



PrismArch

PrismArch

Deliverable No D6.3

Report on testing and evaluating the PrismArch platform

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Abstract	The purpose of this report is to demonstrate the strategy followed about the testing process, the tools that were decided to be used and initial data extraction of the gathered information about the evaluation plan and usability study.
Keywords	Evaluation, usability, plan, data,data extract, test, software.

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List of abbreviations and Acronyms

Abbreviation	Meaning
AB	Advisory Board
BIC	Bank Identifier Code
CA	Consortium Agreement
CFS	Cost Financial Statement
DoA	Description of Action
DR	Deliverable Responsible
EC	European Commission
GA	Grant Agreement
GNU	GNU is not Unix
IBAN	International Bank Account Number
IoT	Internet of Things
IP	Intellectual Property
IPR	Intellectual Property Rights
NDA	Non-Disclosure Agreement

PC	Project Coordinator
PHP	PHP: Hypertext Preprocessor
PM	Person-Month
PMB	Project Management Board
PTM	Project Technical Manager
R&I	Research and Innovation
SB	Project Supervisory Board
SBM	Supervisory Board Member
ToC	Table of Contents
UML	Unified Modelling Language
QMR	Quarterly Management Report
WP	Work package
WPL	WP Leaders
AEC	Architecture, Engineering and Construction
AR	Augmented Reality
BIM	Building Information Modelling
CAD/CAM	Computer-Aided Design & Computer-Aided Manufacturing
ICT	Information and communication technology
NDA	Non-Disclosure Agreements
SME	Small and Medium-sized Enterprises
UG	User Group
VR	Virtual Reality

Executive Summary

Deliverable D6.3 is the initial report which encapsulates the results of the first tests conducted for PrismArch. Based on the usage scenarios from D6.1 and the information in D6.2 about how to perform an evaluation plan and a usability study, D6.3 aims at giving the first officially captured impressions of the users about PrismArch. The platform is being tested by the consortium members initially, however, there is an intention to reach a wider audience over the coming period to gather more diverse and enriched data. This report captures the process, the tools and presents the data gathered which have been executed as soon as v5 of PrismArch was released. Over the coming months, more tests and tools will be added as the platform is being developed aiming at proving PrismArch as the solution for the AEC industry when it comes to virtual reality collaboration and design solutions.

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INTRODUCTION

The purpose of D6.3 is to describe the testing process as this has been agreed upon, the tools that have been tested and an analysis of the evolution of PrismArch up to the date this Deliverable is submitted. Based on the usage scenarios as described in D6.1, the evaluation plan and usability study in D6.2 and the actual testing itself, this deliverable aims to capture the effectiveness of the tools which have been created and what the users experience when they enter the PrismArch world. This work complements the work by ETH on cognitive issues relevant to PrismArch development and empirical user-testing activities as described in deliverables D3.1 and D3.2. The deliverable describes the process of testing the platform by giving an overview of the process. An analysis of what has been agreed, researched, and developed from a testing perspective is given over the next chapters and an analysis of the tested tools is followed. The deliverables contain examples of the relevant forms which were used to capture the data, describe the recognition of the complexity of the platform throughout the testing process and analyse the ways the platform was tested to effectively communicate any bugs or poor user experience. The principles identified in D6.2 were followed to compile the testing process and used as a guideline for D6.3. What was described in theory in D6.2 will be executed in this deliverable, demonstrating a proper flow of software testing evolution for PrismArch. This deliverable is split into sections that follow a proper flow for the information which needs to be disseminated through this document.

The testing workflow section is split in the PrismArch testing process graph where we analyse the initial thinking of breaking down the platform into several subjects which aid in what to test, the questions needed and how to form a proper flow of questions based on the actual experience.

The participants' section focuses on the actions needed to be taken by the participants for successful execution of the testing process. The section analyses the agreed consent form and information sheet which is sent to the participants.

The bug reports section describes what is within the bug reports and the ways the participants can use the bug reports to send information back to the developer team.

The Surveys section describes the different surveys which were produced to facilitate the software testing process. The platform's tools and modules developed up to the date this deliverable is submitted are covered, however this information is in constant review and updated.

The final section gives a conclusion and recommendations about the next steps of the software testing process.

THE TESTING WORKFLOW

The PrismArch Testing Process Graph

When the PrismArch testing process started, consortium members from Sweco got together and decided that a way to move forward was to analyse the platform in its current state. To better understand what to test and how to test it, an inspection of different tools and processes were investigated. The preferred way to present the current state of PrismArch was with a Miro Board, which is a well-known tool that has been used previously in other instances throughout the development of PrismArch. Within the Board, we developed a detailed approach of how PrismArch should look. Throughout the process, we then identified where the different tools sit within PrismArch. Afterwards, research of where the different tools of PrismArch should exist and what should be expected as an outcome from the software testing process occurred. Although some of the tools have not been fully developed yet or are in a conceptual stage, the consortium thinks it is useful to consider them and get a better understanding of what PrismArch should look like at the end of the research. The Board will be further enhanced and developed as more tools are created or existing ones are upgraded. A discussion between the consortium revealed that the level of detail is more than enough to capture the necessary data in this phase of the project. However, with the end in mind we all agreed that it is a good way to move things forward and capture the necessary evaluation data.

The key areas identified are the following

- Landing Space
- Personal Work Sphere
- Collective Work Sphere

Within these areas we investigated common menus. A good example is the Settings menu, however, due to the variation of the setting in each area, we decided to treat common menus as separate entities. The reason is that even if a menu is completely the same it may or may not load within different areas of PrismArch. In such instances, this should be captured and corrected if needed.

The graph contains legends that contain the relevant subjects and the potential elements to be tested or the expected outcome. Examples of expectations contain information such as “Information correctly presented” or “Tickbox enables or disables functions”. Another example demonstrates graphical representation expectations such as “Loaded models correctly presented in the lounge table” which actually describe the expected outcome as a graphical representation. The legends include the following sections:

- Settings
- Globe Navigation Tool
- Meeting Room Tool
- Project Data
- Personal / Collective User Tools

These sections are split into subcategories based on how PrismArch is currently designed. Within these subcategories, the relevant tools are mentioned. More specifically:

- Settings
 - Login (Authentication) - Speckle Information Retrieval
 - Graphics
 - Avatar Loading
- Globe Navigation Tool
 - QA
- Meeting Room Tool
 - QA
- Project Data
 - QA
- Personal / Collective User Tools
 - QA

Apart from these legends, the PrismArch development team has also created menus about controls, communications and other individual options which have been captured within the board separately and not in the form of a legend. In case these are further developed and included in additional areas of PrismArch, the graph shall be updated accordingly to reflect such changes.

The sphering levels have been mentioned within the graph, however, since these have not yet been developed shall not be included in this deliverable. Furthermore, the graph and the evaluation process shall include these in the upcoming deliverables as soon as these are developed by the relevant consortium members.

The graph can be found in this [link](#) and can be seen in Figure 1:

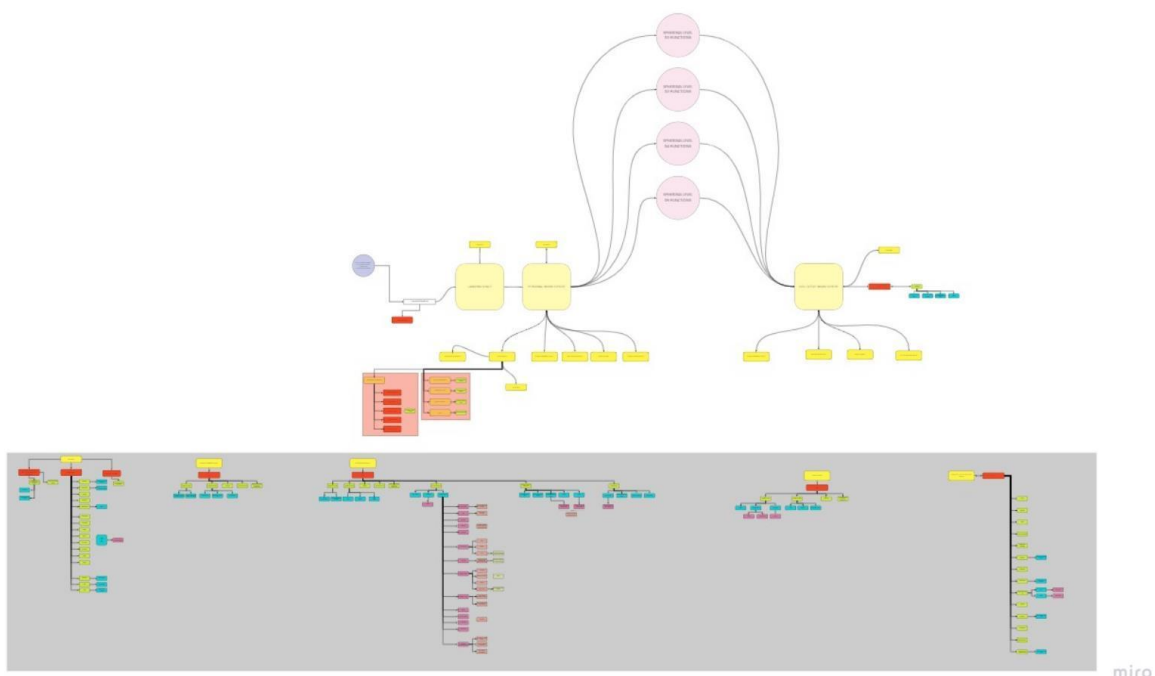


Figure 1: PrismArch software testing board

Participants

The software evaluation process initially focuses on the participation of consortium members. However, the need to include other people which may or may not be involved in the AEC industry became a necessity. Therefore, the first call for entries was performed within the consortium and afterwards throughout our working spaces and then to whoever may be interested. This initially gives an overall vision of people relevant to the AEC industry from a diverse environment of experience and roles. Nevertheless, the intention is to roll out the software tests to as many people as possible from various industries and environments. This will aid in capturing data and perceptions from a wider spectrum and help furthermore develop the platform.

The participant expresses their interest by sending an email to one of Sweco consortium members. A reply thanking us for taking the time to test PrismArch and an attachment of the consent form and information sheet is sent to the participant. The participant needs to read through the information sheet and then sign the consent form. Afterwards, the participant sends the consent form back to one of Sweco's consortium members.

Participant Brief

The participant brief contains a brief description and introduction about what PrismArch is, the benefits of multi-disciplinary virtual reality environments and the request for participating in the testing process. The participant should read this thoroughly and then sign the consent form.

Consent form

The official consent form from the participant is sent back to a Sweco consortium member with a declaration that they will test the software and they agree with the data handling and management. Therefore, for a participant to begin the process a consent form needs to be submitted as a form of official acceptance of the testing process. Only then, the relevant Sweco consortium member shall proceed with the next steps of the testing process.

After these steps are accomplished, the testing process begins. The Sweco consortium member sends an email back to the participant. The email contains the following:

- Link to the latest version of PrismArch for download
- Links to the surveys
- Link to the GitHub bug report
- Attached bug report form for convenience in case a participant is not familiar with GitHub

The participant then downloads and runs PrismArch, starting the evaluation procedure. Encouragement to test all tools, functions, single or multiplayer systems should be given throughout the communications. After the evaluation process is finished, the participant is able to submit bugs through the bug report forms, fill in the surveys or get in touch directly with the consortium for any subject which may be of interest regarding the testing process and PrismArch in general.

Bug reports

The bug reports are a vital part of the software testing and evaluation process. The bug reports capture any information not provided with the surveys or other forms of error communication. A decision was made by the consortium to make good use of web-based technologies to submit bug reports. The decision to use GitHub as a central repository for bug reports was made and is considered the most efficient way of capturing and analysing the bug report data. Additionally, through GitHub, the bug report can be assigned to relevant software developers who will take necessary actions, correct the error and improve the software. The GitHub bug report form can be found by clicking this [link](#). However, since a large volume of participants is expected to test the software from diverse environments, it is expected that not all are familiar with such web-based environments. Therefore, another bug report form is distributed as an attachment with the approval email which is sent to the participant. In such a case, the participant then submits the bug report forms to Sweco consortium members who manage the information accordingly. The bug report forms are uploaded to the relevant Google Drive folder of PrismArch and the relevant consortium members are informed electronically about the existence of the specific form. Afterwards, the relevant software developers are assigned the task and execute all necessary actions to fix the error. The bug report forms require the following information:

Title	Description
Bug ID#	Sequential number of bug
Bug name	A title for the bug
Area Path	Location of bug based on area
Build#	PrismArch version
Severity	Crucial or not crucial
Priority	Based on severity and roadmap, priority is assigned
Assigned to	Software developer to resolve
Reported by	Full name of participant
Date	Date bug was discovered
Reason	Reason for reporting bug
Status	Status of bug (active/inactive)
Operating System	Operating System of the terminal
Description	A description of the bug, what actually happens and this is considered a bug

Expected result	The result which should happen by following the actions and sequence the participant performed
Actual result	The result which actually happened
Screenshot	A screenshot of the software as the bug happens
Notes	Any additional notes to better clarify the issue

Table 1: Bug report form explanation

It is expected that the Bug Report Forms will be handled in collaboration with CERTH and Mindesk to mitigate the errors found during the software testing process. If needed, the bug report shall be updated over the next months to reflect any new requirements. However, it is decided that the bug report and its context is more than sufficient to satisfy the software testing requirements.

Surveys

As mentioned in D6.2, the surveys play an important part of the software evaluation process. The surveys capture data which are related to the actual tools of PrismArch and the experience the users have while using the platform. A series of surveys with a diverse set of questions aim to cover PrismArch holistically, both from an evaluation plan and a usability study perspective. The surveys were created using the Miro Board schematic (described above) as a guideline. The Miro Board aided in identifying the desired user experience, in relation to the available tools and actions in PrismArch. Therefore, a better understanding of what needs to be asked, how the questions shall contribute to the testing process, and efficient data gathering was conducted. The questions follow the D6.1 usage scenarios as flow of actions in accordance with the processes and strategies described in D6.2.

SurveyMonkey.com was decided to be used as the survey platform. After evaluating several survey providers over the internet, Sweco consortium members decided that SurveyMonkey is the best solution compared to other competitive products in the market due to its simplicity and the variety of tools offered by the platform for data gathering, manipulation and extraction. A subscription licence on a monthly basis has already been purchased and participants are able to access the surveys and provide feedback.

TESTING RESULTS AND DATA ANALYTICS

Generally, the consortium members have access to PrismArch's latest versions and have provided feedback, directly in consortium or through the survey. Most participants have provided their feedback through SurveyMonkey. There have been discussions within the consortium meetings which covered many errors and improved the experience. However, the consortium members have already been asked to provide their feedback through the testing process officially. The software testing process could be further enhanced in the coming months. D6.4 should have more data gathered, more tools developed, and more participants involved. However, the data presented over the next paragraphs provide a good

understanding on the condition the platform stands currently and areas to further improve. All questions within the surveys include a custom comments box. This was agreed between the consortium members as it was identified as an efficient way to capture information which may be relevant to the subject, but the question does not completely cover an issue.

General evaluation of PrismArch

The first survey focuses on a General Evaluation of PrismArch. It contains information which gathers generic data and an holistic approach of PrismArch and the impressions the users got by using the platform. The survey includes nine questions in total, which query getting opinions about recommendation of Prismarch to other users, overall satisfaction about the reliability and security of PrismArch and the satisfaction about the Speckle database integration. Additionally, questions about ease of use, look and feel, account setup and collaboration ability aid in capturing the general impression of what PrismArch provides as a virtual reality collaborative environment.

Some interesting results demonstrate that the current platform state required further development. Based on extracted data, PrismArch is not at the level to be recommended to others, therefore needs further development to reach a wider audience.

Q1 How likely is it that you would recommend PrismArch to a friend or family member?

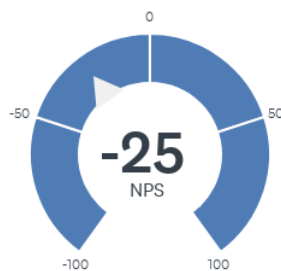


Figure 1: General Evaluation Q1

The level of satisfaction received was 75% Somewhat satisfied and 25% Not so satisfied. The level of security is balanced between, Very Satisfied and Not so satisfied. These are the two dominant options, and received a 50% response respectively. The Speckle database contents integration seems to be at a satisfactory level, receiving 50% response in the Very Satisfied option, followed by Somewhat satisfied and not so satisfied responses claimed 25% each.

Q4 How satisfied are you with the ability to integrate the Speckle database contents in PrismArch?

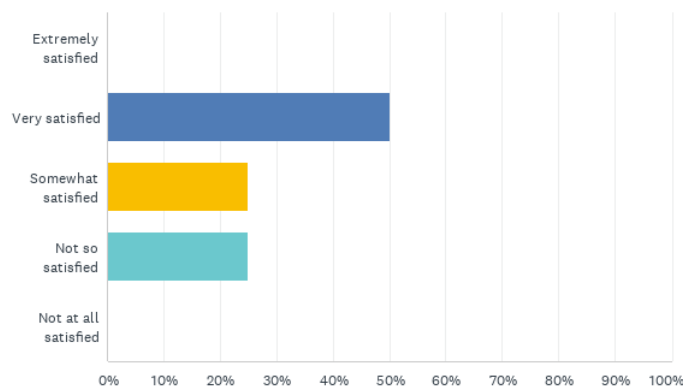


Figure 2: General Evaluation Q4

The participants seem, Somewhat Satisfied with the ease of use, look, and feel of PrismArch. The general participant impression is somewhat satisfied in most questions, indicating possible improvements. The custom comments received highlighted the need for a better copy and paste process, for external source information, within the relevant fields while in VR mode. Some difficulties noted while joining an online session. Additionally, the suggestion to have a tutorial level or controller hints was raised.

Core User UI

The Core User Interface survey focuses on the actions taken when PrismArch starts and the user is presented with the User Interface where the user can change settings, adjust, copy and paste information from external sites and set up the user account. Additionally, graphics settings and options about next steps are found in the Core User UI.

The loading time of PrismArch left the users Very Satisfied and Satisfied (50% each). However, there were issues copying and pasting the Speckle token information from a quarter of the users, while the majority executed this task successfully. There was a small portion which used the demo token instead, however the Speckle token information was successfully deployed within PrismArch. The information was presented correctly, however this was successful while in the real time environment and there were concerns raised through the comments box about the ability to pull this information while in the virtual reality environment. The users generally found the speckle authorisation process easy, however the participants made a couple of suggestions.

Q4 How easy was the speckle token authorisation process?

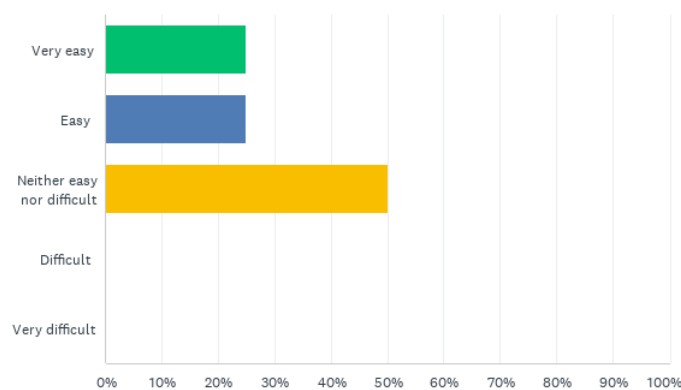


Figure 3: Core User UI Q3

These included the ability to enter the Speckle authorisation without having to navigate away from the platform. Furthermore, a user had trouble and had to try a few times to retrieve the authorisation data. However, the attempt was successful in the end.

The users tested the display resolution and changed it successfully. However, most participants (75% reported an issue with the Window and Full Screen Toggle which did not switch successfully.). No further comments were received for these questions.

An area which raised questions was about the Frame cap. The users were not sure how to tell if the frame cap operated as intended which led to 75% of the users answering, "Not Sure". The participants mentioned this uncertainty through the comments box as well. In a similar manner, the participants were not sure entirely about the Vertical Sync. The same percentage was not sure and added bespoke comments which mainly focused on the inability to tell if Vertical Sync operated as intended. At this point, a follow up discussion with the participants shall determine if there is lack of knowledge about these terms and if this relates to their comments.

The resolution scale slider was operated successfully by three quarters of the participants; however, a concern was raised in the comments box about the performance of the resolution Slider in full screen mode. The participant suggested using the slider in the windowed mode in the essence of having a small window for example with large fonts. The Graphics Options were able to be changed successfully (Options include Low/Medium/High/Epic) by all participants. The Auto-detect button performed as intended as well. This changes functions of PrismArch to suit the system configuration and improve the performance of the platform. These changes are deployed by clicking a relevant button which operates as intended based on the relevant question of the survey. The Reset button successfully reverted all settings back to the original state apart from one participant who did not try it.

PrismArch can pull an avatar via pasting the relevant avatar link obtained from the readyplayer.me website. This loads the immersive human 3d model into PrismArch which the participant has previously set up in the readyplayer.me website. Apart from one

participant who used the demo token, all the rest were able to perform this action without any disruptions.

The information about the PrismArch controls is demonstrated within the platform within the relevant tabs. The participants were able to see all information about the PrismArch controls in the relevant tabs, however they found the information somewhat useful. No further comments have been added; therefore, this should be further investigated, and the consortium needs to identify ways to improve this.

Currently PrismArch contains a link to navigate away from the platform and visit the PrismArch website. Although the participants were able to use the relevant button, there have been a couple of suggestions about the way this function operates. The function seems to successfully open the link in a web browser; however the application remains in Fullscreen mode and the browser does not come in the foreground. Additionally, another participant suggested to keep everything inside the virtual reality environment and not navigate away from the actual software.

The Core User UI transitions to the Globe Navigation Tool by using the Project Model button. This button seemed to operate as intended based on the gathered data, however the software developers need to investigate an instance where a participant used this function initially but not able to repeat the step when he/she shut down the software and restarted it.

Further comments about the Core User UI were received from the participants. Currently the way to shut down the app is by hitting the escape button. The participants suggested the existence of a confirmation pop up message about shutting down the app. Further comments mentioned the inability to effectively use the Alt+Tab keyboard shortcut to switch to other applications from the full screen mode. A participant with a multi monitor setup was able to identify the successful execution of the PrismArch weblink function due to the multi monitor. In a single screen set up the platform cannot navigate away and bring the web browser to the foreground.

Other comments received suggest the following:

- Application name match the project name
- Loading Screen with PrismArch logo (and audio)
- Tutorial level or hints pop ups for controllers
- Controls enhancement (scrolling and clicking)
- VR camera in avatar head instead of having the avatar behind the VR camera
- Name label and status in Avatar
- More efficient colour coding in buttons

Globe Navigation Tool

As it currently stands, the Globe Navigation Tool is the area after the user has inserted their credentials and wants to navigate through the projects and choose which project to work with. This is represented by a globe and the relevant projects have their own boards which then the user can select and enter. The relevant survey covers the participants' experience within this area of PrismArch.

Half of the participants were in the middle of feeling satisfied or unsatisfied with the loading time of the globe and the projects. The rest were balanced between very satisfied and satisfied. The Cesium Globe loaded successfully for all participants and all projects were loaded successfully as per the participants' responses. The presentation of information about the projects was very clear for half of the participants, where the rest two quarters balanced between somewhat clear and not so clear. However, further comments have not been provided therefore the consortium needs to conduct interviews to better understand the issue. No one experienced any frame rate issues. Nevertheless, while in VR the participants experienced motion sickness. Half of the participants experienced a little motion sickness, while 25% none at all and the rest a moderate amount.

Q6 Did you experience any motion sickness?

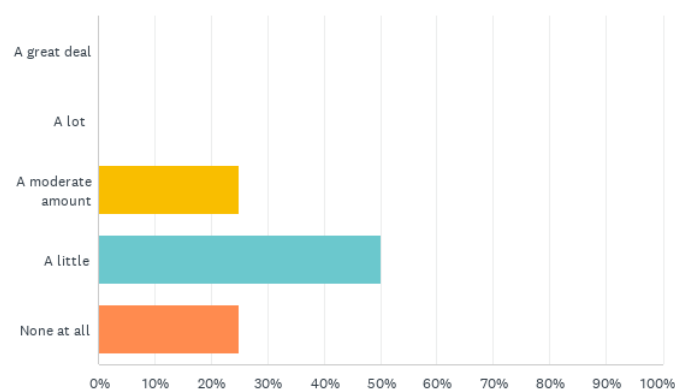


Figure 4: Globe Navigation Q6

The materials and textures were presented correctly, however a comment was received about some materials loaded black and did not receive any lighting. However, since PrismArch is developed in Unreal Engine 4 without Real time GI supported, it needs further enhancement from the developers to identify if this is based on the lighting setup or if it is a glitch. 75% of the participants did not experience any issues with the graphics, however, the ones who did, did not provide any further information, comments or submitted a bug report. These results should be considered together with observations from the behavioural user-testing reported in D3.2 by ETH.

Meeting Room Tool

Meeting Room Tool Evaluation

Survey of the meeting room area focused in the meeting room tool which is the area where the participants perform several actions after they select and enter the project. This includes accessing commits from Speckle, using the Whiteboard tool or hosting a meeting. Additionally, the participants are able to load the models in the meeting room table or in the actual position in the 3d world based on real coordinate data. The survey of the Meeting room tool consisted of 48 questions and covered tools and experiences developed until now. The loading time seemed to cover an increased satisfactory level of 50% while the rest was split between satisfied and neutral satisfaction levels.

Q1 How satisfied were you with the loading time of the Meeting Room?

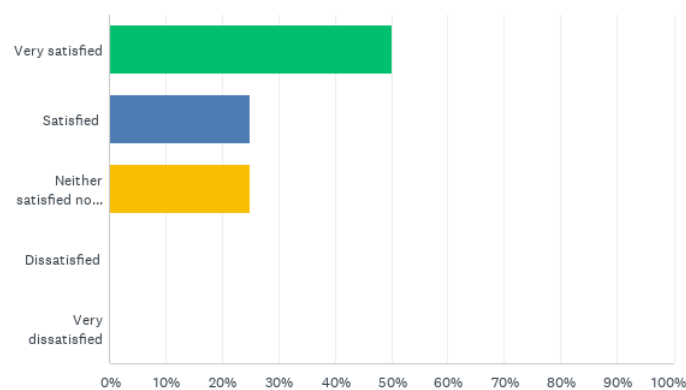


Figure 5: Meeting Room Tool Q1

All participants experienced some level of difficulty with the controls. Half of them declared that they experienced a moderate amount while the rest balanced between little or a lot of difficulties. Some observations about the main menu and returning to Globe Navigation tool and about the controller hints were raised which shall be investigated. When the meeting room loads the user's avatar lands on a specific location which is within the meeting room area. It is interesting that the participants have various experiences as some did not land on the expected location, some did, while a portion was not able to tell where this would be.

Q3 Did you land at the expected location with the correct view target?

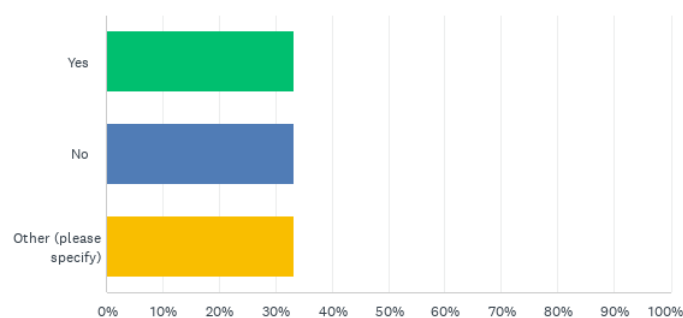


Figure 6: Meeting Room Q3

However, the participants were able to navigate around the meeting room area but the need for collisions has already been raised. The avatars are not colliding with the meeting room table or other elements within the meeting room area therefore this needs to be addressed in a future version of PrismArch. All comments received highlight the importance of collisions and the disturbance this brought while navigating around. On a similar note, a question was posted about the ability to navigate while attending a multiplayer session,

however most of the participants have tried the single player mode leaving room for further investigation. The presentation of information within the meeting room gathered mixed feelings about how clear the information was presented.

Q6 How clear was the presentation of information?

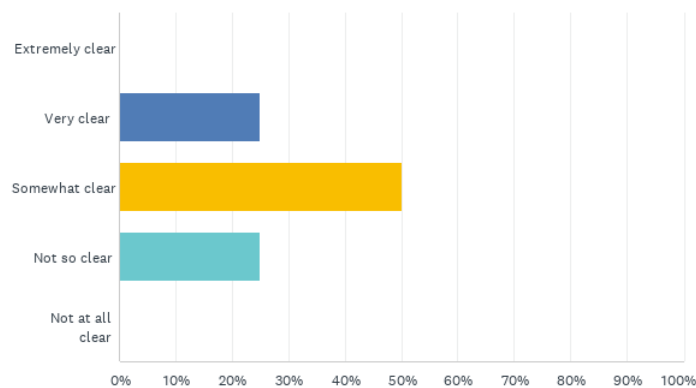


Figure 7: Meeting Room Q7

As seen in Figure 7, most participants thought the information was somewhat clear while the rest seem to feel the information was presented very clear while others found the presentation of information not so clear. All did not experience any frame rate issues, however a comment received about PrismArch crashing while trying to load files requires further inspection. It has been already identified that sometimes PrismArch takes longer than expected to load large files and seems like it crashes, however in some instances it needed more time and performed as expected afterwards.

Diversity about motion sickness was captured in the survey which is somewhat expected. Most experienced a little motion sickness and the rest a moderate amount or none motion sickness.

There were concerns raised about materials and textures of the meeting room, as well as lighting setup. Further improvement is suggested about the overall environment and lighting setup and further improvement is needed in the material change options.

All participants did not experience any graphics issues such as screen resolution errors, font sizes or other issues related to graphical representations of information. Similarly, the navigation speed adjustment seems to perform well, however a comment identified the absence or ignorance on how to use it while in virtual reality mode. The impressions of the meeting room area left mixed feelings to the participants where most feel neither satisfied nor dissatisfied from their experience and only a quarter of the participants felt satisfied. Nobody felt very satisfied, dissatisfied or very dissatisfied.

Further comments received about the meeting room area included the authorisation and loading elements privileges the host should have while in a multiplayer session and the inability to see models when participants re-joined the session. Additionally, the collisions were mentioned again. Furthermore, there was a great concern raised about the

differentiation of single player (personal work sphere) and the multiplayer session which should be considered as joining a collective work sphere session. There was also a concern raised about the two-dimension user interface panels and the ability to align these with PWS geometries. The last comment received was about the similar design of all user interface icons. These observations shall be discussed with the software developers and will be addressed as these shall be agreed.

Menu Pop-Up evaluation

One of the survey's sections focused on the Menu Pop-Up which is presented when pressing the Space Bar while in the meeting room area. All graphics were presented correctly as stated by the participants. The controls need to be further improved. The participants found somewhat helpful or not so helpful to handle the menu based on the current controls. The Project Selection button, the Quit button, and the Show Query tick box worked as intended for three quarters of the participants. Some uncertainty was discovered about the Keep CAE tick box with the comments varying from not even trying the tick box to not sure if it works as intended. However, the statistics from the survey were split into half.

Q19 Did Keep CAE tickbox work as intended?

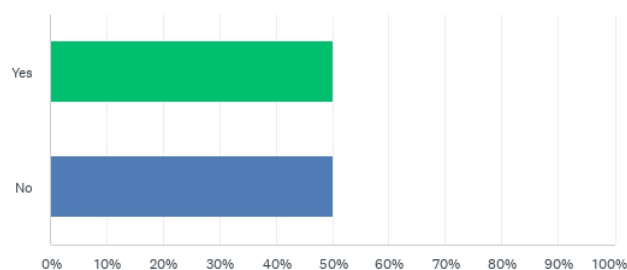


Figure 8: Meeting Room Tool Q19

On a similar note, the AI tool tick box caused a bit of confusion. Some participants did not try it out while others submitted positive or negative answers about the tick box.

The commits history widget and the scroll speed seemed to work well in desktop mode. However, in VR participants seem to find difficulties to control it since it seemed not to stop scrolling and not letting participants select a commit. 75% of the participants were able to select commits and the same number of participants were able to experience their commits loaded on the meeting room table. However, comments were received and stated that only one commit was able to be loaded in the meeting room table while in VR mode. Data gathered about the visual style of the selected commit stated that this was successfully changed and there weren't any further issues.

PrismArch can make changes on months and days to reflect daylight simulations. The ability to change the month and day was successfully executed by all participants based on the relevant survey question.

The survey investigated the overlay transparency and if the participants experienced any issues with this adjustment. This function seems to work for most of the participants,

however there were a lot or a moderate amount of issues for some. Comments received stated that nothing seems to happen, which is subject for further investigation.

Q26 Did you experience any issues with the adjustment of the overlay transparency?

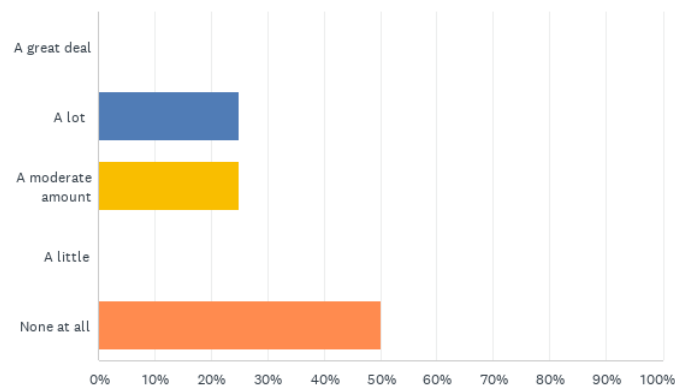


Figure 9: Meeting Room Tool Q26

Similar to month and day, a time zone slider can change functions related to the lighting environment and the sun position. This worked as intended for all participants. Additionally, the compass tick box reveals or hides the compass within the PrismArch environment. Apart from participants not trying it, the rest seem to enable and disable the compass through the tick box successfully.

The menu pop-up also loads the selected commit in real size and in the actual location of the world based on the given coordinates. 50% of the participants were able to activate the Cesium Maps and load the model to the actual location in the virtual world while 25% did not. There was a comment suggesting that the action was completed successfully but the avatar remained in the meeting room, but this is how PrismArch operates in its current state. However, this will be raised within the consortium and investigate if transferring the avatar as well, or other suitable UX approaches can be explored as part of the future functions to be implemented.

While navigating around the loaded commit within the Cesium globe, the user can return to the meeting room. This is accomplished by the Office selection, and three quarters of the participants were able to perform this action successfully. A bug report has not been submitted or further comments have not been received to provide more information about the participants who did not execute this function successfully.

Common menus such as Settings, PrismArch controls, Communication and the PrismArch link work similarly to the Core User UI for half of the participants. As this question caused a bit of confusion, the consortium members involved in the evaluation plan and usability study shall get in touch with participants, make necessary adjustments and eliminate ambiguity of this question. Until now, the statistics presented show that half of the participants experienced the menus to work as intended.

The Query Tool graph contains data related to selected elements within PrismArch. 75% of the participants stated that the data was transferred successfully from the element to the

graph, however the rest did not provide any additional information or bug reports about actions and how to replicate to discover issues. The grabbing and releasing of Query Tool elements and the ability to move graph elements seem to work for the same number of participants. Satisfaction levels of the Query Tool appeared in the spectrum of overall satisfactory levels as presented in Figure 10. Further comments reflected the satisfaction levels of the Query Tool.

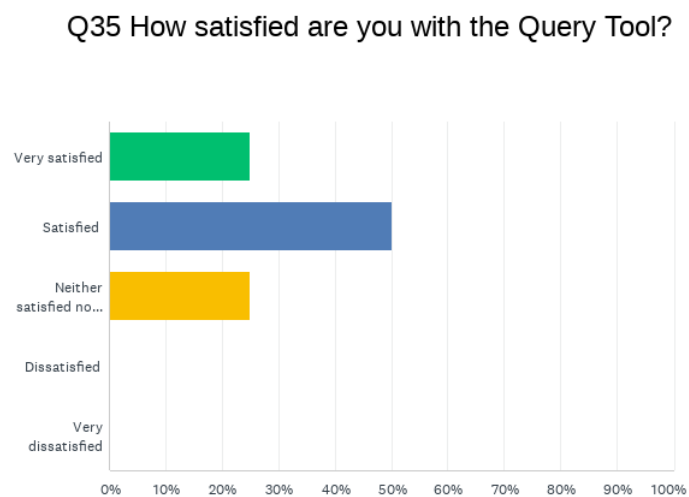


Figure 10: Meeting Room Tool Q35

Additionally, participants seem to agree with the use of the Force Directed Graph as a tool to Query Data within PrismArch, giving a 75% agreement and 25% neither agree nor disagree statement.

Multiplayer experience in PrismArch

Most of the participants tested the software in a single player mode and did not host or participate in a multi-player session. Half of the participants declared that they could see the information about the multi-player session correctly. The participants experienced a moderate amount of latency. The Vivo audio successfully recognised the equipment for half of the participants.

The multi-player session did not load the avatars for the participants. The same avatar model was loaded for each participant. However, the interactions were presented successfully for the majority of sessions.

All were able to see the Whiteboard Tool in the meeting room. Presentation of pictures, swiping through pictures with the previous and next buttons and the transition from one picture to the other was operated successfully. Further commentary was received about the ability to load pictures while in PrismArch, a function which shall be discussed in future meetings. Overall participants seem satisfied from the Whiteboard Tool.

Project Data

The Project Data Tool

The Project Data area is the area where the commits are loaded in the virtual world in a physical scale and with real world coordinates. The survey covers the different tools and options while the participant navigates within this part of PrismArch.

The loading time of the Project Data area left two thirds of the participants neither satisfied nor dissatisfied. The models were not always loaded in the virtual world with one third providing additional comments about the state of the model when loaded or incidents where PrismArch crashed while loading a model in VR mode.

Navigation was smooth for 66% of the participants, however comments were received about the difference in navigation between areas of PrismArch. Motion sickness data again were diverse with others experiencing it after a while, others just a bit and other participants not at all. However, comments received in this question raised the importance of movement speed and the discomfort of passing through virtual assets.

Q4 Did you experience any motion sickness?

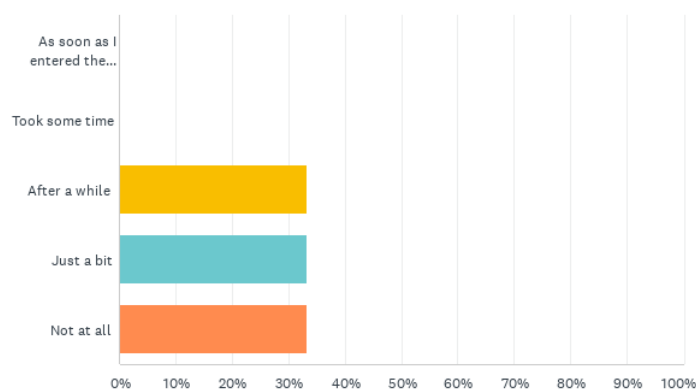


Figure 11: Project Data Q4

There wasn't any drop in the frame rates while in Project Data, however comments stated that when loading large models, the headsets went black and took a few seconds to return to the scene. This shall be further investigated and pushed to relevant software developers for review. Materials and textured were presented correctly as all participants replied "Yes" to this question, nevertheless comments received about texturing models and default materials were raised. Similar to the materials, the fonts, screen resolution and other graphical entities did not cause any issues to the participants. Further comments focused on the design of the UI as a holistic experience which is an ongoing development process.

The navigation within the virtual world was neither easy nor difficult as the participants stated in the survey. Further comments revealed the need for the users to be able to load from the point they left the platform and not having to go through the whole process again to reach the point where they stopped using PrismArch. Another comment raised the

importance of information pop-ups to help the user understand how to navigate through the platform.

Further to the navigation controls, no collisions were detected while experiencing the Project Data.

The overall experience left the participants satisfied in a small percentage. Concerns were raised about the uncontrollable motion which gave a rather not good experience. There was concern over the size of the globe and how the user interacts with the location of the project. Other information received focused on the UI and the difficulty to manage it as it appeared dark enough to cause disturbance.

The scrolling menus did work for the majority of the participants, however there were instances where the slider UI was close to other commands and sometimes it was not possible to control or stop the scrolling.

Further comments received involved the importance of having the models accurately presented in the world coordinates and the inability to accidentally move objects. The importance of an “Undo” command was also mentioned and PrismArch hasn’t got a way of undoing things.

Multiplayer within the Project Data Tool

Further questions focused on the multi-player experience within the Project Data Tool of PrismArch. Although the majority of the participants tried in single player mode, the ones who tried the multi-player mode in Project Data Tool experienced similar issues with the Meeting Room Tool. These included loading only one type of avatar model and not the actual avatar the user pasted in Core User UI tool. Additionally, there was the same issue when loading a commit and the application crashed, the commit was no longer visible when re-joining the session.

The participants experienced neither high nor low quality of interaction and communication with other participants. The latency generally was average, and all participants were able to change the view modes within Project Data Tool.

The Speech to Text tool survey question and whether this was easy to use received diverse replies. Others were not able to make it work, others found it neither easy nor difficult while some did not try it at all. The use of Speech to Text tool was found useful and all mostly agree that it should exist within PrismArch.

The Markup Tool was used successfully by 66% of the participants, however the ones who were not able to use it did not provide any further information or submitted a bug report. The notes were stored successfully in the markup tool for one third of the participants and the feedback given from the ones who did not manage to use the tool mentioned that the notes were not stored in the tool, there wasn’t clarity on how to leave the tool and perform another action ending up restarting the app to get out of the tool.

Q20 Were the notes stored successfully when you wrote something in the markup tool?

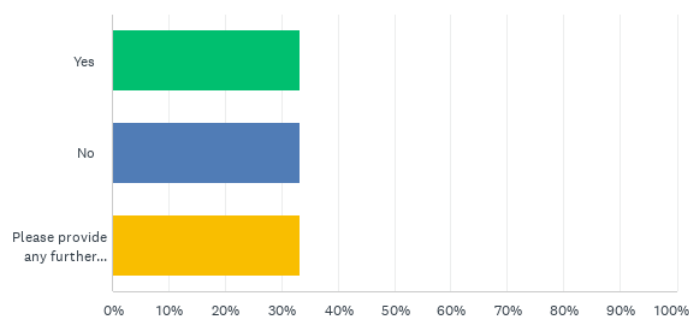


Figure 12: Project Data Q20

The markup tool found the participants having a neutral satisfaction level of the Markup Tool as per the given answers within the survey.

The Whiteboard tool within the Project Data area of PrismArch worked as intended and participants used it effectively. Suggestions have been made and focused on grabbing and handling the location and scale of the Whiteboard tool. All controls worked as intended and as it seems the Whiteboard tool worked efficiently in all areas of PrismArch.

The AI tool was used by a third of the participants and half of them experienced suggested solutions by the AI tool. Most participants stated that it is neither likely nor unlikely to use the AI tool while 33% stated that they will likely use it.

Generally, the tools within the Project Data Tool left 66.67% of the participants neither satisfied nor dissatisfied and the rest declared satisfied.

QUALITATIVE FEEDBACK

Before the software testing process was agreed and all necessary requirements fulfilled, Zaha Hadid VR and AKT-II tested PrismArch and provided their observations through documents. Apart from the discussions held between the consortium in the arranged meetings, the partners tried, tested, and identified bugs, errors or poor experiences and distributed this information within the consortium. Their observations have already been provided to the software developers and relevant discussions are being held in the meetings aiming to improve PrismArch.

ZHA-VR observations

The first observation document from ZHA-VR was shared in early February 2022 and initially relates to information and general instructions about GPU, system, firmware updates etc. The need for step-by-step tutorial documentation is mentioned and also emphasised in specific aspects such as setup, login etc. Regarding the onboarding process, ZHA-VR emphasised the need of PrismArch personal sphere instead of the winter scene and relevant branding. The need for tutorial is also raised via interactive functions or at least hints to controllers for the software usage. Suggestions such as having the browser within the VR

environment instead of opting out of PrismArch or at least having a notification before leaving the platform is proposed. Furthermore, alternative solutions to the project selection button are made. The first part of the observation concludes with the difficulties in understanding the UI scroll and the option of the game level architecture to follow the on-boarding narrative suggested in D6.1. An example is provided which describes in detail the flow, options and selections. The observation document is enriched with figures explaining the thoughts.

ZHA-VR also provided Authentication comments and observations related to the Speckle token, the link and raised concerns about modifying submitted information.

Regarding the Avatar, ZHA-VR provided thoughts and proposals for the Avatar creation process, some bugs found relating to the Avatar link pasting process, the ease of use to paste the link while in VR, the position of the Avatar related to the user and a suggestion about labelling the Avatar.

For the UI, there were observations and suggestions about the UI panels, the web browser notifications and interoperability, the scalability of 2D UI panels and relevance to PWS geometries, and finally the design colour coding alignment of buttons within PrismArch.

The Globe feature (Project Selection) has been reviewed and navigation issues have been identified. Motion sickness is also experienced. Some other features such as scalability of the Globe and the ability to scale based on fixed terms (1:200, 1:100 etc) is mentioned and also the scalability based on the element of interest (master plan, building, furniture) has been proposed.

Concerns about disorientation of the user based on the unfixed PWS within the Globe have also been reported. Additionally, ZHA-VR in their first observation mention about the below ground level interaction and proposes relevant solutions.

Regarding the UI, suggestions about the scalability, rotation and position of the project labels have been made, proposing solutions as well.

The first ZHA-VR observation continues with the Meeting Sphere. Regarding the Environment, issues with the table, floor, materials, and textures have been mentioned. Additionally, lighting setup and collisions are raised as a concern since there seems to be room for improvement.

For the Navigation part, issues about walking / flying, enabling photorealistic view and the different laser systems setup in controls have been raised. ZHA-VR proposed a universal laser system or laser modes according to purpose.

Furthermore, the differentiation between PWS and CWS seems to be only based on the connecting/disconnecting the host server. ZHA-VR provides figures to explain furthermore the vision of differentiation between PWS and CWS and how these can be implemented.

For Image Panels, ZHA-VR mentioned the ability to change the location, scale, and number of panels with images. Additionally, the ability to minimise or maximise the two-dimensional user interface panels and the alignment with the personal work sphere geometries and the screen arrangement should be achieved. There was a concern raised as well about the content of the panels and where these are stored within PrismArch.

Additionally, a question about the scale of the model was raised and a proposal has been made which refers back to the initial proposal of ZHA-VR, returning to the main menu and viewing different scale models.

A couple of comments and suggestions about the Mindesk tool were made as well. The tool could be only enabled on the table, or the table could be hidden, and a base plane could appear in abstract mode. Comments about the user and the ability to grab objects were made and a couple of suggestions accompanied with figures have been provided. Additionally, an issue raised about the Mindesk objects which do not receive any lights and appear to be black.

The final recommendations from ZHA-VR are about going back to the project selection scene and how clear this should be, the importance of having a return or load another project button and how this would make PrismArch more efficient.

The second observation document was based on PrismArch v6.1. The observations begin with the list of design assets and importance that these should be shown to the globe scene as well. This would be formed as part of the information display and query system. This section would also illustrate the difference between the first-time use or if a user is recurring. ZHA-VR describes how they imagine that QUI system as a 3D folder structure and also suggests looking into relevant software providing links which could be useful.

Once more, the absence of collision is mentioned. Suggestions are made about materials within the meeting space, and the proposal about a radial grid structure of project information accompanied with relevant figures is demonstrated. Several proposals about the ability to select and move the nodes QUI in VR, minimising and maximising the graph, show only selected thread and grouping and tagging data are made.

ZHA-VR also proposes and describes analytically UI interactions which relate to Project Information LOD. The workflow is thoroughly analysed with text and figures and an example is provided to support this ability.

The commenting functionality is reviewed. Enhancements have been proposed which add to the user interactions, mentions and information exchange while in PrismArch. However, there is a concern raised over the UI visuals and the importance of improving them for a better user experience.

Another point raised was the ability to accidentally move objects and the absence of an “undo” function.

ZHA-VR also raised the importance of scaling the project from real world dimensions to diorama size. Further to this, the coordinates are also reviewed and need improvement since there isn't a clear definition of how the models treat the coordinates and no other information is provided about the coordinates within PrismArch. These observations have been accompanied with relevant example figures and explanations by ZHA-VR of how they envisage PrismArch and these functions.

The second observation document mentions again the need to change the executable file name from AdvancedFrameworkVR to something more relevant to PrismArch. Once again, the importance of hints and ways to aid the user controls is raised. Additionally, the app seems to connect directly in VR mode if a headset is identified, which means there is a lack of selection or switch between VR and Desktop modes. Further analysis is conducted on the

importance of this aspect throughout the document. Additional information about functionalities, their presence and UI aspects are provided via a combination of text and figures.

For the multiplayer experience, ZHA-VR identified the lack of eye textures of avatars, avatar names and also suggestions about materials while interacting with PWS have been described. Further analysis is written on how the player should walk and interact with the PWS and further issues and suggestions about interactions while in a multiplayer mode have been identified. Further improvements over loading objects and authorisation on who should be able to do what are proposed.

ZHA-VR also provided screenshots of UI issues. Node replication, UI spawn issues and replication of tools have been under consideration for improvement.

The final section of the second observation document focuses on the user manuals PrismArch should implement. Analysis about the different PrismArch controls, the ways these could be presented within PrismArch and other suggestions such as pop-up notifications are mentioned. Additionally, some observations are made on missing descriptions of buttons in the current control menus. These are accompanied with relevant figures.

AKT-II Observations

AKT-II provided their observations and made suggestions and proposals through a document which was also circulated within the consortium. The document consisted of a table which had three columns:

- Item / Date
- Comment / Description
- Action / Status

The item / date had a sequential numbering form and the date the test was conducted.

The comment / description had a brief description of what was tested and comments on found issues.

The Action / Status described whether issues were found and actions such as communications, awaiting information or if no issues were found.

The flow of actions started by logging in, logging into Speckle and creating a token which was executed successfully. Afterwards, a stream was created in Speckle, an Avatar in ReadyPlayerMe and the input of the relevant information in PrismArch in the dedicated fields. These actions were successfully executed. An issue was raised about the demo token which awaits advice from CERTH. Additionally, and at a later stage, the keyboard was not detected preventing a newly generated token to be pasted in PrismArch. This caused the absence of the ability as well to use Space bar to bring up the log-in menu. Both actions are to be resolved with CERTH. Similarly, to ZHA-VR, the need for tutorials is raised and the familiarisation of the controls is achieved after a couple of tests. AKT-II raised a concern about the Globe position and the need to centre it in front of the user. Controls are raised again as a concern and the difficulty to familiarise and navigate effectively. Detailed descriptions of what was trialled and achieved were given reflecting as well to the

discomfort this causes. The importance of objects' collisions is also mentioned since the player can go below level.

Concerns were raised about the render quality and further comments were made about the controls as the users continued the testing process. For all control issues, AKT-II has mentioned that CERTH shall advise.

In the meeting Space, AKT-II managed to bring up the controllers' guide, however the mouse and keyboard were not detected in the meeting space. The testing session was done in a single player mode, and AKT-II requested more information regarding the setup of a multi-player session.

No issues were identified while browsing in a list of models while in the default Demo Speckle Token. All commits list, details and names were visible. However, an overlap between controls was found between scrolling through the commits list and movement of the user while using the same thumb stick for both functions.

There weren't any issues with selecting, grabbing, and moving objects. A description of querying tags and interaction between user and elements is given which also mentions the successful execution of these tasks. The interface works well except from the possibility to scroll down through the dropdown menu.

A suggestion about locking the movement of certain components is mentioned, and the undo function is also raised.

The Whiteboard Tool and the Tracing Paper tool worked as intended. However, there was uncertainty on how to rotate the tracing paper board table around the horizontal axis and place it on top of the meeting table as shown in the prototype video. The selection of tools from the table was not too responsive, however after a number of attempts the property was made active. The sketching tool, the shapes and lines creation and the colour selection did not cause any issues.

The geometry creation tool raised concerns over inconsistency between CERTH and Mindesk tools. The user did not acquire permission to select shapes as shown in the prototype video and only the "Mindesk tools" popped up, resulting in the inability to use geometric modelling tools.

For the Project Data tool, AKT-II raised concerns about the navigation to the real location. Proposal of navigating to the actual location instead of doing this manually was made. There weren't any issues about the lighting menu and the rendering mode is still under testing.

The observation document also seeks advice from CERTH about the ability to create screengrabs and any export options. The document concludes with a summary of issues.

AKT-II provided a second document which they captured additional information and have already circulated with the consortium. The document describe issues in the Core User UI and suggest enabling menus for the following:

- Drawing primitives

- Activating Mindesk tools

- Measuring distances

- Any other tools to be added after review and discussion

Suggestion is to have these disabled and have only the information which is needed in this initial situation. The next observation is related to the controllers which are represented in the VR environment. These seem to be different to what is specified as a testing VR headset of PrismArch which is the HP Reverb 2. Additionally, the selection wand colour was causing disturbance to the participants since it was black and could not be differentiated from similar black areas (e.g. panels) in the UI. Furthermore to the UI, the need to have only one button highlighted is raised because at the moment more than one button can be highlighted.

Finally, AKT-II for this testing purpose was not able to go past the loading screen in their testing process in this version of PrismArch, an issue which is under investigation by the software developers.

CONCLUSIONS / RECOMMENDATIONS

PrismArch is an ambitious research project with a commercial product expectancy. In these early stages of the software development the consortium has managed to cover lots of issues raised within a collaborative virtual reality environment. The surveys conducted gathered data which overall gives the impression that the software is in the right direction, however with lots of improvement areas. Certain tools seem to work as intended such as the Whiteboard tool while other functions need more improvement. The evaluation plan and usability study process has uncovered weaknesses within the platform which need to be addressed to have a working product which will enhance collaboration and make PrismArch the AEC platform of the future. As PrismArch development progresses, more surveys will be created, and more tests will be conducted to feed this information back to the development team and resolve issues within the consortium. D6.4 shall provide the necessary updates and improvements throughout the development and software testing process based on the data gathered.