



MindSpaces

Art-driven adaptive outdoors and indoors design

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D2.4 Design needs in architecture and urban scale and use case scenarios v1

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Abstract	
<p>D2.4 describes an initial version of the pilot use cases and the pilot use case creation methodology as reflecting issues concerning design and modelling in architectural and urban scales. This information is documented in the project proposal and the DoA. Deliverable D2.4, in addition, it includes detailed descriptions for each PUC, which derive from the project's partners' feedback. The deliverable also discusses issues concerning space and the public realm, the use of art installations and the challenges faced in the design procedure.</p>	
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Executive Summary

This deliverable is the first version of the pilot use cases (PUC), as documented in the project proposal and the DoA. More specifically, the PUC scenarios are presented and will be further updated and elaborated based on the extensive feedback provided by project partners, consisting of architecture professionals, local stakeholders, artists and art residents. Initial storyboards have been also used to provide more concrete information on the way use cases can be developed. Besides, diagrams and visual material are addressing issues related to the way that the PUCs are operating.

In addition, the deliverable describes issues concerning space and the public realm. In particular, it discusses issues regarding the three initially formulated PUCs that are consisting of cases of designing and rearranging urban space (related to local condition of the city of L'Hospitalet), designing of professional environments (related to ZHA expertise on the field) and the design of interior domestic environments (related to E-Senior's activity on the field).

Taking into consideration that expanding urban areas are at risk of losing their cultural and social character, MindSpaces first pilot use case (PUC), aims to create solutions that promote its cultural, social and environmental assets and improve flow and functionality for increasing social interaction, tourism and economic activity. In the second pilot use case, MindSpaces seeks to gain a deep understanding of the relationship between human emotion and behaviour in relation to working spaces, and professional environments. In the third and last use case concerning interior design for senior people, the aim is to create proposals for the redesigning and space-defining equipment of existing homes, or the design of new ones, with the goal of making it emotionally and functionally friendly to their senior inhabitants.

Overall, indoors and outdoors design solutions created within MindSpaces are expected to result in more humane living and working environments, improving the overall wellbeing of citizens of working age, as well as seniors. Moreover, the software tools, which will be also developed within the MindSpaces project, will allow stakeholders within industry, municipalities and civil society to co-create their environment and co-affect the living and working space-defining procedures. The functionality of spaces will improve in sync with user responses, which will subsequently increase their use and social interactions within them. Future projections of social benefits may even include the development of tighter-knit communities.

Abbreviations and Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
CEO	Chief Executive Officer
CRE	Commercial Real Estate
DoA	Description of Action
EEG	Electroencephalography
EMEA	Europe, Middle East and Africa
IOT	Internet of Things
PUC	Pilot Use Case
RBS	The Royal Bank of Scotland
VR	Virtual Reality

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1 INTRODUCTION

MindSpaces is addressing design needs that are present in a diverse set of environments, ranging from public, openly accessible urban space, to demanding professional indoor environments and finally to sensitive domestic environments with special needs for their inhabitants. This array of spaces, both outdoors and indoors, reflect an important part of today's city challenges, holding an important social character. In total, design needs that are described in Section 2 refer to a big part of contemporary urban societies, whether they are city inhabitants, professionals or senior citizens. What is very important is the role of art installations or artistic spatial interventions in the design procedure of the related spaces and the way it can affect human behaviour and living or working conditions.

MindSpaces will bring together artists, creatives and technology experts to produce AR/VR installations representing emotionally and functionally adaptive designs of outdoors and indoors spaces. Innovative design ideas will be introduced by art practices, through their ability to imagine futures that do not just reflect the current consensus in mathematics, logic and engineering, setting into motion new ways of seeing, hearing, touching, feeling, transforming and experiencing spaces, places and community. Emotional, cognitive, behavioural measurements will provide insights into the effects of proposed designs on end users. Artists will incorporate these responses into "living" installations, adapting them online to elicit positive emotional and behavioural feedback.

MindSpaces project and its basic intentions are at the vanguard of a new wave of designers, architects and engineers that affirm the necessity of an interdisciplinary approach that integrates novel technologies to inform design and generate a notion of humanism suggested by artistic thinking. By integrating approaches from neuroscience, physiology and psychology with architectural research, sociological and ethnographic methodologies, human experience can be directly linked to design by correlating specific measures of the built environment (input) with quantified measures of the brain's, body's and other human responses (neural, physiological and psychological responses), as well as sociological, behavioural and economic outcomes (output). Using neuroscientific tools objective measurements can now be used along with traditional subjective evaluations. These results and a more encompassing framework in which also there is a better chance to address the needs and preferences of various special populations with physical or psychological impairments.

The initial pilot use cases, user requirements and a first outline of the evaluation plan have already been documented in the proposal and the DoA. This deliverable (D2.4) is the first version of pilot use cases, which will be complemented in the following months (D7.1) by an updated version of the PUCs, an elaborated list of user requirements and the description of

the evaluation plan to be implemented. Towards the direction of developing that deliverable document, we have already initiated the extracting and aggregating of user requirements collected from: a) proposed pilot use cases; b) prior user experience, as this is expressed with the aid of questionnaires from user partners; c) information related to relevant market analysis.

More specifically, Section 2 presents the design needs that have to be addressed for the development of the three use cases and the focus groups that are being set up consisting of people from user partner organizations who are either directly involved in the project or they are simply experts in the field. The focus groups will be contributing to the elaboration of PUC scenarios and the refinement of user requirements.

Section 3 documents the initial version of the three PUCs, presenting a detailed description of the scenarios along with initial function diagrams for each scenario.

2 DESIGN NEEDS IN ARCHITECTURE AND URBAN DESIGN

2.1 Issues concerning architecture and urban space

2.1.1 Issues concerning urban space and the public realm

Urban design in rapidly expanding cities is facing new challenges that arise related to its functionality, mobility, attractiveness, protection of culture and environment. These include physical spaces, systems and rules that regulate it, definition of private and public space, services offered, ecology, issues regarding sensitivity and awareness towards the cultural significance of a city, related to the environment and mobility. MindSpaces can raise visibility of the city's cultural value, related to its material (buildings, public spaces, etc.) and immaterial character (history of the city, knowledge based in the city, culture of people, etc.) and increase awareness of issues related to its expansion, particularly environmental and mobility concerns. Cities lack environments that are amenable to new types of social interaction and new degrees of social connectivity with the urban fabric, those environments are crucial in order to increase touristic potential, the wellbeing of citizens, quality of life of an area, as well as its overall economic activity. The first concerns of the designing of an outdoors space in a vibrant, modern city neighbourhood (City de L'Hospitalet, in the outskirts of Barcelona) are to attract citizens and generally users of public space through the MindSpaces participatory design process. Emotionally sensitive aesthetics combined with artistic inputs will result in intriguing and stimulating outdoors spaces that can thus become a social and cultural hub, encouraging human interaction, attracting cultural events, and increasing touristic and subsequently economic activity in the area.

This procedure can initiate a new sense of connectivity between the city and its people. This connectivity can move in both directions, encouraging social relations and activation of contemporary public space, it may also facilitate forms and practices of urban regeneration and social innovation, such as a cosmopolitan version of localism, which is both possible and necessary in a densely populated and highly connected world.

Digital identity networks and new technologies allow us to identify public space as a space of free expression 'par excellence'. "The future of the city could be profoundly modified by information made available by new technologies"¹

Artists, being aware of contemporary society, could place the proper questions through artistic work and help address important issues for the city. Installations suggested by MindSpaces search the emotional connection of citizens with the space, where they there

¹ Toscano, Patricia. Instagram-City: New Media, and the Social Perception of Public Spaces. Academic Journal | Visual Anthropology; May/Jun2017, Vol. 30 Issue 3, p275-286, 12p

are living and working, not only aesthetically but mostly in a sense of being engaged in a community, being aligned in the same project of life and citizenship. “Strategically, it is believed that creative actors such as artists and architects are particularly well suited to utilizing disinvested, vacant spaces temporarily. They are able to perceive distinctive aesthetics, historic and functional characteristics within disinvested, vacant spaces and to efficiently activate these potentials, and thereby add high symbolic, social and economic value to those sites. A second component of creativity is the interesting consumption opportunities that new, temporary uses of urban spaces are believed to offer to residents and visitors”²

2.1.2 Issues concerning architecture, design and professional environments

Corporations today face massive pressures to keep up with expansion, mergers and acquisitions, and new technology while competing to attract and retain the most talented and competitive workforce they can. Fierce global competition drives today’s CEOs, workplace designers, and architects to consider new strategies for planning adaptive workplace strategies. Gone are the days of uninspiring workplaces setup as simple physical places for people to work. Today’s industry giants in social media, technology, and other most other industries

Many successful CEOs such as Mark Zuckerberg and Elon Musk run unconventional businesses and therefore are developing workplaces that are as non-conventional as their businesses – no low ceilings, fluorescent lights, cubicles or carpets. They want their offices to give occupants the experience of a great lifestyle, to feel more like they are in a Manhattan Loft, or a great artist’s studio, or a sophisticated member only club, experiences employees may never otherwise have the opportunity to have. Workplaces should reinforce that they are entrepreneurial in spirit, dynamic and visionary.

Professional workplace environments today are complex ecosystems demanding new solutions that effectively leverage new technology. Workplaces today must be increasingly global, smart, collaborative, and sustainable, while supporting a healthier well being of the workforce. Office occupiers, whether they are technology, financial or other, range from pioneers to late adopters. There is a diversity of workplace requirements dependent upon their corporate culture, country of origin, and business focus. It is therefore vital to provide for a flexibility to occupy the space in both a more traditional and more contemporary way, whilst also allowing the workplace to change over time as these occupants evolve. Job roles across all sectors are becoming less process driven and more innovation focused with an

² Stevens, Quentin. “Temporary uses of urban spaces: how are they understood as “creative” ? Archnet.IJAR, Volume 12- Issue 3- November 2018 (90-107)

emphasis on cross functional collaboration and whole system thinking which drives a movement towards more collaborative work settings and less individual workspace. Work processes have become much more complex and collaborative - with increased complexity of products and services, innovation and disruption, and changes in regulations and reporting. The emphasis in the workplace has shifted away from individual, separate work spaces towards more team-based work areas, where complex and fast changing opportunities and challenges can be tackled more quickly and effectively. Whereas traditionally office space was 10-20% shared space, it is now often 50% or more shared space - including shared space on office floors as well as on separate conference or amenity floors.

Organisations and workplace designers have come to realise that providing spaces for people to collaborate is often not enough – collaboration needs to be encouraged. Designing spaces to be accessible, conveniently and centrally located increases opportunities for planned and spontaneous collaboration. How to connect people and spaces becomes as important as the spaces themselves. Visual connection is as important as physical connection. Being able to see people encourages collaboration, and seeing collaborative spaces encourages their usage.

To enable the highest functioning workforce, businesses have increased focus on emotional and physical health of their workers. Numerous studies illustrate how natural elements, including daylight, fresh air and access to nature can enhance the productivity and effectiveness of staff. A recent study of office workers in EMEA showed 13% higher levels of wellbeing, and 8% higher productivity, for workers in environments with natural elements such as greenery and sunlight. Workers are unique in their preference for where and how they work. New mobile platforms are enabling real-time feedback mechanisms to workers. A deeper understanding of how features of workplace design affect emotional well being will enable us to better design and tailor work environments to the needs of our workforce.

Disruptive technologies such as sensor analytics, computer vision, artificial intelligence, and virtual and augmented reality are changing both the way workplaces are designed and interacted with. These technologies are rapidly transforming the corporate real estate industry and driving new service based business models such as WeWork that leverage real-time and predictive analytics. According to the Deloitte Center for Financial Services 2019 Commercial Real Estate Outlook, 80% of surveyed investors believe CRE companies should focus their attention on predictive analytics and business intelligence. Coworking is increasingly not just for start-ups. Major and established corporations are embracing coworking spaces to provide instant access to an innovative community of start-ups, entrepreneurs and freelancers as well as a stimulating workplace environment. Google currently has six co-work Campuses for entrepreneurs in London, Madrid, Sao Paulo, Seoul

and Tel Aviv. Banks that have already embraced coworking include RBS in Edinburgh, National Australia Bank in Melbourne and BNP Paribas in Belgium.

Workplaces of today must enable future flexibility yet be adaptive and specific to a range of new workplace cultures. They must adapt to both the needs of the individual, the team, and the business owner's goals and preferences. They must positively contribute to the emotional and physical wellbeing, collaboration, and productivity of highly diverse workforces. To respond to these pressures, architects and stakeholders must leverage data driven insights to begin to unlock and promote successful design features for better working environments.

2.1.3 Issues concerning architecture, design and interior, domestic environments

One of contemporary world's important issues has to do with domestic living conditions for special people groups. Design issues for enhanced independent living of seniors will be specifically addressed here. Such environments, in some cases enhanced with smart technologies, become more widespread, given the world population age increase and the prevalence of chronic conditions. Elderly inhabitants face various difficulties around the home, related to accessibility of spaces, functionality, or tied to their mobility, while there is also increasing interest for smart sensing solutions to be integrated into their house. The redesign of their environments will take into account the MindSpaces feedback, aiming to support physical health and independence in daily life. Moreover, aesthetic elements that appeal to them will be integrated into the art-inspired representations of their future interiors, aiming to create sense of comfort, familiarity and overall improved emotional status. Issues such as loneliness and the importance of memory will also be taken into account. The expected results will be homes or broadly defined domestic environments, that appeal to the elderly, that enhance their sense of independence and closeness to friends, relatives and each other, therefore improving their emotional and physical wellbeing. Societal benefits will spread to their possible caregivers, family members and social circles, who will enjoy improved quality time with them and have reduced caretaker obligations. Economic benefits to the workforce will be another positive societal impact, as family members will have lower chances of needing to abandon work to support an elderly relative who is unable to live independently

2.2 Focus group creation

Focus groups are widely used in many research fields to investigate new ideas. 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 MindSpaces, we use this method to distil the

needs related to architecture and urban space design in order to elaborate the initial PUC scenarios, to formulate the prior user experience which will be furtherly incorporated in the elaborated list of user requirements and to evaluate the system prototypes. Specifically, three focus groups have been created consisting of: a) Architecture professionals, b) Local stakeholders and c) Artists and art residents (Open Call). The first focus group, mainly related to all PUCs, consists of architecture professionals from industry and academic environment.

The second focus group consists of local stakeholders (L'Hospitalet, Espronceda and E-Seniors) and the third group consisted of Artists. 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 regular users meetings being conducted on a bi-weekly schedule.

At this stage, the involvement of the focus groups is mostly revolved around the first articulation of the needs of the users and the defining of user requirements lists and then, based on these needs, the use case elaboration. However, we expect members of the focus groups to be involved at further stage in order to 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.

2.2.1 Architecture, professionals

The architecture-related focus group involves architects, both practice-based 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 architectural and urban design for all use cases, 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 design, urban design arrangements, construction detailing, construction management. 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, 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 members from the user partners AUTH and ZHA while its members are expected to be increased in the next months,

using an open form provided through the project's webpage, which will be set up for people to be able to sign up.

2.2.2 Local stakeholders

During the development of all PUCs, local stakeholders will define issues related to the place and suggest required changes. For the outdoors design scenario, MindSpaces partners L'Hospitalet and Espronceda are going to properly describe the needs of the area and how they believe that they can be surpassed by the use of artistic exploration. For workspace design, MindSpaces partner ZHA will be addressing issues related to the creation of functionally efficient workspaces, increased worker interaction, improved emotional and mental wellbeing of employees, resulting in increased productivity. They will communicate the specific challenges faced in workspaces and how to tackle them by integrating the measurements of user feedback to the MindSpaces VR representations. Finally, for interior design, MindSpaces partners E-Seniors will determine challenges that seniors face in their daily life, how they tackle them, and how they believe MindSpaces can help improve the design of their domestic environment. Architects will collaborate with artists to propose innovative designs that create functionally senior-friendly living, and also incorporate emotionally relevant design elements, relevant to the aesthetic preferences of the elderly, that aim to improve their overall emotional and cognitive wellbeing. The definition of the interior design use case will be implemented with the inclusion of seniors who want to improve their home, architects and artists in user workshops, questionnaire and one-to-one interviews.

2.2.3 Artists and art residents (Open Call)

This group will examine the connection between arts and emotion, by examining the relevant literature, from various perspectives, including psychological, neurological and aesthetical. This will provide a solid foundation for interpreting the effects of art and discovering how emotional and behavioural responses can be invoked by art and will define a novel working model between artists and technology oriented partners and users. The potential for resulting societal benefits will be investigated, so as to understand how they should be used within the context of MindSpaces.

MindSpaces is a rich and complex project where designers, artists and creatives are meant to collaborate at all levels with the partners and the different methodologies and techniques. Additionally an open call, as shown in **(Figure 1)** below, for Artists and creatives will offer cross-disciplinary residencies of a collaborative nature. Residents are expected to present their proposals concerning emerging technologies, and/or interactive installations, AR/VR installations, architectural design and art in public spaces.

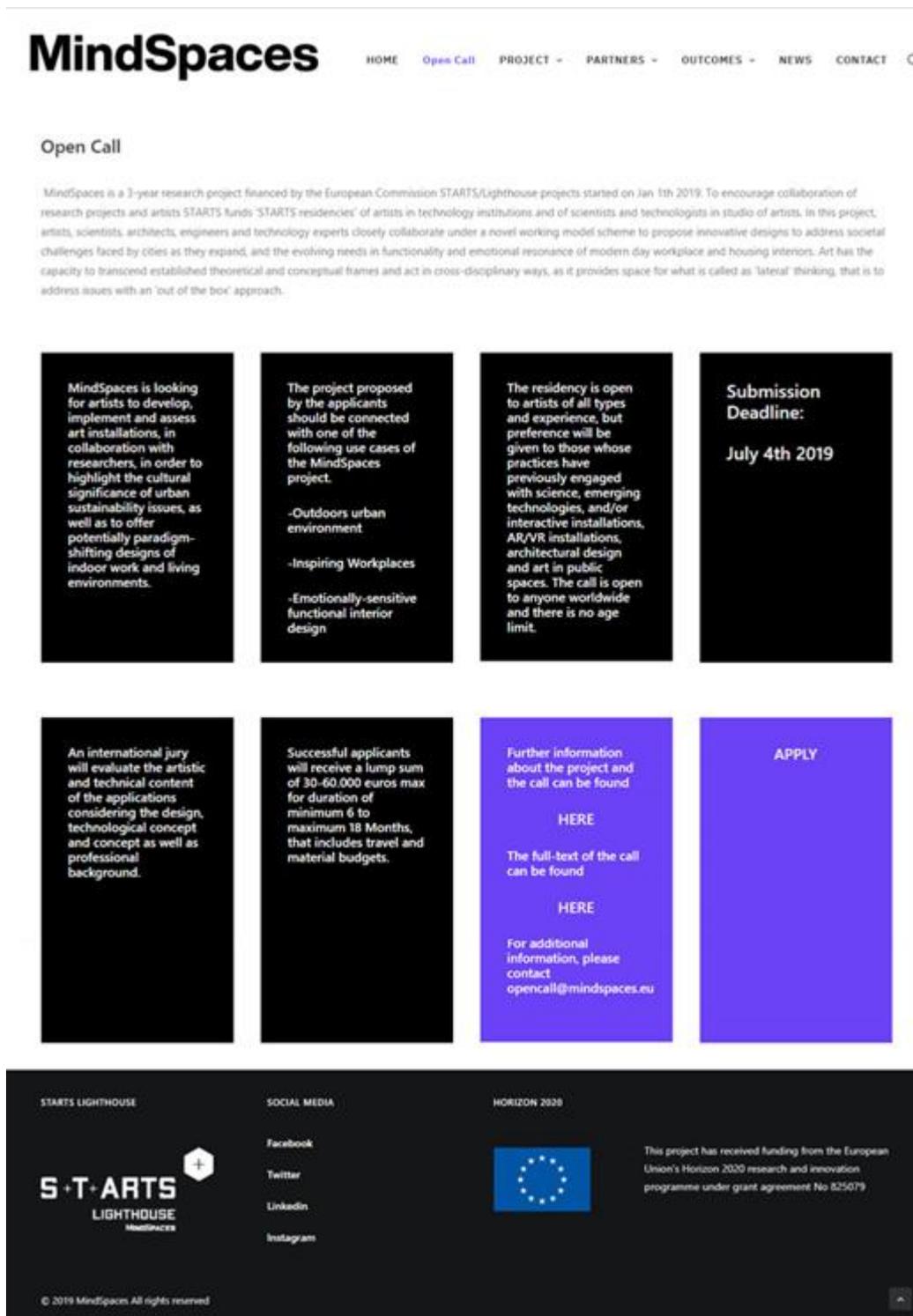


Figure 1: Overview of open call webpage

The projects proposed by applicants should be connected with one of the use cases of the MindSpaces project:

PUC1: The first pilot is focused in an outdoor urban setting of important cultural interest. MindSpaces architects and selected artists from the Open Call will use advanced modelling software to produce blueprint documentation of the area, and propose new urban design schemes that showcase its cultural importance, generate new types of social interaction, and draw attention to issues it is facing regarding environmental pollution and mobility (e.g. air or water pollution, traffic congestion). Selected artists for this use case will be asked to think, research and propose artistic inputs, installations or actions which will be discussed with specific technological partners of MindSpaces for the creation of AR/VR solutions allowing citizens and other users to experience renewed designs of these spaces, move in them, interact with the others, to assess their functionality and understand their cultural and environmental history and value. More specifically, they are expected to propose art-based suggestions on how to dynamically adapt the spaces (in VR) based on the information coming from MindSpaces technologies and from the environment (e.g. citizen's emotions and feelings captured in social media, detected behaviour of people around the area of interest, day, time, weather etc.). The final goal consists in introducing innovative designs for outdoors areas which support and sensitize the public to issues like environment, migration, gentrification, future of work, history, culture, etc. The response of the citizens to the proposed solutions will be measured via EEG, physiological and visual sensing, leading to online modifications for improved designs.

PUC2: For the second pilot, talented artists and creative thinkers are called to propose ideas, concepts, interventions, and designs for new and innovative solutions to designing more inspiring and effective offices of the future. Artist's proposals should contribute to the ideation and development of, and/or utilize the MindSpaces platform (in the concept of an authoring tool and interaction tools for measuring public reactions via VR and EEG, as described in the above section) and data insights in their conception. Artists will be asked to propose solutions that can be measured to improve the performance of office space design based on considerations such as promotion of emotional well-being, improved productivity, increased flexibility, and the enabling and encouraging of dynamic social interaction and collaboration. To develop their work, artists and creative thinkers will have access to 3D digital models of potential office space designs, and, for the purpose of the project demo, to the 3D model of the existing workspace, which will be re-designed via the artists' contribution, as well as data provided through the MindSpaces platform and should be capable of interacting with these media. Artists will contribute to rethinking the notion of how offices can be designed as well as by creating interventions and full design proposals for office spaces potentially taking on the following roles:

- Conceptualise fundamentally new approaches to office design which provide productive user requirements / considerations that contribute to the development of the MindSpaces platform

- Design virtual 3d VR/AR interventions for existing office spaces or architect's designs
- Design virtual 3d VR/AR office space designs entirely
- Propose and install physical interventions in real world office spaces

PUC3: The third use-case address challenges of a sensitive audience, i.e. senior people and their domestic inhabitation. Artists and creative thinkers are called to propose innovative, art related ideas concerning the quality of these environments and the level of emotional and functional friendliness. Selected artists in collaboration with architects will propose an art installation inspired for a senior individual's living space. The senior will be between 60 and 85 years-old, have no particular health or mental illness and live independently. MindSpaces proposition is to focus on the topics of emotional support and affective state, such as solitude, loss, etc. Additionally, solutions for practical issues can be potentially suggested, since they are of a sometimes more explicit character (accessibility, security, life rhythm, health, etc.). This can modify a lot of aspects of seniors' lives and increase the level of emotional and practical comfort. The art works will be presented to the senior through adapted supports (3D, virtual reality headsets). The artists will be provided with the 3D plan of the senior living space as well as information coming from sensing cameras and interviews about the senior habits in his/her home. The emotional state of the seniors will be measured through technological means, with non-invasive EEG and physiological sensors, as described in the above sections. This will allow the determining of emotions felt by the senior in interaction with the artwork in his/her living space.

2.3 Pilot use cases creation methodology

The PUC scenarios, which have been initially outlined in the proposal phase, are now further elaborated based on extensive feedback and experience provided by the partners during discussion sessions in regular teleconferences taking places on a bi-weekly basis, as well as physical meetings. The starting point of the MindSpaces 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) Outdoors urban environments b) Inspiring workplaces c) Emotionally-sensitive functional interior design. A detailed exchange of ideas and expertise of MindSpaces partners of the initial general topics of the proposed PUCs has been performed, before coming to conclusion about the selected cases.

For all PUCs, an initial space documentation procedure will take place, producing 3D models of existing environments, which will serve as the basis for innovative design ideas, being implemented by MindSpaces partner U2M. Additionally, the MindSpaces partner UPF will conduct textual analysis for all pilot cases.

Eventually, partners have agreed upon one scenario for each of the 3 PUCs. For PUC1, design interventions in an outdoor urban environment specified by the city council located in City de L'Hospitalet, Barcelona, Spain. The area of L'Hospitalet has been selected as a case of an

urban area of special cultural interest (i.e. city square, old market, riverside, etc.). Besides, this selection takes advantage of the proximity and knowledge of the selected place by project partners, L'Hospitalet de Llobregat City Council and the Espronceda Centre for Art & Culture, both based in the Barcelona area.

For PUC2, the partners have decided to focus on the case of designing friendly, emotionally sensitive and functional interior workspaces and interior objects. The office facilities of MindSpaces partner ZHA and/or McNeel will be used as a testing environment based on their knowledge and familiarity with the selected working environments and practices.

For PUC3, the partners have decided to focus on the case of redesign and refurbishment of existing home, or designing of a new one for senior people. The goal is to make domestic environments emotionally and functionally senior-friendly, as well as designing objects and spaces that evoke positive cognitive and emotional experiences and memories, and following design trends and aesthetic values likely to be appreciated by the elderly living there. This PUC's location is selected based on the proximity and knowledge of MindSpaces partner E-Seniors.

3 PUC SCENARIOS

3.1 PUC1- Outdoors urban environment

3.1.1 Executive summary

Scenario Topic: Interventions in City de Hospitalet

The pilot use case for “Designing of improved, attractive city spaces”, intends to improve urban design in a rapidly expanding city by addressing new challenges that may arise related to the city’s functionality, mobility, attractiveness, protection of culture and environment. MindSpaces will aim to increase sensitivity and awareness towards the cultural significance and current issues of the city, related to the environment and mobility, through innovative art installations in key locations. Thus, MindSpaces will raise visibility of the city’s cultural value and increase awareness of issues related to its expansion, particularly environmental, mobility and other socially sensitive concerns. It can also generate environments that are amenable to new types of social interaction and new degrees of social connectivity with the urban fabric. This, in turn, will improve touristic potential, the wellbeing of citizens, quality of life in the area, as well as its overall economic activity. The pilot will use advanced modelling software (e.g. Rhino, Grasshopper) to produce blueprint documentation of the area, and propose new urban design schemes that showcase its cultural visibility and importance, generate new types of social interaction, and draw attention to issues it is facing regarding environmental pollution and mobility (e.g. air or water pollution, traffic congestion).

The use case will be focusing on the city of L’Hospitalet de Llobregat, a city located in the metropolitan area of Barcelona. Being Catalonia’s second city, with a population of more than 262.000 inhabitants, it faces major challenges regarding high urban density, high levels of multiculturalism and an industrial past, which has shaped the city. The past 20 years have brought intensive urban, economic and cultural programs creating today a dynamic metropolis that attracts artists, new companies and new population. The Tecla Sala Cultural Centre and surroundings will be the focus point of the urban outdoor design procedure of the first PUC, the spatial base of work that will host the artists’ installations, and will also serve as a final exhibition space of the result of the work led by the artists.

It is a central area in L’Hospitalet, which holds several projects on contemporary visual arts regarding training, creation, production and exhibition. It is also a pleasant urban park connecting the north and the south of the city and a future neuralgic area with new perspectives of flows once the intermodal metro and train station, which is currently under construction, will be opened.

The pilot is targeting City councils and municipalities that want to renovate outdoors urban spaces, architecture offices that want to democratize the design process and improve outdoors urban design, architecture academic units studying trends and innovations in outdoors urban design, VR/AR companies that want to deploy realistic city scenarios in their games.

3.1.2 Rationale

A professional architecture office (ZHA) and an academic architecture unit (AUTH), have been assigned to collaborate with city council of the City De L'Hospitalet, art curators (Espronceda Centre of Art and Culture) and artists (MoBen, AN) in order to produce outdoor architecture and urban design proposals for an urban area of special cultural interest. ZHA and AUTH will cooperate with artists selected by the project's 'Open call for artists' to deploy artistic projects that are aligned with the mission of MindSpaces and STARTS, bringing technology to urban design, bringing human centred thinking, ethics and values closer to its technical deployment. The general public will experience the proposed urban design in the outdoors area itself, through artistic interventions potentially expressed via media façades and/or new spatial installations linked with an AR or/and VR environment. Art projects (virtual or physical) will contribute to the definition of a psycho-geographic and economic character of the city, catalysing new processes of local identification with public spaces within local neighbourhoods

Art installations may provide direct representations of cultural assets, reproductions or projects on the historical urban fabric, urban challenges, like mobility issues or environmental pollution data, aiming to elicit interest and engagement in these issues from city dweller and visitors. Additionally, installations may generate a platform for new types of social interaction within the urban context. User's emotional and cognitive responses will be indirectly assessed by a combination of environmental and physiological sensors appropriately chosen for each installation (EEG, motion sensors, activity sensors, video etc.) **(Figure 2)**. MindSpaces public installations will dynamically change according to the artists' sense of aesthetics, in response to the sensor feedback from the public, so as to arrive at the most emotionally appealing and functional design proposal or/and a proposal, which is generated through the collective behaviour of the participants.

3.1.3 Detailed description

The selected building complex of Tecla Sala and its urban outdoor surroundings (**Figure 3, Figure 4, Figure 5**) an old factory complex that dedicates nowadays its several buildings to visual arts: The Tecla Sala Metropolitan Arts Centre, the Tecla Sala Central Public Library, the Arranz-Bravo Arts Foundation and the private TPK Arts Centre. The complex is surrounded by a dynamic urban area that will host during the next years a central intermodal train and metro station that will bring new circulations and mobility into the area.

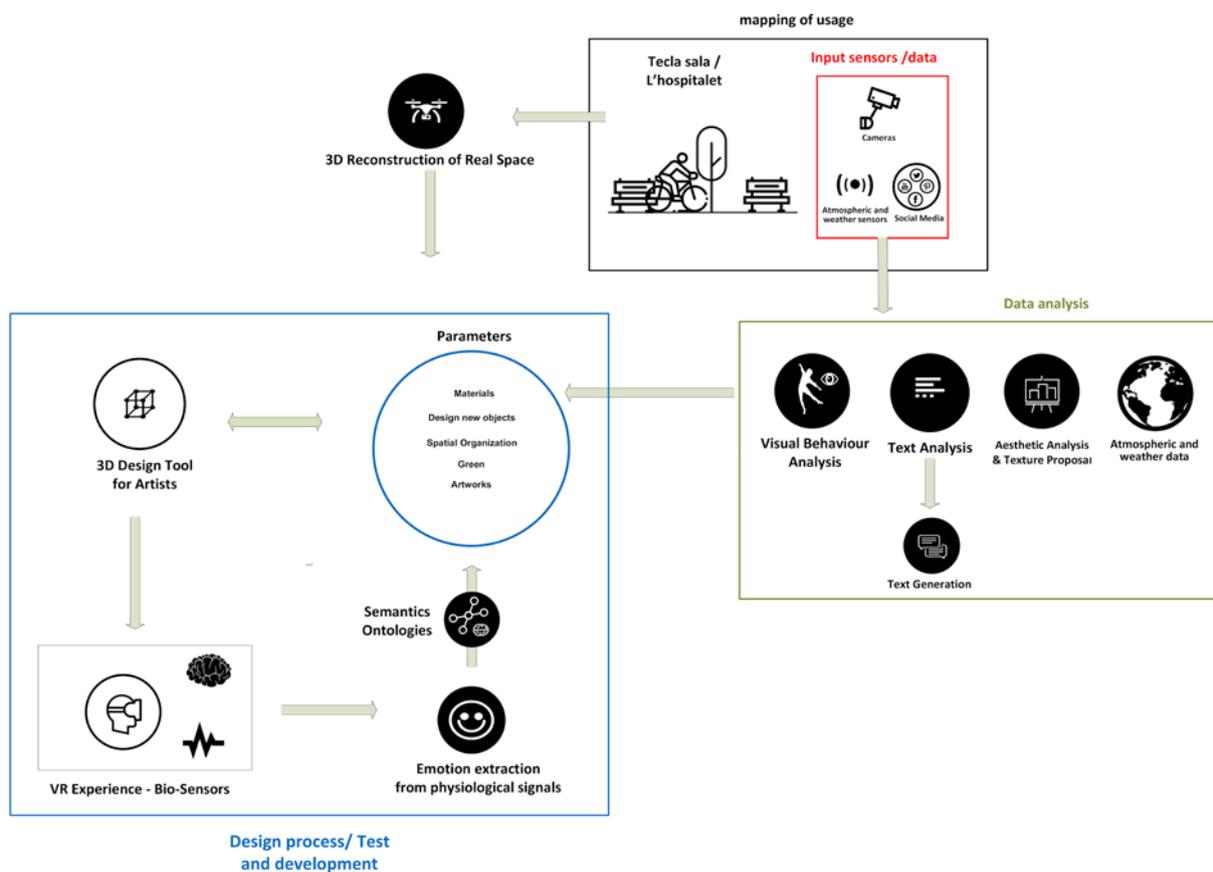


Figure 2: Diagram Pilot Use Case 1_ Interventions in City de Hospitalet

The process of the PUC1 will start with the creative collaboration between architects, artists and technological partners inspired by all obtained data. This process will actually settle an innovative methodology of work based on a transversal cooperation and co-creation. A journalist will follow the process compiling documentary materials such as pictures, video, mental schemes, brainstorming meetings, interviews and a travel journal.

Once the AR/VR Tecla Sala inspired platform is produced, along with the art installation(s) (whose number is yet to be determined), the PUC will develop into a real citizen experience that will take place in Tecla Sala area during a fixed period of time (between 1 and 2 weeks). Conceived as an experiential setting opened to any citizen and tourist, it will consist in a temporary pavilion holding several experiential zones: the AR/VR computers zone to test the platform; the documentary exhibition showing the methodology of the process with all the compiled materials; the meeting zone where speeches, seminars and workshops will be held to think about the new creative parameters between art and technology. An initial installation by the artists (MoBen, AN) is under development; soon there will be more details about the project. The result will be a public main event around art-driven innovation conceived as an experiential activity for citizens with a clear social impact promoting a new vision of the urban space where users have their own voice.

3.1.4 Initial storyboard and function diagram

MindSpaces partner U2M will use drone scans to produce 2D and 3D documentation of the urban environment that architects (ZH, AUTH) and artists (ESP, MoBen, AN) will work on. Additional input might be available through citizen participation and social media data. Architects (ZHA, AUTH) will use the urban documentation material as a basis for collaboration with well-known artists (ESP, MoBen, AN) in order to produce artistically and aesthetically rigorous, interactive public installations that will thus lead to a redesigned, better operating urban public space. The installations will utilize aspects of the ZHA Agent Based Parametric Semiology research of social crowd behaviour within the generative design process. It will engage city dwellers and tourists by appealing to their emotions and connection with the city, its history and its environment. It will provide a platform for new types of social interaction environments within the city. City users will interact with/within the AR or/and VR (ZH, NURO) installation. Cognitive, emotional and environmental sensor measurements will be collected from the users and the data will be used to evaluate and generate improvements and alterations of the installation.



Figure 3: Images of the area of the city de L’Hospitalet_Tecla Sala Metropolitan Arts Centre



Figure 4: Images of the area of the city de L’Hospitalet_Tecla Sala Metropolitan Arts Centre



Figure 5: Images of the area of the city de L’Hospitalet_ Tecla Sala Metropolitan Arts Centre

3.2 PUC2 – Inspiring workplaces

3.2.1 Executive summary

Scenario Topic: Inspiring workplaces

Inspiring Workplaces is a Pilot Use Case designed to test and develop the MindSpaces platform specifically for designing better quality workplace environments. MindSpaces research partners collect and analyse behavioural, emotional, and textual data from people inhabiting workplace environments physically and virtually (AR/VR environments) to develop design and analysis tools used in designing workplaces. Artists, architects, and designers will leverage the tools and data insights to explore and envision improved workplace environments.

In recent years, aesthetically and functionally innovative workspaces are being created which are more capable of enabling the dynamic communication that is needed within today’s networked society. Increasing opportunities for positive social interaction in work environments leads to improved productivity and creativity across departments and teams. The pilot use case for “Inspiring Workplaces” aims to create emotionally appealing work environments that are inspiring, allow more dynamic and diverse social behaviour, lead to increased and improved worker collaboration, productivity and well-being.

Designers have potential to guide modern workplace design in unexpected directions, to improve its appeal and effectiveness. To do so we must consider current cultural office trends that are driving changes in the needs and requirements of effective workplaces. Today, businesses are treated as ecosystems required to support and enable increasingly adaptive and interdisciplinary collaborations. More businesses are embracing the Gig Economy which has given rise to the exponential growth of co-working spaces in past 10 years globally. Building owners are increasingly looking to curate not only the type, but size and stage of development of occupiers, to create a synergistic mix of entrepreneurial and established businesses. This requires us to consider designs which are more adaptive and flexible for building stakeholders, business owners, and building users. There is a concerted effort to enable both curated and unexpected spontaneous collaboration. Our designs must not only allow for such collaboration, but actively encourage and enable more dynamic social interaction and collaboration through connectivity. Additionally, in a war for retaining talented workers, businesses are increasingly considering ways of providing a better work-life balance through increased and diversified amenities, more exposure to natural light and green spaces and pleasant stress reducing working environments which feel less like the cold office spaces of the past.

Today's design processes must be driven not simply by intuition, but through deeper data driven insights that unlock the features that enable a high functioning workplace. To gain insights we must utilise predictive analytics to solve multi-objective workplace design problems. Additionally, we need to unlock and measure how workers feel about their work settings and instrumentalise them. Today architects see massive opportunities at each step of the design process in gaining insights from data to increase design performance and reduce risks to clients. From environmental data to social data, design consultancies are increasingly being commissioned to integrate real world data as well as simulated data to provide early insights to directly influence workplace design geometry and organization. The multi-faceted pressures felt by all stakeholders in workplace design (Corporate Real Estate Managers, CEOs, users/workers, and designers), require new approaches to the design process. Through Pilot Use Case 2 the consortium will collect and analyse both empirical and simulation data surrounding the design of workplaces to gain actionable insights that improve the design process.

3.2.2 Rationale

Internet of Things (IOT), camera vision and AI, and smart building technology present us with new opportunities to integrate feedback mechanisms for real data about how people work and interact to influence design decisions. VR and AR provide new ways to experience and respond to design options in a simulation environment. Textual analysis and language processing give us opportunities to understand trends and sentiments across groups of

people who use these office spaces. In order to leverage these powerful data sources, we identify and analyse the key parameters of workplaces we are designing with such as light, material, spatial organization (**Figure 9**), and form. From these parameters we begin to identify relationships with human emotion and behaviour.

The planning of workplaces is well defined design problem with clear parameters and constraints. Some of these parameters are specific to workplaces while others can be generalised to many architectural design problems, which provides a useful testing and development case for the overall MindSpaces ambition. By gaining deeper insight into how people behave and interact in workplaces both real and virtual we can begin to cull out uninspiring and ineffective design solutions and focus on models which are highly performative across multiple objectives. The development of a design simulator in VR enables us to test many design options and parameters without the expense of changing physical designs. Understanding emotional and physiological feedback in these virtual environments gives us the means to gather generalisable insights to be applied in generating new models in an iterative process. Textual data can help us gain insights into people's sentiment, likes, dislikes, and feelings surrounding existing designs and workplaces in general. This added layer of data provides high level specific degree of understanding of parameters that are not so easily simulated. While we cull and prune inappropriate design options we begin to focus on key parameters and provide solutions tailored to how specific company cultures would weigh various design objectives.

3.2.3 Detailed description

The implementation of PUC2 involves artists, architects, and researchers collaborating to develop and test designs for workplaces. Through this process the consortium partners will test and develop the MindSpaces platform for designing better quality workplace environments. MindSpaces research partners collect and analyse behavioural, emotional, and textual data from people inhabiting workplace environments physically and virtually (AR/VR environments) to develop design and analysis tools used in designing workplaces. Artists, architects, and designers will leverage the tools and data insights to explore and envision improved workplace environments.

Cameras will be setup in real workplaces to gather data over time of human occupancy and behaviour. Researchers will analyse video feeds using advanced computer vision and artificial intelligence to identify and quantify behavioural patterns over time. Researchers will analyse how individuals move in relation to spaces, spatial features, and other people. Additionally, researchers will analyse pairwise and group behaviour of people in relation to spaces, spatial features, and other people. This data will be considered in relation to time in terms of frequency, time of day, and duration. The goal is to find correlations between

architectural elements that can potentially be parameterized and human behaviour, time of day, and other human occupancy. The research seeks to try to find useful relationships between human behavioural events such as a conversation and physical spatial features.

In parallel with studying real office environments, a series of experiments will be conducted by producing 3d virtual workplace environments which can be experienced in virtual reality. Each experiment will involve changing 1-2 design parameters such as material or lighting conditions. Human users will experience each variation in VR while researchers collect physiological and EEG data to understand the user's emotional and physiological signals in relation to what they experience. Among others, researchers will study emotional and physiological data in response to different options for artificial and natural lighting, materials and material contrast, colour, spatial proportion, spatial organization, and specific spatial conditions. These insights will then be generalised to guide the biasing of parameters in the design of improved workplaces.

Textual data surrounding workplace design features and specific workplace designs will be extracted through web crawling and analysed using language processing and sentiment analysis to provide useful insights relating to how people feel about specific workplaces, design parameters, and design features. Textual analysis will be segmented by types of workplaces and attributed to design parameters and design goals such as spatial organization, spatial features, interactable design elements, visual connectivity, and others.

Zaha Hadid Architects' Agent Based Semiology Research team has developed tools for designing workplaces and simulating human life process behaviour. These tools will be utilised to iteratively develop and test workplace designs for a series of social and spatial performance metrics. The toolset will enable designers to test options and simulate and predict how people would behave within them. Some of the metrics include producing spatial occupancy maps, quantifying spatial and asset utilisation, producing 3d spatial vision maps, quantifying and visualising social encounters and group behaviours. This will be coupled with spatial and asset analysis to predict how well a workplace design might perform.

3D virtual models of work environments are created and serve as the basis for innovative design ideas. The latter will arise through the synergy of artists, creatives with architects, whose propositions will be presented in AR/VR installations to end users. Online feedback from EEG, physiological sensing, integrated with environmental sensing, and Agent Based Parametric Semiology (ABPS) life process simulation modelling analysis (**Figures 7, 8**) will guide modifications to the initial designs to create environments that truly appeal to the people working in them and provide a platform for high quality social interactions.

3.2.4 Initial storyboard and function diagram

MindSpaces partner U2M will use terrestrial laser scanner and data from a custom-built 3D sensing platform to build 3D models of the original workspaces, which will be re-designed by architects (ZH, AUTH) and artists (ESP, MoBen, AN). ZH’s Agent Based Parametric Semiology life process modelling will be used to simulate and test social behaviour within proposed workplace designs (**Figures 9, 10, 11**). Users will participate in art-inspired immersive VR ABPS simulation design environments in Unity 3d game engine. These simulations coupled with direct user feedback data will be used as training data for an ABPS machine learning model to generate improved workplace designs (**Figure 6**).

In this pilot the targeted organizations are big companies, which occupy more than 200 employees, and need to renovate their workspace so as to maximize the engagement, productivity and interaction of their workers, architecture offices, that design efficient, functional and relaxing workspace (**Figures 12, 13, 14**).

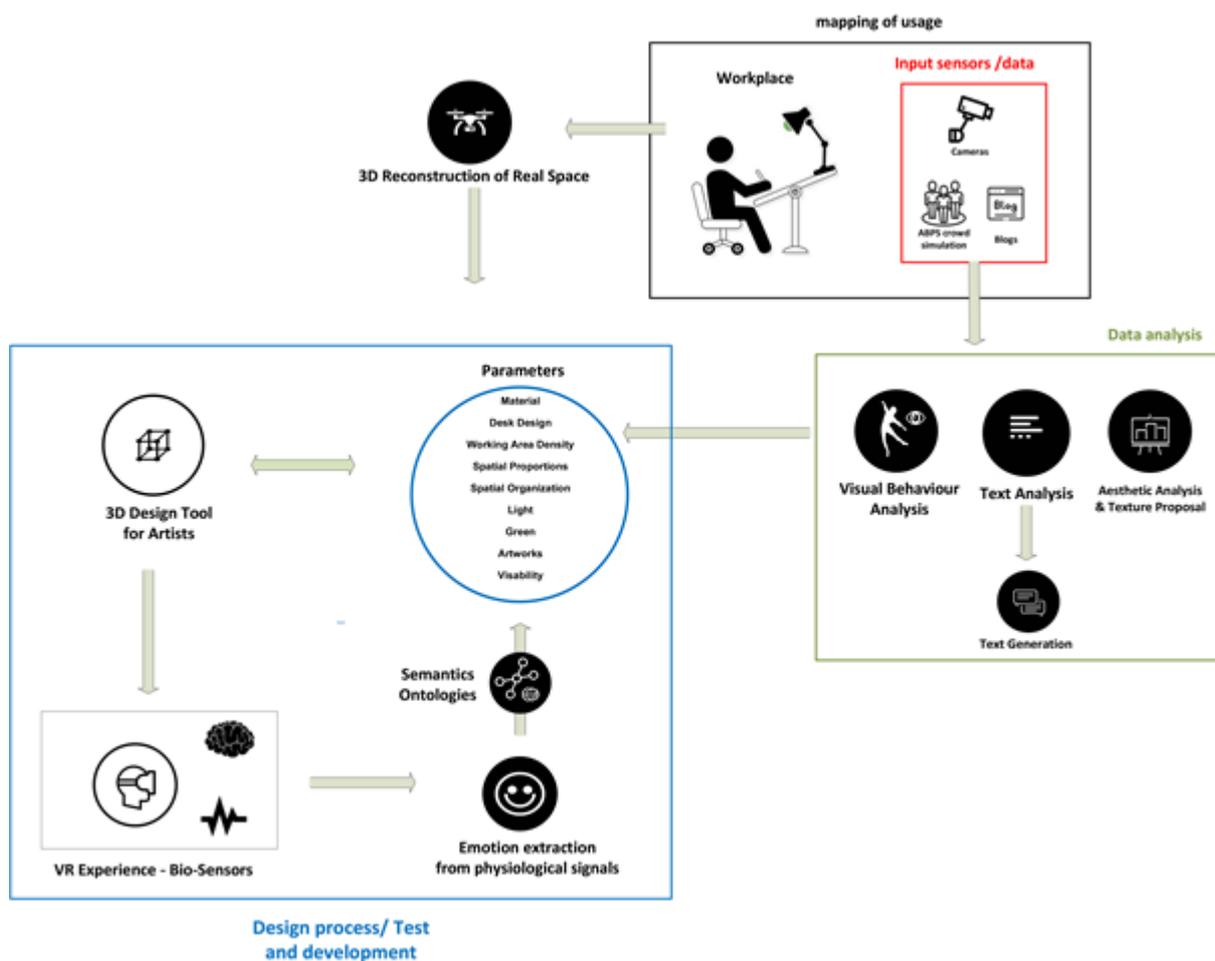


Figure 6: Pilot Use Case 2 Diagram: Inspiring workspaces

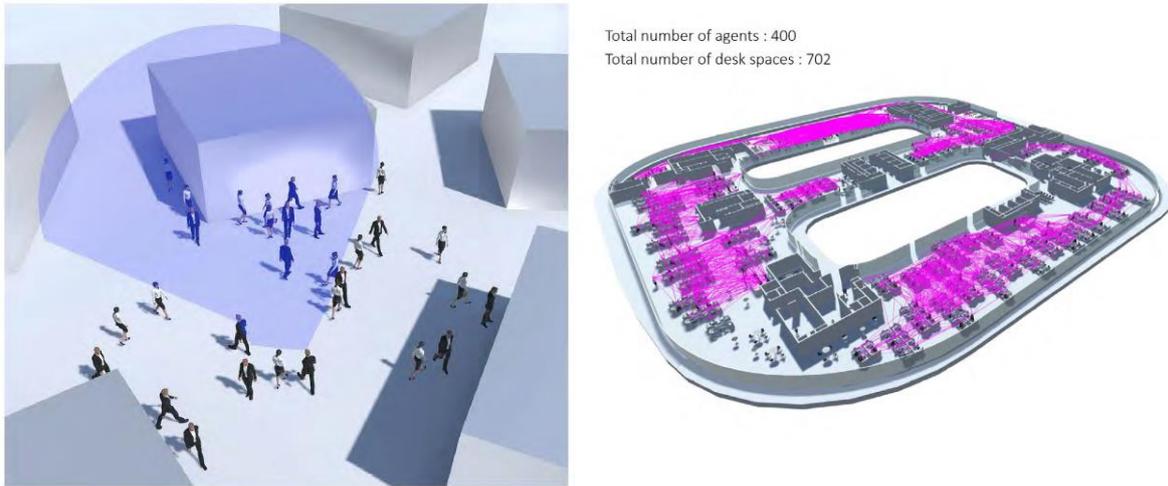


Figure 7: Autonomous Agent Simulated Perception



Figure 8: Autonomous Agents Simulations

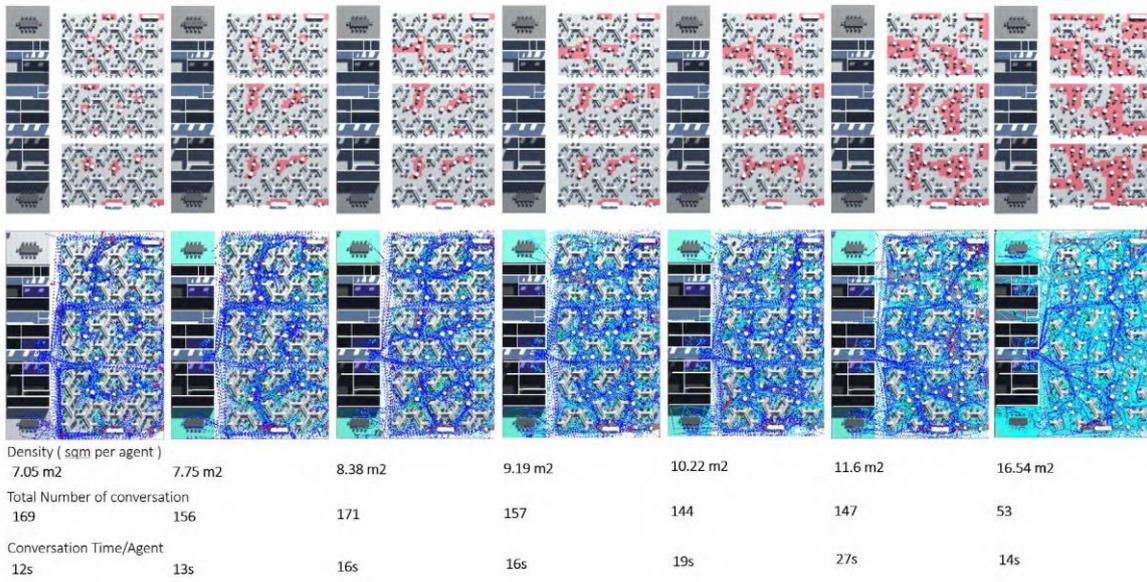


Figure 9: Spatial Organization Simulation Experiments



Figure 10: Data Visualization

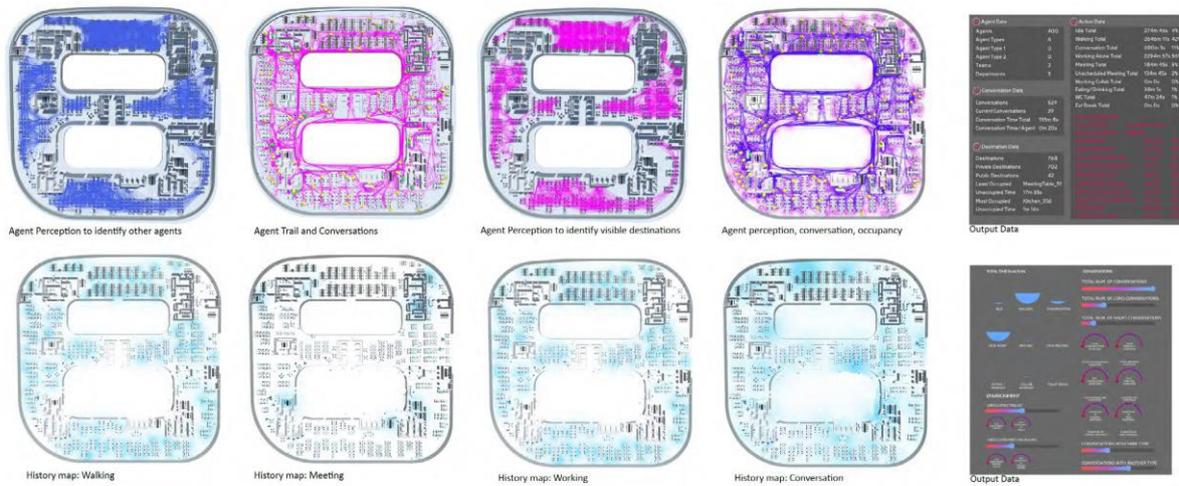


Figure 11: Data Visualization



Figure 12: VR Workplace Environments

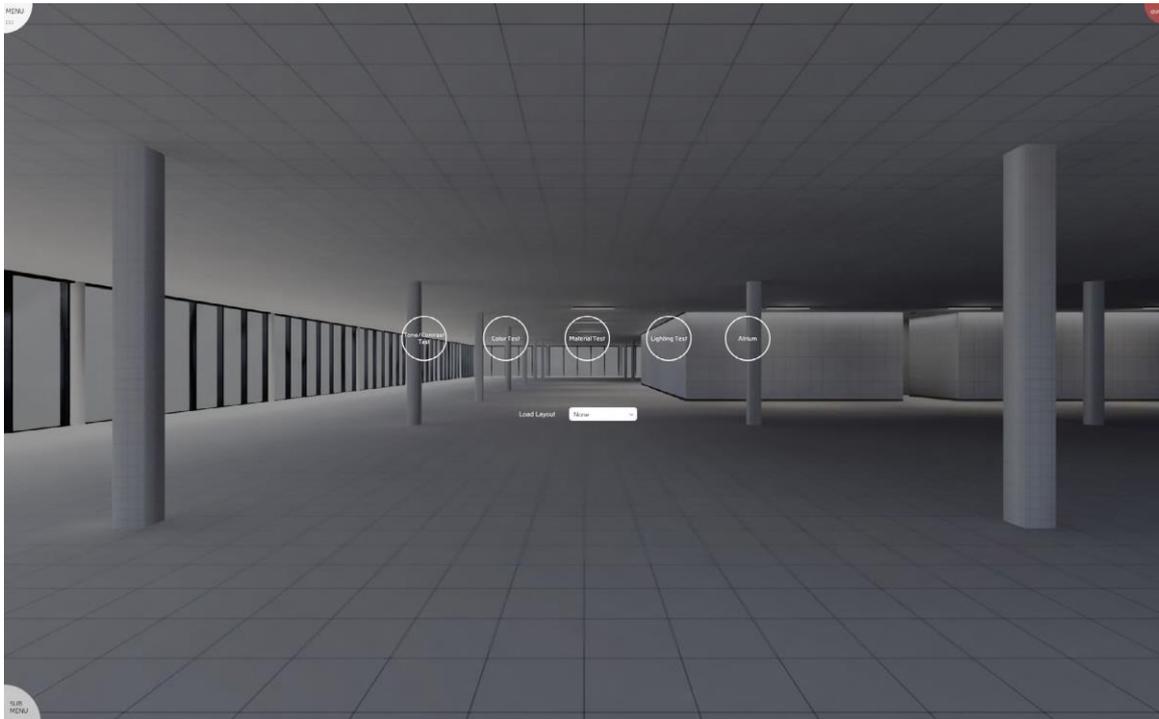


Figure 13: VR Workplace Parameters Experiments

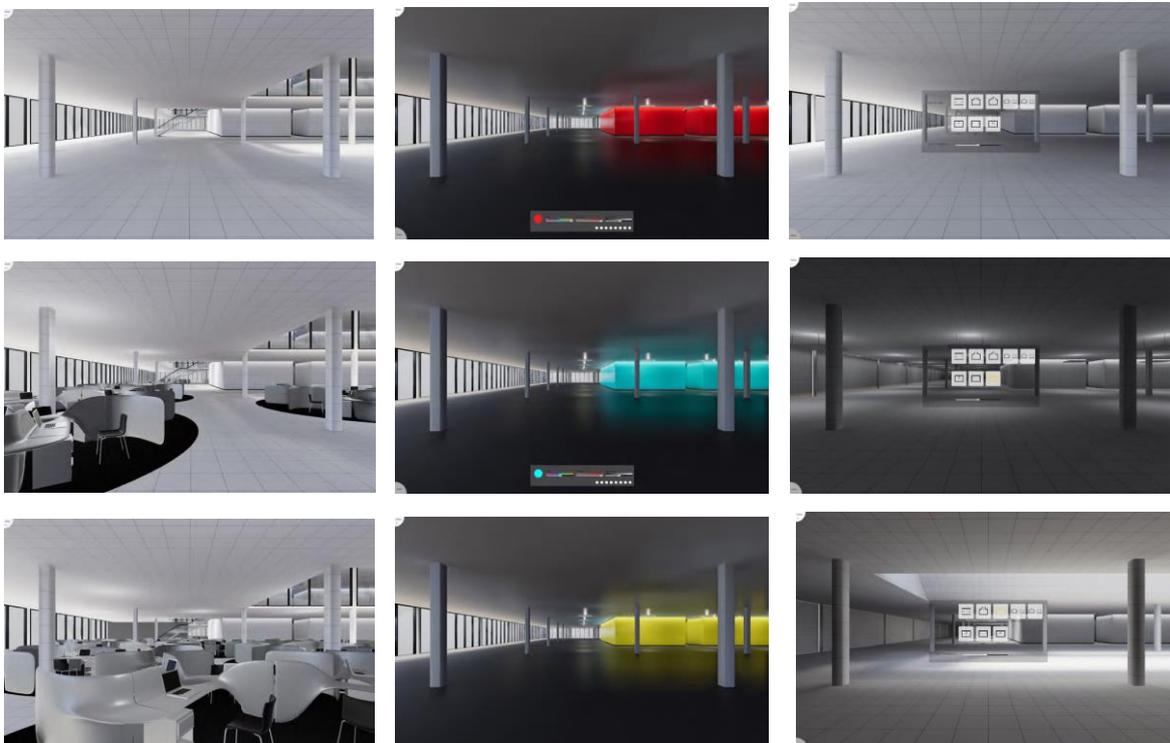


Figure 14: VR Workplace Parameters Experiments

3.3 PUC3 – Emotionally-sensitive functional interior design

3.3.1 Executive summary

Scenario topic: Emotionally-sensitive functional interior design

Architectural and interior design has always aimed at creating emotionally appealing and functional environments. But it is only in recent years that emotional effects and the usability/functionality of a designed space are being assessed in an objective, quantifiable manner and in such a way that quantitative data using multiple sensors now shows great potential to support design. Additionally, the widespread availability of digital representations of past aesthetic trends and features enables their innovative re-use and integration in new designs. MindSpaces will combine these trends, enabling the realization of aesthetically sensitive interior design that integrates the end users' responses and leverages specific aesthetic features that appeal to certain target groups.

3.3.2 Rationale

An association for seniors (E-Seniors) will ask a group of architects, such as a professional architecture office (ZH) collaborating with an academic unit (AUTH) to make a proposal for the re-design and refurbishment of an existing home, or the design of a new one, with the goal of making it emotionally and functionally senior-friendly. Architects (ZH, AUTH) in collaboration with artists (AN, MoBen) will design objects and spaces that evoke positive cognitive and emotional experiences and memories, by following design trends and aesthetic values likely to be appreciated by the elderly living there. 3D-models of the proposed designs will be imported in an AR and/or VR environment so as to be evaluated from the end-users based on their EEG and other physiological measurements.

3.3.3 Detailed description

The third pilot (PUC3) of the project will take place in a senior individual's home in the city of Paris. The senior will be between 60 and 85 years old, with no particular illness and live independently.

The senior will be recruited through E-Seniors channels, which include contact with social centres, mailing list, events, ICT classes and participation in previous European projects related to technology. After being explained the goals of the project, the results expected, the methodology, the technology used in the pilot test at home and all the implications of the participation in the project, the senior will sign an informed consent. The pilot procedure will be overseen by E-Seniors staff that will be present at all stages accompanying the senior, insuring a successful contact with the technical team in charge of the deployment of the pilot (CERTH, U2M, UPF) and informing and answering to pressing questions.

The proposal for PUC3 is to work on the themes of emotional support and affective state. Issues such as affective deficit (solitude, loss) and memory will be addressed.

At this stage (M6), interviews and focus groups with seniors have already been conducted in order to define their needs, their views and expectations. In general, what seniors look for in an artistic creation is to feel a wide range of emotions, to feel inspired, to connect with others and to understand the world around them. There is generally a positive feeling at home, a feeling of safety, but issues such as noise, limited luminosity, small size of Parisian homes or crowded interior living space were pointed out (**Figures 15, 16**). The contact with the outside environment and especially with nature is very valued as well as comfort and being in a house that is well equipped. The issue of autonomy is also a prominent one as it influences well-being and well-being at home. Finally, it should be noted that ageing individuals often try to stay active and to boost their creativity, many of them consider their homes as their refuge and source of inspiration. In PUC3, the goal of MindSpaces will be therefore to re-design and re-furbish a senior home to be emotionally reactive, comforting, appealing as well as inspirational.



Figure 15: The interior of a senior's home



Figure 16: The interior of a senior's home

3.3.4 Initial storyboard and function diagram

3D-scanners (U2M) will be used for the 2D and 3D-modelling of existing interior objects and spaces, forming the basis of new architectural design proposals at indoor level or space reconstructions by architects (ZH, AUTH). Sensor based feedback of the users' responses (by mobile EEG, physiological sensing, visual tracking of activities, behavior and use of space) will be used by architects and artists to guide the architectural design and artistic exploration. Their initial design ideas will be imported in a AR/VR environment (NURO) and will be assessed by the end-users via sensor feedback, leading to emotionally-adaptive design solutions (**Figure 17**). Targeted organizations: People that want to refurbish their dwellings, associations for the elderly, nursing homes, architecture offices that specialize in interior design.

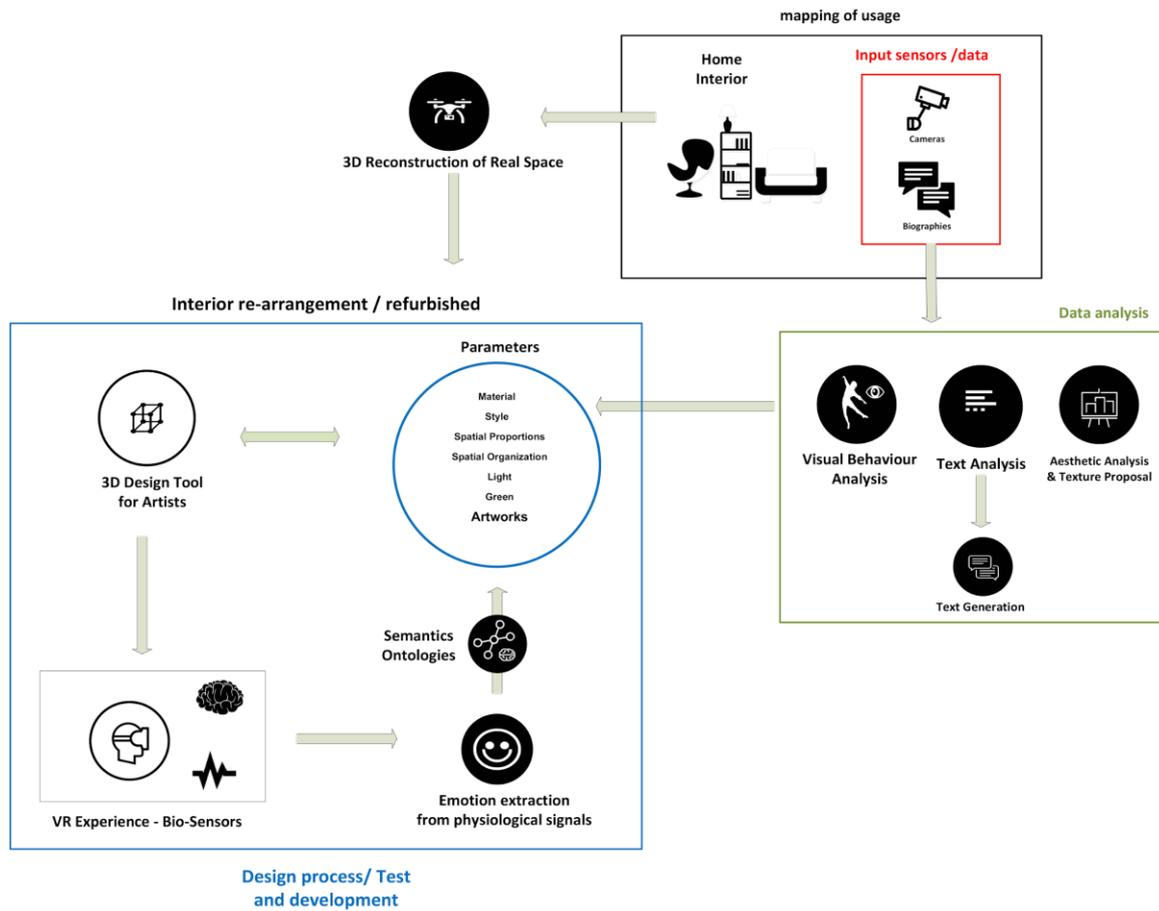


Figure 17: Pilot Use Case 3 Diagram: Emotionally-sensitive functional interior design

4 CONCLUSIONS

This deliverable describes an initial version of the pilot use cases and the pilot use case creation methodology as reflecting issues concerning design and modelling in architectural and urban scales, city outdoors and indoors space and the public realm. More specifically, it discusses issues regarding the three PUCs that are consisted of urban public space (L'Hospitalet), designing of professional environments (ZHA / McNeel) and the design of interior domestic environments (E-Seniors).

The PUC scenarios are presented and will be further updated and elaborated based on the extensive feedback provided by project partners, consisting of architecture professionals, local stakeholders, artists and art residents. Initial storyboards have been used to provide more concrete information on the way use cases can be developed. Besides, diagrams and visual material are addressing issues related to the way that the PUCs are operating.

This deliverable further discusses the creation of focus groups consisted, at this point, of members that come from user partners research team and associates, who participated in the discussions throughout the procedure of the proposal phase as well as user meetings. Finally, the deliverable elaborates on each PUC and the motivation and implementation of each case. The use case scenarios and the user requirements will be further developed and extended in the subsequent phases of the project.

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