PRESENCE

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# A toolset for hyper-realistic and XR-based human-human and human-machine interactions, PRESENCE

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## D1.1 Human centred Development Phase I Foundations, Requirements and Initial Planning

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| **V1.0** | 30-06-2024 | IMEC, I2CAT | Final formatting, minor editions, addition of the EEA report; submission to the EC through the Participant Portal |

## Executive summary

Deliverable 1.1 provides a detailed outline covering the theoretical framework and methodology for a human-centred approach. It ensures that all relevant stakeholders are involved throughout the project phases, emphasising a mixed methods approach, specifically the exploratory sequential design. Additionally, it presents an evaluation plan for all project phases, including user requirement gathering, usability and UX testing, presence evaluation, and system Ethics, Trust, and Privacy evaluation, detailing stakeholder involvement. The deliverable also includes detailed use case descriptions and scenarios for Professional Collaboration, Manufacturing Training, Health, and Cultural Heritage. These scenarios translate use case descriptions from a user perspective and are discussed in D5.1 *Integration and Demonstration I - Initial definition and planning* as well. Furthermore, preliminary results on the robustness and reliability of artificial intelligence (AI) within PRESENCE are presented, along with a register of AI components to be developed, which will be regularly updated. Moreover, an overview of the initial set of User Requirements is presented, which is based on the Use Case descriptions from the proposal, the Use Case descriptions discussed at the project kick-off meeting, and insights from co-creation workshops with consortium members. These initial requirements mark the first step in iteration. Finally, the deliverable proposes a strategic recruitment plan, incorporating the walk-through method and Guidance Ethics approach from task 1.5 including an overall recruitment strategy, a call for participation, and informed consent. The deliverable concludes by considering the next steps, given its iterative nature.

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# 1. Introduction

## 1.1. Purpose of the Document

The purpose of Deliverable 1.1 (D1.1) is to provide an overview of the goals and tasks of Work Package 1 (WP1). It will outline the required tasks and the roadmap to fulfil those tasks as described in the DoA.

## 1.2. Scope of this Document

This document aims at fulfilling Milestone 2, Deliverable 1.1: Human-Centred Development Phase I - Foundations, Requirements and Initial Planning. It will outline the theoretical framework and methodology for user-centred approach, an evaluation plan, the initial requirements, initial results for robustness and trustworthiness of AI in PRESENCE, the Use Case (UC) definition and a recruitment strategy. This document is iterative and will undergo revisions throughout the project

## 1.3. Status of this Document

The document is currently being worked on for Milestone 2.

## 1.4. Relation with other activities in the PRESENCE Project

WP1 serves as the foundation for WP2, WP3, WP4, and WP5. In WP1, we gather feedback on the prototypes developed in WP2 (Holoportation), WP3 (Haptics), and WP4 (Intelligent Virtual Humans). WP1 establishes the experimental protocols and requirements necessary to guide the integration of the technological components, leading to the creation of two demonstrators in WP5.

# 2. WP1: Human Centred Development

## 2.1. Objectives of WP1

The objectives of WP1 are:

1. To develop a sound Mixed Method Research (MMR) framework that enables methodological innovation within the field of Human-Centred Design (HCD);
2. To define and confirm the use cases (UCs) and user requirements
3. To conduct standardised usability and user experience (UX) tests for individual technical components and the integrated systems as a whole
4. To evaluate the UX of social and co-presence, both in individual technical components and integrated UCs,
5. To improve the effectiveness and efficiency, end-user satisfaction and accessibility
6. To identify ethical, trust and privacy-related issues and opportunities to guide the development of Extended Reality (XR) technologies.

## 2.2. Overview of WP1

WP1 starts M01 and finishes M36 with deliveries at Milestones MS2 (month 6), MS4 (month 18) and MS7 (month 36).

**MS2:** Entails delivery of Deliverable 1.1: Human-Centred Development Phase I - Foundations, Requirements and Initial Planning.

**MS4:** Entails delivery of Deliverable 1.2: Human-Centred Development Phase II - Intermediate User Testing, Presence Evaluation, Ethics, Trust & Privacy.

**MS7:** Entails delivery of Deliverable 1.3: Human-Centred Development Phase III - Final User Testing, Presence Evaluation, Ethics, Trust & Privacy.

## 2.3. Tasks & Key Performance Indicators (KPI) in WP1

WP1 has five tasks and four KPI's that need to be fulfilled by the end of the project. Tables 1 and 2 below provide an overview of them:

| Task | Description |
|---|---|
| T1.1 Theoretical and methodological foundation | • Providing the theoretical backbone as well as the methodological project framework<br>• Defining and streamlining the methods used for requirement gathering, user evaluation ensuring inclusion and diversity in recruitment of participants<br>• Setting up an innovative MMR design to implement in the process of requirement definition (T1.2)<br>• Combining the strengths of qualitative methods to gather requirements (internal validation) with those of quantitative methods, more specifically Multi-criteria assessment (MCA) or Multi-criteria decision making (MCDM)<br>• IMEC will lead by developing the theoretical foundations and specifying the application of MMR design for requirement gathering and evaluation within PRESENCE<br>• UHAM and UB will provide input on the methods for UC definition and technical requirement gathering (T1.2), Usability and UX testing (T1.3) and social and co-presence evaluation (T1.4)<br>• Iterative validation of the framework and the applied methodology by the project partners in the first months of the project |
| T1.2 UC and requirements definition & validation | • Defining and validating UCs and user requirements of PRESENCE<br>• Combining established HCD processes such as ISO 9241-210 [Ref. 49] with the novel framework and methodology developed in T1.1 to:<br>  ○ Identify key users of the system<br>  ○ Developing personas and mindsets<br>• Iteratively collecting feedback on the developed prototypes (cf. WP 2, WP 3 and WP 4) |
| T1.3 User Centric Approach and UX testing | • Evaluation of individual technical components and the integrated systems as a whole to better understand the drawbacks and limitations of each prototype and mock-up<br>• Performing usability studies with developers and end-users to evaluate if the provided components can be used efficiently, effectively and in a satisfying way<br>• Using qualitative and quantitative measures as developed in T1.1 |
| T1.4: Presence evaluation | • Evaluating presence (Place Illusion, Plausibility, Body ownership and co-presence) using the following methods:<br>  ○ Questionnaires to give a crude and fast indication of the responses |

| Task | Description |
|---|---|
| | of participants<br>○ Neuroscience methods to understand at a deeper level the brain mechanisms involved in responses<br>○ The psychophysical methods including reinforcement learning, in order to evaluate particular configurations of factors – in particular, for analysis of the new technological advances and their combinations<br>• Sentiment analysis to get deeper insight especially for the analysis of the UCs (WP5) where the virtual environments are considered as whole.<br>• Carrying out one experimental study with a minimum of 50 participants in each year of the project (for a total goal of 150 participants) that will feed back into the development of the technology and the design (T1.2)<br>• Completing one major study using technology in each of years 2 and 3 with at least 5 participants per study |
| T1.5: System Ethics, Trust and Privacy | • Identifying gender, ethical, trust and privacy related issues to guide the creation of PRESENCE technologies<br>• Outcome is a systematic overview of possible uses for XR technology in highly contextualised scenarios to anticipate ethical issues in the development<br>• IMEC will create an overview of different ethical themes organised by technology, UC and stakeholders so that developers can leaf through these themes to check if there are relevant themes |

*Table 1: Tasks within WP1*

| KPI nº | Description |
|---|---|
| KPI 1.1 | Provide one novel mixed-methods research strategy with inclusive and diversity-oriented recruitment plans, providing human-centred requirements and UC definition of the three pillars (WP1, T1.1, T1.2, D1.1). |
| KPI 1.2 | Analyse the three pillars in usability and UX tests with ≥ 100 participants, spanning two user groups (developers, end-users) reaching a SUS score ≥ 80 (i.e., excellent usability) and TAM score ≥ 5 (i.e., indicating high perceived usefulness and ease of use) (WP1, T1.3, D1.3). |
| KPI 1.3 | Create a novel methodology for evaluating social and co-presence at four levels, such as place illusion, plausibility, body ownership and co-presence, analysing the impact of the new technologies and UCs, relying on experimental studies encompassing, at least, 150 participants (WP1, T1.4, D1.3). |
| KPI 1.4 | Delivery of the ethics, trust and privacy strategy (by M18 in D1.2), describing the use of ethics, privacy and General Data Protection Regulation (GDPR) forms for a safe process involving end-users in the two demonstrators (WP1, WP7 - T1.5, T7.3, D1.2). |

*Table 2: KPI's within WP1*

# 3. Methodology

## 3.1. Human-Centred Design (HCD)

Within the PRESENCE project, HCD plays a very prominent role. It will be applied throughout the project to involve all stakeholders in the development of the technologies. This aims to ensure that the technologies developed in the PRESENCE project fit the needs of the stakeholders as closely as possible.

HCD is an approach that uses mixed methods to align a product (technology) with how people use it in their daily lives. Different HCD-approaches can be identified, but the following components always recur [Ref. 83]: Firstly, an HCD seeks to understand potential users. This means looking for users' needs, capabilities, limitations and goals. Secondly a product (technology) should be designed to meet users' needs. Finally, the product (technology) should be evaluated by the users.

Within this project, ISO 9241-210 (*Ergonomics of human-system interaction - Part 210. Human-centred design for interactive systems:) Human-centred design for interactive systems*) [Ref. 49], a standard for HCD, will be used. It provides requirements and recommendations on how to apply HCD principles and activities to computer-based interactive systems at every stage of their lifecycle. The primary objective of HCD is to enhance product usability, thereby maximising user satisfaction and improving the safety performance of the systems. According to the ISO standard [Ref. 49], HCD encompasses four key activity phases. Firstly, the user needs to be identified and the context of use needs to be specified. Secondly, the user requirements need to be specified. Thirdly, design solutions need to be produced to meet the specified user requirements. The last phase is to evaluate the designs according to the requirements. Through these four steps, designed solutions will meet user requirements. A key element of the HCD process is that these 4 activities are repeated iteratively throughout the process. The four stages of the HCD process are illustrated in Figure 1 [Ref. 39] .

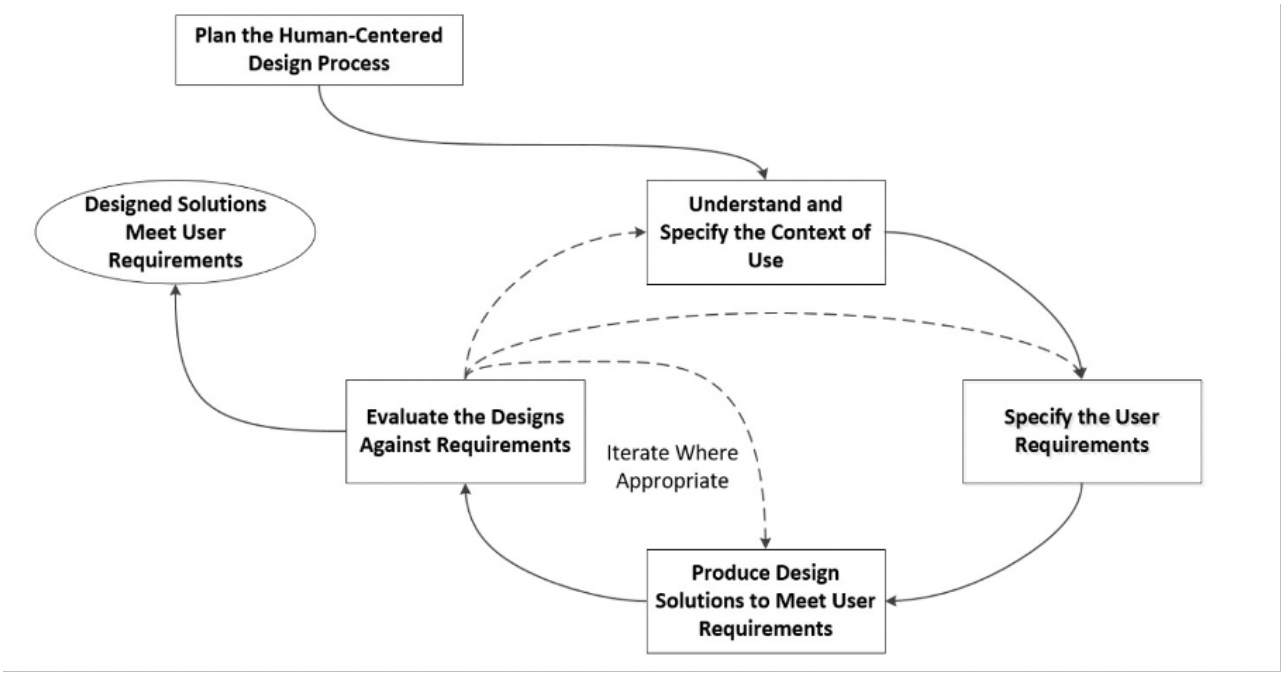


*Figure 1: 4 phases of a HCD process*

In addition, a process can only be considered an HCD process if it meets the following six requirements (Harte, 2017):

| Requirements | Descriptions |
|---|---|
| The design is based on an explicit understanding of users, tasks, and environments | Understanding users, tasks, and environments through methods like interviews and observations is crucial for HCD, as it ensures alignment with real user requirements [Ref. 1] |
| Users are involved throughout design and development | Involving users in the design process guarantees that their needs and feedback shape the final product, minimising usability issues and facilitating acceptance [Ref. 61] |
| The design is driven and refined by user-centred evaluation | Continuous user-centred evaluation via usability testing and feedback guides design improvements, ensuring the product meets user expectations [Ref. 38]. |
| The process is iterative | An iterative process with cycles of design, prototyping, and testing allows for continuous improvement based on user feedback, ensuring a user-centred final product [Ref. 64]. |
| The design addresses the whole UX | Taking into account the user's entire journey ensures seamless and satisfying interactions that meet both functional and emotional needs. This comprehensive strategy is essential for developing successful and engaging UXs [Ref. 40]. |
| The design team includes multidisciplinary skills and perspectives | A multidisciplinary team combines different areas of expertise, promoting comprehensive solutions that address all facets of the UX [Ref. 71]. |

*Table 3: Requirements for a HCD process*

## 3.2. PRESENCE HCD Methodology

PRESENCE will use HCD as its general methodological framework, according to the standard ISO 9241-210. In addition, a Mixed Method Research (MMR) design will be used for requirements gathering and evaluation. Consequently, insights will be obtained through qualitative methods and quantitative methods. This will be done to overcome the shortcomings of both methods. Qualitative methods such as co-creation sessions and interviews will be used to gain insights into users' current practices, values, attitudes and behaviours [Ref. 7]. This provides high internal validity, but on the other hand has low external validity (generalizability). Quantitative methods such as surveys make it possible to collect larger data sets which then makes external validity higher [Ref. 51]. Exploratory sequential design, a MMR design, will be applied mainly as a method. It is divided into three phases [Ref. 18]:

1. Collecting and analysing qualitative data
2. Developing and analysing quantitative data based on results from qualitative data collection
3. Using integrated findings to report on the considerations for the complex intervention

These 3 steps from the MMR approach are repeated during the project, as ISO 9241-210 indicates as an important aspect of a HCD process (ISO, 2010). That iterative process will ensure that the technologies developed in PRESENCE can be adapted and optimised based on the collected feedback. In this way, user feedback will certainly be incorporated into the various development phases [Ref. 39]. Figure 2 below shows in a visual way how stakeholders are involved in the project in an iterative way.

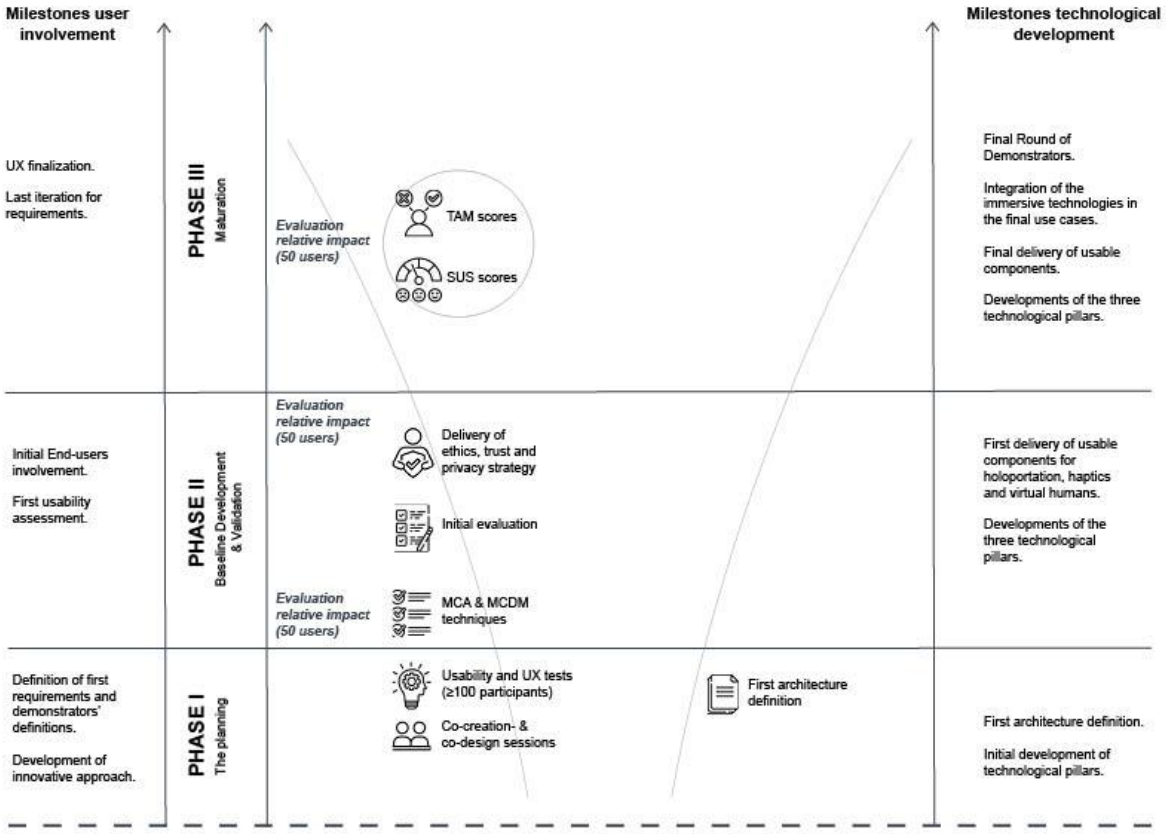


*Figure 2: PRESENCE iterative process and milestones*

The overall approach and methodology of PRESENCE can be divided into 3 phases:

- **Phase 1 - Planning (M1 - M6)**: This phase spans the first six months of PRESENCE and focuses on assessing the methodology for requirement gathering through mixed methods (T1.1). Initial requirements and demonstrator definitions are established through collaboration between the technical team and end-users (T1.2). These are then analysed and mapped to functionalities and specifications to define the project's architecture. Project management, coordination procedures, and initial exploitation and communication activities are also established.
- **Phase 2 – Baseline Development & Validation (M7 – M18):** The second phase lasts twelve months and focuses on developing the three technological pillars to deliver usable components for holoportation, haptics, and virtual humans (MS3). End-user involvement continues with usability, integration, and PRESENCE evaluation tests (T1.3, T1.4 – MS4). The first integration of technologies within UC scenarios is performed, ending with pilot demonstrations to assess technologies in real-world environments. Parallel activities include project management, strategic partnerships, and research dissemination.
- **Phase 3 – Maturation (M19 – M36)**: Covering the final eighteen months, this phase starts with the final iteration of requirements and UX definitions and outlining UC scenarios. Development continues towards the final delivery (M32), which includes the second stage of user involvement and technology integration in final UCs. The phase ends with demonstrator validations, finalising requirements, and user interface validations. Project management, strategic alliances, and dissemination activities reach their culmination, delivering final reports and joint business models (D6.3).

Figure 3 below shows the different phases within PRESENCE.

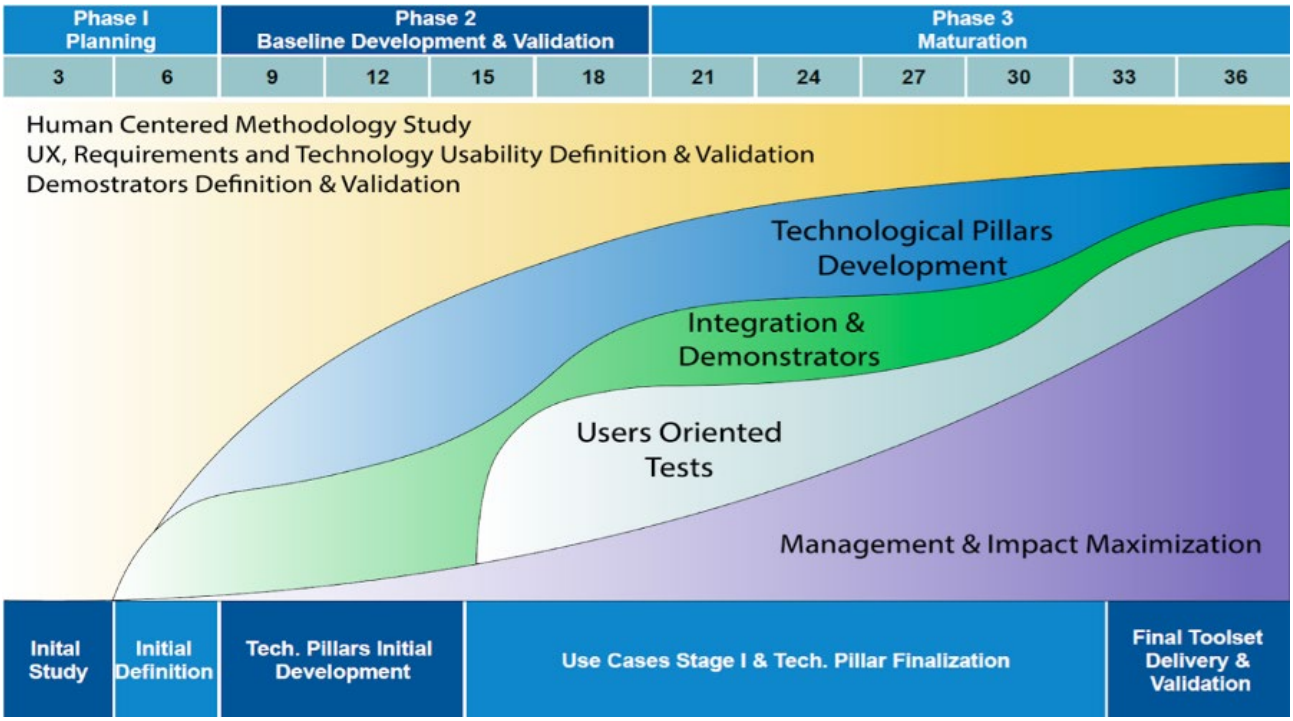


*Figure 3: PRESENCE's development methodology*

### 3.2.1. User Requirement Gathering and Prioritisation (Overall Methodology)

User requirement gathering is a critical phase in the development of the PRESENCE technologies to ensure that the final technologies meet user needs. Therefore the 4 phases of the HCD process will be used as a guideline (see Figure 1). After specifying the context of use and all potential users and stakeholders, the data collection will follow. Hence, a MMR design will be used, namely the Exploratory sequential design (as explained in Section 1.2). In alignment with this Exploratory Sequential Design framework, qualitative methods will initially be employed to gather user requirements, which describe what users need from a system [Ref. 67]. This will involve workshops, co-creation sessions, focus groups, and interviews, aiming to identify the limitations and needs of the current technology. Afterwards the user requirements will be translated into functional and nonfunctional requirements to produce design solutions to meet the user requirements. The functional requirements specify the behaviour and tasks of the system and describe in detail what the system should do [Ref. 53]. In contrast, non-functional requirements will define the quality attributes of the system, such as performance, usability and security [Ref. 16].

Following the qualitative phase, quantitative techniques such as MCA and MCDM will be utilised. These techniques prioritise design features based on weighted criteria, thereby guiding the technology development process [Ref. 72].

In the PRESENCE project, the Weight Scoring Model (WSM) will serve as the chosen quantitative MCDM technique. This method involves assigning numerical weights to different criteria based on their importance, then scoring (scale from 1-10) each (user and technical) requirement based on these criteria [Ref. 37]. The criteria to be utilised within PRESENCE include **impact**, which measures the degree to which the requirement will affect users or the product; **urgency**, indicating how critical it is to implement the requirement; **cost**, representing the estimated (economic) expense of implementation; and **technical feasibility**, assessing how technically achievable it is to implement the requirement. These criteria may be adjusted and supplemented as the project progresses. The weighted score is calculated by multiplying the score of each (user and technical) requirement by its corresponding weight and then summing all products to determine the priority of each requirement [Ref. 37].

Throughout the user requirement process, continuous feedback and revision will be crucial, ensuring that the requirements remain aligned with user needs and project goals.

### 3.2.2. UX Evaluation (Overall Methodology)

The usability and UX testing for the PRESENCE project is designed to be thorough and systematic. Our methodology combines both qualitative and quantitative evaluation methods, ensuring a comprehensive understanding of user interactions with the system. In the project, we will consider two different user groups: (i) developers, who will integrate the technical components into their UCs, and (ii) end-users, who will use the systems in the different UCs. We will create detailed user personas for both developers and end-users across each UC. In addition, we will distinguish between professional users and end users for each UC. Although both user groups will use the system, they may differ in their needs and requirements. For instance, for the health UC, we would see the therapy receiver as the end user and the therapy giver or the health professional as the professional user. Therefore, we will create a persona for each UC and also for their professional users. These personas will include demographic details, technical proficiency, user goals, and pain points. By crafting accurate and representative personas, we ensure that the design and evaluation processes remain user-centred, addressing the specific needs of varied user groups. The plan for the UX evaluation unfolds in three distinct phases: Planning, Baseline Development & Validation, and Maturation. Each phase involves specific activities tailored to meet the project's objectives and ensure an iterative improvement process.

In order to execute this methodology efficiently we will follow several strategies. First, we will follow user-centred design which ensures all design decisions are influenced by user input and requirements, maintaining an iterative loop between development and real-world usability feedback. Therefore, we will benefit from regular virtual meetings with both developers and end users. These meetings are essential for discussing progress, challenges, and incorporating iterative feedback into the development process. Finally, we will employ a hybrid testing approach by conducting both online and on-site testing to maximise flexibility and accessibility. XR research facilities located at each project partners' site (such as in i2CAT in Spain or UHAM in Germany) will be utilised to perform on-site user testing. Developed prototypes of the system, which encapsulate the three technical pillars: holoportation, haptics, and virtual humans, will form the basis for our UX evaluation, offering tangible systems for users to interact with and provide feedback on. Conducting user studies for evaluating these prototypes and mockups in various consortium countries will provide a geographical diversity to the results, ensuring that the feedback reflects a wide range of cultural and demographic backgrounds. As a result, the development process could be enriched with diverse perspectives.

The UX evaluation methods will be a mix of quantitative and qualitative methods, each of which serves a specific purpose in the overall UX evaluation. The following measures will be employed for this purpose:

- SUS [Ref. 9] [Ref. 14]: Administered post-interaction, providing a quick measure of usability perceptions. Scores range from 0 to 100, with a target of 80 or above to indicate excellent usability. SUS is a widely used questionnaire for assessing the perceived usability of a system or a product. The SUS scores have been also associated with a range of acceptability adjectives which can help determine if the usability of a system is acceptable by the users or not. This scale has been largely used in UX evaluations of XR systems (e.g., [Ref. 62] ; [Ref. 6]).
- AttrakDiff 2 [Ref. 43] [Ref. 41] [Ref. 42]: Consists of 28 items grouped into four sub-scales: Pragmatic Quality (usefulness, efficiency), Hedonic Identification (pleasure, engagement), Stimulation, and Attractiveness. This questionnaire helps evaluate overall user satisfaction and enjoyment. It has been also used in previous XR research for evaluating UX with XR systems (e.g.,[Ref. 47];[Ref. 31])
- UX Questionnaire (UEQ) [Ref. 54]: Assesses UX across six scales: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. It consists of 26 items covering

different aspects of UX, including pragmatic and hedonic qualities. The UEQ provides a comprehensive evaluation of the UX, helping designers and researchers understand how users perceive and interact with a product or system. By using the UEQ, we can gather valuable feedback to improve user satisfaction and enhance the overall UX of our developed prototypes and mockups of all three technical pillars. This questionnaire has been also largely used to evaluate the experience of the users with XR-based systems (e.g., [Ref. 81]; [Ref. 80]).

- Extended Technology Acceptance Model (TAM2) [Ref. 86]: This questionnaire is an extension of the original Technology Acceptance Model (TAM) developed by Fred Davis in the 1980s. TAM2 incorporates additional factors such as perceived usefulness, perceived ease of use, subjective norm, image, result demonstrability, and voluntariness of use to explain user acceptance and adoption of technology. The model posits that users' attitudes and behavioural intentions are influenced by these key factors when adopting new technologies. By understanding users' perceptions of a system's usefulness, ease of use, social influence, and other relevant factors, designers and researchers can predict and influence the acceptance and usage behaviours of individuals towards technology. TAM2 has been widely used in various fields to understand user behaviour and acceptance of technology, facilitating the design of more user-friendly and successful technological solutions. In the context of XR, TAM2 has been used to capture user's acceptance and their resistance towards XR systems (e.g., [Ref. 60]; [Ref. 15]).
- Questionnaires and Scales: In addition to the above-mentioned standardised questionnaires, open-set questions will be used throughout the testing phases to gather detailed feedback which standardised questions might not be able to capture.
- Focus Groups: Similarly, analysis of discussions during focus groups may provide rich qualitative data which can reflect user sentiments and preferences.
- Performance Metrics: Task completion time, precision, and accuracy are recorded to provide objective data on system efficiency and effectiveness. This metric is UC dependent and will be used in UCs in which performance metrics are relevant outcomes. For instance, Professional collaboration and Manufacturing Training UCs could benefit from this metric.
- Other metrics: We will also stay open to include further metrics that might emerge during the second and third phases of the project from focus groups and interviews with the users.

Our chosen methodology combines both formative and summative evaluation techniques, distinguishing it from approaches that might focus solely on one type. Formative evaluations, conducted during the design process, facilitate continuous improvement, while summative evaluations, conducted after system development, provide an overall assessment of usability. Previous research [Ref. 73] emphasize the importance of combining formative and summative evaluation methods to cover all aspects of the UX. By incorporating both types of evaluations, we ensure iterative improvements and comprehensive system assessments. Furthermore, we will include diverse testing locations and varied users which will allow for a more holistic understanding of usability across different contexts and demographics. Including diverse users helps to uncover a broader range of usability issues, ensuring the system is robust and meets the needs of all potential users. This is supported by broader UX literature, suggesting that diverse user involvement is crucial for comprehensive usability testing [Ref. 55] [Ref. 74]. Finally, we will combine quantitative and qualitative methods which ensures a thorough evaluation. Quantitative measures (e.g., SUS, TAM2) provide objective data, while qualitative methods (e.g., focus groups, open-ended questionnaires) offer deeper insights into user perceptions and experiences. This mixed-methods approach is supported by research from Plano Clark [Ref. 66], who advocate for combining different data sources to gain a comprehensive understanding of the research problem.

All in all, the UX evaluation methodology for the PRESENCE project is designed to be extensive and iterative, ensuring that both individual components and the integrated system achieve high usability

and user satisfaction. By employing a mixture of quantitative and qualitative methods, conducting diverse and iterative testing, and maintaining continuous feedback loops, we will ensure that the final system has a high usability and is accepted by end-users and developers.

### 3.2.3. Trustworthiness and Robustness of AI (Overall Methodology)

The activities related to trustworthiness and robustness of AI are coordinated by T1.3. The analysis to be done, the assessment needed and the measures to be taken depend strongly on the type of AI approach, the level of human oversight and the risk related to the use of the component. Most of the activities need to be performed by the developers of the respective AI components, who have full access and deep insight into the components' function. This section lays out the process that T1.3 has put in place in order to ensure that these activities are performed in following a common approach in the project.

In order to monitor the need for assessment, PRESENCE has established a registry of AI components to be developed in the project. The registry collects the following information for each component:

- Identification and description: title and brief description of the component as well as responsible task and partner
- Risk-level: self-assessment of the risk level according to the classification in the AI Act [Ref. 26]
- Data source(s) for training: whether the dataset(s) used are own datasets of the responsible partner, public research datasets of EU or non-EU origin, or from other sources
- Decision made by AI: A brief description whether the AI component performs a decision, and if so, what is the consequence of the decision
- Human oversight: A brief description whether there is human oversight, and how this interaction is done.
- Explainability features planned: Whether there are plans to implement explainability features, and a brief outline of them, if applicable.

The registry[1] has been initially populated in M5 and will be regularly updated throughout the project.

We aim to perform trustworthiness assessments for all AI components developed in PRESENCE. In addition, bias analysis methods will be applied to selected datasets and AI components, when this is determined to be relevant. We discuss approaches for these two tasks in the remainder of this subsection.

#### *3.2.3.1. Trustworthiness Assessment*

For the assessment of the trustworthiness of the AI components developed in PRESENCE, the consortium will apply the Ethics Guidelines for Trustworthy AI developed by a High-Level Expert Group on AI and published in April 2019 by the European Commission. These guidelines provide a practical approach to assess the following key requirements [Ref. 24]:

- ***Human agency and oversight***: AI systems should empower human beings, allowing them to make informed decisions and fostering their fundamental rights. At the same time, proper oversight mechanisms need to be ensured, which can be achieved through human-in-the-loop, human-on-the-loop, and human-in-command approaches.

[1] Notice to the attention of the EU Officers and external reviewers: most of the below URL links direct to the project Repository and thus with access limited to the project consortium members. The documentation is available under demand, contact info@presence-xr.eu

- ***Technical Robustness and safety***: AI systems need to be resilient and secure. They need to be safe, ensuring a fallback plan in case something goes wrong, as well as being accurate, reliable, and reproducible. That is the only way to ensure that also unintentional harm can be minimized and prevented.
- ***Privacy and data governance***: besides ensuring full respect for privacy and data protection, adequate data governance mechanisms must also be ensured, taking into account the quality and integrity of the data, and ensuring legitimised access to data.
- ***Transparency***: the data, system and AI business models should be transparent. Traceability mechanisms can help achieve this. Moreover, AI systems and their decisions should be explained in a manner adapted to the stakeholder concerned. Humans need to be aware that they are interacting with an AI system and must be informed of the system's capabilities and limitations.
- ***Diversity, non-discrimination, and fairness***: unfair bias must be avoided, as it could have multiple negative implications, from the marginalisation of vulnerable groups to the exacerbation of prejudice and discrimination. Fostering diversity, AI systems should be accessible to all, regardless of any disability, and involve relevant stakeholders throughout their entire life circle.
- ***Societal and environmental well-being***: AI systems should benefit all human beings, including future generations. It must hence be ensured that they are sustainable and environmentally friendly. Moreover, they should consider the environment, including other living beings, and their social and societal impact should be carefully considered.
- ***Accountability***: mechanisms should be put in place to ensure responsibility and accountability for AI systems and their outcomes. Auditability, which enables the assessment of algorithms, data and design processes plays a key role therein, especially in critical applications. Moreover, adequate and accessible redress should be ensured.

These guidelines are complemented by the Assessment List for Trustworthy AI (ALTAI), which is also available as a web-based tool [Ref. 25]. In previous use of the online ALTAI tool we observed some limitations that apply in particular when using it in the context of a research project.

- ***Static question list*****:** Some aspects may not apply to the services being assessed; however, dependent questions are not removed in the tool when the answer to an earlier question makes them obsolete. Thus, answers to these questions may result in a lower score, even if they are not relevant. It is thus necessary to check the detailed responses in ALTAI rather than just the overall score.
- ***User interaction*****:** ALTAI assumes that an entire system that comes with a user interface is being assessed. For components that are services that provide a quite limited API some questions are not applicable.
- ***Deployment status*****:** ALTAI assumes a system deployed for productive use, and asks, e.g., about continuous monitoring of quality, training of users, monitoring whether users understand the system's decisions, etc. Many of these aspects are not applicable in the prototype stage of a research project.

Despite these limitations, which are more due to the online tool implementation than due to the underlying methodology, ALTAI is a useful tool, as it provides an effective and easy to use way of enabling developers to analyse the aspects that apply to their AI tools and to think about measures for improving the trustworthiness of these tools. While some aspects covered by ALTAI are not directly accessible for a research prototype or a service not yet tested in its intended workflow, it is still useful to make the developers of the AI components aware of these aspects early on in the process.

#### 3.2.3.2. *Bias Analysis*

Bias analysis is a critical aspect of ML and data science, which aims to identify, quantify, and mitigate the biases that can occur in data and models. Bias can significantly impact the performance, fairness, and interpretability of ML models, leading to skewed or unfair outcomes. This document provides a comprehensive overview of bias analysis, covering various forms of bias, key definitions and metrics, analysis methods and tools, and mitigation strategies.

##### 3.2.3.2.1. Sources of Bias

Bias can be encountered at various stages in the ML workflow (see Figure 4). It begins with inherent bias in the real world, which leads to potentially skewed observations. These observations then contribute to the generation of data, which may also be influenced by bias. This data is subsequently utilised by a learning mechanism that could be biased itself, resulting in the creation of a model [Ref. 46].

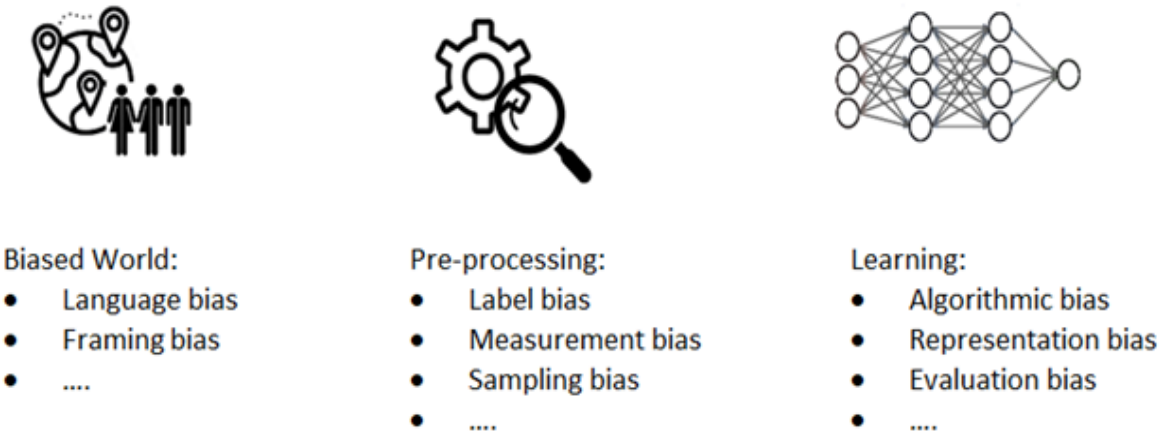


*Figure 4: Bias can be encountered at various stages in the ML workflow*

**Language bias:**

Language bias refers to the potential for biased results or misinterpretation due to the inherent limitations and biases of human languages. These biases can arise from a variety of sources, such as cultural, social and historical factors that influence how languages are structured and used.

**Framing bias:**

Framing bias refers to the observation that the manner in which data is presented can affect the result. For example, if a ML model is trained to predict whether a patient has a disease based on a dataset where the majority of patients have the disease, the model might be biased towards predicting the presence of the disease.

**Label Bias**:

This happens when the labels used for classification problems are biased. For example, if a human annotator consistently labels certain types of images incorrectly, this can introduce bias.

**Sampling Bias**:

This occurs when the method of selecting training data favours one outcome over another. For example, if a model is trained on data collected from a specific location or time period, it may not generalise well to other locations or time periods.

**Measurement Bias**:

This type of bias occurs when the data collected is systematically off-target from the true values. For example, if a sensor used to collect data is faulty and consistently overestimates a measurement, this can introduce bias.

**Algorithmic Bias**:

This type of bias arises from the assumptions and simplifications made by the algorithm itself. For example, a linear regression model assumes a linear relationship between the input and output variables, which may not always be the case.

**Representation Bias**:

This is the bias that comes from the way the model represents the problem space. For instance, decision trees tend to create boundaries that are parallel to the axis, which might not always be the best representation of the data.

**Evaluation Bias**:

This type of bias occurs when the evaluation metric used to assess the model's performance doesn't fully capture the model's objectives. For example, accuracy might not be the best metric for imbalanced datasets.

**Bias due to Overfitting or Underfitting**:

Overfitting occurs when the model learns the noise in the training data, making it perform poorly on unseen data. Underfitting, on the other hand, happens when the model is too simple to capture the underlying patterns in the data.

#### 3.2.3.2.2. Fairness

The definition of fairness can vary depending on the situation. A statistical notion of fairness is easy to measure, but statistical definitions are not always sufficient. Most of the valuable statistical metrics require verified outcomes, which may not always be available or consistent in real classified data [Ref. 88]. The choice of fairness metric depends on the specific context. A decision tree proposed for the Arize Tool [Ref. 2] is shown in Figure 5. The first question to consider is whether your business problem requires addressing disparate representation or errors. Disparate representation occurs when different groups or subpopulations are underrepresented or overrepresented in the training data used to build the ML model, leading to biased outcomes for these groups. Disparate errors occur when an ML model's performance varies significantly across different groups or subpopulations, which can lead to biased outcomes for some groups and worse predictions for others. Disparate errors occur when an ML model's performance – such as accuracy, precision, recall – vary significantly across different groups or sub-populations. A more detailed version of the decision tree can be found in the Aequitas Tool documentation [Ref. 19].

Bellamy et al. (2019) [Ref. 11] discusses two opposing worldviews on group fairness. These can be roughly summarised as "We're All Equal" (WAE) and "What You See is What You Get" (WYSIWYG). The WAE worldview holds that all groups have the same abilities, while the WYSIWYG worldview holds that observations reflect the abilities of groups. If the UC follows the WAE worldview, use the demographic parity metrics (such as *disparate_impact* and *statistical_parity_difference*). If the UC follows the WYSIWYG worldview, use the equality of odds metrics (such as *average_odds_difference* and *average_abs_odds_difference*). Other group fairness metrics (often labelled "equality of opportunity") lie in between the two worldviews. The classification of the UC and the choice of metrics will depend on the specific context in which an AI component is used, rather than making a general choice across the project.

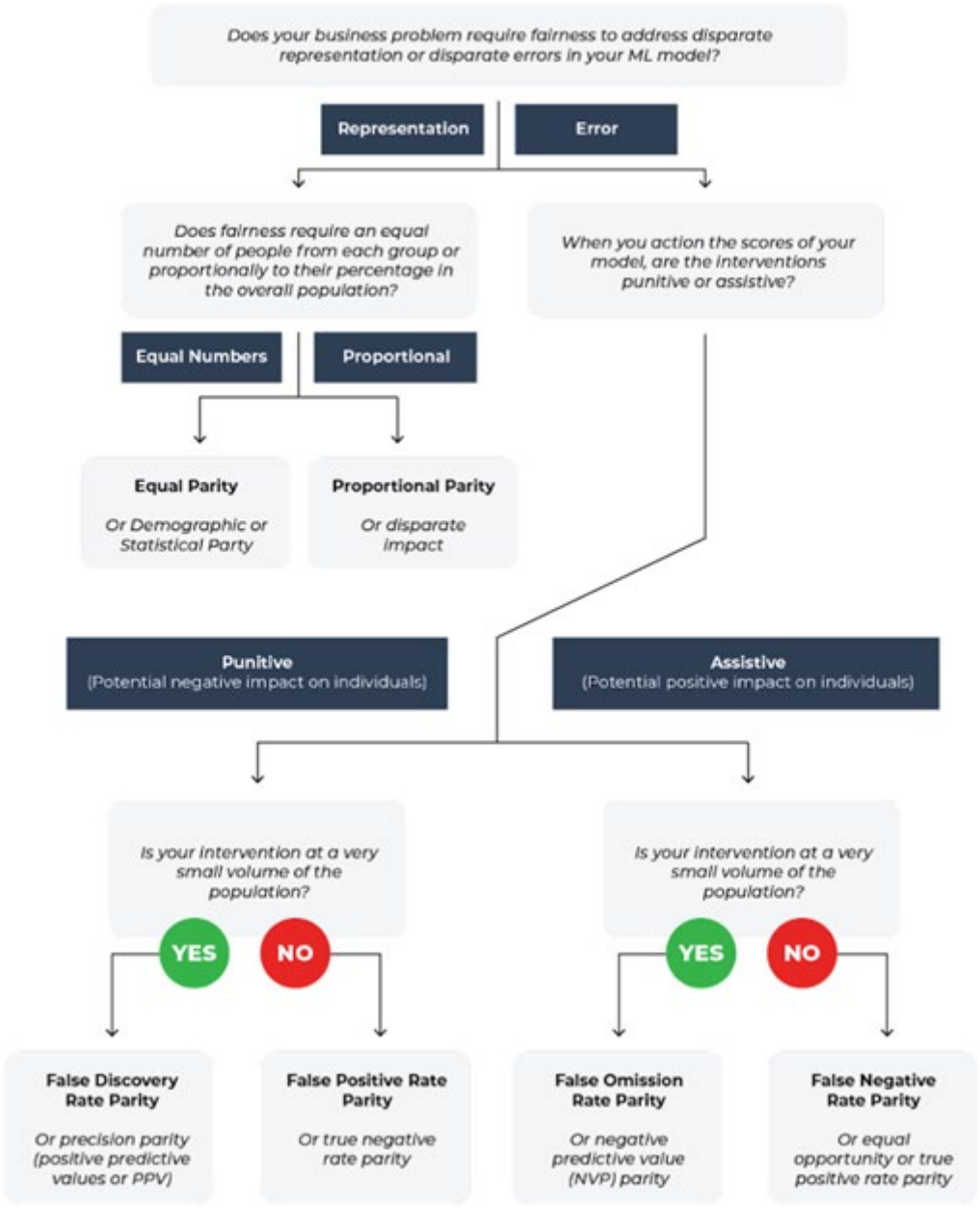


*Figure 5: Decision tree for choice of fairness metric proposed for the Arize Tool.*

A number of bias analysis toolkits exist, which differ in terms of the types of data they support, the bias analysis methods supported and types of tasks for which they are suitable. PRESENCE will review the state of the art of open source tools, and select appropriate tools for the cases in the project that will require bias analysis.

### 3.2.4. Presence Evaluation (Overall Methodology)

This task will concentrate on three evaluation methods with respect to how people respond to the scenarios in terms of 'presence' (Place Illusion, Plausibility, Body ownership and copresence). Recall that Place Illusion (PI) is the illusion of being in the virtual place depicted by the displays, and is dependent on the extent to which natural sensorimotor contingencies for perception are afforded by the immersive system. Plausibility (Psi) is the illusion that virtual events are really occurring [Ref. 76] [Ref. 77] and depends at least on how much reactivity there is to the actions of the participant in the

environment, and that events in the environment accord with expectations. Both PI and Psi are qualia that include the sensation of being in the depicted place, and that events are really occurring, in spite of the participant's sure knowledge that this is not the case. Body ownership is the illusion that the virtual body that may substitute the participant's own body is their body (again, in spite of knowing that this is not the case). This is based largely on multisensory integration (for example, visuomotor synchrony where the body moves synchronously with the participant's real movements, and visuotactile synchrony where objects seen to collide with the virtual body are felt synchronously on the real body) [Ref. 13]. Body ownership has been shown many times to occur within VR, even when the virtual body does not look like the actual person – e.g. [Ref. 8]. Finally, copresence is the illusion of being present in an environment with other people in shared virtual meetings. It is essentially a corollary of PI (the perception of others being in the virtual space), Psi (the virtual bodies of others respond to the participant and depict expected behaviours – such as changes in facial expression and appropriate movements), and body ownership (the relation between the self and the virtual body is the same for all participants and assumed to be the same by all participants).

We will evaluate the impact on presence of the technological advances introduced in this project using three different methods. These same methods could be used for any other qualia related to the responses of people to the virtual environment. The first method we refer to as Multimodal Matching (3M) or Adaptive Multimodal Matching (A3M), the second method is the use of sentiment analysis, and the third is the use of Electroencephalogram (EEG) to obtain brain activation, especially with respect to copresence. We describe each of these in turn.

#### *3.2.4.1. Multimodal Matching*

A method based on the impact on any component of presence (or any other quale) of real-time changes in various factors in the scenario (such as the level of visual realism, the field-of-view of the display, and others) was introduced by Slater, Spanlang and Corominas [Ref. 79]. This method offers the participant a number of system configurations, for example: wide field-of-view or narrow field-of-view, realistic visual rendering or simple visual rendering, vision from first- or third-person perspective, having a virtual body or not having one. The original idea of the method is that at any moment the virtual environment is constituted by $k$ such factors $F_{i1}, F_{i2}, \ldots, F_{ik}$ forming a *configuration* $C_i$. If each factor is binary then $i = 0, 1, \ldots 2\hat{}k - 1$. For example $F_{i1}$, is either 0 (monovision) or 1 (stereovision). The participant first enters the environment with all factors at their highest level $C_H$ (e.g., $F_{H1}$ is stereovision) and pays attention to the corresponding sensation of PI. They are also trained on the meaning of the various factors and how to change their levels. Then they enter the environment now with all factors at their lowest or at randomly chosen levels $C_0$. At various times during their exposure they are able to change the level of one of the factors (under a cost constraint) in order to attain the sensation of presence that they had during their exposure to $C_H$. Each such change leads to a transition $C_i \longrightarrow C_j$. They continue to make transitions until they declare a *match* with their original sensation of presence while they experienced $C_H$. From this, over all participants, we obtain a large number of transitions from which we can compute a $2\hat{}k \; x \; 2\hat{}k$ Markov probability matrix $P$with elements $P_{ij}$ , the probability that conditional on the configuration being $C_i$ that the next configuration would be $C_j$ (including the possibility that $i = j$). From these data various interesting probabilities can be computed, for example the equilibrium state of the Markov chain, and conditional probabilities such as $P(match\ I\ C_i)$, the probability of a match being declared given that the current configuration is $C_i$ . We refer to this method as the Multi-Modal Matching (3M) method.

The method was extended by Llobera et al. [Ref. 59] where instead of participants directly choosing which element in a configuration to change, changes were offered to them by a Reinforcement Learning (RL) agent. The agent initially offers configuration changes at random, but then, depending on participant choices (to accept a proposed change or not) eventually converges, meaning that it has estimated probabilities of participants accepting proposed changes, and thus is unlikely to propose changes with low probability of acceptance. Across many participants a consistent pattern of selected configurations emerges. We refer to this as Adaptive 3M (A3M).

The 3M method was also used by Azevedo, Jorge and Campos (2014) [Ref. 3] who examined the impact of 4 factors (vision, hearing, haptics and olfaction) on PI and Psi in the context of virtual environments that depicted outdoor scenes. They also combined the method with the use of EEG monitoring. Bergström, Azevedo, Papiotis, Saldanha and Slater [Ref. 12] used the method to examine the impact on Psi of a virtual string quartet of the factors gaze (whether or not the musicians sometimes looked towards the participant), sound spatialization (Mono, Stereo, Spatial), auralization (no sound reflections, incorrect or correct sound reflections in relation to the virtual room), and environment (no outside sounds, or sound that corresponded to the setting). Skarbez, Neyret, Brooks, Slater and Whitton [Ref. 75], in the context of participant interaction with virtual human characters, also examined the impact on a variation of Psi referred to as 'coherence' of the behaviours of virtual human characters and other objects, as well as that of their own virtual body. Debarba, Chagué and Charbonnier [Ref. 20] examined the impact on Psi in relation to a virtual human and of a self-avatar of various aspects of their animation - the face, hands, upper body and lower body of the character.

The method can be used for any qualitative response to a VR experience, not just presence. For example, Murcia-López et al. [Ref. 63] required participants to change factors in the configuration to optimise the quality of their experience – where they observed a virtual human giving a presentation and could manipulate the eye gaze, blinking, mouth animation, and micro expressions of the virtual speaker. Gao, Kim, J. and Kim, H. (2018) [Ref. 35] examined the impact on the level of believability of a virtual rock climbing environment of the visual appearance of the rocks, the overall visual scene, the environmental sound and dynamic behavioural factors. Fribourg, Argelaguet, Lécuyer and Hoyet (2020) [Ref. 33] used the method to discover preferences for embodiment in a self-avatar of type of its appearance, control over it and perspective position. Gonçalves, Melo, Monteiro, Coelho and Bessa (2023) [Ref. 36] required participants to optimise the feeling of being in a virtual room that was a replica of a corresponding real room that they had experienced, where they could switch amongst illumination rendering methods (global illumination, ambient occlusion, screen space reflections and direct shadows) finding that global illumination was the most effective. In an XR environment Lim and Ji [Ref. 57] considered presence as the illusion of being co-located with surrounding objects and the impact of four factors on this (force feedback, occlusion, lighting, and material properties).

Combining 3M with Reinforcement Learning, leading to what we have called A3M, was first introduced by Llobera et al. [Ref. 59]. An advantage of A3M is that the process of participant choice selection amongst configurations is automated. They do not have to remember which possible changes might be made, since at each change-point the specific alternatives offered can be demonstrated and their impacts can be experienced before the choice is made. This is more important the greater the number of factors. However, the disadvantage is that a large number of trials might be needed for convergence, though this has not occurred in our applications to date, albeit with a small number of possible factor changes. Although 3M results in a Markov Chain which is a probabilistic model of participant choices, the A3M method produces a further probabilistic model which is the *policy* associated with the RL. This is the set of probabilities associated with which transitions will be offered in the context of each configuration that maximise the long-term reward to the RL. Although we have not made use of this before, it may be useful.

#### *3.2.4.2. Sentiment Analysis*

Sentiment analysis [Ref. 5] is a ML technique based on assignation of numerical scores to words in massive dictionaries. Each word is assigned a positive or negative valence. A score is derived for each piece of text, for example, as the average score over all the relevant words in the text, though modified by natural language analysis, for example, to take account of negations. Thus, sentiment analysis employs natural language processing, text analysis, and computational linguistics in order to give, for example, a greater score to 'it was very good' compared with 'it was good' and to understand that 'it was not very good' has negative sentiment, and thus a lower score than each of the previous two examples. Of course, it also deals with much more complex sentences than these.

There are many different sentiment analysis methods, Rinker (2021) [Ref. 70] includes a comparative evaluation of several sentiment analysis packages. In previous work [Ref. 10] we used 4 different sentiment analysis packages available through the R statistical programming language. This was to capture different nuances of sentiment that vary between different approaches. We used sentimentr [Ref. 70], the VADER system [Ref. 48] with the R implementation by Katherine Roehrick, the syuzhet package [Ref. 50] and Sentiment Analysis [Ref. 29] [Ref. 30].

After their immersive experience participants are either interviewed or asked to write a commentary on their immersive experience. The sentiment analysis is applied on these texts. By applying, for example, each of the 4 sentiment methods mentioned above to these texts we obtain a $n\ x\ 4$ matrix $S$, where $n$ is the number of texts and the 4 columns are the sentiment scores produced by the 4 packages. Then k-means cluster analysis can be used to find subsets of the texts that have similar scores, and these clusters can be visualised by finding the first two principal components of $S$,, and then plotting a scatter diagram of one against the other. It is then possible to identify the clusters through computation and rendering of the convex hulls around the points representing each cluster. Finally, we can use the udpipe package [Ref. 85] [Ref. 84] and in particular dependency parsing, which finds nominal subjects and the adjectives that describe them, and these can be summarised as word clouds. We can use the lexRank [Ref. 23] method to summarise the text in the clusters.

Using this method in earlier work led to discoveries about the deep reactions of participants to a virtual music concert scenario that we would not have found in any other way [Ref. 10]. For example, when placed in the audience of a virtual concert participants reported a high level of Psi (they responded as if the events taking place were real). However, from the sentiment analysis we found that for some participants this was an affectively negative experience – for example, participants felt alone (they normally attend concerts with friends or family) and women participants felt anxious about the apparent glances of the entirely virtual men around them in the audience. Thus, in the PRESENCE project we will use sentiment analysis to get behind the surface statistics in order to understand participant responses at a deeper subjective level, yet nevertheless using quantitative techniques.

#### *3.2.4.3. EEG-eye-tracking hyperscanning*

As well as other physiological measures of arousal (e.g., skin conductance levels or heart-rate), brain activation has also been measured with EEG, more specifically using multichannel Event-related brain potentials (ERPs) and decomposition of oscillatory brain activity [Ref. 4]. One study suggested that placing participants in a stressful situation in VR can lead to extreme stress as indicated by brain activation responses Ref. 27]. A new avenue for testing the idea of copresence (PI / PSI) is to use new hyperscanning EEG-based techniques [Ref. 4] that allow the synchronous recording of EEG in a small group of individuals while performing a specific common task. Using multiple EEG portable devices (e.g., using Emotive multichannel Headsets), it has been previously possible to study groups of participants and evaluate their level of intersubject brain synchrony (using inter-subject correlation -ISC- analysis and previously introduced for functional magnetic resonance imaging using in naturalistic stimuli [Ref. 44. For example, a couple of recent naturalistic multi-subject studies showed that students EEG brain-to-brain synchrony measures reflected the degree of engagement of students in a classroom setting (as well as observing patterns across participants regarding their likeness of other participants and the teacher) [Ref. 69] [Ref. 22]. Thus, EEG-ISC can be used across small groups to evaluate the degree of engagement and alignment to a particular situation (current task).

We will use EEG-ISC and related EEG measures (OA) as a proxy for the evaluation of plausibility, in the sense that higher synchrony and more brain-to-brain alignment across actors in a XR setting could indirectly indicate engagement in the current task (“sense that something is really happening”). Importantly, ISC could also reflect the amount of likeness or enjoyment in a particular task, as it also reflects the degree of shared attention (increase ISC) within the group. This approach could provide a promising new avenue to indirectly investigate the neuroscience of a “wild-type” group interaction in a XR setting in ecologically natural circumstances. Importantly also for PRESENCE aims, ISC

analysis could also be applied to the analysis of time-series of eye-tracking data obtained across participants in the same experimental conditions. Indeed, across participants eye-movements become highly coupled during natural, task-free vision, suggesting similar goal-directed visual sampling strategies [Ref. 45].

In order to validate the use of ISC as a neural marker of the PSI, we aim to obtain three type of evidences using VR-setting EEG-eye-tracking hyperscanning:

1. Provide convergent analysis using self-reported questionnaires (plus sentiment analysis) about the experience during or after a particular task and ISC-EEG synchrony measures in a virtual meeting (3-4 multi-subject simultaneous recording);
2. Evaluate the convergence of the ISC-EEG measures with other eye-tracking recording measures available in head-mounted displays and indirectly measuring attention engagement.
3. Evaluate the usability of ISC-EEG (plus eye-tracking measures) under different XR conditions that we know might affect co-presence (PI/PSI). With this aim, different experimental XR environments will be used, from random interactions, externally triggered attention-grabbing conditions (movie, listening to a teaching speech, etc.) and controlled interactive conditions (interactive games; guided turn-taking interactions).

Methodological development of VR-setting EEG-eye-tracking hyperscanning experiments:

Pilot experiments. Initial VR settings will be designed to prove the validity of the use of ISC-EEG measures/eye-tracking and self-reported qualia measures (PI/Psi). For first piloting this new methodology, 3-4 participants will be situated in different rooms and each of them will be joining a virtual meeting. EEG multichannel recordings (using 32-electrodes for each participant, BrainAMPs systems) will be used. Each subject EEG recording will be connected to a different amplifier. Triggers will be sent to each amplifier and derived from a mother-head mounted display, releasing the trigger as relevant visual information is presented and associated to the different experimental conditions (triggers are used to synchronise EEG recordings for later ISC-EEG analysis). The first pilot experiments will consist on variations of three different experimental conditions: (i) a *resting-state conditions* (10 min-duration), in which participants are present in the meeting but with the instructions to rest and not to do any specific task; (ii) *Movie watching*, in which participants will be focused watching a 10-min duration movie [Ref. 44]; and (iii) an *interactive Game condition*. Initial analysis will compare the movie observation condition which has been previously observed to create optimal environments for brain intersynchrony (strong EEG-ISC) with the Resting-state condition, in which no brain synchrony might be expected due to its natural randomness (lack of interaction between participants or common external triggering information). Finally, the Game situation will allow to pilot the potential use of EEG-ISC plus eye-tracking as a measure of interaction and its relation to the feeling of co-presence (PI and Psi).

#### *3.2.4.4. Evaluation of presence in the UCs*

The UC scenarios will evaluate presence using the 3 methods described in Section 3.2.4 All the UCs involve multiple participants in the same virtual scenario. Therefore, the more interesting aspect to evaluate is co-presence (the illusion to be with others) rather than just Place Illusion. However, the methodology can be used for evaluation of any preferred qualia. The objective is to discover whether the technology developed in PRESENCE has advantages over existing techniques. Here we concentrate on Holoportation, Haptics and Avatars, and we will use the techniques discussed in Section 3.2.4. We consider each in turn:

**A3M (Adaptive Multimodal Matching)**

In the UC scenarios the factors are:

*Transportation* with 2 levels: (i) The technology Holoportation developed in PRESENCE and (ii) using an existing method such as passthrough in the Quest devices.

*Haptics* with 3 levels: (i) The technology developed in presence Haptics, (ii) A simpler already existing haptic technology, and (iii) no haptics.

*Intelligent Virtual Agent* (IVA) with 3 levels: (i) The volumetric avatars developed in PRESENCE, (ii) An alternative mesh based avatars such as those available at UB (for example, as shown in [30]), and (iii) Normal cartoon avatars for example, as used in Horizon Worlds.

In the scenarios the most important aspect is not 'presence' as Place Illusion (the illusion of 'being there'), but co-presence, the illusion of being present with other people.

Moreover, using the A3M methodology in the context of a multi-person meeting is a new challenge for the methodology, which in the past has only been used with individuals. The method can be adapted to the UC scenarios and actually become part of the collaborative task of the participants.

We propose that there will be a screen in the scenario displaying information. Every so often (to be determined in pilot experiments) the screen will offer the participants the chance to change the level of one of the 3 factors above (Transportation, Haptics and IVA's). The participants will be able to flip between the two alternatives offered (for example between the current configuration [Holoportation, haptics, Mesh Avatars] and the new proposed one [Holoportation, haptics, Volumetric Avatars] ). The participants must agree on which configuration to choose – Current or New. After they have agreed, the scenario will maintain the new configuration and later on another similar choice will be made.

Hence a sequence of transitions will be obtained, and the method will proceed as described in Section 3.2.4.1 will be used.

**Sentiment Analysis**

For sentiment analysis we will ask participants to write brief essays describing their experience, especially concentrating on the final configuration reached. The methods described in Section 3.2.4.2 will be used.

**EEG-eye-tracking Hyperscanning**

For EEG-eye-tracking hyperscanning, 3-4 multi-subject EEG recording will be carried out in different experimental conditions and in order to obtain ISC-EEG measures. The degree of relationship between these measures and self-reported evaluation of co-presence illusions will be reported.

### 3.2.5. System Ethics, Trust & Privacy (Overall Methodology)

The system ethics and trust assessment identify gender, ethical, trust and privacy related issues to guide the creation of PRESENCE technologies. Assessment activities will be conducted to better understand how users feel about a given technological change in their lives, how users expect to interact with the technology and system, and what the users' goals are in using the PRESENCE technology. For these assessments we will mainly focus on the end users and professional users as relevant stakeholders, who will be using the technology/system in the different UCs. These assessment/evaluation activities will be conducted in combination with user requirement gathering, since the users will be giving input on how the developed technology/systems can be improved to meet their expectations and needs. The system ethics and trust assessment/evaluation will be involving more than 100 participants from both user groups for all UCs. The methods that mainly will be used to conduct these activities are the walk-through method [Ref. 56] and the Guidance Ethics approach [Ref. 87]. The walk-through method is used to dig deeper into how technology frames users' self-expression, relationship, and interaction with a given technology, and it provides a systemic approach to look at how/whether certain components might have been overlooked in its development [Ref. 56]. As the users interact with the technology, these aspects can be better revealed and can thus inform how the technology can be further improved/developed. For this method we will conduct workshops and think aloud sessions in which users will be introduced to the PRESENCE technology and then given the opportunity to try it out themselves and give feedback on how they experienced the technology. The Guidance Ethics approach is used as a 'normative

guidance' of technology in society and where ethics guide society in how to deal with the technology [Ref. 87]. Here, we want to see how users interact with the technology and how this interaction is different (or not) from the way it was initially intended. In investigating how users use and interact with the technology, as well as reflect on possible social implications and central values, we are guided by the input/feedback on how to improve and further develop the technology within the project. For this method we will conduct workshops, focus groups, and think-aloud sessions to gather input and feedback from users.

# 4. Implementing HCD in the PRESENCE UCs

In the following sections, we will give an overview of the planning per UC that shows how our overall methodology will be implemented in each UC. Therefore, we will provide a scenario of use, personas, opportunities and threats as well as detailed UX evaluation activities for each UC. The developed personas cover end and professional users along with a developer persona. For the developer persona, we initially drafted general developer personas for each technical pillar in addition to one that uses all technical pillars for all UCs. These personas are presented in the Adjunts' Section 11.1. However, during the course of our user requirement workshops during 24.4-26.4, we realised that a developer persona for each UC that uses all technical pillars for the purpose of creating each specific UC would result in more accurate user and technical requirements. The specific developer personas per UC are presented in this section under each respective UC subsection.

## 4.1. General Activities across UCs

**Phase I** - Planning (M01 – M06)

- Objectives:
  - Creation of a technical component matrix.
  - Capture essential features and functionalities of all four UCs.
- Activities:
  - Creation of low-fidelity prototypes in specific scenarios with certain stakeholders.
  - Conduct requirement-gathering workshops with the consortium (M4)
  - Develop user personas for each UC and user group.

**Phase II** - Baseline Development & Validation (M07 - M18)

- Objectives:
  - Design and test initial mockups and prototypes for all four UCs.
  - Conduct think-aloud sessions and workshops to start a conversation around scenarios and mockups/prototypes developed.
  - Gather user requirements in terms of how to improve the so far developed technology.
  - Create an overview of ethical themes per technology, UC, and stakeholder.
  - Conduct experiments.
- Activities:
  - Develop initial mockups and prototypes for all four UCs, including all three technical pillars.
  - Organise regular assessment sessions in consortium countries to collect feedback on gender, ethical, trust and privacy-related issues, as well as feedback and input on the system usability and UX and acceptance to guide the further development of the PRESENCE technology.

- Organise prioritisation workshops with consortium partners to decide which ethical challenges and opportunities are relevant (or not) to the PRESENCE project.
- Organise experiments.

**Phase III** - Maturation (M19 - M36)

- Objectives:
  - Integrate feedback from phase II to refine and improve issues related to gender, ethics, trust and privacy.
  - Integrate feedback from Phase II to refine XR features, specifically focusing on user interaction with the technical pillars.
  - Conduct guidance ethics workshops to map ethical values and user requirements of relevant stakeholders to further improve the PRESENCE technology.
  - Finalise the development of XR setup for all four UCs, ensuring robust performance and high usability of developed applications.
  - Finalise the development of the PRESENCE technology/system in terms of gender, ethics, trust and privacy-related issues.
  - Confirm that the system meets all KPIs through extensive user testing with both developers and end-users.
  - Conduct experiments
- Activities:
  - Expand assessment to include diverse users, e.g. business clinics.
  - Final validation of the system with a larger user group to ensure widespread usability and satisfaction and to ensure that the PRESENCE technology is accessible and inclusive for a wide range of users
  - Conduct experiments

**Execution strategy:**

- Testing location and format:
  - On-site testing to allow for users to test and get a feel for the technology.
  - Set up and schedule assessment/testing at partner locations with users/relevant stakeholders.
- Communication and iteration:
  - Maintain a continuous and iterative communication loop with developers and users to ensure that feedback is integrated accordingly.
  - Organise meetings with relevant partners to discuss progress, challenges, feedback, and opportunities.

## 4.2. UC 1.1: Professional Collaboration

For this UC, we formulated scenario of use which was discussed by consortium partners within the course of a workshop (on 26/04/24) that was organised to gather requirements. The outcomes of the workshop are depicted in a Miro board (see Adjunts' Section 11.2.1). As a result of this workshop and multiple iterative revisions by the UC owner (VECTION) and consortium partners, the following scenario of use was developed for this UC:

**Title: Collaborative Armchair Design Discussion in XR Environment**

In this XR-based professional collaboration scenario, four actors wearing VR headsets come together in a virtual meeting room while physically being in different places to discuss the design of an armchair. The meeting room is equipped with a meeting table, a pedestal showcasing a 3D model of the armchair under review, a whiteboard, and a wall panel displaying a PDF document detailing the chair's specifications. **Actor 1** updates colleagues on recent chair modifications, while **Actor 2** visually illustrates these changes on the whiteboard. **Actor 3** consults the PDF document, indicating to **Actor 4** the required functionalities of the armchair. Actor 4 interacts with the virtual armchair, verifying its rotation and height adjustment as per the document's instructions. All actors inspect the armchair's features, confirming its capabilities and exploring material alternatives presented on a menu. After collaborative discussion, they reach a consensus on the preferred material and conclude the meeting, exchanging farewells before disconnecting from the application.

| Actor name | Function / role | Represented in experience via… | Location + HW needed |
|---|---|---|---|
| Emma (actor 1) | Furniture Designer | Avatar | Design studio + VR Headset |
| Tom (actor 4) | Materials Specialist | Avatar | Home Office + VR Headset, Haptic glove |
| Lisa (actor 2) | Industrial Engineer | Holoportation | Meeting room + VR Headset |
| Alex (actor 3) | Sales Representative | Avatar | Home office + VR headset |

*Table 4: Actors of the professional collaboration UC*

### Step 1: Starting the experience

Actor 1 logs into the PRESENCE platform for professional collaboration from her studio. In setting up the meeting, Actor 1 is assisted by Actor 2 takes notes on the whiteboard, visually illustrating Actor 1’s explanations. Actor 1 is joined by three colleagues: Actor 4, a materials specialist from her office; Actor 2, an industrial engineer from the company meeting room; and Actor 3, a sales representative from his home. They are all wearing VR headsets. Actor 4 is wearing haptic gloves. Actor 1 in VR, Actor 4 is in VR with Digital Touch and can feel the digital environment, Actor 2 is in VR with Holoportation, Actor 3 in VR. As they enter the virtual meeting room, they see a meeting table surrounded by chairs, a pedestal showcasing a 3D model of an armchair, a whiteboard, and a wall panel displaying a PDF document detailing the chair's specifications.

### Step 2: Completing tasks in the experience

Actor 1 starts the meeting by updating her colleagues on recent modifications to the armchair design. She gestures towards the 3D model while explaining the changes. Actor 4 nods in agreement, while Actor 2 takes notes about Actor 1’s explanation that will immediately be displayed on a whiteboard. In the meanwhile, Actor 3 accesses the PDF document on the wall panel, reviewing the chair's functionalities and features. Actor 3 points out specific requirements to Actor 4 in the PDF document, who adjusts his material suggestions accordingly.

On the table, there will be three spheres that represent the three different possible materials, with different consistencies that Actor 4 can feel with his haptic gloves **(haptics).** Actor 4 interacts with the virtual armchair, verifying its rotation and height adjustment features as per the document's instructions. He gives feedback on the material alternatives presented on the table, exploring their suitability for the design.

Throughout the discussion, all actors inspect the armchair's features and capabilities, sharing insights and suggestions. They collaborate on refining the design, exploring different options until they reach a consensus on the preferred material.

**Step 3: Concluding the experience**

After a productive discussion, they conclude the meeting and exchange farewells before disconnecting from the application, all satisfied with the progress made in designing the armchair. Thanks to PRESENCE, the team was able to discuss, evaluate, and refine the armchair design efficiently in a virtual environment, leveraging XR technology for effective communication and collaboration. They successfully reached a consensus on the preferred material, ensuring that the project will continue moving forward smoothly.

| Tech pillar | Summary of how it is integrated in the UC |
|---|---|
| Holoportation | Actor 2 needs to be holoported. |
| Haptics | Actor 4 uses the haptic glove to manipulate the chair |
| Virtual Human | Actors 1, 3 and 4 are represented as avatars. |

*Table 5: Integration of tech pillars in the professional collaboration UC*

*Figure 6: Professional collaboration UC*

| Iteration 2: Suggested improvements for phase 2 |
|---|
| **Haptic vest:** Actor pokes Actor, who is looking away, on the shoulder. Actor feels the touch through the haptic vest and turns around. |
| **IVA:** While not completely sure about the chair's ergonomic design, he asks the IVA to describe the essentials of ergonomic product design. IVA takes notes, etc. |
| **Haptic Gloves:** Materials feel for rough and soft material (MaxL discussion) |

*Table 6: Integration of tech pillars in the professional collaboration UC-Iteration 2*

## 4.2.1. User Groups to involve

### *4.2.1.1. Professional and End Users*

In the remote and immersive collaborations/sessions two main users emerge, the **meeting lead** (professional user) and the **meeting participant** (end user). The meeting lead is the orchestrator of proceedings, they guide discussions, facilitate collaboration, and ensure that objectives are met. Their virtual presence sets the stage for a cohesive and productive exchange of ideas. The meeting lead is typically a designated person within an organisation who takes on the role of leading meetings, e.g. those involving executive-level decisions, strategic planning sessions, or other types of collaborative meetings/sessions.

The meeting participants encompass a diverse range of people who join meetings that are led by the meeting lead and may include team members, colleagues from different departments or locations, external stakeholders (e.g. clients or partners), consultants, etc. They play an active role in collaborating on projects, contributing ideas, sharing insights, and making decisions during these collaborative meetings, which can be done through a range of virtual collaborative tools, including interactive boards, models, and document handling gadgets, and with these tools, they can actively contribute to discussions, sketch plans, work on documents, etc.

As depicted in the below images, two personas were developed for UC 1.1 Professional collaboration. The first one plays the role of the meeting lead in immersive meetings. She spends more than 8 hours daily in meetings and highly desires seamless integration of XR in her working environment.


*Figure 7: Professional collaboration professional user persona*

The second persona spends less time daily in meetings and has a high level of concern about technical hurdles. Still, he is eager to adopt new technologies.


*Figure 8: Professional collaboration end user persona*

### 4.2.1.2. Developer

The following Persona was developed for the professional collaboration UC which uses all PRESENCE APIs to create the UC scenario that was defined for professional collaboration.


*Figure 9: Professional collaboration developer persona*

### 4.2.2. Opportunities and Thresholds

In the virtual training scenario for industrial manufacturing, several key events are anticipated, such as orientation sessions and verification tests. These occasions provide significant opportunities to test the effectiveness of VR simulations in conveying complex procedures and safety in handling heavy machinery like the hydraulic press. However, some predictable difficulties arise. Recruiting trainees with a predisposition for VR training can be challenging, requiring not only technical skills but also a certain familiarity with immersive technologies. In terms of privacy, managing data collected from user interactions in VR, such as movements and responses during training, must be handled carefully to comply with privacy regulations. Technological openness is another challenge; users must be open to learning in a completely virtual environment, which can vary greatly from traditional practical training.

### 4.2.3. Activities in Each Phase of the Project

An evaluation plan for each phase of the project is presented in a visual manner via Miro board. For the convenience of the reader, we made screenshots of the Miro boards and included them in Adjunts' Section 11.3.

The Miro-Board indicates the following aspects for each phase of the project:

- Type of evaluation activity
- Owner of evaluation activity
- User groups involved
- Recruitment
- Amount of participants
- What is tested
- Methodology
- Technical pillars involved
- Location for evaluation
- Outcomes

## 4.3. UC 1.2: Manufacturing Training

For this UC, we formulated scenario of use which was discussed by consortium partners within the course of a workshop (on 24/04/24) that was organised to gather requirements. The outcomes of the workshop are depicted in a Miro board (see Adjunts' Section 11.2.2). As a result of this workshop and multiple iterative revisions by the UC owner (VECTION) and consortium partners, the following scenario of use was developed for this UC:

**Title: XR-Based Training for Safe Operation of Hydraulic Press**

There are four actors in this UC scenario: **one virtual trainer** and **four trainees**. All of them are physically located in the training room and put their VR headsets on to participate in this training scenario. They all enter a virtual environment that has the appearance of a production department of industrial manufacturing where the hydraulic press will be placed and users will be trained on its safe usage. The virtual trainer will explain the general operation of the machine and indicate the three main systems that users will have to learn to use: (i) hydraulic clamp for the placement of the heavy sheet of steel inside the press and for the removal of the scrap after pressing, the actor must wait 60 seconds to let the sheet cool down before taking it to avoid being burned (Alex, the person with haptic gloves will feel vibration from the sheet if they touch the sheet before the 60 second interval), (ii) safety door (opening/closing, locking/unlocking), and (iii) pressing two buttons to start

the blanking action. The virtual trainer (IVA) showcases the incorrect usage and the potential consequences of each of these actions in VR while the other actors stay still and observe the virtual trainer. After that, the trainer invites the trainees to carry out all these actions on their own in VR. While they do so, the Supervisor (Tom) evaluates the correctness of what has been done by them to make a judgment on the level of preparation achieved. In the end, they agree to conclude the training and disconnect from the VR application.

| Actor name | Function / role | Represented in experience via | Location + HW needed |
|---|---|---|---|
| Alex | Trainee | Avatar | Training room manufacturer + VR headset, haptic glove |
| Sarah | Trainee | Avatar | Joining from home + VR headset |
| Michael | Trainee | Avatar | Joining from home + VR headset |
| Lisa | Trainee | Avatar | Joining from home + VR headset |
| Tom | Supervisor | Holoportation | Training room manufacturer + VR headset |
| TBA | Virtual trainer | IVA | NA |

*Table 7: Actors of the manufacturing training UC*

**Step 1: Starting the experience**

Alex, Sarah, Michael, and Lisa are new hires at a steel factory. They are about to undergo training on the safe operation of a hydraulic press. This training is crucial as the proper handling of machinery is essential to ensure their safety. All four trainees are aware of the potential risks involved in operating the hydraulic press, and they understand the importance of receiving thorough training before starting their work. To provide them with comprehensive training in a safe and controlled environment, their supervisor, Tom, has arranged the PRESENCE VR-based training session with a virtual trainer **(IVA)**. The trainees (**avatars**) put on their headsets, and haptic glove (Alex only), immersing themselves in the virtual environment that simulates a production department of industrial manufacturing. In this virtual space, they see the hydraulic press they'll be trained to operate.

*Figure 10: Manufacturing training UC*

**Step 2: Completing tasks in the experience**

The supervisor, Tom (**holoportation**), introduces the trainees to the general operation of the hydraulic press. Tom explains the three main systems that the trainees will need to learn: the hydraulic clamp, safety door, and double buttons for starting the blanking action.

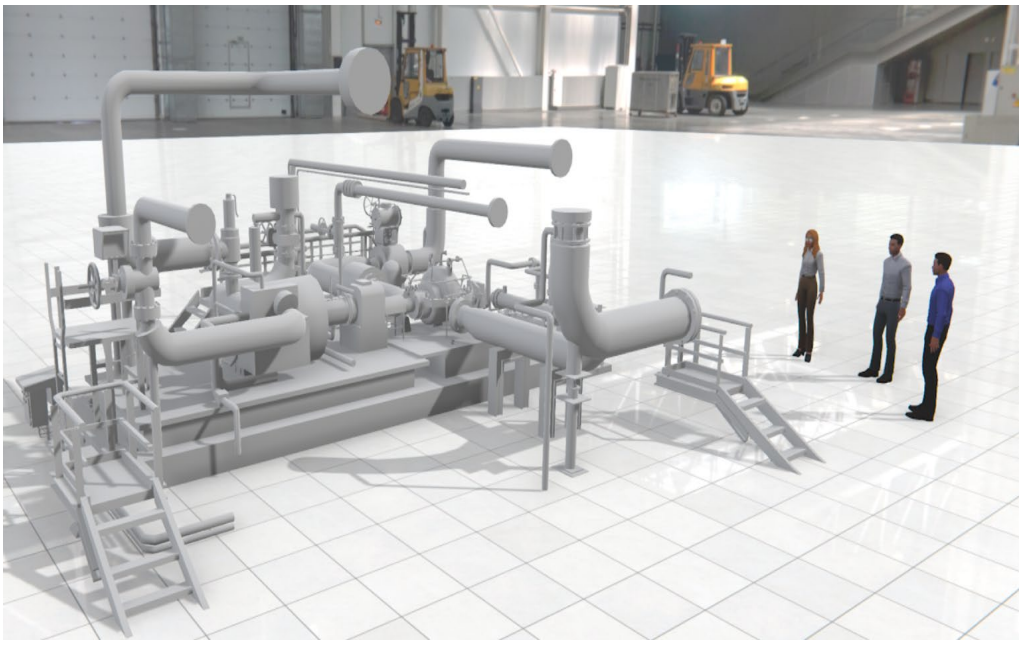

*Figure 11: Virtual factory in manufacturing training UC*

While Tom is explaining how to use the hydraulic clamp, open/close the safety door, and initiate the blanking action, the virtual trainer (IVA) is showcasing how to operate the systems in an incorrect and correct way.

After the demonstration, Tom invites the trainees to carry out the actions themselves in VR. One by one, each trainee, starting from Alex (with haptics), takes turns practising the operation of the hydraulic clamp(i), safety door(ii), and double buttons(iii) while the supervisor observes their performance.

(i) Hydraulic clamp: for the placement of the heavy sheet of steel inside the press and for the removal of the scrap after pressing, the actor must wait 60 seconds to let the sheet cool down before taking it to avoid being burned. All participants receive strong and intense haptic vibrations caused by the heat of the sheet through the gloves or controllers if they touch it before the 60-second interval has elapsed.

(ii) Safety door: the actors take turns in opening/closing and locking/unlocking the safety door. Alex, the person with haptic gloves receives force feedback from the physical elements of the door he touches while all others receive slight vibrations via the controllers.

(iii) Pressing two buttons: the actors take turns in pressing both buttons to start the blanking action. Alex, the person with haptic gloves receives force feedback from the buttons he touches while all others receive slight vibrations via the controllers.

As the trainees perform the actions, the supervisor Tom evaluates the correctness of their movements and procedures. They provide feedback and guidance to help the trainees improve their skills and ensure they understand the proper operation of the hydraulic press.

**Step 3: Concluding the experience**

Once all trainees have had the opportunity to practise and receive feedback, the supervisor Tom concludes the training session. He comments on the trainees' efforts and progress, emphasising the importance of safety in the workplace. The trainees thank the virtual trainer for their guidance. Thanks to the PRESENCE XR-based training, Alex, Sarah, Michael, and Lisa feel more confident and prepared to operate the hydraulic press safely in their workplace.

| Tech pillar | Summary of how it is integrated in the UC |
|---|---|
| Holoportation | Tom + role/advantages of holoportation for Tom |
| Haptics | Alex needs a haptic vest to feel when the steel is still too hot or cold enough to handle |
| IVA | Shows the proper /improper way to safely conduct the tasks that are part of the training |

*Table 8: Integration of tech pillars in the manufacturing training UC*

**Iteration 2: Suggested improvements for phase 2**

- More than one actor has a haptic glove
- Include haptic vest (e.g. for heavy lifting)
- Include more than one actor holoported

## 4.3.1. User Groups to involve

#### *4.3.1.1. Professional and End Users*

In the manufacturing training UC, three users emerge, **manufacturer trainers** (professional user) and **new hires** (end user) who need training. Manufacturer trainers are typically experienced professionals within the manufacturing industry who have experience operating heavy machinery and ensuring a safe workplace environment. They could be trainers employed by a manufacturing company or external consultants who are hired to conduct the training sessions. In the remote and immersive manufacturing training sessions, manufacturer trainers get access to a platform that allows them to simulate different scenarios that can occur during training (e.g. dangerous scenarios) in a controlled environment. This way, they can to a greater extent personalise learning outcomes and practical experiences, which can teach new hires a deeper understanding of crucial manoeuvres that involve force, weight, and pressure, as well as teach them how to manoeuvre different types of machinery without exposing them to actual danger.

The new hires involve people who have recently joined the manufacturing workforce or are undergoing training to transition into new roles that involve operating machinery or handling equipment. They could be recent graduates from technical schools/universities, career changers (who seek to join the manufacturing industry), or people who want to re-enter the workforce after being absent. With the presence of photorealistic instructors and learning in a controlled environment (while getting the required/necessary training), engagement and collaborative learning are facilitated.

Detailed personas for the two first user groups are depicted in the below images.


*Figure 12: Manufacturing training professional user persona*

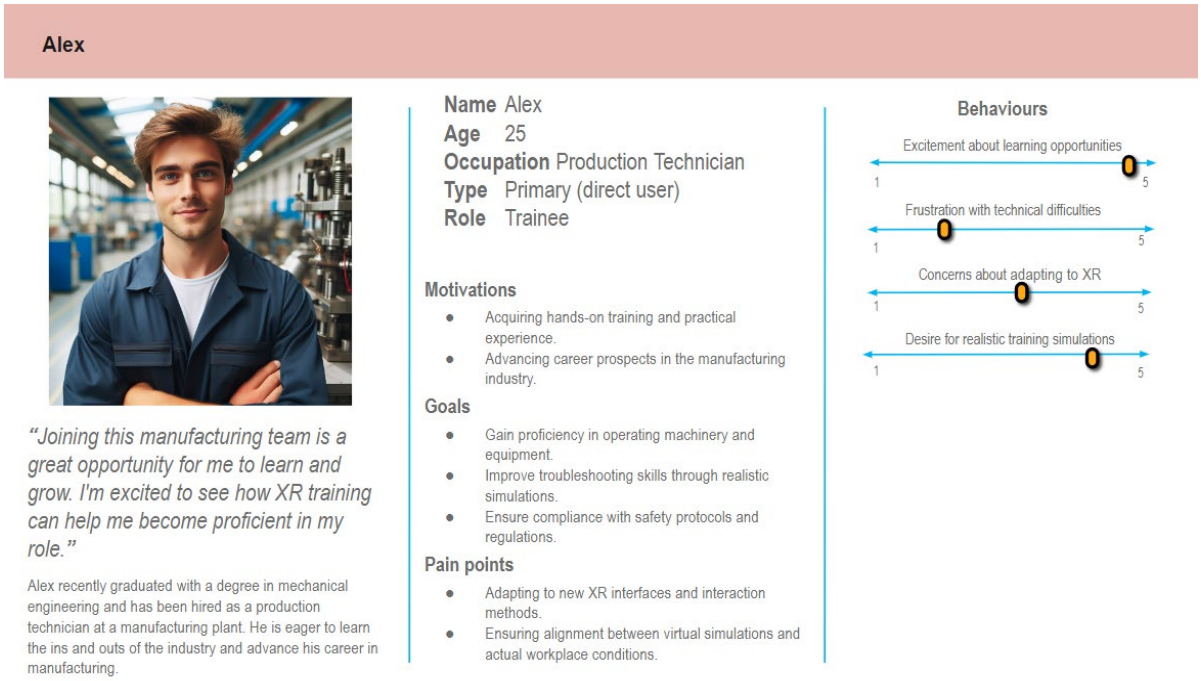


*Figure 13: Manufacturing training end user persona*

#### *4.3.1.2. Developer*

The following Persona was developed for the manufacturing training UC which uses all PRESENCE APIs to create the UC scenario that was defined for manufacturing training.


*Figure 14: Manufacturing training developer persona*

### 4.3.2. Opportunities and Thresholds

In the VR training scenario for industrial manufacturing, scheduled events include practical training sessions and competency verification tests. These sessions provide the opportunity to directly test the effectiveness of virtual learning in conveying complex operational procedures and safety management for heavy machinery. However, several challenges are anticipated. Recruiting trainees who are adequately qualified for VR training can be a challenge, given the need for specific technical skills and familiarity with immersive technologies. Privacy issues are also crucial, as VR training involves collecting and analysing large amounts of personal data related to participants' performance and interactions. Openness to change and adapting to a solely virtual learning environment require a flexible and innovative mindset from participants. Lastly, technical difficulties such as maintaining VR system stability and effectively managing sensory inputs, like haptic gloves, require continuous technological attention to ensure a smooth and immersive training experience.

### 4.3.3. Activities in Each Phase of the Project

An evaluation plan for each phase of the project is presented in a visual manner via Miro board. For the convenience of the reader, we made screenshots of the Miro boards and included them in Adjunts' Section 11.3.

The Miro-Board indicates the following aspects for each phase of the project:

- Type of evaluation activity
- Owner of evaluation activity
- User groups involved
- Recruitment
- Amount of participants
- What is tested
- Methodology

- Technical pillars involved
- Location for evaluation
- Outcomes

## 4.4. UC 2.1: Health

For this UC, we formulated a scenario of use which was discussed by consortium partners within the course of a workshop (on 25/04/24) that was organised to gather requirements. The outcomes of the workshop are depicted in a Miro board (see Adjunts' Section 11.2.3. As a result of this workshop and multiple iterative revisions by the UC owner (SyncVR) and consortium partners, the following scenario of use was developed for this UC:

**Title: Pain/Stress Relief**

Manuel, a 46-year-old with a strong fear of needle procedures, is at the clinic today for a joint injection procedure. To aid him, Dr. Garcia, his doctor aware of his needle phobia, has prepared a specialised session using PRESENCE technology designed to help Manuel cope effectively during the procedure. Unfortunately, Manuel's usual source of support, his long-time friend Ben, is unable to be present physically this time. However, through the use of PRESENCE technology, Ben can be virtually holoported into the VR environment to provide Manuel with his customary support and reassurance during the procedure.

Upon arriving at the clinic, Manuel is visibly tense, dreading the upcoming procedure. Dr. Garcia greets him with a comforting smile and gives him a professional briefing on how to use the PRESENCE technology. With the help of Dr. Garcia, Manuel puts on a VR Headset and dives into a distracting virtual environment where he finds his friend Ben and Ava, a virtual assistant, ready to support him throughout the procedure. The virtual environment is seamlessly synced with the medical procedure and guided by Ava, ensuring Manuel receives the ideal distractions and support tailored to his needs. This allows Dr. Garcia to concentrate on the procedure, which can be successfully completed without any complications, as Manuel is kept in a state of comfort and reassurance.

| Actor name | Function/role | Representation | Location | Hardware |
|---|---|---|---|---|
| Manuel | Patient with needle phobia undergoing the procedure | Virtual hands | Hospital | VR headset, haptic gloves, haptic vest |
| Dr. Garcia | Doctor performing procedure | - | Hospital | - |
| Ava | Virtual assistant | IVA | - | - |
| Ben | Supporting friend | Holoportation | Quiet room | Holoportation camera, VR headset |

*Table 9: Actors of the health UC*

**Step 1: Starting the experience**

Three weeks before the scheduled injection, Dr. Garcia arranges a phone consultation with Manuel to explain the upcoming joint injection procedure and introduce the PRESENCE technology. During the call, they discuss the role of VR in reducing anxiety and how holoportation will allow Manuel to receive support from his friend Ben, despite Ben being unable to attend physically due to a business trip. Manuel later contacts Ben, who confirms his virtual availability during the procedure. Thereupon, Dr. Garcia also provides Ben with information about the PRESENCE technology and the necessary equipment to attend the procedure virtually.

On the day of the procedure, Manuel arrives at the clinic and is greeted by Dr. Garcia, who provides reassurance and guides him to the specially prepared treatment room. The room is equipped with

PRESENCE technology, including a VR headset, haptic gloves, and a haptic vest. It is designed to be calming and controlled, minimising external stimuli that could increase Manuel's anxiety. Ben has received a call from Dr. Garcia's secretary to ensure he will be there at the planned time of the procedure.

**Step 2: Participating in the experience**

Upon putting on the VR headset, Manuel is greeted by Ava, a virtual assistant. Ava's purpose is to guide Manuel through the VR experience, offering information such as the purpose of the injection, expected outcomes, duration, and what to expect from the VR experience. Her presence is designed to relieve Dr. Garcia of the information she would otherwise have to provide. The virtual environment represents a beautiful nature setting, which serves to relax and distract Manuel from the procedure. During the instruction by Ava, Manuel's friend Ben is also present in the environment, holoported from a quiet room he chose to attend. Seeing Ben helps Manuel remain comfortable and ease the stress he would otherwise feel.

As Manuel engages with Ava and Ben in the virtual environment, Dr. Garcia begins preparing the joint injection. Dr. Garcia first ensures that all medical instruments required for the joint injection are sterilised and neatly arranged for easy access during the procedure. She then prepares the medication, calculating the correct dosage based on Manuel's medical history and specific needs related to his meniscus condition. The medication is then drawn into a syringe, ensuring it's ready for administration. Lastly, Dr. Garcia selects the optimal site for the injection on Manuel's knee. She marks the site and cleans it thoroughly with an antiseptic solution to prevent any infection.

As the procedure nears the actual injection phase, the haptic vest Manuel is wearing begins to gently inflate and deflate, guiding him to take deep, calming breaths. This not only helps in reducing anxiety but also stabilises his body for the injection. Concurrently, the haptic glove on his arm activates. Manuel feels gentle, soothing sensations on his skin, which are synchronised with visuals in the VR environment. For instance, as he sees a visual of a gentle waterfall in VR, he feels corresponding sensations through the haptic devices, enhancing the distraction from the injection.

Throughout the session, Ben holds Manuel's hand, while having an informal chat as they do so often. While Manuel is deeply engaged with the virtual environment and conversing with Ben, Manuel holds Manuel's hand a little tighter and Dr. Garcia carefully administers the joint injection. Manuel feels the injection and experiences a light level of pain, but due to the relaxation and support, he handles it without the usual stress and panic.

**Step 3: Concluding of the experience**

After the injection has been performed, Ben congratulates Manuel, says goodbye, and leaves the virtual environment. Ava informs Manuel about the required restriction of strenuous activity, the option to use ice in case of swelling, and other practical points. She further seeks feedback from Manuel and gathers feedback about his experience such as his level of comfort throughout the procedure. Manuel's responses are overwhelmingly positive, noting a significant reduction in anxiety and an increased sense of control over the situation.

Finally, Dr. Garcia then takes off the devices from Manuel and guides him to the exit of the procedure room. Dr. Garcia has only had to focus on the procedure, while Ava provided relevant information and Ben gave comforting support. After Dr. Garcia gave the devices to Manuel, she did not have to control anything other than the medical equipment required for the procedure, which was a great support for her.

| Tech pillar | Summary of how it is integrated into the UC |
|---|---|
| Holoportation | Ben is holoported into the VR environment to comfort Manuel and allow Dr. Garcia to focus on the procedure. |

| Tech pillar | Summary of how it is integrated into the UC |
|---|---|
| Haptics | Manuel receives a haptic vest and gloves to create haptic stimuli to distract him from the procedure in sync with the visuals of the virtual environment and help him manage his stress levels while also receiving physical feedback from his friend Ben. |
| IVA | Ava provides Manuel with the necessary patient information before and after the procedure and guides him through the virtual experience. |

*Table 10: Integration of tech pillars in the health UC*

Possible adaptions for the second iteration

- Ava could provide information on the current status of the procedure to increase transparency.
- Ben could be provided with haptic gloves to also receive haptic feedback while holding Manuel's hand.
- A Nurse could be included that supports the medical procedure and ensures that the virtual environment stays in sync with the actual procedure.

**Notes on validation**

Due to the potential difficulty of receiving timely ethical approval to conduct a study in clinical settings, this UC will be validated with volunteers using standardised evaluation tools and instruments to measure UX and the sense of presence. No medical information will be gathered. Ethical approval will be sought from the ethical boards of the hospitals contacted to help set up the study.

## 4.4.1. User Groups to involve

#### *4.4.1.1. Professional and End Users*

The main users here were identified as **therapy givers** (i.e., professional user, health professionals or clinical experts) and **therapy receivers** (or patients who are end users):

**Therapy Givers:**

These are the health professionals or clinical experts who specialise not just in general healthcare but specifically in pain and stress management. This group includes psychologists, psychiatrists, pain management doctors, and nurses who are trained to handle emotional and psychological distress as well as physical pain. They possess the expertise, knowledge, and training necessary to design, implement, and oversee comprehensive pain and stress relief programs that may include VR interventions. These professionals are skilled in using advanced technology to enhance therapeutic outcomes and are essential in administering the VR sessions and interpreting the results to provide optimal care.

**Therapy Receivers:**

Therapy receivers are individuals experiencing pain, stress, or anxiety, which can stem from various sources including chronic conditions, acute medical interventions, or even psychological distress. This group encompasses a wide range of individuals such as:

Patients undergoing painful medical procedures like joint injections or chemotherapy, where VR can be used to provide distraction and pain relief.

Individuals dealing with chronic pain conditions such as fibromyalgia or chronic back pain, where VR helps manage pain through immersive distraction and relaxation techniques.

People experiencing high levels of stress or anxiety, possibly from intense professional environments or personal challenges, who can benefit from stress-relief sessions facilitated through VR.

The detailed personas of this UC are depicted in the below figures. For the professional user, we initially had designed a clinical psychologist persona (see Figure 15). However, during the course of the workshop, another persona for professional users evolved. Figure 16 shows a persona of a nurse who should deliver the PRESENCE solution to the therapy receivers.

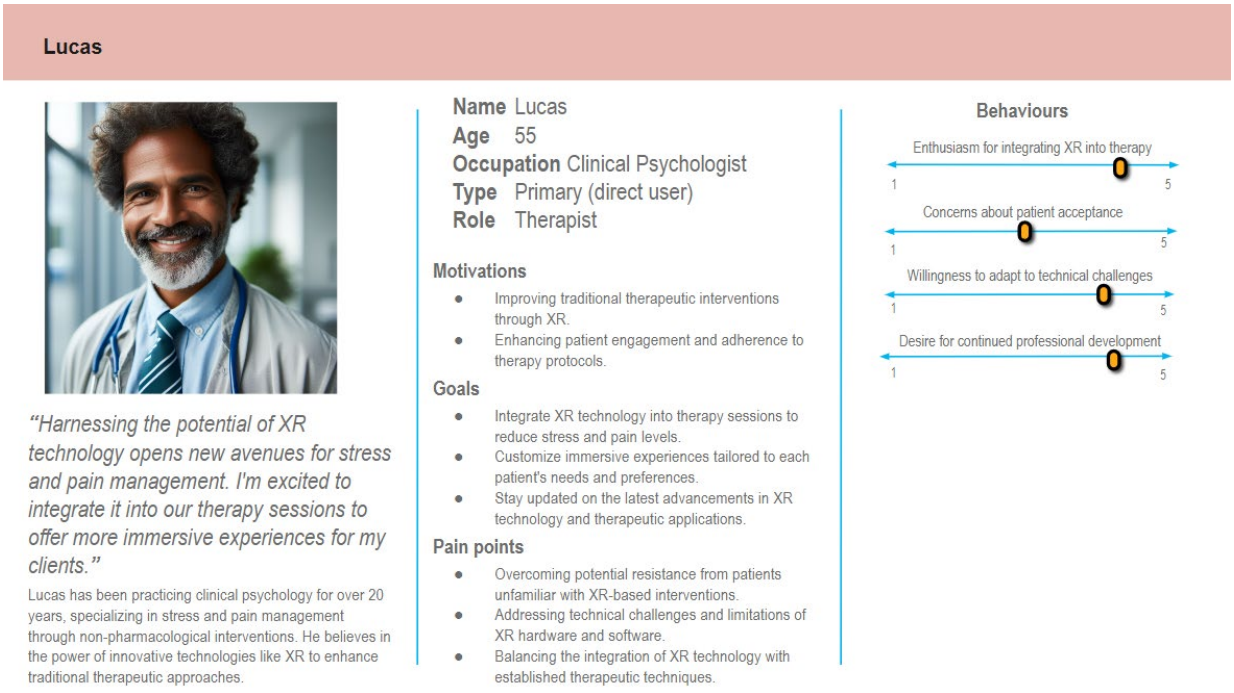


*Figure 15: Health UC professional user persona-Clinical Psychologist*

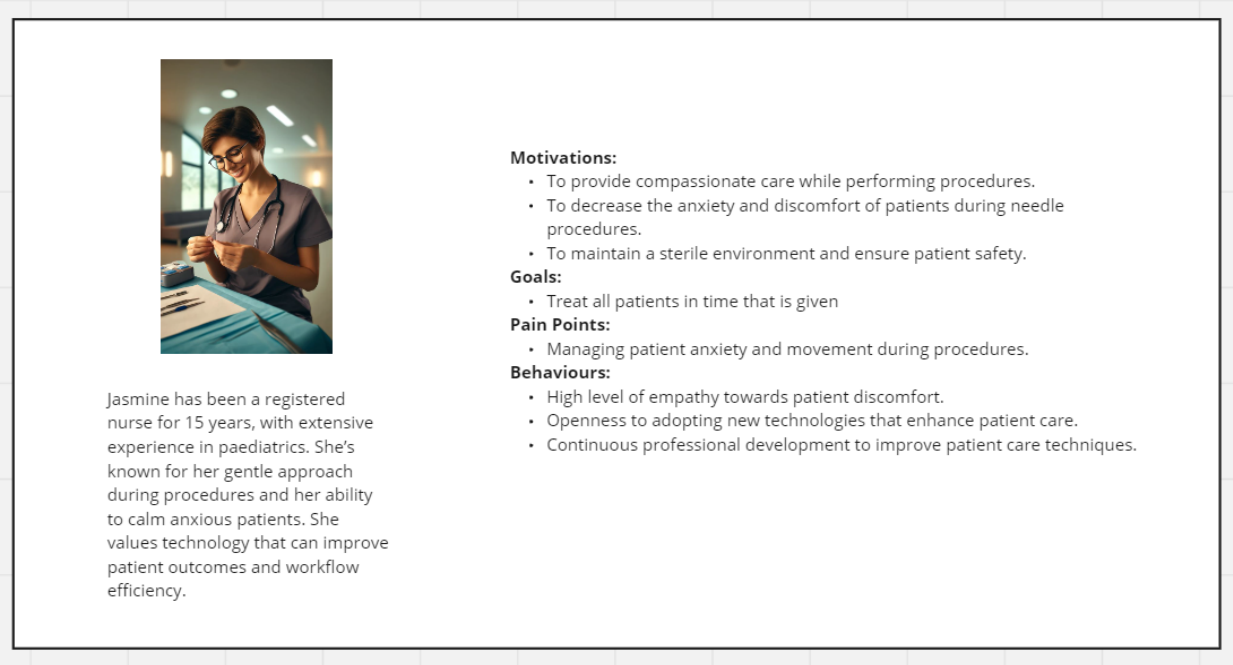


*Figure 16: Health UC professional user persona-Nurse*


*Figure 17: Health UC end user persona*

#### 4.4.1.2. Developer

The following Persona was developed for the XR health UC which uses all PRESENCE APIs to create the UC scenario that was defined for XR health.


*Figure 18: Health UC developer persona*

### 4.4.2. Opportunities and Thresholds

Hospital sites in the network of SyncVR Medical will be used for testing and data collection. Technical difficulties include the lack of stable WiFi connection on hospital sites, and the lack of technical savviness of clinical end users. Other risks include the organisational complexity of healthcare providers, such as their staff turnover which risks the absence of relevant stakeholders, requirements for ethics approval, and potential unsuccessful collection of the requirement number of patients to include.

### 4.4.3. Activities in Each Phase of the Project

An evaluation plan for each phase of the project is presented in a visual manner via Miro board. For the convenience of the reader, we made screenshots of the miro boards and included them in Adjunts' Section 11.3.

The Miro-Board indicates the following aspects for each phase of the project:

- Type of evaluation activity
- Owner of evaluation activity
- User groups involved
- Recruitment
- Amount of participants
- What is tested
- Methodology
- Technical pillars involved
- Location for evaluation
- Outcomes

## 4.5. UC 2.2: Cultural Heritage

For this UC, we formulated scenario of use which was discussed by consortium partners within the course of a workshop (on 24/04/24) that was organised to gather requirements. The outcomes of the workshop are depicted in a Miro board (see Adjunts' Section 11.2.4. As a result of this workshop and multiple iterative revisions by the UC owner (ZAUBAR) and consortium partners, the following scenario of use was developed for this UC:

**Title: Tunnel 57 Experience**

This UC scenario is about exploring the escape "Tunnel 57" under the former Berlin Wall. The following actors are involved in this scenario: tourist, time witness as a pre-recorded holoportation, and a tour guide as an intelligent virtual assistant with chatbot functionality and corresponding interface.

To start, the tourist puts on the XR headset, haptic gloves, and vest. The virtual environment loads and immerses the tourist in the virtual space (avatar). The tourist enters a replica of a cellar (anteroom of the tunnel in Berlin) with a tour guide (holoported) and can explore the room. The tour guide starts introducing the tourist to the experience and the room and invites the tourist to explore the digital points of interest (POIs).

With the ability to freely explore, interact, and engage with POIs in the room, the tourist delves into the past while conversing with the tour guide (holoportation) and uncovering hidden truths. Upon discovering a triggering POI, a time-witness also appears (recorded holoportation) transporting the tourist deeper into the narrative as the tour guide steps away. Navigating through a virtual tunnel, the tourist experiences the tension and urgency of an escape, culminating in a pivotal moment of

decision and consequence. Emerging from the tunnel, the tourist witnesses the aftermath of historical events unfold before their eyes, shedding light on the complexities of division and reconciliation. With immersive haptic feedback from the vest and gloves and audio cues amplifying the emotional journey, the tourist is not merely a spectator but an active participant in revisiting the narrative of the past.

| Actor name | Function / role | Represented in experience via | Location + HW needed |
|---|---|---|---|
| Sophia | Tourist | Holoported or avatar | Berlin + VR headset, haptic gloves, vest |
| Hannes | Historical expert (Time Witness) | Holoported (Pre-recorded) | - |
| David | Tour guide | Holoported live | (Guide room + VR headset) |

*Table 11: Actors of the cultural heritage UC*


*Figure 19: Artistic AI rendering of cultural heritage UC*


*Figure 20: Cultural heritage UC-Sophia in equipment*

**Step 1: Starting the experience**

Sophia is a history enthusiast visiting Berlin for the first time. She's always been fascinated by the stories of the Berlin Wall and is eager to explore its history in a unique and immersive way. Today, she's embarking on the PRESENCE "Tunnel 57" XR experience. Sophia arrives at the site, where she's greeted by the PRESENCE staff and equipped with an XR headset, haptic gloves, and a vest.

She is excited to dive into the virtual world and uncover the secrets of Tunnel 57. Sophia puts on the XR headset, haptic vest and glove and is transported into the virtual space of Tunnel 57. She finds herself in a volumetric scan of a cellar, the anteroom of the tunnel in Berlin, with David, who is an expert on Berlin's history and acts as Sophia's virtual tour guide by **holoporting** himself live into the virtual world.

**Step 2: Completing tasks in the experience**

David welcomes Sophia to the experience, providing an overview of Tunnel 57 and its significance during the Cold War era. He encourages Sophia to explore the digital points of interest (POIs) in the room and interact with the environment. Sophia teleports freely into the virtual cellar, examining artifacts and listening to David's explanations about each point of interest. **Haptic gloves** are used for simulating interacting with POI that have to be found by the user in order to trigger actions.

*Figure 21: Cultural heritage UC-Artistic AI rendering of 3D tunnel placed inside the museum at entrance of tunnel*

*Figure 22: Cultural heritage UC-Artistic AI rendering of David and Sophia*

She engages in conversation with David, asking questions and sharing her own insights about the historical context. As she delves deeper into the narrative, Sophia stumbles upon a POI that triggers the appearance of Hannes, a virtual time witness (pre-recorded holoportation). Hannes transports them deeper into the story, guiding them through a virtual tunnel as they experience the tension and urgency of an escape. A small physical reconstruction of the former tunnel is rebuilt in order for the user to crawl through. The haptic vest will simulate and underline storyline points:

- Rain and wetness from the tunnel will hit Sophia's shoulders via the haptic west
- Shooting of a gun will have a kickback effect via the haptic gloves
- Tightness in the tunnel will be transmitted via the haptic vest
- Wind is simulated through vest, gloves and fans


*Figure 23: Cultural heritage UC-Artistic AI rendering Time-witness*

Emerging from the virtual tunnel, Sophia witnesses the aftermath of historical events, seeing firsthand the impact of division and the journey toward reconciliation. Immersive **haptic** feedback and audio cues amplify the emotional journey, allowing Sophia to feel connected to the past in a profound way.

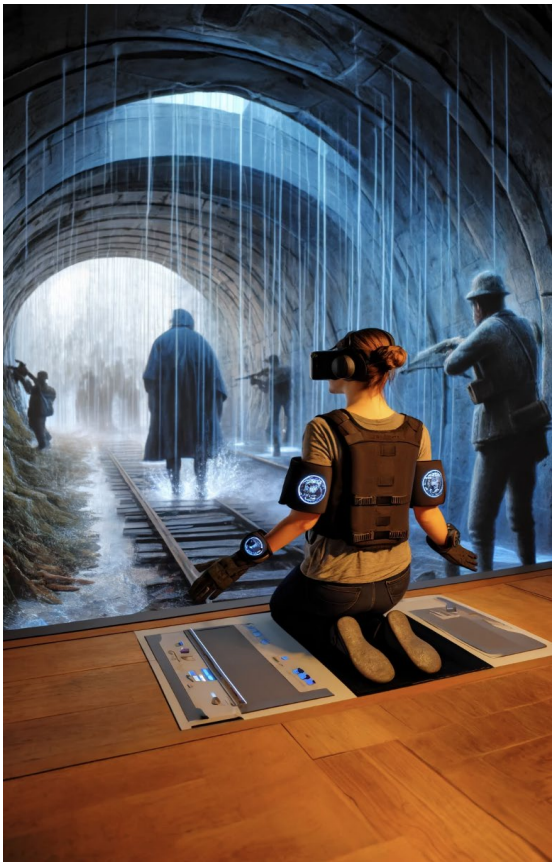

*Figure 24: Cultural heritage UC-Artistic AI rendering of Sophia affected by haptic feedback*

**Step 3: Concluding the experience**

Sophia emerges from this experience and reflects on the lessons learned and the importance of understanding history to shape a better future. As she bids farewell to David and removes her XR gear, she carries with her a newfound appreciation for the power of immersive storytelling in preserving and sharing the past.

| Tech pillar | Summary of how it is integrated in the UC |
|---|---|
| Holoportation | David is a holoported tour guide, he can interact live with the tourist.<br>Hannes is a pre-recorded holoportation, as we want to involve the expert but not as an IVA. Hannes can share his personal experience without worrying about being at the location or about being misrepresented through an IVA or avatar. |
| Haptics | Simulate interaction with POIs and underline the storyline.<br>Sophia needs a haptic vest and glove as they help her to understand the experience on an emotional and physical level. |

*Table 12: Integration of tech pillars in the cultural heritage UC*

Second iteration: Suggestions for Phase 2

- Additional tourist(s) join from off-site location
- Tour guide as IVA

## 4.5.1. User Groups to involve

#### *4.5.1.1. Professional and End Users*

For the cultural heritage UC, we could identify two groups of users, namely, **tour guides** (professional user) and **tourists** (end user).

The tour guides involve individuals who are experts in European cultural heritage, having deep knowledge of historical landmarks, artistic expressions, and local traditions, and they could be professional tour guides, historians, or enthusiasts who are passionate about sharing their expertise (in this case, people who are knowledgeable/have a deep interest in and wants to share insights/knowledge about Tunnel 57 under the former Berlin wall). The tour guides serve as virtual hosts where they lead tourists on immersive journeys through significant cultural sites in Europe, providing insightful commentary, historical context, etc.

Tourists include people from different backgrounds who are interested in exploring European cultural heritage (in this case Tunnel 57 under the former Berlin Wall), and maybe travellers, students, educators, families, or anyone in general who is curious/interested in experiencing European cultural landmarks and historical sites.

The detailed personas of both user groups are depicted below.

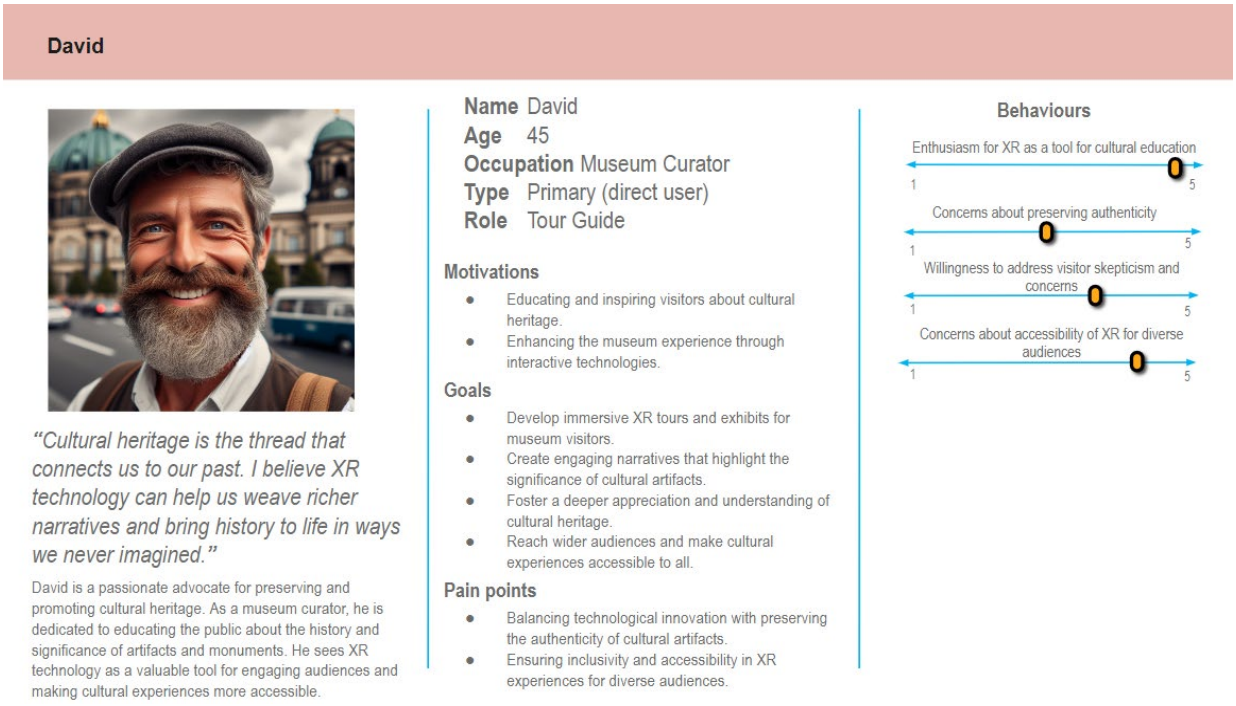


*Figure 25: Cultural heritage UC professional user persona*


*Figure 26: Cultural heritage UC end user persona*

#### *4.5.1.2. Developer*

The following Persona was developed for the cultural heritage UC which uses all PRESENCE APIs to create the UC scenario that was defined for cultural heritage.

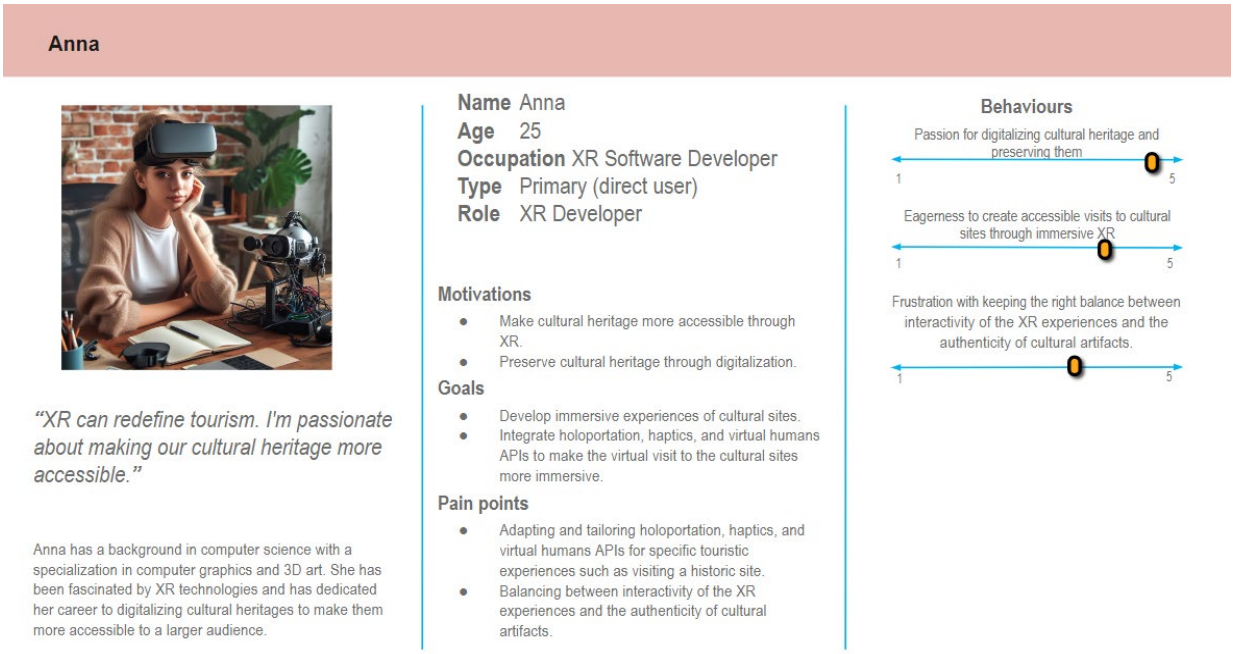


*Figure 27: Cultural heritage UC developer persona*

### 4.5.2. Opportunities and Thresholds

The demonstrator will undergo testing by members of the Unterwelten organisation in Berlin, as well as by some of their guests and paying visitors. Scheduling organised user group testing sessions with members of Berliner Unterwelten and visitor groups is expected to present challenges. Managing all the hardware components simultaneously will also be difficult. Additionally, internet access in the underground locations may pose a significant challenge during demonstrations.

### 4.5.3. Activities in Each Phase of the Project

An evaluation plan for each phase of the project is presented in a visual manner via Miro board. For the convenience of the reader, we made screenshots of the miro boards and included them in Adjunts' Section 11.3.

The Miro-Board indicates the following aspects for each phase of the project:

- Type of evaluation activity
- Owner of evaluation activity
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- What is tested
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- Technical pillars involved
- Location for evaluation
- Outcomes

# 5. The Initial Results for Robustness and Trustworthiness of AI in PRESENCE

An initial analysis of the set of AI components to be developed in PRESENCE has been done, collecting information as outlined in Section 3.2.3. The data collected in this initial stage may not yet cover all the components to be developed, and information will be updated and made more concrete.

The initial data provided the following information:

- The risk self-assessment puts about half of the components in the minimal risk category and the other half into the limited risk category. The components with the higher risk are mostly related to understanding and interpreting user actions and inputs, where their misinterpretation may lead to unwanted behaviour of the system.
- Half of the components are trained on open datasets originating from the EU, while the other systems will use privately collected data by the partners, or other data. This will require investigating which level of transparency can be provided for this data, and which information about the dataset can be made available in order to understand the risks of bias.
- Half of the components are expected to make decisions of some kind. For all of these components, it is also planned to have human oversight of this decision process.
- Most models to be used are either expected to be explainable by design, or work on explaining the outputs of the model is planned. The exceptions are LLM-based components, where full explanation of the results may not be feasible.

# 6. The Initial Set of User Requirements for PRESENCE

In gathering the initial set of User Requirements (UR), we first translated the UC descriptions from the project proposal and UC descriptions presented during the project kick-off meeting in February 2024. To extend the list of an initial set of UR, we also conducted co-creation workshops with consortium members to gather feedback on the user scenarios developed at this point of the project (system-user interaction) and user requirements (for both end users, professional users, and developers). These co-creation workshops took place at the end of April (M4).

During the sessions, the scenarios and personas (at that point developed) were presented to the participating consortium partners, upon which we asked them to evaluate the scenarios and personas as well as defining user problems, solutions (solutions also in relation to the three technical pillars outlined for the project (holoportation, haptics, and virtual humans)), and user outcomes. These co-creation sessions offered an opportunity to understand opportunities and potential pitfalls of the project from the perspective of the participants, but more importantly how the PRESENCE project can answer and/or solve problems that users face. This exercise has given us a good stepping point in formulating an initial set of user requirements, and to further improve the scenarios and personas used to illustrate the UCs.

The co-creation sessions were organised online through Zoom. The sessions were also recorded through Zoom, and then transcribed using Scribewave and GoodTape, to finally be analysed by Imec and UHAM in MAXQDA. All data that was retrieved from the workshops (recordings, transcripts, and analysis of outcomes) is stored on the project's Google Drive repository. The data has also been anonymised and has only been used to inform the first set of UR and as a stepping stone to finalise the personas and user scenarios in the project. The informed consent forms that were signed at the beginning of each workshop are stored in Qualtrics.

The analysis of the workshop results was done by Imec and UHAM using an inductive Thematic Analysis (TA) approach. TA is a method used for "identifying, analysing, and interpreting patterns of

meaning (“themes”)” [Ref. 17]. By going over the data back and forth we could more easily code our output and thus find these patterns of meaning or themes better. We confirmed the analysis and interpretation by going over each other's outputs and coding to see whether we interpreted the data in a similar or different manner, in the case of the latter additional codes would be added to the output. From the codes and themes found, we could more easily translate the results into UR. This was done by looking at what was said by the respondents and rephrasing these inputs in terms of “the user shall be able to…”, in cases where it was less explicit what the user needs and expectations were, we had to do some ‘reading between the lines’ to find what the URs could be.

In translating the insights garnered from workshops and from the analysis of UC descriptions in the project proposal and KoM documents, several URs have been found. In the working document[2], which is stored on the project’s repository, these are ordered per UC, and follow a numerical ascending order in signifying the coding convention of each UR. The initial set of UR per UC has been summarised and can be consulted in Table 13 below. This table, however, is organised in an alphabetical order by category, thus the UC and UR signifiers are not indicated in an ascending order as described above. Here, you can also see the origin of the UR as well as to which user it applies to, the end user (end), the professional user (prof), and/or the developer (dev).

| Category | UC | UR |
|---|---|---|
| Accessibility and inclusivity | 2.1 | UR112.0 The user (prof) shall be able to access the PRESENCE technology/system to provide VR therapy to their patients without having to develop or provide their own system. |
| | | UR115.0 The user (end and prof) shall be able to make use of the system regardless of condition or procedure. |
| | 2.2 | UR189.0 The user (end) shall be able to experience cultural sites virtually regardless of disability/limitations. |
| Adaptability and Customization | 1.1 | UR11.0 The user shall be able to organize meetings from anywhere. |
| | | UR12.0 The user shall be able to attend meetings from anywhere. |
| | | UR13.0 The user shall be able to access and attend meetings from anywhere no matter hardware resources. |
| | | UR14.0 The user shall be able to set up different/a variety of meeting types. |
| | | UR40.0 The user shall be able to design collaborative virtual workspaces with minimal customization. |
| | 1.2 | UR66.0 The user shall be able to adapt the setup to different types of trainees. |
| | | UR88.0 The user shall be able to easily fine-tune and adjust parameters within the SDK to personalize their experience based on their objectives or resources. |
| | | UR89.0 The user shall be able to adjust the intensity of haptic feedback and resolution of holograms to their preference. |
| | | UR93.0 The user shall be able to train either by using a VR headset at home or a more complex setup found in a training center. |
| | | UR97.0 The user shall be able to adapt the system to the device or platform they are using, whether it is a powerful PC or a lightweight PC. |
| | | UR156.0 The user (prof) shall be able to choose different technicalities |

[2] Notice to the attention of the EU officers and external reviewers: most of the below URL links direct to the project Repository and thus with access limited to the project consortium members. The documentation is available under demand, contact info@presence-xr.eu

| Category | UC | UR |
|---|---|---|
| | 2.1 | depending on procedure.<br>UR479.0 The user shall be able to pre-program/customize different cues in the virtual experience for different devices. |
| | 2.2 | UR10.0 The user shall be able to create and customize avatars and character representations. |
| | ALL | UR151.0 The user (dev) shall be able to easily use API to customize and create different experiences in XR.<br>UR157.0 The user (dev) shall be able to adjust and customize the code to improve the PRESENCE technology offerings. |
| Awareness and Understanding | 2.1 | UR132.0 The user (prof) shall be able to reframe the medical treatment into a more positive one through the usage of the PRESENCE system/technology.<br>UR133.0 The user (end) shall be able to go through medical treatments with a positive state of mind/leave with a positive experience.<br>UR137.0 The user (end) shall be able to experience what is happening in the real world also in the virtual environment based on guidance/explanations from the intelligent virtual humans.<br>UR149.0 The user (end) shall be able to remain aware of the process of the procedure.<br>UR153.0 The user (dev) shall be able to easily get information about different scenarios/procedures through an interface. |
| Collaboration | 1.1 | UR1.0 The user shall be able to participate in remote collaborations either as holoported avatar or remotely controlled avatar.<br>UR2.0 The user shall be able to experience enhanced remote collaboration through the integration of haptic technologies, allowing multisensory interaction and improving cognitive feedback through forces and tactile sensations.<br>UR3.0 The user shall be able to perform collaborative activities with others, such as sketching plans on a board, working on documents, or manipulating 3D models.<br>UR4.0 The user shall be able to perceive other's forces and touch thanks to integrated haptic technologies during collaborative activities.<br>UR37.0 The user shall be able to use the PRESENCE technology/system to enhance cooperation and communication to be more efficient.<br>UR46.0 The user shall be able to more effectively communicate design work and material shapes through enhanced social interactions and virtual presence in the virtual environment.<br>UR47.0 The user shall feel that they have worked together on a product in the virtual environment, enhancing the sense of collaboration and teamwork. |
| Comfort and relaxation | 2.1 | UR111.0 The user shall be able to feel increasingly relaxed and have reduced anxiety levels in stressful/painful experiences, due to VR therapy.<br>UR122.0 The user (end) shall be able to use haptic devices to help them calm down and feel relaxed.<br>UR129.0 The user (end) shall be able to use the PRESENCE technology to feel more relaxed and distracted during their appointment. |

| Category | UC | UR |
|---|---|---|
| | 2.2 | UR148.0 The user (end) shall be able to feel more calm and relaxed in the VR environment.<br>UR190.0 The user (end) shall be able to comfortably experience the virtual cultural site without it being too crowded. |
| Compliance | 1.1 | UR48.0 The user shall be able to ensure that collaborative and co-creative spaces comply with corporate and regulatory requirements, including security and GDPR standards.<br>UR49.0 The user shall be able to address compliance issues. |
| Cost saving | 1.1<br>ALL | UR21.0 The user shall be able to save time and costs by using the PRESENCE technology/system for virtual meetings.<br>UR22.0 The user shall be able to use the PRESENCE technology/system to reduce the need for travel expenses. |
| Distraction | 2.1 | UR116.0 The user (end) shall be able to receive haptic feedback on different parts of the body to distract them from the procedure taking place. |
| Easy set up | 1.1<br>2.2<br>ALL | UR5.0 The user shall be able to easily calibrate the system.<br>UR6.0 The user shall be able to easily and intuitively set up meetings and virtual experiences.<br>UR7.0 The user shall be able to easily and efficiently create virtual representations of participants.<br>UR474.0 The user shall be able to easily set up the system for all three technical pillars.<br>UR63.0 The user shall be able to set up the system quickly and easily, regardless of their technical familiarity or adeptness. |
| Easy use | ALL | UR172.0 The user (end) shall be able to easily use and navigate the PRESENCE technology/system and devices, without prior experience or knowledge of the system.<br>UR471.0 The user shall be able to easily use the system to customize experiences. |
| Efficient | 1.1 | UR8.0 The user shall be able to use the PRESENCE technology/system to set up more efficient and effective meetings in a virtual environment.<br>UR20.0 The user shall be able to perform tasks in the virtual meeting environment that are not possible in the physical environment to enhance overall efficiency. |
| General usability | 2.1 | UR154.0 The user (dev) shall be able to set up different scenarios in the virtual environment for different procedures and patients.<br>UR155.0 The user (prof) shall be able to use the PRESENCE technology/system to provide VR therapy to their patients |
| Human interaction and training comfort | 1.2 | UR99.0 The user shall be able to train alongside and interact with fellow trainees who are also real humans, to enhance comfort during training sessions. |
| Interaction with system | 1.1 | UR24.0 The user shall be able to have full body control even when wearing only a headset.<br>UR50.0 The user shall be able to choose to be represented as an avatar in |

| Category | UC | UR |
|---|---|---|
| | 1.2 | the virtual environment.<br>UR60.0 The user shall be able to interact with the virtual environment using tactile technologies to simulate realistic force, weight, and pressure feedback.<br>UR94.0 The user shall be able to develop and interact with virtual devices when the real device is not present. |
| | 2.1<br>2.2 | UR143.0 The user (end) shall be able to interact with intelligent virtual humans during the procedure to ask questions and/or be guided by it.<br>UR186.0 The user (end) shall be able to interact with physical objects in the virtual environment.<br>UR188.0 The user (end) shall be able to actively interact and engage with the virtual environment.<br>UR473.0 The user shall be able to enhance the virtual experience by e.g. adding colliders between objects and/or virtual characters. |
| Interoperability | 1.1 | UR23.0 The user shall be able to use pre-existing resources and settings for meetings. |
| | 1.2 | UR64.0 The user shall be able to integrate the holoportation system easily through a simple API.<br>UR73.0 The user shall be able to access well-elaborated solutions within the SDKs to facilitate the development of distributed environments.<br>UR87.0 The user shall be able to join the training program even with limited hardware access.<br>UR96.0 The user shall be able to implement or adopt solutions that are compatible with third-party technologies, such as third-party developer units or robot solutions, to ensure a good experience. |
| | 2.1 | UR114.0 The user (end) shall be able to access and use the system from anywhere/remotely. |
| | 2.2 | UR173.0 The user (prof) shall be able to pre-record experiences.<br>UR174.0 The user (end) shall be able to experience and use the PRESENCE technology/system from anywhere/remotely.<br>UR184.0 The user (prof) shall be able to be holoported into the experience to better guide tourists in a virtual cultural site. |
| Intuitive boarding process | 1.2 | UR62.0 The user shall be able to complete a quick and easy onboarding process. |
| Motion tracking | 1.2 | UR84.0 The user shall be able to train with grabbing objects and receive highly specific cues from haptic feedback.<br>UR85.0 The user shall be able to use various haptic devices, e.g. controllers, haptic gloves, haptic vests, during training. |
| Multimodal | 1.1 | UR38.0 The user shall be able to experience and interact with the PRESENCE technology/system in a multimodal way. |
| Performance | 1.2 | UR98.0 The user shall be able to use the system effectively with varying network conditions, such as high bandwidth or Wi-Fi connections. |

| Category | UC | UR |
|---|---|---|
| Personalization | 1.2 | UR83.0 The user shall be able to receive personalized training from intelligent virtual humans that accommodates varying skill levels and learning speeds. |
| Presence and Plausibility | 1.1<br>1.2<br>2.1<br>2.2 | UR26.0 The user shall be able to experience and exhibit natural behaviours and expressions, such as body language and facial expressions, in virtual meetings.<br>UR36.0 The user shall be able to in a realistic and faithful way experience teleportation and locomotion in the virtual environment.<br>UR39.0 The user shall be able to to feel a heightened level of presence in the virtual environment.<br>UR91.0 The user shall be able to feel present in the training scene through the use of holoportation, haptics, and realistic environments.<br>UR117.0 The user (end) shall be able to (as holoported) see a representation of their body (first- or third-person) to better follow what is happening during the procedure when in the VR environment.<br>UR118.0 The user (end) shall be able to see a representation of physical objects in the virtual environment.<br>UR134.0 The user (end) shall be able to follow the procedure in the virtual world in a plausible way.<br>UR136.0 The user (end) shall be able to feel present/heightened sense of presence in the virtual environment.<br>UR138.0 The user (end) shall be able to in a plausible way experience the virtual environment's representation of the real world.<br>UR144.0 The user (end) shall be able to see a representation of their body (first- or third-person) to better follow what is happening during the procedure when in the VR environment.<br>UR150.0 The user (end) shall be able to see a representation of their body (first- or third-person) to better follow what is happening during the procedure when in the VR environment.<br>UR169.0 The user (end) shall be able to experience European cultural heritage remotely, with a realistic sense of being present at the location.<br>UR179.0 The user (end) shall have a balanced and non-overwhelming experience that integrates cultural content and virtual technology seamlessly. |
| Procedural efficiency | 2.1 | UR145.0 The user (prof) shall be able to more efficiently conduct procedures. |
| Procedural efficiency and user comfort | 2.1 | UR113.0 The user (prof) shall be able to perform procedures in a comfortable, effective, and efficient way.<br>UR146.0 The user (end) shall be able to more efficiently and comfortably go through procedures. |
| Realism | 1.1 | UR16.0 The user shall be able to experience/see a photorealistic representation of themselves.<br>UR17.0 The user shall be able to experience haptic sensations as realistically as possible within the technological means of the project.<br>UR33.0 The user shall be able to share and feel the texture of virtual objects (e.g., a chair) through haptic feedback.<br>UR34.0 The user shall be able to sense the weight and other physical |

| Category | UC | UR |
|---|---|---|
| | 1.2<br>2.1<br>2.2 | sensations of virtual objects through haptic feedback.<br>UR41.0 The user shall be able to experience high-quality 3D graphics to make virtual representations more realistic.<br>UR51.0 The user shall be able to have their avatar display smooth and natural animations.<br>UR78.0 The user shall be able to have a realistic representation of themselves within the system.<br>UR79.0 The user shall be able to interact with a realistic representation of the trainer.<br>UR86.0 The user shall be able to experience force feedback when touching buttons or grabbing objects to enhance the realism of the training.<br>UR92.0 The user shall be able to see realistic representations of themselves, colleagues, and trainers.<br>UR159.0 The user (end) shall be able to see a photorealistic representation of themselves in the virtual environment.<br>UR160.0 The user (end) shall be able to see a photorealistic representation of the intelligent virtual humans in the virtual environment.<br>UR161.0 The user (end) shall be able to see photorealistic representations of physical objects in the virtual environment.<br>UR191.0 The user (end) shall be able to experience a cultural site as if it was the actual site.<br>UR481.0 The user shall be able to experience high levels of realistic representations with low latency. |
| Reality and plausibility | 1.1 | UR27.0 The user shall be able to use the PRESENCE system/technology to enhance client presentations, such as to walk around and show products in the virtual environment. |
| Realtime interaction | 1.2<br>2.1<br>2.2 | UR61.0 The user shall be able to share tactile feedback and interactions with others in real-time through the interhaptics engine and providers system.<br>UR107.0 The user shall be able to interact with physiotherapists in real-time.<br>UR108.0 The user (prof) shall be able to engage with end users through a multi-user real-time holoportation pipeline.<br>UR170.0 The user shall be able to interact seamlessly with the tour guide and other elements of the virtual environment, projected in real-time using a holoportation pipeline. |
| Reassurance | 2.1 | UR128.0 The user (end) shall be able to use the PRESENCE technology during procedures to overcome their concerns. |
| Representation | 2.1 | UR109.0 The user shall be represented as 3D avatars without needing volumetric capturing systems. |
| Robustness | 1.2 | UR95.0 The user shall be able to utilize a robust system that ensures high dependability and reliability. |
| Safety and security | 1.1<br>1.2 | UR18.0 The user shall be able to in a safe manner participate in virtual meetings.<br>UR58.0 The user shall be able to undergo practical training experiences in a simulated environment without facing real physical danger. |

| Category | UC | UR |
|---|---|---|
| | 2.2 | UR74.0 The user shall be able to train in a safe environment without endangering themselves.<br>UR75.0 The user shall be able to use VR training to simulate dangerous situations safely through a digital twin.<br>UR180.0 The user (end) shall be able to in a safe manner experience a cultural site.<br>UR181.0 The user (prof) shall be able to in a safe manner guide tourists in cultural sites. |
| Satisfaction | 2.1 | UR130.0 The user (end) shall be able to follow breathing exercises with the PRESENCE technology to release stress. |
| Scalability | 1.1<br>1.2<br>2.2 | UR15.0 The user shall be able to set up meetings without much preparation time to enhance scalability.<br>UR68.0 The user shall be able to conduct training without needing the whole team to be in the same location.<br>UR72.0 The user shall be able to scale the training program effectively due to the flexibility of location and the absence of a need for an in-person trainer.<br>UR177.0 The user (prof) shall be able to scale their business by using the PRESENCE technology/system.<br>UR178.0 The user (prof) shall be able to guide multiple visitors at the same time. |
| Social interaction | 1.1<br>2.2 | UR25.0 The user shall be able to interact with other participants in the virtual environment.<br>UR32.0 The user shall be able to utilize haptic feedback to simulate social cues such as tapping someone on the shoulder or facilitating other social interactions.<br>UR171.0 The user shall be able to engage in realistic physical interactions, including social hand interactions, within the virtual environment. |
| Standardization | 2.2 | UR472.0 The user shall be able to experience cost reductions due to streamlined pipelines and higher levels of automation. |
| Support | 2.1<br>2.2 | UR141.0 The user (prof) shall be able to use the PRESENCE technology as support to help patients during procedures, so they can focus more on doing the procedure.<br>UR142.0 The user (end) shall be able to use the PRESENCE technology/intelligent virtual humans as support guiding them through the procedure to feel more calm and relaxed.<br>UR147.0 The user (end) shall be able to interact with intelligent virtual humans that will guide and comfort the user.<br>UR185.0 The user (prof) shall be able to use intelligent virtual humans to support them in guiding tourists in a virtual cultural site. |
| Supporting role of system | 2.1 | UR119.0 The user (prof) shall be able to get support from intelligent virtual humans within the PRESENCE technology/system to help calm/guide patients so they can more efficiently do their job. |
| Sustainability | 1.2<br>2.2 | UR69.0 The user shall be able to provide training remotely by shipping necessary equipment or facilities to the trainees.<br>UR182.0 The user (prof) shall be able to guide tourists and showcase cultural |

| Category | UC | UR |
|---|---|---|
| | | sites without harming it.<br>UR183.0 The user (end) shall be able to experience a cultural site without harming it. |
| Synchronization | 1.1<br>2.1<br>2.2 | UR28.0 The user shall be able to experience reduced latency in speech communication with the intelligent virtual humans in the virtual environment.<br>UR124.0 The user (dev) shall be able to adjust the code to better enhance the experience of synchronized communication.<br>UR152.0 The user (end) shall be able to experience the virtual environment in sync with the real world without errors or lag.<br>UR478.0 The user shall be able to synchronize devices to better optimize and enhance the virtual experience. |
| System control | 1.1<br>2.1<br>2.2 | UR19.0 The user shall be able to easily and intuitively set up an auto protection system without a technician.<br>UR131.0 The user (prof) shall be able to easily indicate to the system what is going to happen in the procedure.<br>UR176.0 The user (prof) shall be able to jump in between guiding-sessions/groups/scenarios. |
| Time-saving | 1.2<br>2.1 | UR65.0 The user shall be able to utilize helper functions to save time on implementation.<br>UR126.0 The user (prof) shall be able to focus on doing the procedure, and save time by not having to calm patients. |
| Training and simulation | 1.1<br>1.2 | UR30.0 The user shall be able to interact with intelligent virtual humans that can play roles such as potential customers, consultants, or trainers for various scenarios like customer pitch training.<br>UR31.0 The user shall be able to use intelligent virtual humans to demonstrate product ergonomics and customize virtual agent characteristics to show different body types and interactions with products.<br>UR43.0 The user shall be able to train for customer interactions by engaging with a virtual human that can play the role of a potential customer.<br>UR44.0 The user shall be able to interact with a virtual human that asks relevant questions about the product, simulating real customer inquiries.<br>UR45.0 The user shall be able to practice and refine their customer selling pitch by interacting with a virtual human powered by a large language model.<br>UR59.0 The user shall be able to individually perform described actions in hands-on-training under intelligent virtual humans guidance.<br>UR71.0 The user shall be able to train at their own pace and repeat the training as needed.<br>UR76.0 The user shall be able to do the training over and over again.<br>UR80.0 The user shall be able to train at their own pace and as needed, with the support of intelligent virtual humans.<br>UR82.0 The user shall be able to see examples of actions being performed by intelligent virtual humans.<br>UR90.0 The user shall be able to train in a virtual environment that closely imitates the real training process. |

| Category | UC | UR |
|---|---|---|
| Uninterrupted training | 1.2 | UR77.0 The user shall be able to conduct training without needing to shut down any part of the factory, office, or production line. |
| User support, guidance, and assistance | 1.1 | UR29.0 The user shall be able to receive support from an intelligent virtual humans during meetings, including note-taking, moderating, and verifying and admitting participants |
| | | UR42.0 The user shall be able to use the intelligent virtual humans as a consultant in virtual meetings. |
| | 1.2 | UR81.0 The user shall be able to receive consistent instructions from intelligent virtual humans. |
| | 2.1 | UR110.0 The user shall be able to receive guidance and feedback on how to improve their movements, form, and technique. |
| | | UR120.0 The user (end) shall be able to get support and guidance from intelligent virtual humans throughout a procedure. |
| | | UR135.0 The user (end) shall be able to follow the procedure based on guidance/explanation from an intelligent virtual human. |

*Table 13: Initial Set of User Requirements*

## 6.1. General UR (across UC)

It can be seen from the results of the workshops that have been translated into URs, that many of them are recurring across UCs. At this point, we have been able to translate a total of 165 URs, which are based on the UC description in the DoA, KoM, and the UR gathering workshop with the consortium in M04. However, to proceed with finding/establishing the general UR across UCs, we must first adjust and remove/merge duplicate URs within each UC, then we will together with the consortium validate and prioritise the relevant UR to each UC to see what general UR emerge. This will be done in a validation and prioritisation workshop that will be conducted during the Plenary meetings in M07. In general, for each UC, next steps include getting a more concise overview of these URs by listing the most relevant UR to each UC as well as validating and prioritising the URs together with the consortium.

In the following sections, the results or main points from each workshop will be discussed. It will also be presented how many URs were translated per UC (across all themes found), it is, however, important to note, that at this point we have already been able to identify URs that may be applicable across UCs, although this is still a work in progress. So far, we have been able to identify 7 URs across UCs.

## 6.2. UC 1.1

From the results of the *professional collaboration* workshop, it can be seen that the most important, or at least the most widely discussed, matters concern usability (21), IVAs (14), social interaction (14), haptics (11), holoportation (9), assistance (8), and flexibility (8), seeing that these themes were found several times in the data (for a more detailed overview of the themes found in the data, consult Adjunts' Section 11.4).

In the discussions of the workshop, it was clear that usability is of high importance. Mainly the user friendliness aspect was discussed, stressing the importance of a highly accessible and user friendly system and technology for all users, e.g. mentioning things such as it should be easy for users to calibrate and prepare the system without any difficulty or extensive prior technical knowledge. The IVAs were also widely discussed where these would preferably have more of a supportive role to the professional user, e.g. the IVA could assist the professional user during meetings by taking notes, moderate parts of the meeting, as well as verifying and admitting participants to meetings. The IVA

was also discussed in terms of other supporting roles, such as acting as potential customers, consultants, or trainers so that end users can practise on e.g. customer pitching, but the IVA could also act as a demonstrator, showing product ergonomics and other types of interactions with the designed product using e.g. different settings for body type. Social interactions within the virtual environment was also deemed important, where users can interact with each other with haptics by e.g. shaking hands or tapping each other on the shoulder, but also with objects in terms of sharing and feeling texture and/or weight of different objects. As the user is holoported, it was also discussed that they shall be able to express natural body language and see realistic representations of themselves and other holoported users. In responding to some of the frustrations found among the personas, the flexibility of the system to allow organising and attending meetings from anywhere was discussed, where this flexibility also accounts for access to devices and the flexible use of various devices among users. In total, we were able to translate the output into 43 URs (across all themes found).

## 6.3. UC 1.2

From the results of the *manufacturing training* workshop, it can be seen that the most important, or at least the most widely discussed, matters concerns usability (21), haptics (20), flexibility (9), and devices (8), seeing that these themes were widely found in the data (consult Adjunts' Section 11.4 for a more detailed overview of themes found).

In the discussions of the workshop, usability was a widely discussed matter, in which it was emphasised that it should be easy for the user (professional and developer) to use, setup, and navigate the technology/system without necessarily needing any extensive technological background. It should be easy for the user to set up, use, and adjust the system, to save them time and make it easier for users to do manufacturing training. This also goes hand in hand with flexibility, in the sense that it should be easy to bring trainees together for training, no matter from where they choose to join (in person or remotely), and that trainees can choose to redo the training over and over again if they want. This way, professional users can reduce costs in terms of travel costs but also by not having to close down parts of the manufacturing line. The haptics were discussed as to be the main feature/technology to use in this UC, where the haptic gloves and vest can provide an enhanced immersive experience in the virtual training environment, by giving haptic feedback for different exercises, e.g. force feedback when grabbing objects, haptic vibration feedback when walking into restricted areas, and/or a hand controller giving force /haptic feedback when touching certain buttons. In terms of devices, it was discussed that in case of users not having access to certain devices, there should be options of virtual devices to use, and that it should be possible to use the technology/system with just a headset if joining remotely but also the option to do the training with a more complex system if joining at the test location. In total, we were able to translate the output into 35 URs (across all themes found).

## 6.4. UC 2.1

From the results of the *health* workshop, it can be seen that the most important, or at least the most widely discussed, matters concerns usability (23, including sub themes 'easy to set up', 'easy to use', and 'fast to set up'), IVA (10), supportive (10), and user guidance (7), seeing that these themes were widely found in the data (consult Adjunts' Section 11.4 for a more detailed overview of themes found).

As in the two previous workshops, usability is a main point brought up in the discussions of this workshop, where it was stressed the time saving aspect is incredibly important for the professional user and thus the system must be easy for the user to set up, use, and that the set up time must be fast. The discussion centred around the fact that the PRESENCE system is to function as a support to the professional user, the time that the professional user spends on calming or guiding patients shall be overtaken by the system so that the professional user can focus on completing the procedure. The main conclusion of this discussion was that the professional user should be left with a feeling that their job is made easier and more efficient after using the PRESENCE

technology/system. The IVA was discussed to be the main point of support, by guiding and calming the patient/end user by e.g. describing the different steps of the procedure and/or guiding the patient through calming breathing exercises (also aided by a haptic vest). The main conclusion of the discussion on the end user was that the user should leave their procedure with a feeling of having had a positive experience due to the supporting and distracting aspects of the PRESENCE technology/system. Another point of discussion was that the experience must be adjustable to different types of procedures and patients/end users with different needs, either by a preset of different choices or that developers can adjust the code/settings of the system to include different choices/options.

In this workshop, another professional persona was also made up, the nurse. This persona was also thought of during our discussions on the professional user/persona and their potential needs. In total, 41 URs were translated (across all themes found).

## 6.5. UC 2.2

From the results of the *cultural heritage* workshop, it can be seen that the most important, or at least the most widely discussed, matters concerns interaction with system (12), usability (8, including sub themes ‘easy to set up’ and ‘easy to use’’), flexibility (7), accessibility (6), customizable (6), integration concerns (6), scalability (6), seeing that these themes were widely found in the data (consult Adjunts’ Section 11.4 for a more detailed overview of themes found).

In this workshop, it can be seen that the interaction with system aspects were the most prominent in the discussions, there was a great emphasis on the importance of the end users being able to interact with the virtual environment, but also that the professional user shall be able to pre-record experiences to better be able to scale up their business. It was also discussed that it should be easy for the users (end, professional, and developers) to use and navigate the system and devices, as well as it being easy for the developers to set up the systems and devices for the experience. It was also widely discussed that the end users can through the PRESENCE experience access cultural sites that otherwise would not be accessible to them, but also for users with disabilities to be able to experience and access sites that to them otherwise would have been difficult to access. In terms of the developers, it was also widely discussed that the PRESENCE system and technology should be customizable to better enhance the experience, e.g. in terms of representations of virtual characters and social interactions between users and characters (e.g. being able to add colliders to characters that otherwise would not have that). This does, however, bring some concerns in terms of integration, since we do not know how we can ensure that all characters can interact with each other/are interactable. This discussion also revolved to a large extent around the possibility for developers to combine APIs, in terms of different cues being programmed for different devices so that in cases where certain devices are not used, the experience can continue but with other cues instead. Through the possibility to customise and use the PRESENCE technology/system to give access to end users to experience cultural heritage sites, developer and professional users can better scale up their business due to cost reductions, e.g. for the developer in terms of streamlined pipelines and higher levels of automation. In total, 23 URs were translated (across all themes found)

# 7. Practical Guidelines for Involving Human Participants in PRESENCE

## 7.1. General recruitment strategy

PRESENCE will implement an inclusive recruitment strategy. Our inclusive and diverse recruitment strategy consists of following points:

1. **Diverse User Group Composition**:

We have specified relevant user groups and participant numbers for each phase and UC, as outlined on our Miro Board[3]. These specifications are based on a stakeholder analysis to ensure appropriate distribution.

Research shows that there is a link between gender and likelihood to get motion sick in VR/XR [Ref. 82] [Ref. 34] and also a link between age and likelihood to get motion sick in VR/XR [Ref. 52]. For example, women experience higher levels of discomfort during VR sessions due to nausea and other symptoms [Ref. 82]. This gender difference could be explained by hardware differences. For example, the default HMD settings are usually tuned to fit the interpupillary distance of men, rather than women [Ref. 34]. Looking at the link between age and likeliness to get motion sick in VR/XR, it can be noted that older adults tend to experience less motion sickness in VR than younger people. An explanation for this could be due to age-related decline in sensory sensitivity and vestibular function [Ref. 52].

To ensure that as few participants as possible get motion sickness, a questionnaire [Ref. 32] will have to be completed beforehand that predicts how likely someone is to get motion sickness. In case the questionnaire indicates a high probability of becoming motion sick, candidates will still have the option to participate in case they desire to do so. There will also always be communication about the dangers and how XR can affect them, but participants can decide for themselves whether they want to take the risk or not.

Consequently, since it appears that young adults and mainly women may be left out because they are more likely to get motion sick, additional efforts will be made to attract these target groups (see below).

2. **Relevant Recruitment Channels:**

To recruit participants from diverse backgrounds, we will utilise various media channels such as: the communication channels of the partners, third parties funded in open call projects, stakeholder and related associations, such as announcements at websites, social media channels and mailing lists, etc.

The first call for participation should be sent out two weeks before the event. This gives the recipients enough time to respond but is also not too much in advance so that they would forget about the event [Ref. 21]. Follow-up reminders are also extremely important to increase response rates. Therefore, follow-up reminders should be sent 48 hours and 24 hours in advance [Ref. 28].

3. **Gender Neutral Language and Imagery:**

Our participation calls will use only inclusive language and imagery to attract a broader pool of participants. We will avoid gender-coded words and unnecessary requirements that might deter diverse candidates. The organisation's commitment to diversity and inclusion will clearly be communicated in all recruitment materials. Highlighting these values can make the organisation more attractive to young adults and women [Ref. 68]. The focus in the call for participation will also be on gaining experience with VR/XR so that it will benefit young adults and women in their personal development [Ref. 68].

Deliverable *D7.1 Project Management Handbook* provides, in its Section 7, guidance to assist the integration of gender and diversity dimension during the project implementation, in research activities. These guidelines are based on the *EC gender equality strategy*[4] and aim assisting the development of the work by rethinking standards, and questioning norms, behaviour and attitudes, to best suit the needs of the target groups, thus strengthening the impact proposed by PRESENCE.

[3] https://miro.com/app/board/uXjVKT_Tfqc=/?share_link_id=745376122477

[4] https://ec.europa.eu/newsroom/just/items/682425/en

While the section below will discuss the requirements for the call for participation and informed consent, we would also like to refer to deliverable *D7.2 Ethics Framework and Data Management Plan I*, which provides insight into the ethical standards that will be used within PRESENCE and in the handling of personal data

## 7.2. Call For Participation

The recruitment of potential participants is a delicate and important task that requires careful attention. It is important that a trustworthy relationship between the recruiter and the participants can be developed, since this has an impact on the PRESENCE research and its final products. It is important to stress that in recruiting participants, this will only be done for specific research activities and we will not use the participant's information to send newsletters nor inquiries for participation in further research activities - unless the participant has explicitly stated that they would like to receive such inquiries and information. When recruiting participants it is important to be transparent and have an open communication towards them, as otherwise this might impact participation and/or research outcomes.

The participant should therefore be informed that their participation is voluntary, and that due to this they can choose to end their participation at any point during an experiment, workshop, interview, survey, etc., and that they can thus demand that their personal and collected data will be deleted. They should also be informed about the purpose of the processing and collection of their personal data, what type(s) of personal data will be collected and processed, as well as how it will be used, processed, stored, handled, and who has access to it during the project duration and after its completion. It is also important that participants are informed about what their rights are as data subjects according to GDPR, of what nature their input is, the timing and location of the research activity, as well as potential health hazards in relation to the research activity.

It also has to be clear to the participant what the project is about, what the purpose of the research activity is, what types of data that will be collected and who will store and access it, their rights as participants, information about data privacy, and where they can find published articles, blog posts, deliverables, etc. Participants must formally consent to take part and attest to their full understanding. Data from studies will only be publicly accessible with participant consent and the correct depersonalization.

In the call for participation itself, it is also important to be specific about the kind of participants that are required for each research activity, including their age range, level of VR experience, and other demographic requirements. Alongside this, specific details about what their participation could involve can also be provided, such as test duration, the tasks that participants must complete, and any incentives or compensation that they could receive for participating. To guarantee a representative sample of participants, inclusiveness and diversity in participant recruitment should be given top priority. To do this, we will interact with various demographic groups and make certain that no prospective participants are taken out due to their age, gender, ethnicity, or disability. To recruit participants we will reach out to specific stakeholders through email and we will make use of the project's (or the hosting partner's) social media channels, such as LinkedIn, X, and Instagram, to reach a broader and more inclusive demographic.

Summary attention points:

- **Project overview:** Clearly explain the PRESENCE project, its aims and innovative use of VR technology.
- **Purpose of research:** State the purpose of the research activity and specific objectives.
- **Criteria for participants:** State demographics and other criteria for selecting participants.
- **Participation details:** Provide details on the duration, tasks and commitment required of participants.
- **Compensation:** Inform participants about any compensation or incentives.

- **Data collection:** Describe what types of data will be collected and how it will be used.
- **Data privacy:** Provide information about data privacy, including who stores the data and who has access to it.
- **Participants‘ rights:** Clearly state participants’ rights, including the right to withdraw at any time without cause.
- **Potential risks:** Inform participants of potential risks, especially those associated with the use of virtual reality.
- **Ethical considerations:** Ensure that participants are fully informed and give explicit consent
- **Inclusion and diversity:** When recruiting participants, emphasise efforts to ensure inclusion and diversity.
- **Communication:** Ensure open communication so that participants are fully informed about all aspects of the study.
- **Access to publications:** Provide information on where participants can find articles, blog posts and results published by the project.
- **Follow-up:** Explain that participants will not be contacted about further research activities unless they have given explicit consent.

An example of a call for participation for a user requirement workshop and the communication on socials for each UC can be consulted in the Adjunts’ Section 11.5.

Figure 28 shows a template for the visual we will use for our calls for participation in social media.


*Figure 28: Template call for participation visual in social media*

## 7.3. Informed Consent

The informed consent form needs to be signed prior to the start of any testing, experiment, workshop, focus group, or interview. This can be signed physically or digitally, e.g., via a Word or PDF document. When testing/experiments are conducted in the native language of the participant, the informed consent form must also be translated into their native language. The informed consent must also include a brief description of the project, its goals, and whether or not the research will be recorded (e.g., audio, video, and/or notes). The timing, location, and what is expected of the participant should also be mentioned, but most importantly, participants must be made aware of their rights, e.g. that they have the freedom to stop participating in the activity at any moment and without giving a reason. Furthermore, our data processing strategy should be outlined as well, describing the measures we take to ensure data privacy and that the data will be anonymized. Participants must give explicit consent before any additional data collection is done, e.g. having pictures taken of them, especially if those images will be used in deliverables, blogs, articles, social media posts, etc.

An example of an informed consent for a user requirement workshop for each UC can be consulted in the Adjunts' Section 11.6. The consent form will also ask for demographic information and other relevant details about the participants, such as age, gender, profile and experience with XR. Although these specific details are not provided in the examples in the Adjunts' Section, they will be further integrated into it.

# 8. Conclusion and Next Steps

## 8.1. User Requirement Updates and Adjustments

The gathering, validation, and prioritisation of user requirements is an iterative process. From each activity throughout the project, new URs will emerge which we will need to validate and prioritise, and eventually implement (or not). This iterative nature is important to stress, since it is needed to specify and adjust the UR throughout the lifecycle of the project. At this point of the project, we have been able to translate a total of 165 URs, which will need further handling, thus they are not currently a finished product, but rather a stepping stone to work with. Starting from here, the next steps are to adjust the URs so that we can validate and prioritise them together with the consortium at the General Assembly in Barcelona in M7. Adjusting the URs is necessary to ensure that there are no duplicates and that requirements within UCs can be merged if necessary, this way we work with a slightly smaller but more efficient set of URs when validating and prioritising them. By validating and prioritising the URs after each testing/user activity and iteration, we can get a better overview of what URs are the most (and least) relevant to implement in the project, at the same time meeting user needs.

## 8.2. Consistent Alignment Between User Research and Technical Development Throughout the Project

Over the course of the project, there will be consistent alignment between user research and technical development. Bi-weekly meetings will be organised for both WP1 and WP5 (in which Work Package owner of WP1, 2, 3 and 4 also attend) where immediate issues are communicated and where insights from user research are shared with the development team. In addition, monthly meetings are also organised between WP1, 2, 3, 4 and 5 enabling strategic adjustments and long-term planning based on evolving user feedback and technical progress. This structured communication ensures that our project remains user-centric while remaining technically feasible. Continuous alignment will ultimately lead to technologies that meet user expectations and industry standards.

# 9. Abbreviations and definitions

## 9.1. Abbreviations

| | |
|---|---|
| **3M** | Multimodal Matching |
| **A3M** | Adaptive Multimodal Matching (A3M) |
| **AI** | Artificial Intelligence |
| **ALTAI** | Assessment List for Trustworthy Artificial Intelligence |
| **DoA** | Description of the Action (Annex I to the Grant Agreement contract) |
| **EU** | European Union |
| **EEA** | External Ethics Advisor |
| **GDPR** | General Data Protection Regulation |
| **HCD** | Human Centred Design |
| **MCA** | Multi-Criteria Assessment |
| **MCDM** | Multi-Criteria Decision Making |
| **ML** | ML |
| **MMR** | Mixed Metho Research |
| **MS** | Milestone |
| **SUS** | System Usability Scale |
| **TAM** | Technology Acceptance Model |
| **UC** | Use Case |
| **UEQ** | User Experience Questionnaire |
| **UX** | User Experience |
| **WP** | Work Package |
| **XR** | eXtended Reality |

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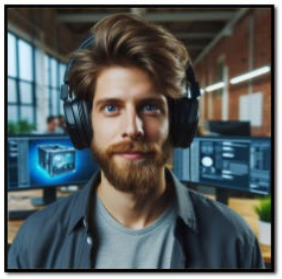
# 11. Adjunts

## 11.1. General Developer personas

Initially, we drafted general developer personas for each technical pillar in addition to one that uses all technical pillars for all UCs. These personas are presented in this section. However, during the course of the workshops, we realised that a developer persona for each UC that uses all technical pillars for the purpose of creating each specific UC would result in more accurate user and technical requirements. The specific developer personas per UC is presented in Section 4.

### 11.1.1. Developer persona for Holoportation tech pillar

**Ryan**



*"Holoportation has the potential to redefine how we connect with others across distances. I'm passionate about pushing the boundaries of technology to create immersive and lifelike holographic experiences."*

Ryan has a background in computer science with a specialization in computer graphics and computer vision. He has been fascinated by the concept of holoportation since its inception and has dedicated his career to developing cutting-edge technologies that enable real-time holographic communication.

**Name** Ryan
**Age** 35
**Occupation** XR Software Engineer
**Type** Primary (direct user)
**Role** Software Developer

**Motivations**

- Pushing the boundaries of technology in communication and collaboration.
- Creating immersive and realistic holographic experiences.

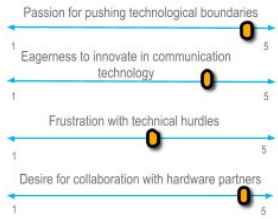
**Goals**

- Develop advanced algorithms and software for real-time holoportation.
- Enhance user experience by improving the fidelity and realism of holographic projections.
- Explore applications of holoportation in various industries, such as telecommunication, entertainment, and education.

**Pain points**

- Overcoming technical challenges in achieving real-time holoportation.
- Addressing bandwidth and latency issues for seamless communication.

**Behaviours**




### 11.1.2. Developer persona for Haptics tech pillar

**Maya**

*"Haptics adds a new dimension to XR experiences, making them more immersive and engaging. I'm driven to create innovative haptic solutions that enhance user interactions in virtual environments."*

Maya holds a degree in electrical engineering and has specialized in haptics and sensory feedback systems. She is passionate about creating immersive experiences that engage multiple senses, with a focus on developing haptic feedback devices for XR applications.

**Name** Maya
**Age** 30
**Occupation** XR Hardware Engineer
**Type** Primary (direct user)
**Role** Hardware Developer

**Motivations**

- Creating immersive and engaging XR experiences through haptic feedback.
- Pushing the boundaries of haptic technology to simulate realistic sensations.

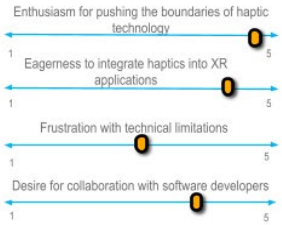
**Goals**

- Develop haptic feedback devices that enhance user interactions in XR environments.
- Integrate haptic technology into existing XR platforms and applications.

**Pain points**

- Overcoming technical limitations in haptic hardware and software.
- Addressing compatibility issues with different XR platforms and devices.
- Balancing cost-effectiveness with the quality and performance of haptic feedback systems.

**Behaviours**



### 11.1.3. Developer persona for Virtual Humans tech pillar

**Max**

*"Virtual humans have the potential to revolutionize how we interact and communicate in virtual environments. I'm dedicated to developing realistic animation techniques to create compelling virtual characters."*

Max has a background in computer science, AI, and 3D art, with a specialization in virtual human creation. He is passionate about creating lifelike and emotionally intelligent virtual characters that can enhance communication in XR environments.

**Name** Max
**Age** 40
**Occupation** XR Software Engineer
**Type** Primary (direct user)
**Role** Designer and Developer

**Motivations**

- Creating emotionally intelligent virtual humans that enhance communication.
- Pushing the boundaries of 3D art, AI and animation technology in XR.

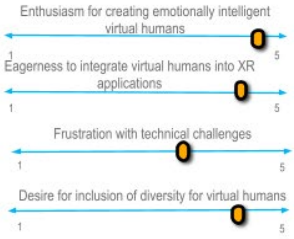
**Goals**

- Develop AI-driven virtual humans with realistic behaviors and emotions.
- Integrate virtual humans into XR applications for communication, training, and therapy.
- Conduct research to understand human responses to virtual characters and improve their acceptance.

**Pain points**

- Overcoming technical challenges in creating realistic virtual human behaviors and expressions.
- Ensuring diversity and inclusivity in virtual human representations.

**Behaviours**




### 11.1.4. Developer persona for all tech pillar and all UCs

In addition, the following Persona was developed who uses all PRESENCE APIs to develop XR applications for XR social and professional UCs:

**Maya**

*"Integrating APIs across haptics, holoportation, and virtual human technologies opens up endless possibilities for creating immersive XR experiences. I'm excited to harness the power of these APIs to revolutionize training, healthcare, collaboration, and cultural preservation."*

Maya holds a master's degree in computer science with a specialization in human-computer interaction. She has extensive experience in developing XR applications across various domains. Maya is passionate about leveraging emerging technologies to create immersive and impactful experiences for users.

**Name** Maya
**Age** 30
**Occupation** XR Developer
**Type** Primary (direct user)
**Role** Developer

**Motivations**

- Enhancing user engagement in social XR and professional XR setups.

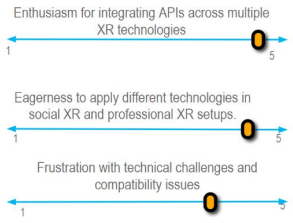
**Goals**

- Integrate haptics, holoportation, and virtual human APIs into XR applications across different domains.
- Develop XR experiences for manufacturing training, XR health, professional collaboration, and cultural heritage that utilizes holoportation, virtual humans, and haptic.

**Pain points**

- Ensuring compatibility and seamless integration of APIs from different providers.
- Addressing performance issues and optimizing XR applications for various devices and platforms.
- Balancing realism and immersion with usability and accessibility in XR experiences.
- Managing the complexity of multi-faceted XR projects and coordinating cross-functional teams.

**Behaviours**

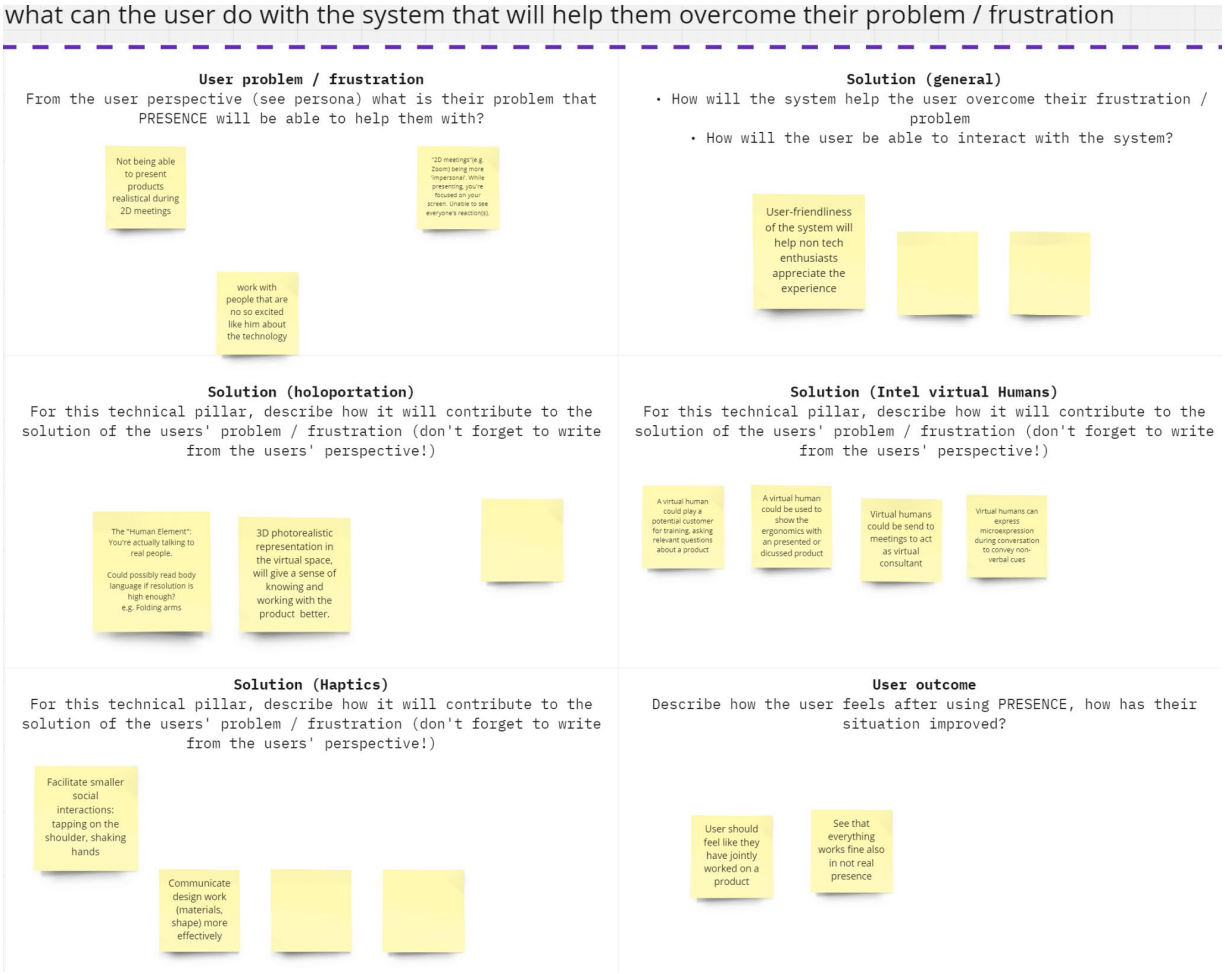


## 11.2. Miro Boards of the Requirements Gathering Workshops

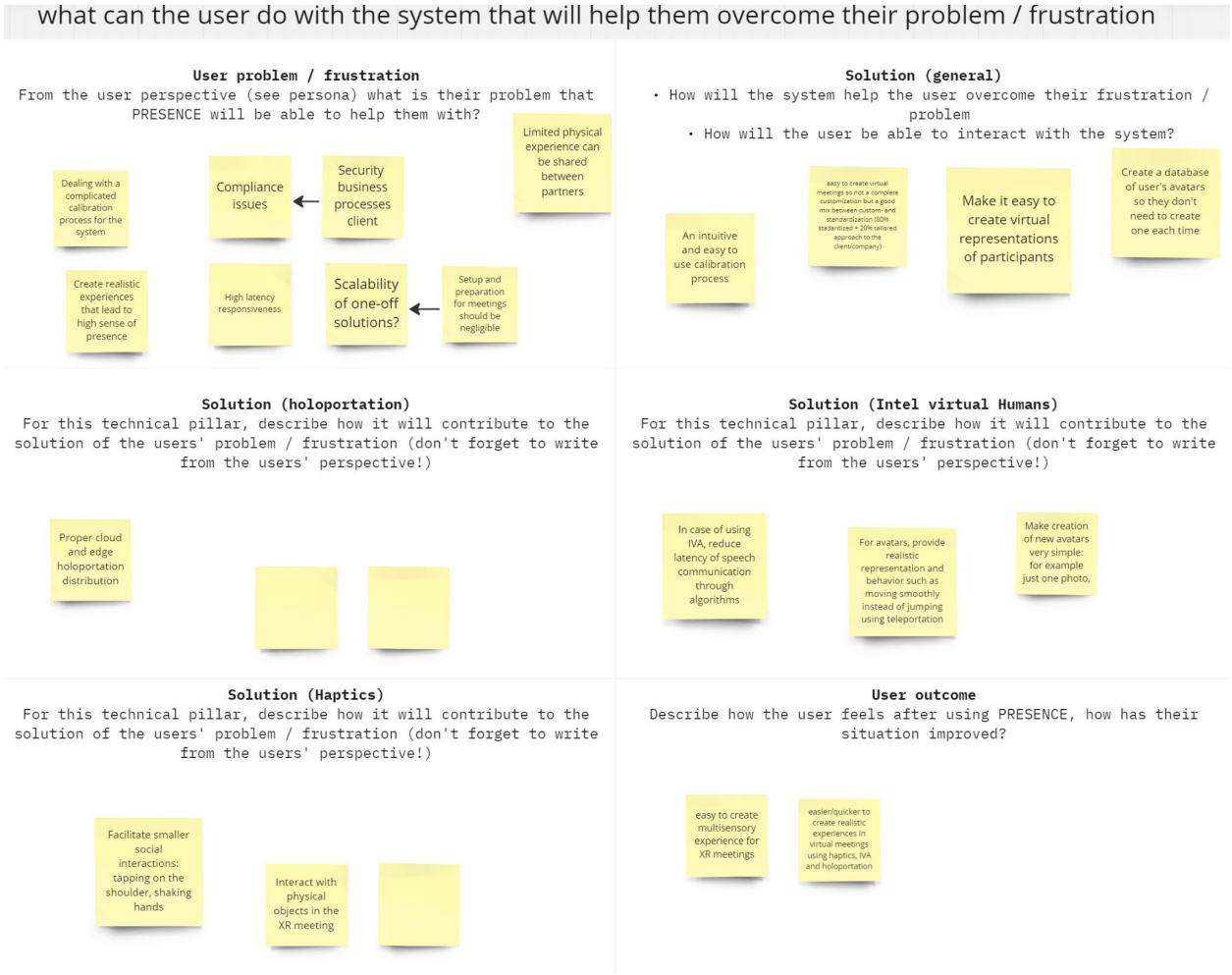
### 11.2.1. Professional Collaboration

#### *10.2.1.1. Professional User Perspective*

### 10.2.1.2. End User Perspective



### 10.2.1.3. Developer Perspective

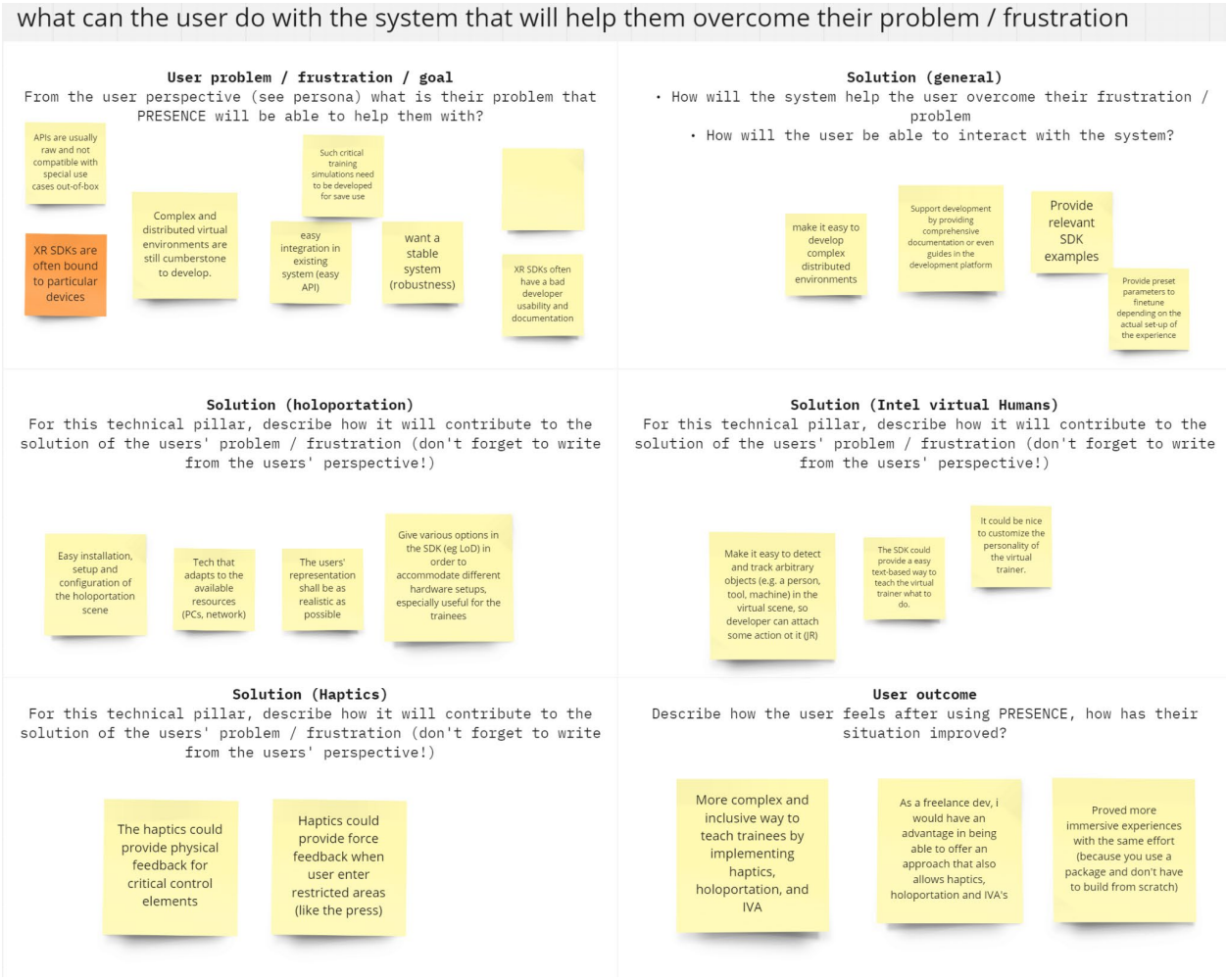


## 11.2.2. Manufacturing Training

### *10.2.2.1. Professional User Perspective*

### 10.2.2.2. End User Perspective

### 10.2.2.3. Developer Perspective



## 11.2.3. Health

### *10.2.3.1. Professional User Perspective*

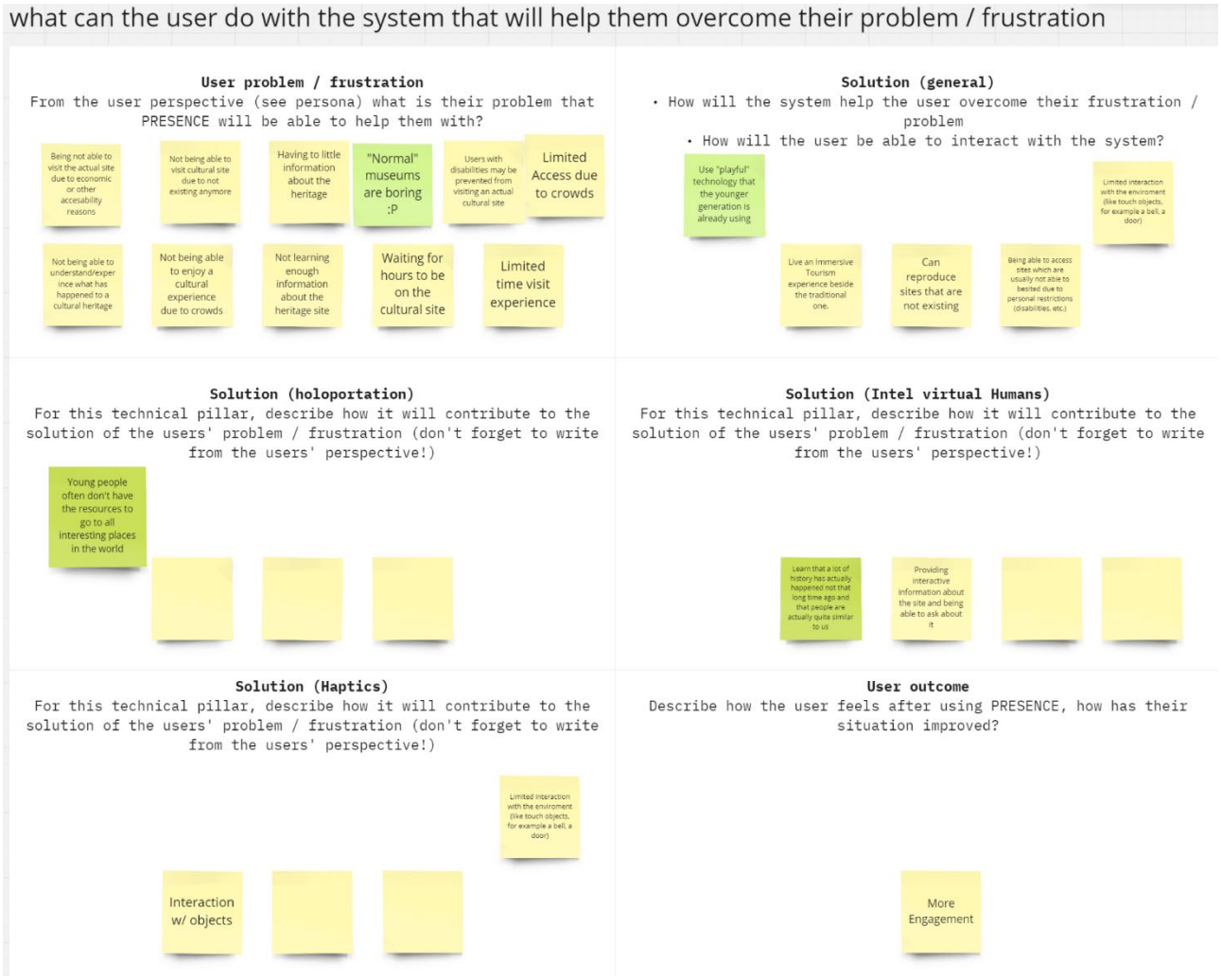
### *10.2.3.2. End User Perspective*

### *10.2.3.3. Developer Perspective*

## 11.2.4. Cultural Heritage

### *10.2.4.1. Professional User Perspective*

### *10.2.4.2. End User Perspective*

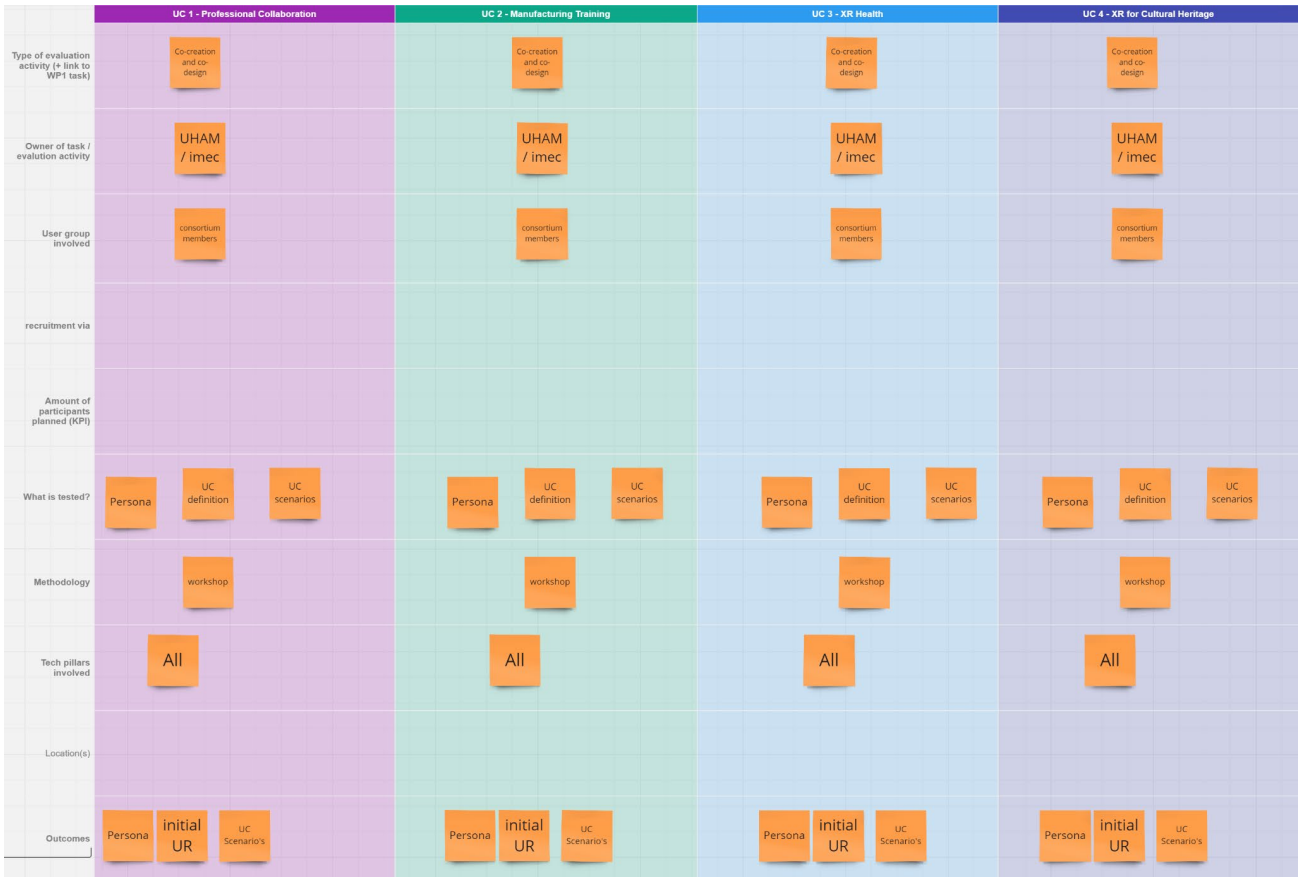


### 10.2.4.3. Developer Perspective

## 11.3. Miro Boards of the Activities in Each Phase of the Project

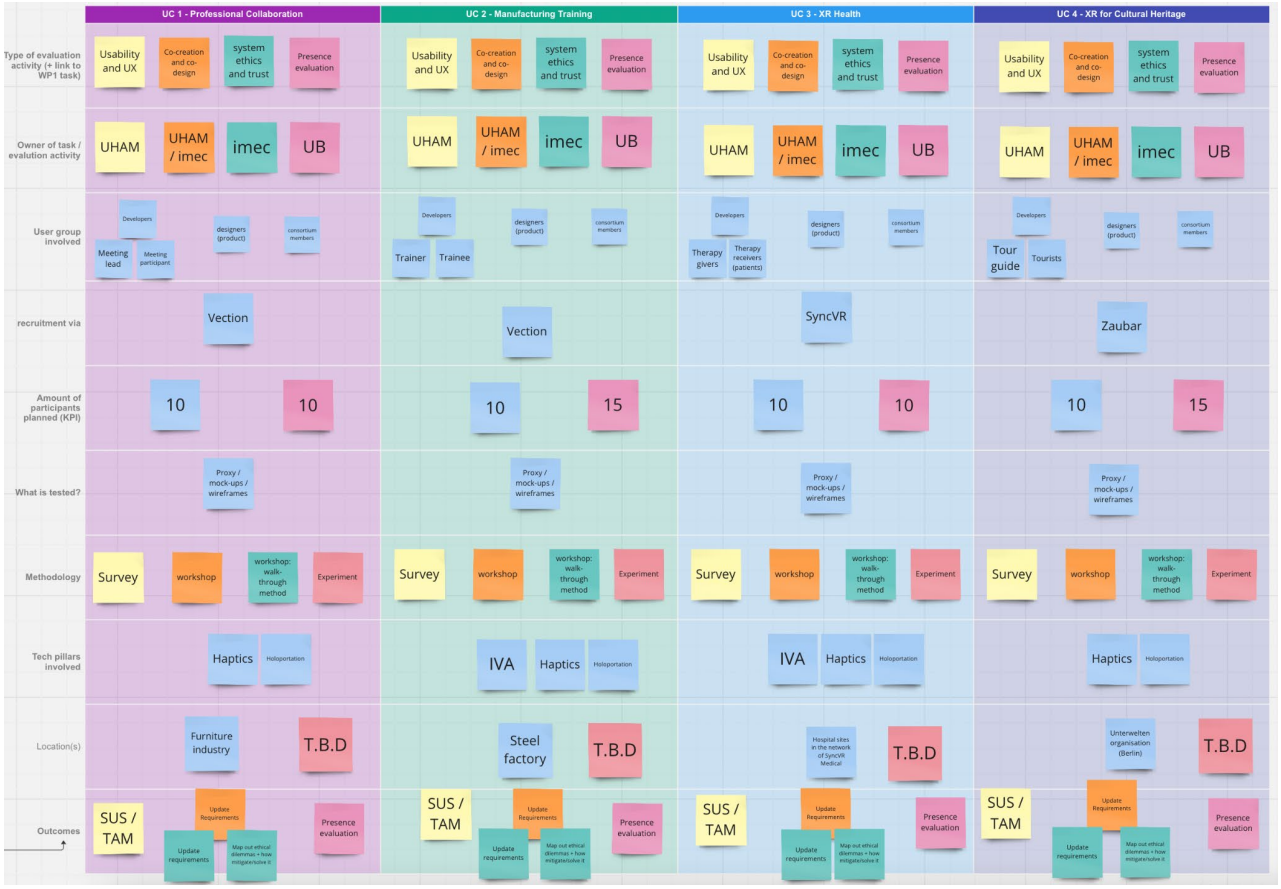
### 11.3.1. Evaluation Plan during Phase I

Phase I - Planning (M1 - M6)



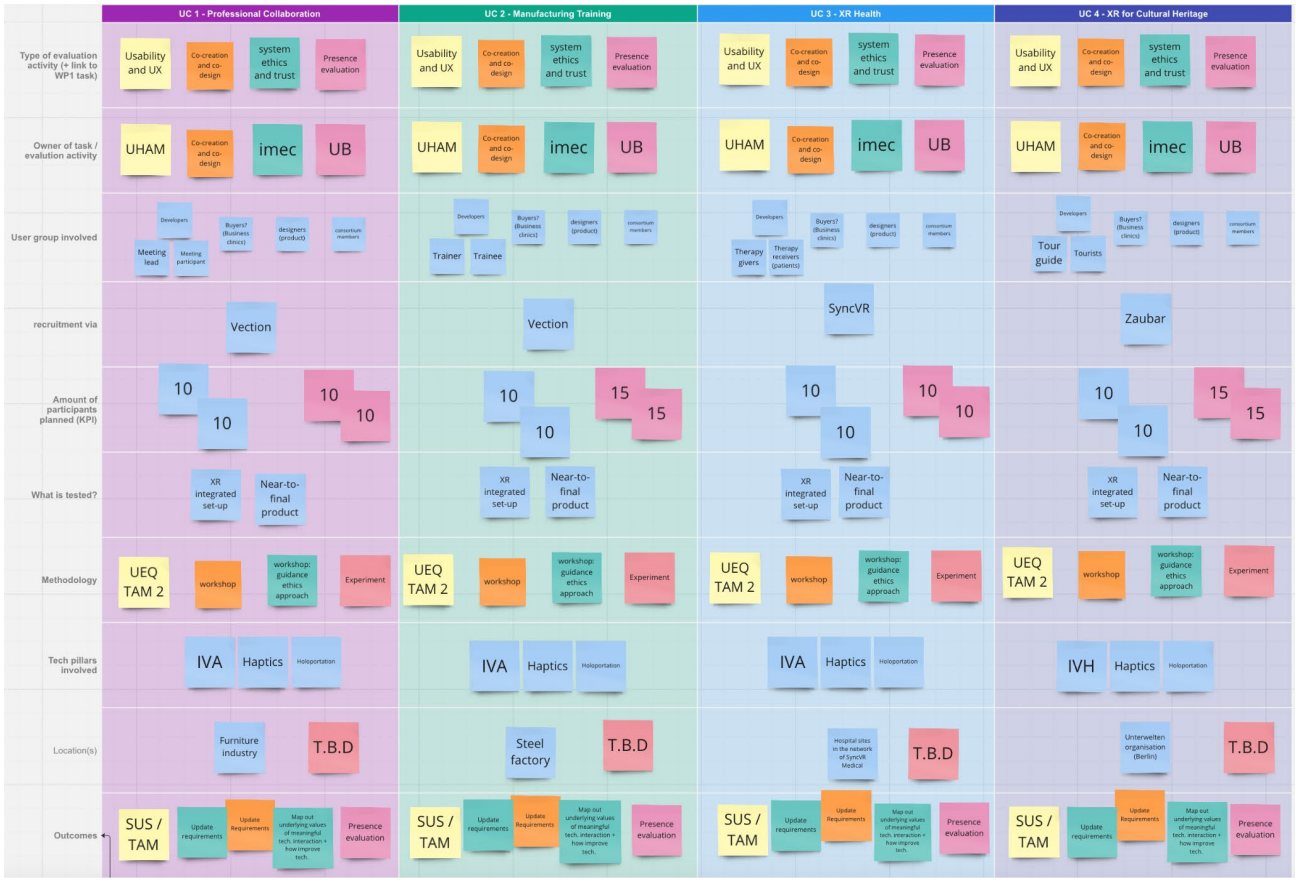
### 11.3.2. Evaluation Plan during Phase II

Phase II - Baseline Development & Validation (M7 - M18)



### 11.3.3. Evaluation Plan during Phase III

Phase III - Maturation (M19 - M36)



## 11.4. Number of Times Themes Found per UC

| Number of times theme found per UC | | | | |
|---|---|---|---|---|
| **Theme** | **UC 1.1** | **UC 1.2** | **UC 2.1** | **UC 2.2** |
| Usability | 25 | 21 | 7 | 6 |
| Flexibility | 8 | 9 | 2 | 7 |
| Scalability | 5 | 1 | | 6 |
| Integration concerns | 3 | 6 | 1 | 7 |
| Safety | 1 | 4 | | 3 |
| Sustainability | 2 | 6 | | 3 |
| TP Holoportation | 9 | 2 | 6 | 2 |
| TP IVA/IVH | 14 | 4 | 10 | 1 |
| TP Haptics | 11 | 10 | 6 | 3 |
| Interaction with system | 1 | 2 | 2 | 12 |
| Accessibility | 3 | 5 | 3 | 6 |
| Inclusivity | | | | 3 |
| Faithfully | 1 | | | 2 |
| Time saving | | | 5 | |
| Overcoming concerns | | | 2 | |
| Distracting | | | 4 | |
| Relaxing | | | 3 | |
| Easy to set up | | | 6 | 1 |
| Easy system control | | | 1 | |
| Positive experience | 1 | | 4 | |
| Multimodal | 2 | | 2 | |
| Presence | 4 | 1 | 1 | |
| Plausibility | | | 4 | |
| Easy to use | | | 6 | 1 |
| Fast to set up | | | 4 | |
| Supportive | | | 10 | |
| User guidance | | | 7 | |
| Avatar | | | 2 | |
| Comfort | | | 2 | |
| Combination pillars | | | 1 | |
| Environment | | | 1 | |
| Synchronisation | | | 7 | 1 |
| Situation awareness | | | 5 | |
| Standardisation | 2 | | | |
| Customizable | 2 | 1 | 3 | 6 |
| Avoid complexity | | | 1 | |
| Photorealistic representation | 11 | 6 | 2 | 1 |
| Feedback personas | 2 | | | 1 |

| Number of times theme found per UC | | | | |
|---|---|---|---|---|
| **Theme** | **UC 1.1** | **UC 1.2** | **UC 2.1** | **UC 2.2** |
| Feedback scenarios | | | | 6 |
| Assistance | 8 | | | |
| Demonstration purposes | 4 | | | |
| Consultant purposes | 2 | | | |
| Training purposes | 4 | | | |
| Social interaction | 14 | 2 | | |
| Compliance issues | 2 | | | |
| Multi User | 1 | | | |
| Animation | 3 | | | |
| Smart avatars | 2 | | | |
| High latency | 4 | | | |
| Devices | | 8 | | |
| Motion tracking | | 4 | | |
| Robustness | | 1 | | |
| Adaptability | | 4 | | |
| Interoperability | | | 2 | |
| Diversity inclusion | | | | 1 |
| Device optimization | | | | 1 |
| Device agnostic | | | | 3 |
| Low latency | | | | 1 |

## 11.5. Call For Participation UR Workshop and Communication on Socials

### 11.5.1. UC Professional Collaboration

#### *10.5.1.1. Call For Participation*

*Dear [name/stakeholder(s)],*

*Are you eager to shape the future of collaboration technology? Join us for a collaborative workshop where your insights and feedback will help shape the development of XR-based professional collaboration tools.*

*About the project:*

*In our quest to redefine collaboration for the digital age, we are exploring the potential of Extended Reality (XR) technology to facilitate seamless and immersive teamwork. Our project aims to develop XR-based collaboration tools that empower professionals to collaborate effectively across distances and disciplines. To ensure these tools meet the needs and expectations of users like you, we are hosting a User Requirements (UR) workshop to gather input and feedback directly from the field.*

*Workshop overview:*

*This workshop is not your typical tech demonstration – it's a collaborative forum where participants play a central role in shaping the future of XR-based collaboration. Through interactive discussions, hands-on demonstrations, and group activities, participants will:*

- *Explore the current landscape of collaboration technology and its limitations.*
- *Experience firsthand the capabilities of XR technology in facilitating professional collaboration.*
- *Share insights, challenges, and expectations regarding the use of XR in their respective fields.*
- *Provide feedback on the usability, functionality, and features of XR-based collaboration tools.*
- *Collaborate with peers and experts to brainstorm ideas and co-create solutions to common challenges.*

*Why participate:*

*By participating in this workshop, you will:*

- *Have a direct impact on the development of XR-based collaboration tools.*
- *Gain insights into the latest advancements in collaboration technology.*
- *Network with industry professionals, researchers, and fellow users.*
- *Contribute to ongoing research and development efforts in the field of XR technology and collaboration.*

*Who should attend:*

*This workshop is open to professionals from diverse backgrounds who are interested in the future of collaboration technology, including:*

- *Designers*
- *Engineers*
- *Architects*
- *Project Managers*
- *Entrepreneurs*

*No prior experience with XR technology is required – just bring your ideas, insights, and enthusiasm for shaping the future of collaboration.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be part of a collaborative effort to revolutionize collaboration technology. Join us and help shape the future of teamwork with XR technology!*

*Sincerely,*

*[name and contact info]*

#### *10.5.1.2. Communication on Socials*

**Facebook:**

✳ Calling all professionals interested in collaboration technology! Want to have a say in how XR technology shapes the future of teamwork? Join us for an interactive workshop where your insights

matter. Apply now to be part of the XR-based professional collaboration UR workshop! [link to application form] #XR #Collaboration #Workshop #TechInnovation

**LinkedIn:**

🚀 Excited to shape the future of collaboration technology? Join us for a collaborative workshop where your input matters! Our XR-based professional collaboration UR workshop is your chance to influence the development of XR-based collaboration tools. Don't miss this opportunity to be part of the conversation. Apply now! [link to application form] #XR #Collaboration #Workshop #TechInnovation

**Twitter/X:**

📢 Want to influence the future of collaboration tech? Join our XR-based professional collaboration UR workshop! Apply now to shape the development of XR-based collaboration tools. #XR #Collaboration #TechInnovation [link to application form]

## 11.5.2. UC Manufacturing Training

### *10.5.2.1. Call For Participation*

*Dear [name/stakeholder(s)],*

*Are you passionate about shaping the future of industrial training? Join us for a collaborative workshop where your insights and feedback will play a pivotal role in refining XR-based training solutions for industrial settings.*

*About the project:*

*In our commitment to advancing safety and proficiency in industrial workplaces, we are harnessing the potential of Extended Reality (XR) technology to revolutionize training methodologies. Our project focuses on developing XR-based training tools tailored to the needs of industrial workers, with a particular emphasis on safety protocols and machinery operation. To ensure these tools align closely with the needs and expectations of end-users like you, we are hosting a User Requirements Workshop to gather your invaluable input and feedback.*

*Workshop overview:*

*This workshop goes beyond traditional demonstrations – it's an interactive forum where participants actively contribute to the development of XR-based training solutions. Through engaging discussions, immersive demonstrations, and collaborative activities, participants will:*

- *Explore the current challenges and opportunities in industrial training.*
- *Experience firsthand the capabilities of XR technology in simulating real-world scenarios.*
- *Share insights, concerns, and expectations regarding the use of XR in industrial training.*
- *Provide feedback on the usability, effectiveness, and applicability of XR-based training tools.*
- *Collaborate with industry peers and experts to identify innovative solutions to common training challenges.*

*Why participate:*

*By participating in this workshop, you will:*

- *Directly influence the development of XR-based training tools tailored to industrial environments.*
- *Gain insights into the latest advancements in training technology and immersive learning.*
- *Connect with industry professionals, safety experts, and fellow stakeholders to exchange ideas and best practices.*
- *Contribute to ongoing research and development efforts aimed at enhancing workplace safety and efficiency through XR technology.*

*Who should attend:*

*This workshop is open to professionals from various industrial sectors who are committed to advancing safety and proficiency in the workplace, including:*

- *Safety managers*
- *Training coordinators*
- *Equipment operators*
- *Maintenance technicians*
- *Industrial engineers*
- *Health and safety professionals*

*No prior experience with XR technology is necessary – all that's required is your enthusiasm for improving industrial training practices.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be part of a collaborative effort to revolutionize industrial training with XR technology! Join us and help shape the future of safety and proficiency in the workplace.*

*Sincerely,*

*[name and contact info]*

**Call for participation to XR-based industrial training UR workshop for trainees**

*Dear [trainees],*

*Are you eager to shape the future of industrial training and safety practices? Join us for an interactive workshop where your insights and feedback will be instrumental in refining XR-based training solutions tailored to your needs.*

*About the project:*

*In our ongoing commitment to fostering a culture of safety and excellence in industrial workplaces, we are embracing the potential of Extended Reality (XR) technology to revolutionize training*

*methodologies. Our project aims to develop immersive XR-based training tools designed specifically for industrial trainees like you. To ensure these tools effectively prepare you for the challenges of the workplace, we are hosting a User Requirements Workshop to gather your invaluable input and feedback.*

*Workshop overview:*

*This workshop offers more than just a glimpse into new technology – it's an opportunity for you to actively shape the development of XR-based training solutions. Through engaging discussions, hands-on demonstrations, and collaborative activities, you will:*

*Explore the current landscape of industrial training and identify key areas for improvement.*

*Experience firsthand the potential of XR technology in simulating real-world scenarios and enhancing learning outcomes.*

*Share your experiences, challenges, and expectations regarding training in industrial environments.*

*Provide feedback on the usability, effectiveness, and relevance of XR-based training tools from a trainee's perspective.*

*Collaborate with industry professionals and peers to co-create innovative solutions to common training challenges.*

*Why participate:*

*By participating in this workshop, you will:*

*Play a direct role in shaping the development of XR-based training tools tailored to your needs and preferences.*

*Gain insights into the latest advancements in training technology and immersive learning experiences.*

*Connect with fellow trainees, industry experts, and technology innovators to exchange ideas and best practices.*

*Contribute to ongoing efforts aimed at enhancing workplace safety and proficiency through XR technology.*

*Who should attend:*

*This workshop is open to trainees from diverse industrial sectors who are passionate about enhancing their skills and knowledge in a safe and engaging manner, including:*

*New hires*

*Apprentice technicians*

*Entry-level workers*

*Vocational students*

*Industrial interns*

*No prior experience with XR technology is necessary – all that's required is your enthusiasm for improving your training experience.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to shape the future of industrial training with XR technology! Join us and be a part of the journey towards safer and more efficient workplaces.*

*Sincerely,*

[name and contact info]

#### *10.5.2.2. Communication on Socials*

**Facebook:**

🚀 Call for participation to XR-based industrial training UR workshop 🚀

Calling all [trainees/stakeholders]! Here's your chance to influence the future of industrial training with XR technology. Join our workshop to provide feedback on training tools and help create safer work environments. Apply now! [Link to application form or event page]

#XR #IndustrialTraining #SafetyFirst #Innovation #FutureOfWork

**LinkedIn:**

🔧 Call for participation to XR-based industrial training UR workshop 🔧

Attention [trainees/stakeholders]! Want to shape the future of industrial training? Join our interactive workshop to provide feedback on XR-based training tools. Your input will help create safer and more efficient workplaces. Apply now! [link to application form or event page]

#XR #IndustrialTraining #SafetyFirst #FutureOfWork #Innovation

**Twitter/X:**

🛠️ Call for participation to XR-based industrial training UR workshop 🛠️

[Trainees/stakeholders], your input matters! Join our workshop to shape the future of industrial training with XR technology. Apply now to contribute to safer and more efficient workplaces! [Link to application form or event page]

#XR #IndustrialTraining #SafetyFirst #Innovation #FutureOfWork

### 11.5.3. UC Health

#### *10.5.3.1. Call For Participation*

*Dear [name/stakeholder(s)],*

*Are you committed to transforming patient care and enhancing treatment outcomes through cutting-edge technology? We invite you to join us for a collaborative workshop where your insights and feedback will drive the refinement of XR-based stress and pain relief therapy for clinical practice.*

*About the project:*

*In our quest to revolutionise healthcare and improve patient experiences, we are harnessing the power of Extended Reality (XR) technology to develop innovative solutions for stress and pain management. Our project focuses on creating XR-based therapy tools tailored to the needs of patients and healthcare professionals. To ensure these tools meet the highest standards of effectiveness and usability, we are hosting a User Requirements Workshop to gather input directly from stakeholders like you.*

*Workshop overview:*

*This workshop is not just about presentations – it's a dynamic forum where participants actively shape the future of healthcare technology. Through interactive discussions, immersive demonstrations, and collaborative activities, you will have the opportunity to:*

- *Explore the current challenges and opportunities in stress and pain management in clinical settings.*
- *Experience firsthand the potential of XR technology in providing immersive therapy experiences.*
- *Share your insights, concerns, and expectations regarding the integration of XR-based therapy into clinical workflows.*
- *Provide feedback on the usability, effectiveness, and applicability of XR-based therapy tools.*
- *Collaborate with industry experts and healthcare professionals to identify innovative solutions to common healthcare challenges.*

*Why participate:*

*By joining this workshop, you will:*

- *Directly influence the development of XR-based therapy tools tailored to clinical environments.*
- *Gain insights into the latest advancements in healthcare technology and patient care.*
- *Connect with healthcare professionals, therapists, and fellow stakeholders to exchange ideas and best practices.*
- *Contribute to ongoing research and development efforts aimed at improving patient outcomes and experiences through XR technology.*

*Who should attend:*

*This workshop is open to professionals from various healthcare sectors who are dedicated to enhancing patient care and treatment outcomes, including:*

- *Healthcare practitioners*
- *Therapists*
- *Patient advocates*

*No prior experience with XR technology is required – all that's needed is your passion for advancing healthcare innovation.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be at the forefront of healthcare innovation with XR technology! Join us and help shape the future of patient care.*

*Sincerely,*

*[name and contact info]*

**Call for participation to workshop on co-designing XR-based stress and pain relief therapy for patients**

*Dear [patient/therapy receiver],*

*Are you eager to explore innovative approaches to managing stress and pain in healthcare settings? We invite you to participate in a groundbreaking workshop where your voice will guide the development of XR-based stress and pain relief therapy tailored specifically for patients like you.*

*About the project:*

*In our pursuit of enhancing patient experiences and treatment outcomes, we are leveraging Extended Reality (XR) technology to pioneer new methods of stress and pain management. Our project centers on creating XR-based therapy tools designed to provide you with immersive and effective relaxation experiences. To ensure these tools meet your unique needs and preferences, we are hosting a User Requirements Workshop specifically for patients like yourself.*

*Workshop overview:*

*This workshop is your opportunity to actively shape the future of healthcare technology. Through engaging discussions, hands-on demonstrations, and collaborative activities, you will have the chance to:*

- *Share your experiences and challenges with stress and pain management in medical settings.*
- *Experience firsthand the potential of XR technology in delivering personalized therapy experiences.*
- *Provide feedback on the usability, comfort, and effectiveness of XR-based therapy tools.*
- *Collaborate with healthcare professionals and technology experts to co-design solutions that prioritize your well-being.*

*Why participate:*

*By joining this workshop, you will:*

- *Influence the development of XR-based therapy tools tailored to your needs and preferences.*
- *Gain insights into cutting-edge advancements in healthcare technology and patient-centred care.*
- *Connect with fellow patients, advocates, and healthcare professionals to share insights and support.*
- *Contribute to ongoing efforts to enhance patient experiences and outcomes through innovative technology.*

*Who should attend:*

*This workshop is open to patients who are interested in exploring alternative methods of stress and pain management in healthcare settings. Whether you have experience with XR technology or are entirely new to it, your perspective is invaluable in shaping the future of patient care.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be a driving force in transforming healthcare with XR technology! Join us and help create a future where stress and pain management are more accessible, effective, and tailored to your needs.*

*Sincerely,*

*[name and contact info]*

#### *10.5.3.2. Communication on Socials*

**Facebook:**

🚀 Call for participation to co-designing XR-based stress & pain relief therapy (for patients) 🚀

Excited about the potential of XR technology in revolutionising patient care? Join us for a collaborative workshop where your input will shape the development of XR-based therapy tools! Together, let's redefine the future of healthcare. Apply now! [Link to application form or event page] #XR #Healthcare #Innovation #PatientCare #Therapy

**LinkedIn:**

🌟Call for participation to co-designing XR-based stress & pain relief therapy (for patients) 🌟

Join us for an exciting workshop where your insights will shape the future of healthcare! We're hosting a collaborative forum to gather feedback on XR-based therapy tools. Don't miss this chance to influence the next generation of patient care solutions! [Link to application form or event page] #XR #Healthcare #PatientCare #Innovation #Therapy

**Twitter/X:**

🔥 Call for participation to XR therapy workshop 🔥

Ready to shape the future of patient care? Join our XR-based therapy workshop and be part of the innovation journey! Apply now to contribute your insights and shape the next-gen therapy tools! [Link to application form or event page] #XR #Healthcare #Innovation #PatientCare #Therapy

## 11.5.4. UC Cultural Heritage

### *10.5.4.1. Call For Participation*

Dear *[name/stakeholder(s)]*,

*Are you passionate about immersive storytelling and eager to shape the future of historical exploration through cutting-edge technology? Join us for a collaborative workshop where your input and feedback will drive the development of the Tunnel 57 XR experience.*

*About the project:*

*In our quest to redefine historical narratives, we are harnessing the power of Extended Reality (XR) technology to create an immersive journey through Tunnel 57, an iconic escape route under the former Berlin Wall. Our project aims to not only transport participants back in time but also empower them to actively engage with history, uncovering its hidden truths and complexities.*

*Workshop overview:*

*This workshop is a collaborative forum where participants will play a pivotal role in shaping the future of the Tunnel 57 XR experience. As part of the workshop, you will:*

- *Explore the capabilities of XR technology in historical storytelling and education.*
- *Experience a live demonstration of the Tunnel 57 XR experience, immersing yourself in its virtual world.*
- *Share your insights, needs, and expectations regarding the use of XR in historical exploration.*
- *Collaborate with fellow participants to identify user requirements and opportunities for improvement.*

*Why participate:*

*By joining this workshop, you will:*

- *Contribute directly to the development of a groundbreaking XR experience that redefines historical exploration.*
- *Gain firsthand experience with state-of-the-art XR technology and its potential applications in storytelling.*
- *Engage with industry professionals, technologists, and fellow enthusiasts to exchange ideas and best practices.*
- *Shape the future of historical narratives and their impact on contemporary society.*

*Who should attend:*

*This workshop is open to all stakeholders interested in the intersection of history and technology, including:*

- *Historians*

- *Educators*
- *Cultural heritage professionals*
- *Storytellers*

*No prior experience with XR technology is necessary – all you need is a passion for history and a desire to shape its future.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be part of a transformative project that brings history to life through collaborative innovation. Join us and help shape the future of historical exploration.*

*Sincerely,*

*[name and contact info]*

**Call for participation: Tunnel 57 XR experience UR workshop for tourists**

*Dear [tourist/travel enthusiast],*

*Are you an avid explorer with a thirst for unique and immersive travel experiences? Join us for an exclusive workshop where your insights will shape the future of historical tourism through cutting-edge technology.*

*About the project:*

*In our pursuit of redefining travel narratives, we are leveraging Extended Reality (XR) technology to create an unforgettable journey through Tunnel 57, an iconic escape route under the former Berlin Wall. Our project aims to not only transport tourists back in time but also empower them to actively engage with history, uncovering its hidden truths and complexities.*

*Workshop overview:*

*This workshop is a collaborative forum where tourists like you will play a pivotal role in shaping the future of historical tourism experiences. As part of the workshop, you will:*

*Explore the capabilities of XR technology in immersive historical storytelling and tourism.*

*Experience a live demonstration of the Tunnel 57 XR experience, immersing yourself in its virtual world.*

*Share your insights, needs, and expectations as a tourist regarding the use of XR in historical exploration and travel.*

*Collaborate with fellow participants to identify user requirements and opportunities for improvement in tourist-focused XR experiences.*

*Why participate:*

*By joining this workshop, you will:*

*Contribute directly to the development of a groundbreaking XR experience that redefines historical tourism.*

*Gain firsthand experience with state-of-the-art XR technology and its potential applications in immersive travel.*

*Connect with fellow travelers, historians, and technologists to exchange ideas and best practices.*

*Shape the future of travel narratives and experiences, leaving a lasting impact on the tourism industry.*

*Who should attend:*

*This workshop is open to all tourists and travel enthusiasts interested in the intersection of history and technology.*

*Date and venue:*

*[Date] | [venue/online platform]*

*How to apply:*

*To apply for participation, please [application instructions, e.g., fill out an online form].*

*Don't miss this opportunity to be part of a transformative project that brings history to life through collaborative innovation in tourism. Join us and help shape the future of historical exploration for travellers around the world.*

*Sincerely,*

[name and contact info]

#### *10.5.4.2. Communication on Socials*

**Facebook:**

🚀 Exciting opportunity alert! 🚀

Attention all [tourist/travel enthusiasts/stakeholder(s)]! We're hosting a collaborative workshop to shape the future of historical exploration through XR technology. Don't miss out on this chance to be part of something groundbreaking! Find out more and apply today: [link]

#XR #HistoricalTourism #ImmersiveExperience #Collaboration #UserFeedback

**LinkedIn:**

🌟 Call for participation to Tunnel 57 XR experience UR workshop 🌟

Are you passionate about immersive storytelling and cutting-edge technology? Join us for an exclusive workshop where your insights will shape the future of historical exploration through Extended Reality (XR). Learn more and apply now: [link]

#XR #HistoricalExploration #ImmersiveStorytelling #UserFeedback #Workshop

**Twitter/X:**

🌐 Calling all [tourist/travel enthusiasts/stakeholder(s)]! 🌐

Join us for an exclusive workshop shaping the future of historical exploration through XR technology. Don't miss this opportunity to be part of history in the making! Apply now: [link]

#XR #HistoricalExploration #ImmersiveTech #UserFeedback #Workshop

## 11.6. Examples of Informed Consent for Workshops

### 11.6.1. UC Professional Collaboration

***PRESENCE workshop Professional Collaboration***

You are asked to participate in the PRESENCE workshop. Your participation is voluntary: you are not obliged to take part and if you refuse, this will have no (negative) consequences for you. Take enough time to decide whether or not you want to participate. You can also ask the researcher questions at any time if something is not clear. You can stop your participation at any time (in writing or orally) and you do not have to give a reason for doing so.

Below you can find more information about the project, this study and how it will proceed. If you would like additional information, you can always contact the researcher or his/her supervisor.

Contact details

Hallström Louise

imec-SMIT

E-mail: louise.hallstrom@vub.be

Blanckaert Elias

imec-SMIT

E-mail: elias.blanckaert@vub.be

Iris Jennes

Imec-SMIT

E-mail: iris.jennes@vub.be

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**1. Purpose of the study**

This study is part of the PRESENCE project. In PRESENCE we focus on enhancing the impact of immersive human-to-human and human-machine interactions, delivering a toolset of technologies such

as holoportation, haptics and virtual humans, integrated and demonstrated in XR professional and social setups, analysed in user studies. Regarding to this workshop, in our project we are exploring the potential of Extended Reality (XR) technology to facilitate seamless and immersive teamwork. Our project aims to develop XR-based collaboration tools that empower professionals to collaborate effectively across distances and disciplines. To ensure that these tools closely match users' needs and expectations, we are organising a workshop to collect the valuable input and feedback from our target group. Therefore, your participation is crucial to develop the tools/applications that the industry truly needs.

**2. Who can participate**

Participant needs 18+ and sign the informed consent to participate in the online workshop.

**3. Practical conduct of the study and workshop**

The workshop will take place online via Zoom. It won't take longer than 2 hours. To start, the participants will be guided through the informed consent, they will be able to digitally sign their form via Qualtrics and receive a signed copy via email.

The whole workshop will be recorded via Zoom (audio and video). This recording will not be published or shared with third parties and serves solely for the purpose of analysing the content of the workshop by imec-SMIT and UHAM for the purpose of the PRESENCE project. Both the recording and transcript will only be available to imec-SMIT and UHAM to analyse the session. Imec-SMIT will transcribe the recording and pseudonymize the participants names. The recording will start after the participants have consented, by digitally signing the informed consent (via Qualtrics). The participants are free to leave the interview if no recording is desired and all previously collected data (i.e., name, company, mail address, etc.) will be deleted.

Your data will be stored on the protected VUB SharePoint (by imec-SMIT) and the PRESENCE Sharepoint. It will not be shared with third parties. Your input will always be pseudonymized when mentioned in publications or shared between consortium partners.

**4. Privacy and confidentiality**

First of all, you should know that, as researchers, we have a **duty of confidentiality** with regard to the data collected. This means that we undertake, for example in the context of a publication or a conference, never to reveal your name or any other data that could identify you. Nor will individual results ever be published.

Secondly, in the course of this research personal data will be collected about/from you. The collection and processing of your data is based on your **explicit consent**.

The collection and processing of data is in accordance with the legal principles imposed by the new European **General Data Protection Regulation** (GDPR or AVG), which has been in force since 25 May 2018. Imec is the controller relating to the processing activities mentioned in this informed consent. Louise Hallström, Elias Blanckaert and Iris Jennes, supervise the correct processing of your personal data and the associated information obligation.

This obligation to provide information means that I have to inform you about:

A. What **personal data** I collect from/about you, in particular: video or audio recordings, your name, gender, your email address, organisation, notes and professional occupation.
B. That the data are collected and processed for the purpose of the aforementioned study and will be deleted when the use is no longer relevant.

C. That we may only use your personal data for the purpose of research and development within the PRESENCE project.

D. That you have the right to access and correct your data. You also have the right to erase your data, to limit their processing, to object to their processing and to transfer your data to third parties. If you have any questions, please contact the researcher(s).

E. You have the right to withdraw your consent to the processing of your data at any time. The withdrawal of consent does not affect the lawfulness of the processing of the data obtained prior to the withdrawal of consent.

F. That your details will only be accessible by the researcher(s) appointed above and will not be shared with other institutions. Shared data between consortium partners will always be pseudonymized. Except, the recording and transcript, both will be shared with imec-SMIT, due to their involvement with the analysis of the workshop. Only imec-SMIT and UHAM will have access to the recording and transcript.

G. If you wish to exercise your rights or if you have any further questions regarding your rights and the processing of your personal data, you can always contact the imec **Data Protection Officer**: privacy@imec.be.

H. That in order to guarantee your privacy the following protection measures will be taken:

- The data collected are not anonymous in the first phase, which is why they are converted into codes (pseudonymization) as soon as possible. This is a second dataset that is created where it is no longer possible to identify you directly. A "translation key" is therefore created which can convert the codes back to their original meaning. Only the researchers (Louise Hallström, Elias Blanckaert and Iris Jennes) have access to this key and thus to the non-anonymous data. This ensures that only the researchers can link this data to you as a person. The encryption key is stored separately and securely or deleted when the data is no longer relevant for the PRESENCE project.
- The audio and/or video recordings made during the workshop are converted to transcriptions as soon as possible and the audio and/or video recordings will be deleted when they are no longer relevant for the PRESENCE project.
- Your data will only be stored on the VUB SharePoint (by imec) and on the PRESENCE Sharepoint. This has strict access conditions and offers a high degree of protection. Your data is therefore never stored on the personal computer or on a USB stick (except when the data is encrypted on the USB stick) of the researcher(s) and is never forwarded by email.

I. Finally, you also have the right to **complain** about how your data is being handled. You can do this with the Belgian supervisory authority responsible for enforcing data protection legislation, in particular:

Gegevensbeschermingsautoriteit (GBA)

Drukpersstraat 35

1000 Brussel

Tel. +32 2 274 48 00

e-mail: contact@apd-gba.be

Website: www.gegevensbeschermingsautoriteit.be

## 5. Statement by the Researcher

The undersigned moderator Elias Blanckaert, declares that he has provided the required information about this study orally, as well as a copy of the information document to the participant.

We confirm that no pressure has been exerted on the participant to have him / her consent to participate in the study and we are willing to answer any additional questions.

We confirm that we work in accordance with the ethical principles as stated in "The Code for Scientific Research in Belgium" and the ethical principles within my specific research discipline.

We confirm that we work in accordance with the legal obligations regarding the correct processing of personal data as stated in "General Data Protection Regulation (GDPR).

---

Name, First Name and date

Blanckaert, Elias, April 26th 2024

**Participant**

I declare that I'm informed about the nature, purpose, duration, potential benefits and risks of the study and that I know what is expected of me.

I have had enough time to think and I have been able to ask all the questions that have come to mind and I have received a clear answer to my questions.

I understand that my participation in this study is voluntary and that I'm free to stop my participation in this study without having to give a reason.

I understand that during my participation personal data about me will be collected and that the researcher ensures the confidentiality of these data in accordance with the relevant Belgian and European privacy legislation (Cf. AVG or GDPR)

I agree to the processing of my personal data in accordance with the modalities described in the "Privacy and confidentiality" section.

I consent to the processing of my data for scientific purposes.

I consent to the publication of the research results. My name will not be published and the confidentiality of the data is guaranteed at every stage of the research.

I consent to the sharing of my data with project consortium partners.

I agree that my interview will be recorded with an audio / video recorder.

I agree to participate in the study described.

I have received a copy of the signed information and consent form.

---

Name, first name, date and signature of the participant

### 10.5.5. UC Manufacturing Training

***PRESENCE workshop Manufacturing Training***

You are asked to participate in the PRESENCE workshop. Your participation is voluntary: you are not obliged to take part and if you refuse, this will have no (negative) consequences for you. Take enough time to decide whether or not you want to participate. You can also ask the researcher questions at any time if something is not clear. You can stop your participation at any time (in writing or orally) and you do not have to give a reason for doing so.

Below you can find more information about the project, this study and how it will proceed. If you would like additional information, you can always contact the researcher or his/her supervisor.

Contact details

Hallström Louise

imec-SMIT

E-mail: louise.hallstrom@vub.be

Blanckaert Elias

imec-SMIT

E-mail: elias.blanckaert@vub.be

Iris Jennes

Imec-SMIT

E-mail: iris.jennes@vub.be

---

**1. Purpose of the study**

This study is part of the PRESENCE project. In PRESENCE we focus on enhancing the impact of immersive human-to-human and human-machine interactions, delivering a toolset of technologies such as holoportation, haptics and virtual humans, integrated and demonstrated in XR professional and social setups, analysed in user studies. Regarding this workshop, in our project we have a commitment to advancing safety and proficiency in industrial workplaces, we are harnessing the potential of Extended Reality (XR) technology to revolutionize training methodologies. Our project focuses on developing XR-based training tools with a particular emphasis on safety protocols and machinery

operation. To ensure that these tools closely match users' needs and expectations, we are organising a workshop to collect the valuable input and feedback from our target group. Therefore, your participation is crucial to develop the tools/applications that the industry truly needs.

**2. Who can participate**

Participant needs to be 18+ and sign the informed consent to participate in the online workshop.

**3. Practical conduct of the study and workshop**

The workshop will take place online via Zoom. It won't take longer than 2 hours. To start, the participants will be guided through the informed consent, they will be able to digitally sign their form via Qualtrics and receive a signed copy via email.

The whole workshop will be recorded via Zoom (audio and video). This recording will not be published or shared with third parties and serves solely for the purpose of analysing the content of the workshop by imec-SMIT and UHAM for the purpose of the PRESENCE project. Both the recording and transcript will only be available to imec-SMIT and UHAM to analyse the session. Imec-SMIT will transcribe the recording and pseudonymize the participants names. The recording will start after the participants have consented, by digitally signing the informed consent (via Qualtrics). The participants are free to leave the interview if no recording is desired and all previously collected data (i.e., name, company, mail address, etc.) will be deleted.

Your data will be stored on the protected VUB SharePoint (by imec-SMIT) and the PRESENCE Sharepoint. It will not be shared with third parties. Your input will always be pseudonymized when mentioned in publications or shared between consortium partners.

**4. Privacy and confidentiality**

First of all, you should know that, as researchers, we have a **duty of confidentiality** with regard to the data collected. This means that we undertake, for example in the context of a publication or a conference, never to reveal your name or any other data that could identify you. Nor will individual results ever be published.

Secondly, in the course of this research personal data will be collected about/from you. The collection and processing of your data is based on your **explicit consent**.

The collection and processing of data is in accordance with the legal principles imposed by the new European **General Data Protection Regulation** (GDPR or AVG), which has been in force since 25 May 2018. Imec is the controller relating to the processing activities mentioned in this informed consent. Louise Hallström, Elias Blanckaert and Iris Jennes, supervise the correct processing of your personal data and the associated information obligation.

This obligation to provide information means that I have to inform you about:

What **personal data** I collect from/about you, in particular: video or audio recordings, your name, gender, your email address, organisation, notes and professional occupation.

A. That the data are collected and processed for the purpose of the aforementioned study and will be deleted when the use is no longer relevant.
B. That we may only use your personal data for the purpose of research and development within the PRESENCE project.
C. That you have the right to access and correct your data. You also have the right to erase your data, to limit their processing, to object to their processing and to transfer your data to third parties. If you have any questions, please contact the researcher(s).
D. You have the right to withdraw your consent to the processing of your data at any time. The withdrawal of consent does not affect the lawfulness of the processing of the data obtained prior to the withdrawal of consent.
E. That your details will only be accessible by the researcher(s) appointed above and will not be shared with other institutions. Shared data between consortium partners will always be pseudonymized. Except, the recording and transcript, both will be shared with imec-SMIT, due to their involvement with the analysis of the workshop. Only imec-SMIT and UHAM will have access to the recording and transcript.
F. If you wish to exercise your rights or if you have any further questions regarding your rights and the processing of your personal data, you can always contact the imec **Data Protection Officer**: privacyr@imec.be.
G. That in order to guarantee your privacy the following protection measures will be taken:
    - The data collected are not anonymous in the first phase, which is why they are converted into codes (pseudonymization) as soon as possible. This is a second dataset that is created where it is no longer possible to identify you directly. A "translation key" is therefore created which can convert the codes back to their original meaning. Only the researchers (Louise Hallström, Elias Blanckaert and Iris Jennes) have access to this key and thus to the non-anonymous data. This ensures that only the researchers can link this data to you as a person. The encryption key is stored separately and securely or deleted when the data is no longer relevant for the PRESENCE project.
    - The audio and/or video recordings made during the workshop are converted to transcriptions as soon as possible and the audio and/or video recordings will be deleted when they are no longer relevant for the PRESENCE project.

    - Your data will only be stored on the VUB SharePoint (by imec) and on the PRESENCE Sharepoint. This has strict access conditions and offers a high degree of protection. Your data is therefore never stored on the personal computer or on a USB stick (except when the data is encrypted on the USB stick) of the researcher(s) and is never forwarded by e-mail.

H. Finally, you also have the right to **complain** about how your data is being handled. You can do this with the Belgian supervisory authority responsible for enforcing data protection legislation, in particular:

    Gegevensbeschermingsautoriteit (GBA)
    Drukpersstraat 35
    1000 Brussel
    Tel. +32 2 274 48 00
    e-mail: contact@apd-gba.be
    Website: www.gegevensbeschermingsautoriteit.be

### 5. Statement by the Researcher

The undersigned moderator Elias Blanckaert, declares that he has provided the required information about this study orally, as well as a copy of the information document to the participant.

We confirm that no pressure has been exerted on the participant to have him / her consent to participate in the study and we are willing to answer any additional questions.

We confirm that we work in accordance with the ethical principles as stated in "The Code for Scientific Research in Belgium" and the ethical principles within my specific research discipline.

We confirm that we work in accordance with the legal obligations regarding the correct processing of personal data as stated in "General Data Protection Regulation (GDPR).

---

Name, First Name and Date

Blanckaert, Elias, April 24th 2024

**Participant**

I declare that I'm informed about the nature, purpose, duration, potential benefits and risks of the study and that I know what is expected of me.

I have had enough time to think and I have been able to ask all the questions that have come to mind and I have received a clear answer to my questions.

I understand that my participation in this study is voluntary and that I'm free to stop my participation in this study without having to give a reason.

I understand that during my participation personal data about me will be collected and that the researcher ensures the confidentiality of these data in accordance with the relevant Belgian and European privacy legislation (Cf. AVG or GDPR)

I agree to the processing of my personal data in accordance with the modalities described in the "Privacy and confidentiality" section.

- I consent to the processing of my data for scientific purposes.
- I consent to the publication of the research results. My name will not be published and the confidentiality of the data is guaranteed at every stage of the research.
- I consent to the sharing of my data with project consortium partners.
- I agree that my interview will be recorded with an audio / video recorder.
- I agree to participate in the study described.
- I have received a copy of the signed information and consent form.

Name, first name, date and signature of the participant

### 11.6.2. UC Health

***PRESENCE workshop Health***

You are asked to participate in the PRESENCE workshop. Your participation is voluntary: you are not obliged to take part and if you refuse, this will have no (negative) consequences for you. Take enough time to decide whether or not you want to participate. You can also ask the researcher questions at any time if something is not clear. You can stop your participation at any time (in writing or orally) and you do not have to give a reason for doing so.

Below you can find more information about the project, this study and how it will proceed. If you would like additional information, you can always contact the researcher or his/her supervisor.

Contact details

Hallström Louise

imec-SMIT

E-mail: louise.hallstrom@vub.be

Blanckaert Elias

imec-SMIT

E-mail: elias.blanckaert@vub.be

Iris Jennes

Imec-SMIT

E-mail: iris.jennes@vub.be

**1. Purpose of the study**

This study is part of the PRESENCE project. In PRESENCE we focus on enhancing the impact of immersive human-to-human and human-machine interactions, delivering a toolset of technologies such as holoportation, haptics and virtual humans, integrated and demonstrated in XR professional and social setups, analysed in user studies. Regarding this workshop, in our project, we are harnessing the power of Extended Reality (XR) technology to develop innovative solutions for stress and pain management. Our project focuses on creating XR-based therapy tools tailored to the needs of patients and healthcare professionals. To ensure that these tools closely match users' needs and expectations, we are organising a workshop to collect the valuable input and feedback from our target group. Therefore, your participation is crucial to develop the tools/applications that the industry truly needs.

**2. Who can participate**

Participant needs to 18+ and sign the informed consent to participate in the online workshop.

## 3. Practical conduct of the study and workshop

The workshop will take place online via Zoom. It won't take longer than 2 hours. To start, the participants will be guided through the informed consent, they will be able to digitally sign their form via Qualtrics and receive a signed copy via email.

The whole workshop will be recorded via Zoom (audio and video). This recording will not be published or shared with third parties and serves solely for the purpose of analysing the content of the workshop by imec-SMIT and UHAM for the purpose of the PRESENCE project. Both the recording and transcript will only be available to imec-SMIT and UHAM to analyse the session. Imec-SMIT will transcribe the recording and pseudonymize the participants names. The recording will start after the participants have consented, by digitally signing the informed consent (via Qualtrics). The participants are free to leave the interview if no recording is desired and all previously collected data (i.e., name, company, mail address, etc.) will be deleted.

Your data will be stored on the protected VUB SharePoint (by imec-SMIT) and the PRESENCE Sharepoint. It will not be shared with third parties. Your input will always be pseudonymized when mentioned in publications or shared between consortium partners.

## 4. Privacy and confidentiality

First of all, you should know that, as researchers, we have a **duty of confidentiality** with regard to the data collected. This means that we undertake, for example in the context of a publication or a conference, never to reveal your name or any other data that could identify you. Nor will individual results ever be published.

Secondly, in the course of this research personal data will be collected about/from you. The collection and processing of your data is based on your **explicit consent**.

The collection and processing of data is in accordance with the legal principles imposed by the new European **General Data Protection Regulation** (GDPR or AVG), which has been in force since 25 May 2018. Imec is the controller relating to the processing activities mentioned in this informed consent. Louise Hallström, Elias Blanckaert and Iris Jennes, supervise the correct processing of your personal data and the associated information obligation.

This obligation to provide information means that I have to inform you about:

A. What **personal data** I collect from/about you, in particular: video or audio recordings, your name, gender, your email address, organisation, notes and professional occupation.
B. That the data are collected and processed for the purpose of the aforementioned study and will be deleted when the use is no longer relevant.
C. That we may only use your personal data for the purpose of research and development within the PRESENCE project.
D. That you have the right to access and correct your data. You also have the right to erase your data, to limit their processing, to object to their processing and to transfer your data to third parties. If you have any questions, please contact the researcher(s).

E. You have the right to withdraw your consent to the processing of your data at any time. The withdrawal of consent does not affect the lawfulness of the processing of the data obtained prior to the withdrawal of consent.
F. That your details will only be accessible by the researcher(s) appointed above and will not be shared with other institutions. Shared data between consortium partners will always be pseudonymized. Except, the recording and transcript, both will be shared with imec-SMIT, due to their involvement with the analysis of the workshop. Only imec-SMIT and UHAM will have access to the recording and transcript.
G. If you wish to exercise your rights or if you have any further questions regarding your rights and the processing of your personal data, you can always contact the imec **Data Protection Officer**: privacy@imec.be.
H. That in order to guarantee your privacy the following protection measures will be taken:
    - The data collected are not anonymous in the first phase, which is why they are converted into codes (pseudonymization) as soon as possible. This is a second dataset that is created where it is no longer possible to identify you directly. A "translation key" is therefore created which can convert the codes back to their original meaning. Only the researchers (Louise Hallström, Elias Blanckaert and Iris Jennes) have access to this key and thus to the non-anonymous
    - data. This ensures that only the researchers can link this data to you as a person. The encryption key is stored separately and securely or deleted when the data is no longer relevant for the PRESENCE project.

    - The audio and/or video recordings made during the workshop are converted to transcriptions as soon as possible and the audio and/or video recordings will be deleted when they are no longer relevant for the PRESENCE project.

    - Your data will only be stored on the VUB SharePoint (by imec) and on the PRESENCE Sharepoint. This has strict access conditions and offers a high degree of protection. Your data is therefore never stored on the personal computer or on a USB stick (except when the data is encrypted on the USB stick) of the researcher(s) and is never forwarded by email.

I. Finally, you also have the right to **complain** about how your data is being handled. You can do this with the Belgian supervisory authority responsible for enforcing data protection legislation, in particular:

    Gegevensbeschermingsautoriteit (GBA)

    Drukpersstraat 35

    1000 Brussel

    Tel. +32 2 274 48 00

    e-mail: contact@apd-gba.be

    Website: www.gegevensbeschermingsautoriteit.be

### 5. Statement by the Researcher

The undersigned moderator Elias Blanckaert, declares that he has provided the required information about this study orally, as well as a copy of the information document to the participant.

We confirm that no pressure has been exerted on the participant to have him / her consent to participate in the study and we are willing to answer any additional questions.

We confirm that we work in accordance with the ethical principles as stated in "The Code for Scientific Research in Belgium" and the ethical principles within my specific research discipline.

We confirm that we work in accordance with the legal obligations regarding the correct processing of personal data as stated in "General Data Protection Regulation (GDPR).

---

Name, First Name and Date

Blanckaert, Elias, April 25th 2024

**Participant**

I declare that I'm informed about the nature, purpose, duration, potential benefits and risks of the study and that I know what is expected of me.

I have had enough time to think and I have been able to ask all the questions that have come to mind and I have received a clear answer to my questions.

I understand that my participation in this study is voluntary and that I'm free to stop my participation in this study without having to give a reason.

I understand that during my participation personal data about me will be collected and that the researcher ensures the confidentiality of these data in accordance with the relevant Belgian and European privacy legislation (Cf. AVG or GDPR)

- I agree to the processing of my personal data in accordance with the modalities described in the "Privacy and confidentiality" section.
- I consent to the processing of my data for scientific purposes.
- I consent to the publication of the research results. My name will not be published and the confidentiality of the data is guaranteed at every stage of the research.
- I consent to the sharing of my data with project consortium partners.
- I agree that my interview will be recorded with an audio / video recorder.
- I agree to participate in the study described.
- I have received a copy of the signed information and consent form.

Name, first name, date and signature of the participant

### 11.6.3. UC Cultural Heritage

***PRESENCE workshop Cultural Heritage***

You are asked to participate in the PRESENCE workshop. Your participation is voluntary: you are not obliged to take part and if you refuse, this will have no (negative) consequences for you. Take enough time to decide whether or not you want to participate. You can also ask the researcher questions at any time if something is not clear. You can stop your participation at any time (in writing or orally) and you do not have to give a reason for doing so.

Below you can find more information about the project, this study and how it will proceed. If you would like additional information, you can always contact the researcher or his/her supervisor.

Contact details

Hallström Louise

imec-SMIT

E-mail: louise.hallstrom@vub.be

Blanckaert Elias

imec-SMIT

E-mail: elias.blanckaert@vub.be

Iris Jennes

Imec-SMIT

E-mail: iris.jennes@vub.be

**1. Purpose of the study**

This study is part of the PRESENCE project. In PRESENCE we focus on enhancing the impact of immersive human-to-human and human-machine interactions, delivering a toolset of technologies such as holoportation, haptics and virtual humans, integrated and demonstrated in XR professional and social setups, analysed in user studies. Regarding this workshop, With our project, we aim to shape the future of historical tourism through cutting-edge technology and enable immersive travel experiences with new tools. To ensure that these tools closely match users' needs and expectations, we are organising a workshop to collect the valuable input and feedback from our target group. Therefore, your participation is crucial to develop the tools/applications that the industry truly needs.

**2. Who can participate**

Participant needs to be 18+ and sign the informed consent to participate in the workshop.

**3. Practical conduct of the study and workshop**

The workshop will take place online via Zoom. It won't take longer than 2 hours. To start, the participants will be guided through the informed consent, they will be able to digitally sign their form via Qualtrics and receive a signed copy via email.

The whole workshop will be recorded via Zoom (audio and video). This recording will not be published or shared with third parties and serves solely for the purpose of analysing the content of the workshop by imec-SMIT and UHAM for the purpose of the PRESENCE project. Both the recording and transcript will only be available to imec-SMIT and UHAM to analyse the session. Imec-SMIT will transcribe the recording and pseudonymize the participants names. The recording will start after the participants have consented, by digitally signing the informed consent (via Qualtrics). The participants are free to leave the interview if no recording is desired and all previously collected data (i.e., name, company, mail address, etc.) will be deleted.

Your data will be stored on the protected VUB SharePoint (by imec-SMIT) and the PRESENCE Sharepoint. It will not be shared with third parties. Your input will always be pseudonymized when mentioned in publications or shared between consortium partners.

**4. Privacy and confidentiality**

First of all, you should know that, as researchers, we have a **duty of confidentiality** with regard to the data collected. This means that we undertake, for example in the context of a publication or a conference, never to reveal your name or any other data that could identify you. Nor will individual results ever be published.

Secondly, in the course of this research personal data will be collected about/from you. The collection and processing of your data is based on your **explicit consent**.

The collection and processing of data is in accordance with the legal principles imposed by the new European **General Data Protection Regulation** (GDPR or AVG), which has been in force since 25 May 2018. Imec is the controller relating to the processing activities mentioned in this informed consent. Louise Hallström, Elias Blanckaert and Iris Jennes, supervise the correct processing of your personal data and the associated information obligation. This obligation to provide information means that I have to inform you about:

A. What **personal data** I collect from/about you, in particular: video or audio recordings, your name, gender, your email address, organisation, notes and professional occupation.
B. That the data are collected and processed for the purpose of the aforementioned study and will be deleted when the use is no longer relevant.
C. That we may only use your personal data for the purpose of research and development within the PRESENCE project.
D. That you have the right to access and correct your data. You also have the right to erase your data, to limit their processing, to object to their processing and to transfer your data to third parties. If you have any questions, please contact the researcher(s).
E. You have the right to withdraw your consent to the processing of your data at any time. The withdrawal of consent does not affect the lawfulness of the processing of the data obtained prior to the withdrawal of consent.

F. That your details will only be accessible by the researcher(s) appointed above and will not be shared with other institutions. Shared data between consortium partners will always be pseudonymized. Except, the recording and transcript, both will be shared with imec-SMIT, due to their involvement with the analysis of the workshop. Only imec-SMIT and UHAM will have access to the recording and transcript.

G. If you wish to exercise your rights or if you have any further questions regarding your rights and the processing of your personal data, you can always contact the imec **Data Protection Officer**: privacy@imec.be.

H. That in order to guarantee your privacy the following protection measures will be taken:

- The data collected are not anonymous in the first phase, which is why they are converted into codes (pseudonymization) as soon as possible. This is a second dataset that is created where it is no longer possible to identify you directly. A "translation key" is therefore created which can convert the codes back to their original meaning. Only the researchers (Louise Hallström, Elias Blanckaert and Iris Jennes) have access to this key and thus to the non-anonymous data. This ensures that only the researchers can link this data to you as a person. The encryption key is stored separately and securely or deleted when the data is no longer relevant for the PRESENCE project.
- The audio and/or video recordings made during the workshop are converted to transcriptions as soon as possible and the audio and/or video recordings will be deleted when they are no longer relevant for the PRESENCE project.
- Your data will only be stored on the VUB SharePoint (by imec) and on the PRESENCE Sharepoint. This has strict access conditions and offers a high degree of protection. Your data is therefore never stored on the personal computer or on a USB stick (except when the data is encrypted on the USB stick) of the researcher(s) and is never forwarded by email.

I. Finally, you also have the right to **complain** about how your data is being handled. You can do this with the Belgian supervisory authority responsible for enforcing data protection legislation, in particular:

Gegevensbeschermingsautoriteit (GBA)
Drukpersstraat 35
1000 Brussel
Tel. +32 2 274 48 00
e-mail: contact@apd-gba.be
Website: www.gegevensbeschermingsautoriteit.be

## 5. Statement by the Researcher

The undersigned moderator Elias Blanckaert, declares that he has provided the required information about this study orally, as well as a copy of the information document to the participant.

We confirm that no pressure has been exerted on the participant to have him / her consent to participate in the study and we are willing to answer any additional questions.

We confirm that we work in accordance with the ethical principles as stated in "The Code for Scientific Research in Belgium" and the ethical principles within my specific research discipline.

We confirm that we work in accordance with the legal obligations regarding the correct processing of personal data as stated in "General Data Protection Regulation (GDPR).

---

Name, First Name and Date

Blanckaert, Elias

**Participant**

I declare that I'm informed about the nature, purpose, duration, potential benefits and risks of the study and that I know what is expected of me.
I have had enough time to think and I have been able to ask all the questions that have come to mind and I have received a clear answer to my questions.
I understand that my participation in this study is voluntary and that I'm free to stop my participation in this study without having to give a reason.
I understand that during my participation personal data about me will be collected and that the researcher ensures the confidentiality of these data in accordance with the relevant Belgian and European privacy legislation (Cf. AVG or GDPR)

- I agree to the processing of my personal data in accordance with the modalities described in the "Privacy and confidentiality" section.
- I consent to the processing of my data for scientific purposes.
- I consent to the publication of the research results. My name will not be published and the confidentiality of the data is guaranteed at every stage of the research.
- I consent to the sharing of my data with project consortium partners.
- I agree that my interview will be recorded with an audio / video recorder.
- I agree to participate in the study described.
- I have received a copy of the signed information and consent form.

---

Name, first name, date and signature of the participant

# Annex I: project External Ethics Advisor report

## ETHICS ADVISOR REPORT

**PRESENCE - A toolset for hyper-realistic and XR-based human-human and human-machine interactions (Grant Agreement n. 101135025)**

**Period:** Semester 1: 1st Jan 2024 – 30th June 2024

## APPOINTMENT OF AN EXTERNAL ETHICS ADVISOR

The PRESENCE consortium proposed the appointment of an External Ethics Advisor (EEA) at the time of the proposal. In May 2024, Joana Porcel was appointed as the project's EEA to assess the ethical aspects of the work carried out in the project and to provide independent recommendations. In particular, the following deliverables will be review and reports will be prepared (June 2024, June 2025, December 2026):

Year 1:
D1.1- Human Centred Development Phase I - Foundations, Requirements and Initial Planning
D7.2- Ethics Framework and Data Management Plan I

Year 2:
D1.2- Human centred Development Phase II - Intermediate User Testing, Presence Evaluation, Ethics, Trust & Privacy
D4.1- Virtual humans technologies report I
D7.4- Ethics Framework and Data Management Plan II

Year 3:
D1.3- Human centred Development Phase III – Final User Testing, Presence Evaluation, Ethics, Trust & Privacy
D4.2- Virtual humans technologies report II
D7.6- Ethics Framework and Data Management Plan III

Additional input in the set-up of the experiments, e.g., the content of the informed consent, the nature of the requested participation, data management practices or provided incentives is also foreseen.

## MEETINGS

The beneficiaries and the EEA have met on:

| DATE | ATTENDEES | OBSERVATIONS |
|---|---|---|
| June 17th, 2024 | - Sergi Fernandez (i2CAT). Project coordinator, WP7 leader, and co-leader of Task T7.3 Project Ethics, IPR and Data Management<br>- Frank Steinicke (UHAM). WP4 leader, co-leader of Task T7.3, and Technical Manager of the project.<br>- Erik Wolf (UHAM). Main responsible of D7.2 Ethics Framework and data Management Plan.<br>- Mària Sanchez (i2CAT). Project financial manager.<br>- Joana Porcel (ISGlobal). EEA | The following topics were discussed during the meeting:<br>General comments on the ethics self-assessment<br>D1.1, D7.2<br>European projects on Extended Reality and ethics |

## COMMENTS ON THE ETHICS SELF-ASSESSMENT

The beneficiaries provided a detailed self-assessment addressing the different ethics issues related with the project implementation.

PRESENCE will recruit adult volunteers for the XR experiments. Several case studies will be conducted recruiting end users that may include healthy volunteers (professionals in interior design, real estate, and consumers) and patients (under pain treatment). Issues related with the participants' safety are considered.
The evaluation by the local Ethics Committees is foreseen and all participants will sign an informed consent form.

Personal data, including health data (behavioural responses, and physiological measures like EEG), will be processed. Compliance with GDPR and the local regulations is confirmed. It is planned to anonymise the data.

The HLEG on AI guidelines will be followed.

## DOCUMENTS REVISED

**D1.1- Human Centred Development Phase I - Foundations, Requirements and Initial Planning**
(Version 0.3; 13-06-2024).

This deliverable describes how the use case studies will be conducted.
The document addresses the ethical issues, including privacy issues, associated with the recruitment of participants. Information on the recruitment strategy and informed consent process is clearly described, addressing issues such as diversity (age, gender, ethnicity, disability), safety and comfort (motion sickness). Examples of informed consent forms are provided; the forms include all relevant information in accordance with Aet 13. GDPR.

The document also proposes the general framework based on an ethics by design approach for technology development: i) the implementation of the ALTAI tool for the AI components; and ii) a systematic assessment to identify issues related to gender, ethics, trust and privacy that guide the creation of technologies, using the following methods: the walk-through method, which explores how technology affects user interactions and experiences; and the Guidance Ethics approach, which provides normative guidance on societal interactions with technology and a method for active dialogue on how the technology is developed and how to deal with it in a responsible way. Workshops, focus groups, etc. will be conducted to gather user input and improve technology development.

**D7.2- Ethics Framework and Data Management Plan I**
(Version 0.6; 21-06-2024)

This is the initial version of the data management plan. In relation to ethics and personal data protection, the document describes how data will be collected and processed according to the ethics requirements (approval from the Ethics Committees, informed consent, etc.) and the GDPR. Also, how data will be handled to guarantee the participants' privacy (data security policy, pseudonymisation/anonymisation). A general reference to the incidental findings is also included.

From the review of these two deliverables, it can be concluded that the consortium is aware of the ethical implications and has clear mechanisms in place to deal with them. Some recommendations for consideration are given below:

- It is important that the approach described in D1.1 to guide the development of new technologies is shared with all members of the research teams, not only the leaders and coordinators, but also young researchers (pre-doctoral and post-doctoral) and technicians, and that these groups are involved in the dialogue and debate.

- It is advisable to develop project-specific protocols 1) to manage personal data incidents, including data breaches, and 2) to address the rights of participants regarding the processing of personal data. These protocols could be part of an updated version of the DMP and should be shared with all members involved in the project.

- The contact details of the DPOs could also be included in the DMP so that all partners can easily contact the DPOs if necessary.

- A project-specific policy for dealing with potential incidental findings should be developed, as the current description is rather general. This is particularly relevant in the case of potential incidental findings that may affect participants' health. The policy needs to be communicated to participants during the informed consent process.

- Regarding the privacy of participants, it is mentioned that the data will be anonymised, but it also appears that the key to the personal identifiers will be retained. Where possible, the consortium is encouraged to use anonymised data rather than pseudonymised data.

## ETHICS ISSUES ON EXTENDED REALITY

The consortium is recommended to contact / explore the following projects:

**irecs** (https://www.irecs.eu/), tackles the ethical challenges of new technology used in research, including biobanking, AI for health, genome editing and XR reality.

See the policy brief on extended reality.

**XR4HUMAN** (https://xr4human.eu/), focus on the responsible development and uptake of XR technologies. The project aims to provide guidance and tools to ensure equitable, inclusive and human-centered development of XR technologies.

The project has launched a SURVEY to map the ethical needs and requirement related to XR from different stakeholders.

Signed:

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