

## EDUCATION AND CERTIFICATION IN WELDING

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**Keywords:** Welding, Education, Vocational, Qualification system, Training, Certification scheme, EWF, IIW

### Contents

1. General
2. Welding Education in Universities
3. Welding Education Vocational Training Schools
  - 3.1. Welders Qualification Training:
    - 3.1.1. Welders Comprehensive Training:
    - 3.1.2. Welders Specific Welding Process Training:
    - 3.1.3. Welders Specialization Training:
  - 3.2. Practitioner Qualification Training
  - 3.3. Specialist Qualification Training
4. The International/European Harmonized Training Qualification System
  - 4.1. Introduction
  - 4.2. The International Training and Qualification System for Welding Personnel
  - 4.3. The Practical Education and Training
  - 4.4. The international Harmonized Examination for the Training and Qualification System for Welding Personnel
  - 4.5. Management of the Qualification System
5. Certification schemes for Welding Personnel
  - 5.1. Welders Approvals
  - 5.2. Welding Inspection Personnel
  - 5.3. Non-Destructive Testing Personnel
6. The European Certification System for Welding Personnel
  - 6.1. Management of the System
7. Conclusions
- Glossary
- Bibliography
- Biographical Sketches

### Summary

Welding is a joining process used in many products which range from cars and planes to mobile phones, to plastic bags, to dental implants.

Education is certainly a route to avoid poor quality welds. Welding is not easy – the diversity of materials, joint types, processes and positions is such that repeatability is

not something a welder can count on.

Education in Welding can be found in many different organizations being more frequent in vocational training schools and universities.

Qualification and Certification of welding personnel is addressed in several ISO and CEN standards.

The European Welding Community felt the need of interchanging views and experiences more than two decades ago and created the European Council for Co-operation in Welding (ECCW) in 1972. This organization further on became EWF-European Federation for Welding, Joining and Cutting with members from all European Countries. The harmonization of training and qualification in welding was the first priority addressed by EWF.

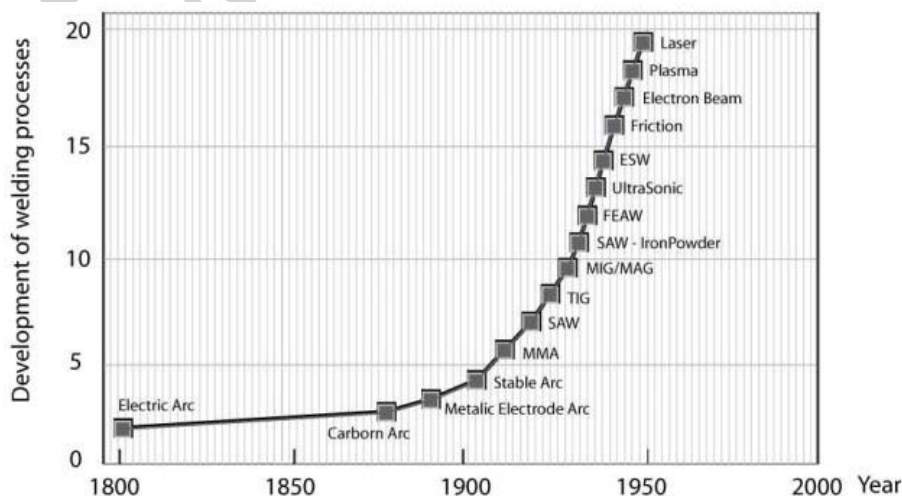
The EWF system is recognized in Europe and abroad and its adoption by countries outside Europe is in course through an agreement signed between IIW – International Institute of Welding and EWF for the development of an international scheme based on the EWF Training guidelines and Qualification procedures.

Personnel welding certification it is also another field that have been developed at National level, the first certification schemes were developed for welders approval and welding inspectors. Also EWF has developed a certification scheme for the welding personnel.

## 1. General

Why education and certification in welding technology? Welding is a joining process used in many products and materials, in constructions with scales that range from nano-, micro- to meter and kilometer.

To solve all the joining needs that require welding, many different processes have been developed along the years (Fig. 1).



### Figure 1. Evolution of Welding Processes

The diversity of techniques available can solve any welding job required though the assurance that the performance of the welded part in service can only be achieved if the process is conducted properly. Failure to perform a good quality weld can lead to severe disasters with significant economic drawbacks and loss of lives.

In the above photos it is possible to observe some examples of collapse of welded constructions due to poor quality welds.

Education is certainly a route to avoid poor quality welds. Welding is not easy – the diversity of materials, joint types, processes and positions is such that repeatability is very seldom possible.

One can argue that if welding is so complicated how can it be robotized?

The answer is with sensors and control software which allows programming the robotised system for different jobs.

For large series of similar parts it is possible to robotize welding. The automotive industry is a good example of successful robotized welding applications, though even in car fabrication, manual welding is still required.

For small batch fabrications, robotized welding is also possible in many cases but there is no way to avoid manual welding both in construction and repairing. Welders and welding professionals will always be needed. Presently the shortage of these professionals worldwide is creating difficulties. The Wall Street Journal - USA (2007) estimates that this shortage will reach in 2010 a number of 200.000 skilled welders.

Education in Welding can be found in many different organizations being more frequent in vocational training schools and universities. In figure 2 it is given a view of welding education, qualification and certification.

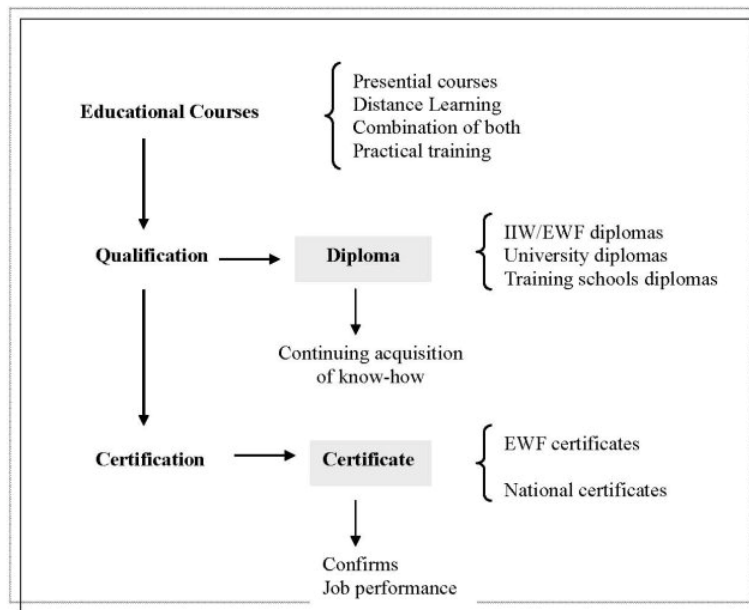


Figure 2. Structure of welding education, qualification and certification

Qualification and Certification of welding personnel is addressed in several ISO and CEN standards, such as:

Welders' approval – EN 287-1, series EN ISO 9606

Welder operators' approval – EN 1418, ISO 14732

Welding Coordinators – EN ISO 14731

NDT Personnel – EN 473, ISO 9712

Quality requirements for fusion welding of metallic materials – series EN ISO 3834

Until the late 80's almost every industrialized country had its own system for training, qualification and certification of welding personnel.

In the early 90's Europe recognized that the harmonization of these would benefit industry. Circulation of workers in Europe was growing and as the EU would become stronger it was expected that this would grow.

In those days, for example, a welder trained, qualified and certified in Spain would, if working in Germany, be required another certification, recognized by the German authorities. This was costly for the industry, time consuming for the individuals and was generating many problems.

The European Welding Community felt the need of interchanging views and experiences more than two decades ago and created the European Council for Co-operation in Welding (ECCW) in 1972, with the participation of Belgium, Denmark, Germany, France, Ireland, Italy, Netherlands and United Kingdom.

The ECCW was later enlarged with the participation of all countries in the European Union and, in 1992, to the EFTA and Eastern European countries. The name was then changed to European Federation for Welding, Joining and Cutting, better known as

EFW - European Welding Federation.

The first issue EWF has addressed was the harmonization of training and qualification of welding personnel, as it was clear that the industry strongly needed knowledgeable and skilled personnel.

Training and education are issues on which the future of European industry is dependent. In fact, a look through the publications and newspapers, which reflect informed opinion in Europe, will confirm that there is considerable national concern for these topics. Moreover, the significant investment on the part of the European Union in programs related to training and education is indicative of the paramount importance these issues have assumed.

EFW – The European Federation for Welding, Joining and Cutting, in conjunction with the relevant welding institutes and organizations of 27 countries, has launched, in 1991, a harmonized training and qualification system in the field of welding technology, by publishing a guideline defining minimum requirements needed to train a European Welding Engineer.

Following this first experience EWF has developed several other Guidelines covering all professional levels in welding technology and also related areas such as Adhesive Bonding. The EWF training and qualification system now comprises 18 Guidelines leading to mutually recognized qualification in more than 27 European countries.

The EWF system is recognized in Europe and abroad and its adoption by countries outside Europe is in course through an agreement signed between IIW – International Institute of Welding and EWF for the development of an international scheme based on the EWF Training guidelines and Qualification procedures.

In order to administer this system and to develop it still further, the IIW has established the IAB – International Authorisation Board. This organization, aimed at the effective integration of the EWF and IIW systems and its implementation in all IIW countries, by publishing Guidelines for training syllabuses and examinations and implementing the Quality Assurance system controlling the scheme.

An Organization, recognized by the National member, is appointed as the Authorised National Body (ANB) for the supervision of the scheme in each country. Representatives from these ANBs form the operational management within the IAB, electing Lead Assessors who ensure conformity of each ANB to agreed Rules.

## **2. Welding Education in Universities**

Welding education in Universities and Technical Colleges has been offered in several countries for many years.

Welding Education in Universities is usually included in the syllabus of engineering courses where Manufacturing Technologies are addressed. Examples are Mechanical Engineering, Materials Engineering, Production Engineering, Industrial Engineering,

and Naval Engineering, offered all around the world and where in most cases Welding and Joining is addressed as a semestrial or annual subject.

These courses usually cover mostly theory in welding and joining technology and focus on welding processes, metallurgy and weld ability of materials. In some cases Laboratory lectures and demonstrations are also offered.

For students who have finished their undergraduate engineering course some Universities offer pos-graduate courses or master courses in Welding Engineering.

The tables below give some information regarding welding technology taught in European Universities, based on a questionnaire circulated to organizations active in welding in all European countries.

Mechanical Engineering courses include a topic in welding in 100% of the cases. Most of the answers indicate that welding is also addressed in Materials Engineering (60%) and other Engineering courses.

The data indicates that welding technology is addressed in a vast range of engineering courses usually at a semestrial subject with a duration in a range of 40-70 hours and the phase of course, when this occurs, varies evenly between undergraduate, postgraduate and MSc levels.

### **3. Welding Education Vocational Training Schools**

The welding technology qualification programs that are normally developed on the vocational training schools have the aim to give to students the knowledge and practical competences that are considered necessary to perform certain professional activities.

In the welding technology field the National Qualification programs are normally developed to delivery to candidates/students the basic knowledge and the competences regarding a certain professional activity. In the case of National Certification programs the aim is to verify and validate the candidate experience and competence in terms of his/her ability to apply his/hers knowledge.

National Qualification programs in the welding field are normally designed for the following levels:

Qualification:

- i. Specialist
- ii. Practitioner
- iii. Welder

Certification:

- i. Welders approvals
- ii. Welding Inspection

- iii. Non Destructive Testing
- iv. Other Welding Certification Personnel Schemes

In the National Qualification programs the most common procedure gives the possibility for the candidate, after having been awarded to a certain Diploma, to move upwards to the next Qualification level, thus allowing to progressing on their professional carriers.

Qualification programs are also used as a tool to update technical knowledge.

### **3.1. Welders Qualification Training:**

Welders vocational programs, are usually divided in three types of qualification programs

#### **3.1.1. Welders Comprehensive Training:**

The comprehensive programs are normally designed for young people who do not have any know how regarding welding and need to develop skills and knowledge that will allow them to start their professional activities.

These programs include practical training in several welding processes such: MMA/SMAW, TIG/GTAW, MIG/MAG/GMAW, FCAW and also different base materials, such as: Mild steel, Austenitic Stainless steel, and Aluminum

The training courses also include theoretical knowledge, not only welding process related, but also focusing on basic concepts regarding materials, weld ability, welding construction and design, health & safety, standards, and other fields related with the general basic knowledge like, mother language, mathematics, chemistry, physics, and so on.

These types of programs have at least duration between 1 to 2 years, varying in function of the depth of knowledge and skills aimed to be given to the students.

#### **3.1.2. Welders Specific Welding Process Training:**

Training on specific welding process is normally developed as vocational training but the public target can be active welders, or personnel that have no welding experience. In this qualification programs the goal is to give to the candidates know how and competence/skills in a welding process and in a type of base material.

These programs are designed for a given welding process and a certain type of base material; this is the big difference between this type of training and the previous one.

On these programs the theoretical part is also very important and is treated with the same type of depth like the previous type of qualification program.

The average duration of this type of programs is normally between 1 to 6 months.

### **3.1.3. Welders Specialization Training:**

The specialization is normally designed to give the candidates a specific training either in terms of base materials, or in specific welding process applications, or to develop new skills regarding welding positions and/or fillet, plate or tube welds.

The content of this type of training is very difficult to be characterized, due to the broad type of applications.

The average duration of these types of programs goes from 1 week to a maximum of 3 weeks

In all welders qualification programs it is very important to design exams that will be able to test the candidates understanding of the theoretical parts and to evaluate the skills progression, on the practical exams the evaluation should not be only visual inspection, but also other types of weld tests should be used, like non destructive or destructive tests.

It is also typical that on the end of each welder training program, a final practical exam is done, with the aim to issue a welder approval according to a certain standard, or construction code.

### **3.2. Practitioner Qualification Training**

The qualification programs for the Practitioner level are normally programs to prepare welders team leaders or in small companies to prepare a welder to act as a foreman or deputy foreman.

Typically this type of programs can be designed for two types of public, one type can be young people that are not related to welding that want to develop their professional activities in the welding field and aim not only to be welders, in which case these programs are a mixture of welders training and practitioner. The average duration of this type of program is around 2 to 3 years.

If the candidates are welders, that want to progress on their welding carrier, on this type of programs the content is developed namely to improve the candidates theoretical knowledge giving at the same time some basic skills in a new welding process(es) and/or base material(s).

For this type of programs the average duration is between 3 weeks to 2 months.

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### **Biographical Sketches**

**L. Quintino** received the Diploma of Mechanical Engineering from Instituto Superior Técnico in 1977, the PhD - Doctor of Philosophy, from Cranfield University in 1986 and the Diploma "Management of Technology", from MIT - Massachusetts Institute of Technology in 1991. She has been awarded the "Brooker Medal 2003", The Welding Institute, 2004, Title of "Honorary Professor", Universitatea "Dunărea de Jos" Din Galati, România, 2004, Titlul Academic de Profesor Onorific, Universitatea Politehnica Din Timisoara, 2003., International Meritorious Award, American Welding Society, 2001., The Jim Kape Memorial Medal, The Institute of Metal Finishing, Aluminium Finishing Group, 2000., Adams Memorial Membership Award, American Welding Society, 1994., the George Willis Memorial award, AWS- American Welding Society, 2007

L. Quintino is Professor of Mechanical Engineering at, Instituto Superior Técnico, TU-Lisbon since 1994, Chief Executive of the European Welding Federation/International Authorisation Board, since 1992, Consultant of ISQ-Instituto de Soldadura e Qualidade, since 1992. and Vice- President of IIW- International Institute of Welding since 2006.

She has published approximately 150 papers, books and lecture notes.

**Italo Fernandes**, received the Bachelor Diploma in Mechanical Engineering from Instituto Superior de Engenharia de Lisboa – ISEL in 1982, a pos-graduation in Welding Engineering from Instituto de Soldadura e Qualidade (ISQ) in 1986, and the Diploma European Welding Engineer in 1993. He has pos-graduations in Quality Engineering from ISQ in 1997 and in Management of Integrated Systems for Quality, Environment and Safety from ISQ in 2006.

Italo Fernandes develops his activities at ISQ, namely as the System Manager of the EWF-IAB/IIW Secretariat staff since 2005, he is the Chairman of the Portuguese Standardisation Welding Committee, since 1992, he is also a lecturer at the ISQ pos-graduation welding engineering course (EWE/IWE) since 1995. He is a coauthor of more than 20 papers, books and lecture notes