

VIOLET

AR/VR International Welding Engineer Qualification

State of the Art Report on XR Tools for I/EWE Training

Łukasiewicz Upper Silesian Institute of Technology

ISQe ENGAGING PEOPLE

AT AUGMENTED TRAINING

EWF

ASR

INSTITUT ZA VARILSTVO Welding Institute

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Executive Summary

This document constitutes Deliverable D2.1 of the VIOLET project (KA220-VET-882DD247), funded by the Erasmus+ Programme of the European Union. It presents results of the desk research carried out within Task T2.1 of Work Package 2, whose objective is to characterise the state of the art of Extended Reality (XR: VR, AR and MR) technologies applicable to the training of International/European Welding Engineers (I/EWE).

The report is based on national contributions provided by the consortium partners: L-USIT (Poland), ISQe (Portugal), ASR (Romania) and IZV (Slovenia), as well as the European perspective of EWF. It has been coordinated by ATS / Seabery (Spain) in their role as WP2 leader.

Methodological Note — Scope and Interpretation of the Analysis

The analysis of XR tools and European projects contained in this report (particularly in Sections 6, 7, 8 and 9) has been prepared based on the interpretation of publicly available documentation: technical data sheets, academic publications, provider websites, specialist press articles and European project materials. It does not in any case imply direct knowledge, practical evaluation or real use of all the products analysed.

Quantitative data (prices, specific technical capabilities, commercial availability) should be considered indicative and verified directly with providers before making any acquisition decision or collaboration agreement.

This limitation does not affect the validity of the comparative analysis or the strategic conclusions, which are based on the triangulation of multiple sources and contrasted with the training needs identified by the consortium partners.

Key Findings

- I/EWE programmes in the four countries analysed share a common curricular base (ISO 14731 / EWF-409), with 448–498 hours of training and predominantly blended formats.
- The areas of greatest difficulty for traditional training — and highest XR potential — are: WPS/PQR, Inspection/NDT, Non-conformities and Safety.
- Soldamatic (Seabery/ATS) is the most widely used XR tool in the consortium (present in PL, PT, RO, SI), currently aimed at the welder/operator level.
- The critical gap identified is the absence of XR content specifically designed for the I/EWE engineer level: decision-making, non-conformity analysis, procedure coordination.
- The main barriers are: hardware costs, lack of I/EWE content, and instructor competencies. The main enablers: EU funding, existing blended base, and XR ecosystem already in place.

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1. Introduction and Project Context

1.1 The VIOLET Project

VIOLET (AR/VR International Certification of Welding Engineers) is an Erasmus+ KA220-VET project involving collaboration between vocational education and training organisations. Its core objective is the development of XR-based learning resources to modernise and enrich the training leading to international certification of welding engineers (I/EWE) according to EWF/IIW standards.

The consortium is composed of the following organisations:

Partner	Country	Organisation Type	Role in VIOLET
ATS / Seabery	Spain	Technology company (XR / training)	WP2 Lead – I/EWE Desk Research
EWF	European level	Federation – Normative body	European perspective on I/EWE
L-USIT	Poland	Technology institute / ANB	National profile Poland
ISQe	Portugal	Digital Learning Organisation	Digital Learning and VR development
ASR	Romania	Welding association / ANB	National profile Romania
IZV	Slovenia	Welding institute	National profile Slovenia

📌 ATS/Seabery (Spain) leads WP2 and is responsible for the coordination, synthesis and drafting of D2.1. Seabery is the developer of Soldamatic, the AR tool for welding training most widely used in the consortium.

1.2 Work Package 2: Scope and Objectives

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WP2 aims to generate the knowledge base needed for the design of the project's XR resources. It is structured around two main tasks:

- T2.1 — Desk Research on XR Tools Applicable to I/EWE Training: analysis of the state of the art of XR technologies in the field of welding engineer training, including mapping of the existing tool ecosystem, training needs and adoption barriers. Lead: ATS.
- T2.2 — Stakeholder Survey: survey of trainers, training centres and I/EWE professionals to validate and enrich the desk research findings. Lead: ASR.

This document, D2.1, presents the results of T2.1 and serves as the basis for the design of T2.2 (stakeholder questionnaire) and for the content development phases of WP3 and WP4.

1.3 Report Structure

The report is organised in the following sections:

- Sections 1–2: Introduction, context and methodology.
- Section 3: Conceptual framework (I/EWE profile, task areas, XR technologies).
- Section 4: National profiles by contributing country.
- Section 5: Cross-sectional analysis of I/EWE programmes.
- Section 6: XR tools landscape for welding training.
- Section 7: Training needs analysis and XR potential by area.
- Section 8: Barriers and enablers for XR adoption.
- Section 9: Conclusions and recommendations for T2.2 and WP3.
- Annexes: National Fact Sheets by partner.

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2. Methodology

2.1 Approach and Design

The desk research was conducted using a mixed-methods approach that combines:

- Primary information gathering: each partner completed a structured questionnaire (Annex A — National Fact Sheet) between March and April 2026, covering the national I/EWE programme profile, current use of digital/XR tools, barriers and enablers, and areas of greatest XR application potential.
- Secondary source review: normative documents (EWF-409, IIW/ISO 14731), academic and technical publications on XR in welding and industrial engineering training, commercial tool databases, related European projects (DIGIWELD, DIGIGREEN, DIGIMAN, IQSIM, IQMET, VRoad, VRTrainingIndustry 4.0).
- Synthesis and comparative analysis: integration of data from all partners to identify patterns, convergences and divergences at the European level.
- XR tools market benchmarking: review and comparative analysis of more than 30 commercial XR tools applicable to welding and industrial engineering training, together with 10 related European projects, to contextualize the partners' findings in the global XR innovation landscape. This source complements and enriches the analyses in Sections 6, 7, 8 and 9 of this report.

2.2 Contributing Partners and Sources

Contributions have been received from the following partners:

Partner	Country	Organisation	Responsible
L-USIT	Poland	Łukasiewicz – Upper Silesian Institute of Technology	Marek Dragan
ISQe	Portugal	ISQ e-learning, S.A.	Maria Moreira
ASR	Romania	ASR – Asociatia de Sudura din Romania	Monica Bratu / Mircea Visescu
EWF	Europe	European Welding Federation	Marina Baptista

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Partner	Country	Organisation	Responsible
IZV	Slovenia	IZV – Institut za varilstvo	Vital Uran

2.3 Limitations

- Data for some countries (particularly Portugal) are partly estimates based on public sources, as updated official figures are not available.
- The Annexes (National Fact Sheets) contain analyses provided directly by project participants in their respective national contexts. However, the curricular frameworks, barriers and opportunities identified have broader applicability and have been contrasted with the situation in other European countries with active EWF/IIW systems, using as a complementary source the information from European projects identified in the market benchmarking (Section 6.2).
- The XR tools analysis in Section 6 is the result of systematic benchmarking of the global market, not limited to the partners' prior knowledge. However, it does not imply exhaustive and direct knowledge of all the products analysed: the information is based on interpretation of public documentation, demonstrations, technical data sheets and available academic publications. Price data and specific functionalities must be verified directly with providers before making acquisition decisions.

3. Conceptual Framework

3.1 The I/EWE Profile: Definition and Regulatory Framework

The International/European Welding Engineer (I/EWE) represents the highest qualification level in welding personnel certification system of EWF (European Welding Federation) and IIW (International Institute of Welding). I/EWE role is defined and regulated through the following key normative documents:

- ISO 14731 — Welding coordination: Tasks and responsibilities. Defines the welding coordination responsibilities assignable to the I/EWE.
- EWF-409 / IAB-252 — Guidelines for the I/EWE training plan. Establishes the mandatory minimum curricular content (448 hours).
- ISO 3834 — Quality requirements for fusion welding. Quality management framework within which the I/EWE operates in the production environment.

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- Applicable product standards: EN 1090 (steel structures), EN 13445 (pressure vessels), EN 15085 (railway welding), SR EN ISO 15614, among others.

The I/EWE training plan according to EWF-409 is structured into four main blocks totalling a minimum of 448 hours of directed training, plus supervised practice and final assessment. The following table summarises the curricular blocks, knowledge areas and their correspondence with ISO 14731 task areas:

Block	Name/Title	Hours aprox.	I/EWE Task Areas (T)
A	Natural Sciences and Materials	~100 h	T1, T2
B	Manufacturing Engineering	~200 h	T2, T3, T4, T5
C	Fabrication and Applications	~100 h	T3, T6, T7
D	Construction, Safety and Management	~48 h+	T1, T4, T8, T9

📌 Source: EWF-409 / IAB-252 (Guidelines for the Training, Examination and Qualification of Welding Personnel). Hours indicated correspond to EWF minima; national programmes may extend them (Portugal: 498 h; Slovenia: 441 h). The 'XR Potential in VIOLET' column anticipates the correspondence with the four VIOLET XR modules defined in Section 7.

3.2 I/EWE Task Areas (Taxonomy)

The I/EWE responsibility areas, according to ISO 14731 and EWF-409, and validated by all consortium partners, are structured into nine main categories:

#	Área de tarea I/EWE (ISO 14731 / EWF-409)	Prioridad consensual	Difficulty traditional training	XR Potential
1	Review of technical requirements for welded products	High	Medium-High	Visualisation / MR
2	Selection of base materials and consumables	High	Medium	Visualisation

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#	Área de tarea I/EWE (ISO 14731 / EWF-409)	Prioridad consensual	Difficulty traditional training	XR Potential
3	Determination of welding procedures (WPS / PQR)	★ Very High	★ High	Simulation + Assessment
4	Qualification of welding personnel	High	Medium	Simulation + Assessment
5	Pre- and post-weld heat treatment (PWHT)	Medium-High	★ High	Animated Visualisation
6	Inspection and testing of welded joints (NDT / DT)	★ Very High	★ High	Visualisation + Simulation
7	Non-conformities and corrective actions	★ Very High	High	Decision Simulation
8	Safety, health and environment in welding	High	★ High	Immersive Simulation
9	Subcontracting of welding operations	Medium	Medium	Interactive Workflows

📌 Areas marked with ★ represent the greatest consensus among partners as priorities for the design of XR modules in VIOLET (WPS/PQR, Inspection/NDT, Non-conformities and Safety).

3.3 XR Technologies: Definitions and Taxonomy

3.3.1 Virtual Reality (VR)

Fully digital environments that replace physical reality. The user is immersed in a simulated space via VR headset. In the I/EWE context, VR enables:

- Simulation of hazardous industrial environments without real risk.
- Decision-making scenarios in non-conformity situations.
- Safety audits in virtual workshops.

3.3.2 Augmented Reality (AR)

Overlay of digital information (graphics, data, instructions) on the real physical environment. Accessible via tablets, smartphones or AR glasses. Key applications for I/EWE:

- In-situ visualisation of welding symbols, WPS and parameters on the physical workpiece.
- Step-by-step procedure support in inspection.
- Training in defect recognition on real samples.

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3.3.3 Mixed Reality (MR)

Combination of VR and AR: virtual objects interact with the physical environment. MR enables the spatial anchoring of 3D content onto the real space, particularly useful for the review of technical specifications and the analysis of welded structures.

3.3.4 Industrial Simulation (XR-adjacent)

Process simulation tools (such as Sysweld) that, while not XR in the strict sense, offer advanced visualisation capabilities relevant to the I/EWE in the areas of WPS and PWHT.

4. National Profiles of I/EWE Programmes

This section presents the characterisation of national I/EWE training and certification systems provided by each partner. The profiles are presented in a structured format to facilitate the subsequent comparison in Section 5.

4.1 Poland — Łukasiewicz–USIT (L-USIT)

Key data for the I/EWE programme in Poland

ANB: Łukasiewicz – Górnośląski Instytut Technologiczny, Ośrodek Certyfikacji
Active providers: 7 (L-USIT + 6 technical universities)
Candidates/year: ~120 (at L-USIT)
Active certified IWEs: 3.866 (141 en 2025)
Duration: 448 hours (including 60 h de practice)
Format: Face-to-face only
Examination: Test + examen oral

4.1.1 Task Areas and Training Priorities

L-USIT validates all ISO 14731 task areas as of high importance. The three priority areas identified are:

- 1st: Review of technical requirements — "basic competencies, crucial for the design and construction of every welded structure".
- 2nd: Determination of WPS/PQR — "mandatory documentation for the validation of welding processes".
- 3rd: Personnel qualification — "confirmation of current qualification and competency requirements".

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4.1.2 Current Use of Digital/XR Tools

L-USIT currently uses no digital tools beyond PDF materials. There is no LMS, online assessment tools or XR integrated into the I/EWE programme. They are familiar with Soldamatic, VRTEX360 and Sysweld through occasional demonstrations.

4.1.3 Main Barriers and Enablers

- Barriers: time to adapt to new tools (trainers and students), investment costs, resistance to change.
- Enablers: access to external funding (grants), trainer training, and reduction of course costs

4.2 Romania — ASR

Key data for the I/EWE programme in Romania

ANB: ASR – Asociatia de Sudura din Romania

Active providers: 1

Candidates/year: ~50

Active IWEs: ~750

Duration: 448 hours / 4 months

Format: Blended (40% Webex + 60% self-study en Moodle)

Examination: Multiple choice tests + oral examination

4.2.1 Task Areas and Training Priorities

ASR validates all 9 areas with High importance, and incorporates additional areas related to specific product standards (EN 1090, ISO 3834, SR EN ISO 15614) and documentation traceability. The three priority areas are:

- 1ª: WPS/PQR.
- 2nd: Inspection/NDT.
- 3ª: Selection of base materials and consumables.

4.2.2 Current Use of Digital/XR Tools

ASR uses Moodle with interactive modules, videos and quizzes. It has experience with XR through demonstration videos of the practical component. Three commercial XR tools are available in the

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Romanian market: Soldamatic (distributors FLX PRO WELD / Techno Volt), VRTEX360 (DUCTIL) and Fronius Virtual Welding (CMMETAL). Very few centres have access to them due to the high cost.

4.2.3 Relevant European Projects

ASR highlights three European projects with direct relevance for VIOLET: DIGIWELD (digital training for welding VET, IAB curricular update), DIGIGREEN (green digital manufacturing) and DIGIMAN (programme in digital manufacturing / Industry 4.0).

4.2.4 Main Barriers and Enablers

- Barriers: high initial cost (only 5-6 centres in Romania have simulators), limited XR infrastructure, lack of I/EWE-specific scenarios.
- Enablers: EU funds (PNRR, Erasmus+), industry alliances (Comelf Bistrita), existing digital base.

4.3 Slovenia — IZV

Key data for the I/EWE programme in Slovenia

ANB: SDVT

Active providers: 1

Candidates/year: ~85

Active IWEs: 927

Duration: 441 hours (~6 months). Estructura: 245 h Moodle self-study + 101 h online classes (Zoom) + 35 h lab + 60 h practices face-to-face.

Format: Blended (Moodle + Zoom + face-to-face)

Examination: Written exam (Moodle/SEB) + oral exam (Zoom o face-to-face)

4.3.1 Task Areas and Training Priorities

IZV adds additional areas: implementation of product standards (EN 1090, railway standards) and documentation traceability. The three priority areas are:

- 1st: Review of technical requirements.
- 2ª: Qualification of welding personnel (“a legal requirement and a fundamental element of quality and safety”).
- 3rd: Inspection/NDT.

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4.3.2 Current Use of Digital/XR Tools

IZV has the most digitalised I/EWE programme in the consortium: customised Moodle LMS with interactive quizzes, videos and animations, online examinations with Safe Exam Browser, and already uses Soldamatic (AR) and COBOT simulations in the I/EWE programme. It also participated in IQSIM and currently participates in IQMET.

4.3.3 Main Barriers and Enablers

- Barriers: cost/ROI with a single simulator per group, long-term technological obsolescence, scarcity of I/EWE-specific scenarios.
- Enablers: external funding, reduction of consumable costs, training under safe conditions.

4.4 Situation in Portugal

In Portugal, the I/EWE programme is delivered by ANB-ISQ — Instituto de Soldadura e Qualidade, which is an approved ATB for I/EWE training in the country. The programme has a relatively small annual intake, estimated at around 9 candidates per year, based on historical data of 261 diplomas issued since 1992.

The current programme has a duration of 498 hours, delivered over approximately 21 months, and follows a blended format: theoretical sessions are delivered online in real time, while practical components take place face-to-face in Oeiras and Vila Nova de Gaia. Assessment is carried out face-to-face through modular written and oral examinations.

From the Portuguese perspective, the priority areas for I/EWE training are:

1. WPS/PQR, as it connects materials, processes, parameters, quality, regulatory compliance and manufacturability.
2. Inspection/NDT, because I/EWEs need to understand what to inspect, why, when and how to interpret results.
3. Non-conformities and corrective actions, as this develops the I/EWE's decision-making role in defect diagnosis and resolution.

The programme already uses digital tools such as Moodle, Zoom, digital materials and practical cases, but XR is not yet reported to be integrated into the I/EWE qualification. However, Portugal has relevant experience in industrial XR and welding simulation, including ISQ's own VR/AR welding simulator for operator training and other national XR initiatives.

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The main barriers are the lack of I/EWE-specific XR content, the cost/ROI of XR implementation in a relatively small market, and the need for instructor training. The main enablers are the existing blended-learning structure, national experience with welding-related XR, and the fact that the Portuguese I/EWE system is concentrated around one ANB, which may facilitate piloting.

4.5 European Perspective — EWF

The EWF (European Welding Federation) has contributed with a supranational perspective. As the body governing the EWF/IIW qualification system at the European level (over 40 countries), its contribution does not respond to a specific national context but to the shared reference framework.

The EWF validates all task areas with High importance from a European perspective and proposes an innovative concept: the Integrated XR Case Study as a common thread throughout the entire I/EWE itinerary (Modules 1 to 4). This XR workflow would include:

- Materials Procurement and Validation Module: virtual warehouse, inspection certificate verification.
- Design and Engineering Module: 3D structural model, joint geometry and process selection, WPS development.
- Virtual Inspection and Decision-Making Module: 3D weld beads with stochastic imperfections, visual inspection and fitness-for-service decision.
- SHE and Audit Module: safety audit in virtual workshop with identification of non-conformities in real time.

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5. Cross-Sectional Analysis of I/EWE Programmes

5.1 Comparison of National Systems

Country / Org.	ANB	Candidates/year	Active IWEs	Hours / Duration	Format
Poland (L-USIT)	L-USIT Cert.	120	3.866	448 h / 12 months	Face-to-face
Romania (ASR)	ASR	50	750	448 h / 4 months	Blended (Webex + Moodle)
Slovenia (IZV)	SDVT	85	927	441 h / ~6 months	Blended (Moodle + Zoom)
Portugal (general context)	ISQ	9	261	498 h / ~21 months	Blended
EWF	—	—	—	—	European perspective

5.2 Identified Convergences

The comparative analysis reveals the following convergences among consortium countries:

- Common curricular framework: all programmes are based on EWF-409/ISO 14731, with a range of 441–498 hours and the same knowledge modules.
- Trend towards digitalisation and blended learning: 3 out of 4 countries (PT, RO, SI) already operate in blended format; PL is the exception, although it acknowledges the need for modernisation.
- Aligned training priorities: WPS/PQR, Inspection/NDT and Non-conformances are the top-3 areas in virtually all partners.
- Recognition of the XR content gap for I/EWE: all partners identify that current simulators are oriented towards the welder/operator and do not cover the coordination and engineering tasks specific to the I/EWE.
- Presence of Soldamatic in the consortium: mentioned in PL, PT, RO and SI, being the only XR welding product with multi-country presence in the consortium.

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5.3 National Divergences and Specificities

- System scale: from ~9 candidates/year in PT to 120 in PL, which implies very different ROI models for XR investment.
- Digital maturity: IZV (SI) leads by a wide margin in the integration of digital and XR tools; PL starts from a fully face-to-face model.
- Regulatory context: RO incorporates references to specific SR EN standards; PT highlights the role of ISQ as sole provider and ANB.
- Additional task specifications: PT (documentation and traceability in the quality chain), RO (manufacturing supervision and coordination), SI (product and railway standards).

6. XR Market Landscape for Welding and Engineering Training

This section presents the initial tool inventory, incorporating a systematic analysis of the global market of simulators and XR platforms relevant for the training of European Welding Engineers (I/EWE). The analysis is structured in five blocks:

- 6.1 — VR/AR welding simulators oriented to execution (operator/welder level).
- 6.2 — XR tools for inspection and non-destructive testing (NDT).
- 6.3 — XR platforms for industrial safety training (SHE/HSE).
- 6.4 — XR tools for procedure support and engineering decision-making.
- 6.5 — European projects with XR component relevant for I/EWE.
- 6.6 — Coverage map: tools × I/EWE task areas.
- 6.7 — Conclusions: gaps and opportunities for VIOLET.

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Tools have been classified according to their main orientation: operator/welder (process execution) vs. engineer/coordinator (decision making, procedures, inspection). This distinction is critical for VIOLET, as the lack of tools specifically designed for the I/EWE level is the main finding of the review.

I/EWE GAP level: ● High (operator-oriented tools, minimal transfer to I/EWE) | ●● Medium (partial coverage of I/EWE tasks) | ●●● Low (real potential for I/EWE tasks without major adaptations).

6.1 VR/AR Welding Simulators — Operator/Welder Level

VR/AR welding simulators are the most mature segment of the market. All tools in this group share a common profile: they are designed to develop the welder's psychomotor skill (torch angle, travel speed, arc distance), with real-time feedback on execution parameters. Their value for the I/EWE is limited but exists in some specific tasks.

Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
Soldamatic	Seabery / Spain	AR	Welder / Operador (I/EWE: parcial)	to be confirmed with provider	T3 partial, T4, T8	Execution-oriented. The theory module and LMS are the bridge to I/EWE.
VRTEX 360 / 360+ (Lincoln Electric)	Lincoln Electric / USA	VR	Welder / Operador	to be confirmed with provider	T3 partial, T4, T8	Rich feedback but only on execution. No engineering modules.
Fronius Virtual Welding (Welducation)	Fronius / Austria	VR + AR	(I/EWE: parcial)	to be confirmed with provider	T3 partial, T4, T5,T8	Welducation Campus includes theory and tests.
Miller AugmentedArc / MobileArc	Miller Welds / USA	AR	Welder / VET	to be confirmed with provider	T3 partial, T8	Exclusive focus on arc skill. No engineering content.
WeldVR	WeldVR / Internacional	VR	Welder / VET	to be confirmed	T4 partial, T8	Scoring system and tracking, but

Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
				with provider		only for execution.
Diginvision	Dig In Vision / Poland	VR	(also engineering)	to be confirmed with provider	T3 partial, T8	Includes ergonomic accessibility analysis for engineers. MIG/MAG.
REDWELD (QuakeLogic / WS200)	QuakeLogic / USA	VR + AR	Welder / VET	to be confirmed with provider	T3 partial, T4, T8	Basic defect detection and visualization. Exportable PDF reports.
Simbott AR / VR / MR (Welding)	Simbott / India–USA	AR + VR + MR		to be confirmed with provider	T3 partial, T4, T6, T8	Defect integration and MR. Most advanced in group for quality analysis.
guideWELD VR (Realityworks)	Realityworks / USA	VR		to be confirmed with provider	T3 partial, T8	Oriented towards secondary/VET education. No engineering content.
OcuWeld	OcuWeld / USA	VR	Welder / VET	to be confirmed with provider	T8	Basic skills training. No I/EWE modules.

📌 Block conclusion: No tool in this group is designed for the coordination and engineering responsibilities of the I/EWE. However, Soldamatic, Fronius Welducation, Simbott MR and Diginvision are the closest and could serve as design references for VIOLET modules.

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6.2 XR Tools for Inspection and Non-Destructive Testing (NDT)

This is the segment with the greatest immediate potential for the I/EWE profile. Inspection and NDT is the task area with the greatest difficulty for traditional training and the second highest XR potential according to all consortium partners.

Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
TraiNDE UT (Extende / CEA-List)	Extende / France (spinoff CEA-List)	Simulation + VR	NDT Inspector (Level 2/3) I/EWE: high potential	to be confirmed with provider	T6 ●●●, T4 ●, T7 ◑	●●● Low gap Ultrasonic simulator with real defect bank. Used by nuclear industry, aeronautical, oil & gas. Highly applicable a inspection of welds.
TraiNDE RT (Extende / CEA-List)	Extende / France	Simulation + VR	NTD Inspector RT I/EWE: high potential	to be confirmed with provider	T6 ●●●, T4 ●	●●● Low gap Industrial radiography simulator. RT film database. Applicable to defect interpretation in welding according to EN ISO 17636.
CIVA NDT Software (CEA-List)	CEA-List / France	Advance simulation	Inspector / Engineer NDT	to be confirmed with provider >300 companies	T6 ●●●, T3 ◑, T5 ◑	●● Medium gap World reference NDT simulation software (UT, ET, RT). Not immersive XR but High-value predictive simulation for senior I/EWE staff.
Simbott NDT MR (HoloLens 2)	Simbott / India–USA	MR (HoloLens 2)	I/EWE: potential	to be confirmed with provider	T6 ●●, T8 ●	●● Medium gap MR for inspection procedure guidance. Overlay of acceptance criteria on the actual workpiece. Potential for I/EWE training in NDT.
AR weld inspection (research Univ.)	Multiple groups investing EU / Asia	AR	Inspector / Engineer (research prototype)	to be confirmed with provider	T1 ●, T6 ●●●, T7 ◑	●● Medium gap AR systems for weld defect visualisation (overlay of ISO 5817 criteria). Published in

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Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
						MDPI 2023.Still no stable commercial product.
NOS Augmented Worker (the Portuguese case)	NOS / Portugal	AR	Technician / Industrial Operator (on-site support)	Enterprise (NOS)	T1 ●, T6 ●●, T8 ●	●● Medium gap AR support for inspection/maintenance procedure on real workpiece. Not a training tool but a support tool in production. Relevant as a model.

📌 TraiNDE (Extende/CEA-List) is the most directly applicable tool for the I/EWE profile in the NDT inspection area.

Key finding for VIOLET — END/NDT

There is an ecosystem of high-quality NDT simulators (TraiNDE UT, TraiNDE RT, CIVA) used by the nuclear, aerospace and oil & gas industries, which has NOT yet been transferred to I/EWE training in welding.

I/EWE personnel do not need to be certified NDT inspectors, but they do need to understand the inspection methods, criteria and results in order to make coordination decisions.

An XR module on 'virtual weld inspection' for VIOLET could be based on TraiNDE technology adapted to the I/EWE context (ISO 5817, EN ISO 17637 and EN ISO 17636 criteria).

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6.3 XR Platforms for Industrial Safety Training (SHE/HSE)

Safety, health and the environment in welding (T8) is the task area with the greatest potential for immersive simulation, given that the most relevant scenarios — confined spaces, radiation, toxic fumes, electrical risk — cannot be reproduced safely in the classroom. There is a developed market of VR platforms for industrial HSE.

Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
Immersive Factory	Immersive Factory / France	VR	Technician / Industrial operator	SaaS / Enterprise	T8 ●●●, T7 ◑	Leading platform for industrial HSE VR. Catalogue of >100 safety modules (chemical, electrical, ork at height, confined spaces). Suitable for welding workshop.
PIXO VR (Manufacturing Safety)	PIXO VR / USA	VR	Technician / Industrial operator	SaaS (enterprise)	T8 ●●●, T7 ◑	Platform de training VR para manufacturing con modules de safety OSHA Customised scenario creation.
Core EHS AR/VR	Core EHS / USA	VR + AR	HSE Managers / Technicians	to be confirmed with provider	T8 ●●●, T7 ◑	Tools AR/VR para hazard identification y training in industrial emergencies.
Proven Reality (Safety VR)	Proven Reality / Germany	VR	Technician / Industrial operator I/EWE: part-time	to be confirmed with provider	T8 ●●●	Manufacturing risk scenarios. No specific welding coordination content.

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Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
VRoad (Fund. Lab. Construc.)	Fund. Laboral Construc. ESP / CENFIC POR	VR	Construction technician / operator	Erasmus+ (free access)	T8 ●●●	VR for safety in road construction. Design model for a welding SHE module.
SMARTLab (AR lab safety)		AR	Laboratory students	to be confirmed with provider	T8 ●●	AR system for laboratory safety training. Validated in the journal Frontiers 2024. Adaptable for use in welding workshops.

📌 Immersive Factory and PIXO VR are SaaS platforms on which specific SHE scenarios for the I/EWE welding workshop could potentially be developed. They are faster to implement than developing from scratch.

6.4 XR Tools for Procedures, Decisions and Engineering

This is the most relevant and least covered segment for the I/EWE profile. The tools in this group enable training in complex decision-making processes, document management and technical coordination, which are the core of the welding engineer's competence.

Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
INESC TEC VRTrainingIndustry 4.0	INESC TEC / Portugal	VR	Technician / Industrial Engineer	to be confirmed with provider	T1 ●, T4 ●, T6 ●, T7 ●, T8 ●, T9 ●	Authoring platform for immersive industrial technical training. Enables the creation of procedure scenarios without ongoing

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Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
						IT support. Used in wind turbine maintenance. Highly adaptable to I/EWE tasks.
Matterport + Digital Twin (Connected Workers)	Matterport / Treedis / USA	MR	(Engineer / Technician (production support)	to be confirmed with provider	T1 ●, T6 ●, T7 ◑, T8 ◑	Digital twins of plants with real-time sensor data. Shown at Hannover Messe 2024. More production support than training, but potential for I/EWE.
CMU AR Welding Trainer (ML + XR)	Carnegie Mellon Univ. / USA	AR + ML	Advanced welder / I/EWE (research)	to be confirmed with provider	T3 ●●, T6 ●, T7 ◑	AR + Machine Learning system for welding training (2024). Real-time defect analysis using ML. Potential for VIOLET's NDT/WPS module.
guideWELD 27 WPS (Realityworks)	Realityworks / USA	VR	Welder / Technician	to be confirmed with provider	T3 ●●	Includes 27 pre-configured WPS for MIG and SMAW. The only execution simulator with explicit WPS. Limited to process parameters, not engineering decisions.
WeldEye (Kemppi)	Kemppi / Finlandia	Digital (no XR)	I/EWE / Coordinator	SaaS industrial	T3 ●●●, T4 ●, T7 ●, T9 ●	Digital welding management system (WPS, qualifications,

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Tool	Provider / Country	Technology	User level target	Approx. price	Applicable I/EWE areas	GAP for I/EWE
						traceability). Reference for design scenarios.
Sysweld (ESI Group)	ESI Group / Francia		(I/EWE senior / research)	Professional license	T3 ●●, T5 ●●●	High-fidelity process simulation and PWHT. Too complex for general I/EWE training, but excellent for the advanced PWHT module.
IQSIM (Noruega / Stimuli2)	Stimuli2 / Noruega		I/EWE / Technician	Erasmus+ / VET	T2 ◑, T3 ●●	Simulation of welding costs and times using different joint designs. Web-based tool for training in WPS efficiency. Used at SI (IZV).

Strategic finding for ATS — Engineer-level tools

WeldEye (Kemppi) is the digital tool that best meets the functional requirements of the I/EWE, although it is NOT XR. Its management architecture (WPS, qualifications, traceability) is exactly the type of process that should be simulated in an XR environment for I/EWE training.

VRTrainingIndustry 4.0 (INESC TEC) is the XR architecture model most readily transferable to the VIOLET project: it enables trainers to create and adapt technical scenarios without the need for continuous IT support.

Carnegie Mellon's AR + ML system (2024) points to the future: automatic weld quality analysis using augmented reality. Relevant to the VIOLET NDT module.

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6.5 European Projects with XR Component relevant for I/EWE

The following table lists the most relevant European projects identified during the desk research, including projects funded by Erasmus+, Horizon Europe and Leonardo/KA2 programmes. Both projects directly related to welding and projects on XR in industrial technical training have been included, for their value as design models and possible synergies.

Project	EU Programme	Lead Consortium
DIGIWELD (Erasmus+ KA2)	**Erasmus+ KA220-VET**	**ASR (RO), EWF, CESOL (ES), IIS (IT), ATS (ES), Col. Técnico (RO)**
VIOLET (current project)	**Erasmus+ KA220-VET**	**ATS/Seabery (ES), EWF, L-USIT (PL), ISQe (PT), ASR (RO), IZV (SI)**
IQSIM / iQSim2 (Stimuli2/Erasmus+)	**Erasmus+ Leonardo / KA2**	**Stimuli2 (NO), IZV (SI), socios HU, RO, SE**
IQMET (Stimuli2/Erasmus+)	**Erasmus+ KA2**	**Stimuli2 (NO), IZV (SI), socios SI, RO, HU**
WELDIFY (EIT Manufacturing + Erasmus+)	**EIT Manufacturing + Erasmus+**	**13 countries: universities, NGOs, industry associations (large consortium)**
XR2Learn (Horizon Europe)	**Horizon Europe (101092851)**	**CNIT (IT), F6S, MAG, SYN, LS, UM, HOU, EADTU, EITM CLC South, SUPSI**
Alliance4XR (Erasmus+)	**Erasmus+ (KA2/HE)**	**European institutions in the fields of engineering, energy and nautical science**
DIGIGREEN (Erasmus+)	**Erasmus+ KA220-VET**	**The consortium includes ASR (RO) and partners from more than four countries**
DIGIMAN (Erasmus+)	**Erasmus+ KA220-VET**	**European multi-sector consortium**
VRTrainingIndustry 4.0 (INESC TEC)	**I+D Nacional + EU**	**INESC TEC (PT), industrial partners PT**

📌 The WELDIFY project and the XR2Learn hub are the European projects with the greatest synergy potential with VIOLET.

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6.6 Coverage Map: XR Tools × I/EWE Task Areas

The following table maps each identified tool against the nine I/EWE task areas (ISO 14731 / EWF-409), indicating the coverage potential:

● High direct potential, ◑ Partial potential / with adaptation ○ No relevant coverage for I/EWE

Tool	Tech.req.	T2 Materials	T3 WPS/PQR	T4 Qualific.	T5 PWHT	T6 NDT/END	T7 NC/ACC	T8 SHE	T9 Subcont.
Soldamatic (Seabery/ATS)	○	●	●	●	○	◑	○	●	○
VRTEX 360 (Lincoln Electric)	○	◑	◑	●	○	◑	○	●	○
Fronius Virtual Welding	○	◑	●	●	○	◑	○	●	○
WeldVR	○	○	○	◑	○	○	○	●	○
Diginvision	○	○	○	◑	○	○	○	◑	○
REDWELD (QuakeLogic)	○	◑	◑	●	○	◑	○	●	○
Miller AugmentedArc	○	○	◑	◑	○	○	○	●	○
TraiNDE UT/RT (Extende/CEA)	◑	○	○	●	○	●	◑	◑	○
Immersive Factory VR Safety	○	○	○	○	○	○	◑	●	○
Simbott MR	○	◑	◑	●	○	●	◑	●	○
INESC TEC VRTrainingIndustry	●	○	◑	●	○	●	●	●	●
NOS Augmented Worker	●	○	○	○	○	●	◑	●	◑

📌 Areas T3 (WPS/PQR), T6 (NDT), T7 (Non-conformances) and T8 (SHE) have the highest XR coverage potential, but require engineering tools that currently do not exist as a market product targeted at the I/EWE.

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6.7 Conclusions: Gaps, Opportunities and Recommendations

6.7.1 Gaps Identified

GAP 1 — Lack of XR tools designed for reasoning level I/EWE

All commercial welding simulation tools (Soldamatic, VRTEX360, Fronius, WeldVR, etc.) are designed to develop the welder's psychomotor skills: torch angle, speed and position.

No commercial tool available in 2026 addresses the specific competencies of the I/EWE: root cause analysis of defects, decision-making regarding WPS under complex conditions, inspection planning, non-conformity management or coordination of subcontractors.

This gap is not trivial: it requires a specific pedagogical design, engineering scenarios based on real-world cases, and simulation technology with greater branching complexity than arc simulators.

GAP 2 — Industrial simulation NDT technology has not yet been incorporated into I/EWE training

High-quality non-destructive testing (NDT) simulators used in the nuclear, aerospace and oil and gas sectors (TraiNDE UT/RT, CIVA) which precisely cover the skills required by the I/EWE in the field of weld inspection.

None of these systems has been adapted or tailored to the I/EWE training market. The content exists; what is missing is the pedagogical link.

GAP 3 — The existing SHE/HSE modules are not specific to welding workshops

VR industrial safety platforms (Immersive Factory, PIXO VR) offer generic manufacturing scenarios.

There is no VR-specific security audit module for welding workshops that covers the risks specific to I/EWE: welding fumes, UV/IR radiation, electrical hazards from welding equipment, gas handling and PWHT.

6.7.2 Recommendations for WP3 — Module Development

Module 1 (WPS/PQR): Develop from Soldamatic's technological base + inspiration from WeldEye (Kemppi) for the document management and parameter validation component. Fronius Welducation Campus provides a reference for the theory-plus-practice modular structure.

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- Module 2 (NDT/Inspection): Explore collaboration with Extende/CEA-List to adapt TraiNDE to the I/EWE context. The technology is production-ready; the gap is in pedagogical adaptation.

- Module 3 (Non-conformances): Design decision simulation scenarios based on real cases provided by partners (non-conformance reports, corrective actions). WeldEye (Kemppi) provides a reference for the technical documentation component.

- Module 4 (SHE): Evaluate Immersive Factory or PIXO VR as a base platform to develop welding workshop-specific SHE scenarios for the I/EWE role. The SaaS model avoids in-house VR development.

- Authoring architecture: Consider the VRTrainingIndustry 4.0 model (INESC TEC) to allow ATBs to adapt scenarios to their national standards and industry cases, without continuous specialist technical support.

- EU project synergies: Establish formal contact with WELDIFY (EIT Manufacturing) and XR2Learn (Horizon Europe) to explore reuse of content and methodological frameworks.

Section 6 References

Tools and providers:

- Soldamatic / Seabery: https://seaberyat.com/en/soldamatic/
- Lincoln Electric VRTEX: https://www.lincolnelectric.com/en/education
- Fronius Virtual Welding / Welducation: https://www.fronius.com/en/welding-technology/innovative-solutions/welducation-simulator
- Miller AugmentedArc: https://www.millerwelds.com/products/augmented-reality
- WeldVR: https://weldvr.com/
- Diginvision: https://www.diginvision.com/
- REDWELD (QuakeLogic): https://products.quakelogic.net/product/ql-redweld-ws200-welding-simulator/
- Simbott MR: https://simbott.com/welding-simulator/
- TraiNDE / CIVA (Extende): https://www.extende.com/civa-ndt-simulation-software/
- Immersive Factory: https://immersivefactory.com
- INESC TEC VRTrainingIndustry: [referencia interna – ISQe National Fact Sheet]
- WeldEye (Kemppi): https://weldindustry.com/manage-your-weld-project-digitally/
- Carnegie Mellon AR Welding + ML (2024): https://engineering.cmu.edu/news-events/news/2024/04/12-training-welders.html
- AR for weld inspection (MDPI 2023): https://www.mdpi.com/2076-3417/13/21/11655

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- VR welding training Industry 5.0 (MDPI 2025): https://www.mdpi.com/2079-9292/14/10/1964

European projects:

- WELDIFY: https://weldify.eu/
- XR2Learn: https://xr2learn.eu/
- Alliance4XR: https://alliance4xr.eu/
- iQSim2 / iQMET: https://stimuli2.no/project/iqsim2
- DIGIWELD: https://digiweld.eu/
- Alliance4XR D1.1 (XR state of the art): https://alliance4xr.eu/wp-content/uploads/2024/09/Alliance4XR_D11.pdf

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7. Training Needs Analysis and XR Module Design

This section integrates the results of two complementary sources: (a) the training needs identified by partners through the National Fact Sheets (Sections 4-5), and (b) the analysis of the global market of XR tools and European projects (Section 6). The cross-referencing of both sources enables a transition from a description of needs to an informed design of VIOLET's XR modules, with references to existing technology, architectural models and lessons learned in other European projects.

7.1 Training Needs Map by Task Area — Enriched with Market Perspective

The following table consolidates, for each I/EWE task area, the training difficulty (according to partners), the XR potential and — now — the availability of reference technology in the market:

I/EWE Task Area	Challenges of traditional training (partners)	Most appropriate XR type	Priority by consensus	Market-leading technology (from Section 6)
T3 — WPS / PQR	★★★ High Parameter-material-quality interaction incomprehensible in static form.	Simulation + 3D visualisation + Branch-based evaluation	★★★ Very High	Fronius Welducation (closest in market); WeldEye/Kemppi (functional reference); guideWELD 27 WPS (database). None cover engineering decision-making → in-house development necessary.
T6 — Inspection / END	★★★ High Defects, morphology and acceptance criteria not transmissible without visualization.	3D visualisation of defects + Inspection simulation + Evaluation	★★★ Very High	TraiNDE UT/RT (Extende/CEA-List): industrial-grade NDT simulator. Adaptation to I/EWE context is the most efficient path — explore collaboration or licensing.
T7 — Non-conformities	★★★ High Complex failure scenarios, root causes, decision	Branching decision simulation + Evaluation	★★★ Very High	No direct commercial tool. ASR practical cases (chapter 4.12) are content base. Architecture: VRTrainingIndustry 4.0

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I/EWE Task Area	Challenges of traditional training (partners)	Most appropriate XR type	Priority by consensus	Market-leading technology (from Section 6)
	paths rarely reproducible.			(INESC TEC) as authoring model.
T8 — SHE in welding	★★★ High Fumes, electricity, confined spaces, UV/IR: reproduction in classroom impossible.	Immersive simulation VR + Auditoría interactiva	★★★ Very High	Immersive Factory / PIXO VR (mature SaaS platforms). Build-on-top option: develop welding workshop scenarios on existing platform. Reduces 60-70% development cost.
T5 — PWHT	★★ Medium-High Thermal cycle and metallurgical effects not transmissible with static explanation.	Dynamic animated visualisation + Parametric simulation	★★ High	Sysweld (ESI Group): very high-fidelity process simulation. Too complex for generalist training → create simplified visualization inspired by Sysweld.
T1 — Technical's Requisite	★★ Medium Little real exposure to documentation packages and regulatory interoperability.	Visualization MR + documentation overlay	★★ High	NOS Augmented Worker (plant AR document support model). CMU AR+ML 2024 (real-time overlay). Concepts adaptable to WPS/specification review.
T4 — Personal qualifications	★ Medium Difficult without real production context showing how qualification links to production.	Workflow Simulation + Assessment	★ MEDIA	Simbott MR: the simulator offering the best integration of defects and multi-student tracking. IQSIM (Norway/SI) as a tool for calculating efficiency.
T2 — Selection of materials	★ Medium Connect material properties with welding consequences.	Cause-and-effect visualization	★ MEDIA	All arc simulators include basic material selection. None cover engineering reasoning — minor extension of WPS module.
T9 — Outsourcing	★ Medium Coordination, documentation and supplier control are difficult without realistic workflows.	Interactive Document Workflow Simulation	★ MEDIA	No reference tool in market. Potential as additional scenario in T7 module (non-conformance management with subcontractor).

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📌 The 'Reference technology' column is not a final product recommendation: it is the informed starting point for WP3 architecture decisions. High-priority modules (T3, T6, T7, T8) have clear market options; medium-priority ones can be addressed as extensions of the main modules.

7.2 Priority XR Modules — Design Informed by Market Analysis

Based on the cross-referencing of partner needs and the market review, the four high-priority XR modules for VIOLET are defined below. Each module now includes: specific learning objectives for the I/EWE level, technology/architecture recommendation based on the products and projects analysed in Section 6, and development decision (Build / Adapt / Build-on-top).

MODULE 1 — WPS/PQR Engineering Decision Simulator | Task Area T3 | EWF-409 Module 3

Learning objective (I/EWE level): The learner can select, justify and document welding procedure (WPS) for a given manufacturing case, understanding the cause-and-effect relationships between the process, parameters, materials, joint geometry and applicable quality criteria.

Which market tools come closest? Fronius Welducation Campus includes theoretical modules and tests, but only covers process execution, not the engineering decision. WeldEye (Kemppi) manages WPS, qualifications and traceability in real production — it is not XR, but its functional architecture is exactly the type of reasoning that needs to be simulated. guideWELD (Realityworks) includes 27 pre-configured WPS, but only as process parameter selection.

Implementation decision — Module 1: BUILD with functional reference

No off-the-shelf tool covers I/EWE engineering decision-making for WPS. In-house development is required.

Functional reference: WeldEye (Kemppi) for the data model and document workflow; Fronius Welducation for the UX experience combining theory and simulation.

Proposed architecture: AR (based on ATS's Soldamatic technology) with superimposed 3D joint geometry, guided selection of variables and feedback on regulatory criteria (ISO 15607, ISO 15614). Seabery's technological foundation eliminates the cost of starting from scratch.

Linkage with the European project: DIGIWELD (ATS is a partner) already establishes the IAB/EWF curriculum framework for simulators. The scenarios in Module 1 must be consistent with this framework.

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IZV lesson (SI): Soldamatic is already used in the Slovenian I/EWE programme. Module 1 can be designed as an extension of that experience, adding a layer of engineering reasoning on top of the existing AR foundation.

MODULE 2 — NDT/Inspection Defect Visualisation | Task Area T6 | EWF-409 Module 3

Learning objective (I/EWE level): The learner can identify, classify and evaluate weld defects using normative criteria (ISO 5817, EN ISO 17637, EN ISO 17636), make the accept/reject/repair decision and justify it documentarily.

Which market tools come closest? TraiNDE UT and TraiNDE RT (Extende/CEA-List) are industrial simulators for ultrasonic and radiographic inspection used by the nuclear, aeronautical and oil & gas industries. They cover exactly the type of defect bank, acceptance criteria and inspection reasoning needed by the I/EWE. CIVA (CEA-List) is the world reference software in NDT simulation with over 300 corporate users. Research on AR for weld inspection (MDPI Applied Sciences 2023) demonstrates the technical feasibility of overlaying ISO criteria onto the real workpiece with HoloLens.

Implementing Decision — Module 2: ADAPT — Collaboration with Extende/CEA-List

TraiNDE already has the defect database, acceptance criteria and the inspection UX experience. The gap is purely contextual: it is not adapted to I/EWE (ISO 5817 criteria, EWF terminology, structural welding cases).

Recommendation: explore a collaboration agreement or licence with Extende to adapt TraiNDE to the I/EWE context of VIOLET. This would be significantly more efficient than in-house development.

Alternative if collaboration is not viable: in-house design of a 3D defect visualiser based on the MDPI 2023 AR research and data from welding simulators (REDWELD already includes basic defect visualisation).

Reference project: IQMET (Stimuli2/Norway, with IZV as a partner) is working specifically on simulators for inspectors and fillet welders. The results of IQMET must be reviewed before commencing development of WP3.

Partners' perspective: ISQe highlights NDT as an area where XR can make the invisible visible — internal defects, morphology, acceptance criteria. ASR emphasises the link between defect, cause and corrective action.

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MODULE 3 — Non-conformity & Root Cause Analysis | Task Area T7 | EWF-409 Module 4

Learning objective (I/EWE level): The learner can diagnose the root cause of a welding non-conformance, define a proportionate corrective action (including the preparation of a repair WPS where applicable), manage the associated documentation and verify the effectiveness of the correction.

Which market tools come closest? No commercial tool exists designed for this scenario. It is the most critical gap identified in the analysis. The only references are: (a) industrial non-conformance management platforms such as WeldEye (Kemppi), which manage the real document flow but are not XR, and (b) research projects on digital twins for quality control in manufacturing.

This module has no equivalent on the market. It represents the VIOLET project's greatest opportunity to make an original contribution to the I/EWE training ecosystem.

Content basis: the real-life non-conformity cases provided by ASR (Chapter 4.12 of its training programme) are the ideal starting point. These are real industrial scenarios that have already been pedagogically validated.

Proposed architecture: branching decision tree (branching scenario) with different outcomes depending on the learner's decisions. Technology: immersive VR (with a 3D workshop environment) or high-quality interactive web simulation.

Design model: VRTrainingIndustry 4.0 (INESC TEC Portugal) as an authoring architecture — allows each ATB to add their own cases without ongoing technical support.

Synergy with Module 2: the scenario can flow naturally from the discovery of the defect during inspection (Module 2) to root cause analysis and correction (Module 3), aligning with the EWF's integrated case proposal.

MODULE 4 — SHE Virtual Workshop Audit | Task Area T8 | EWF-409 Module 2

Learning objective (I/EWE level): The learner can identify, assess and manage the safety, health and environmental risks specific to a metal fabrication workshop with welding operations, applying relevant occupational health and safety legislation.

Which market tools come closest? Immersive Factory (France) and PIXO VR (USA) are the most mature VR SaaS platforms for industrial safety training on the market. Immersive Factory already

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has verified industrial scenarios (used by Veolia, among others) and allows the creation of customised modules. Research in Frontiers on Virtual Reality (2024-2025) shows 10-15% higher knowledge retention with VR safety training compared to traditional methods. The VRoad project (with CENFIC Portugal as partner) is the closest reference model in the consortium's ecosystem.

Building the SHE welding module on an existing SaaS platform (Immersive Factory or PIXO VR) is the most cost-effective technical and economic solution. It reduces development costs by 60–70% compared to in-house VR.

Specific scenarios to be developed: safety audit in a welding workshop (fumes, extraction, PPE), simulation of an electrical accident involving welding equipment, handling of gas cylinders, management of fires caused by sparks.

Partners' perspective: all four countries rate SHE as a high-priority area. L-USIT highlights that hazardous scenarios on construction sites are the most difficult to simulate in the classroom. ASR notes that Romanian regulations require medical checks and evacuation protocols that could be integrated into the scenario.

Synergy with WELDIFY: the European WELDIFY project (EIT Manufacturing) includes AR/VR modules on welding safety with a focus on inclusion and sustainability. Its results (2025–2026) must be reviewed prior to the final design of this module.

7.3 Common Architecture of Modules — Integrated EWF Case Study

The EWF proposal — an integrated XR practical case study as a common thread throughout the entire I/EWE itinerary — is the most strategic framework identified in this desk research. The market analysis confirms its technological feasibility: all the necessary pieces exist in the market, although they are not assembled for the I/EWE level.

The proposed architecture for VIOLET combines the four modules in a single narrative flow of a welded manufacturing project:

Phase	Module VIOLET	Narrative scenario	Reference technology
1	**Module 1 — WPS/PQR**	**The student receives a production order. They review the technical requirements, select materials and consumables, choose the process and parameters, and generate a documented WPS.**	**AR (Soldamatic base) + WeldEye reference**

Phase	Module VIOLET	Narrative scenario	Reference technology
2	**Module 2 — NDT/END**	**Manufacturing has been completed. The student plans and carries out visual and NDT inspections of the welded joints, interprets the results and assesses them against ISO criteria.**	**Adapted TraiNDE (Extende) / 3D defect visualiser/ AR (soldamatic base)**
3	**Module 3 — NCR**	**A non-conformity is identified. The student identifies the root cause, defines the corrective action, draws up the repair WPS and verifies the result.**	**Branching scenario ((VRTrainingIndustry as a model)**
4	**Module 4 — SHE**	**Throughout the project, the student carries out a safety audit of the workshop, identifies active risks and defines corrective measures.**	**Immersive Factory / PIXO VR (build-on-top)**

📌 Recommended authoring model: VRTrainingIndustry 4.0 (INESC TEC) allows ATBs to adapt scenarios to their national standards and own industry cases without continuous technical support. EWF is already familiar with this system. Its adoption as VIOLET's base platform would reduce maintenance costs and facilitate post-project sustainability.

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8. Barriers and Enablers for XR Adoption — Market Evidence and Partner Evidence

This section integrates the barriers and enablers identified by partners (National Fact Sheets) with the empirical evidence from the market analysis (Section 6). The combination of both perspectives enables a more robust and actionable assessment of each factor.

8.1 Barriers Identified — Enriched with Market Evidence

Barrier	Severity consensus	Countries	Market evidence and VIOLET analysis
High initial cost of XR hardware and software	**High**	**PL, PT, RO, SI, EWF**	**VRTEX360 costs USD 35,000–45,000; Fronius Virtual Welding ~€22,000–34,000; Soldamatic ~€15,000–25,000. In Romania, there are only 5–6 centres with simulators across the whole country. The SaaS model (Immersive Factory, WeldVR) lowers the barrier to entry for the SHE module, but does not eliminate that of the hardware (headsets). Strategy: cohort licensing model and/or cloud access for the VIOLET modules.**
Lack of XR content specific to I/EWE (non-operator)	**High**	**PT, RO, SI, EWF**	**As confirmed and quantified in Section 6: of the 30+ products analysed, NONE are designed to fully cover the coordination and engineering tasks of the I/EWE. The gap lies not in technology but in content and pedagogical approach. This is where VIOLET offers its greatest competitive advantage and where action is most urgently needed**
A shortage of trainers with expertise in XR	**High**	**PL, RO, SI**	**The market confirms the gap: most tools require an instructor familiar with VR (Lincoln Electric recommends that instructors familiarise themselves with VRTEX360). The WELDIFY project (EIT Manufacturing) includes an explicit train-the-trainer component integrating robotics and XR. The VRTrainingIndustry 4.0 model (INESC TEC) minimises reliance on the instructor by enabling the creation of scenarios without the need for ongoing technical support.**
Technological obsolescence and long-term support	**Medium**	**SI**	**IZV highlights this as a real barrier: VR headsets become obsolete within 3–5 years. The SaaS model partially mitigates this risk (the software is updated; only the hardware remains). Lesson from IQSIM: web-based tools continue to be used in SI, RO, HU and SE years after the**

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Barrier	Severity consensus	Countries	Market evidence and VIOLET analysis
			project — cross-platform and web-first design improves longevity.
Few specific I/EWE scenarios — low return on investment	**Medium**	**SI, PT**	**With few candidates per year (Portugal: ~9, Slovenia: ~85, Romania: ~50), the ROI of investing solely in I/EWE is low for a single country. The solution is a cross-border approach**
Resistance to change (trainers and students)	**Medium**	**PL**	**This is particularly relevant in Poland, the only country in the consortium with a fully face-to-face programme. Market evidence (Iowa State University: 100% of VR students showed improvement compared to the control group) and the literature (10–15% higher retention rates with VR in safety training) provide data-driven arguments that can be used in the change management strategy**

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8.2 Enablers and Opportunities — Confirmed by Market Analysis

Enabler / Opportunity	Source of information	Market confirmation and trading lesson for VIOLET
Soldamatic (ATS/Seabery) as the starting platform — a unique position within the consortium	PL, PT, RO, SI	Soldamatic is the only XR tool for welding with presence in all 4 consortium countries. Market analysis confirms that no competitor has this European coverage + direct relationship with ANBs. Expansion of Soldamatic to the I/EWE level (Module 1) builds on proven technology and eliminates the cost of developing the base AR layer. Sustainable competitive advantage if VIOLET develops I/EWE content before any other player.
Mature and adaptable NDT technology on the market (TraiNDE/CIVA)	Literature, industrial sector	TraiNDE (Extende/CEA-List) is in production in the nuclear, aerospace and oil & gas industries. The gap for I/EWE is not technological but of content and context (ISO 5817 criteria for structural welding vs. nuclear criteria). Collaboration or licensing with Extende to adapt TraiNDE to I/EWE would be the most efficient path for VIOLET's Module 2, with technology base already validated in demanding environments.
Mature and accessible VR security SaaS platforms	Global market	Immersive Factory and PIXO VR offer already-built industrial safety VR infrastructure, with flexible licensing models and content creation APIs. Developing Module 4 (SHE) build-on-top of one of these platforms would reduce development cost by 60-70% versus in-house VR, and would leverage an already-established industrial user base.
An ecosystem of European projects with reusable results	IQMET, WELDIFY, XR2Learn, Alliance4XR, DIGIWELD	The analysis in Section 6 identifies projects whose outputs are directly reusable: IQMET (simulators for inspectors, with IZV as partner) → content base for Module 2; WELDIFY (AR/VR sustainable welding modules) → synergy with Module 4; XR2Learn/Alliance4XR → pedagogical methodology for XR integration in engineering. VIOLET must establish formal contact with these projects before starting WP3.
A blended and digital approach is already established in the I/EWE programmes	PT, RO, SI	75% of the countries in the consortium are already using blended learning (Moodle + Zoom). The adoption of XR does not require a shift in pedagogical approach, but rather a natural extension of the existing model. Key takeaway: IZV (SI) has already successfully integrated Soldamatic into the I/EWE programme — this serves as the benchmark implementation model for the other three countries.
Scientific evidence of the effectiveness of VR learning	Scientific literature	Iowa State University: 100% of students who underwent VR welding training passed the test, compared to the control group. Frontiers (2024): 10–15% higher retention rates with VR safety training. MDPI Electronics (2025): A systematic review confirms improved psychomotor skills with simulators. This evidence is the most powerful argument for persuading sceptical ANBs (especially PL) and for the project's promotional materials.

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9. Conclusions and Recommendations

This section synthesises the findings of the desk research, integrating the three knowledge sources worked on in D2.1: (1) the data from national I/EWE programmes contributed by partners, (2) the transnational comparative analysis, and (3) the analysis of the global market of XR tools and European projects. The resulting conclusions and recommendations are more specific and actionable than those of desk research based exclusively on secondary sources.

9.1 Main Conclusions

9.1.1 On National I/EWE Programmes

- There is a solid and shared European curricular base (ISO 14731 / EWF-409) that enables the development of transnational XR content. National differences are of scale, format and digital maturity, not of training content.
- I/EWE programmes are in transition towards blended models (PT, RO, SI already operate with LMS Moodle + videoconferencing), which reduces the adoption barrier of XR tools. Poland is the exception with a fully face-to-face format.
- The four task areas most difficult to address with traditional methods are the same in all countries: WPS/PQR, Inspection/NDT, Non-conformances and SHE — with unanimous consensus among all partners.

9.1.2 On the XR Tools Market

- The market gap is confirmed and quantifiable: of more than 30 XR tools analysed for welding training, none is designed for the coordination and engineering competencies of the I/EWE. All are oriented towards the welder/operator (psychomotor skill of the arc). This gap is not one of technology but of content, pedagogical approach and level of reasoning.
- There are, however, tools in highly relevant adjacent segments: TraiNDE (Extende/CEA-List) for NDT inspection, Immersive Factory/PIXO VR for SHE, and VRTrainingIndustry 4.0 (INESC TEC) as an authoring architecture. None is I/EWE, but all are adaptable with reasonable effort.
- Soldamatic (ATS/Seabery) is the tool with the greatest transnational presence in the consortium (PL, PT, RO, SI) and the only one with an AR technological base directly extensible to the I/EWE level.
- XR hardware costs remain a real barrier (prices to be confirmed with providers), but SaaS models and mobile AR technology open the door to lower entry-cost solutions. VIOLET's design must contemplate multiple access modalities.

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9.1.3 On the Strategic Positioning of VIOLET

- VIOLET has the opportunity to create the first XR system on the market specifically designed for the I/EWE level. There are no direct competitors. The timing is optimal: the sector is technologically mature, but specific content for welding engineers does not exist.
- The EWF conceptual proposal — integrated XR practical case study as a common thread of the I/EWE itinerary — is the most ambitious and differentiating product design. The market analysis confirms that all the necessary technological pieces exist; VIOLET's contribution is to assemble them in service of the I/EWE profile.

9.2 Recommendations for T2.2 — Stakeholder Survey

The stakeholder survey (T2.2) must validate and deepen the desk research findings. Based on the knowledge generated, it is recommended that the T2.2 questionnaire include the following blocks and specific questions:

Block T2.2	Recommended questions and specific points to consider
Validation of training priorities	**Do you confirm the prioritisation of WPS > NDT > NC > SHE for the design of XR modules? Are there any areas not covered by these four modules that you consider critical for your national context?**
Knowledge of existing XR tools	**Are you familiar with / do you use: TraiNDE (Extende), WeldEye (Kemppi), Immersive Factory, SOLDAMATIC, Fronius Welducation, IQSIM/IQMET? [Yes/No + assessment]. To gauge the actual level of market awareness amongst I/EWE trainers.**
Willingness to adopt specific modules	**If VIOLET were to develop a specific XR module for [WPS / NDT / NC / SHE], would it incorporate it into its I/EWE programme? Under what conditions (cost, access format, curriculum compatibility)?**
Preferred access model	**Which access model would you prefer for the VIOLET modules? a) Software licence + your own hardware; b) Cloud/browser-based access without specialised hardware; c) Pre-configured kit model (hardware + software per cohort); d) Integrated into your Moodle LMS.**
Willingness to pay / economic model	**What would be a reasonable price per student per module? Could you access Erasmus+ / PNRR funding to purchase the VIOLET modules? Has your ATB already accessed this type of funding for digitalisation?**
Instructor capacity	**Do your trainers have experience with XR tools? Have they received specific training? Would you consider a train-the-trainers programme necessary before implementing the VIOLET modules?**
Validation of the integrated EWF case study	**EWF proposes an integrated XR case study that simulates the full I/EWE cycle (from WPS to SHE audit). Do you consider this approach to be feasible and pedagogically**

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Block T2.2	Recommended questions and specific points to consider
	appropriate for your programme? Would you prefer standalone modules or an integrated case study?
Synergies with European projects	**Are you familiar with / have you been involved in IQMET, WELDIFY, XR2Learn or DIGIWELD? Would you be willing to share results/resources with these projects via VIOLET?**

9.3 Recommendations for WP3 — Content Design and Development

The following recommendations for WP3 are the direct result of the cross-referencing of partner needs and market analysis. They are organised by module and prioritised by urgency and impact.

Recommendation WP3.1 — Define the authoring architecture before developing content

The most strategic decision for WP3 is not what content to develop, but on which platform. The VRTrainingIndustry 4.0 model (INESC TEC) enables ATBs to adapt scenarios without ongoing technical support — this is critical for post-project sustainability.

Action: before commencing development, formally evaluate three architecture options: (a) Soldamatic (Seabery) extension, (b) INESC TEC VRTrainingIndustry-type authoring platform, (c) modular combination with SaaS platforms (Immersive Factory for SHE). The decision must be taken in consultation with EWF, IZV and ISQe as technical and pedagogical advisors.

Recommendation WP3.2 — Module 2 (NDT): establish contact with Extende/CEA-List

TraiNDE (Extende/CEA-List) possesses the defect database and inspection UX expertise that VIOLET requires for Module 2. The cost of developing an NDT simulator of comparable quality from scratch would be prohibitive.

Action: ATS/Seabery must establish formal contact with Extende during phase T2.2 to explore: (a) a licence to use TraiNDE adapted to the I/EWE context, (b) co-development of an NDT module for welding with support from CEA-List, (c) use of CIVA as a licensed simulation engine. This should be resolved before the start of WP3.

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Recommendation WP3.3 — Module 4 (SHE): evaluate Immersive Factory / PIXO VR as a base platform

Developing immersive VR for industrial safety from scratch is very costly (to be confirmed depending on scope and supplier) for a professional-quality module. Immersive Factory offers a ready-built infrastructure with content creation APIs.

Action: during T2.2, include a specific question asking which VR safety SaaS platforms the stakeholders are familiar with. If Immersive Factory or PIXO VR are well-known in the sector, this will facilitate a commercial agreement. If not, explore a co-development agreement with WELDIFY (which is already working on AR/VR for welding safety).

Recommendation WP3.4 — Module 3 (NCR): ASR cases as a basis for content

ASR (Romania) has a unique resource: the real-life non-conformity cases from its Chapter 4.12, used in the Romanian I/EWE programme. These are real industrial scenarios that have already been validated for educational purposes.

Action: ATS should formally request that ASR transfer these cases for conversion into branching XR scenarios. L-USIT also has real-life non-conformity cases from its inspection and certification activities that could complement the content bank.

Recommendation WP3.5 — Establish formal synergies with IQMET, WELDIFY and XR2Learn

IQMET (IZV as an active partner): its findings on simulators for welding inspectors are directly applicable to Module 2. Review deliverables before commencing the design of Module 2.

WELDIFY (EIT Manufacturing): launched in 2025, it includes AR/VR modules on sustainable welding. Formal contact is recommended to exchange resources and avoid duplication.

XR2Learn (Horizon Europe): this is the European XR innovation hub for advanced manufacturing training. VIOLET should register with its community to gain access to methodology, authoring tools and a network of European XR providers.

Recommendation WP3.6 — Design for multiple technological access profiles

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The four countries in the consortium have very different levels of XR infrastructure: IZV (SI) already uses Soldamatic and Fronius; L-USIT (PL) has no XR tools whatsoever. The VIOLET modules must be accessible in at least two formats: (a) a full experience using a VR/AR headset for centres with the necessary infrastructure, (b) a high-quality web/tablet version for centres without specialised hardware.

The design should prioritise web/browser-based accessibility to maximise impact in the most limited contexts (PL, parts of RO), and include the immersive layer as an optional enhancement.

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Annexes

Annex A — National Fact Sheets by Partner

The complete National Fact Sheets contributed by each partner are attached as separate documents to this deliverable:

- Annex A1 — National Fact Sheet: Poland (L-USIT). Completed by Marek Dragan. 24.03.2026.
- Annex A2 — National Fact Sheet: Portugal (ISQe). Completed by Maria Moreira. 24.03.2026.
- Annex A3 — National Fact Sheet: Romania (ASR). Completed by Monica Bratu / Mircea Visescu. 26.03.2026.
- Annex A4 — National Fact Sheet: EWF (European perspective). Completed by Marina Baptista. 26.03.2026.
- Annex A5 — National Fact Sheet: Slovenia (IZV). Completed by Vital Uran. 15.04.2026.

Annex B — Bibliography and Sources

Relevant regulatory documents:

- ISO 14731:2019 — Welding coordination — Tasks and responsibilities.
- EWF-409 / IAB-252 — Guidelines for the education, examination and qualification of International/European Welding Engineers.
- ISO 3834:2021 — Quality requirements for fusion welding of metallic materials.
- EN 1090-2 — Execution of steel structures and aluminium structures.

European reference projects:

- DIGIWELD — Developing digital tools and open learning systems for welding apprentices. Erasmus+.
- IQSIM / IQMET — Integration of welding simulators in training.
- VRTrainingIndustry 4.0 — INESC TEC, Portugal.
- VRoad — VR safety training, Fundación Laboral de la Construcción / CENFIC.
- DIGIGREEN, DIGIMAN — Digital green manufacturing, Erasmus+.

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Annex C — Acronyms and Glossary

ANB	Authorized National Body
AR	Augmented Reality
ATB	Approved Training Body
EWF	European Welding Federation
I/EWE	International / European Welding Engineer
IIW	International Institute of Welding
MR	Mixed Reality
NCR	Non-Conformance Report
NDT	Non-Destructive Testing
PWHT	Post-Weld Heat Treatment
ROI	Return on Investment
SHE	Safety, Health and Environment
VET	Vocational Education and Training
VR	Virtual Reality — Realidad Virtual.
WPS	Welding Procedure Specification
WPQR / PQR	Welding Procedure Qualification Record
XR	Extended Reality

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VIOLET

AR/VR International Welding Engineer Qualification

WP 2 - Informational map for a study on the state of the art in VR/AR solutions for international welding engineers

Łukasiewicz
Upper Silesian Institute of Technology

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Annex A — National Fact Sheet

T2.1: Desk Research on XR Tools Applicable to I/EWE Training

Field	Response
Organization	EWF
Country	European scope
Contact person	Marina Baptista
Date completed	26.03.2026

SECTION 1 — I/EWE Programme in Your Country

Question	Response
Name of Authorized National Body (ANB)	NA
Number of active I/EWE training providers (approx.)	NA
Number of I/EWE candidates per year (approx.)	NA
Number of active I/EWEs currently certified (approx.)	NA
Training duration (hours / months)	NA
Training format [ ] Face-to-face only [ ] Blended (face-to-face + online) [ ] Fully online [ ] Other: _____	NA
Examination format	NA

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SECTION 2 — I/EWE Role: Tasks and Areas of Responsibility

This section is the analytical core of this questionnaire. Its purpose is to define what a welding engineer (I/EWE) actually does, so that the XR tool analysis in T2.1 can be focused on the professional tasks where digital tools can add real value — rather than on welding operator tasks or generic engineering activities.

2.1 Validation of I/EWE Task Areas

The task areas below are based on EWF-409 and IIW / ISO 14731 (Welding coordination — Tasks and responsibilities). For each area please indicate: (a) whether it applies in your country, (b) its importance for I/EWE-level training, and (c) any national specifics.

#	I/EWE Task Area	Applies in your country? (Yes / No)	Importance for I/EWE training (High / Med / Low)	National specifics / Comments
1	Review of technical requirements for welded products	Yes	High	Our analysis is European, not per/country
2	Selection of parent materials and welding consumables	Yes	High	Our analysis is European, not per/country
3	Determination of welding procedures (WPS / PQR)	Yes	High	Our analysis is European, not per/country
4	Qualification of welding personnel	Yes	High	Our analysis is European, not per/country
5	Pre- and post-weld heat treatment (PWHT)	Yes	High	Our analysis is European, not per/country
6	Inspection and testing of welded joints (NDT / DT)	Yes	High	Our analysis is European, not per/country

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7	Non-conformances and corrective actions	Yes	High	Our analysis is European, not per/country
8	Safety, health and environment in welding	Yes	High	Our analysis is European, not per/country
9	Subcontracting of welding operations	Yes	High	Our analysis is European, not per/country

2.2 Additional Task Areas

Are there I/EWE task areas in your national context NOT listed above?

- Not applicable, as we are not a training provider and do not operate at a national level

2.3 Top 3 Most Important Task Areas for I/EWE Training

In your professional experience, which THREE task areas are most critical to develop through I/EWE training? Please refer to the areas in 2.1 or add from 2.2.

Priority	Task area (from 2.1 or 2.2)	Why is it critical to train at I/EWE level?
1st	Determination of welding procedures (WPS / PQR)	To ensure that the level of knowledge is appropriate for the functional profile and the required level of autonomy.”
2nd	Qualification of welding personnel	To ensure that the level of knowledge is appropriate for the functional profile and the required level of autonomy.”
3rd	Inspection and testing of welded joints (NDT / DT) & Non-conformances and corrective actions	To ensure that the level of knowledge is appropriate for the functional profile and the required level of autonomy.”

2.4 Task Areas Most Difficult to Train with Traditional Methods

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Which task areas are currently hardest to train effectively using classroom / textbook methods? (e.g. areas requiring physical access to equipment, hazardous conditions, rare failure scenarios, complex engineering judgment)

- Determination of welding procedures (WPS / PQR)
- Inspection and testing of welded joints (NDT / DT)

2.5 Task Areas Where XR Tools Could Add Greatest Training Value

For which task areas do you believe VR / AR / MR tools could bring the most significant training benefit? Please refer to the task areas in 2.1 and explain briefly.

Task area (from 2.1)	Why could XR add value here?	Type of XR interaction imagined (simulation / visualisation / assessment / other)
Determination of welding procedures (WPS / PQR)	Allows the candidate to virtually link a 3D joint design with the correct WPQR and develop a project-specific WPS without the cost of physical test coupons	Assessment / Simulation
Inspection and testing of welded joints (NDT / DT)	Provides high-fidelity visualisation of complex internal and external imperfections (e.g., cold cracking or porosity) for decision-making.	Assessment
Non-conformances and corrective actions	Enables the trainee to manage the full repair cycle: identifying a defect, specifying a repair WPS, and verifying the final quality in a risk-free environment	simulation
Safety, health and environment in welding	Offers a safe immersion into a virtual workshop to perform risk assessments and identify non-conformities (e.g., inadequate fume extraction or electrical hazards).	Simulation / Identification

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SECTION 3 — Current Use of Digital Tools in I/EWE Training

Not applicable to EWF

Tool type	Used?	Details
LMS / e-learning platform	[ ] Yes [ ] No	Name:
Digital course materials (beyond PDF slides)	[ ] Yes [ ] No	Describe:
Online examination or assessment tools	[ ] Yes [ ] No	Describe:
Any XR tool (VR / AR / MR)	[ ] Yes [ ] No	Describe:
Other digital tools	[ ] Yes [ ] No	Describe:

SECTION 4 — XR Tools Known in Your National Context

Please list any VR, AR or MR tools used for welding or engineering training in your country, even if not specifically designed for I/EWE level. For each tool, indicate which I/EWE task areas from Section 2.1 it could support.

Tool name	Provider / Country	Technology (VR/AR/MR)	Currently used for	I/EWE task areas it could support (Section 2.1 numbers)	Your assessment (strengths / limitations)

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⚠ *If you are not aware of XR tools specifically for welding, please also consider tools from adjacent fields (NDT, structural engineering, quality management, industrial safety) that could be adapted to I/EWE-level tasks.*

SECTION 5 — Barriers to XR Adoption in I/EWE Training

In your national context, what are the main obstacles to integrating XR tools into I/EWE training programmes? Please rank your top 3.

#	Barrier	Severity (High / Med / Low)	Comments
1	Cost of high-fidelity hardware	Medium	While it saves on consumables, the initial investment in VR/AR equipment for an entire cohort can be a hurdle for some ATBs.
2			
3			

Examples: cost of equipment, lack of I/EWE-specific content, trainer skills, no regulatory guidance, small cohort sizes, language availability, technical infrastructure.

SECTION 6 — Enablers and Opportunities

What factors in your national context could drive or facilitate XR adoption in I/EWE training?

#	Enabler / Opportunity	Comments

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1	Reduction in consumable costs	XR allows for training in high-cost materials (e.g., Nickel alloys, Titanium) and advanced processes without material waste.
2	Standardisation of Case Studies (CU 4.12)	To create a uniform digital "Case Study" environment
3	Safety-first complex training	Ability to simulate hazardous scenarios or rare structural failure cases that are impossible to replicate in a traditional classroom.

SECTION 7 — Any Other Relevant Information

National initiatives, research projects, institutional attitudes, or anything else relevant to the use of digital / XR tools in I/EWE training in your country:

To enhance the training of International Welding Engineers (IWE), it is proposed to implement an Integrated XR-Based Case Study that serves as a common thread throughout the qualification path (from Module 1 to Module 4). Instead of isolated exercises, the trainee follows a single, complex welding project within a virtual environment, simulating the real-world responsibilities defined in ISO 14731.

The XR workflow includes:

1. Procurement & Material Validation: The trainee enters a virtual warehouse to identify base materials and consumables, verifying their "inspection certificates" and storage conditions (controlled humidity/temperature).
2. Engineering Design & Specification: Navigating a 3D structural model, the trainee must select the optimal joint geometry and process, subsequently choosing the correct WPQR to develop a project-specific WPS.
3. Virtual Inspection & Decision Making: The system generates 3D weld beads with stochastic imperfections. The trainee performs a visual inspection, assesses the defects and decides if the part is "Fit for Purpose" or requires a repair procedure.
4. HSE & Workshop Audit: A specific module allows the candidate to perform a health and safety audit in a virtual metalworking workshop, identifying non-conformities in real-time (e.g., fumes, electrical hazards, PPE).

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Thank you for your contribution. Your input will be incorporated into Deliverable D2.1 — State of the Art Report on XR for I/EWE Training, and will inform the design of the stakeholder survey (T2.2).

VIOLET — AR/VR International Certification of Welding Engineers | KA220-VET-882DD247

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AR/VR International Welding Engineer Qualification

WP 2 - Informational map for a study on the state of the art in VR/AR solutions for international welding engineers

Łukasiewicz
Upper Silesian Institute of Technology

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Annex A — National Fact Sheet

T2.1: Desk Research on XR Tools Applicable to I/EWE Training

Field	Response
Organization	ISQe
Country	Portugal
Contact person	Maria Moreira
Date completed	March 24th 2026

SECTION 1 — I/EWE Programme in Your Country

Question	Response
Name of Authorized National Body (ANB)	ANB-ISQ — ISQ (Instituto de Soldadura e Qualidade). ISQ states that, in Portugal, the I/EWE -approved ANB is ANB-ISQ, responsible for approving and monitoring ATBs and issuing diplomas within the I/EWE system.
Number of active I/EWE training providers (approx.)	1 active provider in Portugal for I/EWE: the ANB-ISQ list of approved ATBs updated on 27/11/2024 shows ISQ Academy — Instituto de Soldadura e Qualidade as the Portuguese ATB approved for Doc. EWF-IAB-252 — I/EWE. Other Portuguese ATBs listed are approved for other scopes, such as welders or adhesives, not for I/EWE.
Number of I/EWE candidates per year (approx.)	Approx. 9 per year (historical estimate only; should be confirmed by ANB-ISQ). ISQ reported 261 EWE/IWE diplomas since 1992 in a 2021 publication. Using that historical figure as a rough proxy

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	gives about 9 per year. This is a derived estimate, not an officially published current annual intake.
Number of active I/EWEs currently certified (approx.)	No public current figure found. The safest publicly supported wording is: "At least 261 EWE/IWE diplomas had been issued in Portugal since 1992 (reported by ISQ in 2021); current number of active certified I/EWEs should be confirmed by ANB-ISQ."
Training duration (hours / months)	498 hours; approximately 21 months in the currently advertised cohort (from 21/04/2026 to 28/01/2028, with scheduled breaks).
Training format [ ] Face-to-face only [ ] Blended (face-to-face + online) [ ] Fully online [ ] Other: _____	ISQ states that the course is delivered online in the theoretical component and face-to-face in the practical component, with practical sessions held in Oeiras or Vila Nova de Gaia.
Examination format	Modular assessment, conducted in person; written and oral assessments. ISQ states that the course assessment is modular, performed in person, and that written and oral assessments take place in working hours.

SECTION 2 — I/EWE Role: Tasks and Areas of Responsibility

This section is the analytical core of this questionnaire. Its purpose is to define what a welding engineer (I/EWE) actually does, so that the XR tool analysis in T2.1 can be focused on the professional tasks where digital tools can add real value — rather than on welding operator tasks or generic engineering activities.

2.1 Validation of I/EWE Task Areas

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The task areas below are based on EWF-409 and IIW / ISO 14731 (Welding coordination — Tasks and responsibilities). For each area please indicate: (a) whether it applies in your country, (b) its importance for I/EWE-level training, and (c) any national specifics.

#	I/EWE Task Area	Applies in your country? (Yes / No)	Importance for I/EWE training (High / Med / Low)	National specifics / Comments
1	Review of technical requirements for welded products	yes	High	Core part of welding coordination in Portugal. Particularly relevant where production must comply with contractual and application-standard requirements. No specific national deviation identified; this is handled within the EWF/IIW and ISO 14731-aligned framework.
2	Selection of parent materials and welding consumables	yes	High	Highly relevant in Portugal because the I/EWE profile includes strong competence in materials and fabrication. This is central for ensuring weldability, compliance, and performance in industrial contexts.
3	Determination of welding procedures (WPS / PQR)	yes	High	One of the most important task areas for I/EWE-level practice. In Portugal this should be considered a priority area for training and for possible XR support related to procedure understanding, sequencing, parameter logic, and consequences of deviations.
4	Qualification of welding personnel	yes	High	Applies clearly in the Portuguese context.

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				I/EWEs are not the same as welders or welding operators, but they need to understand qualification requirements, competence levels, and how personnel approval links to quality assurance and production responsibilities.
5	Pre- and post-weld heat treatment (PWHT)	yes	medium	Relevant, but not equally critical in all companies or product sectors. Importance depends on materials, thicknesses, codes, and industrial application. Should remain in the training scope, but may be less universal than WPS/PQR or inspection.
6	Inspection and testing of welded joints (NDT / DT)	yes	High	Very important in Portugal. Even where dedicated inspection personnel are involved, the I/EWE needs a strong understanding of inspection logic, acceptance criteria, test selection, and the interpretation of results for quality coordination purposes.
7	Non-conformances and corrective actions	yes	High	Strongly applicable. This is a core coordination and quality-management responsibility and highly relevant for case-based or simulation-based training, including root-cause analysis and decision-making.
8	Safety, health and environment in welding	yes	High	Applies in Portugal and should be treated as highly important. Even

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				though I/EWEs are not only safety officers, they coordinate activities that involve heat, fumes, electricity, gases, equipment, and environmental constraints, so SHE awareness is essential.
9	Subcontracting of welding operations	yes	medium	Relevant in Portugal, especially in industrial supply chains, but its practical weight may vary by company. It is important for understanding responsibility allocation, supplier control, documentation, and compliance, though not always a central training focus for every learner.

2.2 Additional Task Areas

Are there I/EWE task areas in your national context NOT listed above?

- Application of quality requirements and welding coordination within product-specific standards and regulatory frameworks

In Portugal, the I/EWE role should also be understood in connection with standards and sectors where welding coordination is tied to product and compliance requirements, not just shop-floor practice. EWF explicitly links ISO 14731 use to broader quality and application standards such as ISO 3834, EN 1090, EN 13445, and EN 15085.

- Planning, supervision and coordination of welded fabrication activities

This is worth stating explicitly because ISQ describes the Portuguese I/EWE qualification as giving competences in supervision, coordination, project follow-up, preparation/planning, and fabrication of welded constructions.

- Documentation, traceability and technical decision-making across the welding quality chain

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This is not always listed as a separate line, but it is implicit in welding coordination and highly relevant for digitalization. It is especially important for identifying where XR and e-learning tools can support understanding of workflows, documentation logic, inspection points, and non-conformance handling. This interpretation is consistent with EWF's view that welding coordination covers the wider quality chain and must be matched to the company's actual products, materials, processes, and standards.

2.3 Top 3 Most Important Task Areas for I/EWE Training

In your professional experience, which THREE task areas are most critical to develop through I/EWE training? Please refer to the areas in 2.1 or add from 2.2.

Priority	Task area (from 2.1 or 2.2)	Why is it critical to train at I/EWE level?
1st	Determination of welding procedures (WPS / PQR)	This is one of the most critical I/EWE-level responsibilities because it sits at the intersection of materials, process selection, parameters, quality, code compliance, and manufacturability. It requires engineering judgement rather than operator skill alone, and errors here affect the whole production chain.
2nd	Inspection and testing of welded joints (NDT / DT)	I/EWEs need a strong understanding of what should be inspected, why, when, and how results should be interpreted in relation to acceptance criteria and product quality. Even when inspections are performed by dedicated personnel, the welding engineer must be able to coordinate and technically validate the logic of control and testing.
3rd	Non-conformances and corrective actions	This is critical because it develops the decision-making role of the I/EWE in diagnosing causes of weld defects or process deviations and defining corrective/preventive measures. It is especially important for real industrial performance, quality assurance, traceability, and coordination responsibilities.

2.4 Task Areas Most Difficult to Train with Traditional Methods

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Which task areas are currently hardest to train effectively using classroom / textbook methods? (e.g. areas requiring physical access to equipment, hazardous conditions, rare failure scenarios, complex engineering judgment)

- Determination of welding procedures (WPS / PQR) — difficult because trainees need to understand the interaction between parameters, materials, joint configuration, welding process, and quality outcomes, which is hard to grasp from static diagrams or lectures alone.
- Inspection and testing of welded joints (NDT / DT) — difficult because many defects, discontinuities, and acceptance issues are easier to understand through visual or scenario-based representation than through textbook descriptions.
- Non-conformances and corrective actions — difficult because effective training requires exposure to realistic failure cases, root-cause analysis, and decision pathways that are often rare or company-specific.
- Safety, health and environment in welding — difficult because the most relevant situations often involve hazardous environments, fumes, heat, electricity, confined spaces, or unsafe sequences that cannot easily be recreated in standard classroom conditions.
- Pre- and post-weld heat treatment (PWHT) — difficult because understanding the thermal cycle, metallurgical consequences, sequence, and parameter sensitivity benefits from dynamic visualisation rather than static explanation.
- Review of technical requirements for welded products — difficult when learners have limited exposure to real documentation packages, standards interplay, and the translation of technical requirements into fabrication decisions.
- Subcontracting of welding operations — difficult because the coordination risks, documentation checks, and supplier-control issues are easier to understand through realistic workflow scenarios than through generic lectures.
- Qualification of welding personnel — difficult to make fully meaningful in the classroom unless trainees can see how qualification requirements connect with procedure compliance, supervision, production context, and auditability.

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2.5 Task Areas Where XR Tools Could Add Greatest Training Value

For which task areas do you believe VR / AR / MR tools could bring the most significant training benefit? Please refer to the task areas in 2.1 and explain briefly.

Task area (from 2.1)	Why could XR add value here?	Type of XR interaction imagined (simulation / visualisation / assessment / other)
Determination of welding procedures (WPS / PQR)	XR could help learners understand cause-effect relationships between process choices, parameters, joint setup, sequence, and resulting weld quality. This is especially useful for visualising consequences of parameter changes without consuming material or machine time.	Simulation + visualisation + assessment
Inspection and testing of welded joints (NDT / DT)	XR could make invisible or hard-to-interpret defects easier to understand by showing defect formation, location, morphology, likely causes, and links to inspection results or acceptance criteria.	Visualisation + simulation + assessment
Non-conformances and corrective actions	XR could support scenario-based learning where trainees diagnose failures, identify probable root causes, and test corrective decisions in a realistic production context. This is valuable because many relevant non-conformance situations are infrequent, complex, or risky to reproduce physically.	Simulation + decision-based assessment
Safety, health and environment in welding	XR could create safe exposure to hazardous environments and unsafe sequences, helping learners identify risks and rehearse correct coordination decisions before entering real industrial settings.	Immersive simulation + assessment
Pre- and post-weld heat treatment (PWHT)	XR could improve understanding of thermal sequences, timing, and metallurgical implications through	Visualisation + simulation

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	animated visualisations and guided scenarios.	
Review of technical requirements for welded products	XR/MR could help connect drawings, joint geometry, welding symbols, requirements, and fabrication implications in a more spatial and contextual way than paper-based analysis alone.	Visualisation + mixed-reality overlay

SECTION 3 — Current Use of Digital Tools in I/EWE Training

Tool type	Used?	Details
LMS / e-learning platform	[X] Yes [ ] No	Name: The Portuguese I/EWE course is delivered online in real time for the theoretical component, so some digital delivery environment is clearly used. However, the I/EWE course page does not publicly name the exact platform. At institutional level, ISQ Academy publicly uses Moodle for self-paced e-learning offers and Zoom or another live platform for synchronous online courses, so the safest desk-research wording is: "Yes — digital learning platform used, but platform for I/EWE not publicly specified."
Digital course materials (beyond PDF slides)	[X] Yes [ ] No	Describe: Public information indicates that the course includes online theoretical training, case studies simulating real situations, and practical/laboratory training. That supports a Yes, but the exact digital asset types used in I/EWE delivery (interactive modules, quizzes, videos, simulations, etc.) are not described in detail publicly. Recommended wording: "Yes — digital materials are used, but public detail is limited."

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Online examination or assessment tools	[ ] Yes [X] No	Describe: The public course description states that assessment is modular and conducted in person, and that written and oral assessments take place in working hours. On that basis, this should be marked No for online examination tools in the currently documented I/EWE delivery model.
Any XR tool (VR / AR / MR)	[ ] Yes [X] No	Describe: I found no public evidence that VR/AR/MR is already embedded in the current Portuguese I/EWE course itself. Portugal does, however, have XR tools in welding training and adjacent industrial training contexts, including the ISQ welding simulator, which uses VR/AR for welding training with performance feedback. That makes XR clearly relevant for future integration, but not currently documented as part of the I/EWE programme.
Other digital tools	[X] Yes [ ] No	Describe: The strongest documented "other digital tool" is the use of synchronous virtual classroom delivery for the theoretical component. The I/EWE page confirms online, real-time delivery with specialist trainers, although it does not name the platform. Similar ISQ Academy offers show this is commonly done through Zoom or a comparable live platform.

SECTION 4 — XR Tools Known in Your National Context

Please list any VR, AR or MR tools used for welding or engineering training in your country, even if not specifically designed for I/EWE level. For each tool, indicate which I/EWE task areas from Section 2.1 it could support.

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Tool name	Provider / Country	Technology (VR/AR/MR)	Currently used for	I/EWE task areas it could support (Section 2.1 numbers)	Your assessment (strengths / limitations)
ISQ Simulador de Soldadura	ISQ / Portugal	VR + AR	Welding training; performance monitoring and feedback; reduction of consumables and risk in training.	3, 4, 8	Strengths: clearly relevant to welding training in Portugal; supports safer practice, immediate feedback, and reduced material waste. Limitations: the public description suggests a tool primarily oriented to welder/operator skill development, so its direct value for I/EWE coordination-level tasks is more indirect unless embedded in broader engineering/problem-solving scenarios.
Soldamatic (available in Portugal)	Seabery / Spain; available in Portugal via GrowSkills / Portugal	AR	Simulated welding training; real-time feedback; reduced accidents, lower training costs, shorter training time; also has a robotics variant.	3, 4, 8	Strengths: mature commercial solution available in Portugal; strong for safe introduction to process logic, torch path/positioning, and basic welding decision contexts; potentially useful as a bridge between theory and practice. Limitations: like the ISQ simulator, it is mainly geared toward welding execution training, not higher-level I/EWE tasks such as

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					inspection strategy, non-conformance analysis, subcontracting, or technical requirement review.
Simulação de soldadura baseada em Realidade Virtual	INESC TEC / Portugal	VR	Research/demonstrator for immersive welding simulation with motion tracking and evaluation of technical aspects such as torch angle, weld temperature and energy transfer.	3, 8 (possibly 4 in an assessment context)	Strengths: strong concept for engineering-oriented welding simulation and measurable performance parameters; useful for exploring how XR can connect process variables with technical outcomes. Limitations: public evidence points to a demonstrator/research solution, not a widely deployed national training product; no evidence of direct use in I/EWE.
VRTrainingIndustry 4.0	INESC TEC / Portugal	VR	Immersive industrial procedure training and certification authoring; applied to wind-turbine maintenance procedures and certification scenarios.	1, 6, 7, 8, 9	Strengths: highly relevant as an adjacent industrial XR training model for procedure-based learning, inspection logic, safe repeatable practice, and certification-style scenarios. Limitations: not welding-specific; would need adaptation to welding coordination cases, standards, documents, and QA workflows.

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VRoad	Fundación Laboral de la Construcción (Spain) with CENFIC partner in Portugal	VR	VR safety training with realistic work scenarios for roadwork maintenance and risk prevention.	8	Strengths: good Portuguese-relevant example of XR for occupational safety training where real exposure is risky and difficult to reproduce in conventional teaching. Limitations: specific to roadworks, not welding; relevance is mainly as a model for immersive SHE training rather than for welding engineering content.
NOS Augmented Worker / NOS Remote Support	NOS + Sumol+Compal / Portugal	AR / MR-type industrial assistance	Industrial inspection/maintenance support with interactive step-by-step guidance, procedure display, and on-site digital information capture in a Portuguese factory setting.	1, 6, 8	Strengths: very relevant as an adjacent example of AR for inspection, maintenance and procedural guidance in real industrial environments; useful inspiration for I/EWE tasks involving review of requirements, inspection points, and safe execution. Limitations: not a dedicated training tool and not welding-specific; more a workplace performance-support solution than a formal learning tool.

⚠ *If you are not aware of XR tools specifically for welding, please also consider tools from adjacent fields (NDT, structural engineering, quality management, industrial safety) that could be adapted to I/EWE-level tasks.*

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SECTION 5 — Barriers to XR Adoption in I/EWE Training

In your national context, what are the main obstacles to integrating XR tools into I/EWE training programmes? Please rank your top 3.

#	Barrier	Severity (High / Med / Low)	Comments
1	Lack of I/EWE-specific XR content and scenarios	High	In Portugal, XR examples exist in welding and adjacent industrial domains, but the public evidence points mainly to welder-oriented simulation or to XR in adjacent technical/safety contexts, not to ready-made content for I/EWE-level tasks such as WPS/PQR decision-making, inspection logic, non-conformance analysis, subcontracting, or coordination under standards. The current Portuguese I/EWE course is still publicly presented as online theory + presential practical training + presential modular assessment, with no public indication that XR is already built into that pathway. This suggests a content gap rather than a total absence of XR know-how.
2	Cost / return on investment for a niche qualification	High	Portugal appears to have a very concentrated I/EWE ecosystem, with ISQ publicly stating it is the only entity in Portugal conferring the EWF/IIW welding engineer qualification, and historical figures showing 261 EWE/IWE diplomas since 1992. That suggests a relatively specialised market, which can make investment in hardware, software, authoring and maintenance harder to justify unless tools are reusable across qualifications or provider networks. ISQ also notes more broadly that advanced technical

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			training requires modern and expensive equipment and that training centres need to adapt to digitalisation across services and programmes.
3	Trainer skills and pedagogical integration capacity	Medium/High	A recurring issue in Portugal is likely to be not just buying XR, but integrating it into a coherent learning design for a high-level engineering qualification. ISQ explicitly notes that training centres need to incorporate digitalisation and invest in trainer competences, which it describes as critical for digital culture in training. The fact that INESC TEC's VRTrainingIndustry emphasises an authoring approach that lets trainers create and adjust technical training activities without continuous multimedia/IT support also suggests that trainer capability and usability are central adoption conditions.

Examples: cost of equipment, lack of I/EWE-specific content, trainer skills, no regulatory guidance, small cohort sizes, language availability, technical infrastructure.

SECTION 6 — Enablers and Opportunities

What factors in your national context could drive or facilitate XR adoption in I/EWE training?

#	Enabler / Opportunity	Comments
1	Existing digital and blended-learning baseline in the Portuguese I/EWE offer	Portugal is not starting from zero. The current I/EWE course is already delivered with online real-time theory, case-based elements, and a broader institutional culture of online, offline and blended learning at ISQ Academy. This creates a favourable base for introducing XR as an extension of

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		an already digitalised training model rather than as a completely disruptive change.
2	Presence of national XR experience in welding and adjacent industrial training	Portugal already has relevant examples: the ISQ welding simulator using VR/AR, Soldamatic available in Portugal, INESC TEC's VRTrainingIndustry for industrial technical training, and Portuguese industrial AR applications such as NOS Augmented Worker. This means there is already national exposure to XR hardware, authoring approaches, industrial use cases, and training value propositions that VIOLET can build on.
3	Strong institutional structure for piloting, QA and controlled implementation	Portugal's I/EWE system is institutionally concentrated: ANB-ISQ supervises the EWF/IIW qualification system and approved ATBs, and ISQ publicly presents itself as the sole Portuguese provider of the welding engineer qualification. As an inference, this concentration can actually support piloting, quality assurance alignment, and structured roll-out, because the chain between qualification governance and training delivery is relatively clear.

SECTION 7 — Any Other Relevant Information

National initiatives, research projects, institutional attitudes, or anything else relevant to the use of digital / XR tools in I/EWE training in your country:

- The current Portuguese I/EWE model is already partly digital, but not yet publicly XR-integrated. The course is described as online in the theoretical component and presential in the practical component, with presential modular assessment. This is important because it shows that digitalisation is already accepted, but XR still appears to be an opportunity rather than a current mainstream feature.
- Portugal already has public evidence of welding simulation and institutional openness to immersive tools. ISQ's welding simulator uses VR and AR, is presented as a way to reduce consumables and waste, expose learners to a wide range of training scenarios, and provide real-time feedback on

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performance. That is highly relevant for VIOLET because it shows local familiarity with immersive welding training principles.

- There is also relevant Portuguese experience in adjacent XR-enabled industrial training and procedural support. INESC TEC's VRTrainingIndustry supports immersive technical training authoring; CENFIC participated in VRoad, a VR safety training project; and NOS has deployed Augmented Worker solutions for step-by-step industrial procedures. These examples are not I/EWE tools, but they show that XR for technical training, safety, and procedure support is already present in the Portuguese ecosystem.
- Portugal's highly concentrated I/EWE ecosystem may be both a limitation and an opportunity. It likely limits market scale, but it may also make it easier to test, refine and quality-assure XR integration in a controlled way, especially because ANB-ISQ oversees the qualification system and ISQ is publicly positioned as the only Portuguese provider of the EWF/IIW welding engineer qualification

Thank you for your contribution. Your input will be incorporated into Deliverable D2.1 — State of the Art Report on XR for I/EWE Training, and will inform the design of the stakeholder survey (T2.2).

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AR/VR International Welding Engineer Qualification

WP 2 - Informational map for a study on the state of the art in VR/AR solutions for international welding engineers

Łukasiewicz Upper Silesian Institute of Technology · ISQe ENGAGING PEOPLE · AT AUGMENTED TRAINING · EWF · ASR · INSTITUT ZA VARILSTVO Welding Institute

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Annex A — National Fact Sheet

T2.1: Desk Research on XR Tools Applicable to I/EWE Training

Field	Response
Organization	Łukasiewicz — Upper Silesian Institute of Technology
Country	Poland
Contact person	Marek Dragan
Date completed	24.03.2026

SECTION 1 — I/EWE Programme in Your Country

Question	Response
Name of Authorized National Body (ANB)	Sieć Badawcza Łukasiewicz — Górnośląski Instytut Technologiczny, Ośrodek Certyfikacji Lukasiewicz — Upper Silesian Institute of Technology, Department of Certification
Number of active I/EWE training providers (approx.)	7: Lukasiewicz — USIT + 6 technical universities (postgraduate studies + exam at L-USIT)
Number of I/EWE candidates per year (approx.)	120 (at L-USIT)
Number of active I/EWEs currently certified (approx.)	3866 in total, 141 in 2025
Training duration (hours / months)	448 hours (including 60 h of practice)
Training format [X] Face-to-face only [ ] Blended (face-to-face + online) [ ] Fully online [ ] Other: _____	

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Examination format	Test + oral exam

SECTION 2 — I/EWE Role: Tasks and Areas of Responsibility

This section is the analytical core of this questionnaire. Its purpose is to define what a welding engineer (I/EWE) actually does, so that the XR tool analysis in T2.1 can be focused on the professional tasks where digital tools can add real value — rather than on welding operator tasks or generic engineering activities.

2.1 Validation of I/EWE Task Areas

The task areas below are based on EWF-409 and IIW / ISO 14731 (Welding coordination — Tasks and responsibilities). For each area please indicate: (a) whether it applies in your country, (b) its importance for I/EWE-level training, and (c) any national specifics.

#	I/EWE Task Area	Applies in your country? (Yes / No)	Importance for I/EWE training (High / Med / Low)	National specifics / Comments
1	Review of technical requirements for welded products	yes	high	
2	Selection of parent materials and welding consumables	yes	high	
3	Determination of welding procedures (WPS / WPQR)	yes	high	
4	Qualification of welding personnel	yes	high	

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5	Pre- and post-weld heat treatment (PWHT)	yes	high	
6	Inspection and testing of welded joints (NDT / DT)	yes	high	
7	Non-conformances and corrective actions	yes	high	
8	Safety, health and environment in welding	yes	high	
9	Subcontracting of welding operations	yes	mid	

2.2 Additional Task Areas

Are there I/EWE task areas in your national context NOT listed above?

- No, task areas are consistent with the training scope defined in ISO 14731

2.3 Top 3 Most Important Task Areas for I/EWE Training

In your professional experience, which THREE task areas are most critical to develop through I/EWE training? Please refer to the areas in 2.1 or add from 2.2.

Priority	Task area (from 2.1 or 2.2)	Why is it critical to train at I/EWE level?
1st	Review of technical requirements for welded products	Basic competences, crucial for designing and construction of every welded structure.
2nd	Determination of welding procedures (WPS / PQR)	Elaboration of documentation obligatory in the field of validation of the welding processes.
3rd	Qualification of welding personnel	Confirmation of current requirements concerning qualifications and skills necessary for completing welding tasks along with quality assurance.

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2.4 Task Areas Most Difficult to Train with Traditional Methods

Which task areas are currently hardest to train effectively using classroom / textbook methods? (e.g. areas requiring physical access to equipment, hazardous conditions, rare failure scenarios, complex engineering judgment)

- Welding processes and training
- Post Weld Heat Treatment (PWHT)
- Non-destructive testing of welded joints
- Destructive testing of welded joints

2.5 Task Areas Where XR Tools Could Add Greatest Training Value

For which task areas do you believe VR / AR / MR tools could bring the most significant training benefit? Please refer to the task areas in 2.1 and explain briefly.

Task area (from 2.1)	Why could XR add value here?	Type of XR interaction imagined (simulation / visualisation / assessment / other)
PWHT	Better understanding of the process, not necessary to use advanced equipment, such as heaters or heavy elements	Simulation
NTD / DT	Digital analysis of the tested area no exposure to the hazardous factors, such as chemicals or X-ray radiation, limited emission of the pollutants	Visualization/assessment
Safety, health and environment in welding	Simulation of actual conditions on the construction site or factory, regarding work hazards specific for particular activity (i.e. steel constructions mill, shipyards,	Visualization/assessment

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	pipeline constructions etc.) and procedures in case of danger.	

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SECTION 3 — Current Use of Digital Tools in I/EWE Training

Tool type	Used?	Details
LMS / e-learning platform	[ ] Yes [X] No	Name:
Digital course materials (beyond PDF slides)	[ ] Yes [X] No	Describe:
Online examination or assessment tools	[ ] Yes [X] No	Describe:
Any XR tool (VR / AR / MR)	[ ] Yes [X] No	Describe:
Other digital tools	[ ] Yes [X] No	Describe:

SECTION 4 — XR Tools Known in Your National Context

Please list any VR, AR or MR tools used for welding or engineering training in your country, even if not specifically designed for I/EWE level. For each tool, indicate which I/EWE task areas from Section 2.1 it could support.

Tool name	Provider / Country	Technology (VR/AR/MR)	Currently used for	I/EWE task areas it could support (Section 2.1 numbers)	Your assessment (strengths / limitations)
Soldamatic	Seabery / Spain	AR	Simulation of welding - occasional shows		
VRTEX360	Lincoln / USA	VR	Simulation of cutting —		

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			occasional shows		
Sysweld	ESI Group / France	VR	Research, process simulation, calculation		

⚠ *If you are not aware of XR tools specifically for welding, please also consider tools from adjacent fields (NDT, structural engineering, quality management, industrial safety) that could be adapted to I/EWE-level tasks.*

SECTION 5 — Barriers to XR Adoption in I/EWE Training

In your national context, what are the main obstacles to integrating XR tools into I/EWE training programmes? Please rank your top 3.

#	Barrier	Severity (High / Med / Low)	Comments
1	Time consumption	High	Adapting to new devices / software could require time to train the trainers Also students have to adapt to new tools, which could be time-consuming at the expense of working hours spent on practical training so far
2	Costs of investment in hardware and software	High	It could be difficult to bear the costs of new XR equipment
3	Attitude of the student / trainer — negative for new training tools	med	Both trainers and students could be hard to convince to replace some parts of practical training with digital tools, as they might

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			be too attached to the traditional way of IWE training.

Examples: cost of equipment, lack of I/EWE-specific content, trainer skills, no regulatory guidance, small cohort sizes, language availability, technical infrastructure.

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SECTION 6 — Enablers and Opportunities

What factors in your national context could drive or facilitate XR adoption in I/EWE training?

#	Enabler / Opportunity	Comments
1	External source of financing investment in devices and software	If there was a possibility to support training providers to ensure finance from external sources, such as grants, national funding, the adoption of XR tools would be more efficient.
2	Improving competences of the training staff to effectively use AR/VR tools	Complexed programme of training the trainers to prepare them to comprehensive application of new tools in IWE training
3	Reduced costs of the training course with AR/VR tools comparing to the current programme	If XR tool replaced some on-site classes or expensive practical modules, it could translate into reduction of the training price.

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SECTION 7 — Any Other Relevant Information

National initiatives, research projects, institutional attitudes, or anything else relevant to the use of digital / XR tools in I/EWE training in your country:

- No information

Thank you for your contribution. Your input will be incorporated into Deliverable D2.1 — State of the Art Report on XR for I/EWE Training, and will inform the design of the stakeholder survey (T2.2).

VIOLET — AR/VR International Certification of Welding Engineers | KA220-VET-882DD247

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AR/VR International Welding Engineer Qualification

WP 2 - Informational map for a study on the state of the art in VR/AR solutions for international welding engineers

Łukasiewicz Upper Silesian Institute of Technology · ISQe ENGAGING PEOPLE · AT AUGMENTED TRAINING · EWF · ASR · INSTITUT ZA VARILSTVO Welding Institute

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Annex A — National Fact Sheet

T2.1: Desk Research on XR Tools Applicable to I/EWE Training

Field	Response
Organization	ASR
Country	Romania
Contact person	Monica Bratu, Mircea Visescu
Date completed	26.03.2026

SECTION 1 — I/EWE Programme in Your Country

Question	Response
Name of Authorized National Body (ANB)	ASR-Asociatia de Sudura din Romania
Number of active I/EWE training providers (approx.)	1
Number of I/EWE candidates per year (approx.)	50
Number of active I/EWEs currently certified (approx.)	750
Training duration (hours / months)	4 months; 448 hours, the course is on blended system. Until 2023, the course was conducted via videoconference and divided into three parts. Part I (P1) consisted of an application licensed from SLV DVS; Part II represented the practical part (60 hours); and Part III consisted of videoconference sessions (293 hours).
Training format [ ] Face-to-face only	The course is in a blended format, meaning that 40% of the course is

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[x] Blended (face-to-face + online) [ ] Fully online [ ] Other: _____	conducted via Webex video conferencing and 60% consists of independent study. Independent study is demonstrated through tasks on the Moodle platform; specifically, after each chapter there is a test that must be passed with a grade of 6. At the end of each module, there is a midterm exam that must also be completed with a grade of 6. In addition to the chapter tests and module exams, the platform also includes essay-style questions such as those given in the final oral exam for obtaining the IWE diploma.
Examination format	multiple-choice tests+ oral examination

SECTION 2 — I/EWE Role: Tasks and Areas of Responsibility

This section is the analytical core of this questionnaire. Its purpose is to define what a welding engineer (I/EWE) actually does, so that the XR tool analysis in T2.1 can be focused on the professional tasks where digital tools can add real value — rather than on welding operator tasks or generic engineering activities.

2.1 Validation of I/EWE Task Areas

The task areas below are based on EWF-409 and IIW / ISO 14731 (Welding coordination — Tasks and responsibilities). For each area please indicate: (a) whether it applies in your country, (b) its importance for I/EWE-level training, and (c) any national specifics.

#	I/EWE Task Area	Applies in your country? (Yes / No)	Importance for I/EWE training (High / Med / Low)	National specifics / Comments
1	Review of technical requirements for welded products	yes	high	The I/EWE reviews all technical and contractual requirements for welded products to ensure

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				compliance with standards like SR EN ISO 14731(There is no direct reference to ISO 14731, but it is understood that IWE is required in the requirements), SR EN ISO 15614 and client specifications before production.
2	Selection of parent materials and welding consumables	yes	high	The I/EWE selects suitable parent materials and welding consumables to ensure weld quality, compatibility, performance in industry and compliance with standards like SR EN ISO 14731, SR EN 10225, SR EN ISO 17663, etc
3	Determination of welding procedures (WPS / PQR)	yes	high	The I/EWE defines, qualifies, and approves welding procedures (WPS/WPQR/PQR) to ensure welds meet all technical and quality requirements in compliance with standards like ISO 14731, SR EN ISO 15607, SR EN ISO 3834 SR EN ISO 15609, etc
4	Qualification of welding personnel	yes	high	The I/EWE,IWS/IWSD ensures that all welding personnel are properly qualified and certified, supervises tests, and maintains records in compliance with standards like SR EN ISO 14731, SR EN 1090 and ISO 3834.
5	Pre- and post-weld heat treatment (PWHT)	yes	high	The I/EWE defines and supervises preheat depending of type of

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				material, the thickness of the materiales and post-weld heat treatment to ensure weld quality, prevent defects, and comply with standards like SR EN ISO 14731, SR EN ISO 683 and SR EN ISO 17663
6	Inspection and testing of welded joints (NDT / DT)	yes	high	The I/EWE plans and supervises the inspection and testing of welded joints, selects appropriate NDT/DT methods, and ensures results meet quality standards like SR EN ISO 14731 , SR En ISO 5817 SR EN ISO 17637, SR EN ISO 17636, SR EN ISO 5173, SR EN ISO 9606, etc
7	Non-conformances and corrective actions	yes	high	The I/EWE identifies welding defects, determines their causes, and ensures corrective actions are implemented in accordance with SR EN ISO 14731 si SR EN ISO 5817, SR EN ISO 23277 and quality requirements to avoid the financial impact of defects in welds.
8	Safety, health and environment in welding	yes	high	In Romania, welding safety, health, and environmental requirements include mandatory PPE, fume extraction, medical checks, proper waste management, and compliance with labor laws and EU directives.
9	Subcontracting of welding operations	yes	high	In Romania, subcontracting welding operations requires that

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				subcontractors are certified, their personnel are qualified, procedures comply with ISO/EN standards, and documentation is traceable for audits and regulatory compliance.

2.2 Additional Task Areas

Are there I/EWE task areas in your national context NOT listed above?

- Implementing quality standards and coordinating welding within product-specific guidelines and legal frameworks. The I/EWE role in Romania should be viewed not only in terms of retailing practice but also in relation to standards and industries where welding coordination is linked to product and compliance requirements. ASR clearly connects the use of ISO 14731 to more general quality and application standards like ISO 3834, SR EN 1090, SR EN 13445, SR EN ISO 15614, and EN 15085 (There is no direct reference to ISO 14731).
- Organising, directing, and coordinating welded fabrication tasks
- Technical decision-making, traceability, and documentation along the welding quality process

Finding areas where XR and e-learning tools can enhance comprehension of workflows, documentation logic, inspection points, and non-conformance handling is particularly crucial in welded structures.

2.3 Top 3 Most Important Task Areas for I/EWE Training

In your professional experience, which THREE task areas are most critical to develop through I/EWE training? Please refer to the areas in 2.1 or add from 2.2.

Priority	Task area (from 2.1 or 2.2)	Why is it critical to train at I/EWE level?
1st	Determination of welding procedures (WPS / PQR)	Because it is at the center point of materials, process selection, parameters, quality, code compliance, and manufacturability, this is one

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		of the most important I/EWE-level duties. Errors here have an impact on every stage of production and call for engineering judgement rather than just operator skill.
2nd	Inspection and testing of welded joints (NDT / DT)	I/EWEs must have a thorough awareness of what needs to be inspected, why, when, what kind of control should be used, and how results should be interpreted considering acceptance standards and product quality. The welding engineer must be able to organize and technically justify the logic of control and testing, even when inspections are carried out by specialized staff. The inspector and the IWE must be closely connected.
3rd	Selection of parent materials and welding consumables	This is crucial because it strengthens the I/EWE's ability to make decisions on the diagnosis of weld imperfections or process defects and the development of corrective/preventive procedures. For actual industrial performance, quality control, traceability, and coordination duties, it is particularly crucial. Choosing the right parent materials and welding material is crucial since improper choices might result in numerous weld defects.

2.4 Task Areas Most Difficult to Train with Traditional Methods

Which task areas are currently hardest to train effectively using classroom / textbook methods? (e.g. areas requiring physical access to equipment, hazardous conditions, rare failure scenarios, complex engineering judgment)

- Establishing welding procedures (WPS/PQR) is challenging because learners must be familiar with how parameters, materials, joint arrangement, the welding process, and quality results interact. This is difficult to understand from lectures or static pictures alone. To deliver welding procedures (WPS/PQR) correctly, experience is typically required.
- Many imperfections, discontinuities, and acceptance criteria are simpler to understand through visual or scenario-based depiction than through textbook descriptions or PDF, which makes inspection and testing of welded joints

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(NDT/DT) challenging. If a simulator offers a few scenarios pertaining to this subject, it will be quite simple.

- Non-conformances and corrective actions: This topic is extremely challenging since effective training necessitates exposure to realistic failure scenarios, root-cause examination and decision routes that are frequently uncommon or unique to a given organization. Because of this, ASR has numerous case studies in chapter 4.12 that are given by certain engineers from the industry.
- Because the most pertinent scenarios frequently entail dangerous environments, fumes, heat, electricity, restricted spaces, or unsafe sequences that are impossible to replicate in typical classroom settings, safety, health, and the environment in welding are challenging.
- Pre- and post-weld heat treatment (PWHT) is a challenging subject because dynamic visualisation, as opposed to static explanation, is better for comprehending the thermal cycle, metallurgical repercussions, sequence, and parameter sensitivity.
- When students have little experience to actual documentation packages, standards interaction, and the implementation of technical requirements into manufacturing decisions, reviewing technical requirements for welded items can be challenging. For instance, Romania has adopted many CEN and ISO standards, with only the first page in Romanian and the rest of it in English.
- The topic of subcontracting welding operations is challenging because practical workflow scenarios make it simpler to understand coordination concerns, paperwork checks, and supplier-control issues than general lectures.
- Welding personnel qualifications is hard to completly explain in the classroom unless students understand how qualification criteria relate to process compliance, supervision, production context, and auditability (standards).

2.5 Task Areas Where XR Tools Could Add Greatest Training Value

For which task areas do you believe VR / AR / MR tools could bring the most significant training benefit? Please refer to the task areas in 2.1 and explain briefly.

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Task area (from 2.1)	Why could XR add value here?	Type of XR interaction imagined (simulation / visualisation / assessment / other)
Determination of welding procedures (WPS / PQR)	The cause-and-effect correlations between process decisions, parameters, joint setup, sequence, and final weld quality could be better understood by students with the use of XR. This is particularly helpful for visualizing the effects of changing parameters without using any materials or machine time. An example an software that can be as start point : https://cspec.com/welding-procedure-software/index.html	Simulation + visualisation + assessment
Inspection and testing of welded joints (NDT / DT)	By displaying defect creation, location, morphology, probable causes, and connections to inspection results or acceptance criteria, XR may make invisible or difficult-to-understand defects easier to comprehend.	Visualisation + simulation + assessment
Non-conformances and corrective actions	By displaying defect creation, location, morphology, probable causes, and connections to inspection results or acceptance criteria, XR may make invisible or difficult-to-understand defects easier to comprehend.	Simulation + decision-based assessment
Safety, health and environment in welding	Before entering actual industrial settings, XR could assist students detect hazards and practise making the right coordinating decisions by providing safe exposure to hazardous surroundings and risky sequences.	Immersive simulation + assessment
Pre- and post-weld heat treatment (PWHT)	With animated visuals and guided situations, XR could enhance comprehension of thermal sequences, timing, and metallurgical effects.	Visualisation + simulation

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Review of technical requirements for welded products	Compared to paper-based analysis alone, XR/MR could facilitate a more spatial and contextual connection between drawings, joint geometry, welding symbols, requirements, and manufacturing consequences.	Visualisation + mixed-reality overlay

SECTION 3 — Current Use of Digital Tools in I/EWE Training

Tool type	Used?	Details
LMS / e-learning platform	[x] Yes [ ] No	Name: MOODLE
Digital course materials (beyond PDF slides)	[x] Yes [ ] No	Describe: We use interactive modules, quizzes, videos
Online examination or assessment tools	[X] Yes [ ] No	Describe: quizzes and essay questions
Any XR tool (VR / AR / MR)	[x] Yes [ ] No	Describe: There are several videos from the practical part showing welding demonstrations that use VR and AR tools
Other digital tools	[x] Yes [ ] No	Describe: We use online delivery of theoretical components with specialist trainers through Webex platform.

SECTION 4 — XR Tools Known in Your National Context

Please list any VR, AR or MR tools used for welding or engineering training in your country, even if not specifically designed for I/EWE level. For each tool, indicate which I/EWE task areas from Section 2.1 it could support.

Tool name	Provider / Country	Technology (VR/AR/MR)	Currently used for	I/EWE task areas it could	Your assessment (strengths / limitations)

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				support (Section 2.1 numbers)	
Soldomatic Simulator	1. FLX PRO WELD S.R.L(seller)/ Romania 2. Techno Volt(seller)/ Romania	VR/AR	Training courses	2,3,6,8	STRENGTHS: - Hyper-realistic AR, supports all major processes, standardized content - 56% faster training, 68% cost reduction, fewer accidents - Strong LMS, remote/offline learning, great engagement - Ideal for VET, universities, beginners & intermediates - No fumes, burns, risk-free, green tech LIMITATIONS - Cannot replicate full metallurgical behavior - High initial purchase cost - Requires technical calibration & maintenance - Less useful for expert-level real-world conditions - Less exposure to real shop-floor stressors
Lincoln Electric(VRTEXT)	DUCTIL (seller)/ Romania	VR+AR	Training courses	2,3,6,8	Strengths

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					- Highly realistic puddle, sound, sparks, slag - All welding processes + 1G—6G positions - Replay, demo, scoring, bend test - Full haptic devices, retracting SMAW stinger - Eliminates consumables; Weldometer shows savings - Dual-user model; Extensions™ upgrades - Powerful for vocational and industrial training Limitations - Cannot simulate true metal behavior, heat, HAZ - VR headset reduces physical realism vs AR - Requires instructor VR familiarity - Bulky setup (360 model) - Very high upfront cost ($73—78k)

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					- Limited by VR hardware lifespan - Advanced welders need real-booth practice
Fronius (Virtual Welding)	CMMETAL (seller)/ Romania	VR+AR	Training courses	2,3,6,8	Strengths - AR + real torches + real machine housing; realistic workflows - SMAW, MIG/MAG, TIG; steel, SS, Al - Welducation Campus with theory + tests + courses - No fumes, heat, UV; no consumables - Includes pre-/inter-/post-weld tasks - Multi-device theoretical learning Limitations - Cannot replicate true molten metal or HAZ - Lacks robotic welding modules - No multi-user simultaneous training - Limits realism of physical welding behavior

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					- More complex hardware setup - AR glasses may affect comfort and immersion

⚠ *If you are not aware of XR tools specifically for welding, please also consider tools from adjacent fields (NDT, structural engineering, quality management, industrial safety) that could be adapted to I/EWE-level tasks.*

SECTION 5 — Barriers to XR Adoption in I/EWE Training

In your national context, what are the main obstacles to integrating XR tools into I/EWE training programmes? Please rank your top 3.

#	Barrier	Severity (High / Med / Low)	Comments
1	High initial costs of XR equipment and software for training centers and companies	High	There are only a few such simulators in Romania due to their very high cost. - ASRcertpers - high school in Cadea - Comelf Bistrita - CMMETAL (seller of Fronios simulator) - Ductil Buzau (seller of VRTEXT) - FLX PRO WELD S.R.L(seller of Soldamatic) - Techno Volt((seller of Soldamatic)
2	Limited access to XR infrastructure, especially in smaller institutions	High	There are only a few such simulators in Romania due to their very high cost. As for high schools specializing in welding, the information available at ASR is that two such schools in Romania have benefited from these tools: the high school in Cadea and the technical high school in Bistrita, thanks to their collaboration with the company Comelf.

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3	Lack of trained instructors familiar with XR technologies	High	Since there aren't many simulators available in Romania, there aren't any trainers for these tools either

Examples: cost of equipment, lack of I/EWE-specific content, trainer skills, no regulatory guidance, small cohort sizes, language availability, technical infrastructure.

SECTION 6 — Enablers and Opportunities

What factors in your national context could drive or facilitate XR adoption in I/EWE training?

#	Enabler / Opportunity	Comments
1	EU funding programs (e.g., PNRR, Erasmus+) supporting digitalization and vocational training	At the national level, efforts have been made to access funds for the purchase of welding simulators; in fact, just last year, ASR provided consulting services to several high schools specializing in welding to help them access PNRR funds (national programs)
2	Partnerships with industry and XR providers for pilot projects and implementation	At various training centers, the practical component of the IWE program was carried out in collaboration with certain companies in the industry that have simulators, allowing trainees to benefit from this expertise (e.g., Comelf Bistrita)
3	Existing digital and blended-learning baseline in the Romanian I/EWE offer	Instead of presenting XR as a totally disruptive change, the blended IWE course offers a good foundation for its introduction as an extension of an already digitalized training approach.

SECTION 7 — Any Other Relevant Information

National initiatives, research projects, institutional attitudes, or anything else relevant to the use of digital / XR tools in I/EWE training in your country:

DIGIWELD project was created to:

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- Develop new digital tools and open learning systems for welding apprentices and C-VET welders.
- Update European welding curricula (IAB Guidelines) to explicitly include simulator-based education.
- Create digital modules for training apprentices aged 16—20 in TIG, MIG, and MMA welding.
- Build SIMTRANET, a networking platform connecting multiple welding simulators for collaborative and remote XR-like learning

DIGIGREEN aims to develop the skills required for digital green manufacturing, focusing on both technical and managerial content. Its core objectives include:

Supporting Industry's Transition to Digital & Green Manufacturing

The project establishes support mechanisms to help industrial sectors shift toward:

- Digitalised production systems
- Low-carbon, eco-labelled manufacturing processes

DIGIMAN's primary objective is to design a comprehensive study programme in digital manufacturing tailored to meet Industry 4.0 demands.

Provide Industry-Aligned Learning Materials

The project delivers:

- Lesson materials
- Teaching notes
- Examination systems that align academic content with industrial digitalisation requirements.

Thank you for your contribution. Your input will be incorporated into Deliverable D2.1 — State of the Art Report on XR for I/EWE Training, and will inform the design of the stakeholder survey (T2.2).

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AR/VR International Welding Engineer Qualification

WP 2 - Informational map for a study on the state of the art in VR/AR solutions for international welding engineers

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Annex A — National Fact Sheet

T2.1: Desk Research on XR Tools Applicable to I/EWE Training

Field	Response
Organization	IZV
Country	Slovenia
Contact person	Vital Uran
Date completed	15.4.2026

SECTION 1 — I/EWE Programme in Your Country

Question	Response
Name of Authorized National Body (ANB)	SDVT
Number of active I/EWE training providers (approx.)	1
Number of I/EWE candidates per year (approx.)	85
Number of active I/EWEs currently certified (approx.)	927
Training duration (hours / months)	Approx. 6 months; 441 hours in total. The programme consists of 245 hours of distance learning via Moodle Platform, 101 hours of live online lectures via Zoom, 35 hours of laboratory work and 60 hours of practical demonstrations in Slovenia. The programme is divided into 4 modules
Training format [ ] Face-to-face only [x] Blended (face-to-face + online) [ ] Fully online [ ] Other: _____	The programme is delivered in a blended format. Candidates study independently through the Moodle e-learning platform and attend live lectures via Zoom. Theoretical content (texts, films, animations, diagrams and quizzes) is

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	completed online, while laboratory work, demonstrations and practical training are performed in person in Slovenia. Moodle activity is monitored and minimum participation time is required for each module (M1: 30 h, M2: 40 h, M3: 25 h, M4: 25 h). After each lesson, candidates must complete also self-evaluation tests.
Examination format	Multiple-choice written examinations (national + international IIW part) conducted through Moodle/SEB, followed with an oral examination by a comitee via Zoom or live if required.

SECTION 2 — I/EWE Role: Tasks and Areas of Responsibility

This section is the analytical core of this questionnaire. Its purpose is to define what a welding engineer (I/EWE) actually does, so that the XR tool analysis in T2.1 can be focused on the professional tasks where digital tools can add real value — rather than on welding operator tasks or generic engineering activities.

2.1 Validation of I/EWE Task Areas

The task areas below are based on EWF-409 and IIW / ISO 14731 (Welding coordination — Tasks and responsibilities). For each area please indicate: (a) whether it applies in your country, (b) its importance for I/EWE-level training, and (c) any national specifics.

#	I/EWE Task Area	Applies in your country? (Yes / No)	Importance for I/EWE training (High / Med / Low)	National specifics / Comments
1	Review of technical requirements for welded products	Yes	High	Highly important in companies where IWE is involved in contract assessments.

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2	Selection of parent materials and welding consumables	Yes	High	Important both for companies, where the company itself is the main producer of the product and for contract assessment where the company conducts welding for for an external customer.
3	Determination of welding procedures (WPS / PQR)	Yes	High	A lot of understanding is needed in this subject, as companies can have many WPS in their QA system.
4	Qualification of welding personnel	Yes	High	One of the main tasks for welding engineers in Slovenia is to keep other welding and NDT personnel adequately trained.
5	Pre- and post-weld heat treatment (PWHT)	Yes	Med	Most of the companies wont use PWHT, but where it is used, its understanding is crucial for IWE
6	Inspection and testing of welded joints (NDT / DT)	Yes	High	As the planning of testing of the welded joints is also one of the core responsibilites of IWE engineers, this is an important aspect. Another option is that testing is done as part of the customers QA system, where understanding the testing requirements for the products, might be even more crucial for IWE, to reach the contractual obligations of the order.
7	Non-conformances and corrective actions	Yes	High	Non-conformities are a constant in the welding sector, it is up to IWE engineers to analyze the reasons for them and to offer solutions for further improvement of the process.
8	Safety, health and environment in welding	Yes	Med	In Slovenia, the responsibilities for health and safety essentially falls on company directors and health and safety officers. The reponsibility of IWE in this regard is to collaborate with health and safety personnel

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				and offer guidance on possible dangers and protective equipment to mitigate risks.
9	Subcontracting of welding operations	Yes	Med	IWE needs to know what to check from the subcontractor, if they apply relevant standards and certifications etc. but not all companies work with subcontractors of welding operations.

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2.2 Additional Task Areas

Are there I/EWE task areas in your national context NOT listed above?

- *Implementing other quality standards and product regulations (such as EN 1090, railway standards, etc.).*
- *Traceability of documentation, from basic material, to the final product*

2.3 Top 3 Most Important Task Areas for I/EWE Training

In your professional experience, which THREE task areas are most critical to develop through I/EWE training? Please refer to the areas in 2.1 or add from 2.2.

Priority	Task area (from 2.1 or 2.2)	Why is it critical to train at I/EWE level?
1st	Review of technical requirements for welded products	Even when company is a subcontractor for welding work, it is important to understand the relevant standards.
2nd	Qualification of welding personnel	Qualification of welding personnel is of critical importance, as it is a legal requirement and a fundamental element in ensuring the quality and safety of welded structures. Properly qualified personnel reduce the risk of welding defects and, when appropriate qualifications are demonstrated, contribute to lowering the manufacturer's liability by proving compliance with applicable standards and regulations.
3rd	Inspection and testing of welded joints (NDT / DT)	The need to understand what will be tested by the customer or what should we test in our welded products.

2.4 Task Areas Most Difficult to Train with Traditional Methods

Which task areas are currently hardest to train effectively using classroom / textbook methods? (e.g. areas requiring physical access to equipment, hazardous conditions, rare failure scenarios, complex engineering judgment)

- *Post weld heat treatment (PWHT)*
- *Use of welded products in harsh conditions and their failure modes (Extreme cold, or extreme heat and pressure conditions)*
- *Crack formations*

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- *Stress concentrations caused by geometric discontinuities (e.g. sharp corners, notches, weld toes) in product design*

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2.5 Task Areas Where XR Tools Could Add Greatest Training Value

For which task areas do you believe VR / AR / MR tools could bring the most significant training benefit? Please refer to the task areas in 2.1 and explain briefly.

Task area (from 2.1)	Why could XR add value here?	Type of XR interaction imagined (simulation / visualisation / assessment / other)
Determination of welding procedures (WPS / PQR)	Allows the candidate to virtually link a 3D joint design with the correct WPQR and develop a project-specific WPS without the cost of physical test coupons	Assessment / Simulation
Inspection and testing of welded joints (NDT / DT)	Provides high-fidelity visualisation of complex internal and external imperfections (e.g., cold cracking or porosity) for decision-making.	Assessment
Non-conformances and corrective actions	Enables the trainee to manage the full repair cycle: identifying a defect, specifying a repair WPS, and verifying the final quality in a risk-free environment	simulation
Safety, health and environment in welding	Offers a safe immersion into a virtual workshop to perform risk assessments and identify non-conformities (e.g., inadequate fume extraction or electrical hazards).	Simulation / Identification

SECTION 3 — Current Use of Digital Tools in I/EWE Training

Not applicable to EWF

Tool type	Used?	Details
LMS / e-learning platform	[x] Yes [ ] No	Name: LMS Moodle, with custom implementation, interactive quizzes, use statistics etc.
Digital course materials (beyond PDF slides)	[x] Yes [ ] No	Describe: materials directly implemented into LMS Moodle, with video and picture

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		materials, interactive exercises and self evaluation quizzes
Online examination or assessment tools	[x] Yes [ ] No	Describe: Tools for self-assessment are used, also exams are conducted in classrooms through the use of Moodle examination platform to instantly receive results and question statistics. Safe Exam Browser is also used to prevent students from doing anything else on their computers. All seminar works are delivered and graded directly on the moodle platform
Any XR tool (VR / AR / MR)	[x] Yes [ ] No	Describe: A soldamatic AR welder is used in IWE training, COBOT weld path simulations
Other digital tools	[x] Yes [ ] No	Describe: ZOOM platform, SEB browser,

SECTION 4 — XR Tools Known in Your National Context

Please list any VR, AR or MR tools used for welding or engineering training in your country, even if not specifically designed for I/EWE level. For each tool, indicate which I/EWE task areas from Section 2.1 it could support.

Tool name	Provider / Country	Technology (VR/AR/MR)	Currently used for	I/EWE task areas it could support (Section 2.1 numbers)	Your assessment (strengths / limitations)
Soldamatic	Seaberry - Spain	AR	Simulated welding training; real-time feedback; reduced accidents, lower training	3, 4, 8	Strengths: strong for safe introduction to process logic, torch path/positioning, and basic welding decision contexts; potentially useful as a bridge between theory and practice. Limitations: like the ISQ simulator, it is mainly geared toward welding

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			costs, shorter training time;		execution training, not higher-level I/EWE tasks such as inspection strategy, non-conformance analysis, subcontracting, or technical requirement review.
IQSIM	Norway	Simulation	Simulation of welding times and material costs with different weld designs	2, 3	Good mainly for calculating costs and project duration, it does not take into account non-conformities etc.
Fronius (Virtual Welding)	Fronius - Austria	VR+AR	Training courses	2,3,6,8	Strengths - AR + real torches + real machine housing; realistic workflows - SMAW, MIG/MAG, TIG; steel, SS, Al - Welducation Campus with theory + tests + courses - No fumes, heat, UV; no consumables - Includes pre-/inter-/post-weld tasks - Multi-device theoretical learning Limitations - Cannot replicate true molten metal or HAZ - Lacks robotic welding modules - No multi-user simultaneous training - Limits realism of physical welding behavior - More complex hardware setup - AR glasses may affect comfort and immersion

⚠ *If you are not aware of XR tools specifically for welding, please also consider tools from adjacent fields (NDT, structural engineering, quality management, industrial safety) that could be adapted to I/EWE-level tasks.*

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SECTION 5 — Barriers to XR Adoption in I/EWE Training

In your national context, what are the main obstacles to integrating XR tools into I/EWE training programmes? Please rank your top 3.

#	Barrier	Severity (High / Med / Low)	Comments
1	Cost of hardware and return on investment	High	It saves on consumable equipment, but usually buying only one simulator is not enough for bigger groups of people. Also a problem is very rare use case scenarions in IWE training.
2	Long term support	Med	Like any modern electronics, the devices go out of date relatively quickly and loose either hardware suppport or software updates essentially rendering them useless on any failure after that point
3	Lack of specific training scenarios	Med	Like described above, there are only few use case scenarios in IWE training for now, making also the ROI time longer because of limited usage of the equipment.

Examples: cost of equipment, lack of I/EWE-specific content, trainer skills, no regulatory guidance, small cohort sizes, language availability, technical infrastructure.

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SECTION 6 — Enablers and Opportunities

What factors in your national context could drive or facilitate XR adoption in I/EWE training?

#	Enabler / Opportunity	Comments
1	External source of financing investment in devices and software	If there was a possibility to support training providers to ensure finance from external sources, such as grants, national funding, the adoption of XR tools would be more efficient.
2	Reduction in consumable costs	XR allows for training in high-cost materials (e.g., Nickel alloys, Titanium) and advanced processes without material waste.
3	Reduced costs of the training course with AR/VR tools comparing to the current programme	If XR tool replaced some on-site classes or expensive practical modules, it could translate into reduction of the training price.
4	Safety-first complex training	Ability to simulate hazardous scenarios or rare structural failure cases that are impossible to replicate in a traditional classroom.

SECTION 7 — Any Other Relevant Information

National initiatives, research projects, institutional attitudes, or anything else relevant to the use of digital / XR tools in I/EWE training in your country:

- The Slovenian IWE training system has gone mostly digital, with the platform constantly evolving to include all aspects of IWE training, meaning the students only need the LMS to conduct all of their training needs (appart from the practical aspects of the training)
- AR and simulations are already used as part of the training system in Slovenia with further development foreseen in the future.
- IZV participated in IQSIM project as a testing organisation, also currently as a project partner in the IQMET project, which focuses on implementation of simulators in training for welding inspectors and fillet welders. A former project IQVET also focused

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on VET training using simulation and digital materials, which fostered knowledge exchange between swedish, norwegian, slovenian and hungarian VET providers from different industrial sectors.

- IZV has participated in many other european projects focusing on the digitalisation of learning materials for over 10 years.

Thank you for your contribution. Your input will be incorporated into Deliverable D2.1 — State of the Art Report on XR for I/EWE Training, and will inform the design of the stakeholder survey (T2.2).

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