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AdTech project - European harmonized training system focus on adhesive bonding technologies

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Abstract

The technology of adhesive bonding is experiencing rapid growth in Europe and in other world markets, leading to products of improved quality. Therefore, a strong competitive advantage is gained if industries are able to master the knowledge, competencies and techniques needed for the implementation of vital manufacturing techniques. Harmonised training systems have become crucial to respond to the labour market needs and to link education to industrial environments. The AdTech project developed a European harmonized training system to support the industries that depend on the availability and knowledge of professionals to better leverage the adhesive practice. This project tackled this challenge by supporting the development of high-quality work-based vocational educational training for adhesive bonding, encompassing professional profiles that will cover the industries' requirements regarding the application of adhesive technologies. With AdTech, it has been possible to address training needs, develop harmonised curricula and implement a sustainable consortium.

1. Introduction

Adhesive bonding and sealant technologies are widely implemented in many technological industrial sectors, including the aerospace, automotive, shipping, railway footwear, electronic components and sports equipment industries. It is seen a key technology that drives manufacturing into modern, 21st century practices (da Silva, Öchsner, and Adams 2018; Cognard 2006; Wacker et al. 2004; Banea et al. 2016; Machado et al. 2018; Marques and da Silva 2008). The introduction of non-metallic materials, such as plastics or composites and the necessity to join dissimilar materials, have pushed the industry to apply alternative joining technologies (Banea et al. 2014; Banea et al. 2016; Marques et al. 2015; da Silva, Pirondi, and Öchsner 2011). The increasing acceptance of adhesive bonding technology is related to the great benefits associated with its usage, especially when compared to traditional joining technologies. Among these are the lower heat input, the prevention of contact corrosion and, perhaps the most important advantage, the possibility to join very thin sheets and dissimilar materials (i.e. metals to polymer) (da Silva, Öchsner, and Adams 2018; da Silva et al. 2012). As a result, product designers and manufacturing engineers now rely on adhesives in an unprecedented way, since they enable a superior design flexibility, a more efficient production and improved performance assembled structures, reducing the final weight of structures (da Silva, Pirondi, and Öchsner 2011; Costa 2013; da Silva and Öchsner 2008; Banea et al. 2014). Adhesive usage is growing rapidly both in Europe and the rest of the world, as it represents a strong competitive advantage for companies and industries able to muster the knowledge, competencies and techniques needed to successfully use it. This is especially true as we are at a juncture where there is an increasing requirement for EU businesses to become more competitive through endowment and modernisation (FEICA 2018; Wiesbaden 2014).

Notwithstanding the existence of several professionals working with adhesives joints, it is noted that in the industry, in 2015 (project start date) there was a clear lack of technical awareness associated to the mechanical behavior and the durability of adhesive bonds, generating some mistrust related to this technology (Loureiro, da Silva, and Migueis 2016; Almeida et al. 2018). As in other joint technologies, there is a wide variety of causes that can lead to the failure of the bond. These causes have different origins and can appear in any of the different stages of the manufacturing process (adhesive selection, surface preparation, joint design, planning, supervision and control, application, bonding process) or even during the service phase. Hence, it is particularly important to qualify technical personnel with extensive knowledge regarding the adhesive properties and its life cycle conditions, to establish the best manufacturing options for its final application. The necessity for highly qualified personnel with deep knowledge of the bonding technology which enable the professional to analyse and solve problems and to choose the proper technical solutions when applying this technology, has led to the emergence of the AdTech project, shortened as AdTech (European Federation for Welding 2015). AdTech followed the need to improve the creation of high-quality work-based VET. It considers three professional profiles (Adhesive Bonder, Specialist and Engineer) that cover the market needs identified by the companies using adhesive technologies in their products. Due to the great importance of the mobility of labour and cross-border cooperation within Europe, the AdTech project devoted a lot of effort to the creation of a harmonized toolkit, to ensure that personnel is trained uniformly, regardless of the country where the course takes place (Loureiro, da Silva, and Migueis 2016).

The project started in September of 2015, led by Universidade do Porto. Has supported the achievement of the European Union's targets and the objectives set forth by the Erasmus + Programme by increasing the labour market relevance of VET and reducing skills mismatches

and shortages, as well as showcasing the relevance of further need oriented skills development. The consortium is represented by six countries and seven partners (see Table 1):

Table 1: AdTech consortium partners

Partner	Country		Organization
1	Portugal	UPORTO	Universidade do Porto
2	Belgium	EWF	European Federation for Welding Joining and Cutting AISBL
3	Spain	CESOL	Asociacon Espanola de Soldadura Y Tecnologias de Union
4	Portugal	ISQ	Instituto de Soldadura e Qualidade
5	Slovenia	IZV	Institut Za Varilstvo D.O.O.
6	Germany	FhG	Fraunhofer Gesellschatf Zur Forderung Der Angewandten Forschung
7	Austria	SZA	Schweisβtechnische Zentralanstalt

AdTech intends to contribute to a wider acceptance of adhesive joint technology by delivering a European qualification standard for professionals that use this technology encompassing, the three professional profiles - EAB, EAS and EAE) – that represent the foundation of the harmonized qualification system developed by EWF (European Federation for Welding, Joining and Cutting). It should be noted that, EWF, since its inception in 1992, is an organisation dedicated to education, training, qualification and certification in the field of welding and related technologies (Quintino, Fernandes, and Assunção 2013).

2. Objectives

The AdTech project aims to, in its entirety, create training contents in five languages, English, Portuguese, Spanish, Slovenian and German and the review of three professional profiles (EAB, EAS and EAE). The project objectives were the following:

- To improve the quality of qualification programmes related to adhesive bonding, with regard to contents (high-need orientation), methods and in terms of transparency and recognition between the European countries (using common EU tools);
- To reach an harmonized standard of qualification in the adhesive bonding technology sector, aligned with the requirements of the industry, to promote mobility of specialists in Europe;
- To create and improve a qualification programme for the involved personnel and enhance the integration and exploitation of these offers also to countries with lower engagement and access to these offers;
- To promote language learning and linguistic diversity through the provision of a multinational glossary and a multi-national pilot training;
- To increase transparency of competences and qualifications for the adhesive bonding and sealants sector. The European tool to be developed promotes transparency and mutual trust between VET systems;
- To develop a module which considers the labor market needs by the involvement of different stakeholders (companies, European associations, VET organizations), by going in line with the training requirements, while identifying a competence profile, in order to make the VET more responsive to new challenges and needs in the sector.

To achieve these objectives, the project partners have performed a set of activities and tasks in the scope of six different intellectual outputs. Among these tasks, EAE, EAS and EAB qualification programmes were updated based on the Output 1 (Common State of the Art report) results and training needs were identified. A learning outcomes orientation was set to the curricula aligned with the European Qualifications Framework (EQF) descriptors and

European credit system for vocational education and training (ECVET) recommendations (Output 2 – European Adhesive Bonder, Specialist and Engineer Profiles Curricula) and Output 6 (Operational ECVET KIT), which are EU tools for transparency and recognition of skills (AdTech 2015, 2016). The National Qualifications Framework (NQF) is a single reference tool to categorise all the qualifications produced in the national educational and training system. The NQF adopts the qualification levels and respective descriptors of the EQF.

To implement and improve a qualification programme and enhance the integration and exploitation of these offers, also including countries with lower engagement and access to these offers, a report with guidelines on the implementation of the courses developed in other European countries was generated based on the same structure of the EU recommendation documents. The aim of the AdTech European Recommendations (Output 5) was to support the implementation of the EAB, EAS and EAE training courses at European level in VET, which are not addressed by the project, in order to boost the transferability of the project's results (AdTech 2017b).

Educational contents (slides) were also generated for a set of modules for EAE level and part of these training materials were translated to the national languages of the project's partners, promoting the implementation of the training courses at national level. Furthermore, a didactical tool was created to support trainers and training institutions in the implementation of the EAB, EAS and EAE Profiles Curricula at National level (Output 4). Supporting documents (so-called structuring aids) were generated for all Competence Units and all three profiles. These documents assist in structuring the learning units of the profiles in terms of time, foreseen learning outcomes, methodology and methods used during the training sessions. The transparency and mutual trust between VET systems is also provided by the creation of a database of evaluation questions from which the VET providers can collect questions for their exams. The questions and respective possible answers were all generated by experts in the adhesive bonding field. Hereby, meaning through the EWF Quality Assurance System and harmonised examination procedures, trainees in different countries can be evaluated in accordance with the same criteria. The detailed definition of specific learning outcomes that constitute a common language of qualifications was also a method of ensuring transparency between training institutions and into the labour market. Although these contents are available to all project partners, they are on information protection, ensuring that there are no leaks to the general public, ensuring the trustworthiness and integrity of the examinations and evaluation process.

Nonetheless, the elaboration of all the learning materials for trainees for the three different levels was quickly found to be too ambitious to complete within the available timeframe, involving an extremely large amount of work. It was, therefore, necessary to readjust the initial objectives, focusing only on the preparation of training materials for a set of Competence Units which are transversal to the three qualification levels. The development of these training materials consisted on the preparation of slides for the EAE level. The consortium believes that with the slides prepared for the highest qualification level and with the structuring aids (which include the learning outcomes) fully defined for the three levels, it is possible to prepare the didactic materials for the remaining two qualification levels (AdTech 2017a).

3. Methodology

The 36 month long AdTech project, was organized into 7 main Activities, with some of them directly associated with Intellectual Outputs, while others fall out of that scope. The organisation of the main activities under this project is summarised in Figure 1.

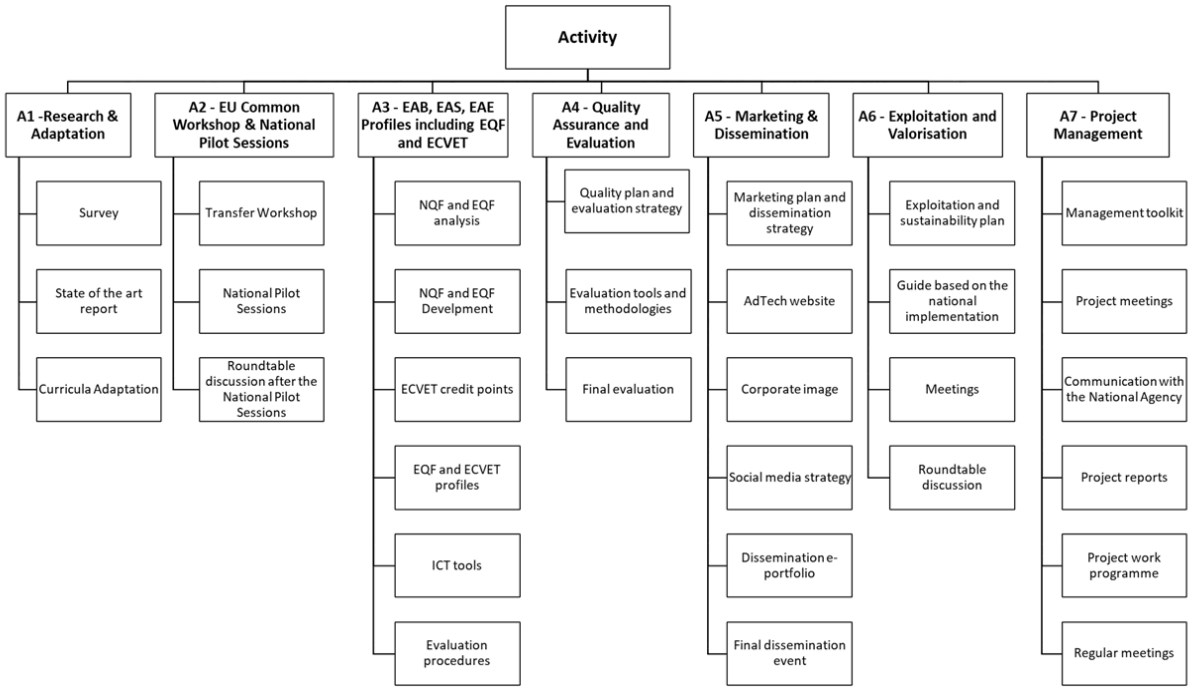

Figure 1: AdTech Project activities organization

The initial project activities were divided into two main groups: A1 - Research & Adaptation and A2 - EU Common Workshop & National Pilot Sessions. In A1, it was necessary to develop a survey to identify the pedagogical and market needs, most critical points and skill gaps to be overcome during the training. A study was subsequently carried out on state of the art, considering the training methodology and the requirements of the stakeholders, using a common template and based on the survey results. Lastly, AdTech Curricula and tools according to each partner reality and needs, aimed the creation of a national Tool Box and planning the transfer workshop, were adapted.

In A2, Common Transfer Workshop on the AdTech Curricula was initially held. Subsequently, National Pilot Sessions for the target groups (companies, VET trainers and teachers) were conducted by each partner. The closing activity of the project was roundtable discussion after the National Pilot Sessions with their participants and national stakeholders (as experts, VET promoters, companies, local and national policy makers), in order to launch a process for the sustainability of the product methodology.

The A3 is divided into seven tasks, firstly a Comparative Analysis of each NQF (national qualification framework) and the EQF (European qualification framework) levels and the ECVET systems were performed, then the EQF and ECVET for the EAB, EAS and EAE Profiles were defined in terms of learning outcomes, descriptors of knowledge, skills and competences, with an EQF level assigned. ECVET credit points to the EAB, EAS and EAE Profiles were also allocated. Subsequently, the EQF and ECVET Profiles were presented to stakeholders, namely national qualification authorities. As well as a Common Guideline to promote a common understanding and validation of the EQF Profile and ECVET among VET stakeholders and policy makers, promoting further dissemination and valorisation. New

Information and Communications Technology (ICT) tools, such as innovative ICT training solutions and a set of Evaluation Procedures, such as a database with exam questions were developed, closing the loop for a complete training programme for the profiles.

There are three main tasks of the A4 activity related to Quality Assurance and Evaluation. Initially, quality plan and evaluation strategy, including project milestones, indicators per activity methodology and procedures focused on ISQ evaluation model were developed; evaluation tools and methodologies in the EN (European standard) with cross information methods and focus groups were developed and launched. Finally, mid-term and final evaluation and reporting, for identification of possible risks and needs of project re-engineering and improvement actions, including the analysis of project impact were carried out.

Due to the complexity of the project and its productive nature, there was an obligation to include an activity (A5) focused on marketing and dissemination. In this activity, a marketing plan and dissemination strategy, including specific action plan, descriptors, time frame and stakeholders that each partner will ensure and develop were defined. A website has been created and managed, as it is an excellent platform to disseminate and store information (www.adtecheducation.com). The corporate image (logo and layouts) and e-marketing materials were also designed, including project brochures, newsletters, teasers and publications (European Federation for Welding 2015). Social media strategies using existing social media tools and promotion of project through Erasmus+ valorisation channels were evaluated and applied and a dissemination e-portfolio with the major results from the dissemination activities carried out by each partner were produced. Lastly, a final dissemination event on AdTech Project key milestones, outcomes and good practices was conducted.

Since this project aimed not only at implementing the harmonization of courses, but also at ensuring their future continuity, an exploitation and sustainability plan, including specific actions plan, descriptors, timeframe and mainstreaming committee, per partner, were developed under the scope of A6 (Exploitation and Valorisation) (AdTech 2018). For the same reason, a Guide based on the national implementation experiences to boost the transferability to other European countries was also produced. Meetings with relevant stakeholders (from VET/schools and organisations/workplace sides) were held to influence further development of project products, create a shared understanding and gain support for the validation/certification of EAB, EAS and EAE Profiles countries of the AdTech project. Roundtable discussions were also held with the stakeholders focused on piloting strategies, usefulness and the added value of the products for the national context.

The final activity (A7) concerns the project management: management toolkit, including work plan, contractual process, etc.; and also project meetings, communications with the National Agency, reports and implementation and monitoring of the project work programme and risk assessment analysis.

4. Results

4.1. Market needs

For the harmonisation of programme content to be successful, it is necessary to survey market needs in order to better understand the overall needs of European business and industry. It is intended that the training should be uniform, so that it meets the needs of the market, regardless of the country where the course is held. The market survey was conducted in two stages:

1. Development of a survey to identify the market needs, most critical points and skills gaps that will be targeted with the methodology and training, in each partner language;
2. Elaboration of a common EU state of the art report on the methodology and market requirements, namely the requirements in terms of Qualified Personnel.

With the contribution of all partners, the survey was developed, launched online and sent by the project partners to companies of their respective countries and some countries outside the EU. The survey main goals were to understand and identify the most critical points and skills gaps in terms of education and training in adhesive bonding in each country, such as the market needs identification in terms of available training courses. The survey included a total of twenty-five questions, covering different topics, such as:

- Companies characterization;
- Application of the adhesive bonding technology in companies;
- Adhesive bonding courses;
- Specific questions for VET organisations.

The questions were elaborated with the collaboration of all project partners allowing to understand the industry's opinion on the above points in order to identify what the best teaching strategies would be. These were some examples of the questions asked in the questionnaire made to the institutions: How would you rate the importance of the adhesive bonding in your company? What kind of other joining techniques besides bonding does your organization uses and how important is it? How would you rate in terms of importance, the added value of participating in an adhesive bonding related course? Does your organisation have employee(s) trained in a course within the adhesive bonding technological area?

It also allowed for an understanding of whether there was a need for specific training and its origin. In general, the information gathered with this survey is quite valuable for several stages of the project. The survey was answered by 129 companies, however the disparity recorded in the number of answers obtained between different countries precluded a deeper comparison between the different partners' countries (see Figure 2 for more detailed information). More than 77% of the answers were collected by Portugal and Germany and the results from other partners are almost negligible. This disparity of results may preclude a reliable comparison between different countries (Loureiro, da Silva, and Migueis 2016).

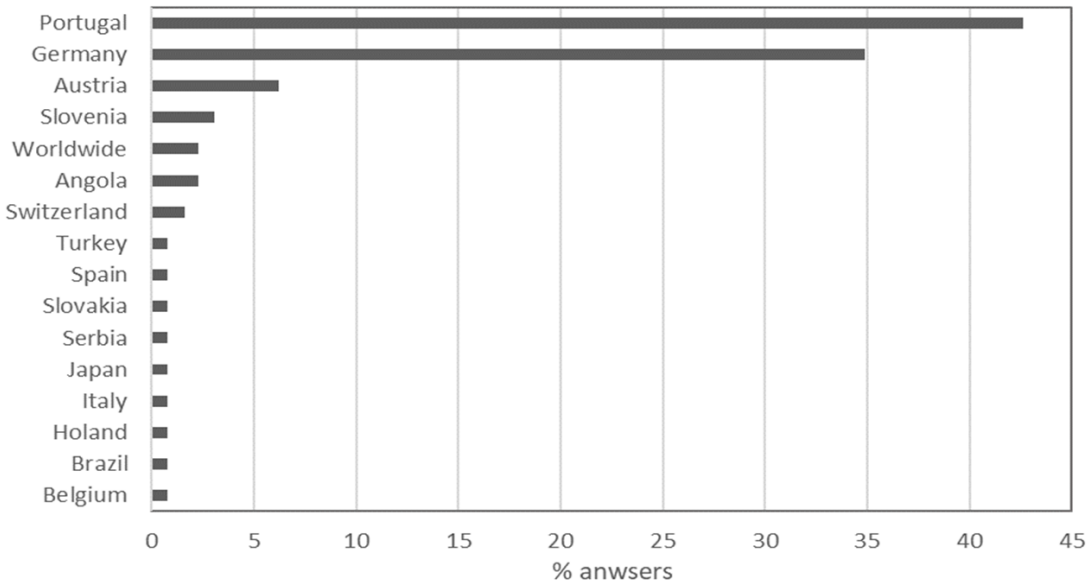

Figure 2: Provenance of the survey answers

With the results obtained from the survey, an evaluation of the importance level of adhesive bonding in the companies' production processes and the added value of adhesive bonding courses were performed. A significant percentage (80%) of participants was aware of the existing EWF courses and considered them to have a high added value for trainees. It was also concluded that traditional classroom learning was elected as the best approach to carry out the theoretical education and participants prefer the use of traditional materials. Thus, it can be concluded that no significant changes have to be made to the actual methodology and teaching materials. Conversely, the content complexity should be reconsidered.

The 129 interviewed companies consider the use of adhesive bonding in their process chain to be of great importance and are aware of the high benefit of adhesive bonding courses. Companies consider that EWF courses are an asset for trainees and that the current content provides them with all the necessary skills. As stated above, 57.7% of the companies which are not VET providers (see Figure 3) choose the traditional classroom learning as the best approach to lecturing out the theoretical education and the majority favour the use of traditional materials. In the last section of the questionnaire there are three questions addressed to VET organisations. Due to the scarce number of answers a comparison between two different groups was conducted: VET providers companies and all of the other surveyed companies (see Figure 2). While these two groups agree about the fact the companies are the entities who search most the training courses, the same is not true when inquired about the existence of a demand for training in adhesive bonding field. Surprisingly, most of the VET providers consider that this demand does not exist while the industry has an opposite view. The final question aimed to estimate the market's perception regarding the creation of educational offers in the adhesive bonding area. The results show that VET provider companies perceive the need for new courses to be lower than what the industry believes. With the analysis of the data, it was observed that there is a gap between the industry needs and the services provided by VET institutions.

The profile of the participating companies was drawn, considering the category which best fits them (seven main categories were considered):

1. VET provider;
2. Construction products fabrication;
3. Structures, construction and assembly;
4. Automotive industry;
5. Railway industry:
6. Furniture industry;
7. Others (during the filling in of this field, the request was made to specify the commercial area).

It can be observed that the participating companies belong to a wide range of business areas (see Figure 3). Most of the participants (41.9%) fit into the "others" group, which reveals the versatility of this type of technology. The responses from groups that commonly use adhesives (automotive and railway) add up to a percentage of 25.6%.

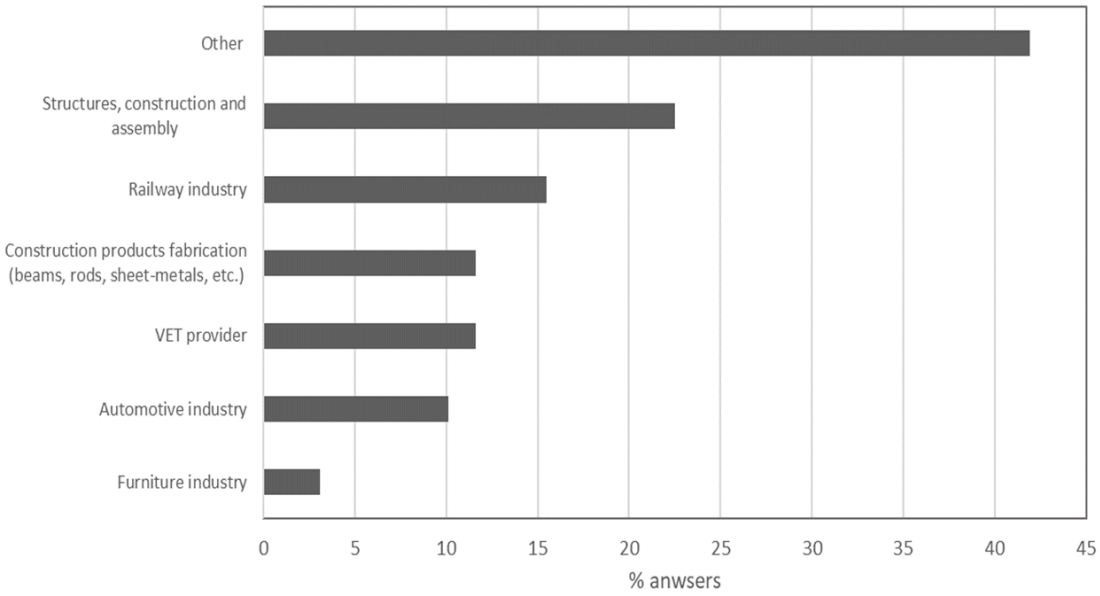

Figure 3: Categories of companies that responded to the survey

According to the survey, it is possible to state that more than 74.4 % of the enquired entities are private companies and about 42.6 % of them have more than 1000 employees, which gives several information on the turnover of these companies and the potential need for training of their employees.

With regard to specific training in the adhesive bonding technology, the results illustrate that 88.6% of companies, which apply adhesives to develop their products, have trained employees. More than 74% of these companies are from Germany and approximately 48% of them had their training performed only by external organizations (Loureiro, da Silva, and Migueis 2016).

4.2. Harmonized curricula

With the elaboration of the state of the art, it was possible to draw elations for the harmonization of the programmatic contents, meeting the needs identified in the survey. To this purpose, the existing guidelines for training in this area have been updated. The use of this guideline is restricted to organizations approved by the Authorized Nominated Body (ANB). Each of the training courses (EAB, EAS and EAE) has specific guidelines that must be scrupulously followed (European Federation for Welding 2010a, 2010b, 2010c, 2019). This guideline for the European Education and training of Adhesive Bonders has been prepared, evaluated and formulated by Members of the Committee for Education and Training of the EWF. They have been designed to provide the basic core education in adhesive technology required for a number of adhesive personnel being active in job functions (foreman, instruction, technical sales etc.). It is expected that it may be possible that additional training and/or experience may be required by the adhesive personnel beyond the basic core education to lead to qualification in the applicable job functions. EAB has industrial experience and can carry out bonding tasks, according to specific procedures. The bonder is able to read and understand working instructions as well as production methods concerning bonded products. The bonder has a basic understanding in bonding technology (European Federation for Welding 2010a, 2019).

The EAS has specialized and factual knowledge in the field of adhesive bonding technology (European Federation for Welding 2010c). Specialists shall have skills at a level that is required in the field of bonding technology which demonstrate:

- Being able to develop solutions on common/regular problems;
- Being able to choose appropriate methods when applying bonding technology in common /regular problems;
- Being able to manage and supervise common or standard adhesive applications and related professional activities;
- Taking responsibility for decision making in common or standard work;
- Taking responsibility to supervise the tasks of adhesive and related personnel.

The EAE has advanced knowledge and critical understanding of adhesive technology application (European Federation for Welding 2010b). Engineers shall have advanced skills at a level that is required in the field of bonding technology which demonstrate:

- Technology mastery and required innovation;
- Being able to solve high-level complex and unpredictable problems;
- Being able to choose the proper technical and economical solutions in complex and unpredictable conditions;
- The ability to manage highly complex technical and professional activities or projects related to bonding applications;
- Taking responsibility for decision making in unpredictable work or study contexts;
- Taking responsibility for managing the professional development of individuals and groups of workers.

The contents for EAB, EAS and EAE and corresponding number of teaching hours are given in the following structure (Table 2 and Table 3):

Table 2: EAB contents and teaching hours
(European Federation for Welding 2019)

	Teaching Hours
Theoretical Education	**EAB**
1. Fundamentals of Adhesion and Adhesives	1
2. Surface Preparation Before Adhesive Bonding	4
3. The Main Families of Adhesives and Sealants	10
4. Construction and Design	0.5
5. Quality Control	1
6. Durability of Adhesively Bonded Joints	0.5
7. Benefits and Limitation of Adhesives	1
8. Health and Safety	1
Practical Education	
Practical Skills Training	15
Examination	6
Total	40

Table 3: EAS and EAE contents and teaching hours (European Federation for Welding 2010b, 2010c)

	Teaching Hours	
Theoretical Education	**EAS**	**EAE**
1. Adhesion and Adhesives	14	48
2. Materials as Adherends	14	40
3. Construction & Design	8	28
4. Durability	12.5	28.5
5. Bonding Process	12.5	33.4
6. Testing and Analysis	14	30
7. Health & Safety	4	8
8. Quality Management	4.75	24
9. Manufacturing Case Studies	8	24
Practical Education	22	40
Examination	8	12h15
Total	121.75	316.05

The guideline covers the basic requirements for education and training, agreed upon by all national welding and joining societies within the EWF, in terms of themes, keywords and times devoted to them. Its content will be revised periodically by the Committee considering any changes, which may affect the "state of the art". Trainees having successfully completed this course of education will be expected of being capable of applying adhesive technology as covered by this guideline.

Each teaching session will contain at least 50 minutes of direct teaching time. It is not mandatory to follow exactly the order of the topics given in this guideline and choice in the arrangement of the syllabus is allowed. In this syllabus, the workload (WL) is an estimation of the time learners typically need to achieve the defined learning outcomes and small rearrangements are allowed. WL covers theoretical training and self-study, as well as the time devoted to practical training and examination. Credit points are allocated to the Competence Unit and Qualification, where 1 credit equals to 25 hours of WL. It should be noted that the overall structure of the syllabus for all levels (EAE, EAS and EAB) is similar, but some items are not considered appropriate in the Education of EAB. The depth of the topics covered should take into account the number of hours allocated in the guidelines, and will be reflected consecutively in the scope and depth of the examination. EAB, EAS and EAE course consists of theoretical training and practical training. Applicants must pass theoretical and practical exams, according to the approval formula presented in the guideline. The theoretical education lectured aims at understanding of the appropriate bonding process and the materials behavior including standards and safety regulations (according to the level: EAB, EAS or EAE) (BSI 2016; Meiß 2016; DIN 2015a, 2015b, 2016). The practical training advised in this Guideline will bring the students up to the comprehensive skill required for practical work in industry.

4.3. Structuring aids

4.3.1. Training materials

The AdTech project was also responsible for the creation of a toolbox for adhesive bonding personnel, consisting of training materials, presentations, demonstrations, kit, videos and online software. When the project was proposed, it was intended to create teaching materials for all levels (EAB, EAS and EAE). As the activities progressed, it became clear that this task was unaffordable given the duration of the project and the amount of human resources available. The preparation of all the learning materials for trainees for the three different levels was found to be too ambitious, involving an extremely large amount of work. It was,

therefore, necessary to readjust the initial objectives, focusing only on the preparation of training materials for a set of Competence Units which are transversal to the three qualification levels. The development of these training materials consisted of the preparation of slides for the EAE level. The consortium believes that with the slides prepared for the highest qualification level and with the structuring aids (which include the learning outcomes) fully defined for the three levels, it is possible to prepare the didactic materials for the remaining two qualification levels. Afterwards each partner translated the slides contents into their national language, promoting the implementation of the training courses at national level.

A demonstration kit has also been developed, consisting of a toolbox (45.5x32.5x15 cm) containing samples of different kinds of adhesives bonding joints and adhesives, as well as examples of failure patterns and surface treatment. In Figure 4, it can be seen the different elements that are included in the toolbox, namely: 1 - bonded sandwich panel, 2 - butt joints, 3 - examples of fracture surfaces, 4 - adhesive bead examples, 5 - lap joints with varied substrates, 6 - sealant demonstration, 7 - bulk adhesive and 8 - examples of aluminium surface treatments (AdTech 2015).

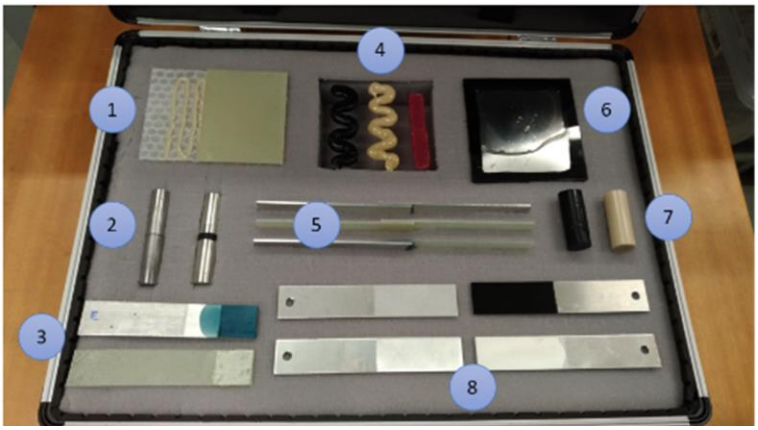

Figure 4: Toolbox developed within the AdTech project

A joining design software has also been included in the training materials and a demonstration version is available in the project website (Costa 2013; da Silva, Lima, and Teixeira 2009). This tool as used for the design of bonded joints. It incorporates the following aspects:

- Elastic and plastic analysis of adhesives and adherends;
- Isotropic and anisotropic analysis of adherends;
- Wide range of analytical methods;
- Saving analysis results online, print and export to PDF/CSV/ Excel;
- Personal database of materials to save information on custom adhesives and adherends.

In complement, educational videos were produced. They are available in the project website and YouTube channel and address the following subjects:

- Single lap joint manufacture;
- Bulk specimens manufacture;
- Thick Adherend Shear Test (TAST) specimens manufacture;
- Torsion specimens manufacture;
- Double cantilever beam (DCB)/ End-Notched Flexure (ENF) specimens manufacture;

Composite Plate manufacture. Additionally, a didactical tool was generated to support trainers and training institutions to implement the EAB, EAS and EAE Profiles Curricula at National level. Structuring aids, also known as supporting documents were produced for all

Competence Units and all three profiles. These documents support and structure the learning units of the profiles in terms of time, foreseen learning outcomes, methodology and methods used during the training sessions. The development of a database, from which the VET providers can collect the questions for their exams with evaluation questions promoted transparency and mutual trust between the VET system. The questions and respective possible answers were generated by adhesives experts. This means that, through the EWF Quality Assurance System and harmonised examination procedures, trainees in different countries can be evaluated in accordance with the same criteria, promoting the much-desired harmonisation. The detailed definition of specific learning outcomes that constitute a common language of qualifications was also a method of ensuring transparency between training institutions and into the labour market.

In order to standardize the way contents should be taught, a workshop was carried out. The workshop was given by EWF trainers with the contribution of all partners, aiming mainly at testing/sharing with all partners the developed Toolbox, ensuring its adequacy and transferability to their national contexts. Representatives from all partners participated in the event which occurred before the Hands-on Approach Seminars. This activity was of great added value to the project because it enabled moments of close cooperation and mutual collaboration among all partners, promoting brainstorm situations which have led to the creation of solutions for problems identified at the event. During this activity, some minor changes were made to part of the documents developed in the scope of different intellectual outputs, in order to achieve final and consensual versions of them (e.g. guidelines, evaluation questions of the database and slides). For the reasons previously mentioned, partners have no doubts in considering that this activity has contributed positively to the improvement of the project.

4.3.2. Impact

With the objective of gathering the opinions of different stakeholders in this project a survey has been carried out, inquiring on the importance of this specialised training in adhesive bonding technology. The inquired stakeholders have unanimously agreed on its need and great importance. All the stakeholders are aware that for new manufacturing technologies and materials to be successfully applied on a broad scale across industries, new professionals with higher and deeper qualifications are required. Businesses targeting the professional use of adhesives in macro- and micro-bonding on an industrial level have to assure appropriate training of their staff. Through the several events, the majority of the participants were enthusiastic about the advances made by the AdTech project to boost the specialized training in adhesive bonding technology, mainly since they recognized and appreciate that the harmonized way by which project was guided allows to promote the transparency of the training in different countries (AdTech 2018). It is common knowledge that the use of adhesives has increased exponentially in recent decades. The statistics emphasize the necessity for addressing the qualification and certification of the personnel involved in adhesive bonding manufacturing and repairing processes. The update of these three professional profiles is not only able to meet training needs in the European market, but also to enable the mobility of qualified professionals, demonstrating the large impact that AdTech will have at all levels (local, regional, national and European) (AdTech 2017a).

It is believed that the impact of AdTech on the target groups and other relevant stakeholders will be substantial and will include:

- Targeting of an actual market need, matching education and employment by creating the new EAB, EAS, EAE Profiles Curricula, considering three professional profiles which are of extreme importance to the industry, namely Small and medium-sized enterprises (SMEs) and large companies;
- Creation of the EAB, EAS, EAE Profiles Curricula Toolbox that will assist the implementation of the new training curricula by VET Providers/Teachers/Trainers;
- EQF and ECVET Trainer Kit, based on EQF learning outcomes, defined in terms of knowledge, skills and competences, and allocation of ECVET points, taking into account European recommendations;
- Absorption of the lessons learnt from transferring and adapting the existing contents (based on previous projects) to the partners countries realities and needs;
- Adaptation, dissemination and exploitation of the developed results by/to other relevant stakeholders (National Authorities for VET National and EU VET Networks);
- Creation of jobs by companies involved in adhesive bonding, via the market availability of highly qualified personnel.

4.3.3. Sustainability

As already pointed out, this project lasted for three years and had a team of adhesive bonding experts. One of the fundamental objectives of this project is that the activity developed during the duration of the project should have continuity and be sustainable. The team believes that the harmonization process is a continuous one; there is a need to consolidate the trust and transparency created between the partners in the project, as well as the adjustment of the concepts to the new technological advances in this area that is growing exponentially. One of the outcomes of this project is the updating of the three guidelines for personnel involved in adhesive bonding: EAB, EAS and EAE. These updated guidelines will be included in the EWF system, allowing it to be applied across Europe in a harmonized way in line with the EU targets, assuring that the results obtained will be used in the long term, after the end of the project.

In line with these guidelines, EWF, through its members, intends to distribute part of the training materials to bonders, specialists, engineers, etc. This will also enable the increased use of training materials in the long term.

In addition to the aforementioned initiatives:

- The established curricula and the respective methodologies, tools and concepts transferred and adapted during the project, as the final products developed, that have been brought into the day to day activities of the partner institutions and their national VET systems, will continue to be utilized, developed and promoted in partners' countries and across Europe, by partners' networks and EU databases;
- The conception of an ECVET kit is an enabling point for ECVET implementation in each partner's country, and the common guidelines produced and delivered in each national board will allow to foment this process;
- The project website (www.adtecheducation.com/index.html) will remain available for at least five years, as a valuable resource of information;
- The cooperation achieved through this project has been to a great extend tested through previous cooperation and will be maintained. The consortium is interested in the furtherance of the development of the project results;
- The classroom training materials developed was provided by partners as a public program and will be further developed with other pedagogical tools;

- EWF's Training and Qualification system will be an important approach to ensure the preservation of the project results. In addition, the expected increase in the demand for the EAB, EAS, EAE training courses by European large enterprises and SMEs, mainly those in the Manufacturing sector, will ensure the sustainability in the partner countries involved and across Europe.

5. Conclusions

The indicators of the AdTech project were analysed and an evaluation was made of all the effort carried out over the lifetime of the project and its furtherance after the closure of the project in 2017. Three years after the AdTech project was completed, the following conclusions can be drawn:

- From the survey and the elaboration of the state-of-the-art, it was possible to improve the didactic contents in order to satisfy the real training needs.
- Harmonised curricula and didactic tools have been developed that can be easily used by all partners and translated into the language of each country.
- It was initially intended to develop the content for all levels, but it was understood that this would be a herculean task given the time constraint of the project, so in order not to compromise the quality of the content it was decided to focus on preparing materials for the EAE level. Given the complexity of this level, the partners understood that the contents would be easily transposable to the lower levels of demand (EAB to EAS).
- The conception of an ECVET kit was starting point for ECVET implementation in each partner's country, and the common guidelines produced and delivered in each national board will allow to foment this process.
- The consortium has demonstrated that it is possible to have a commitment to cooperation and transparency between partners. This could be a rather critical issue, since with the harmonisation of curricula the project partners could be understood as direct competitors. However, they are aware that this condition brings more advantages than disadvantages, considering that given geographical distance and language barriers, there is a market for all trainees in their respective countries of origin.
- Even after the completion of the project, the spirit of cooperation and transparency remains within the consortium. This is a clear sign of the sustainability of this type of initiative.

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