SKILLMAN

Sector Skills Alliance
for Advanced Manufacturing
in the Transport Sector

CURRICULUM: ROBOTICS AND AUTOMATION

Curriculum & Teachers methodological guide

Work Package 4 Final Curricula

Contents

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

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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

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- 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"

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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:
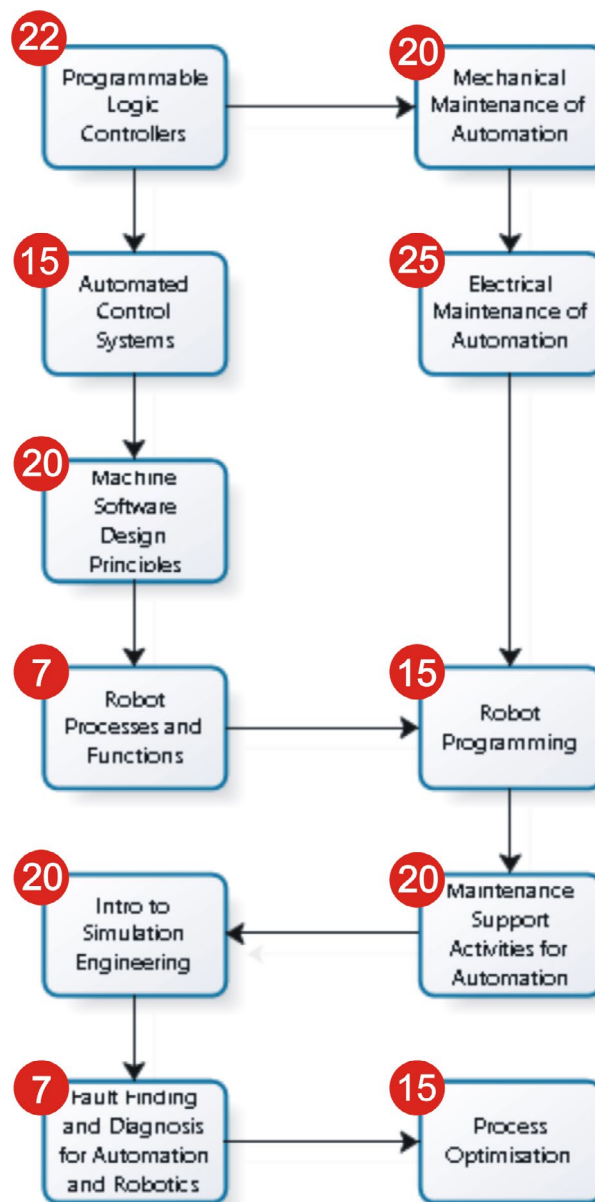
Part A
Teachers methodological guide

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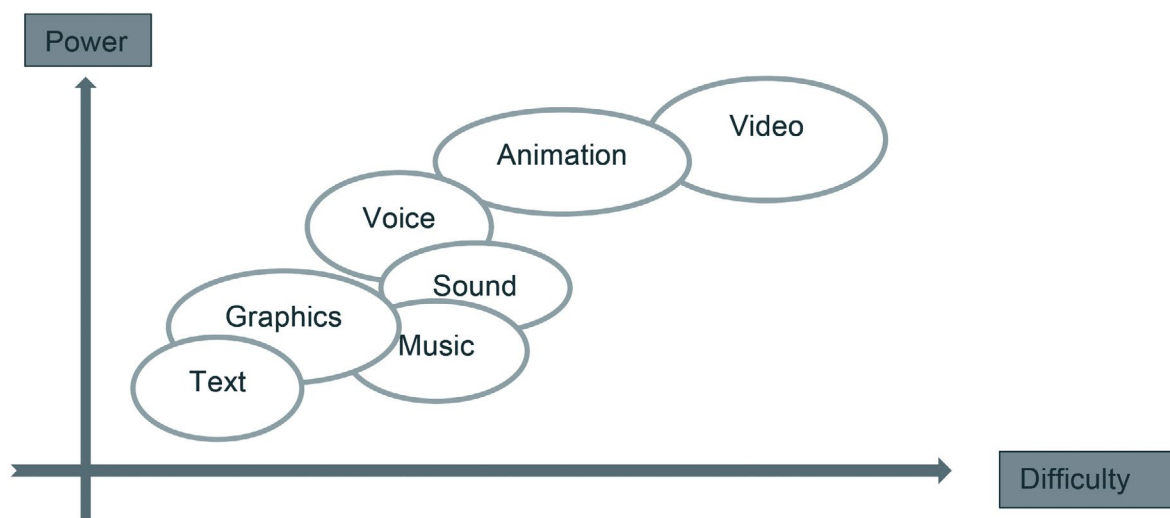
Technology applications that can be used in OER: a brief overview

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
Curriculum: Robotics and Automation

Part B
Curriculum: Robotics and Automation

1. Introduction

This qualification covers the knowledge, understanding and practical skills involved with robotic and automation engineering within a manufacturing environment.

It should be noted that the structure of UK qualifications is not aligned with the structure of the Work Package 4 Template.

The following items are not specified or set out as requirements by awarding organisations therefore there are no formal references made in the qualification documentation. Some assumptions can be made however and have been included in this document however further information is provided in Section 6.

These items include:

- *Number of recommended hours of self-study or hands on learning:* this is a minimum GLH (guided learning hours) requirement imposed but this is not split in to delivery modes. The delivery centre makes this judgement when the learning programme is constructed.

- *Assessment methods:* all delivery centres undergo rigorous quality assurance on a regular basis, carried out by the awarding organisation (EAL). Any issues linked to assessment methodology are highlighted within this process. In addition all Assessors are required to be suitably qualified, undergo regular Continuous Professional Development (CPD) which includes review of current assessment methodology.

- *Assessment criteria:* as per previous point for Assessment Methods

- *Delivery methods and activities:* devised by the delivery centre and not prescribed by EAL however outline guidelines are provided.

2. Targeting

Who is this qualification for?

- Learners who wish to understand robotic and automation engineering.

- Technicians and engineers who already work within the manufacturing industry who wish to enhance or re-confirm their skills and understanding of robotic and automation engineering.

What does this qualification cover?

This qualification comprises of a series of units which cover the knowledge and skills of robotic and automation engineering including: programmable logic control, maintenance of automation, fault finding and diagnosis, robot processes and functions, automated control systems, machine software design principles, robot programming, simulation engineering, process optimisation. There is an additional unit covering innovation in automation which can be selected as applicable to suit local needs.

3. Qualification Structure

This qualification has 186 Guided Learning Hours (GLH) and a Total Qualification Time (TQT) of 205 hours - which is the notional time required by the learner to complete the qualification. It will be obtained by the learner once they have completed the 11 mandatory units.

Unit ROB3-10 is an additional unit and can be chosen to suit local needs, however is not required for the qualification to be awarded.

The following are mandatory units ROB3-01 to ROB3-09

Unit	Unit title	GLH	Ofqual Code
ROB3-01	Programmable Logic Controllers	22	H/616/2149
ROB3-02A	Mechanical Maintenance of Automation	20	Y/616/2150
ROB3-02B	Electrical Maintenance of Automation	25	D/616/2151
ROB3-02C	Maintenance Support Activities for Automation	20	H/616/2152
ROB3-03	Fault Finding and Diagnosis for Automation and Robotics	7	K/616/2153
ROB3-04	Robot Processes and Functions	7	M/616/2154

ROB3-05	Automated Control Systems	15	T/616/2155
ROB3-06	Machine Software Design Principles	20	A/616/2156
ROB3-07	Robot Programming	15	F/616/2157
ROB3-08	Intro to Simulation Engineering	20	J/616/2158
ROB3-09	Process Optimisation	15	L/616/2159

Additional unit which can be chosen to suit local needs, however is not required for the qualification to be awarded.

Unit	Unit title	GLH	Ofqual Code
ROB3-10	Innovation in Automation	7	F/616/2160

4. Staffing

Staff Responsible for Registering and Certification of Learners

Centres are required to appoint a suitable member of staff who can take responsibility for registering learners onto the qualification and submitting entries for exams to EAL. They may also be responsible for applying to EAL for learner certificates.

Teaching Staff

These personnel must have the necessary knowledge and understanding of the assessment criteria and learning outcomes they are delivering. They must also understand the structure and content of the qualification.

It is a recommendation that the teaching staff will:

● Have 2 years experience in teaching/training.

or

● Are working towards an appropriate teaching/training qualification (e.g. Cert Ed or Learning & Development trainer units).

or

● Hold an appropriate teaching/training qualification (e.g. Cert Ed or Learning & Development trainer units).

Personnel Carrying out Assessment

The Centre MUST provide EAL with the names of any individuals who will undertake internal assessment, so that these can be approved prior to them carrying out an assessment role.

Personnel carrying out assessment must have:

- Knowledge and understanding of the assessment criteria they are assessing.
- Have knowledge and understanding of the qualifications structure and content.
- Understanding of the assessment process.

It is a recommendation that personnel carrying out assessment will be working towards or have achieved an assessment qualification.

Quality Assurance Staff

The quality assurance staff must have knowledge and understanding of the qualification's structure and content. They must also understand the assessment process and the role of quality assurance.

It is a recommendation that the quality assurance staff will:

- Have experience in quality management/internal verification

or

- Hold an appropriate qualification (e.g. V1).

5. Learners

There are no formal entry requirements for this qualification; however centres should ensure that the learners have the potential to achieve the qualification. Learners must have the minimum levels of literacy and numeracy to complete the learning outcomes and assessment.

Centres should make learners with particular requirements aware of the content of the qualification and they should be given every opportunity to successfully complete the qualification. EAL will consider any reasonable suggestions for, and from, those with disabilities that would help them to achieve the learning outcomes without compromising the standards required.

Age Restrictions

Learners must be at least 16 years old.

6. Assessment

This qualification is assessed by centre set assessments using the process provided by EAL.

EAL does not prescribe the format or nature of centre set assessments. Centres are free

to develop what they feel is appropriate and assessment material can be tailored for a specific cohort and/or industry.

The type of assessment tasks can vary and it is for the centre to choose what is appropriate.

However, all assessment tasks must meet the standard of the qualification and not pose any unnecessary barriers to achievement.

There is no limit on the number of assessment tasks set for a learner, but the centre must be mindful that there is sufficient depth and breadth of assessment to ensure the learner is capable of meeting the standards of the qualification.

It is the centre's responsibility to provide a detailed mapping of their assessment tasks to the standards in the qualification. This mapping must explicitly demonstrate where the individual 'Assessment Criteria' of each unit are met.

The centre must have a plan for their assessment, which demonstrates a consistent and considered approach to the assessment delivery.

In accordance with the policy all assessment material, mapping documentation and assessment plans must be validated by EAL prior to use by the centre. Any additions or enhancements to existing assessment material must also be validated by EAL prior to first use.

Centre set assessments serve to inform the assessment decisions of centre staff and they are supported by observation. Therefore EAL does not require that assessment is carried out within an invigilated examination environment. However, the centre must be able to demonstrate that the assessed work is that of the learners (this is supported through a process of internal quality assurance).

Assessment can be carried out by the centre delivery staff (those who are also delivering the training).

It is imperative that the delivery staff have an understanding of processes of internal assessment and verification and the types of quality assurance systems that can be used to facilitate these. If there is a perceived conflict of interest between the same staff undertaking the delivery and assessment, then this must be mitigated through the centre's process of internal quality assurance. Alternatively centres can choose to use separate assessment staff who are not involved in the delivery.

The Assessor must provide auditable feedback to the learner from the outcome of the assessment/s. This must be retained at the centre for external quality assurance.

7. Learner Registration and Certification

Learners must be registered with EAL on a code which relates to the qualification - this must be completed prior to assessment. Both learner registration and certification can be completed on line at the EAL Website www.eal.org.uk

For paper based registration and certification use forms CRF1, and CAF1A. These are located on the EAL Website, for guidance on registration and Certification please refer to the Registration and Certification User Guide.

8. Curriculum

Note that UK qualifications are structured into units rather than modules, each of which has learning outcomes set against them. This is reflected in the template below.

'Centre' refers to the delivery organisation/VET deliverer.

Robotics and Automation 603/2296/2		
Module	**N/A**	
Unit of learning	**1. Programmable Logic Controllers ROB3-0**	
Duration	22	Lessons hours: 15 Self-study hours: 5 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand PLC systems and associated communication methodology. 2. Understand create and edit PLC Programmes	

Knowledge	Skills
The development of PLCs and how they differ from PC-based control systems. Commonalities/differences between different systems. Health and safety implications of PLC-controlled equipment. Understanding and use of the different types of inputs/ output commonly used on PLC-based equipment. Different methods of communication systems commonly used. Potential security issues with networked PLC systems	Utilise PLC programming languages. Explain Boolean logic and its relationship to PLC programming. Explain the number systems used in digital systems: Binary, Hex. Demonstrate the ability to read, develop and debug PLC Ladder Logic programs. Produce programmes that operate the equipment in an energy efficient manner. Demonstrate the ability to use PLC programming software. Demonstrate documentation, archiving and restoration techniques

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Websites: Papers and VOIP from Skillman Videos and tutorials: Tutorials in the workshop including demonstration on live robots
Activities	Real-time vs. non real-time, harsh environments, IO capabilities. Allen-Bradley, Siemens, Schneider-Electric, Hitachi etc. Inputs including switches, pressure/temperature sensors, Analogue signals e.g. 4-20mA, voltage-based signals, digital signalling. Outputs include digital signalling to other equipment (motor driver boards, relays and contactors etc.) Bus networks: ethernet, profinet, fibre optic etc.

Unit of learning	**2. Mechanical Maintenance of Automation ROB3-02A**	
Duration	20	Lessons hours: 15 Self-study hours: 3 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	

Learning outcomes *Number and title*	The learner will: 1. Understand and carry out safe mechanical maintenance on industrial automation systems

Competences
To understand the procedures involved with the safe mechanical maintenance on industrial automation systems.

Knowledge	Skills
The development of PLCs and how they differ from PC-based control systems. Commonalities/differences between different systems. Health and safety implications of PLC-controlled equipment. Understanding and use of the different types of inputs/ output commonly used on PLC-based equipment. Different methods of communication systems commonly used. Potential security issues with networked PLC systems	Use standard pneumatic and fluid power connection standards and components covering failure modes and health and safety.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots

Activities	Wide range as set out in the Delivery Unit information: Motors, bearings, linear actuators, gearboxes, Can be contextualised for learners Cover the use of schematic drawings. Single and double acting cylinders, pilot operated valves, directional control valves, proportional valves and control systems, quick release and push fit couplings, position sensors and electrically operated circuits. Contextualised for learners' real work environment. Cover the use of circuit diagrams and symbols. Cover failure modes of fluid power systems. Cover Regulations, ISO standards, and safety. Cover siting and provision of services Lock-out/safe- isolation procedures and handing over back to production.

Unit of learning	**3. Electrical Maintenance of Automation ROB3-02B**	
Duration	25	Lessons hours: 18 Self-study hours: 5 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand the procedures involved with the safe electrical maintenance on industrial automation systems.	

Competences
Understand and carry out safe electrical maintenance on industrial automation systems.

Knowledge	Skills
Describe the electrical hazards associated with industrial automation. Explain common problems with electrical systems. State the operating principles and wiring of AC and DC motors.	Read, design and evaluate basic electrical circuits. Perform maintenance on automated systems and ancillary components.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly

Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Wide range as set out in the Delivery Unit information: Cover a safety overview of the various hazards and their typical severity and likelihood. Cover the safe working practices relating to electrical equipment including the key aspects of statutory and non-statutory Acts, and Regulations and codes of practice and safe isolation procedures. Read, design and evaluate basic electrical circuits. Include how to read schematic diagrams. Explain common problems with electrical systems. Such as: power quality, interference, connection issues – vibration, mechanical damage, unit failure etc. Perform maintenance on automated systems and ancillary components. Motor change, invertor change, electrical control system repair, and contactors etc. Cover industrial connection standards and equipment. Use of electrical test/measurement equipment and voltage indicators. Use of GS 38 approved test probes and leads. Cover fundamental theory of operation, and wiring topologies. Cover variable speed drives.

Unit of learning	**4. Maintenance Support Activities for Automation ROB3-02C**	
Duration	20	Lessons hours: 15 Self-study hours: 3 Hands-on hours: Other (please specify): 2 Assessment hours: set by the centre

Number of ECVET Points *(if applicable)*	N/A
Learning outcomes *Number and title*	The learner will: 1. Understand maintenance support activities related to electrical and mechanical automation systems.

Competences
Competent in the diagnosis of faults-on industrial automation and robots.

Knowledge	**Skills**
Explain how devise a generic, logical process for identifying faults. Explain fault diagnosis methods Describe how to select suitable data-capture methods to aid in fault diagnosis and rectification, where the automation system itself does not provide such a function. Describe how progressive failure of equipment may lead to increased energy usage.	Identify specific fault-finding techniques applicable to particular manufacturers / models of equipment. Identify a series of fault conditions using a particular make/ model of robot. Put the robot into a safe condition for maintenance, undertaking the correct action and restorative techniques. Interpret machine error logs to aid fault-diagnosis.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots

Activities	Wide range as set out in the Delivery Unit information: Explain a variety of manufacturers equipment Cover the methods and applications of fault diagnostics methods Select suitable data capture methods eg. temperature, current consumption, vibration sensors). Calibration methods/records and maintenance logs. Explain how progressive failure of equipment may lead to increased energy usage. Explain fault finding techniques to cover manufacturer and machine-specific Cover returning the robot to a production-ready state

Unit of learning	**5. Fault Finding and Diagnosis for Automation and Robotics ROB3-03**	
Duration	7	Lessons hours: 7 Self-study hours: Hands-on hours: Other (please specify): Assessment hours: set by the centre
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand how to diagnose faults-on industrial automation. 2. Carry out fault-finding techniques.	

Competences
To understand and demonstrate the procedures involved with diagnosing faults-on industrial automation and robots.

Knowledge	Skills
Describe health and safety aspects of maintenance activities. Explain document control procedures. Explain how equipment maintenance can contribute to energy efficiency.	Checking the compatibility of replacement components. Create a suitable and efficient preventative maintenance schedule for equipment.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly

Assessment criteria *Description and timing*	Describe health and safety aspects of maintenance activities: 1.2 Check the compatibility of replacement components. 1.3 Explain document control procedures. 1.4 Create a suitable and efficient preventative maintenance schedule for equipment. 1.5 Explain how equipment maintenance can contribute to energy efficiency. Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Wide range as set out in the Delivery Unit information: Explain a variety of manufacturers equipment. Cover the methods and applications of fault diagnostics methods. Select suitable data capture methods eg. temperature, current consumption, vibration sensors). Calibration methods/records and maintenance logs. Explain how progressive failure of equipment may lead to increased energy usage. Explain fault finding techniques to cover manufacturer and machine-specific. Cover returning the robot to a production-ready state.

Unit of learning	**6. Robot Processes and Functions ROB3-04**	
Duration	7	Lessons hours: 6 Self-study hours: Hands-on hours: Other (please specify): Assessment hours: 1

Number of ECVET Points *(if applicable)*	N/A
Learning outcomes *Number and title*	The learner will: 1. Understand industrial robot processes and functions. 2. Operate an industrial robot.

Competences
To understand industrial robot processes and functions and how to operate a robot.

Knowledge	**Skills**
Describe Health and safety risks involved with industrial Describe the technology used in a chosen manufacturer's equipment. Describe the generic structure and functions of an industrial robot. Explain how industrial robots are integrated into production cells/lines. Explain common applications of industrial robots	Operate an industrial robot in a safe manner to execute a pre-existing programme. Identify the energy usage of robots: - in its various operational states: standby drives-on etc. - dependant on robot manufacturer - suitability of the robot for a task.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots

Activities	Wide range as set out in the Delivery Unit information: Cover health and safety information and where possible reflect on their own workplace, also provide scenarios and case studies Operate an industrial robot in a safe manner to execute a pre-existing programme. Identify the energy usage of robots: • in its various operational states: standby drives-on etc. • dependant on robot manufacturer • suitability of the robot for a task. Cover the relevant aspects including jogging etc.

Unit of learning	**7. Automated Control Systems ROB3-05**	
Duration	15	Lessons hours: 10 Self-study hours: 3 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand the elements of control systems. 2. Understand the application of control theory.	

Competences
This unit enables learners to understand industrial control systems.

Knowledge	Skills
Describe the importance of integrating safety into automatic control systems. Describe and relate control theory to a modern industrial robot. Explain how manufacturer specifications may be used to determine machine characteristics for: optimal performance and energy efficiency.	Critically appraise the types of automatic control and their suitability for different applications.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.

Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Wide range as set out in the Delivery Unit information: Identify types of control systems compare and contrast the various elements of control theory, and the methods of sensing and control; identifying where each would be best employed. Cover control systems such as: open/closed loop, sequence, discrete, input and output devices, and control technology. Cover how an industrial robot is driven and controlled how the sensors, controller and the drive interact to produce movement under constant software control. Learner to use industry terminology where possible. Energy efficiency will also involve using the appropriate machine for a given task.

Unit of learning	**8. Machine Software Design Principles ROB3-06**	
Duration	20	Lessons hours: 15 Self-study hours: 3 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: Understand how to diagnose faults-on industrial automation. Carry out fault-finding techniques.	

Competences
To understand software design in order to create a program to correctly perform a specific function.

Knowledge	Skills
Describe generic programming terminology and philosophy	Create a programme using a high level language that satisfies a given set of criteria
Explain instruction sets, variables, numbering systems	Apply de-bugging techniques to identify and correct errors in programmes
Explain the basic syntax rules of a high level programming language	Programme design principles
Describe how efficient code can lead to reduced energy usage.	

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Describe generic programming terminology and philosophy. Explain instruction sets, variables, numbering systems. Explain the basic syntax rules of a high level programming Language. Describe how efficient code can lead to reduced energy usage. Create a programme using a high level language that satisfies a given set of criteria. Apply de-bugging techniques to identify and correct errors in programmes. Programme design principles.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots

Unit of learning	**9. Robot Programming ROB3-07**	
Duration	15	Lessons hours: 15 Self-study hours: Hands-on hours: Other (please specify): Assessment hours:set by centre
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Safely manipulate an industrial robot. 2. Program an industrial robot system.	

Competences

This unit enables learners to understand how to use industrial robots.

Knowledge	Skills
Knowledge Must be able to describe the generic structure and functions of an industrial robot. Interpret a typical program used to control a modern industrial robot and describe common communication themes. Show knowledge and then describe the generic structure and functions of an industrial robot. Be able to identify the varied data types used and give examples of system parameters/ configurations. Must create documents to outline how the programmes were created.	**Skills** Show evidence of programming an industrial robot in a safe manner . Manipulate an industrial robot competently within a time frame. Develop and safely modify a given program to achieve a specific task, test, and upload this program to a robot and demonstrate its function. Demonstrate knowledge of robot logic and interfaces. Be able to create robot programs to show how they perform tasks.

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): by centre set assessment
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4

Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Wide range as set out in the Delivery Unit information: Motors, bearings, linear actuators, gearboxes, Can be contextualised for learners Cover the use of schematic drawings. Single and double acting cylinders, pilot operated valves, directional control valves, proportional valves and control systems, quick release and push fit couplings, position sensors and electrically operated circuits. Contextualised for learners' real work environment. Cover the use of circuit diagrams and symbols. Cover failure modes of fluid power systems. Cover Regulations, ISO standards, and safety. Cover siting and provision of services Lock-out/safe- isolation procedures and handing over back to production.

Unit of learning	**10. Introduction to Simulation Engineering ROB3-08**	
Duration	20	Lessons hours: 15 Self-study hours: 3 Hands-on hours: Other (please specify): Assessment hours: 2
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand and appreciate simulation engineering in relation to automated systems and robotics.	

Competences
To model a production process using simulation software.

Knowledge	Skills
Identify simulation packages available and their purpose. Explain the advantages and limitations of simulation engineering in the design of robotic manufacturing systems such as: • modelling energy usage of the equipment in real time to realise an energy efficient process • skills, costs incurred benefits, time saved, and design mistakes.	Make modifications to a production cell model to meet a revised specification using a chosen simulation system. Model a simple production cell from given data using a chosen simulation system. Demonstrate FMEA techniques relating to an automation process.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Identify simulation packages available and their purpose. In this unit provide learners with a system that has been created Cover: current trends, robot simulation packages (such as ABB RobotStudio), KUKA worksvisual etc. The integrations between software simulation packages. i.e. Siemens PLM.

Unit of learning	**11. Process Optimisation ROB3-09**	
Duration	15	Lessons hours: 12 Self-study hours: 2 Hands-on hours: Other (please specify): Assessment hours: 1
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand process optimisation in relation to industrial robotic systems.	

Competences
To understand and apply methods of process optimisation.
To understand and apply optimisation techniques to industrial robotic systems.

Knowledge	Skills
Identify the main methods used to optimise a process. Explain how optimisation techniques can be applied to industrial robots systems. Describe how machine-specific limitations may limit optimum operation in certain circumstances, and how these may be mitigated or overcome.	Apply optimisation techniques to a given process, and suggest ways that the process could be improved. Calculate the costs incurred for introducing potential improvements. Optimise software to achieve optimum operation. Measure existing energy usage and compare to an optimised process.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4

Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Identify the main methods used to optimise a process. Cover: ● Equipment optimisation – bottlenecks, uptime / gaps in utilisation, uptime (e.g. OEE, OPC) ● Operating procedures – automation vs. manual, standard operating procedures ● Control optimisation – tuning the various parts of the process to produce optimal output. Calculate the costs incurred for introducing potential improvements. Such as: cost benefit analysis; process time, product quality, reduction in cost. Explain how optimisation techniques can be applied to industrial robots systems. Such as: placement of units, work areas, tools and product to minimise movement and cycle time. Optimise software to achieve optimum operation. Such as: speed, energy, efficiency, equipment life-cycle costs, improving communication times with other equipment.

Unit of learning	**12. Innovation in Automation ROB3-10**	
Duration	7	Lessons hours: 7 Self-study hours: Hands-on hours: Other (please specify): Assessment hours:
Number of ECVET Points *(if applicable)*	N/A	
Learning outcomes *Number and title*	The learner will: 1. Understand the considerations that influence the decision to automate a process.	

Competences
To understand the considerations that influence the decision whether or not to automate a process.

Knowledge	Skills
State the technical and financial factors that determine the effectiveness of automation Describe the financial factors that may be used to guide the decision to introduce an automated process such as: ● Capital Cost ● Improvements to the manufacturing process ● Energy usage ● Maintenance costs	Examine a production process and evaluate if automation is appropriate.

Assessment methods *(Click appropriate box/s)*	As specified by the Awarding organisation, assessment is by 'Centre Set Assessment' which should use a combination of the following methods: ☐ Written exercises and test ☐ Oral examination and exercises ☐ Practical assignment under supervision ☐ Practical assignment autonomously and responsibly
Assessment criteria *Description and timing*	Timing and activities as set out in the Assessment Plan. This plan should be established by the centre prior to the commencement of delivery.
Qualifications framework *Reference to EQF and NVQ*	NVQ Level 3 EQF Level 4
Delivery methods	All of the following methods are appropriate to support the delivery process when set out in schemes of work and lesson plans and should be set out by the delivery centre: ☐ Hands-on ☐ Lectures/lessons/presentations ☐ Job-shadowing ☐ Placement ☐ Project work ☐ Video tutorials
Resources	Tutorials: Tutorials in the workshop including demonstration and practice on robots
Activities	Summarise on the basis of given data the suitability of automation Calculate the financial impact of a decision to automate e.g. payback time, ROI. Perform a basic quantitative analysis using technical and financial factors.

9. References

The following are available on the Skillman Portal for the purposes of the project:

- EAL Delivery Units: 12 documents providing information on each unit

- Level 3 Certification Robotics and Automation: Qualification Specification

- Level 3 Certification Robotics and Automation: Qualification Manual

All guidance and information relating the delivery, assessment and administration of this qualification are available by contacting the awarding organisation EAL www.eal.org.uk