 5. Voluntary norms for statistical sampling	1. Process engineering 2. Software engineering 3. Monitoring and control of the information flow and data from the production line, against pre-defined parameters and indicators 4. Using statistical tools for quality control and cause-effect diagrams

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing

This module enables learners to understand how to improve the production in a close to industrial contest related to the Industry end Production. The first part of the unit will provide elements to design part of a plant by the use of tools like Process Simulate (by Siemens) or similar, where the line is designed by the implementation of some cells with robots to operate a partial production.
Learners will be assigned to improve the production by the modification of cell layers according to the knowledge so far achieved (e.g. ROS or other robot programming, and data analysis).
Learning outcomes
1. Application of ROS or other robot programming for robot manipulation in the cell
2. Analysis of process production and identification of process improvement strategies (cycle time on different configuration extrapolated by process simulate and analyzed with previous module tools)
3. Cell re-design according to the production improvement
4. Data analysis of new production (cycle time)
Assessment strategy

- A practical project to design a new cell layout to be analyzed over the target described
- Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Project	50%	1, 2, 3
Exam	50%	2, 4

Qualifications framework
Reference to EQF and NVQ

Level EQF V

Delivery methods

- [x] Hands-on
- [ ] Lectures/lessons/presentations
- [ ] Job-shadowing
- [ ] Placement
- [x] Project work
- [ ] Role-play
- [x] Video tutorials
- [ ] Other activities (please specify):

Resources	**Readings:** Process Simulate Virtual Commissioning. Shay Shomroni, Siemens AG **Websites:** Videos and tutorials: Process simulate basics https://www.youtube.com/watch?v=VkpuVCi8C2A Demonstrating the Integration of ROS with Siemens' Process Simulate http://rosindustrial.org/news/2014/11/19/bxqx7o47u8uwckdeehh3gvtu25bjy9 TU Darmstadt process simulate tutorial https://community.plm.automation.siemens.com/t5/Collaborate-Contribute-Curriculum/TU-Darmstadt-s-online-tutorials-for-Tecnomatix/td-p/321025 Calculate and Display Cycle Time and Average Cycle Time https://www.youtube.com/watch?v=nWxV0ekNiCE Process Simulate Virtual Commissioning https://www.youtube.com/watch?v=onf_ZY8ex_k Plant Simulation Student Download https://www.plm.automation.siemens.com/it/academic/resources/tecnomatix/simulation-download.cfm

Learning outcomes *Number and title*	**9.3 Implementing E-security**

Competences
1. Ensure security and appropriate use of ICT resources
2. Evaluate risks, threats and consequences
3. Adopts tools for technical validation of security
4. Contribute to definition of security standards
5. Interact with security specialist to audit security vulnerability
6. Monitor security developments to ensure data and physical security of the ICT resources

Knowledge	**Skills**
1. Legislation about privacy 2. Techniques for the Information security management system 3. Risks of e-security related to the purchase, development or modification of ICT systems 4. Techniques and procedures of business continuity 5. Techniques and procedures of disaster recovery 6. Techniques and procedures of crisis management 7. Norm UNI CEI ISO/IEC 27001:2014	1. Apply measures to ensure integrity, availability and confidentiality of ICT systems, networks and data 2. Apply security policy of the organization, interacting with other departments and e-security experts 3. Implement, with the involvement of e-security specialists, business continuity, disaster recovery and crisis management 4. Identify vulnerabilities of ICT systems

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	Business and organisations are increasingly dependent on ICT for communication outside a "protected" internal, organisation-only environment. Trends such as mobile technology, cloud and social networking increase an organisation's interaction with customers, staff, suppliers, partners and other parties. At the same time, this makes them more vulnerable to deliberate or accidental security breaches and cyber-attacks. The demand for security technologies and skills in IT security is evolving into a need for complex, context-aware protection. As a result, IT security technology and skills are in big demand. There are three main areas of ICT security: • Identity and access management (IAM) - solutions used to identify users in a system and control their access to resources within that system by associating user rights and restrictions with the established identity. • Secure content and threat management (SCTM) - products to defend against viruses, spyware, spam, hackers, intrusions, and the unauthorized use or disclosure of confidential information. • Security and vulnerability management - solutions that focus on allowing business and organizations to determine, interpret, and improve their risk position. The course will provide a clear understanding to learners on the E-security aspects, and how to better interact with ICT experts. Assessment strategy • Examination on legislation issue • Examination on ICT risks
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	■ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	Nash, A., Duane, W., & Joseph, C. (2001). *PKI: Implementing and Managing E-security*. McGraw-Hill. Liu, J. K., Samarati, P. (2017) *Information Security Practice and Experience: 13th International Conference ISPEC 2017*, Springer.

Learning outcomes *Number and title*	**9.4 Planning new production lines**

Competences
1. Define criteria and procedures for the acquisition and analysis of data from new production line
2. Define methodologies, equipment, timing and costs for new production lines
3. Define criteria for the selection of the providers and sub-contractors

Knowledge	**Skills**
1. ICT Project management system Norm UNI 11506 and 21500 2. Techniques and tools for project management 3. SWOT analysis	1. Operate simulation systems for the conception of new production lines 2. Provide data and technical specifications for new production lines 3. Monitor and test the appropriate configuration of new production lines

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing

In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment.
This module enables learners to understand how to improve the production in a close to industrial contest related to the Industry end Production working at Plant level. The first part of the unit will provide elements to design a plant by the use of tools like Plant Simulation (by Siemens) or similar, where the plant is designed considering also the flow inside, the resources utilization, and the logistic.
Learning outcomes
1. Analysis of process production and identification of process improvement strategies (flow, logistic, resources, …)
2. Plant re-design according to the production improvement
3. Determining the optimal configuration for new production systems
4. Establishing proper levels of work-in-process inventory
5. Setting appropriate production schedules
6. Establishing the correct production throughput-to-resource utilization ratio
Assessment strategy

- A practical project to design a plant layout with flow and logistic to be analyzed over the target described
- Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Project	50%	1, 2, 3, 4, 5, 6
Exam	50%	4, 5, 6

Qualifications framework
Reference to EQF and NVQ

Level EQF V

Delivery methods

☐ Hands-on
■ Lectures/lessons/presentations
☐ Job-shadowing
☐ Placement
■ Project work
■ Role-play
☐ Video tutorials
☐ Other activities (please specify):

Resources	**Readings:** Plant Simulation 3D Tutorial, Tecnomatix. Peter Komarek, Siemens Simulation Modelling using Practical Examples: A Plant Simulation Tutorial, Martijn R.K. Mes, University of Twente Plant_Simulation_Fact_Sheet_book_HQ (1).pdf **Websites:** Videos and tutorials: Introduction to Plant Simulation - Part 1 - … https://www.youtube.com/watch?v=VAVVWg5D-lM https://www.youtube.com/results?search_query=plant+simulate https://www.youtube.com/watch?v=sZy6OHNS_M4 Tecnomatix Plant Simulation https://www.youtube.com/watch?v=UL13f4d4y-s&list=PLBAybh8T2zuMQM63SfJxt0cyOve69vqou Plant Simulation Student Download https://www.plm.automation.siemens.com/it/academic/resources/tecnomatix/simulation-download.cfm

B. Curriculum template

Unit of learning	**10. Process optimisation**	
Duration	55	Lessons hours: 30 Self-study hours: 10 Hands-on hours: 10 Other (please specify): Assessment hours: 5
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**10.1 Optimising process**	

Competences

1. Identify the main methods used to optimise a process –
   a. Equipment optimisation – bottlenecks, uptime / gaps in utilisation, uptime (e.g. OEE, OPC)
   b. Operating procedures – automation vs. manual, standard operating procedures
   c. Control optimisation – tuning the various parts of the process to produce optimal output
2. Apply one or more optimisation techniques to a real-world process, and suggest ways that the process could be improved. Calculate the potential for improvements (process time, product quality, reduction in cost)

Knowledge	**Skills**
1. To have the knowledge to identify variables in a process 2. To know how to program a robot & PLC 3. To gain knowledge of team-working, work studies, communication techniques 4. Knowledge of lean manufacturing & QA techniques	1. To demonstrate application of lean manufacturing techniques (six sigma etc.) 2. Demonstrate the ability to understand and change process layouts and orders

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):
Assessment criteria *Description and timing*	This module enables learners to understand how to optimize process, and demonstrate this knowledge through the application to a real process. The first part of the unit will provide element to analyses a process, identify lack and consider different techniques to optimize the process. Learning outcomes 1. Process analysis capability 2. Identify the main methods used to optimise 3. Apply one or more optimisation techniques Assessment strategy • A practical project to anaylse the current process and to evaluate the optimisation potential • Exam to understanding and theoretical knowledge of learners
Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ■ Video tutorials ☐ Other activities (please specify):

Method of assessment	Percentage weighting	Learning outcomes assessed
Project	50%	1, 2, 3
Exam	50%	2

Resources	**Readings:** Optimisation problem formulation and solution techniques. **Websites:** http://www.electronics-tutorials.ws/systems/closed-loop-system.html

Learning outcomes *Number and title*	**10.2 Optimisation techniques**

Competences
2.1 Explain how optimisation techniques can be applied to industrial robots – placement of units, work areas, tools and product to minimise movement and cycle time.
2.2 Demonstrate how to optimise software to achieve optimum operation
2.3 Describe how machine-specific limitations may limit optimum operation in certain circumstances, and how these may be mitigated or overcome

Knowledge 1. Understand limitations of equipment	**Skills** To demonstrate proficient programming techniques To apply optimisation techniques to cell design

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ■ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing

This module enables learners to understand the different optimization techniques and hot to adopt them to optimize process.
Learning outcomes
1. Definition of process optimization
2. Process optimisation methods-approaches
3. Process optimisation techniques/tools
4. Apply one or more optimisation techniques/tools
Assessment strategy
- A practical project to appoly the right optimisation approach and select one or more optimisation technique/tool
- Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Project	50%	2,4
Exam	50%	1,3

Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** R2_EN_COSIMA_Process_Optimization_methods TQM_process_improvement_tools

B. Curriculum template		
Unit of learning	**11. Collaborative robotics**	
Duration	90 (30+30+30)	Lessons hours: 40 Self-study hours: 20 Hands-on hours: 10 Other (please specify): Assessment hours: 10
Number of ECVET Points *(if applicable)*		
Learning outcomes *Number and title*	**11.1 Programming and computing language**	
Competences 1. Detect software and hardware faults 2. Troubleshooting of software and hardware faults		
Knowledge 1. Software programming language 2. Robot / vendor specific programming language		**Skills** 1. Ability to modify job routines via programming language of the robot
Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):	

Assessment criteria *Description and timing*	Module Aims: the trainers will start with the first look: Features and terminology. Starting with the previous know-how generated by the programming robot module, teacher will focus on the Interaction with external devices aspects, especially on Safety settings aspects. Teacher will present different collaborative robots available on the market, like Universal Robot, Sawyer/Baxter, Kuka, COMAU and others produced by different robot producers. According to the resource available, course will be based on previous robot/hardware architecture adopted in Programming Robot module, or will be based on specific HRC hardware. As alternative, specific HRC programming code will be used, without the deployment on HW level. Learning outcomes 1. Understand principle of Human robot collaboration 2. Understand design and programming approach of HRC 3. Understand HRC programming language Design Assessment strategy ● A practical project to create an interaction between different robots/Human robots ● Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Group Project	40%	2, 3
Exam	60%	1,2

Qualifications framework *Reference to EQF and NVQ*	Level EQF V
Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):

Resources	**Readings:** Collaborative Mobile Robot Design in an Introductory Programming Course for Engineers Robert Avanzato Penn State Abington College Abington, PA 19001 Lightweight-robots-and-Collaborative-Robotics How to make collaborative robot programming easier: Workflow visualization on a tablet device. Tilda Pentikäinen Stina Richard, Department of Information Technology Collaboration in Human-Robot Teams Guy Hoffman and Cynthia Breazeal MIT Media Lab, 20 Ames St. E15-468, Cambridge, MA, 02139, USA Social Robots and Human-Robot Interaction Ana Paiva Intera_5_User_Guide_Getting_Started_20170302_RevB.pdf ur3_user_manual_en_global.pdf Different Applications of Mobile Robots in Education, Boris Crnokić, Sveučilište u Mostaru **Websites:** https://www.controleng.com/single-article/collaborative-robots-and-humans-working-together/79089be8f319683475b03b1976fec7a7.html https://www.i-scoop.eu/industry-4-0/cobot-collaborative-robot/ https://blog.robotiq.com/ease-of-using-robotiq-equipment-with-collaborative-universal-robots https://www.generationrobots.com/blog/en/2015/01/collaborative-robots-traditional-robots-5-key-differences/ EU funded research projects on COBOTS – HMI: http://www.robo-partner.eu/ http://www.robo-mate.eu/ http://www.co4robots.eu/ https://www.colrobot.eu/ **Videos and tutorials:** https://www.youtube.com/watch?v=4pdU2rCv91Q https://www.youtube.com/watch?v=pIcxOGo7ieU https://www.youtube.com/watch?v=cMXScEV8VWM https://www.youtube.com/watch?v=tIJNg3uCvS8 Universal robot training course: https://www.universal-robots.com/academy/
Activities	

Learning outcomes *Number and title*	**11.2 HMI - Human machine interaction**

Competences
1. Planning production processes involving human and robot cooperation
2. Ensuring safety in HMI production environments
3. Optimizing automated and robot production processes

Knowledge	**Skills**
1. Norm ISO/TS 15066	1. Using cameras and equipment for monitoring safety and efficacy of HMI working environments

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ■ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing

In designing their tests the teachers are suggested to set at least one 'Performance-based' assessment.
Module aims:
- Present the techniques and issues involved in promoting usable and engaging interaction design
- Present new and emerging platforms for interaction

This module enables learners to understand what is Interaction Design by:
- Designing interactive products to support people in their everyday and working lives
- ID is a process:
  – a goal-directed problem solving activity informed by intended use, target domain, materials, cost, and feasibility
  – a creative activity
  – a decision-making activity to balance trade-offs

And will focus on PACT Analysis:
- 'User-centric' framework for thinking about a design problem
- Take each category - People - Activities - Context and Technology - and work through it
- Use the analysis to help focus/orient early design thinking
- Important: revisit the analysis
  - As you get deeper into the problem the analysis should change and/or get richer

And on User-centred (iterative) design process:
- Identify needs and establish requirements
- Generate alternative solutions/designs
- Build interactive prototypes that can be communicated and assessed
- Evaluating design

Learning outcomes
1. Understand what ID is
2. Understand and apply PACT analysis
3. Understand the basic step of the user-centred

Design Assessment strategy
- A practical project to design a plant layout with flow and logistic to be analyzed over the target described
- Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Group Project	40%	2, 3
Exam	60%	1, 2

Qualifications framework
Reference to EQF and NVQ

Level EQF V

Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ■ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings:** Human Machine Interaction: Research Results of the MMI Program by Bruno Dumas, Denis Lalanne, Sharon Oviatt (auth.), Denis Lalanne, Jürg Kohlas (eds.) Companion website for Preece et al.'s book: http://www.id-book.com/ Web portal maintained by Georgia Tech: http://hcc.cc.gatech.edu/ Ways of Knowing in HCI. Editors: Olson, Judith S., Kellogg, Wendy A. (Eds.). Provides comprehensive and up-to-date coverage of current research methods in HCI https://www.roboticstomorrow.com/article/2015/12/getting-started-with-collaborative-robots-part-1--what-can-collaborative-robots-do/7298/ Design_of_a_3-DOF_Parallel_Hand-Controller, Chengcheng Zhu and Aiguo Song Towards Modern Inclusive Factories: A Methodology for the Development of Smart Adaptive Human-Machine Interfaces, Valeria Villani, Lorenzo Sabattini, Julia Czerniak **Websites:** https://en.wikipedia.org/wiki/User_interface https://www.xsens.com/tags/human-machine-interaction/ http://www.hmiss.it/ https://www.mmi.rwth-aachen.de/en/ https://www.mmi.rwth-aachen.de/vorlesungen/industrie-4-0-fuer-ingenieure/ https://en.wikipedia.org/wiki/User_interface **Videos and tutorials:** https://www.youtube.com/playlist?list=PLF4A01617834A0FB6

Learning outcomes *Number and title*	**11.3 Mechatronics**

Competences
1. Designing circuits
2. Dimensioning components
3. Interfacing systems
4. Programming controls
5. Assembling drives

Knowledge	**Skills**
1. Hybrid technology 2. Directional and speed controls of mechatronic drives	1. Configurating logic control options with PLC, sequences and industrial processes 2. Commissioning control systems

Assessment methods *(Click appropriate box/s)*	■ Written exercises and test ☐ Oral examination and exercises ■ Practical assignment under supervision ■ Practical assignment autonomously and responsibly ☐ Other activities (please specify):

Assessment criteria
Description and timing

Learners, in this unit, will be able to understand mechatronics principle matched to specific cases study. Two alternatives are proposed: unilt learning based on Maplesoft suite or based on "Robotino" tool.
Maplesoft's suite of tools for modeling and analyzing mechatronic systems relieves the burden that is typically associated with using traditional simulation tools to develop high-fidelity models. Maplesoft's next-generation graphical tools for model development and analysis dramatically reduce the time and cost of up-front analysis, virtual prototyping, and parameter optimization of system designs.
Teaching on designing systems where open-loop, closed-loop, kinematic, and dynamic behaviors need to be considered. Tools for transferring work into an existing control development toolchain, and real-time simulation systems for hardware-in-the-loop testing will also be presented.
This module presents different possibilities of using mobile robots in education. Through the application of mobile mechatronic robotic system **"Robotino"** this paper shows the possibilities of developing interactive lectures and exercises in order to raise the quality of education and to provide new competencies for students. Application of robot as a real system supports strengthening specific areas of knowledge and skills that the students develop through design, creation, assembly and operating with the robot. This way of learning contains a very important element and that is "Playful learning" or learning through play. Along with technical competences, combining this method with teamwork improves also social skills and motivation for learning. Open programming environment.
The programming interface (API) of Robotino® allows various programming languages and systems to be used to develop a control program. The API supports the following languages and systems:
- C/C++, JAVA, .Net
- LabVIEW and MATLAB/Simulink
- Robot Operating System (ROS SmartSoft)
- Microsoft Robotics Developer Studio

Learning outcomes
1. Maplesoft tool or Robotino with specific language system
2. Understand and apply mechatronics principle to robot systems
3. Use and managing of sensors on robot system

Design Assessment strategy
- A practical project to design actions for the robotino system
- Exam to understanding and theoretical knowledge of learners

Method of assessment	Percentage weighting	Learning outcomes assessed
Group Project	40%	1, 2, 3,
Exam	60%	1, 2

Qualifications framework
Reference to EQF and NVQ

Level EQF V

Delivery methods	☐ Hands-on ■ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ■ Project work ☐ Role-play ☐ Video tutorials ☐ Other activities (please specify):
Resources	**Readings** Different Applications of Mobile Robots in Education, Article · September 2017, Boris Crnokić at Sveučilište u Mostaru Handbook of Research on Advancements in Robotics and Mechatronics, a cura di Habib, Maki K. Robotino, the new learning system – learning with robots, FESTO Robotino robot, university of Jordan Obstacle Detection for Indoor Navigation of Mobile Robots, Thesis for: Master, Advisor: René Schmidt, Rashedul Islam Rasel Optimal trajectory generation using MPC in robotino and its implementation with ROS system, Conference: 2017 IEEE 26th International Symposium on Industrial Electronics (ISIE), Paolo Mercorelli at Leuphana University Lüneburg A model predictive control in Robotino and its implementation using ROS system, Conference: 2016 International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARS-ITEC), Paolo Mercorelli at Leuphana University Lüneburg **Websites:** http://wiki.openrobotino.org/index.php?title=Main_Page https://en.wikipedia.org/wiki/Mechatronics https://www.maplesoft.com/products/studyguides/index.aspx http://www.festo-didactic.com/int-en/learning-systems/education-and-research-robots-robotino/ http://www.festo-didactic.com/int-en/learning-systems/education-and-research-robots-robotino/robotino-for-research-and-education-premium-edition-and-basic-edition.htm?fbid=aW50LmVuLjU1Ny4xNy4xOC44NTguODAyNQ **Videos and tutorials:** http://doc.openrobotino.org/download/RobotinoView/en/index.html?tutorial_2.htm https://www.youtube.com/watch?v=nS5U4hqXn0k Mechatronic and Robotic Applications of MapleSim: https://www.maplesoft.com/contact/webforms/webinars/MapleSim_MechatronicRobotics.aspx Universal Robots in Festo Didactics' Mechatronics Training System: https://www.youtube.com/watch?v=nS5U4hqXn0k

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- EFFRA – "Factories of the Future Roadmap - Factories 4.0 and Beyond" http://www.effra.eu/factories-future-roadmap
- Global Industry 4.0 Survey (2016) "Industry 4.0: Building the digital enterprise", https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf

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