

V4Design

Visual and textual content re-purposing FOR(4) architecture, Design and virtual reality games H2020-779962

D7.2

Use cases, requirements and evaluation plan

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Abstract

D7.2 describes an updated version of the pilot use cases, as well as the user requirements, which derive from the analysis of the updated pilot use cases, the prior user experience and market needs. The deliverable also includes an updated evaluation methodology, which will be used in order to assess how the final components and the entire V4Design platform have fully realised the project objectives.

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Executive Summary

This deliverable is an updated version of the pilot use cases (PUC), user requirements and the preliminary evaluation plan documented in *"D7.1 Initial use case scenarios and user requirements"*. It capitalises on an updated methodology for eliciting user requirements, which explores and consolidates the information and feedback collected from PUC scenarios, prior user experience of two focus groups elicited with the aid of questionnaires and the analysis of market and industrial needs.

More specifically, the PUC scenarios have been updated and elaborated based on the extensive feedback provided by two focus groups, consisting of architecture professionals and video game specialists. Mock-ups and storyboards have been also used to provide more concrete information on the way users can improve the existing design workflow.

In addition, the deliverable describes the updated user requirements that have been elicited, as a result of the updated methodology that has been followed. More specifically, we identified 29 High Level User Requirements (HLUR) from the analysis of the four PUC scenarios, 4 HLUR through structured questionnaires and 13 HLUR through market analysis and industrial requirements. A "merging" task was necessary in order to remove conceptually overlapping HLUR, resulting in 16 HLUR that provided the high-level context to group a list of 70 User Requirements (UR). The Moscow Framework has been used for assigning priorities to UR according to business benefits and needs, designating in that way potential implementation timelines of the respective technical requirements that will be specified in "*D6.2 Technical requirements and architecture*".

Finally, the deliverable elaborates on the user-oriented evaluation methodology that will be used to evaluate the platform against each user requirement. A detailed evaluation plan is also given along with the planning for key demonstration events.



Abbreviations and Acronyms

AR	Augmented Reality	
CG	Computer Graphics	
DoA	Description of Action	
EU	European Union	
HLUR	High Level User Requirement	
IP	Intellectual Property	
IIR	Interactive Information Retrieval	
КРІ	Key Performance Indicator	
NPV	Net Present Value	
MMF	Minimal Marketable Features	
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting	
PUC	Pilot Use Case	
UIX	User Interface Experience	
UG	User Group	
UR	User Requirement	
USP	Unique Selling Proposition	
VR	Virtual Reality	
VUS	Virtual Urban Simulation	
WLAA	Weighted Look Ahead Approach	

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1 INTRODUCTION

V4Design aims at creating innovative tools for architects, designers and game creators to help them through the design process of both physical, as well as virtual spaces, taking advantage of assets extracted from visual material. In order to develop these tools, pilot use cases (PUC) have to be defined and user requirements have to be elicited, according to the specific user scenarios, prior user experience and market needs. In addition, it is important to formulate a concise evaluation plan for assessing and evaluating the performance of the developed tools.

The initial pilot use cases, user requirements and a first outline of the evaluation plan have already been documented in D7.1. This deliverable is an update of D7.1 providing updated pilot use cases, elaborated user requirements and the description of the evaluation plan to be implemented. To this end, we extracted and aggregated requirements collected from: a) proposed pilot use cases; b) prior user experience, as this is expressed with the aid of questionnaires from user partners (including users not directly involved with the project); c) results of related market analysis (Figure 1). This process has resulted to a more elaborated and comprehensive requirements list compared to D7.1, which will be used for extracting the technical requirements in WP6. In addition, a concise evaluation plan is provided, that will be applied after the implementation of the 1st and 2nd prototypes as well as the final system, and revised accordingly throughout the project procedure.



Figure 1: User requirements extraction methodology

More specifically, Section 2 presents the two focus groups that have been set up consisting of people from user partner organisations who are either directly involved in the project or they are simply experts in the field. The focus groups have contributed to the elaboration of PUC scenarios and the refinement of user requirements, while they will be the main target audience for the initial evaluation of the operational and the 1st prototypes. Therefore, we can assume that the two focus groups are a subgroup of the V4Design User Group (UG).

Section 3 documents the updated PUCs, presenting an extended description of the scenarios along with requirements that have been extracted from each scenario at a higher level (High-Level User Requirements - HLUR). In addition, mock-ups and storyboards have been included to further elaborate the envisioned functionality and illustrate a first possible user interface of the final V4Design system. Similarly, sections 4 and 5 present the High-Level User Requirements collected from focus group and industry.

Section 6 provides details on the aggregated high-level requirements defined in Sections 3, 4 and 5, along with the complete list of the individual (atomic) user requirements that



correspond to the higher-level ones. Last, section 7 provides a concise evaluation plan that will be applied after the implementation of the V4Design prototypes and revised accordingly throughout the project procedure.

2 METHODOLOGY

This section analyses the approach that has been adopted to update and further elaborate the PUC scenarios and the user requirements. In particular, it describes the focus group creation, the PUC scenarios elaboration based on the outcome of the focus group discussions and the methodology for the refinement of the user requirements.

2.1 Focus group creation

Focus groups are widely used in many research fields to investigate new ideas (Kontio, J. et al., 2004). In respect to software engineering, focus group method is a cost-effective and quick empirical research approach for obtaining qualitative insights and feedback from practitioners that can be used in several phases and types of research. In V4Design, we use this method to elaborate the initial PUC scenarios, to formulate the prior user experience which was incorporated in the updated user requirements and to evaluate the system prototypes. Specifically, two focus groups were created consisting of: a) Architecture professionals and b) Game development specialists.

The first focus group, mainly related to PUC1 and PUC2, consists of architecture professionals from industry and academic environment. The second focus group, related to PUC3 and PUC4, consists of video game developers and media experts. AUTH and HdM were the main responsible for recruiting members for the first focus group while the second focus group was formed by members recruited by NURO and DW.

The focus group members come from user partners' research team and associates, who participated in the discussions throughout the procedure of the proposal phase as well as the first users' meetings.

The focus groups are also balanced in terms of gender and present a considerable spread in the age of their members.

At this stage the involvement of the focus groups was mostly revolved around the use case elaboration and the refinement of the user requirements. However, we expect members of the focus groups to be involved at a later stage in order to further enrich the implementation of use cases and ensure that they reflect current needs of the stakeholders as well as at the evaluation cycles of the developed prototypes.

2.1.1 Architecture professionals

The architecture-related focus group involves architects, both professionally and academically focused, experts on design software and the various fields of architectural design. The focus group is not limited to users who currently use advanced design application software (e.g. Rhinoceros3D) in their technology stack and their design workflows, but deliberately is open to allow for comparison with other existing workflows and tools, applicable to non-specialized software users.

Being related to the architecture use cases (PUC1 and PUC2), this focus group includes a wide spectrum of expertise in the creative industry, ranging from architecture concept design, architectural design of temporary elements and installations, indoor and outdoor, construction detailing, construction management to the production of sales and communication material.



More specifically, architectural studios, as well as autonomous working artists, are represented in the focus group. Regarding academic communities, a broad spectrum of users is involved, ranging from teaching staff specialized in advanced design technologies, field experts of design software, academic staff related to architectural, urban and landscape design, as well as students of all levels, undergraduate, postgraduate, PhD candidates and members of broader communities related to architecture and design.

Up to now, the group consists of 16 members derived from AUTH and HdM user partners while its members are expected to be increased in the next months of the project.

2.1.2 Game development specialists

The video game-related focus group articulates a user community for game design and Virtual Reality (VR) applications and experts from related fields. More specifically, it includes game developers and game designers, content creators and end-users from gaming companies and experts on the field. Another major part is the creative directors in game development companies, whose main job is to have a vision for the game, develop a game design document and make sure all the necessary resources are available or can be made available for the game designers and the developers. Regarding game developers and game designers, the group mainly contains game developers that work in the development of 3D games using the Unity game Engine and game designers for 3D models who would eventually be the target users of the assets produced by the V4Design platform. The focus group also includes media production professionals and specialists for documentaries and VR productions from DW.

So far, the group consists of 13 members derived from NURO and DW user partners while its members are expected to be increased in the next months.

2.2 Pilot use cases creation methodology

The PUC scenarios, which have been initially outlined in the proposal phase and then drafted in M4 and described in D7.1, are now updated and elaborated based on the extensive feedback and experience provided by the aforementioned focus groups, during discussion sessions taken place between them.

The starting point of the V4Design PUC scenarios was the initial descriptions during the proposal phase. The main criteria, which were taken into account for the use case creation at that phase, were: a) the relevance to the V4Design challenges; b) the interest for content reuse and repurpose; c) the interest of the stakeholders.

Then, these initial PUC scenarios were outlined in D7.1 while the current deliverable further elaborates the PUC scenarios and concludes on the topics of the suggested PUCs. To achieve this, focus group members had extensive discussions on use cases in bi-monthly teleconferences, as well as in physical meetings (taken place in Thessaloniki, Cologne and Bonn while the meeting taken place in Cologne was dedicated to the definition of use cases). First, they performed a thorough analysis of the initial general topics of the proposed PUCs, before coming to conclusion about the selected cases. These topics initially included historical landscapes and buildings for architectural and outdoor design, artistic styles and movements for interior design, TV series and video game design. Then, they filtered out these cases according to the quantity and quality of available visual material by content providers of the project, which is able to be reused and repurposed, as well as focused



interest and particular knowledge of each case by the project partners. Involved users had the capacity not only to clarify and elaborate on the initial scenarios, as described in D7.1, but also to select alternative versions of the proposed ones.

Eventually, they have resulted in two scenarios for PUC1. For PUC1, Sc.1, the case of the historical area of Delphi, Greece, as a case with a lot of available visual material and a lot of related, visually rich historical input, such as the ancient Greek architecture and art, as well as the proximity and knowledge of the selected place to project partner AUTH. Then PUC1, Sc.2: the case of a new cultural building in downtown Berlin, Germany, as a case with a lot of available visual documentation, also connected to an actual project, result of winning an architectural competition, of project partner HdM. For PUC2, the involved users selected the case of Japanese and East Asian calligraphy and space designed to host and be inspired by it. For PUC3, a television series for German language learning was selected, named 'Nico's Weg', which was an alternative option from 'JoJo' series, which was the initial selection. For PUC4, a case was selected for a 're-living the past' virtual experience, including past historical periods and places in Germany, such as the Gendarmenmarkt square in Berlin, which operates as a initial trial phase for the next phase of PUC4, which will work on the case of Bauhaus building and cultural heritage.

The updated and elaborated use case scenarios are presented in Section 3.

2.3 User requirements extraction methodology

In order to gather the user requirements that will drive the design of the V4Design architecture and the specification of its main components, a combined approach has been adopted. This approach has been articulated in various parts, so as to ensure the credibility and coherence of the procedure. More specifically, the approach comprises five steps as outlined below (Figure 1):

- a. Collection of user requirements from the analysis of the V4Design PUC scenarios.
- b. Collection of user requirements through structured questionnaires distributed to focus groups.
- c. Collection of user requirements through market analysis and industrial requirements derived from "*D8.3 Market analysis and industrial requirements*".
- d. Aggregation of requirements from (a), (b) and (c)
- e. Prioritisation of the requirements

User requirements are hierarchized as high level user requirements (HLUR) and refined user required (UR). HLUR are placed one level up in the hierarchy and include abstract notions of user needs that might include sets and combinations of UR. Such HLUR derive from step (a), (b) and (c) and might be common across these steps. UR is the simpler form of HLUR that will drive the actual development of the V4Design components. Usually a HLUR relates/consists of one or more UR.

The first step (a) of the adopted user requirements' elicitation methodology is to extract user requirements from the PUC scenarios. More specifically, members of the focus groups were participated in several discussions and user meetings in order to conclude with a set of requirements which are directly related to the drafted PUC scenarios. The outcome of step (a) is documented in section 3 (3.1.5, 3.2.5, 3.3.5 and 3.4.5)

Thereafter, the second step (b) of the elicitation methodology is to extract user requirements from prior user experience. Towards this direction we have enriched the two

focused groups with experts in the field who are not directly involved in the project and we have requested their feedback with the aid of questionnaires. The questions were selected through a collaborative exercise between user partners. Two categories of questions have been decided: general and in-depth ones. Essentially we tried to cover all high-level features/requirements (already addressed in the proposal phase) and created a list of questions that will enable to obtain user's scope on these features/requirements and to discover "undreamed of requirements" Most of times, questions evolve naturally as we think through the implications of a feature. The questionnaire was created by V4Design user partners in such a way in order to receive constructive feedback from experts about the users' current tasks, workflows and challenges in each use case. The questions are also drafted in a way that allows the user to express their own ideas and wishes as free texts, rather than selecting options from multiple-choice questions. Then, the questionnaires were distributed in a carefully selected group of 15 experts from the focus group (including mainly users not directly involved with the project), evenly divided into professional architects at both practice and academic level, experts in video game design and media production, which was balanced in terms of experience, age and profession. All participants in the questionnaire procedure have actively given their consent to submit their forms. The original questionnaire that was given to the experts is provided in Appendix A.

User requirements have not been plainly statistically derived from the set of answers received through the questionnaires. The user profiles of the participants have been evaluated, in order to understand the validity of ideas and concerns and whether those should be reflected in HLUR. Due to the nature of the questionnaire, answers have been carefully interpreted and understood, taking user profiles of the participants and their priorities into account. The outcome of step (b) is documented in section 4.

The third step (c) of the elicitation methodology is to extract user requirements from the industrial requirements that were based on the initial market analysis reported in "**D8.3 Market analysis and industrial requirements**". The members of the focus groups analysed the industrial requirements and translated them into user requirements. The outcome of step (c) is documented in section 5.

Once the first three parallel steps are completed, three sets of HLUR requirements are identified. The first set contains a list of HLUR requirements as derived by the analysis of the V4Design PUC scenarios (section 3). The second set contains a list of HLUR requirements collected through the structured questionnaires (section 4). The third set contains a list of HLUR requirements derived by the analysis of the market and the industrial requirements (section 5).

In step (d), the lists of HLUR are merged into one single list of HLUR where common HLUR across different sources are aggregated and produce the final list of HLUR (section 6).

In the final step (e), the final list of HLUR requirements are further analysed to more detailed user requirements (UR). Each UR is analysed according to the following properties:

- Associated HLUR: This column contains the HLUR associated with the specific user requirement.
- **Detailed description**: This column provides a detailed description of the specific user requirement.
- **Functional or Non-functional**: This column is used to identify whether a user requirement is functional or non-functional.



• **Priority based on MoSCoW framework**: The column is used to assign the priority of the user requirements according to the MoSCoW framework which provides four options of "Mo", "S", "Co", "W" standing for 'Must have', 'Should have', 'Could have', 'Won't have', respectively.

This step involves a prioritization exercise following the **MosCoW Framework**, which was proposed by Dai Chegg as part of Dynamic Systems Development Method¹. The MosCoW Framework assumes that all requirements are considered important but the prioritization method is used to establish delivery timelines of the requirements with regards to the business benefits and needs. More specifically, it considers the following categories:

- **Must Have**: Requirements labelled as 'must haves' have the highest priority in the development and delivery timeline. These are the requirements without which the program would not make sense form a business perspective and the project delivery is considered not successful.
- **Should Have**: Requirements labelled as 'should haves' are quite important but not considered as necessary as the 'Must have'. They are less time-critical and often have alternatives to fulfil their purpose in the program.
- **Could have**: Requirements with 'could have' label are mostly requirements which are desirable but not necessary. These requirements are considered to be developed in case of extra resources.
- Won't Have: Requirements labelled as 'won't have' are the ones agreed as the stakeholders as least desirable and have the lowest priority and are usually not planned in the development plans.

¹ <u>https://en.wikipedia.org/wiki/Dynamic_systems_development_method</u>

3 PUC SCENARIOS

This section elaborates on the four PUCs, as they have been already described in D7.1. It provides detailed descriptions and updated information that have been following the project's development. It presents a mock-up overview of the real life function of the expected tool following a related storyboard. Finally, it elaborates on the associated High Level User Requirements (HLUR), which have been initially defined during the 1st user workshop and extended during the 2nd plenary meeting, as well as through the continuous collaboration and discussions between the focus group members. The PUCs are therefore described with relevance to the users' needs and requirements as well as their business perspective.

Each PUC is described in a separate section with the following structure:

- **Executive summary,** which contains a brief summary of the PUC.
- **Rationale,** which describes how the PUC will exploit V4Design so as to demonstrate the system's capabilities and enlightens how V4Design could benefit the PUC's business processes.
- **Detailed description,** which provides a thorough documentation of the PUC, including the actors that are involved, along with its motivation and usability.
- **Mock-ups and Storyboards,** which dictates how the PUCs can be implemented in a real life environment and defines the actors that are involved and the use of V4Design components
- **High level user requirements (HLUR),** which have been compiled so far. They describe the special requirements of the particular PUC and the users' needs for the realisation of the PUC.

3.1 PUC1 - Architectural design, related to existing or historical buildings and sites and their environments

3.1.1 Executive summary

The pilot use case for "Architectural design, related to existing or historical buildings and sites and their environments", addresses business needs in the field of architecture professionals, practice or academic-oriented for facilitating the architectural design procedure for landscapes and buildings. It is designed to use the capabilities of V4Design so as to acquire digital models of existing architecture and related spatial elements of landscapes or buildings. The pilot will use existing content, images and/or videos from various content providers and additionally free content available on the web. This content will be used for the three-dimensional (3D) reconstructions of the general geometry and urban massing of existing places. It will be used for the generating of related spatial elements (textures, 2D patterns, natural or manmade outdoor elements, plantation, sculptures) and surrounding elements, such as facades of nearby buildings. It will also be used to retrieve textual information, related to cultural references online, data from social media and other available sources. This will assist the architectural design procedure, which will be implemented by architects and designers, both in professional and academic level.

The first PUC is articulated in two distinct scenarios, covering the described diversity of the use case in architectural design in both outdoor historical landscape areas and buildings inside historical urban sets. The two scenarios reflect the expertise and deeper knowledge of each case by the project's user partners. More specifically, first scenario (Sc.1) is mainly elaborated by user partner AUTH and second scenario (Sc.2) is mainly elaborated by user partner HdM. The two scenarios are described in the following sections.

Scenario 1 Topic: Outdoor design for an historical landscape in Delphi, Greece

The first scenario (Sc.1) of PUC 1 is addressing issues of architectural design of temporary outdoor elements that are related to the historical character of a place and the way it can influence the actual design process. Architects have to conduct a significant amount of investigation on dominating architectural and typological elements, spatial configurations and further contextual characteristics. In addition to the physical surroundings, archaeological qualities and all site-specific data available, architects also have to investigate the historical, cultural or sociological dimension of the broader context. In the selected use case scenario, we are addressing the broader area of the historical site of Delphi, Greece (Figure 2). The V4Design platform will be used to help architects in the reconstruction of the surrounding landscape and the various spatial elements that articulate it. Further on, V4Design will support the designing of open-air infrastructures, such as pavilions, land-art elements and scenography arrangements for the broader area of the historical site of Delphi and its urban part. Design proposals might include temporary infrastructure for drama and theatre plays, outdoor events, accessibility solutions, pedestrian pavements, outdoor furniture, etc.

All these elements will be articulating tasks assigned to academic environments inside the School of Architecture of Thessaloniki, AUTH. Design approaches might initially vary over a scale from the very conceptual to the very realistic. Further on, design proposals can be informed by actual needs expressed by local authorities and used for possible realistic design projects in the urban area of Delphi. Alternatively, proposals might address programs not actually located in the area of Delphi, but inspired by it, e.g. scenography solutions for theatre plays elsewhere, etc.



Figure 2: Aspect of Delphi landscape²

² <u>https://www.youtube.com/watch?v=jvcA3PMUiT4</u>



Scenario 2 Topic: Concept design for a new building in central Berlin, Germany

The second scenario (Sc.2) of PUC1 is modelled after a typical design process which an architecture studio undergoes when developing a concept and delivering a design project in the early stages design. In early phases, designers usually spent a lot of time on gathering information about the project's context. In addition to the physical surroundings, infrastructure and any site-specific data, architects will also research in other fields such as the historical, cultural or sociological dimension of the projects context.

In this scenario, the V4Design tool will be used to help architects in the reconstruction of the surrounding space and its specific spatial elements. Further on, this scenario will illustrate how V4Design tools can support the design process of an entirely new design on a given plot.

As an example and showcase, we have chosen a real-world scenario of a site in central Berlin, Germany. More specifically, a plot at the Kulturforum (Figure 3), a collection of cultural buildings in Berlin was chosen. HdM is currently working on a professional commission to design a new building for the Neue Nationalgalerie (Figure 4) – Museum des 20. Jahrhunderts (New National Gallery – Museum of the 20th Century). The building is located on an urban plot, placed between the iconic building of the Neue Nationalgalerie (designed by Mies van der Rohe in 1968) and the Berlin Philharmonic Concert Hall (designed by architect Hans Scharoun, in 1960).

The prominent location comprising several architectural landmark buildings, large scale artworks and sculptures, as well the eventful urban history of Berlin will provide a multitude of existing content to work with.



Figure 3: Kulturforum **Berlin**, Germany: Kammermusiksaal (left) and Philharmonie³(right)

³ <u>https://de.wikipedia.org/wiki/Berliner_Philharmonie</u>





Figure 4: New national gallery in Berlin⁴

3.1.2 Rationale

V4Design aims to develop technologies to extract digital assets from existing images and video data, related to both historical and contemporary settings. A data repository of digitalised image and video content is provided by partners of the consortium (Europeana, Solaris film production and Artfilms). It constitutes a promising source for the V4Design platform to demonstrate its capabilities. There is a need for applications that can support architects and designers, in both professional and academic environments, to improve the efficiency of workflows and to find novel strategies to design. The V4Design tool will be a tool, which can be handled intuitively and allows designers to quickly browse and repurpose footage from existing video content and other archives.

The pilot intends to validate the following system characteristics:

- To extract 3D assets from video archive material, as well as from other available footage
- To extract patterns and textures from 2D image material
- To support the design procedure as part of the architects' task
- To access semantic information, available from online sources

PUC1 Scenario1

In this scenario, the V4Design authoring tool will be used to help architects and students of architecture in the design process, during academic activities. They will have access to digital reconstruction of outdoor spaces, both natural and manmade, reconstructed 3D models of topography, 3D models of ancient ruins and related architectural sub-elements (roofs, walls, columns, etc.), 3D models of local flora (logs, trees etc.). The tool will also produce 2D geometry of patterns, colour palettes and colour codes from related images and artworks, shape grammars, material library, textures (grains, mosaic, emboss, engravings etc.) and

⁴ https://gr.pinterest.com/pin/542050505127914434/?lp=true

metadata of related texts (ex. most visited areas of the site, texts by social media, online reviews etc.). PUC1 Sc.1 will showcase how V4Design can be used to facilitate the procedure of collecting all sources necessary in order to articulate coherent design proposals.

PUC1 Scenario 2

In this scenario, the V4Design tool will be used to help architects in their initial steps in the digital reconstruction of the surrounding space and its specific spatial elements when approaching a new design task. Further on, this PUC1 Sc.2 will illustrate how V4Design tools can support the design process of an entirely new design on a given plot. At last, PUC1 Sc.2 will showcase how V4Design can be used to facilitate the labour intense creation of design documentation and communication material.

3.1.3 Detailed description

Today there is growing demand to preserve the built environment in world heritage sites, not only physically, in the analogue world, but also digitally, so as to store and transcribe information about the built world heritage. It is important to understand the built environment inside and outside cities as an ever-changing landscape which society constantly shapes. Architects and designers intervene in the built environment with their work, so they have to carefully take the surroundings, either manmade or natural landscapes, under serious consideration in their design. Therefore, they rely strongly on precise records of the built and surrounding environment, increasingly using 3D digitization and modelling in recent years. Architects need to have accessibility to all the relevant data and information about existing historic building and the surroundings. Moreover, they need to be able to access all necessary digital tools that will facilitate the design procedure and make it more time effective and productive.

Architects, designers and artists frequently gather information and repurpose existing digital media or data in order to about the subject they study. This information is mostly unstructured data and supplied in raw format. However, architects could largely benefit from a tool that will have access to various sources, and that will make available information in an easy and fast way.

Academic partner (AUTH) and the architectural office (HdM) will use advanced modelling software 'Rhinoceros3D' as an authoring tool to extract usable content from the given sources. The V4Design tool, as a plugin software tool to Rhinoceros3D, shall then help to generate 3D models of different scales, (landscape-, urban-, building- and object-scale) e.g. to reconstruct 3D models of landscape and topography, (historical) buildings and architectural elements like columns, roofs etc.

Initial decisions about PUC1 and PUC2, as they have been described in the project proposal, have been elaborated through the procedure of initial testing, that is described as follows: First, architects (academic related) AUTH and the professional architectural office HdM discussed and defined the topics of PUC1 scenarios 1&2. A list of relevant keywords has been generated, related to the selected cases, in order to facilitate the search within databases. Content providers (Europeana, Artfilms and Solaris film production) used the list of relevant keywords, so as to effectively search into their archives of images and videos and the material repositories. The search for material has produced a list of available material, images and videos, which has been properly classified. Available material has been enriched



by free video sources found online, through appropriate sharing licences (creative commons). Initial testing (Figures 5, 6, 7) for 3D reconstruction has been made with available visual material so as to conduct a quick test with the 3D generating procedure of spaces and spatial elements. After receiving satisfactory 3D output, the content providers have conducted extensive searches through their databases and collected visual and video material for this PUC, both for scenario 1 and scenario 2. Following the production of the software tool prototype, we can move on to actual parts of the design procedure and do the tool testing for the selected sites, as described in the DoA of the project.



Figure 5: Delphi –Initial testing





Figure 6: Delphi –Initial testing



Figure 7: Delphi –Initial testing



3.1.4 Mock-ups and storyboards

Scenario 1 Topic: Outdoor design for an historical landscape in Delphi, Greece



Figure 8: Delphi Landscape⁵

PUC1 Sc.1 will try to facilitate the design procedure followed by architects and students of architecture, within academic environments. It will provide necessary material and information related to selected contexts (3D, 2D and textual), so as to be able to analyse the context more effectively. This material includes reconstructed models of outdoor spaces, both natural and manmade, reconstructed 3D models of topography, ancient ruins and related architectural elements (columns, capitals, shafts, bases etc.), local flora (logs, trees etc.) (Figure 8). It also includes two-dimensional geometry of patterns (Figures 9, 10), colour palettes and colour codes from related images, material library, textures and other metadata of online sources.

Students of architecture and architects in academic environments (AUTH) will be assigned the task to make proposals for outdoor temporary installations (pavilions, land-art elements, and scenographic installations) for the greater area of the historical site of Delphi, Greece, and its urban part e.g. temporary infrastructure for drama and theatre plays, outdoor events, accessibility solutions etc.

They will use V4Design in order to find related material for research upon the topic. They are going to need information (3D, 2D and textual) of local natural and cultural environment and the topography (Figures 11, 12) in order to examine the possibilities of the site of intervention.

V4Design will be used to support the design procedure and make it more effective. Also it will be used to produce all the necessary material to better communicate their design proposals. The output from the tool is going to be used to produce 360° Images, animations,

⁵ <u>https://www.youtube.com/watch?v=jvcA3PMUiT4</u>



rendering, VR Scenes, final proposal explanatory texts and analysis etc., images and other visual content.



Figure 9: 3d texture of Omphalos of Delphi⁶



Figure 10: Acanthus column with dancers Delphi⁷

⁶ <u>https://docplayer.net/48264940-Cloudcompare-3d-arch-2017.html</u>

⁷ https://docplayer.net/48264940-Cloudcompare-3d-arch-2017.html





Figure 11: the dense point cloud of part of the theatre (about 120 million points measured⁸



Figure 12: Orthophotograph of the main archaeological site⁹

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https://www.researchgate.net/publication/321022714 Delphi4Delphi Data Acquisition of Spatial Cultural Heritage Data for Ancient Delphi Greece/figures?lo=1

⁹

https://www.researchgate.net/publication/321022714_Delphi4Delphi_Data_Acquisition_of_Spatial_Cultural_ Heritage_Data_for_Ancient_Delphi_Greece/figures?lo=1



Scenario 2 Topic: Concept design for a new building in central Berlin, Germany

PUC1 Sc.2 will illustrate some of the typical actions undertaken when approaching the design of a new building. V4Design is going to assist in providing necessary material and information (3D, 2D and textual) to analyse the site of intervention and its context. This includes the layout of the urban fabric, the geometry and materiality of adjacent buildings and prominent site-specific elements, which need to be, represented in the architect's 3D model, like vegetation, street furniture or art pieces.

It will facilitate the presentation and visualization of the proposal with its characteristic materials and a variety of design options. The output produced by the design team is going to be a multitude of media such as diagrams, photo-realistic visualizations, 360° Images, animations, VR scenes, explanatory texts and analysis, other visual content.

For those uses, individual case studies will be shown from a variety of office projects to illustrate the relevance of such tasks in professional practice. Additionally we will use a generic design project as digital mock-up to elaborate more on certain workflows.

One example of a real-world application is HdM's commission to design a new building for the New National Gallery (Figure 13) – Museum of the 20th Century in Berlin, Germany.

Here we will compile a 3D model of the entire area, featuring the notable adjacent buildings in necessary level of detail. We will add high-quality 3D models of prominent art pieces to achieve VR scenes from significant viewpoints around the building.



Figure 13: Henry Moore, The Archer, 1964, Germany, Berlin, outside Neue Nationalgalerie¹⁰

V4Design make available a library of photographic textures (Figure 14) to quickly study the materiality of building components in various options.

¹⁰ Photography © Andreas Praefcke, Wikimedia Commons





Figure 14: Collection of 2D brick textures

3.1.5 High level user requirements

Based on the aforementioned use case the following user requirements have been elicited.

HLUR	HLUR Title	HLUR Description
HLUR_1.1	Extraction of 3D models	Architects and designers can extract 3D models of places, buildings and objects out of videos and images of buildings, landscapes, artworks or sensitive space elements.
HLUR_1.2	Extraction of CG assets	Architects and designers can extract 3D textures, computer graphics (CG) materials from 2D images of buildings, landscapes, artworks or sensitive space elements.
HLUR_1.3	Architectural design tool to form innovative ideas	Architects and designers have a tool that can assist in formulating new, innovative architectural ideas
HLUR_1.4	Multiplicity of assets	Assets can be 3D objects, 2D videos/images, textual information, audio etc.
HLUR_1.5	User interaction and control	Architects and designers will be able to access the 3D assets (3D models, point clouds, Meshes) in a 3D environment and they will be able to edit and manipulate them.
HLUR_1.6	Extraction of 2D assets	Architects and designers can extract 2D patterns of artworks and culturally sensitive space elements in editable vector format
HLUR_1.7	Asset accessibility and searching refinement	Architects and designers can have access to a variety of extracted assets and have the ability to filter and refine their search results.
HLUR_1.8	Related and suggested assets	Architects and designers can have access to a variety of other related or suggested assets to the asset they are working on.

Table 1: HLUR extracted from PUC1



3.2 PUC2 - Architectural design, related to artworks, historic or stylistic elements

3.2.1 Executive summary

Scenario Topic: Exhibition elements on East Asian, Japanese Visual Culture

The pilot use case for "Architectural design, related to artworks, historic or stylistic elements" addresses business needs in the field of architecture professionals, practice or academic oriented, to have the architectural design procedure for interiors and related small-scale objects facilitated. It is designed to use the capabilities of V4Design for assisting the design process for interior and exterior spaces, related to artistic, historical and cultural heritage of Japan and East Asia and their visual representations. It will be used for acquiring digital models of stylistic interest, culturally sensitive, of existing architectural settings. The pilot will use existing content, images and/or videos from various content providers and additionally free content available on the web. This content will be used for the 3D reconstructions of small-scale elements, furniture, textures, and industrial objects. This will assist the architectural design procedure, which will be implemented by architects and designers, both in professional and academic level, as they are represented among the user partners of the project.

The selected scenario reflects the expertise and interest of the project's user partners, as well as needs related to focus groups. More specifically, user partners AUTH and HdM will mainly elaborate this scenario.

Design approaches might initially vary over a scale from conceptual to realistic. Further on, design proposals will be informed by actual needs defined by user partners. Certain parts and elements of the design proposals will be fabricated and prototypes will be evaluated within the evaluation procedure and related events, according to the project's DoA.

3.2.2 Rationale

The V4Design tool will use 2D media and 3D models of elements related to East Asian and more specifically Japanese visual culture. This may be visual material about calligraphy (Figure 15), traditional textiles, fabrication techniques and cultural rituals. It may also include images and 3D models of local flora (logs, trees etc.), or specific architectural small-scale elements (furniture, equipment, etc.). The tool will make available 2D geometry of patterns, colour palettes and colour codes from related images and artworks, shape grammars, material library, textures (grains, mosaic, emboss, engravings etc.), metadata of related texts (ex. texts by social media, online reviews etc.)

V4Design aims to develop technologies to extract 3D models of small-scale elements, from images and video sources. Therefore, the data repository of content providers, partners of the consortium (Europeana, Solaris film production and Artfilms) constitutes a good source for the V4Design platform to demonstrate its capabilities. There is need of applications that can help the architects and designers to find new ways to organise more effectively and productively the designing procedure. The development of V4Design gives them an easy-to-use tool to develop such applications, repurpose existing documentaries and re-use their archived footage.

TE P I 昭 Ŧ E JEL

Figure 15: Japanese Calligraphy¹¹

The pilot intends to validate the following system characteristics:

- Extract 3D assets from video archive material, as well as from other available footage.
- Extract patterns and textures from 2D image material.
- Support the design procedure as part of the architects' task.

3.2.3 Detailed description

There is high demand, nowadays, for visual representations of objects, with a clear intention to explore and create new forms and designs. Those concepts may be motivated by the interpretation of a certain art period and reflect any of its stylistic attributes, or any other

¹¹ <u>https://en.wikipedia.org/wiki/Japanese_calligraphy#/media/File:Gakkiron_1.jpg</u>



properly articulated design principle (e.g., well-defined local variations, surface appearance characteristics such as colour, decoration and texture – leading to stylistic classifications). In this use case scenario, architects, designers and artists are given the opportunity to reinterpret key aspects of artworks and produce designs and objects (e.g. furniture collections, decorative objects, lighting accessories, etc. - see Figure 16) that are original but at the same time stylistic and historically charged. Architects need to have accessibility to all the relevant data and information about existing culturally located material. Moreover, they need to be able to access all necessary digital tools that will facilitate the design procedure and make it more time effective and productive.



Figure 16: envisioned interior spaces of Museum M+ designed by Herzog & de Meuron, HongKong¹²

Architects, designers and artists often use digital files to search existing data to examine environments associated with stylistic and culturally sensitive settings. These files are usually disorganized, with no direct access to them. An additional difficulty is the fact that this data exists only in image format, and not in 2D or 3D models in manageable and editable formats. However, architects need a sophisticated tool that will have access to 2D and 3D digital media referenced to certain stylistic frames, and that will provide information and data in an easy and fast way.

Academic partner (AUTH) and the professional architectural office (HdM) will use the authoring tool to extract and reconstruct 2D and 3D models of small scale elements, belonging to specific cultural end stylistic frames (Figure 17), from video sources and images. The V4Design tool will also reconstruct and generate models of small-scale objects and related interior spaces, using point clouds of related environments, 3D models of small-scale architectural elements (furniture, equipment, space partitions, tapestry, etc.).

¹² Herzog & de Meuron, HongKong





Figure 17: Japanese Calligraphy¹³

In the initial stages of developing this PUC, the procedure that has been followed is described as follows: First, architects users academic partner (AUTH) and the professional architectural office (HdM) discussed and defined the topics of PUC 2. They generated a list of related keywords, related to the selected cases. Content providers (Europeana, Art Films and Solaris film Production) used the list of relevant keywords, so as to effectively search into their archives of images and videos and the material repositories. The search for material has produced a list of available material, images and videos, which has been properly classified. Available material has been enriched by free video sources found online, through appropriate sharing licences (creative commons). Initial tests have been made so as to move towards the reconstruction of small scale elements.

After a successful initial testing, the content providers have collected visual and video material for this PUC. Following the production of the software tool prototype, we can move on to actual parts of the design procedure and do the tool testing for the selected sites, as described in the DoA of the project.

3.2.4 Mock-ups and storyboards

Scenario topic: Exhibition elements on East Asian, Japanese Visual Culture

Designers are commissioned to design the interior and specific elements for an exhibition space, (inside a museum project designed by HdM), so as to host a temporary exhibition on Japanese visual culture and calligraphy. The project team responsible for the task (HdM and AUTH) will use the V4Design tool in order to find relevant visual material, which can be used in the design process. They are going to accumulate information (3D, 2D and textual) related to the brief, in order to facilitate the process to design elements for the exhibition space. The scope of design includes furniture and exhibition partitions as well as signage and lighting fixtures. The creative team will use V4Design to browse for elements related to Japanese or Far East Asian culture and experiment with them (Figure 18). V4Design will be used to support the design process by making content (2D & 3D) available to the designer within his design authoring software (Rhinoceros3D).

¹³<u>https://www.japantimes.co.jp/culture/2018/02/06/arts/openings-outside-tokyo/wang-xizhi-japanese-calligraphy/#.W63eVWgzaUI</u>





Figure 18: interior spaces of Volkshaus Basel, designed by Herzog & de Meuron, Basel, Switzerland, Seventeenth century etchings have been transferred to the wallpaper used in the antechambers of the restrooms, thus establishing a link with Basel in the days of the former medieval manor¹⁴

They are going to use output from 3D, 2D and textual analysis in order to further develop design options for physical prototypes and potentially further developed design products and additional visual material to shape their proposal and communicate it to the public. The output produced by the design team is going to be a multitude of media such as diagrams, photo-realistic visualizations, 360° Images, animations, VR scenes, explanatory texts and analysis, other visual content. Prototypes of this design process will be fabricated and evaluated through the activities of the evaluation procedure, which is described in the project's DoA.

3.2.5 High level user requirements

Based on the aforementioned use case t	he following user r	requirements have	been elicited.
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HLUR	HLUR Title	HLUR Description
HLUR_2.1	Extraction of 3D models	Architects and designers can extract 3D models of places, buildings and objects out of videos and images of buildings, landscapes, artworks or sensitive space elements.
HLUR_2.2	Extraction of CG assets	Architects and designers can extract 3D textures, cg materials from 2D images of buildings, landscapes, artworks or sensitive space elements.
HLUR_2.3	Architectural design	Architects and designers have a tool that can assist in

¹⁴ Photography ©Adriano A. Biondo



	tool to form innovative ideas	formulating new, innovative architectural ideas
HLUR_2.4	Multiplicity of assets	Assets can be 3D objects, 2D videos/images, textual information, audio etc.
HLUR_2.5	User interaction and control	Architects and designers will be able to access the 3D assets (3D models, point clouds, Meshes) in an 3D environment and they will be able to edit and manipulate them.
HLUR_2.6	Extraction of 2D assets	Architects and designers can extract 2D patterns of artworks and culturally sensitive space elements in editable vector format
HLUR_2.7	Asset accessibility and searching refinement	Architects and designers can have access to a variety of extracted assets and have the ability to filter and refine their search results.
HLUR_2.8	Related and suggested assets	Architects/Designers and game developers can have access to a variety of other related or suggested assets to the asset they are working on.

Table 2: HLUR extracted from PUC2

3.3 PUC3 - Design of virtual environments, related to TV series and VR video games architectural design, related to artworks, historic or stylistic elements

3.3.1 Executive summary

The PUC concentrates on a business need based on new market segments to develop games/applications in VR environments from 3D objects extracted from different entertainment, eLearning TV-shows and other video content. The PUC will develop a game based on an environment coming from video footage currently in DW archives. The footage would mostly be from the telenovela called 'Nicos Weg' and the game planned would include the environments and exercises inspired from the Telenovela (Figure 19).



Figure 19: Nicos Weg PUC



3.3.2 Rationale

The components of V4Design includes the NURO Authoring tool which will be capable of developing 3D environments for use in VR games from the models extracted by V4Design. The particular PUC will demonstrate V4Design ability to extract 3D models and textual analysis from archives of DW and other content providers. The PUC uses the following features of V4Design platform:

- 1. To be able to extract smaller 3D objects
- 2. To be able to extract textures of walls
- 3. To be able to create 3D environments for use in VR games
- 4. To be able to easily modify how the game environment interacts with assets
- 5. To be able to drag and drop 3D models

3.3.3 Detailed description

A telenovela is a limited run television drama or soap opera. Telenovelas or TV shows are usually surrounded around a particular environment. Fig 20 and 21 represent, the famous TV show Friends¹⁵ was surrounded around the Cafe and their apartment respectively.



Figure 20: Apartments from FRIENDS¹⁶

¹⁵ <u>https://www.imdb.com/title/tt0108778/</u>

¹⁶ https://www.imdb.com/title/tt0108778/





Figure 21: Apartments from FRIENDS¹⁷

To create a game surrounding the TV series, it would be important for the game creators to create a similar environment inside the game scene to give an exciting game play and include smaller 3D models such as tables, sofas and kitchen equipment. V4Design can help in faster development of such environments and to prove this capability, we plan to demonstrate several scenarios with Nico's weg, a telenovela from archives of DW. The following scenarios are designed by NURO to be implemented inside the games as levels:

When a pre-existing video telenovela is adapted to a new medium, the 'adapter' will encounter different challenges – especially when the company is a not tech-savvy person. This is where V4Design and its components come into play. In this PUC we work in developing a 3D environment for a VR based game that can be developed by a production company with little knowledge. The game will contain various different levels of language learning based on the episodes of "Nicos Weg" and storyline behind the episodes. Each level is a different scenario of the use case.

Example Scenario 1: Vocabulary learning inside an apartment

In this scenario, the environment will be from apartment where Nico lives in, in the telenovela. The environment will contain various smaller assets that are present inside the apartment that the user can move around. The scene starts in apartment's living room and the user is able to interact with various assets (small objects). As soon as he/she comes near an object or points inside the environment, there is information displayed about the object along with the ways it is identified in different languages, so the user can relate to it in German language. Once the user has interacted with the objects inside the living room, he will have the option to move to a different room after passing a small quiz near the door to test his learning and knowledge based on the interactions inside the room. Similarly, during the scenario the player is able to explore the entire apartment.

¹⁷ <u>https://www.imdb.com/title/tt0108778/</u>



The apartment's walls will have the similar textures as Nico's apartment (Figure 22) in the telenovela, which will be extracted using V4Design components, the environment using the authoring tool and the quizzes will be created using an easy to use interface inside the authoring tool. The information about the smaller assets will be extracted from V4Design and downloaded from other asset libraries.



Figure 22: Grocery items inside the video archives of Nicos Weg The following scenario can be adapted to specific topics in vocabulary learning such as food items, household items, grocery items, entertainment items etc.

Example Scenario 2: Interaction with other people inside the apartment

In this scenario, a similar environment like previous scenario will be generated to develop a gameplay of the level where the player has to interact with other flatmates/characters based on Nico's flatmates. The interaction (Figure 23) will consist of basic conversation in German, along with the ability of the player to also view the conversation in their native language. The player will then have to complete a quiz/exercise to move to a different room and talk to a new character.





Figure 23: Interaction with other people in the telenovela **Example Scenario 3: Interaction with random people and objects in an open environment**

This scenario will work in development of an open 3D environment (Figure 24) using the authoring tool with various 3D objects and assets from the V4Design repository as well as other asset sources and databases. The player will be able to interact with the assets and create a storyline and information for the object that the player will see inside the scenario. The player will be able to walk around and interact with assets which can be objects or characters based on the developer.



Figure 24: Market Scene in the telenovela


3.3.4 Mock-ups and storyboards

DW (a production company) with a successful language learning telenovela would like to develop a more immersive experience for its audiences in a new vertical as this would help them in acquiring more users/viewers. They would like to not hire a team with special skills to develop such a game, therefore they would like to use what can help them in creating such an experience at a low cost with using a tool like V4Design to develop the environments and the assets from their video archives.

The production company can then use V4Design's authoring tool and other components to create such an experience. Firstly, the platform takes in the video footage from the archives and develops 3D assets of the objects inside the videos wherever possible, extracting also other features such as textual information, characters etc. to be used in the VR environment. Following this, V4Design's authoring tool gives the ability to easily create this environment as a game component and export the game with Unity game Engine to various App stores.

3.3.5 High level user requirements

HLUR	HLUR Title	HLUR Description
HLUR_3.1	Multiplicity of assets	Assets can be 3D objects, 2D videos/images, textual information, audio etc.
HLUR_3.2	Related and suggested assets	Game developers can have access to a variety of other related or suggested assets to the asset they are working on.
HLUR_3.3	Immersive educational environment	The student finds her-/himself in an environment, where she or he can study by watching a 2D video (= episode of Nicos Weg) and do the corresponding exercises with a clear and comprehensive UI and gameplay that meets the requirements in regard to language learning didactic.
HLUR_3.4	State of the art gameplay	Game developers envision state of the art gameplay (with gaming elements) that takes place in three dimensional environments inspired by 2D content (Nicos Weg)
HLUR_3.5	Avatar Extraction	The components should also be able to extract the following: (i) Avatar, structure, etc. from DW telenovela; (ii) Avatar, structure, etc. from non-DW footage
HLUR_3.6	Tool for Language related Game Design	Game developers would like to have a tool that can assist in the design of new, immersive VR environments for language learning purposes

Based on the aforementioned use case the following user requirements have been elicited.

 Table 3: HLUR extracted from PUC3

3.4 PUC4 - Design of virtual environments, related to actual news for VR (re) living the date

3.4.1 Executive summary

One of the most popular use cases of VR is creating experiences from locations and dates to help people gain experiences that previously were not possible - this accounts especially for



media organizations. Creation of such experiences into an immersive environment has always been a problem for developers due to the lack of tools to facilitate the process. V4Design will help to solve the issues faced by creating specific tools - deployed through the gaming authoring tool - to create an interactive, immersive documentary. The pilot will use the existing content from various content providers, as well as look into new content that has been captured of a particular scene.

Over the course of the first months of the V4Design project we developed two scenarios that will be applied.

Scenario 1 topic: Gendarmenmarkt

The Gendarmenmarkt is a Berlin square (Figure 25) originating from 1688 and features the Konzerthaus (concert hall), the French and German Churches, and a statue of Friedrich Schiller in the centre, among others. Much of it has been destroyed during WWII and is reconstructed by now. It is a great example of a place that has changed itself over time to tell reliving stories by travelling through time.

Scenario 1 served as a blueprint pilot, which has been actively implemented during M5 and M6. Due to the test results (Figures 26, 27, 28, 29) more accurate requirements were derived. This scenario also provided a better understanding of what kind of archive footage suits best for the pilot's and project's primary goals. The test results are reflected in Scenario 2, which will be the focus of PUC4.





Figure 25: Gendarmenmarkt Square



Figure 26: Gendarmenmarkt Square





Figure 27: Gendarmenmarkt Square



Figure 28: Gendarmenmarkt Square





Figure 29: Gendarmenmarkt Square

Scenario 2 topic: Bauhaus, Dessau

2019 marks the 100-year anniversary celebrated by curating the Dessau Bauhaus buildings (Figure 30) as a common ensemble. Thus it will be a relevant topic of reporting about architecture, art, and history, and a perfect fit for reliving the date. This offers an opportunity for the V4Design project to capture optimized material for the use case to further build on what has been learned from Scenario 1 already. As for Scenario 2 we will integrate a timeline and enrich the virtual environment with interactive elements with the result that the end-user will experience an immersive documentary on different levels.

Figure 30: Bauhaus Dessau¹⁸

¹⁸ <u>https://www.bauhaus-dessau.de/de/architektur/bauhausgebaeude/das-bauhausgebaeude.html</u>

3.4.2 Rationale

V4Design aims to develop technologies to extract 3D models from video and/or image sources; therefore, the data repository of DW and other content providers as well as further accessible digital media libraries will demonstrate the platform's capabilities. Companies such as DW are looking forward for applications that can input various video footage and B-roll to be reused within the development of interactive documentaries and other VR environments. Hence, the processes and technologies developed and established over the course of the V4Design project aim to provide an easy-to-use application to create such VR documentaries that are among others based on archived footage.

The pilot intends to validate the following system characteristics:

- To deliver a VR environment using the authoring tool
- To extract 3D assets from the archive as well as other available footage
- To be able to use search inside V4Design database for assets
- To be able to create multiple 3D environments in one application.

3.4.3 Detailed description

Media companies, such as Deutsche Welle, have great collection of archives, where – among others - video footage is stored. Nowadays, audio-visual material is used multiple times for different channels – for TV, online publishing and Social Media. What if journalists want to add another medium and create an immersive, journalistic piece? In journalism everything is about the stories that are told, the content is core, nevertheless, the representation of it is almost equally important as the medium carries the story. Once the journalists decide on a topic they want to cover in their interactive and immersive VR experience in the form of a documentary (the journalists want their audience to not only learn about a topic but also experience the story), they look into storytelling aspects. This includes finding adequate video footage that suits the requirements, meaning it can be converted to actual 3D content or that is already part of the V4Design library. The interactive documentary needs a "starting environment" on which the story is based; in this case it can be footage of a square, such as Gendarmenmarkt (Berlin, Germany) (Figure 31), or an iconic building, such as Bauhaus (Dessau, Germany). In accordance with the overall story the journalists will pick 3D assets and decide on interactive elements, such as a timeline, to enrich the starting material and build the actual story. That is where the gaming-authoring tool comes into play.

Figure 31: Various buildings at Gendarmenmarkt Square

The idea of Virtual Urban Simulation (VUS) has become more relevant due to the increase in the adaptability and decrease in the cost of VR devices as a simulation tool. Various new uses for these simulations have arrived in the past few years. This pilot brings a previously untouched use of these devices and the methodology for VUS design for developers.

The current production process of development on VUS includes three major steps:

- Data Collection
- 3D Modelling
- Presentation

The pilot targets all the steps of the production process and how V4Design can help transform the production process with better and faster results.

3.4.4 Mock-ups and storyboards

DW (as a production company) wants to develop an interactive and immersive documentary using the existing footage they have from various news and locations. They have in-house software engineers who have a basic knowledge of the video game engine Unity and designers as well as dedicated journalistic storytellers. As for every production, the team will decide on a storytelling approach and create a storyboard. After the preparation, V4Design comes into play: The DW team feeds the relevant video footage inside V4Design's non-

semantic database so that the software engineer can start the loop in V4Design to extract 3D Models and textual data using the metadata of the videos.

Once the 3D environment is extracted in the backend tool of V4Design, using the authoring tool developed on top of Unity, the software engineer can import it into their scene and the authoring tool will be able to setup a camera location, which will help in development of one piece of the interactive documentary intended. Similarly, the software engineer can import assets from various times and locations to create a story that they would like to tell and develop it into a timeline or automated scenes for the VR Application.

The engineer can directly view it using the Unity's player to deploy it to various devices using the predefined templates in the Unity application.

The Bauhaus scenario extends the workflow of the Gendarmenmarkt scenario as such, as there is a wide range of assets and materials provided via Europeana leading from the Biedermeier epoch into the modern 20th century architecture and design that can be incorporated into creating a compelling VR experience. From the additional material provided by shooting new video and 360° material, V4Design will be extended with a new range of archetypes, allowing to also integrate principles of "Bildnerische Gestaltungslehre."

DW editors will at first gather sets of Biedermeier images, models and textures through V4Design. They can search the database for objects or styles that resemble the provided samples. The content curator will then provide existing and new material on Bauhaus with exterior and interior shots to the 3D extraction processing engines of V4Design. The resulting 3D model can then be used as an environment for a VR experience to relive the origin of Bauhaus into modern times.

DW's engineers will then turn the building models and individual assets into several relive the date stories - from exterior perspectives and surroundings into interior scenes that showcase the progress of art and styles. Hence, as for the first iteration of Gendarmenmarkt Scenario, the Bauhaus-Scenario will enable the end-user to travel through time. For this the user will apply various technologies developed over the curse of the project and integrated into the gaming engine, such as adding textual information to the virtual environment, applying mashes to objects, changing atmosphere etc.

Figure 32 and Figure 33 display the transformation that the end-user will experience while traveling through time, in this case into the past. Bauhaus and Biedermeier are two periods originated in Central Europe that reflect the political and societal condition of their time and convey different feelings. We will use this link to not only create an immersive documentary about an architectural and design period but to make this time experienceable. (A) and (D) demonstrate the tremendous differences of both periods in their perception of architecture and interior design as also reflected in (B) and (C) showing chairs of both periods.

Figure 32: Experiencing different architectural and societal periods by traveling through time. (A)¹⁹ and (B)²⁰ represent Bauhaus, C)²¹ Biedermeier

 ¹⁹ <u>https://www.bauhaus-dessau.de/bilder-des-bauhauses-3.html</u>, derived September 10th, 2018
 ²⁰ <u>https://www.bauhaus-dessau.de/bilder-des-bauhauses-3.html</u>, derived September 10th, 2018
 ²¹ <u>https://www.antik-</u>

hense.de/index.php?option=com_mijoshop&route=product/product&product_id=3825&search=stuhl&categor y id=35, derived September 10th, 2018

Figure 33: Experiencing different architectural and societal (D)²² Biedermeier.

3.4.5 High level user requirements

Based on the aforementioned use case the following user requirements have been elicited.

HLUR	HLUR Title	HLUR Description
HLUR_4.1	Multiplicity of assets	Assets can be 3D objects, 2D videos/images, textual information, audio etc.
HLUR_4.2	User interaction and control	Game developers will be able to access the 3D assets (3D models, point clouds, Meshes) in an 3D environment and they will be able to edit and manipulate them.
HLUR_4.3	Extraction of 2D assets	Game developers can extract 2D patterns of artworks and culturally sensitive space elements in editable vector format
HLUR_4.4	Related and suggested assets	Game developers can have access to a variety of other related or suggested assets to the asset they are working on.
HLUR_4.5	Multiple environments	Ability to develop multiple environments for the same scene and change them using scrollbar.
HLUR_4.6	Data about the initial asset	Get data about the video that an asset is extracted from

²² <u>http://decorall1.blogspot.com/2016/08/biedermeier-interior-design-comfortable.html</u>, derived September 10th, 2018

HLUR_4.7	Tool for	History	Game developers would like to have a tool that can assist in the
	related Game I	Design	design of new, immersive VR environments for reliving a significant
			past event

Table 4: HLUR extracted from PUC4

3.5 User interaction: A possible V4Design GUI

Based on the requirements and insights gathered through the market analysis and the expert interviews, a first draft of a possible user interface was sketched (Figures 34, 35). After preliminary discussions with the technical partners, these sketches were then transformed into the following mock-ups, representing a first possible interface view but mainly reflecting the workflow users can follow. To avoid any doubts, these mock-ups are much less an example of how the final system should look like but more a tool to demonstrate the typical workflow of an end user. To this end, the following sections present mock-up interfaces of key information types, searching and filtering functionalities provided by the interface. The focus is manly given on PUC1's context, e.g. what assets the users can see, however, the workflow logic is similar to the other use cases as well.

Figure 34: Initial diagram for search functionality

selected object:

Figure 35: Initial diagram for search functionality

V4Design platform offers the user multiple options to search about items: using keyword, type, location, date, example or advanced search method (Figure 36). All of these methods are described in the following sections.

V 4 d e s i g n		_ 🗆 >
Keyword 🔻	Type a keyword	9
Keyword		
Туре		
Location		
Date		
Example		
Advanced		

Figure 36: The available search options

Search by keyword

In this search type, the user types a keyword, and the platform suggests relevant terms using autocomplete function (Figure 37). If the user selects a general term e.g. theatre, the search results include many relevant items (Figure 38, 39, 40, 41, 42, 43)

V4design		_ 0
Keyword 🔻	theater	Ø
	theater	
	theater of Epidaurus	
	theater of Delphi	
	theater of Dionysus	
		\

Figure 37: Search by keyword option

PUC2: autocomplete function

Keyword	chai	Ø
	chair	
	rocking chair	
	swivel chair	
	director's chair	
		[···

Figure 38: Search by keyword option

V 4 d e s i g n			_ 0
Keyword 🔻	theatre		Ø
Previous search	and the second s		
	Marken Milling	A the state	
		A REAL PROPERTY OF	
Director's shair	tin the		
[classic/exterior], Los	Ancient theater of Epidaurus	Ancient theater of Delphi	Ancient theater of Dionysus
★ 7,3 10 views 8	[exterior space], Epidaurus,	[exterior space], Delphi,	[exterior space], Athens,
uses	* 8.2 [100 views] 20 uses	€ 8 5 1 1 20 views 1 45 uses	★ 6.1 [10 views] 3 uses

Figure 39: Search results example

Figure 40: Search results

Figure 41: Search results example

Misc	▼ Th	- Period of time -	
	Thessaloniki, Greece Thermi, Greece Thasos, Greece		

Figure 42: Search results example

Misc V Thessaloniki, Greece	- Period of time -
	Ancient Byzantine Modern

Figure 43: Search results example.

When the user selects a specific item e.g. Ancient theatre of Delphi, the platform directs him to a page with more information about this item including subcomponents of this item, related assets and some general information about it (Figure 44, 45, 46). More information about this item can be found by clicking "More info" button (Figure 47), while user reviews can be found by clicking the "reviews" tab (Figure 48). In this tab the user can also add a new review about the selected item.

PUC1: information

Keyword Ancient theater of Delphi		Ø
Information	Reviews 1	
and the second second	Location 38,482497 22,500692	
	Source	
	Resolution	
	Tileable No	
Ancient theater of Delphi [exterior], Delphi, Greece. ★ 8,5 120 views 45 uses	More info	
Subcomponents	Related assets	

Figure 44: Information about an item

V 4 d e s i g n	_	□ X
Keyword v Rocking chair	Ø	
Information	Reviews (2)	
Trend		
	Location 38.482497 22.500692	
	Source	
	Resolution	
	lileable No	
Rocking chair [vintage style], Athens, Greece.	More info	

Figure 45: Information about an item

PUC1:	information
1001.	mornation

Keyword 🔻 Ancient agora		Ø
	Reviews 2	
The second se		
124 1278	Location 38.482497 22.500692	
A CALL PROPERTY	Source	
	Resolution	
	Tileable No	
	More info	
Subcomponents	Related assets	
*		

Figure 46: Information about an item

Vadesign					п
Keyword 🔽 Ancient theater of Delphi				Model Information	
				Source format	.obj
				Geometry - quads	
				Debugges	
Information		Reviews	1	Converted polycons/to triangles)	
				Vertices	
			-	Size	
About the second				normals	
	Location	38.482497	22.	vertex color	
	•			rigged	
	Source			uv_mapped	
and the second s	Resolution			textures (Map)	
	Tilophlo		No	materials	-
	meable		NU	 Material Information 	
Ancient theater of Delphi [exterior], Delphi, Greece.		More info			-
★ 8,5 120 views 45 uses					
Subcomponents		Related asset	s		
All the second se				CAR CHIERE	
		Contraction of the second	100		

Figure 47: More Information about the item

PUC	1: reviews	5			
V 4	1 design				_ 🗆 X
	Keyword 🔻	Ancient theater of D	elphi		Ø
		Information		Reviews 1	
	1. Gre	at place!			
	Write a revie	2W			
	Email				
	Review				
			Submit		

Figure 48: User reviews about the item.

Search by type

The user can also search by type (Figure 49). This search type is similar to the search by keyword. The user types a general type of an item e.g. theatre and the platform suggests relevant types using the autocomplete function. By clicking on a specific item, the user can view more information about it.

Various sea	arch types: type		_ 🗆 X
Туре	▼ Insert a type	Using autocomplete function as in search by keyword.	Ø

Figure 49: Search by type option

Search by location

In this search type, the platform suggests locations using autocomplete function, when the user types in the textbox. When he selects a specific location, search results are exported which refer to the selected location (Figure 50).

Figure 50: Search by location option.

Search by date

The user can search items, which are associated with a specific time period. This search type is indicated for these situations. Results are exported using a year picker or a drop down list which includes various periods of time (Figure 51).

Figure 51: Search by date.

Search by example

In this search type, the user can search items which are similar to an image that he will browse from his computer. After browsing the image, results are exported, which include all the relevant items that are found in the platform (Figure 52).

V4design	_ D X
Example 🔻 Browse an image	

Figure 52: Search by example.

Advanced search

In this search type the user can fill as many parameters as he wants. By clicking the search button, the platform will search for items which satisfy the requirements that the user filled (Figure 53).

V 4 d e s i g n			
Advanced 🔻 Fill the follow	ving parameters		
Quality			
Mesh completeness Low # of vertex duplicates Homogeneous normal Low # of intersections			
Other parameters		_	
Period Artist Location Object types Views Usage Format			

4 ANALYSIS OF PRIOR USER EXPERIENCE

We have enriched the two focused groups with experts in the field who are not directly involved in the project and we have requested their feedback with the aid of questionnaires. The questions were selected through a collaborative exercise between user partners. Two categories of questions have been decided: general and in-depth ones. Essentially we tried to cover all high-level features/requirements (already addressed in the proposal phase) and created a list of questions that will enable to obtain user's scope on these features/requirements and to discover "undreamed of requirements" Most of times, questions evolve naturally as we think through the implications of a feature. The questionnaire was created by V4Design user partners in such a way in order to receive constructive feedback from experts about the users' current tasks, workflows and challenges in each use case. The questions are also drafted in a way that allows the user to express their own ideas and wishes as free texts, rather than selecting options from multiple-choice questions. Then, the questionnaires were distributed in a carefully selected group of 15 experts from the focus group (including mainly users not directly involved with the project), evenly divided into professional architects at both practice and academic level, experts in video game design and media production, which was balanced in terms of experience, age and profession. All participants in the questionnaire procedure have actively given their consent to submit their forms. The original questionnaire that was given to the experts is provided in Appendix A.

User requirements have not been plainly statistically derived from the set of answers received through the questionnaires. The user profiles of the participants have been evaluated, in order to understand the validity of ideas and concerns and whether those should be reflected in HLUR. Due to the nature of the questionnaire, answers have been carefully interpreted and understood, taking user profiles of the participants and their priorities into account.

HLUR	HLUR Title	HLUR Description
HLUR_5.1	User interaction and control	Architects and designers will be able to access the 3D assets (3D models, point clouds, Meshes) in a 3D environment and they will be able to edit and manipulate them.
HLUR_5.2	Asset accessibility and searching refinement	Architects and designers can have access to a variety of extracted assets and have the ability to filter and refine their search results.
HLUR_5.3	Related and suggested assets	Architects, designers and game developers can have access to a variety of other related or suggested assets to the asset they are working on.
HLUR_5.4	High quality 3D models	Architects, designers and game developers want to be able to reuse high quality 3D models

Table 5: HLUR based on prior user experience

5 ANALYSIS OF INDUSTRIAL REQUIREMENTS

5.1.1 Architecture and design industry

Although several tools exist in the market (see "**D8.3 Market analysis and industrial requirements**") offering high quality designing options and advanced modelling and integration functionalities (such as BIM tools), they do not offer many capabilities of content reuse and repurpose. More specifically, they lack of appropriate functionalities relevant to multimedia content linking, processing and combination from external resources during the design process. Most of them do not directly support 3D reconstruction technologies, so the designers have to use additional software to import the required 3D models in the platform.

Therefore, the following high level industrial requirements are identified for the architecture and design market:

HLUR	HLUR Title	HLUR Description
HLUR_6.1	Retrieval and integration	Easy retrieval and integration of additional multimedia content in the design process
HLUR_6.2	Semantically enriched 3D models	Availability of large libraries of semantically enriched 3D and multimedia objects that can be used for design
HLUR_6.3	Semantically enriched content	Content enrichment with semantic information
HLUR_6.4	Aesthetics	Content description based on aesthetic features
HLUR_6.5	Content interlinking	Content linking with information from the internet
HLUR_6.6	3D model reconstruction	Automatic or semi-automatic generation of 3D models for design purposes using existing multimedia content

 Table 6: HLUR based on industrial requirements for architecture and design

5.1.2 3D and VR game industry

The current game engines and authoring tools in the market are very useful for game designers to develop video and VR games, however they still lack of advanced capabilities of content reusing in the process of game designing. Specifically, the main disadvantage of these tools is that there is no option to re-use and adapt existing multimedia material so to include it in the virtual world. In addition there is lack of appropriate technologies that will allow for the creation of multimedia content enhanced with semantic knowledge.

To this end, the main industrial requirements of V4Design relevant to the game design are:

HLUR	HLUR Title	н	LUR	Descript	tion	
HLUR_7.1	Semantically enriched 3D models	Availability	of	large	libraries	of

		predefined 3D and multimedia objects for game design purpose
HLUR_7.2	Semantically enriched content	Content enrichment with semantic information
HLUR_7.3	Aesthetics	Content description based on aesthetic features
HLUR_7.4	Content interlinking	Content linking with information from the internet
HLUR_7.5	3D model reconstruction	Automatic or semi-automatic generation of 3D models for design purposes using existing multimedia content
HLUR_7.6	Portability of produced assets	Availability of 3D assets and objects that can be imported in 3D and VR game design
HLUR_7.7	Compatibility of produced assets	The authoring tool output has to be compliant with existing popular game engines (e.g. Unity).

Table 7: HLUR based on industrial requirements for 3D and VR game

6 AGGREGATION OF V4DESIGN REQUIREMENTS

We have described so far the HLUR that have been collected from three different sources (use cases, focus groups and industry). In this section, we present the aggregation of the HLUR so as to create a single point of reference of high-level user needs under which the more detailed (atomic) requirements (Table 9) are categorised and prioritized (based on the MOSCOW framework). Table 8 presents the aggregated HLUR that are used as references in Table 9.

		Source			
Final HLUR	PUC analysis	Prior user experience analysis	Industrial requirements analysis	Final HLUR Title	Final HLUR Description
HLUR_201	HLUR_1.1 HLUR_2.1		HLUR_6.1 HLUR_6.6 HLUR_7.5	Extraction of 3D models	Architects and designers can extract 3D models of places, buildings and objects out of videos and images of buildings, landscapes, artworks or sensitive space elements.
HLUR_202	HLUR_1.2 HLUR_2.2			Extraction of CG assets	Architects and designers can extract 3D textures, cg materials from 2D images of buildings, landscapes, artworks or sensitive space elements.
HLUR_203	HLUR_1.3 HLUR_2.3		HLUR_6.1	Architectural design tool to form innovative ideas	Architects and designers have a tool that can assist in formulating new, innovative architectural ideas
HLUR_204	HLUR_1.4 HLUR_2.4 HLUR_3.1 HLUR_4.1		HLUR_6.4 HLUR_6.5 HLUR_7.3 HLUR_7.4	Multiplicity of assets	Assets can be 3D objects, 2D videos/images, aesthetics, textual information, audio etc.
HLUR_205	HLUR_1.5 HLUR_2.5 HLUR_4.2	HLUR_5.1		User interaction and control	Architects and designers will be able to access the 3D assets (3D models, point clouds, Meshes) in an 3D environment and they will be able to edit and manipulate them.
HLUR_206	HLUR_1.6 HLUR_2.6 HLUR_4.3			Extraction of 2D assets	Architects and designers can extract 2D patterns of artworks and culturally sensitive space elements in editable vector format
HLUR_207	HLUR_1.7	HLUR_5.2	HLUR_6.2	Asset accessibility and	Architects and designers can have access to a variety of

	HLUR_2.7		HLUR_6.3 HLUR_7.1 HLUR_7.2	semantic searching refinement	extracted assets and have the ability to filter and refine their search results.
HLUR_208	HLUR_1.8 HLUR_2.8 HLUR_3.2 HLUR_4.4	HLUR_5.3	HLUR_6.5 HLUR_7.4	Related and suggested assets	Architects/Designers and game developers can have access to a variety of other related or suggested assets to the asset they are working on.
HLUR_209	HLUR_3.3		HLUR_7.6 HLUR_7.7	Immersive educational environment	The student finds her-/himself in an environment, where she or he can study by watching a 2D video (= episode of Nicos Weg) and do the corresponding exercises with a clear and comprehensive UI and gameplay that meets the requirements in regard to language learning didactic.
HLUR_210	HLUR_3.4		HLUR_7.6 HLUR_7.7	State of the art gameplay	We envision state of the art gameplay (with gaming elements) that takes place in three dimensional environments inspired by 2D content (Nicos Weg)
HLUR_211	HLUR_3.5			Avatar extraction	The components should also be able to extract the following: (i) Avatar, structure, etc. from DW telenovela; (ii) Avatar, structure, etc. from non-DW footage
HLUR_212	HLUR_3.6		HLUR_7.6 HLUR_7.7	Tool for Language related Game Design	Video game creators would like to have a tool that can assist in the design of new, immersive VR environments for language learning purposes
HLUR_213	HLUR_4.5			Multiple environments	Ability to develop multiple environments for the same scene and change them using scrollbar.
HLUR_214	HLUR_4.6			Data about the initial asset	Get data about the video that an asset is extracted from
HLUR_215	HLUR_4.7		HLUR_7.6 HLUR_7.7	Tool for History related Game Design	Video game creators would like to have a tool that can assist in the design of new, immersive VR environments for reliving a

					significant past event
HLUR_216	-	HLUR_5.4	-	High quality 3D models	Architects, designers and game developers want to be able to reuse high quality 3D models

Table 8: Merging of HLUR from different sources

In Table 9, we present the complete list of the detailed (atomic) user requirements associated with the relevant HLUR. This table constitutes the main input to "*D6.2 Technical requirements and architecture*" for defining the technical requirements. The table also illustrates the type of each requirement (functional or non-functional), as well as its priority, as this has been specified by the users involved in requirement elicitation.

User Requirement (UR)	Associated HLUR	Detailed description	Functional or Non Functional (FR/N-FR)	Priority based on MoSCoW framework
UR_1	HLUR_203 HLUR_212 HLUR_215	As an architect/video game designer I would like to be able to upload videos/images? in V4Design platform using a simple GUI	N-FR	МН
UR_2	HLUR_201	As an Architect I want to be able to retrieve 3D-Models	FR	МН
UR_3	HLUR_202	As an Architect I want to be able to retrieve high and reduced resolution textures	FR	мн
UR_4	HLUR_202	As an Architect I want to be able to reuse textures (Pattern extraction / seamless texture generation)	FR	СН
UR_5	HLUR_204	As an Architect I want the tool to support extraction of material layers	FR	СН
UR_6	HLUR_204	As an Architect I want the tool to support extraction of diffuse	FR	СН
UR_7	HLUR_204	As an Architect I want the tool to support extraction of normal-map	FR	СН
UR_8	HLUR_204	As an Architect I want the tool to support extraction of bump and displacement maps	FR	СН
UR_9	HLUR_204	As an Architect I want the tool to support extraction of ambient occlusion	FR	СН
UR_10	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the acquired footage - image/ video (semantic data/ tags)	FR	мн
UR_11	HLUR_203 HLUR_208	As a user I want further details about the input footage quality	FR	МН

	HLUR_214			
UR_12	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the extracted data quality	FR	мн
UR_13	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the bounding box of the extracted 3D model (unit independent)	FR	мн
UR_14	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the bounding box of the extracted 3D model (unit independent)	FR	мн
UR_15	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about geo-location and date/ time of scan	FR	мн
UR_16	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the author and copyrights of the asset	FR	мн
UR_17	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about the author and copyrights of the asset	FR	мн
UR_18	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about visible colours in the asset	FR	СН
UR_19	HLUR_203 HLUR_208 HLUR_214	As a user I want further details about related scans of the asset	FR	СН
UR_20	HLUR_204	As a user I want augmented data of the acquired 3D model (semantic data/ tags)	FR	SH
UR_21	HLUR_204	As a user I want a description of the acquired 3D model	FR	SH
UR_22	HLUR_204	As a user I want related Wikipedia articles to the acquired 3D model	FR	SH
UR_23	HLUR_204	As a user I want summarizations of textual content related to the 3D model	FR	SH
UR_24	HLUR_204	As a user I want social media entries about/ around scanned area/ object.	FR	SH
UR_25	HLUR_204	As a user I want various file formats as outputs:	FR	SH
UR_26	HLUR_204	As a user I want various output file formats such as OBJ and FBX for 3D models	FR	SH

UR_27	HLUR_204	As a user I want various output file formats such as JPG, TIFF, BMP and PNG for textures	FR	SH
UR_28	HLUR_204	As a user I want various output file formats such as vrmat and mdl for Materials	FR	SH
UR_29	HLUR_204	As a user I want various output file formats such as Adobe swatches library for Colour Palette	FR	SH
UR_30	HLUR_203 HLUR_207	As an Architect I want UIX: 3D-gallery i.e. A distraction free interface with rendered preview thumbnails.[2]	N-FR	мн
UR_31	HLUR_203	As an Architect I want UIX: VR usage scenario	N-FR	SH
UR_32	HLUR_203 HLUR_207 HLUR_208	As an Architect I want a UIX a detailed view of a Gallery of 3D model (with/without texture) and usage examples from other users	N-FR	МН
UR_33	HLUR_203 HLUR_207 HLUR_208	As an Architect I want UIX a detailed view of Additional data: palette of visible colours + bounding box size, author, copyright	N-FR	МН
UR_34	HLUR_203 HLUR_207 HLUR_208	As an Architect I want a UIX a detailed view of Team/Public relation functions: Rating system, Personal notes/ marking/ save to favourites, share functionality for social media.	N-FR	МН
UR_35	HLUR_203 HLUR_207	As an Architect I want UIX: Search by semantic tags (keywords)	N-FR	МН
UR_36	HLUR_203 HLUR_207	As an Architect I want UIX of Tags organized in tree structure and search field for typing tag. Personal tags (non-public tags)	N-FR	МН
UR_37	HLUR_203 HLUR_207	As an Architect I want UIX: Detailed search by features: - Quality (3D model/ texture), Footage features, augmented data	N-FR	SH
UR_38	HLUR_203	As an Architect I want UIX: Download settings (saveable profiles): - Mesh quality/format, Texture quality/ format/ layers (checkboxes), Material definition file, Colour palette (e.g.: adobe swatches)	N-FR	МН

UR_39	HLUR_203	As an Architect I want to upload/extract UI requirements: - Personal footage uploads with detailed upload and extraction progress. Status notification system (email, sms, webhook)	N-FR	SH
UR_40	HLUR_203	As an Architect I want a Timeline: - Max. 10min. coarse extraction for pre-evaluation of scan results. - Max. 1h for full quality extraction. - Possible cancellation of full quality extraction process.	N-FR	SH
UR_41	HLUR_203 HLUR_205 HLUR_206	As an Architect I want texture and material recognition that might appear in images and videos.	N-FR	СН
UR_42	HLUR_203 HLUR_208	As an Architect I want to have the "intelligence" of an architectural composition tool (combination of texture, colours, shapes)	N-FR	СН
UR_43	HLUR_203 HLUR_207	As an Architect I want to browse assets (materials, textures, bumps etc.) in VR/AR environment (not only in screen)	N-FR	СН
UR_44	HLUR_205 HLUR_206	As an Architect I want the ability to have the point cloud and the mesh of the 3D reconstruction	N-FR	SH
UR_45	HLUR_205. HLUR_206	As an Architect I want the ability to edit (and clean) the point cloud before the creation of the mesh	N-FR	SH
UR_46	HLUR_203 HLUR_207 HLUR_208	As an Architect I want Simple and clear visual UI (User Interface). Simple enough for non-specialised users	N-FR	SH
UR_47	HLUR_203	As an Architect I want have access to the code of the tool	N-FR	СН
UR_48	HLUR_203 HLUR_212	As a Content Provider I want the system to start a new processing loop when detecting new content on the server	N-FR	SH
UR_49	HLUR_201 HLUR_204 HLUR_208	As a user I would like to have an easy way to serendipitously find content I might want to reuse	N-FR	SH
UR_50	HLUR_201 HLUR_204 HLUR_208	As a user I would like to have access to lists of 3D models, but also find contextual information, other assets	N-FR	SH

		and related work		
UR_51	HLUR_203 HLUR_212 HLUR_215	As a Content Provider I want to be able to download in STL format from the V4Design platform to aggregate and distribute freely reusable 3D models, for instance, Wikimedia Commons	FR	SH
UR_52	HLUR_203 HLUR_212 HLUR_215	As a Content Provider I want an OAI- PMH endpoint to harvest data from the V4Design platform for re-use, so there is no need to manually scrape freely reusable content	FR	SH
UR_53	HLUR_203 HLUR_208 HLUR_212 HLUR_215	As a Content Provider I want to receive statistics about which items are being seen and/or downloaded from my repository, so I can generate reports on the impact of my content - To know what extent one can re-use and repurpose, and possibly have to attribute, the on-going works	N-FR	МН
UR_54	HLUR_203 HLUR_212 HLUR_215	As a content provider I want to receive user statistics of the amount of users that are using the platform, the retention rate, the bounce rates, and other user metrics • Usability and Analytics feature for users	N-FR	SH
UR_55	HLUR_203 HLUR_212 HLUR_215	As a content provider I want clear and transparent labelling of the reuse rights and copyright status of every item in the V4Design platform so as to enable better communication and IP protection to content providers.	N-FR	МН
UR_56	HLUR_204	As a game designer I want to get information about the asset sizes in the video content - To create a real life sized assets for VR 3D environments	FR	SH
UR_57	HLUR_204	As a game designer I want to get information about the assets - Textual and semantic data about the 3D assets - Textual summaries describing the 3D models	FR	SH
UR_58	HLUR_209 HLUR_210	As a game designer I want to get information about the entire	N-FR	СН

		telenovela series (DW) - While creating 3D environments from telenovelas, to create a gameplay game developer should be able to know everything about the series story		
UR_59	HLUR_204	As a game designer I want to get background audio assets, as there is always a need to add sounds in the gameplay for better immersiveness. V4Design should have related sounds in the data repository.	N-FR	SH
UR_60	HLUR_209 HLUR_210 HLUR_211	As a content provider I want to be able to access a template of game design document - This will help in the better sharing of IPs and involvement all the actors in game development	N-FR	СН
UR_61	HLUR_212	As a content provider I want to have game analytics from the authoring tool - Any game require analytics to better serve to the customers	N-FR	СН
UR_62	HLUR_212	As a film production company I would like to able to decide to import the asset to the database after analysing it first	N-FR	СН
UR_63	HLUR_212 HLUR_213 HLUR_215	As a film production company I want to be able to put location of the assets, such as putting the asset in the exact place as intended. A 3D drag- and-drop would be required	FR	СН
UR_64	HLUR_214	As a game designer I want to be able to get background info about the history of the video content - This will help in the decision of using an asset or not and also give perspective about the video footage used for the asset	N-FR	СН
UR_65	HLUR_214 HLUR_215	As a film production company I want to be able to choose each asset for a time span - This will help in IP protection and also help in development of updated assets	N-FR	СН
UR_66	HLUR_212	As a game designer, I want to get a list	FR	SH

	HLUR_215	of references to existing 3D models that have been detected from a 2D video scene to directly import into the authoring environment.		
UR_67	HLUR_212 HLUR_213 HLUR_215	As a game designer, I want to get lighting, colour grading and skymap settings from an input file (2D image or video) that reflect the mood of the material.	FR	СН
UR_68	HLUR_201 HLUR_204	As a film production company I want to extract V4Design 3D models in order to use them in AR.	FR	СН
UR_69	HLUR_205 HLUR_207 HLUR_208	Batch Download/Load of assets. Have the ability to load multiple assets at once.	FR	SH
UR_70	HLUR_216	Architects, designers and game developers want to have access to high-quality 3D models	NF	СН

 Table 9: Analysis aggregation of user requirements

7 OUTLINE OF THE USER-ORIENTED EVALUATION METHODOLOGY

The evaluation of a system can be **system-centric** or **user-oriented**. The former is performed by testing the system with specific benchmark data and comparing its performance against well-established performance indicators, such as the ones specified in "D1.1 Project management and quality assurance plan" and "D1.2 Data management and self-assessment plan v1", while the latter is based on structured user feedback as derived from usability reviews and testing.

The current section focuses on the **user-oriented evaluation** and presents the updated version of the evaluation plan (which was initially introduced in "**D7.1** *Initial use case scenarios and user requirements*"). More specifically, the following sections present a literature study of current evaluation approaches, which focus on evaluating the impact of the system, the user interface, the user experience, the user perspective and the quality of the system, and the methodology that was finally adopted by V4Design.

7.1 Background on user-oriented evaluation

7.1.1 General approaches

Nowadays there is a great variety of evaluation methodologies. There is not a perfect methodology for everything or a specific methodology for each case. Each method offers advantages and disadvantages. To achieve more validity and objectivity reasons, a combination of one or more evaluation methodologies is usually followed.

Although there is no common methodology with regard to user-oriented trials, there has been some relevant research in the past. Borlund discusses the history and principles of user-oriented evaluation (Borlund, 2009). She proposes an "Interactive Information Retrieval (IIR) Evaluation Model". This is centred on the idea of defining a realistic scenario for the user, called a "simulated work task situation." This consists of a short "cover story" that creates a simulated information need. It also provides some experimental control by guiding the test subjects towards certain goals. The scenario should also provide "situational relevance," which makes the task at hand relevant to the user. Such a scenario may change over time and may be context-dependent. In a well-defined simulated work task situation, the user can identify the task at hand. It may also include genuine information needs, such as test queries from real users.

Saracevic (1995) stresses out the need to consider evaluation on multiple levels and to integrate these. It is pointed out – for instance - that information retrieval methods should be evaluated with regards to the efficiency, coverage of the area, algorithmic performance, the user and usability, the fitness-of-use of the end-product or service and the impact of the product on real-life behaviours. It may be tempting to focus on one low-level area (such as recall or accuracy) or a higher-level area (such as usability), but to fully evaluate a system, all such levels should be considered together.

More detailed discussion and guidance are given by Stone et al. (2005), where the focus is on the design and evaluation of user interfaces. They discuss the importance of considering users, tasks, environments and domains as separate aspects for user-oriented evaluation. One crucial aspect of user-oriented evaluation is the need to create working prototypes of

the system, even if only a subset of the desired features has been implemented. There should be a clear and well-justified decision of which features to include. The prototype should include an attractive, robust and user-friendly interface. Given the limited time that test users will have, they should not be required to spend a great deal of time learning how to use a cumbersome interface. In fact, evaluation and trials in other projects have proven the significance of a well-developed interface for the success of the whole process.

7.1.2 User test plans

The "user test plan" is a brief document that specifies the objectives of the particular useroriented evaluation exercise including, what will be evaluated, how, where, when, who the participants are, who the test team are, and how the test results will be documented. The user test plan includes simulated work task situations. The specific plan depends on the status of the prototype at the time and also on the specific use case scenario in question.

7.1.3 Evaluation context

The aim is to ensure that there is a good match between the evaluation exercise and the application of the system in the intended situation. The main points to consider include:

- **Involve the right participants**: Involve participants that are either current users or likely future users. This could include architects and game developers or those previously involved in the project, through questionnaires and focus groups.
- **Choose the right situations**: Choose situations where the system will be used and consider the different aspects of the environment, timing, interests etc. that may have an effect on its use and perception. This is particularly important for requirements relating to context-sensitive search.
- Set relevant user tasks: Choose user tasks that make the participant seek information and are in accordance with situations that have been identified. Set realistic tasks that are a natural part of the users' current or intended activities. These tasks should also be related to specific WPs.
- **Document results in the situation**: Results are most accurate if recorded in the situation. Evaluation results and observations can be recorded before, during, and after any tasks given to participants, but they should be recorded or logged whilst still in the situation (i.e., location, environment, time). It is often simplest to directly log user interaction with a software system, such as recording click rates, session data, the number of query reformulations, etc.
- **Document the context**: This may be needed to distinguish results within and between participants in addition to helping retrieve and recall details of specific cases. This will help with the reliability and validity of the user evaluations.
- Use relevant evaluation approaches and measures: Each stage of iterative development and evaluation may have a slightly different sub-goal within an overall objective. Hence, different evaluation approaches and measures may be appropriate for different stages. No single evaluation measure will be universally applicable. In particular, the different V4Design use cases will require substantially different approaches.

7.1.4 Iterative development and evaluation

User-oriented evaluation, in common with other evaluation approaches, should not be considered towards the end of the project when there will be no time to benefit from the results. Similarly, it may not be possible to specify far in advance the optimal evaluation techniques. Instead, system development and evaluation protocols should both be improved iteratively and should inform each other as follows.

- Iterative development: Improve both the system and the information in it, based on the results of each evaluation conducted. Early iterations may have only a few system features and limited data sets. Later iterations may have more features and updated, expanded data sets, such as larger sets of indexed content. Generating realistic and timely data is an important aspect of the evaluation process and should not be neglected.
- Iterative evaluation: Improve and redesign the evaluation process iteratively. This is important in ensuring that we are on track with respect to the overall objectives and expectations. Each evaluation exercise can provide additional information for time and resource planning of the subsequent evaluation cycles, and so outcomes, including problems, should be shared between partners at all stages.
- Scale up the number of participants between the experiments: Start with a small number of participants in the first evaluation cycle and carefully scale up between the evaluation cycles. This will help progress from formative to summative evaluation, and gather more evidence for conclusions.
- Shorten the time spent per participant between the experiments: Carefully scale down on the amount of time that is spent with each participant. The quality of our information and information system would normally improve between evaluation cycles. Spending gradually less time per participant enables us to scale up the number of participants without necessarily increasing the amount resources spent on the evaluation.
- **Specify user test plans**: Since each evaluation exercise can reveal problems, it is important to record the plan and any changes so that when improving the system or the information in it there is a clear trail of reasoning. This makes it easier to fix any problems in the evaluation or the system. It also helps improve the plan for the next evaluation. The plan is the driving document for conducting evaluation. Without it, results would be less accurate and more difficult to communicate to others.

As each evaluation cycle is completed, the results should be shared with the partners.

7.1.5 Participants

The exact choice of participants depends on the current research question. During early stages of the evaluation, it is inevitable that the prototype system and the evaluation protocols will have imperfections. It is therefore recommended that early iterations make use of "friendly" users. These could be people that are involved in the project directly, or colleagues or other contacts that are sympathetic to the project and its aims. This helps to reduce the number of dropouts. Later stages will have more robust prototypes and protocols, and so these can be tested on the wider public as appropriate. Care may have to be taken to reduce the number of drop-outs or "junk" responses. Where available, students often make a good group of participants, especially if they are interested in the subject due to their studies.


7.1.6 Usability testing

According to ISO 9241-11 (the standard covering the ergonomics of human-computer interaction), "usability is understood as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". More precisely, usability testing needs to measure the level of effectiveness, efficiency, and satisfaction that is experienced by users when they use the V4Design system in order to achieve specified goals (Barnum, 2010).

Again, the ISO 9241-11 provides definitions for these three criteria:

- Effectiveness: depends on to which extent the user is able to fulfil the task and to achieve his goals.
- **Efficiency:** depends on how the effort the user needs to invest relates to the accuracy and completeness of the results.
- Satisfaction: depends on how satisfied the user is by working with the system

Formative and Summative Usability Testing

Depending on the time when the testing is done and the specific goals of the usability tests, we can distinguish between *formative* and *summative testing*.

- **Formative testing** is carried out during the development phase and focuses on identifying and fixing problems.
- Summative testing validates whether the finished product meets the user requirements.

The distinction between formative and summative testing is highly relevant not only with regard to the different goals of these tests but also with regard to the design and very specifically to the scope of the evaluation. *Formative testing* aims at providing developers with insight on how users evaluate a specific status of the prototype within the development cycle. It is not (or less) about metrics or statistics, but about finding out what works best for users (Barnum, 2010). The findings from formative testing will feed directly into the development process and might also – to some extent – modify the understanding of the use case scenarios and the user requirements. *Summative testing*, on the other hand, will focus on evaluating the integrated system, assess how the individual modules work together and test whether working with the final system in general is effective, efficient and satisfying.



Figure 54: Evaluation Process



7.2 V4Design user-oriented evaluation methodology

Although the V4Design solution is relevant to a broad range of users, such as architects, designers and game creators, we expect that the developed tools will be of similar nature (i.e. software components with user interface for content access, reuse, repurpose and design) and therefore a common methodology for evaluating all PUCs will be applied. In this section, we present the approach we will follow to test the usability of the platform in the different evaluation phases, as well as the KPIs that will be used, considerably extending the lists of KPIs described in *"D1.2 Data management and self-assessment plan v1"*.

7.2.1 Usability testing

With regard to the V4Design evaluation process, formative usability testing will take place within the individual work packages, as well as during the user evaluation of the *first* and the *second* V4Design prototypes, while summative usability testing will be carried out during the evaluation of the *final* V4Design system at the end of the project.

In addition, we have decided to carry out *formative* testing at the beginning with only small groups of users who are very familiar with the project and its goals. Some very obvious advantages of this kind of approach are that small usability studies

- can be incorporated into the system development cycle at little cost;
- can be incorporated into the system development cycle without affecting or disrupting the development timeline;
- can be easily repeated more often.

Additionally, recent research has proven that – at least during formative testing – small usability studies are more beneficial than conducting large studies. Nielsen has shown that testing with *five* participants leads to the optimal return of 85% of the findings from a particular test to be uncovered. Additional participants would mostly just uncover the same issues and bring little new insights (Figure 55).



Figure 55: "Why You Only Need to Test with 5 Users", by Jakob Nielsen²³

With regard to *summative* testing towards the end of the project, we will involve a larger sample in order to achieve evaluation results that are of more relevance. Based on the status of the project, we will also decide at which point to involve the members of the UG in the

²³ <u>http://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/</u>



evaluation. In any case, the evaluation methodology needs to take into account that all V4Design use cases are aiming for rather broad and diverse target groups that will offer a certain freedom to the number of available participants.

7.2.2 Formative usability testing (1st and 2nd prototype)

With regard to formative usability testing of the first two prototypes, we have therefore chosen a mix of *expert reviews* in a *concurrent think aloud process*, followed by a *standard questionnaire* (including some heuristics with regard to the interface) and a *concluding discussion*:

- **Expert reviews:** In the context of the V4Design evaluation, expert reviews means that we will select specialists from the different domains who will use the V4Design system in a typical working environment by performing specific tasks that are common to their day-to-day work.
- **Concurrent think aloud process:** We want to understand participants' thoughts when they interact with V4Design by having them think aloud when performing their tasks. Although this approach can interfere with the work on the tasks itself, it will lead to more direct and authentic feedback.
- **Standard questionnaire:** After having performed the tasks, participants will be asked to fill out a questionnaire that will ask questions about the general experience when using the V4Design system. This approach will deliver a more general assessment of effectiveness, efficiency and satisfaction and will also enable us to test some heuristics with regard to the interface.
- **Concluding discussion:** The evaluation will be concluded by a guided discussion between evaluator and participants that will allow for clarifying some ambiguities with regard to the tasks, the systems' performance and the answers that have been given. This discussion will also be an opportunity to mention additional aspects that have not been covered by the tasks and the questionnaire.
- Focus group discussion: Where possible and appropriate, we will complement expert interviews by focus group evaluation. In these focus groups, the evaluator will present the prototype and will subsequently allow participants to test individual features. This phase is concluded by a group discussion about the benefits of the prototype and its shortcomings. This less formal approach will create additional benefits as participating experts are likely to come up with different ideas and aspects when confronted with their peers in a discussion than in a one-to-one situation with the evaluator alone.
- Involvement of the User Group (UG) and other external experts: As pointed out before, the first formative evaluation session of the first prototype is built on small groups of users who are very familiar with the project and its goals. At this point of the project, we intend to involve members of the UG as well as other external experts in the formative testing of the second prototype.

The goal of formative usability testing will be to support technical partners in the further development and improvement of the V4Design system. At this stage, developers need to know how the users receive the main functionalities. As V4Design is following a modular structure, we need to reflect this modularity by testing individual functionalities rather than the overall system. Hence, at least during the first two evaluation iterations, the focus will lie on tasks that specifically test the performance of individual modules from a user's point of



view. The more advanced the system becomes and particularly during the summative evaluation of the final system, focus will shift to the performance of the integrated V4Design system in general.

Obviously, the design of the different evaluation sessions very much depends on the development status of the prototype, its individual modules and the interface. The general evaluation plan, as described in this deliverable, is therefore subject to change whenever and wherever it is necessary. Also, the findings from evaluating the first prototype might lead to changes when planning the second evaluation iteration.

7.2.3 Summative usability testing (final system)

The evaluation of the final system will follow the rules of summative testing. Normally, summative testing requires a larger sample of test users in order to compute metrics, such as task completion rates, error rates or average time on task (Barnum, 2010). Summative testing will focus more on the integrated V4Design system but might as well – for better comparison – use the same set of tasks and scenarios that are known from the first two (formative) evaluation iterations. The optimal number of participants and the design of the summative evaluation, as well as of specific user tasks, depend on the status of the prototype, its individual modules and its interface.

7.2.4 Effectiveness, efficiency, and satisfaction metrics

This section presents the Key Performance Indicators for assessing the effectiveness, the efficiency and the satisfaction of the developed system, considerably extending the lists of KPIs described in "*D1.2 Data management and self-assessment plan v1*".

7.2.4.1 Effectiveness metrics

Effectiveness is defined as the extent to which the user is able to fulfil a task and to achieve his or her goals. The more completely and accurately the system works the more effective it is. We have decided to evaluate the effectiveness of the V4Design prototype according to the following metrics:

- Number of tasks performed;
- Number of relevant functions used;
- Number of tasks completed successfully on first attempt;
- Number of persistent errors;
- Number of errors per unit of time;
- Number of users able to successfully complete the task;
- Number of errors made performing specific tasks;
- Number of requests for assistance accomplishing task;
- Quality of output;
- Quantity of output.

7.2.4.2 Efficiency metrics

Efficiency depends on how the effort the user needs to invest relates to the accuracy and completeness of the results. It is important to understand that efficiency will be judged from a user's point of view. For example, a summarisation tool might be very efficient compared to other automated summarisation approaches but might not be considered as efficient by



the user with regard to the overall task. We have decided to evaluate the efficiency of the V4Design prototype according to the following metrics:

- Time spent to understand the application and learn about its functionalities;
- Time spent to perform a particular task;
- Time spent to perform a task compared to the current method of handling the task;
- Time spent to perform a task compared to the use of alternative tools;
- Time spent on correcting errors;
- Time spent relearning functions.

7.2.4.3 Satisfaction metrics

Satisfaction depends on how satisfied the user is by working with the system. Some consider this criterion as even more important than effectiveness or efficiency. If users are pleased with the design of and their interaction with the tool, this *feeling* might even trump the fact that the results of working with the tool are less convincing (Barnum, 2010). As mentioned before, the consortium recognises the relevance of the user interface for the project and the evaluation process. Nevertheless, as the focus will be put on the development of back-end functionalities, the V4Design evaluation methodology will consider user satisfaction as less crucial than system effectiveness and efficiency.

We have decided to evaluate the satisfaction that a test person experiences when using the V4Design prototype according to the following metrics:

- Number of users that rate the system as "more satisfying" than their current method of handling the task;
- Number of users that rate the system as "more satisfying" than an alternative tool;
- Number of users who feel "in control" of the system;
- User rating on a five-point scale anchored with "makes me more/less productive";
- Number of users who would recommend it to a friend or colleague;
- Number of users that rate the system as "easier to use" than a potential key competitor.

The evaluation tasks as well as the questionnaire will be designed in a way that covers all these metrics. Whether we will use all these metrics at every stage of the evaluation will again depend on the respective state of the prototype. The comparison with other, already existing tools, for instance, is only reasonable if the functionalities and their level of maturity are indeed comparable.

7.2.5 PUC-specific details on the evaluation methodology

We will describe more specifically what we will practically do, e.g. **who** will validate the V4Design prototype **when** and **how**. In general, the evaluation of the first prototype will be mainly carried out by internal test persons as the system and its performance will be too immature to be tested by external experts. Later stages will have more robust prototypes and protocols, and so these can be tested on the wider public as appropriate.

7.2.5.1 Architecture and design application

The evaluation of the architecture PUCs (PUC1 and PUC2) will mainly be based on: (i) A competitive market analysis (see "*D8.3 Market analysis and industrial requirements"*) and (ii) in-depth expert-interviews and discussions with architects of interior and exterior design



- either individually or in focus groups. Thus, both methods should be used for evaluating the V4Design system.

Existing tools that have been tested in the course of the market analysis ("**D8.3 Market** analysis and industrial requirement") will serve as a benchmark for the V4Design system and its prototypes. Through the competitive market analysis, advantages and disadvantages of already existing tools have been identified, showing their shortcomings and thereby helping to define a market gap and a possible Unique Selling Proposition (USP) for the envisioned V4Design system in a professional architecture design environment. Based on these insights, specific user requirements have been derived. The performance of the V4Design system should therefore be evaluated with regard to the performance of existing tools. The goal must be to compare V4Design's functionalities with regard to a possible additional value to the market.

Following a user centred design approach, the second phase of the evaluation will focus on actual user-tests (HdM, AUTH), involving real users from the target audience. The evaluation will consist of a mix of presentation, personal trials and interviews. Ideally, in a one-on-one situation, the users will be presented with the V4Design project story. Starting with an overview of the project goals and its progress, users will be introduced to the necessary details and basic knowledge to perform the evaluation in an unbiased manner. Functionalities will be presented as well as their state of progress in as much detail as necessary to understand their purpose. This is to ensure a correct evaluation of the prototypes and project results, independent from the state of the V4Design application.

The actual user test will then be performed on the basis of a number of pre-set tasks. These tasks will be written in accordance with the project's state of progress, again taking into account that not all functionality may already be implemented or as perfect as aimed for at this stage. The order in which these tasks are exercised will follow a pre-set schedule. This includes standardisation in terms of number of questions, time for each step of the evaluation, support during the test etc. This method ensures comparable results over a number of test subjects and test sequences.

The progress and outcomes of these tests will be documented on the fly. All tests will be followed by individual interviews of the test persons based on a standardised questionnaire. Test users will be asked to comment on the tasks that they have performed, judging the system's functionalities and performance and also to express their overall assessment of the system. The latter questions are aiming at getting feedback on the tools usefulness for day-to-day professional work, its usability, and its economic potential for a bigger market.

The evaluation will be performed with the support of the user partners (AUTH, HdM), the focus group, and the user group. The users will provide structured feedback in questionnaire forms. The user feedback will be collected both remotely (i.e. by providing remote access to the developed prototype) as well as on site during the demonstration workshops and open days (see section 7.2.7).

In order to promote the developed tool to external users and receive feedback from broader audience we plan to exploit the official McNeel Appstore called Food4Rhino²⁴. The store offers more than 560 Rhino and Grasshopper apps and stats and has more than 3,050,000

²⁴ <u>https://www.food4rhino.com/</u>



downloads. End users will be able to learn about the V4Design system and download the available applications.

7.2.5.2 Video/VR game application

The evaluation of video game PUCs (PUC3 and PUC4) will follow a similar evaluation plan with the evaluation of architecture design PUCs. At the second phase, in-depth expertinterviews and discussions with video game developers, content creators and end-users (who actively try out the language-learning and immersive documentary prototype) – either individually or in focus groups.

Similarly, the evaluation will be performed with the support of the user partners (NURO, DW), the focus group, and the user group while NURO and DW will activate their professional networks as well as V4Design's network to recruit diverse but fitting users.

7.2.6 Timeline

The evaluation timeline with regard to the 4 PUCs will pursue the following steps:

What?	When?	Who?	How?
Evaluation of the operational prototype	M13-M18	Focus groups	The operational prototype and the initial mock-ups for (i) architecture and design application and (ii) video game application will be evaluated by the two focus groups. The constant feedback and interaction with technical partner will feed the development of the two applications.
Evaluation of 1st prototype	M19-26	Focus groups	The 1 st V4Design prototype will be presented to the two focus groups that are familiar and passionate users of Rhino platform and Unity software. They will be asked to validate the overall impression of the first prototype, its main goals, interface and usability as well as specific functionalities that are already available. The focus group will also be asked to assess the performance of the first V4Design prototype in comparison with other already existing tools and the improvement that it brought in Rhino platform or in Unity platform. The received feedback will be incorporated in the development process of the 2 nd prototype.
Evaluation of 2nd prototype	M27-M34	User group	The 2 nd V4Design prototype will be presented to the user group (consisting of focus group members and externals) and similar feedback with the 1 st prototype will be requested. The received feedback will be incorporated in the development process of the final system.
Evaluation of 3rd prototype	M34-M36	User group	The final system will be presented to the user group and the open public and similar feedback with the 2^{nd} prototype will be requested.

Table 10: Evaluation timeline



7.2.7 Demonstration workshops and open days

The V4Design consortium will organise a number of events during the project duration. Among these, a number of events are aimed at demonstrating the V4Design system to the public and receiving constructive feedback in order to improve the supported features and enlarging its potential impact. Below, the most significant open days and demonstration workshops are presented, as they have been decided at the beginning of the project, while the organisation of additional venues will be further considered during the project's lifetime.

- 1st Demonstration workshop: The 1st demonstration workshop will be organised by NURO in collaboration with DW in Germany (probably in the Rhineland), after the deployment of the 1st prototype (M20). The status quo of the 1st prototype will be presented and participants will be able to experience, test and evaluate it while their responses and received feedback will be integrated into the next development cycles. The workshop will also function as dissemination and exploitation event that help to extend the group of people interested in the project.
- 2nd Demonstration workshop: The 2nd demonstration workshop will take place in the AUTH facilities in Thessaloniki, Greece after the 2nd prototype deployment (M28). The main goal of this workshop is to present the status quo of the V4Design to academic groups (students, staff, etc.) of various levels (undergraduate, postgraduate). The workshop will include training seminars, lectures, design studios and actual fabrication of selected designed prototypes. End users will be able to experience, test and evaluate the fabricated prototype and its tools. The workshop will also function as dissemination and exploitation event that helps to inform broader groups of people interested in the project and communicate its capability and potential.
- **1**st **Open Day**: The 1st Open Day will be held by HdM after the deployment of the 2nd prototype (M31), aiming to perform testing and evaluation of the V4Design system. The workshop will demonstrate the V4Design prototype and tools in a broader audience consisting of academic and market representatives. The event's location will be decided later.
- 2nd Open Day / Final Demonstration Workshop: This event will be organised by McNeel, after the release of the final system (M35), to fully demonstrate the V4Design solution to a broader group of potential customers, including architecture offices, video game companies, design industry leaders, governmental members, investors and societal organisations. The event might be collocated with a Rhino User Meeting which is organized by McNeel several times during the year. The event's location will be decided later.

8 CONCLUSIONS

The deliverable summarizes the further development and elaboration of the PUC scenarios, as they have been initially described in deliverable **"D7.1 Initial use case scenarios and user requirements".** For the elaboration of the PUC scenarios, two focus groups have been set up consisting of architecture professionals and video game specialists, for PUC1&2 and PUC3&4 respectively. The PUC scenarios development described here, strongly supports the initial aim, i.e. to test and evaluate the idea behind the development of the V4Design platform. The PUCs are described in detail, along with related scenarios and simulations, both on what is expected as outcome and on the actual user interface.

The deliverable also extensively describes the updated user requirements based on the PUC scenarios and stakeholders' shared and distinct expectations in order to enhance the user experience of the V4Design platform. The user requirements also incorporate the prior user experience elicited by the two focus groups, with the aid of questionnaires from selected experts and the analysis of market and industrial needs. The user requirements in this deliverable provide valuable input to "*D6.2 Technical requirements and architecture*" for specifying the set of functionalities of the V4Design platform and shape the overall architecture.

Finally, the deliverable elaborates on the user-centred evaluation methodology that will be used to evaluate the platform. Key Performance Indicators (KPIs) have been described relevant to performance and usability, which will be assessed in terms of effectiveness, efficiency and satisfaction. An evaluation timeline is also provided, describing who will validate the V4Design prototype, when and how. Last, the key demonstration events are presented.

The use case scenarios and the user requirements will be further elaborated and extended in the subsequent phases of the project, the tool testing procedures and evaluation steps, as they will be described in next versions of the deliverable (i.e., "D7.3 Evaluation of the 1st prototype and updated user requirements").



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Appendix A: Questionnaire template

Below we attach the main questionnaire format, as it has been given to experts by V4Design user partners AUTH, HdM and NURO. A second iteration has been created by the project's user partner DW, in a way that best accommodates their specific needs.

General Questions

As an architect/designer, what are the requests you are mostly confronted with?

What are the most time-consuming factors in your daily work?

In your opinion, what are the greatest challenges in handling design tasks?

What kind of design tools would be of help when performing your daily work?

What kind of software would be truly innovative from your point of view?

How do you usually communicate architectural design both for clients and partners?

What can be improved and where are the main difficulties in getting designs to others or receiving designs from others?

What is your key quality aspect when communicating or presenting design? (e.g. speed, image or rendering quality, simplicity, completeness, etc.)

In-depth Questions

V4Design will start out with a search, allowing you to look for historical periods, monuments, styles, locations, artists, artworks, etc. How should such a search look like and what is important for you through the search procedure?

What do you think on further options to filter/refine the search results?

V4Design allows the reconstruction of 3-dimensional spaces through the upload of visual material (videos, images). What additional features would be useful for this procedure?

V4Design allows the categorization of cities, monuments, artworks into 3d models, textures, patterns and textual information. Assuming we consider it a useful method for organizing information about space what would additionally help you?



After having reconstructed a 3-dimensional object, the system presents an overview of information related to the asset that has been searched (3d model, sub-objects, additional 3d elements, textures, 2d patterns, text, tags, descriptions, categories, etc.) What additional details could be useful in order to grasp the content in its entirety?

Which metadata (author, time, location, style, language, related keywords, file formats, resolutions, duration, etc.) possibly offered by the system do you consider useful for your design routines?

When using modern design software you have to work with complex assets (3d models) that include a variety of sub-assets (sub-objects, 3d textures, 2d patterns, text, tags). How do you think assets and sub-assets incorporated in your design routine?

General Questions (Alteration to address DW's needs)

As a (digital) storyteller, what are the requests you are mostly confronted with?

What are the most time-consuming factors in your daily work?

In your opinion, what are the greatest challenges in handling (digital) storytelling tasks?

What kind of design or scripting tools would be of help when performing your daily work?

What kind of software would be truly innovative from your point of view?

How do you usually communicate your storytelling designs and scripts both for clients and partners?

What can be improved and where are the main difficulties in getting storytelling designs and scripts to others or receiving storytelling designs and scripts from others?



What is your key quality aspect when communicating or presenting designs or scripts? (e.g. speed, image or rendering quality, simplicity, completeness, etc.)

In-depth Questions (Alteration to address DW's needs)

V4Design will start out with a search, allowing you to look for historical periods, monuments, styles, locations, artists, artworks, etc. How should such a search look like and what is important for you through the search procedure?

What do you think on further options to filter/refine the search results?

V4Design allows the reconstruction of 3-dimensional spaces through the upload of visual material (videos, images). What additional features would be useful for this procedure?

V4Design allows the categorization of cities, monuments, artworks into 3d models, textures, patterns and textual information. Assuming we consider it a useful method for organizing information about space what would additionally help you?

After having reconstructed a 3-dimensional object, the system presents an overview of information related to the asset that has been searched (3d model, sub-objects, additional 3d elements, textures, 2d patterns, text, tags, descriptions, categories, etc.) What additional details could be useful in order to grasp the content in its entirety?



Which metadata (author, time, location, style, language, related keywords, file formats, resolutions, duration, etc.) possibly offered by the system do you consider useful for your design routines?

When using modern design software you have to work with complex assets (3d models) that include a variety of sub-assets (sub-objects, 3d textures, 2d patterns, text, tags). How do you think assets and sub-assets should be incorporated in your design routine?

Participant's info

Name of the User / Age / Gender

Profile of the User (80-100 words)

User contact details (email / mobile phone / etc.)



Legal notice

I agree that my responses to this questionnaire will be used for the elicitation and refinement of the user requirements of the V4Design project. My contact details will only be stored so that I can receive information about the project's progress.

Signature