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## The importance of an integrated quality assurance system in professional qualification development and implementation

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**Abstract:** The increasing pace of technological changes in manufacturing is reducing the useful life of formal qualifications. High level monolithic qualifications require large amounts of effort to review and revise them, especially in an international context. The fourth industrial revolution is pushing traditional education systems to their limits and shedding light on their shortcomings. Ensuring that the future workforce is qualified for the challenges of Industry 4.0 involves addressing several aspects. Employers and their employees demand highly relevant pre-employment education, delivering both the fundamental engineering knowledge and addressing the latest materials and processes. The EWF education and qualification approach aims to provide the right qualification at the right time. Its success is derived from a robust and industry-focused quality system, with wide stakeholder involvement from welding research institutes, educational organisations, certification bodies, companies, trainers and trainees. The cooperative approach of EWF members and stakeholders delivers harmonized quality assurance that has ensured the reliability and credibility of the international qualifications so that they have become trusted by employers. This paper aims to present how international qualifications support the implementation and exploitation of new technologies, enabling innovation in manufacturing.

**Keywords:** industry 4.0, EWF Education, Qualification and Certification System, Industrial Training, Quality Assurance in Training

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### Introduction

By 2030, 210 million people around the world are expected to change occupation; that is equivalent to the current population of Brazil, or 40%

of the European Union. This scale of labour disruption is driven by a number of forces, including industrialization, globalization, digitization and automation. Up to 800 million

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workers worldwide are at risk of some degree of labour disruption between now and 2030. Previous industrial revolutions were very slow in their global spread, in that there are still parts of the world that have yet to be touched by the first industrial revolution. Even where people are still doing very traditional and (apparently) immutable tasks, they now have a mobile phone in their hands, which is a profound change, creating huge opportunities for financial services, networking, job searching, and more.

This fourth industrial revolution, as stated in Professor Ian Goldin's and Professor Chris Curnan's book *Age of Discovery*, is part of a broader movement, a new renaissance. This renaissance is different to the last in its speed, and in its depth, and it is not confined to industry, being broader in scope. As the first renaissance, it implies a broad access to knowledge, which is no longer confined to books, but easily accessible to everyone. No sector is left unchallenged, and manufacturing is no exception, with companies quickly merging into both digital and manufacturing centres, creating new challenges and new opportunities. Existing competences are quickly becoming obsolescent, as the change requires knowledge, skills and behaviours from professionals in all areas.

The answer to these challenges is strongly dependent on the ability of academic education and Vocational Education and Training (VET) systems to cope with the demand for new curricula and methodologies to prepare their students for the new business requirements and technologies being exploited. The broadest possible recognition of the acquired knowledge and skills is a critical aspect of enabling the increase in workforce mobility.

Additionally, the education systems need to become more agile; what were established and effective learning methodologies need to adapt quickly to support professionals and companies with an increasing pace of change in customer expectations, products, technologies, and even manufacturing processes and materials.

The demand will be for wide availability of efficient retraining and reskilling that ensures transferability between VET and formal academic education systems and supports progression, irrespective of the route or sequence of learning.

It is essential that vocational qualifications are harmonized, so that they provide universal recognition and transferability of knowledge and skills, and are accepted by employers and further and higher education organisations regardless of the location where the qualification is gained, reducing costs for employers who want to find the best professionals to meet their needs as quickly as possible. This transferability of qualifications is paramount for multi-national companies operating in international markets, not only for mobility of employees but also for international recognition of personnel competence for compliance with requirements for quality control of products and services. Most countries in the European Economic Area have established the relationship between their National Qualification Frameworks and the European Qualification Framework, to create a transfer matrix for qualification levels. Beyond that transfer matrix, harmonization of vocational qualifications requires expert bodies to cooperate and contribute their national qualification content to create international qualifications that satisfy industry requirements and observe all relevant industry standards. The EWF harmonised international qualification guidelines have been created through the cooperation and contribution of welding institutes across and beyond Europe, ensuring that they have high relevance and wide recognition.

The EWF harmonized international qualifications have established themselves as providing an effective response to the challenges of transparency, transferability, mobility and progression for professionals in welding and materials joining technologies. Industry has increasingly specified the EWF qualifications

as one, if not the preferred, means of evidencing knowledge and understanding in welding engineering. EWF is also able to mobilise significant resource to update content and create new guidelines to maintain relevance and address new and emerging industry needs, ensuring the reputation and value of its harmonised international qualifications.

As the challenges of the fourth industrial revolution are inherently global, qualifications need to have the same high level of quality control throughout the ecosystem, to assure the reliability and consistency required by employers and their customers. The EWF quality system embraces the requirements of ISO/IEC 17024, the international standard for certification of personnel, to ensure that best practice management and operations requirements are applied to the Education, Training, Qualification and Certification (E, T, Q & C) products and services. The quality control of EWF's system for E, T, Q & C of personnel has been recognized as a best practice for international sectorial harmonisation of qualifications by Cedefop – The European Centre for the Development of Vocational Training.

### What are the challenges for manufacturing businesses?

The ongoing transformation in manufacturing touches all industries; developments in previously disjointed fields such as artificial intelligence and machine learning, robotics, nanotechnology, 3D printing, and even genetics and biotechnology, are all building on and amplifying one another to produce a paradigm shift in the speed and flexibility of systems. It is expected that smart systems - homes, factories, farms, grids or entire cities - will drive the response to problems ranging from supply chain management to climate change. This is the time of Industry 4.0, but this is far from just a technology initiative, it is the future of manufacturing as we know it.

The nine technologies transforming industrial production (see Figure 1) are: Big Data

and analytics, Autonomous robots, Simulation, Augmented reality, Additive Manufacturing, the Cloud, Cybersecurity, the Industrial Internet of Things, and horizontal and vertical system integration.



Fig. 1. Industry 4.0 - Digital Transformation.  
Source: <https://www.i-scoop.eu/industry-4-0/>

The ultimate goal is the "smart factory" with cyber-physical systems capable of autonomously exchanging information, triggering actions, and controlling each other independently. The integration of these nine technologies facilitates fundamental improvements to the industrial processes involved in manufacturing, including material usage, asset performance and management, and supply chain and lifecycle management. The improvements enable manufacturers to reinvent their business models to focus on value-added services, and/or enter new sectoral or geographic markets, or transform existing products to meet the requirements of adjacent market segments.

The challenges that manufacturers face include changing customer preferences, cost and capital pressures, shorter product lifecycles, new sources of disruptive competition and a quickening pace of expected responsiveness, and are forcing them to rethink and transform their operational and business models. Today's Industry 4.0-outfitted factories are empowered

to drive productivity and keep costs down while ensuring quality and consistency across manufacturing processes.

The nine transformational technologies can address the challenges faced by manufacturers but this requires investment in robotics and machine-to-machine communication to help improve productivity, better analytics to enable improved insights into customer preferences and product usage, digital twinning to model and simulate outcomes to improve design and performance, all of which require educated individuals to select and implement new equipment and systems appropriate to the intended customer requirements and necessary business improvements.

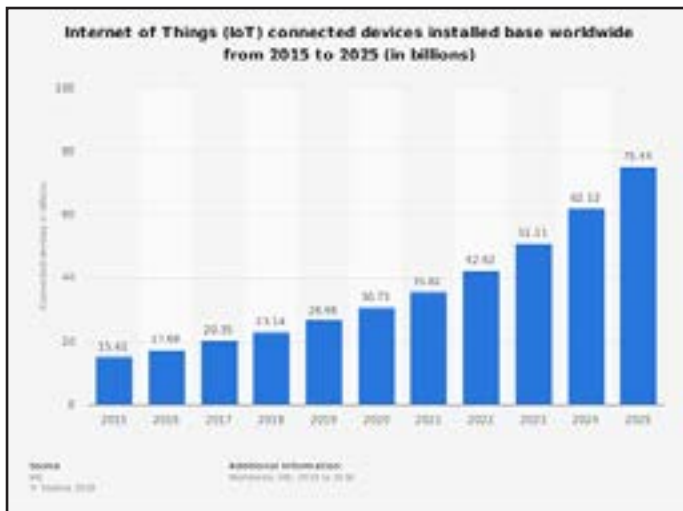


Fig. 2 Internet of Things (IoT) connected devices installed base worldwide from 2015-2025

The scope of opportunity for innovative manufacturers is incredible; analysts predict that the Industry 4.0 market will be massive. Based on the growth of connected devices worldwide (see Figure 2), Gartner believes that the Internet of Things (IoT) market will be worth almost USD 3 trillion by 2020 [1]. And IDC thinks that the virtual and augmented reality market, of great importance for designing and prototyping, will achieve a five-year compound annual growth rate (CAGR) on the period 2017-2021 of 98.8% [2] (see Figure 3). This change is putting a strong pressure on organizations and their leaders, forcing them to adapt and adopt quickly.

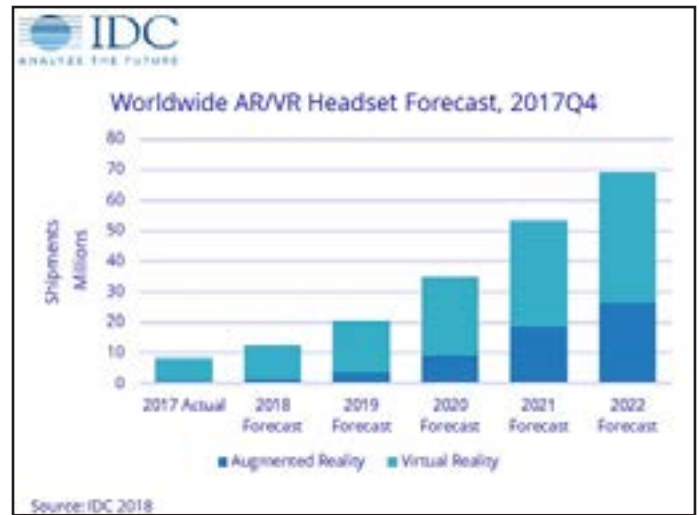


Fig. 3. IDC Forecasts Increasing Demand for Augmented Reality/ Virtual Reality Headsets Over the Next 5 Year

In order to assess the readiness of organizations and leaders to embrace this revolution, Deloitte runs a yearly survey of C-level Executives to analyse how well prepared business leaders are to harness the full potential of Industry 4.0 to the benefit of their customers, their employees, their organizations, their communities, and society overall.

The ensuing Deloitte report [3] highlighted that only 14% of CXOs were highly confident that they were capable of leveraging Industry 4.0. The research also revealed that, while CXOs see new business or delivery models as the biggest threat to their organizations, they are largely using new technologies as a tool to make existing operations more efficient and cost-effective, currently focusing on evolution rather than the emerging revolution.

Also of high relevance, only a quarter of the CXOs who participated in the survey thought that they had the right workforce composition and skillsets required for their future markets and customers, although a large majority of them (84%) felt that they were doing everything they could to create a workforce for Industry 4.0 (see Figure 4).

### The human factor

As whole industries adjust and new ones are born, many occupations will undergo a fundamental transformation. Together, technological,

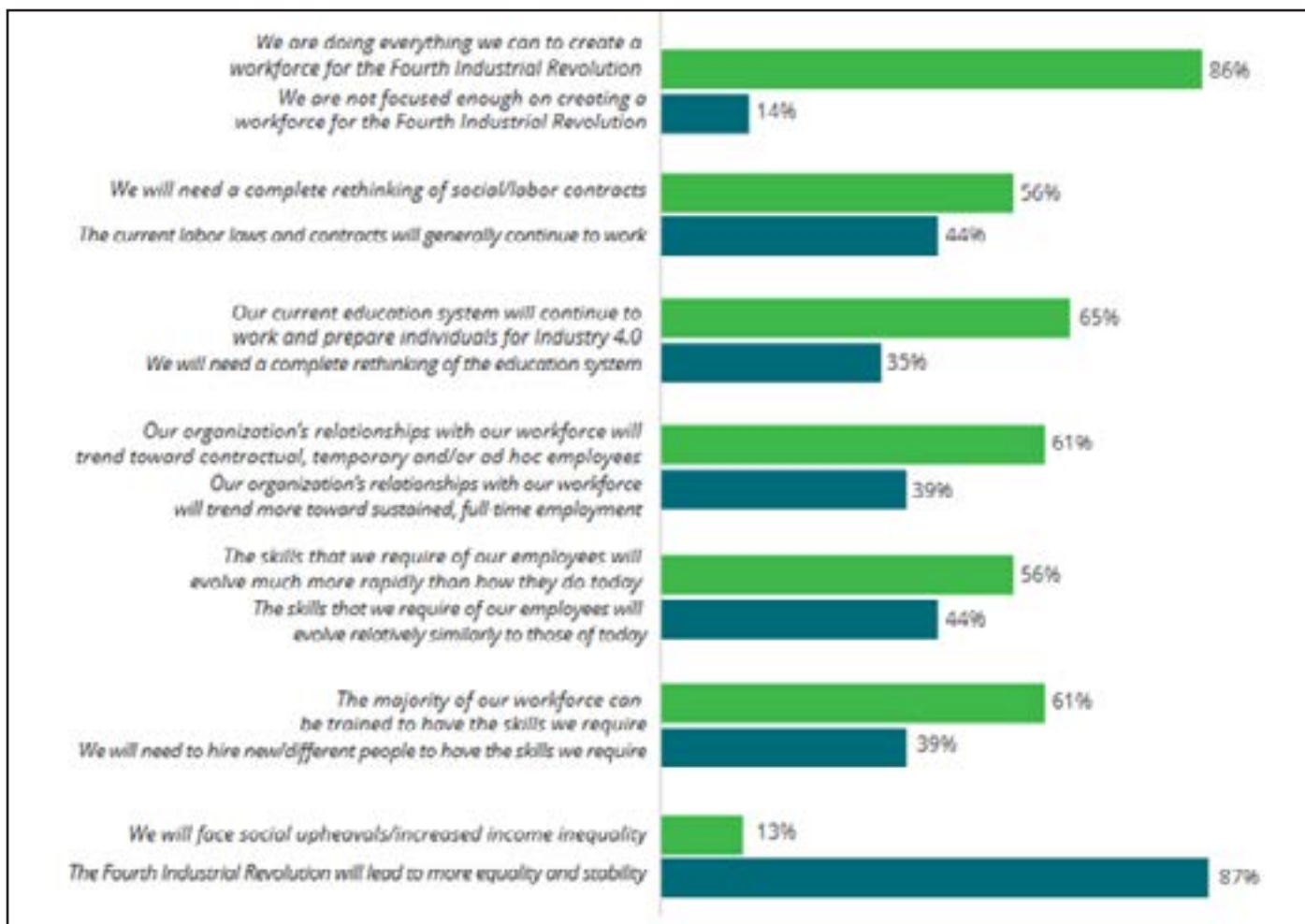


Fig. 4. CXOs answers to the question: Which of the following statements about the Fourth Industrial Revolution's?  
Source: Deloitte Insights – The Fourth Industrial Revolution is here – are you ready?

socio-economic, geopolitical and demographic developments and the interactions between them will generate new categories of jobs and occupations while partly or wholly displacing others. They will change the skillsets required in both old and new occupations in most industries and transform how and where people work, leading to new management and compliance challenges. Whilst the Deloitte Insights report suggests that CXOs recognise the importance of human capital in the implementation of Industry 4.0 innovations, it also reveals that talent and HR topics feature low on boardroom agenda priorities and that the business leaders do not feel able to influence educational provision to a significant enough level.

In practically every industry, the application of technology has already altered when and where work is done; the workplaces of the third industrial age are giving way to work practices of the digital age, including remote, flexible

and on-demand working. Accompanying the increasing technological and behavioural changes, there is a growing need for further specialized knowledge, supplemented by broader knowledge of complementary fields of expertise to support the core.

According to Prof. Goldin, the requirements for deep expertise and broad knowledge will mean more and more specialisation. As the quantity of underpinning knowledge for application of technologies is constantly increasing, the solution may be to provide a T-shape in an individual's knowledge structure – combining very deep learning, with a very broad set of interests and abilities for its application. Today, resources (YouTube videos, blogs, discussion forums and networks, e-books) are available to cultivate curiosity and acquire knowledge in many different fields. It will be necessary for professional development systems to consider all modes and pathways of learning, and to

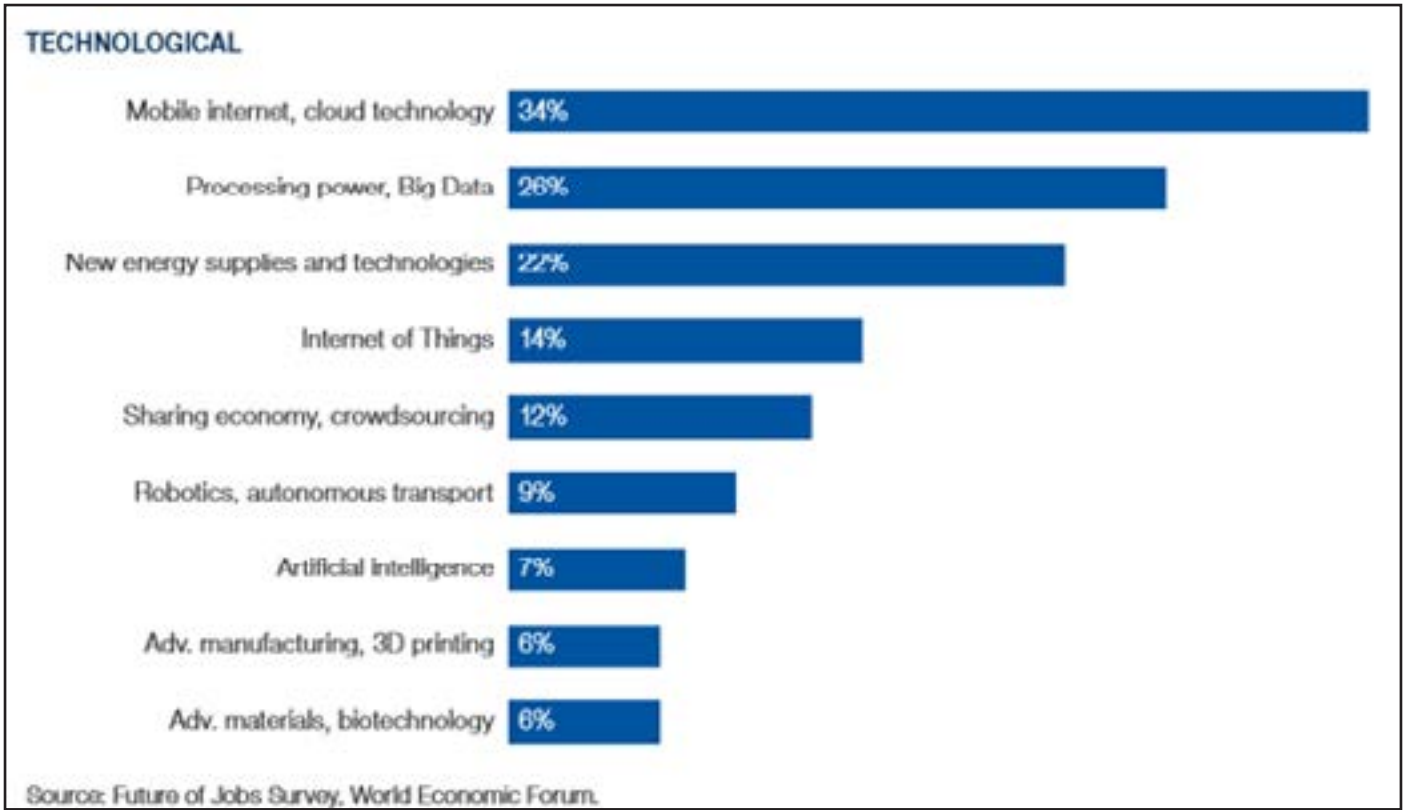


Fig. 5. Technological drivers of employment

enable on-demand options to satisfy career progression and technology development needs. The emerging needs (Figure 5) mean that it is fundamental for Education to change, as most education systems were built for the needs of prior employment opportunities. If today's students are to be prepared for the fourth industrial revolution, a disruption is needed to ensure that they have the knowledge and skills that employers and their customers need.

**Quality system breaks the barriers to widespread adoption of international qualifications**

As economies become increasingly open and companies operate complex value chains of vast geographic scope, harmonized qualifications play a pivotal role in ensuring that organizations can work consistently in any location and can leverage appropriate human resources for optimal results.

To make knowledge acquisition and recognition more effective, it is necessary to establish a connection between its two existing pillars; the traditional education systems used at Colleges

and Universities and the VET provided for specific occupations. Role-specific VET, which is necessary as specialist pre-employment education and training, must be developed with recognised credit values and parity of esteem to ensure that transferability to Further Education and Higher Education is fully supported.

Welding and joining is an area where this need is being answered (Figure 6). Increasingly sophisticated and advanced production and joining processes frequently require welding and joining technicians, technologists and engineers to possess the ability to assemble products coming from diverse locations (that are required to abide by the same standards of



Fig. 6. EWF's mission. [www.ewf.be](http://www.ewf.be)

production quality), be highly knowledgeable about materials and their characteristics, as well as how to operate complex tools and machinery, ones where digital is tightly interwoven into the processes.

To address the challenges of international transferability of qualifications and international mobility of qualified individuals, the welding institutes or professional societies in countries of the EU commenced a cooperative activity in 1992. As members of a newly formed association, the European Federation for Welding, Joining and Cutting (EWF), these organisations voluntarily performed a process of harmonisation of the content of their welding engineering education and the implementation of an international system of qualifications specifically designed for the needs of welding professionals and their employers. The system started by addressing welding technology and its application, and has since then extended its scope to include a wide range of related technologies, e.g. adhesive bonding, plastic welding, thermal spraying and others.

One key issue addressed by the system from the start was the requirement for international recognition to support the mobility of individuals within the international welding engineering industry. The reputation and credibility of the national welding institutes and societies within their domestic and international network of welding professionals and employers, meant that the harmonised educational qualifications had intrinsic value. However, there was also the need to ensure consistency and reliability of the delivery and the assessment of the education across the multiple organisations that would be involved in the system. To achieve quality control across geographical, language, educational system and technical standards boundaries, the EWF members created a quality control system for authorisation, operation, surveillance and review of organisations involved in the delivery of the international harmonised qualifications.

Recognizing the long-term vision and strategy of EWF's International System for Education, Training, Qualification and Certification of Personnel, Cedefop – The European Centre for the Development of Vocational Training – has considered that the EWF approach should be seen as a best practice for international sectorial harmonisation of qualifications.

The uniqueness of EWF's system is two-fold, both aspects of which come from the cooperation of welding institutes and societies across geographical, commercial and regulatory boundaries. Firstly, the single syllabus for each level of the education programme, coupled with a harmonised system for examinations results in consistency of the qualification on an international scale, and secondly, the single quality assurance system of agreed rules and operating procedures, audits, approvals and surveillance provides the highest standard of reliability for an international qualification.

The cornerstones underlying the long-term vision and strategy of EWF are the following:

- Ensure that the education and training guidelines are regularly reviewed and updated to comply with technical innovation and industrial requirements;
- Create new qualifications in line with technological and industrial developments;
- Enable and support flexible pathways for continuous professional development for professionals in manufacturing;
- Assure the quality of the EWF international qualifications through the implementation of effective and efficient rules and operating procedures.
- Implement broad industry stakeholder requirements into all aspects of decision-making for international qualifications.

EWF's qualification system is evolving to address modern demands for flexible learning, including blended learning, specialist pre-employment learning, technology updates, and lifelong learning. The modular approach (Fig. 7) that is being developed will provide much more choice

of when and how learning takes place, within a framework of continuing professional development that is both additive and cumulative, to build into the international qualifications for which the EWF brand has an established reputation.

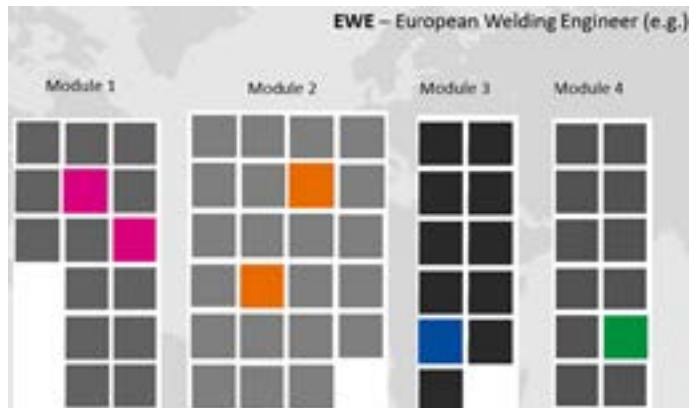


Fig. 7. Modular approach of EWF Qualification system

The modular approach is designed to maximise the benefits of curriculum flexibility, short-term assessment goals and engagement of students in the professional development process. The modular curriculum will offer students more flexibility and variety than traditional forms of programme structure, empowering them to manage their learning as they progress through their careers. The modular approach enables students to choose the modules and pathways that best fit their professional needs and aspirations, whilst minimising duplication and maximising progression.

To enhance the learning experience and maximise flexibility of study, EWF members are engaged in the development of innovative learning platforms, potentially including Welding Simulators, Game Based Learning, and Serious Gaming. These are new and innovative study

methods that allow learners to explore concepts and theories in exciting and interesting ways.

Games are typically designed for different ability levels and with the goal of helping the players to retain the information that they learn and apply it to other problem-solving situations, as well as a means of collaboration between learners and educators.

EWF international qualifications are an undisputed success (see Figure 8) but EWF members are not resting on their laurels, constantly looking for ways to innovate and lead in both technical content and learning methodologies.

The EWF international qualification system is committed to updating current courses and launching new ones for emerging technologies, such as additive manufacturing, creating a virtuous cycle, enabling quick adoption of new technologies and providing relevant, high quality educational support for industry and its employees.

### The impact of a harmonised quality system

Ensuring the quality of the education and examination, regardless of delivery organisation and location, requires a rigorous and transparent quality system, one that is widely accepted by the complete chain of stakeholders involved, from training institutions to awarding bodies, and including feedback from students, employers, and lecturers. The strength of the EWF quality system has been exploited through an agreement with the International Institute of Welding (IIW), to make the international qualifications more widely available and extend their recognition worldwide. The EWF quality

Fig. 8. Overview of the current EWF Harmonized Qualification and Quality System



assurance system ensures that the required and expected standards of consistency and reliability are met uniformly throughout the world in an impartial and non-discriminatory way.

The quality system [4] includes the ecosystem of members, other relevant stakeholders and the training centres (Fig. 9). The members are responsible for the identification of the most appropriate Authorised Nominated Bodies (ANBS), which form the network that implements and manages EWF's rules and operating procedures for ensuring that the standards of the EWF qualifications and/or personnel certifications are maintained.



Fig. 9. The three pillars of EWF Quality Assurance System

To ensure that EWF quality system rules are strictly followed by training centres, an Assessment and Surveillance activity has been implemented, one that ensures that, regardless of location and entity, ANBS are capable of and continue to deliver consistent results. This activity uses trained and approved Lead Assessors, Peer Assessors and Distance Learning Assessors, who undertake scheduled auditing of the required compliance with EWF's quality system rules.

The training centres, in order to be approved as such, are required to comply with rules and procedures which are audited under EWF surveillance. The facilities, equipment, materials and staff of training centres are evaluated in order to ensure that they possess both the capabilities and the capacity to deliver the EWF educational programmes to the expected level of quality and consistency. To gain approval, training centres are also expected to have a close working relationship with industry and

a clear understanding of its requirements for vocational education.

Feedback of experience and outcomes from candidates, employers, training centres and other stakeholders is brought into the EWF quality system by the ANBS to evaluate and challenge its processes, and review and amend its procedures.

### The benefits of a harmonised quality system

That the EWF quality system appears obvious and straightforward is a testament to its implementation. The management of consistency and reliability of education across such a large delivery network and with subject matter experiencing continual and rapid technical change, requires exemplary commitment and cooperation from the ANBS. This straightforward yet secure process is the guarantee that each professional is indeed capable of performing according to the learning outcomes defined for each qualification.

Supporting the provision of a diversified and mobile workforce has enabled EWF diploma holders to take up employment opportunities and to enjoy exciting careers and, as a direct consequence, to provide additional competitiveness to European companies. To deliver parity of esteem of the diplomas and enable their transferability into Higher Education programmes, EWF has been actively pursuing the alignment of its international qualifications with the European Qualification Framework (EQF), through the National Qualifications



Fig. 6. Global implementation of EWF Harmonized Qualification and Quality System

Framework of each individual country. By encouraging these activities through Erasmus+ funding, the EC expects to exploit the EWF achievements as a benchmark for other areas of manufacturing, and other industry sectors.

In summary, the EWF's harmonized qualification and quality systems create a unique achievement in the creation, operation, implementation and recognition of international qualifications (see Figure 11). Currently, this ecosystem comprises 46 countries served by 683 Approved Training Bodies and serving 55,000 companies worldwide. The system, which continues to improve and evolve, assures the quality and reliability of vocational education that manufacturers of welded products demand and rely upon in their competence assurance of employees.

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