C-SPACE

An affordable tool to turn the space surrounding us into a creative experience

Deliverable D.1.2

Use cases and data requirements

WP1 - Definition of use cases, requirements and system architecture

T.1.2 - Definition of use cases and system requirements (functional and non-functional)

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Authors:

Pier Giacomo Sola (Amitié)

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Reviewer(s)	Pier Giacomo Sola (Amitié) Raffaele De Amicis (Fondazione Graphitech) Bruno Simões (Fondazione Graphitech)
Editor(s)	Pier Giacomo Sola (Amitié) Raffaele De Amicis (Fondazione Graphitech) Bruno Simões (Fondazione Graphitech)
Partner in charge(s)	Amitié
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Acronyms

CA	Consortium Agreement
QRM	Quality and Risk Manager
GA	Grant Agreement
PC	Project Coordinator
TB	Technical Board
TL	Task Leader
WPL	Work Package Leader
GRAPHITECH	Fondazione Graphitech
VICOMTECH	Fundacion Centro de Tecnologias de Interaccion Visual y Comunicaciones Vicomtech
GISIG	GISIG - Geographical Information Systems International Group Associazione
Amitié	AMITIE SRL
FRAUNHOFER	Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V
TU/e	Technische Universiteit Eindhoven
EPSILON INTERNATIONAL	Epsilon Internasional Anonymi Etaireia Meleton Kai Symvoulon (Epsilon International Sa)
TECHNOPORT	TECHNOPORT SA

1. Introduction

The **c-Space** framework stems from a very simple idea that hinges on top of disruptive technologies, and that requires the crystallisation of its value through real-world domain applications. It is, therefore, important to define an assessment strategy based on the specification of a number of scenarios that can validate the functionalities proposed by **c-Space**. The three application domain proposed: *architecture and urban planning* (GISIG), *mobile advertisement* (TECHNOPORT) and *individual content creation & cultural tourism* (Amitié) are depicted into Project Pilots, geographically located and based on the requirements of the scenarios themselves, as well as on technologies considered suitable to reach those objectives.

The objective of this deliverable is to identify use cases that advantage of the functionalities expected as an outcome of the **c-Space** project, and that can be valuable to the validating process. Hence, this deliverable describes the first input as well as the expectations that were identified by the users and stakeholders of **c-Space** (which have the domain know-how) for the system architecture process. It describes specific processes in addition to the basic and high-level requirements (that are strongly characterized by the application domain) predicted by the users as essential for the design of the solution. Furthermore, users have also provided a verbose description of how they envision the use of the proposed technology, within their application domain.

Although the input received from the users represents a very be valuable contribution for the next stages of the project as well as a starting point, it might not reflect the true potential of the final system delivered by **c-Space**. First, we have identified that is difficult for users to understand the potential of an emerging technology, mostly because they try to compare its utility/value to existent or unsuccessful technologies. Hence, it might happen that technology with unrecognized potential to innovate of their processes needs is be marginalized. Therefore, these requirements they still have to be validated and refined from the technological point of view, that bring to the users a better understanding of the technology to be used. Lastly, technology is moving at fast pace. On the one hand, existent hardware limitations might have been underestimated. On the other hand, existent hardware limitations might now longer be an issue in a near future. So, the refinement process will ensure that the project gets the best out of the technology available.

During the refinement process we will use the know-how of Graphitech in the domain of Computer Graphics and Interaction Systems, the experience of Vicomtech in the area of avatar animation and emotion recognition, the knowledge of TUe in the domain of routing and recommender systems, the competences of EPSILON in scalable services, and long history of FRAUNHOFER in the process of 3D reconstruction from images, to shape the technology to the user needs and to demonstrate the potential of emerging and disruptive new technologies. To facilitate that process, c-**Space** will deploy an additional pilot - envision by the technical partners of **c-Space** – and that should be executed in parallel with the other pilots. This pilot will be technologically driven, and will explore novel solutions aiming at supporting the product innovation process, through disruptive/emerging technologies. This pilot will provide support to potential problems that can arise due to issues ranging from poor prediction of user interests to

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misunderstanding of the technology to be deployed. And it will provide users of other pilots with a better understanding of the potential of the **c-Space** technology, as we believe that it is challenging to interpret the potential of emerging technology at its current stage.

This deliverable is naturally complemented by the deliverable D1.3 (Project Requirements), that is reporting on the overall project requirements, in terms of technology to be used, cognitive experience to be provided to the user, data to be used by the application, as well as business and market requirements.

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2. Methodology

The aim of c-Space is to develop a new generation of low-cost creative tools that turn the real-space surrounding the user into the backdrop for new forms of creative content. The core service developed by c-Space builds on the creation and use of a library of videos, sounds and images, initially nurtured by existing sets of digital information and continuously enriched with new "scenes" created by casual users with their smartphones and tables. When new content is created, the central service of c-Space reacts by reconstructing, in almost real-time, a continuously evolving 4D model (3D plus time) of the corresponding real scene.

These 4D models can be explored in an augmented-reality (AR) environment that enables users to experience the surrounding scene from different points of view, at different moments in time, together with additional "augmented" content. In this way the user (individual user or creative industry) can also benefit of an easy-to-use low-cost technology that can be applied for creative applications, such as 3D game content creation, architecture, advertisement, cultural tourism, etc.

c-Space scenarios

Several new creative applications can be envisaged. Three domains have been identified for our first tests of the c-Space technology in practical scenarios. 1) Architecture and urban planning, 2) Mobile advertisement, and 3) Individual content creation & cultural tourism.

They have been selected due to the different challenges they are proposing to technology developers and their relevance for potential exploitation by European SMEs.

1. Architecture and urban planning:

The architecture and urban planning scenario is based on the assumption that creativity is, inter alia, what planners and architects need while they are thinking of a complex urban plan, the requalification of an urban area or, on a different scale, when they are designing how to reconstruct an old rundown construction. To get the pursued objectives in such kind of complex problems they usually work in teams, comparing ideas with a vision, to assess how their projects fit within the urban, historical, and cultural landscape context where the projects will be inserted. The challenge of the demonstrator is to provide professionals in urban planning and architecture the possibility to access a set of historical and morphological data through a number of standard web-services, which are used to retrieve data to "augment" the real scene. This demonstrator will allow studying collaborative solutions throughout "augmented" scenes that make it possible for the various people (professionals, city authorities and citizens) to join a participative/cooperative process (e.g. through annotations and authoring of various multimedia materials within the real scene). This process makes it possible to assess possible projects within the real landscape as automatically reconstructed by c-Space and starts a concrete collaboration involving architects and local planners as well as the dialogue with citizens and other local bodies. This

demonstrator, coordinated by GISIG, will be validated in Genoa, Italy, with the involvement of architects & local planners from the local city council engaged by GISIG.

Currently two different operational scales are possible: a larger "building scale" - creating models of the single buildings and structures that implements a "CAD" approach and gets "building models"; a smaller scale, to examine the dialogue of the building with its surrounding landscape, which implements a "GIS/mapping" approach and gets "landscape models".

2. Mobile advertisement

The original idea about this scenario moves from the assumption that advertisement is the most important component of marketing. Mobile advertisement, especially in the mobile App domain, has created new business models where advertisement is often based on visual features embedded within an App (from personal productivity, to entertainment, games, etc.). In the years to come, advertisement will be challenged by personalization with regard to the user's preferences, location and engagement. Starting from this assumption, the c-Space mobile application will allow simple authoring of "augmented" advertisement content that can then be implanted in a "real" scene. With this demonstrator, c-Space will rely upon on projected AR paradigms to deliver a richer experience and create more innovative forms of advertisement through projection -around the users- of interactive content on the real world (e.g. messages, graphics, representation of personal feelings including "I like" or "I dislike"), perfectly "blended" within the real scene. Examples of scenarios will include projection of information around the user while walking, or interacting with the device while sitting in a bar using a smartphone. This demonstrator will also be essential to explore, from a business standpoint, how augmented media streams can be used to generate further revenues through new forms of advertisement.

3: Individual content creation & cultural tourism

Here the basic idea is that, when planning a trip, travellers need to make a selection of the sites they want to visit from a large number of options. Standard tourist packages are losing appeal, as tourists increasingly seek dynamic and individual solutions that are tailored to their needs, interests and resources (time and money).

Starting from this viewpoint, a software component can be developed to create highly personalised cultural routes throughout a real space. Through c-Space clients, content creators can access digital content, reference it to the real space (e.g. an old picture can be referenced to a real building), and cross-link it to create a network of geographical and logical hyperlinks. This information network is used by c-Space to create highly personalised "cultural paths", highly dependent on personal profiles, through "smart" routing between sites, locations or activities, by accounting for psychological factors (e.g., need for entertainment, relaxation, new information, physical exercise etc.) and relationships between (cultural) objects or sites. This also allows creating a variety of different business mechanisms of relevance for SMEs, based on the offer of services (e.g. for temporary refreshment, relaxation or entertainment) according to the location and preferences of the user throughout a cultural tour.

A precise knowledge of position, context and profile of each user can be used to create narratives to be presented to the user by an "augmented" assistant. This will help them appreciate their surrounding scene

through available multimedia information (e.g. audio, graphics, pictures, 3D models, videos). This information is shown in a projective augmented space, e.g. by projecting specific content on the floor or around the user, augmenting existent content and enabling new form interaction, at individual and social level.

The feedback process between scenarios and the c-SPACE platform

In order to fine-tuning the ideas of the c-Space consortium and the potential of the new technology, to the actual needs, priorities and expectations of the professionals working in these sectors, the first activity run by the project has been the identification of stakeholders and key-actors working in the selected sectors, with the aim to present the c-Space objectives and discuss with them the architecture of the demonstrators.

Methodology for collecting user requirements

This analysis has been run by the three partner organizations in charge of preparation of the demonstrators (GISIG for Architecture and urban planning, Tech for Mobile advertisement, and Amitié for Individual content creation & cultural tourism) using a common checklist, presented in Annex 1, for collecting the input of stakeholders (professional and experts of the specific sector). The stakeholders have been contacted through focus groups, when it was possible to have several people around the same table, face to face interviews and telephone interviews for people living in different countries.

Thanks to this effort, whose results are presented in the following section, the original ideas have been discussed and revised according to the suggestions received, paving the way to the actual development of the c-Space platform.

3. From the original scenarios to the c-Space Pilots

Feedback from the stakeholders: Architecture and urban planning:

The c-Space pilot application that focuses on Architecture and Urban Planning, develops a demonstrator that will be validated, under the coordination of GISIG in the city of Genova, Italy. Other demonstrators are currently under discussion and could be added and reported in this description.

The vision imagined by the c-Space project partners for the pilot "Architecture and Urban Planning" has been discussed in the meetings held, in different occasions and in subsequent steps, with the officers of the Genova Municipality:

- the team of the innovation and technical development department:
  - the co-ordinator of the ICT Strategic Planning Department and of the International Projects Unit
  - a project officer in the Department
  - a technical assistant of the Department
- ICT Department, the responsible of the Municipal Mapping Centre and of the technical development in GIS
- Special Projects Department, the responsible of the Task Force for the transfer of the fortresses of Genova from the real estate of the central government to the Municipal one
- Officers of the European Projects Department.

They were requested to provide information about the transformation projects already under discussion, within the Municipality and with the local branches of the central government, for the transfer of fortresses and walls between the two different public estates; to give hints and suggestions about how the tools developed by the c-Space project would be able to answer to their needs and expectations; in other words to express their own requirements.

The discussion with the Municipality of Genova led to the decision of splitting the planned pilot in Genoa into two use cases, with the second one strictly related to the issues of cultural tourism.

What has been assessed by GISIG, thanks to the work carried out with the officers of the Genova Municipality, is below in the description of the pilot and of its use cases and allows a "scalar" understanding: from the general context of the problem to the specific issues addressed, under a unique tangible reference that is offered by the fortress and by the urban walls.

It has to be remarked here the collaborative approach found by GISIG: the theme chosen for the pilot is very present in this period in the Administration and finds its ground on very clear mandates stated by the Italian law on public estate. The transfer of responsibilities is a momentous theme that can find in c-Space an efficient help to answer to the commitments newly assigned to Italian local administration. This is the situation in Genova, but as well in many other cases.

Feedback from the stakeholders: Mobile advertisement

A selected group of entrepreneurs and experts specialised in the advertising, marketing and sales of innovative products and services was interviewed in Luxembourg for the purposes of the c-Space mobile advertising scenario. Those entrepreneurs were asked whether they had an interest in using the c-Space technologies for marketing their own products and services, if they considered the technologies foreseen relevant for such purposes and to which extent they could think of further business applications for c-Space beyond the specific mobile advertising scenario being discussed at Technoport (i.e. use of the c-Space system in a different business context).

Interviews were performed with the following stakeholders:

- Patrick Rahme - All Square (patrick@allsquaregolf.com)
- Philippe and Alex Papanastassiou – Business Quest (ap@businessquests.com)
- Thomas Schecker - Cubelux (thomas.schecker@cubelux.lu)
- Farid Meinköhn – Cybercultus (farid@cybercultus.com)
- Julien Friederich - City Mov' (j.friederich@citymov.lu)
- Victor de Witt - Every 1 (victor@every-one.co)
- Pierre Gérard and Martin Guerber – Jamendo (martin@jamendo.com)
- David Chquiry - Neotechpro (david.chquiry@neotechpro.com)
- Isabelle Dekens – OAT (isabelle@taotesting.com)
- Olivier Zéphir, manager of the co-working space and living labs at Technoport (olivier.zephir@technoport.lu)
- Thierry Silighini - free-lance marketer for the luxury goods industry (mustb@giovanivictorio.com)

All entrepreneurs were interested in using c-Space for marketing their own products and services. They moreover provided insights for further applications of the c-Space technology for events, customer testing or specific user experience purposes. Philippe Papanastassiou indicated that the tool could be used not only as standalone but also as a complement to a presentation made by a person, e.g. a salesman is presenting something with the support of 3D and with the reactions of the audience being analysed. That could be very relevant for training sales forces before attending key trade fairs for instance.

3D is moreover considered of great added-value for showcasing different products and enhancing customer services. According to Neotechpro, demand for innovative retail stores and shopping malls is currently very high. This is true in Europe but also in a number of emerging markets, such as Morocco, China, and Qatar where shops and 5* chains of hotels are exploring new marketing concepts. This can be a way for building owners and facility managers to animate some indoor spaces perceived as being too "static". However, as outlined by Thomas Schecker, shopping malls are not representing the lion's share in terms of advertising budget. Brands are more relevant to target. The c-Space technology could be highly relevant to them for applications in virtual showrooms or for test group purposes.

According to Alex Papanastassiou, 3D is considered likely to become a standard in marketing given the increasing trend towards customised design and fabrication of goods. It allows to showcase different versions of a product without having to produce and store them all. Thierry Silighini outlined that 3D/4D

was becoming increasingly popular and that its use was expanding, although a specific combination of technologies and high-quality creative content is necessary for campaigns to be successful. As that combination will become increasingly available from a number of marketing agencies, 3D/4D applications will spread from the luxury industry to mass consumer retail. At the moment, 3D advertising still tends to be available from specialised service providers only. Thomas Schecker outlined that it was still perceived by retailers as expensive and complicated to use in a daily business context. As a result, current use of mobile 3D is mostly at private or public events and shows, which are typically organised by the big brands (e.g. BMW for showcasing its concept cars or Ralph Lauren in Brussels for buzz marketing purposes). At such events, crowd-generated content is being produced and shared on social networks but such content is usually not integrated into the show itself. Crowd-generated content raises challenges in terms of being fully adequate with the brand image, as well as being suitable for the showcased brand in terms of quality and ownership. Victor de Witt had a more positive view and provided interesting insight as far as this specific issue is concerned. His own business is making heavily use of crow-sourced marketing content and he clearly sees a shift towards that type of material in the future. Most people do not believe anymore in traditional advertising and are considered much more responsive to ground content produced by their peers. Victor de Witt outlined that user-generated content is indeed of very high-added value for brands targeting the mass market (e.g. the food industry) and can be easily managed with a proper moderation procedure. Something to take into consideration in such a business model is the added-value and reward for the content provider. High-quality content is acknowledged to have a value and shouldn't be expected to be provided for free. Crowd content providers should be rewarded somehow by some cash back mechanisms, free gifts and products, or by having access to some special offers.

Several interviewees expressed a strong interest in creating haptic user experiences but the focus was mainly put on "3D + sound" immersive experiences. 3D + capture of a dynamic movement seems more complex to integrate in a mobile advertising scenario. The real-time dimension being explored in c-Space is perceived as a challenge in terms of implementation, although all interviewees acknowledged that it was both an interesting research topic and future trend for augmented reality. Some interest was reported by Thierry Silighini from cultural institutions in Luxembourg (e.g. the MUDAM) but the 4D technology behind it is perceived as being heavy and complex. There are concerns about implementing it in an outdoor environment, in a context of interactions with the general public, whom may not be yet technically "mature" enough for using the system on their own. In the field of creative industries, Olivier Zéphir outlined that choreographs could definitely make use of 4D in the field of contemporary dance, but the funding for such projects and return on investment is typically too difficult to obtain. Motor sports are considered a most promising sector, together with the gaming industry. 4D can allow fans to have an enhanced experience by feeling the real sensations associated with a performance and is considered to be relevant for showcasing and advertising purposes. Given the impact generated and expected by most sport-related industries when organising events, the investment would be justified if providing added-value towards media, sponsors, and gamers.

In the specific field of golf, Patrick Rahme indicated that virtual courses were indeed very relevant to the people, especially beginners, to be able to study distance and slopes and train for difficult holes. 3Dgoldesign.com offers such a service and they are quite successful with their product and service. Geo-

registered personal videos made on site and shared by golfers are relevant as well, but the added-value of 3D for such purposes is not that clear yet.

As regards the "emotion-recognition" technology, the interest among interviewees was indeed very high, since that offers opportunities for feedback and impact analysis during a specific campaign. However, it was outlined that it had to be used in a context in which people can get added value from the system, otherwise it might be perceived as intrusive.

The technology is considered to be highly relevant in the creative industries, where a very wide range of emotions can be generated and expressed. Pierre Gérard and Martin Guerber thus indicated that the potential of the tool for their own business was two-fold: 1. Identify the "mood" of a given audience and adapt the music to that specific mindset 2. Identify the emotions generated by the music, assess the impact and feelings induced, so as to feed the internal recommendation system and refine the categorisation of the music in a specific "theme" or playlist. Farid Meinköhn mentioned similar potential applications in the field of movies and TV content.

The possibility to organise user test groups for new products in a more interactive and appealing way while gathering "scientific-based" feedback is clearly perceived as an added-value offered by the c-Space system. The recording of emotions is not perceived as invasive by the user in such a collaborative context, given the fact that people volunteer to participate in a given test. As indicated by Olivier Zéphir, the same applies to the concept of living labs, during which video recordings are typically being made for further analysis purposes. Isabelle Dekens outlined that the concept could be used in training / education for checking if a given concept or question is clear enough to be used in ground sessions with students. A panel could be asked to pass a test based on 3D material and the system would pinpoint gaps in terms of understanding (e.g. the attention of most people was lost during that specific module or people were obviously puzzled when asked to answer question 20). This opens doors for interesting applications in 3D-based training, interactive testing and serious games, with the purpose of making the applications more user-friendly. According to Isabelle Dekens, use tests are especially important in those specific industries to detect at an early stage when a given step in a scenario is too tiring or boring or if a given situation is experienced as stressful.

The third technology integrated in c-Space, related to individual routing of users based on their profiles, interests, and time available is considered highly relevant in a marketing context for making personal offers and recommendations. If we take the example of Technoport, at the moment, the matchmaking between an implied demand (visitor who may be interested in) and an offer (start-up company active in a specific field) is made by the team at Technoport based on what is being known of the different stakeholders. We are not always aware of the real interests of the person (e.g. he/she likes golf), and there is currently no systemic ground for capturing such background information. This is a chicken and egg problem, which is being faced by all sales and marketing people: clients have to be well-known to be attracted, but they need at the same time to be already attracted in order to be well known. As a result, driving a new and relevant audience to specific products and services is considered a challenge. From that point of view, the recommendation system in c-Space can provide very strong added-value. The content recommendation feature is indeed considered a very key component in the system. Physical routing in contrast is surprisingly not considered that interesting to marketers, in spite of geolocalised marketing

having been a hype for quite a few years. The marketers outlined that this was more a practical support tool in the purchasing process than a triggering factor and that it was somehow out of the scope of the advertisement procedure in the strict sense.

An issue raised by personal routing in an advertising context is that it is perceived as a threat by the different stakeholders as soon as those are competing for a similar audience in a given territory. Alex Papanastassiou however outlined that personal routing can easily be applied at very large business exhibitions and fairs, a scenario in which the technology can be offered by a single decision maker, namely the organiser of the event. In such a context, personal routing provides added-value by allowing the people to optimise their visit and time. The same applies to Technoport, where some visitors are expected to be guided to specific entrepreneurs, in a logics of matchmaking and optimisation of contacts.

In some business scenarios, the routing technology can actually enhance services being offered. The key criterion is to have different services and options being made available by a single or already existing group of service providers. Farid Meinköhn indicated that in natural parks, 3D could be used to augment some scenes (e.g. show animals or landscapes not visible at that period of the year or during opening hours, i.e. sunsets or flowering deserts) while the recommendation system can successively guide people to different sites depending on their expressed preferences and needs (e.g. I would like to enjoy a quiet, isolated, or refreshing atmosphere or in contrast do a very intense and challenging ride). Cybercultus offers interactive television applications which support people in preparing customised trips and travels from home. With a dynamic mobile system, it was outlined that similar services could be offered on the road, possibly in a more spontaneous and adaptive way.

To conclude on the interviews, all participants considered the c-Space system interesting and liked the idea of testing it at Technoport. Interaction with a wide range of potential clients, partners and distributors is considered highly relevant by the entrepreneurs, as well as the idea to personally engage with them. C-Space offers businesses with opportunities to refine their communication strategies, get insight and feedback, as well as present their business in a smarter and more attractive way, to a better targeted audience.

Interviewees were very positive too about the idea of testing the system in the framework of an urban game. All technologies could be relevant in such a scenario, including the recognition of the emotional state of the participant (if some activities would become too tiring or frustrating at some stage, the game would dynamically adapt).

Feedback from the stakeholders: Individual content creation & cultural tourism

The pilot application focusing on Individual content creation & cultural tourism was to develop a demonstrator to be validated, under the coordination of Amitié in the city of Bologna, Italy, and Graphitech in the city of Trento, Italy.

The original vision imagined by the c-Space project partners has been presented to and discussed with twenty professional directly involved in cultural and tourism activities in Emilia-Romagna - the Region where Bologna is located, and Trento – where the c-Space coordinator Fondazione Graphitech is located and an important scientific museum is present, as well as with cultural professional living in Europe and in the United States, in order to catch other interesting ideas. In particular the people contacted were:

- Focus group held at Palazzo Fava, one of the museums managed by Genus Bononiae in Bologna, Italy.
  - Gian Mario Anselmi – Università di Bologna (gianmario.anselmi@unibo.it)
  - Chiara Magni – Centro Studi per il Rinascimento (chiara.magni.rinascimento@genusbononiae.it)
  - Sabine Frommel – Histara, Sorbonne, Université de Paris (sabinefrommel@gmail.com)
- Margherita Sani, project manager for museum education activities at IBACN, the regional Agency for Culture of the Emilia-Romagna Region, Italy (masani@regione.emilia-romagna.it).
- Focus group held at the regional Agency for Culture of the Emilia-Romagna Region, Italy.
  - Laura Carlini (lcarlini@regione.emilia-romagna.it)
  - Isabella Fabbri (ifabbri@regione.emilia-romagna.it)
  - Marvet Michela Guarino (mmguarinoguarino@regione.emilia-romagna.it)
  - Margherita Spinazzola (mspinazzola@regione.emilia-romagna.it)
  - Alessandro Zucchini (alzucchini@regione.emilia-romagna.it)
- Veronica Ceruti, Educator at MAMbo Museo Arte Moderna Bologna (Veronica.Ceruti@comune.bologna.it)
- Ilaria Orsi, responsible Marketing di Bologna Art Hotels (ilaria.orsi@inbo.it)
- Enzo Finocchiaro, responsible for European Policy and expert in tourism policy at the Provincia di Rimini, Italy (e.finocchiaro@provincia.rimini.it)
- Matteo Cattadori, educator at Muse Science Museum in Trento, Italy (mcattadori@gmail.com)
- Alessandro Ascari, Manager at "La Fisica in moto", Laboratory within Ducati Factory, Bologna, Italy (Alessandro.Ascari@ducati.com)
- Michele Mellara, film and documentary maker (mellara@mammutfilm.it)
- Massimo Negri, Director at the European Museum Academy, The Hague, The Netherlands (kriterion.negri@libero.it)
- Anja Schaluschke, Director of the Deutsche Museumbund, Berlin, Germany (Schaluschke@museumsbund.de)
- Julia Pagel, project manager at the Deutsche Museumbund, Berlin, Germany (pagel@museumsbund.de)
- Henrik Zip Sane, Director at Jamtli Museum, Oestersund, Sweden (henrik.zipsane@jamtli.com)
- Christina Kreps, professor at the University of Denver, Colorado, USA, Museum of Anthropology of the University of Denver (Christina.Kreps@du.edu)

They were requested to provide their opinion about their interest in the use of the new technologies developed by c-Space, as well as about the possible obstacles to implementation and large scale use of these technologies by professionals of the cultural sectors and creative enterprises. The local stakeholders have been requested to focus about their possible contributions in the organization of the use case, while the other stakeholders were asked to provide hints and ideas for possible applications in different contexts.

As far as the possible applications of technologies for creating 4D models in the cultural sector, there was a common consensus on the idea that the use of this technology within a museum seems not to be so powerful as per non-museum applications. Similar, even if not so powerful, technologies have been already used in previous applications without tangible success, so it is important to have very innovative tools for improving their success within the creative industry and tourism operators.

The c-Space technology can be used within a historical city centre (e.g. the city of Bologna), that usually includes several museums, interconnected through paths crossing the key areas of the city, and rich of several buildings belonging to Middle Age and Renaissance centuries. Often several buildings are not open to visitors, and their access could be made possible and enhanced by the 4D reconstruction model.

Similarly a special interest should be paid to applications in the analysis of architectonical models, in order to guide Art Historians. This technology could find several interesting applications for new projects to be presented in this field.

However several people remarked that the selection of videos, images and pictures necessary to drive the 4D reconstruction cannot be left only to the spontaneous contributions of ordinary people taking pictures to made available for the community, but should be supervised in a scientific way, in order to guarantee the quality of the information used, and avoid negative effects.

Concerning the possible use within buildings, e.g. museums, a possible application could be the development of a service able to drive operators during emergency / evacuation plans, to support them in the identification of the items to be secured during an earthquake, fire or flood, since it is very helpful to have a plan of the rooms / museum / library before entering the building.

Furthermore the technology seems to be very useful for operators of special museums, such as architecture museum, as well as cultural workers in the restoration activities, even if in these applications there is a limited need of a real-time functionality.

Concerning its potential as a tool for audience development, the technology can be a win-win solution to attract new people who currently do not use cultural services: in fact currently the generic cultural tourist is not accustomed yet to this kind of technology since he/she was never proposed such an application. There is then a large room for creating new services in this field.

At the end of the day all the stakeholders agree that the most relevant and effective use of this technology is when the users has to move from different places (e.g. driving along a cultural route, visiting a large historical city centre, or walking in a cultural park). Some pilot applications have been already developed and could provide the background for using the new powerful technology developed by c-Space in a

practical situation where the advantages of the new solutions could be easily compared to the previous solutions.

The final results show that applications focusing on the theme of "travel" do have a valuable interest. A cultural and sentimental journey along Via Emilia, the Roman road going to Rimini to Milan, could be perfectly used for the demonstrator, due to its numerous cultural and artistic interconnections and the richness of existing digital materials available for the pilot. Such a test bed would pave the way to a massive use of the c-Space technology within the network of European Cultural Routes.

A special interest should be reserved to scientific museums, since the use of the c-Space technology can become a key element of the presentation of the exhibits. Use of GIS tools within the museum is already in Muse museum in Trento, in order to know the position of the visitors and be ready to propose them information concerning the exhibits or the part of museum where are they are moving to. It is evident the opportunity to better interact with the users, receiving useful information about the blockbuster exhibits of the collection, as well as moving the visitors towards areas of the museum that are not so crowded at a given moment.

As far as the possible applications of technologies for capturing the "emotions" of the user, all stakeholders agree that it is interesting, even if it should be well tested, since the possibility of errors can be high. However it is not so evident how this technology can be widely used in the cultural heritage sector.

An App for smartphone partly using a similar technology was developed to celebrate the music composer Giuseppe Verdi, however the final decision was not to use the technology, due to the non-mature state of the art, as well as the privacy problems linked to the management of the information collected in this way.

The preliminary analysis run acknowledges the interest for this technology as far as the artistic creation is concerned, however they can be intrusive of privacy, and mainly focused on commercial objectives, far from the main goals of cultural institutions and creating several doubts about the ethical issues concerned. In fact the use of this technology within a museum or another cultural institution currently frightens the cultural operators: the emotion in front of the piece of art moves reactions that can be very different from person to person: not only changes in the facial expression, but also duration of the stay, coming back several times to the same exhibit, tears, sweat, etc.

This technology could be also perceived as a marketing and commercial activity, as a way to identify the characteristic of the visitors and profiling the users (as well as in supermarket, camera control are more interested in checking the attitudes of the consumer than avoiding theft), creating severe privacy problems. For the same reason also offering a gadget to the visitor according to the kind of emotion measured does not seem an interesting application.

The application of this technology could be checked on a group of users, instead of single visitors, since individual emotions can be difficult to interpret at individual level, e.g. it could be applied to the visitors attending an exhibition, in order to create cluster of visitors attending the museum in a specific moment. In this case we could focus on tools to better define the relationship between the visit to a museum and the emotions created by a piece of art, for better understanding how people "fall in love" with a work of

art instead of another. In this way different human senses could be used. Some experiences already started applied to the sensation created by some type of smell during the Smell Festival and the Museum of Perfume.

At the end of the day, the most interesting application can be outside the cultural institutions, in open spaces where tourists can be shown a set of different places of interest, while a camera is recording their attention and emotion. In this way it is be possible to create a personalized itinerary based on the reactions perceived, providing the user with arguments showing his/her reactions. The benefits generated of such application are also connected to the possibility to attract and tickled curiosity of visitors who are not the usual visitors of cultural institutions, and promote audience development. In this way the museums will reinforce their policy of moving "beyond their walls", increasing the interest of potential visitors even when they are not directly thinking at visiting a cultural site.

Screens located within hotels and shops of a city, providing information about the tourism offer available to the users could be easily adapted to host this technology promoting direct connections between business, creative industry and the cultural sector. This demonstrator can have a blockbuster effect thanks to its easiness to use and the enormous number of places where it can be easily installed.

Once more a different situation should be considered for scientific museums, where this kind of tools is already used by exhibit designer to catch the emotion of users in front of images or videos. The application consists of sensing the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. For this reason this technology could be applied in educational programmes, for better analysing how explanations and examples impact on the learning capacity of the students.

The further analysis concerned the third technology developed by the c-Space project, related to the possibility to define different user profiles, based on personal interest, time and money available, and other individual characteristics, in order to prepare personalised services (e.g. a customised tour of the town, visiting places that optimise the parameters defined by the user).

This is an interesting technology that can be effectively used in a cultural town. Stakeholders guess that it could support management of tourist flows in cultural sites / cities where too many people are visiting the place at the same time, but also in towns where tourists stay for half a day or for short periods. Working at the single tourist level, the technology can be used to propose different solutions to users with different characteristics, and can be very useful on a city scale. However this technology is useful, if the feedback provided is "honest", proposing solutions but also mentioning what is left behind by adopting the proposed solution. Another element to be included in the system would be to track the previous uses of the service by each specific user, in order to check how he/she was satisfied with the solutions previously proposed by the system.

On the other side, the risk is to create a very sophisticated tool, not really useful for people who have limited information sources for implementing the system and managing the feedback. Often the specificity and novelty of the actual needs make difficult to create the background system able to nurture an automatic process.

The use of this technology could be effectively tested during major exhibition events (such as Art Fair and the Children Book Fair in Bologna, when several thousands of people interested in cultural topics come to the city for professional matters and could take profit of such a tool).

Finally most of the stakeholders contacted expressed their willingness and interest in contributing to the development of the demonstrator. Several participants underlined the importance to connect the proposed services to the main social networks, in order to stress the creation of communities of users with similar interests.

As additional suggestions concerning the development of technology, a special attention would be paid to propose tools for managing post visit services: one of the main role of museums is to stimulate curiosity in the visitors, based on their capacity of proposing further activities or visits after the end if the visit. It is important not only provide documentation about the visit just done (as the Museum of Modern Art in New York City already do) but improve communication and run an integrated marketing for stimulating new actions.

The European Museum Academy is willing to establish a permanent collaboration with the c-Space project, for presenting its results in the European conferences and events organised by the Academy, as well as for publishing articles about the project within the EMA newsletter.

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4. C-Space Pilot 1: Architecture and urban planning

Contributors: GISIG

4.1 Pilot Overview

The functional recovery, the rehabilitation and the re-use of some old buildings and architectonic structures emerging in the city of today is a big challenge. In fact it is necessary to find updated uses, matching with the present needs whilst at the same time not to distort and change irrevocably the character of the old structures that still remain as relicts in the city.

This is also the case of the military architecture, moreover accompanied by additional and demanding features: structures very big and strongly characterized and difficult to adapt, bad conservation state after a long period of disposal, high costs for recovery and maintenance, apparent incompatibility with present uses and needs.

The challenge is double: on the one hand the requalification (functional and architectonic) at the building scale, on the other its presence within the urban body and, in case, in its surrounding landscape, to be used as a chance for urban and social re-qualification of a district.

A remarkable example of the problem represented by the recovery of old and apparently useless urban relicts is in the city of Genova. In fact Genova still holds a remarkable urban heritage represented by its system of walls and fortresses: that is, the walls, the fortresses therein included and also a series of external fortresses controlling the surrounding hills and valleys. Despite of the importance of such heritage and of an already shared awareness about it, it is a really big challenge to find feasible ways for its urban re-use. The reuse should be affordable in terms of costs and, even more important, sustainable along the time and rooted into the urban and social fabric of city and citizens.

Problems to be solved are diverse and at different levels:

1. costs to recover the single structure, at minimum in terms of a safe access/visit for any use
2. costs of maintenance, resulting into the need of individuating an operator who can sustain them in the framework of its own activity
3. the need to individuate a suitable use for each single structure
4. the integration of those structures into the urban context (e.g. in terms of accessibility and exploitability)
5. a good embedding into the use and attendance by citizens (well beyond any possible tourism use), that comes after validation and wide acceptance of the proposed solutions
6. integration of the uses of the different structures and buildings into an urban systems of fortresses, perceived as a complex entity: likewise that tourists and citizens recognize unitarily the Genova Old Harbour, it would be a success if we shall be able of getting symmetrically a vision of "Fortresses and walls of Genova", also exploiting the capability of the urban walls as an (even physical) path for integration

Really c-Space can offer an important help in such a direction. The key aspect of the project for doing it is its capability to offer new tools that enrich the surrounding space, creating a new context that joins together reality and creative content. The newly created scene becomes a "virtual stage" for augmented reality.

Moreover the application contexts investigated by the project (architecture & urban planning, culture & tourism, information and promotion to users) perfectly fit into the local Genoese question -exploitation of old fortresses- we are now dealing about.

Finally, the above shown situation would be, in terms of appeal and of physical location, also a perfect stage for the design of an urban game. This opportunity will be verified together with the teams responsible for the other use cases, for checking the most promising conditions for such application.

The process carried out to create synergy between the c-Space project and the Genova Municipal administration, that is facing the challenge of a renovated future for the urban walls, has led to individuate the following elements that must be developed:

- the two different possible "horizons" to approach the problem, that is: an architectonic scale (the building of the fortress and its modelling) and an urban/landscape scale (the fortress in its surrounding context, the walls, the landscape model)
- the best location to start the implementation of a "Genova case", with a choice that was motivated by dimensions and aspect of the building, appertaining areas, position and panorama

The following steps, running also independently from the c-Space project, are now in progress:

- use of the chosen building
- the progressive project development steps, that must be sustainable along the time
- involvement of new actors
- a better step by step exploitation and promotion of the achieved results

The moment is good for action and there is a real willingness to do, also due to a running process that will transfer the property of the buildings from the state to the local Administration. The Administrations are aware of the existing potentiality and motivated to offer new spaces for leisure and culture to the citizens. In this moment, c-Space can give strong support to add value to the work that must be done at the two above outlined scales (building, landscape). That is the reason why the two use cases developed in the Genova pilot will investigate those different scales.

From an operational point of view the initial conditions of the whole Genova pilot are:

- Digital data are available only for the building(s) and the site. That is, the CAD files for the fortress and the mapping files of the territory
- Limitations are: the maps of the areas of interest are at their larger scale 1:2000, from the Municipality and 1:5000 from Regione Liguria. Regione Liguria lets available as well a complete set of thematic maps, especially as regards the environment, both in downloadable vector and in WMS.
- Presently no 3D-models of buildings are available and moreover their internal structure is not even fully digitised.

- A rich set of historical documents is available: paintings, drawings, photos and post-cards; as well as stories and texts of description, but only a very limited part of it has been exported to digital form. In practice this work should be done almost ex-novo. Fortunately inventories are available that enable a focussed search of documentation material
- Furthermore several experts are available, both in the Municipality and in the University

Data sources used:

Apart the availability of GIS data that describe the district of interest at different scales, and include also geology, elevation, hydrography and so on, there is a very limited availability of digital data, e.g. historical maps, design drawings, imagery, description texts and so on. A survey is still in progress with a series of stakeholders for a screening that will allow to focus the research and the work, in order to digitize in a faster way the information of interest.

Involved Stakeholders:

- the Municipality of Genova, that will be in a near future responsible for the system of walls and fortresses. That system is in fact currently passing from the real estate of the central Government to the local properties of the Genova city
- again the Municipality of Genova as holder both of many civic archives and of all the plans for future re-use
- associations of citizens and sport groups, that will be involved in the management of the system and in the project of its future uses
- tourism operators, both as managers of future permanent structures (resorts, restaurants, sport and cultural facilities, …) and as carriers of the tourism flow
- the mountain Associations that take care of the trail signs prepared for the hikers
- the environmental Associations that organize excursions
- University and culture centres for the project of cultural activity (e.g. historical research and setting of historical events to commemorate), scientific support and information.

Beneficiaries are:

- the Municipality that will transform a new management load (the defence system of Genova to be transferred to its local assets) into an opportunity that can be offered to the public
- the tourism operators that will have available , in their commercial offer, new assets of the city to be promoted and will also have new opportunities to develop programs and organize events
- the SMEs, in the ICT and multimedia sectors, that will be committed to develop the SW tools that will be used to implement the exploitation of those assets
- citizens and tourists, who will have new possibilities for leisure and sport.

Actors:

- Researcher

  He/she ensures to the projects background and coherence with the state-of-the-art of the research. Researchers of the Genova University and other Research Centres have a long-lasting expertise that enables them to support the civic Administration in the implementation of any innovative project. That is, they are super partes consultants that feed and/or validate the innovation proposed to the Administration;

- Officer and planner

  He/she elaborates projects in line with the policy of the Administration and with its annual budget

  Inside the Civic Administration he has specific technical competence and an academic scientific background, in domains such as architecture, structural calculus, cost-benefit analysis, urban sociology. By working in a team with the researchers of the different application domains they develop a range of projects that has its background into the strategic plan of the Administration and analyses into details the requirements for the various alternatives, from a technical and economic point of view. A dossier is then created, containing the project technical description and a cost benefit analysis of the alternatives, and considering as well the possible urban and social impacts;

- Data holder

  He/she manages, inside the Administration or not, the data needed for initiatives and projects.

  Inside the Administration or not, he takes part into the process as the person in charge of database(s) of interest, in digital or non-digital form, and of whatever content (GIS and mapping, historical, geological, social and so on), and delivers that data to officers and planners;

  Main holder of data is the Genova Municipality, which has already collected a large amount of data and information on the urban fortresses, architectonic and historical. However the University of Genova as well has a long expertise and data availability.

- Decision maker

  He/she makes a screening in order to submit a short list of plans to Administrators and City Council.

  He is the person in charge to submit to the Administrators and to the City Council one (or some) feasible proposals, properly documented, for the re-use of structures. He does that starting from the work of analysis previously carried out by the technical staff and creates a short list of alternatives, for the discussion and for the following decisions.

- User

  He/she exploits the results, for him/herself (final user) or for final users.

  The main users are instead found in the audience of citizens and tourists and in the related organizations that will take benefit from the final products of the project. However they can be either final users benefiting of renovated structures as just said, but –also- professionals of tourism that need new opportunities and a better offer of leisure facilities in order to create from it occasions and initiatives for the benefit of final users, be they tourists and citizens.

Starting from what aforesaid, hereinafter are drafted in a preliminary version the use cases planned for the Genova pilot. Altogether they are intended as a contribution for the overall planned design of the re-use of Genoese walls and fortresses, and should be able in the end to deliver effective solutions to the above six questions.

4.2   Use Case 1:   Building and site modelling as a support to architects for design

Description

It is planned to produce models of the sites and of the buildings starting from mapping and from GIS data integrated with the construction data of those buildings. Such data is derived from new survey, from CAD recent files when available, from digitization of paper drawings. It is enriched with imagery, recent or not (photos, videos).

It is also enriched with accompanying texts, that describe the present situation but also the original state at the construction time and its following evolutions along the centuries.

Actors

> Researcher
> Officer and planner
> Data holder[1]

Initial conditions

The operators must have access to different archives, in different URLs, so they have to register in advance to them and be logged them at the same time.

The operators need to create their own work-space with a fast access repository of all the material they need to develop their project on the building and with the possibility to save its subsequent steps because it is a complex work that needs several sessions.

Moreover they would like to use c-Space as a "system-of-systems". In other words they should be enabled to use their ordinary tools for drawing, modelling and rendering inside a c-Space work-session. This is more than a simple compatibility with different file formats (but in any case the compatibility of final outputs with the most common available tools should be ensured).

Main process

Researcher
The user (in this case a researcher) has access to the system and creates his own "virtual bookshelf", which allows him to have at his hand all the bricks he needs, e.g. file, URLs, etc. The heart of the system is a 3D spatial grid that is a location where to hold the different components of a 3D model, including non- 3D ones, for example, an image that can be warped on the model.

All points of this 3D lattice that maps the points of the real 3D space give access to a "hidden" dimension, which contains all the information in form of images and text, and may be mixed, if necessary, with the spatial data. In particular, the entire system allows the user to transfer the so built model over time and is thus able to give a diachronic representation of what happens / happened in space. In this way, the

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[1] Describe the position of Decision Maker

system adds a further dimension that introduces the user in a five-dimensional "c - space."[2]. The user creates his own "augmented model" and transfers it into any available tool of advanced visualization, or a multimedia product for the web, or finally, after suitable post-processing, into a "frozen" output for traditional editing. The user puts all his outputs into a virtual "basket of offerings", where it can be retrieved by all other actors.

Officer and planner

The user (in this case an officer or a planner) exploits the outputs delivered by the researcher (he himself could be also a contributor of the work done by the researcher, because he is owner of the data about the current status and the plans). He makes his choice in the "basket of offerings" and uses it to distinguish from it the feasible hypotheses and transfer them into plans, projects and whatever he is asked to set up in order to facilitate the decision making process.

Data holder

He collaborates with the researcher in the crucial phase of preparing the model. He can be a mere contributor of data but his work could also include the phase of analysis and search needed to prepare the list of available data. Moreover, and according to the different situations and his personal expertise, the data holder can work or not for the export of data from the original format (either traditional or digital) to the needed one.

Expected results

The c-Space model is available for any use that could arise in the time and it is composed of: augmented reality model; an accompanying archive of digital texts and imagery; the possibility to produce instances of the model in different times.

2We like to think that this somehow creates a parallel between the "c-Space " and the space of the 5-dimensional KK theory Kaluza - Klein, 1921

4.3 Use Case 2: Site and landscape modelling as a support to landscape architects and tourism operators, to tell stories and to guide citizens and tourists

Description

It is planned to set up a framework valid at the landscape level to create a context of augmented reality. That is, the objective is to get a tool to produce models of the sites and of the landscape in which they are inserted, always starting from mapping and geo-data integrated with models of the single buildings, imagery and digital terrain models warped on the so-created model of landscape; elevation profiles are also planned. The objective is to create as just said a representation of the reality that can be customized and used for: I) the description of the landscape itself and of its morphological characteristics, ii) the creation and documentation of hiking trails, III) reconstruction of historical events and situations and finally for iv) a diachronic representation of the site.

Such work is derived from GIS data, from new surveys, from CAD recent files when available, from digitization of paper drawings. It is enriched with imagery, recent or not (photos, videos). Even more than in the previous case is also enriched with accompanying texts, that describe the present situation but also the original state at the construction time and its following evolutions along the centuries.

Actors

    Researcher
    Officer and planner
    Data holder
    User[3]

Initial conditions

The operators must have access to different archives, in different URLs, so they have to register in advance to them and be logged them at the same time.

The operators need to create their own work-space with a fast access repository of all the material they need to develop their project on the building and with the possibility to save its subsequent steps because it is a complex work that needs several sessions.

Moreover they would like to use c-Space as a "system-of-systems". In other words they should be enabled to use their ordinary tools for drawing, modelling and rendering inside a c-Space work-session. This is more than a simple compatibility with different file formats (but in any case the compatibility of final outputs with the most common available tools should be ensured)

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[3] Describe the position of Decision Maker

The different from Use Case 1 is that the needed datasets and references are now including the tools and the data specifically referred to landscape: but the context is the same, at a different scale of analysis and representation

Main process

Researcher

Many things are similar to use case 1, and are repeated here for convenience.   The user (in this case a researcher) has access to the system and creates his own "virtual bookshelf ", which allows him to have at his hand all the bricks he needs.

The heart of the system is a 3D spatial grid that is a location where to hold the different components of a 3D model, including non- 3D ones. All points of this 3D lattice that maps the points of the real 3D space give access to a "hidden" dimension, which contains all the information in form of images and text, and may be mixed, if necessary, with the spatial data.

In particular, the entire system allows the user to transfer the so built model over time and is thus able to give a diachronic representation of what happens / happened in space. In this way, the system adds a further dimension that introduces the user in a five-dimensional "c - space."[4].

The user creates his own "augmented model" and transfers it into any available tool of advanced visualization, or a multimedia product for the web, or finally, after suitable post-processing, into a "frozen" output for traditional editing.

The user puts all his outputs into a virtual "basket of offerings", where it can be retrieved by all other actors.

However differences are present that are:

- In this case it is important to collect the data about the panorama from the site and tools are needed in order to integrate this within the landscape model. An approach similar to that one of panoramic boards for orienteering should be proposed, and the possibility to add information should be offered for all azimuths and all sites within the horizon
- As well it is important any data about roads, and paths. If possible the model should be able to ingest GPS paths (e.g. gpx files) and show them on the landscape model, also in perspective, to offer a clear idea of the development of the path. Vice versa it should be possible to export a path, previously individuated in perspective on the model, to a planimetric file in gpx format
- Similarly it should be possible to transfer into a perspective view the information coming from on field survey (e.g. location of trenches and development of historical paths)

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[4]We like to think that this somehow creates a parallel between the "c-Space " and the space of the 5-dimensional KK theory Kaluza - Klein, 1921

Officer and planner

No additional needs comparing to the use case no. 1, that says: The user (in this case an officer or a planner) exploits the outputs delivered by the researcher (he himself could be also a contributor of the work done by the researcher, because he is owner of the data about the current status and the plans). He makes his choice in the "basket of offerings" and uses it to distinguish from it the feasible hypotheses and transfer them into plans, projects and whatever he is asked to set up in order to facilitate the decision making process.

Data holder

As in use case no. 1, he collaborates with the researcher in the crucial phase of preparing the model. He can be a mere contributor of data but his work could also include the phase of analysis and search needed to prepare the list of available data. Moreover, and according to the different situations and his personal expertise, the data holder can act or not for the export of data from the original format (either traditional or digital) to the needed one.

However in this use case is also present an "open" component related to users' participation and to their possible contribution to the knowledge. It is then important the c-Space approach and the possibility it offers to add information, e.g. via photos and videos of the situation in a given moment. For this reason the system has to offer the possibility of an external input, and consequently of showing to the user how his input has contributed to the system.

User

In this use-case that is strictly related to tourism exploitation, the final user has a fundamental role that is summarised below:

- the user accesses the c-Space system and chooses a point where to stay to interact with the model.
- he/she sees the whole landscape--model, during the time, and sees both its overall evolution and the specific information about a point of the model (what is there; what was there in the past; which are the information associated to the point, what happened there). All of this can be done both working on a 2d-planar representation (i.e., on a map) or in perspective
- he/she sees a road on the model, be it existing now or in the past, or any other 1-D entity (a trench, a river, old walls), or 2-D (fields, woods) and even 3-D feature (a structure, a geological formation) and is able to locate it on a map and to a GPS receiver, e.g. he/she is able to follow him in the reality, on the field.
- Conversely if he has GPS information of a track, and so on, he/she can transfer it on the model for a clearer understanding of the situation
- finally he is able to enrich the model with his own information and receive back his contribution as add-on to the model

Expected results

The main concepts are already expressed in use case no. 1, That is, the c-Space model is available for any use that could arise in the time and it is composed of: augmented reality model, in this case of building(s) and complex landscape; an accompanying archive of digital texts and imagery; the possibility to produce instances of the model in different times.

We think however important to outline some specific and meaningful results of this use case, always in relation with its "tourism component":

- aerial videos from remote-drones, to catch people's attention, show the elements and structure of military architecture –rather difficult to distinguish with ordinary perspective vision, so offering a vision of the link between the military complex and the below town, to immediately understand the urban structure and its development (historical roads from the town to the inland, what is near to you but beyond the hill)
- creation of paths within the fortresses and along the walls, to be put within a time-depending context thanks to augmented reality
- show in augmented reality of not only the still present evidence of old trenches, very difficult to single out for non-expert people, but as well of the position of opposing troops in the occasions of battles and combats
- show of the old snow reservoirs (neviere), some of which still remain
- creation and multimedia tagging of trail markers (either actual and in augmented reality) of the paths that, starting from the city, ascend to the hills towards the Apennine and the beyond lands (Oltregiogo), in collaboration with the federation of ramblers –FIE- and the Italian Alpine Club –CAI-.
- always in collaboration with the sport reference associations, organization of orienteering games
- reconstruction of the original morphology of places, In fact to understand the mountain structure and the hydrographic network gives a good tool to understand places and implicitly supports a more conscious environmental awareness. Moreover, as regards geology you can also see the geological structure (e.g. stone layers and slopes) and so you understand the reasons of landslides; and you understand the change in the hydrographic network and what is a river capture; you see where are located the marine terraces, also some hundred meters above the present sea level
- lastly and linked to the option for an urban game in the final steps of the project, the possibility of setting an historical event (starting from the XVIII century and arriving to the 2nd World War, there are several options)

5. C-Space Pilot 2: Mobile advertisement

Contributors: Technoport; TUe

5.1 Pilot Overview

The idea of the pilot at Technoport is a virtual presentation of innovative products and services from hosted companies to people visiting the incubator. When walking around in our cafeteria/co-working/ meeting space at 2nd floor of the building, the people will be surrounded by advertising material projected on a table, ground or wall (virtual billboard). That augmented-reality based 3D advertising material will showcase the start-up companies supported by the incubator, based on advertising content supplied by the entrepreneurs.

The 3D/4D content people will interact with in the virtual exhibition, will be recommended to them by the recommender system in c-Space. Based on the background of the visitor, the languages spoken (there will be text in English or French available in the presentations), time constraints and fields of interest, recommendations will be made to have a look first at X, then at Y, etc. The system will thus adapt the advertisement to each specific person and to a specific context, providing them with the most relevant content among the different showcases available to them in the global virtual exhibition.

The visitors will interact with specific presentations as recommended and their emotions will be captured by the c-Space tool. In addition, people will be invited by the system to make/project/select some comments in relation with a given content, e.g. "I like it", "this is interesting", "I don't understand", "I want to know more".

At the end of the virtual visit, the recommendation system will suggest follow-up activities to the people, e.g. go and visit the companies they had most interest in (provision of contact details and location, e.g. we suggest that you meet Mrs X at Agilis Engineering and this is where you can find her) or will make suggestions for further relevant virtual presentations not yet seen (e.g. "thank you for using c-Space. Next time you visit Technoport, we suggest you have a look at...").

Data sources used:

Existing marketing material from the companies will be used for the pilot, such as logos, brochures, video presentations, pictures, 3D models of products, and sound files. All content available for the demonstrator is in principle static, but to make use of 4D reconstruction, a specific outdoor scene will be made available, featuring a dynamic movement. That scene will involve an electric car turning around the corner of the building and moving around a nearby parking space. The dynamic scene as reconstructed will be added to the real view of the parking which can be seen by any visitor from the windows of Technoport.

Something very useful for the entrepreneurs would be to be able to upload new content on a continuous basis (e.g. change the 3D model and text being showcased so as to present a new product). A key requirement in marketing is not as much in very sophisticated content (4D video) as in the renewal of the message on a regular basis. It would be very useful if a kind of "Multimedia Template Editor" could be implemented, allowing staff at Technoport or start-up companies to update their promotional material on the fly. This means that the initial library of videos, sounds and images could be continuously enriched, though in a different way than the crowd-source video content foreseen in the initial scenarios.

The recommender system will use:

1. the data provided to the system at login for initial filtering of the content being showcased,
2. the comments selected and emotions recorded during the presentations for the suggestions of follow-up activities at the end of the virtual visit.

In terms of physical routing and if we want to make use of navigation and public transportation in the scenario, we may consider guiding people interested in visiting a company in Luxembourg City to the train station in Belval and have them take a train from there to reach their destination (provided the system can cover the distance of 20-25 Km). However, we know that public transportation is not the preferred option of our visitors, who typically come to Belval by car. Indoor routing might be more relevant for the scenario (i.e. guiding people to the offices of the start-ups indoor) but our preferred option would be to use the i-locate application for such purposes (to avoid overlaps in terms of technologies).

Involved Stakeholders:

Stakeholders involved in the pilot are entrepreneurs hosted at Technoport or supported by the incubator. Those will be the content providers and the business beneficiaries in the pilot. The demonstrator will moreover include a public of potential clients, partners and investors targeted by the companies and brought to the incubator for demo and marketing purposes. Any and all visitors to Technoport will be targeted as well. Those will be entrepreneurs, business managers or public stakeholders. Some of them may have a technical background, while others may be more sales or marketing-oriented with no specific experience in 3D or augmented reality.

5.2 Use Case 1: Advertising of companies at Technoport

Description

Technoport is supporting IT and industrial companies in Luxembourg, some of which are hosted in the main building of the incubator (9 avenue des Hauts-Fourneaux in Belval), others being located elsewhere in Luxembourg. Those companies offer highly innovative products and services. The added-value of those is not always easily communicated by businesses to the right audience. There is a strong need for engagement, feedback and interaction with potential target customers on an ongoing basis.

The idea of the demonstrator is to:

1. allow businesses active in different fields to better identify potentially relevant users of their offer in a deal flow of visitors and attract them (based on the personal recommendation system in c-Space)
2. catch the attention of users and personally engage with them (based on visually attractive 3D/4D presentations of products and services)
3. gather feedback and qualitative insight from the audience (based on comments and the analysis of micro-expressions by the c-Space emotion recognition tool).

Actors

All kinds of local and international visitors at the incubator: potential clients or partners of the companies showcased; high-tech entrepreneurs; investors; innovation managers; marketers; creative entrepreneurs; public stakeholders; delegations from foreign science parks.

Initial conditions

The application can be downloaded in-house and any specific hardware/software material needed will be made available to the people on site.

Main process

The USER logs into the SYSTEM using social login (LinkedIn/Facebook) or registering by merely providing one's fist name, name and company/university/institution if any (this alternative is important to provide since from experience, apps where social login is a must-have are not very well perceived by the audience. We would like it to remain an option).

The SYSTEM asks questions about the USER's fields of interest, language spoken, and time available.

The USER is asked to select:

- two different fields of interest among: industrial technologies; green technologies; social networks; mobility; sport; retail; entertainment/media and/or education/training.
- languages: English only or English and French

and is being asked to indicate the time he/she has for a virtual visit (if the system can calculate how many presentations can be made) or (if not) the USER is being asked by the SYSTEM to indicate whether he/she would like to see 1, 2, 3 or 4 presentations

Based on the answers of the USER, the SYSTEM chooses a specific company presentation that the user should see first and filters the content in the virtual exhibition.

Specific 3D objects, pictures, text, sound and video content is being displayed as a result to the USER. While the USER goes through the presentation, the SYSTEM records the user's emotions and reactions.

While the USER goes through the presentation and/or at the end of it, the SYSTEM asks the USER to make/select comments in terms of:

- Understanding: the service offered by the company is clear to me: YES / NO
- Attractiveness: I like it: YES / NO
- Impact: I could personally use it: YES / NO / SOMEHOW
- Interest: I would like to know more about the company: YES / NO

After the end of the first presentation and provided there is some time left, the system recommends a second one and so on, until the personal virtual scenario has been fully performed.

As that stage and based on the user feedback (answers to questions + emotions recorded during presentations), the system makes last and final recommendations to the USER. There are two possibilities here, which the system is expected to choose from:

a) if an interest was perceived in some presentations, the system:

- o recommends to visit/meet specific companies or entrepreneurs (provision of contact details, geolocalisation and possibly routing), and

b) if no interest was perceived for the presentations made, the system:

- o taking into account the negative feedback, provides recommendations for other type of content the USER might see later on, i.e. the SYSTEM make recommendations for the next visit of the USER at Technoport, providing a new and different list of content the USER might have a look at next time.

Expected results

A key interest in terms of advertising / marketing is to be able to get quantitative and qualitative statistics and measure the impact of a specific showcase or campaign. Any track record of experiences which may be made available by the system will provide strong added-value to the advertisement scenario.

A highly interesting output of the use case for Technoport would be to gather exploitable data from the system in terms of : content being seen (which presentations are most and least in line with the interests of the users and are therefore being more or less showcased), emotions expressed by the audience (e.g. 80 people were pleased when interacting with this presentation, but 20 looked puzzled), annotations/comment generated or selected by the USER (e.g. number of "I like" or "I would personally use it" gathered when showcasing a given company presentation). Those kinds of metrics are considered

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extremely important for the further exploitation of c-Space beyond the current pilot scenario, given their added-value for brands and advertisers from a general point of view.

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6. C-Space Pilot 3: Individual content creation & cultural tourism

Contributors: Amitié; TUe

6.1 Pilot Overview

> **The Via Æmilia is named after the Roman consul Marcus Æmilius Lepidus, who created it in 187 BC. It ran, largely in a straight line, 260 km from Rimini to its termination at Piacenza, passing through the cities of Forlì, Faenza, Bologna, Modena, Reggio and Parma.**
>
> **See also http://www.viaemiliaedintorni.it/opencms/opencms/progettoViaEmilia/viaEmilia.jsp**

The Kuoni tour operator organised travel, accommodation and logistics of several thousand Chinese businessmen participating in the Expo 2015, held in Milan, Italy. After spending some days in Milan, visiting the commercial stands of the exhibitions, one of these groups, interested in the biomedical sector, move to Modena, for finalising a commercial agreement with the District of Biomedical Industries of the province. The programme also includes some pleasure activities, including a visit to the Ferrari factory - to see the cars that won the highest numbers of Formula 1 Grand Prix competitions, as well as the Luciano Pavarotti museum - to listen to some original recordings of the great Maestro of the Italian Opera. Before coming to Rome to take the flight back to Beijing, the group stop in Bologna for one night, staying at the Art Hotel in the City Centre.

At the Hotel, they receive plenty of information concerning Bologna, the city of the oldest university in the world, both in paper and electronic form. They are informed that the c-Space App for tablet and smartphone is also available to help them in optimising the few hours they will spend in Bologna. According to the preferences, the time available, the mood of each participant (or a group of them) they can receive a personalised programme for optimising their city tour. Wong Cho decided to spend one more week in Italy, to take a rest and discovered something more about a country he poorly knows. For this reason he came with his wife and their 12 years old boy. The grand-grandfather of Wong Cho had been working within the

Italian concession at the beginning of the XX Century in Tianjin, his hometown, and since he was a boy he was used to see old Italian objects, left by his grandparent. He was very happy for the visit at Modena, since – as a medicine doctor – he had the opportunity to discovered very innovative tools to be used for a rapid detection of pancreas cancer, and – as an amateur violin player – he really enjoyed the visit to the Pavarotti's house.

While the other colleagues – who are going to come back home on the following day – are choosing their personal tour, Wong Cho remembers the c-Space application after seeing a promotional panel and decides to download it on his tablet. After agreeing on being recorded for a more personalized experience, he is presented with the main information about the city, its history and tourism opportunities. He clicks on one option and a video is presented showing the main places of interest of Bologna. He is surprised by discovering how many historical places are present in a city he never heard about. He searches on the application for further information, discovering that most of the highlighted places on the application are getting his attention. At certain point, he is informed that a list of several places of interest has been selected for him based on his emotional reactions during the interaction with the application. He accepts
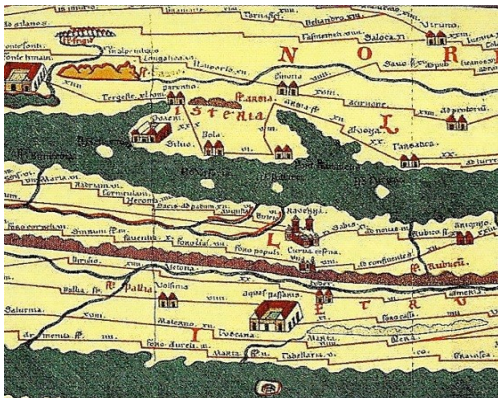
and becomes surprised by the feedback received through the c-Space tool: the top of his interests and emotional feeling was when he was shown the exhibits of Anatomy Wax Museum at the University of Bologna, and the Museum of Ancient Musical Instruments.

In the following morning all the family go to the Museum of Ancient Musical Instruments, where they discover that the ticket is also valid to access all the other museums of the Genus Bononiae network. All of them seem to be interesting, however they would like not to spend the full day within museums, because the boy would get bored and they read that the most attractive experience is getting lost in the medieval narrow streets of the Bologna city centre. At the entrance of the museum they are also informed that they can download the c-Space App for tablet able to drive them in selecting how to optimise his visit. The boy is really amused, and helps the father how to combine visits to the museums and buildings of major interest with a walk downtown, also looking for some tasting of the famous Bolognaise cuisine.

Unfortunately in the afternoon they face two disappointing situations. Firstly they discover that the XIII century-building King Heinz Palace is under repairs, and they cannot perceive the full facade. Never mind: thanks to the c-Space App for 4D reconstruction model, they take some pictures of the area closed for repairs and in a few seconds receive full information not only about the sections now closed to public, just as they were inside the area, but also how the building was during its history, since the captivity of King Heinz. The tour of Bologna was very interesting however it took more time than expected, so that –

arriving to the Anatomy Wax Museum – they discover to have just 20 minutes for completing the tour, since the closing time is imminent and the museum is close during the week-end. However thanks to the c-Space system uploaded on his smartphone, Wong Cho receives useful recommendations how optimising the tour, selecting the more interesting exhibits. Despite the short time, they take several pictures and thanks to the community support provided through the c-Space App for 4D reconstruction model, they can collect pictures of all the items of interest. In this way Wong Cho will be able to look at them in the evening and also when he will be back home to China.

After spending some good time in Bologna, they are curious to discover other attractions in the Region.

Using the c-Space App, he reads that several interesting places are located along the Via Emilia, the ancient Roman road crossing the region. Wong Cho was told that on Sunday the main wine cellars are open to the public, so they hire a car and drive to the Regional Wine Cellar in Dozza, where they can also visit the village to have a look at the Painted Walls, the murales created by major artists from all over the world. Once more thanks to the c-Space App, they can see not only the murales currently painted on the walls, but also all those that have been covered by the new ones since 1965, when the festival started. They can compare the transformations of the same building every two years, according to the new pieces of art created during the bi-annual art festival.

Summer is close and the weather is really hot, so the family drive to Rimini, to get some rest at the seaside resort. They stop there for a small seaside holiday, however Wong Cho is once more surprised by the c-Space App, by which he is informed that the world greatest collection of ancient medical instruments has been discovered few years ago in the city centre of Rimini. The emotion of seeing the old tools used by surgeons living 2000 years ago is equal only to the pleasure of having the opportunity to discover, thanks to the c-Space App, a lot of information and 4D reconstruction of the archaeological area, and have the impression to be the personal doctor of the Emperor Augustus.

Data sources used:

- High quality images and videos of historical buildings, museums, archaeological sites along the Via Emilia road.
- Opening time and address of museums and cultural heritage sites, restaurants.
- Timetable of public transport, contact information to rent a car services.
- Information concerning the user, directly provided by the user in his/her profile when connecting to the c-Space system, as well as taken from alternative sources (e.g. social networks where the use is registered).

Involved Stakeholders:

- Regional Agency for Culture.
- Regional museums.

- Tourism associations.
- Regional and local tourism information centres.

6.2   Use Case 1:   4D Reconstruction of places along Via Æmilia

Description

The use case reproduces the conditions of the pilot previously described, as far as the reconstruction of a 4D reconstruction (3D plus time) is concerned. The use case simulates the provision of information by the user to define the object of his/her interest, and a reaction by the system to provide a full reconstruction of the object itself.

Actors

Cultural bodies and operators of the Emilia-Romagna region and its cities, namely Bologna and Rimini.

Initial conditions

The availability of a mobile device, information screen or other electronic devices in hotels, shops, and taxi of the city of Bologna. The user is provided with a tablet or mobile phone able to download the application for running the system locally.

Main process

- The user logs in into the system.
- The system localizes the position of the user.
- The user takes some pictures and videos of the building, place of his/her interest.
- The system makes a search in its database, to collect all the available information, and is able to improve the point of view of the user, thanks to the local information received by the user him/herself.
- The system provides a 4D reconstruction model of the area.
- The user navigates through the model, with the possibility to create virtual and augmented reality by manipulating objects, adding and removing elements of his/her interest.

Expected results

- The system updates its databases with the new local information provided by the user.

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6.3 Use Case 2: Sentimental journey through the streets of Bologna

Description

The use case reproduces the conditions of the pilot previously described, as far as the capturing of the user emotions is concerned. The use case simulates that the user looks at images and videos of the cultural tourism offer available, and is provided with the information concerning his/her emotional reactions in front of the materials just seen.

Actors

Cultural bodies and operators of the Emilia-Romagna region and its cities, namely Bologna and Rimini.

Initial conditions

The availability of a mobile device, information screen or other electronic devices in some hotels, shops, and taxi of the city of Bologna.

Main process

- The user installs the application or is provided with a device that has it.
- The system asks the user if he accepts to be recorded for a more personalized experience.
- The user is presented with the main menu of the application and chooses to watch a video showing a presentation of the city. Once finished, he navigates through the application content
- After a few minutes using the application, the user is requested if he/she would like to know his/her reactions and emotion during his/her interaction. The system provides the user with the analysis of his/her emotional status during the projection of the video and following navigation. The user is informed about the location / places where his/her emotion was high.
- The user is requested to comment the results of the emotional analysis and if he/she is willing to store anonymously the information gathered for research purposes. In case of negative answer, any information recorded is immediately deleted from the system.

Expected results

- If allowed by the user, the system updates its databases with the new local information just collected.

6.4 Use Case 3:   Maximise your cultural visit to Bologna

Description

The use case reproduces the conditions of the pilot previously described, as far as the optimisation of a cultural tour in Bologna. According to his/her preferences, money and time available, the user receives a personalised programme for optimising the city tour. In the use case the user is requested to provide his/her personal preferences, and – when possible – feelings and mood, according to the Use Case 2, and is provided with the information concerning the different options optimising the constraint defined by the user.

Actors

Cultural bodies and operators of the Emilia-Romagna region and its cities, namely Bologna and Rimini.

Initial conditions

The user is provided with a tablet or mobile phone able to download the application for running the system locally.

Main process

- The user logs in into the system.
- The system localizes the position of the user.
- The system ask some information to the user, asking to specify time available, budget constraints, physical impairments, and any other preference.
- The system makes a search in its database, and proposes some different options for city tours, all of them responding to the specifications inputted by the user.
- The system also informs the user about the other interesting cultural objects that have not been included in the proposed options, and ask the user is he/she want to revise his/her previous specifications.
- The user accepts one of the proposed options, or revises his/her preferences previously specified. In the first case the process stops, in the second the sequence of steps is repeated

Expected results

- If allowed by the user, the system updates its databases with the new local information provided by the user.

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Annexes

Annex 1: Pilot - Cultural Heritage of Trento

Contributors: Graphitech

Existent limitations to interest-based discover content are attributed to single-platform access that inevitably leaves a proportion of interest-based content underexposed, as well as to structural constraints inherent to a rigid hierarchical architecture, limited interaction, inhomogeneity of cross-platform social media, lack of cross-platform interaction mechanism and control over the content.

Interest-based content discovery in a cross-platform context could facilitate user immersion and an interactive experience through non-hierarchical customization and enhanced individual choice in a continuously dynamic unstructured content environment.

Not only efficient content discovery mechanisms are crutial for citizens searching for some particular information, but also to the c-Space framework that hevily relies on content produced by its users – directly through its application or indirectly via public available web 2.0 channels (e.g. Twitter, online pictures, YouTube, etc.).

This pilot is designed to validate the social component of c-Space framework in a scenario based on the cultural heritage of Trento. Existent data about the city of Trento (3D reconstruction of the city from the Medieval period up to now; which includes also the Roman age) will be augmented with UGC in a sort of 4D immersive Wikipedia of the history of Trento, which will bring together artisanal SMEs and citizens into a common interest-based framework. Several mechanisms will be developed to guarantee its sustainability.

The pilot will be deployed in two incremental phases. The first one, continuously stimulated by relevant content discovery, aims at validating new forms of interaction with content (via MUSE pre-pilot). The feedback provided by citizens will be taken into consideration and users' requirements will be reajusted if necessary. Then a second phase of the pilot will be deployed to bring to life the framework that will support a temporal augmented version of Trento and that will enable its users to explore different periods of Trento's history. Artisanal SMEs will benift from exposure, either directly by actively contributing with new artefacts (3D objects that they produce and that are related to a certain period, or 4D reconstructions of specific production processes - how they produce the artifacts) or indirectly through its inclusion in a gamification approach.

Description of the MUSE pre-pilot (first phase)

c-Space will showcase a pre-demonstrator application to validate the use of micro-projection technology, as well people's familiarity with Augmented Reality. By combining these two technologies, c-Space users can visualize and interact with a predefined set of reconstructed models as part of a creative process.
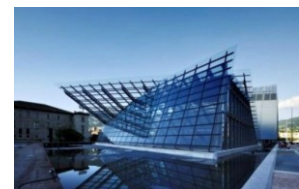
The c-Space project will be presented during an exhibition at MUSE (acronym of MUseo delle ScienzE – Science Museum), during an exhibition that develops on 6 floors and occupies a surface of roughly 5,000 square metres.

Designed by Renzo Piano, MUSE is characterized by a refined, futuristic profile, a homage to the peaks of the mountains that surround Trento. Within the museum, the relationship between science and society is developed along the horizontal axis of the building. For instance, visitors can explore the theory of evolution and notice how the presence of human beings has gradually modified life in the environments they have occupied. Along the vertical axis of the building, visitors can explore different settings and observe the changes that are caused by variations in altitude, by differences in habitat and their specific biodiversity. It starts on the top floor with high peaks and extreme glaciers, and goes down to below sea level in the basement.

Actors

The target users of this pilot are the visitors of the museum interested in wood works. Most likely, it will aim adults in specific due to the nature of the data that has to be visualized.

Initial conditions

The initial conditions are the existence of a pico-projection system, data concerning the 3D representation of the wood objects, and the existence and use of user interaction interfaces.

Main process

This pilot aims at helping users with the creation of personalized parquet (or door), wooden tables, or see-saw objects, as part of a creative process. Users will augment existent wood materials with simulated data in order to model and visualize material changes.

First the visitor is invited to select a wood sample, from a selection of 7 real samples, close to the workbench. Once he/she chooses the sample, he/she has to place it on a specific area of the workbench, where the sample is acquired by a mobile device. Doing so, the full-scale texture of the selected wooden species will be projected on an interaction surface. In addition to basic interaction operations like rotate, move and zoom the object, the visitor will be able to experiment and carry out a series of processes on the "material".

The processes available are:

- Thermal wood treatment;
- Wood staining;
- Wood coating ;
- Wood varnishing.

After selected the option "thermal treatment", through ubiquitous interfaces, the visitor has to pick the temperature to be used during the treatment process. Once the simulation is computed, the texture of the object will be updated to reflect the expected darker tones.

If, instead, the process desired is "staining" then the visitor will have to choose the colour of the stain and, accordingly, the "object" will receive a semi-transparent colour that superimposes the original wooden texture to reflect the output of the treatment. The visitor can repeat the action, (i.e. add more stain layers) thus increasing the intensity of the applied colour.

After selected the option "coating", the visitor can choose the colour of the coating and, accordingly, the "object" will receive an opaque colour that covers the wooden texture. Finally the visitor can also apply some "varnish" to the material.

The visitor can consult a technical data sheet (TDS) of the material once it presents a good-looking appearance. The TDS contains, but is not limited to, the description of the wooden species, temperature of the thermal treatment, and the type of the finishing used by the visitor to obtain the projected results. Additionally, it describes the number of finish layers, estimated cost of the process (raw material + cost of processes), density of the material (that will depend on the selected species and the applied thermal treatment),impact (average energy used for: a) production of the raw material, b) the selected thermal treatment, c) production of the finish technique).

In addition, the visitor can choose to have more information about each of the following characteristics:

- **Wooden species:** images of the tree, geographical distribution of the tree species, anatomic sections at the macroscale and at the microscale;
- **Thermal treatment;**
- **Finishing product:** what are the advantages/disadvantages for each finishing technique.

Expected results

The results expected as outcome for this pre-pilot are two. First, it will validate the use of the micro-projection technology, which has a key role in the c-Space vision. Visitors will use and interact with projected surfaces as a visualization screen. Then it will put together mobile devices, projectors and augmented reality, which will create the "virtual stage" for ubiquitous media creation and sharing. Once validated this technology, we will explore the use of affective and recommender systems, as well as a 4D reconstruction pipeline.

Description of the second phase of the pilot

The second phase of the pilot will provide a conceptual framework to overcome some of the limitations of interactivity described above. It will bridge content generated across multiple platforms, with new forms of user interaction. User interaction will be geared to enable preferred topic filtering, flexibly shifting participation roles, notifications, and navigation through external data sources. The concept of community will be geared towards interest-based access as a new approach to bring together communities aiming at different goals (e.g. Google+ - where users talk to people they want to know (Interest Graph); Twitter - where users comunicate with people they don't know (Broadcast Medium); Facebook - where users communicate to people they know (Relationship Graph)). Hence, combining technological communities like Google+ and Twitter with communities more oriented to promote relationships and their interaction, such as Facebook.

This pilot will prime challenges related with the access to big data repositories (Images, videos, 4D reconstructions at large scale augmented with UGC, etc). One of challenge's is ascribed to a potential cognitive overload. When information supply exceeded individual processing capacity, the overload leads to stress and to segmented engagement. To avoid this problem, c-Space will implement a set mechanisms that will help users accessing and managing data not only through new visualization metaphours at software and hardware level (e.g. pico projectors, Google glasses, etc) but also through novel mechanisms based on user profiling, which provide its users with context-aware notifications and content filtering.

The sustainability of this pilot can be maintained at three different levels:

- at cultural level by SMEs, as a platform where SMEs can introduce or present their products (linked to the history of Trento)
- at tourism level, by visitors interested in getting more involved with local traditions or seeking for further information (monuments/landscape can be enhanced with time-dependent information like for example the creation process or with information about artisanal SMEs that are currently producing related artefacts). Visitors can use this information to find new POI, where they can learn more or where they can buy certain souvenirs.
- at city level, by citizens interested in supporting their history and culture. For example, schools can use the c-Space framework as an educational tool, with the support of the local community.

Actors

Tourism agencies; Tourists, City citizens; Schools; Artisanal SMEs

Initial conditions

The initial conditions are the existence of a pico-projection system, some data concerning the 3D representation of the city of Trento across different periods, and the use of wearable user interfaces.

Main process

The citizen initiates the application and setup their profile and interests. For example, they can specify interest in certain types of cultural events or experiences (e.g. museums, traditional festivals, etc.). Afterwards, the c-Space application will keep them informed about new content that might be of their interest or relevant to their location.

Users will also be able to explore from a specific location the evolution of the city, from the medieval age up to a certain time period. The visualization will be supported by interfaces ranging from simple screens or augmented reality glasses to pico-projectors. Other forms of content will also be integrated, such as contextualized ads and UGC.

The c-Space framework will initially provide a database of models scientifically validated, corresponding to previous eras. But it will be through the c-Space project that we will give continuity to the process of

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documenting future changes, e.g. new houses, new or inexistent roads, 4D cultural events like parades or dances, etc. That is, we will write the history that can then be used by future generations.

This technology will support tourist guides, which can augment the existent landscape and present it to their audience (for example, they can use pico-projectors to show how a certain landscape changed across time, while introducing its story; or augment the scene with additional monuments that have a common past). It can also be used as a form of art that overlaps past cultural events with fresh content in order catch the attention of the audience. The c-Space recommender system can serve many purposes . For example it can provide individual tourists with personalised routes, or help guides to provide a better experience to their audience by understanding better what they prefers to visit (e.g. combining emotions with the recommender system).

c-Space will also support users willing to providing new content to the framework. For example, through the c-Space application, they can share some of their videos and pictures that were captured during parades, cultural events, or at specific locations. Once the supplied material is processed by the c-Space, it will become available for a number of different purposes, e.g. to tourists that were not able to attend or visit the city during a certain season/period/event, game companies that can integrate these models into their games at low cost, or schools can could use it for educational purposes.

Contributors like SMEs will have also play an important role in this framework. They will contribute with new content (as a self-promotion strategy or simply to support the framework) aiming at keeping certain traditions/history alive. For instance, the artisanal SMEs can contribute with 4D content that depicts how they create certain medieval artefact, which can also be available for sale. Their content will guarantee a certain level of quality and originality.

Further levels of interaction will be promoted through gamification, aiming also at strengthening the link between these three types of users. c-Space will promote outdoor sporting games similar to treasure hunting. Instead of using a compass, a participant will use a mobile device with GPS and will try to solve different riddles while learning more about the history of the city. Riddles will consist of a set of steps that together create a piece of the history. It will include quizzes, missions that require following and experiencing the steps of a certain person, e.g. through augmented reality (and for that, users can use Google glasses, tablets, mobile devices, and SpaceGlasses). The user can also learn how to construct or interact with certain old artefacts, e.g. Da Vinci's helicopter. The interaction will be facilitated by using wearable interfaces like Myo than can translate human actions into computer instructions.

Figure 1 – Navigating medival Trento using the Da Vinci' helicopter

The interaction between the user and the c-Space framework can be initiated in three different ways.

- The user initiates interaction (searches for a specific topic or location related quiz, randomly selects a new mission). This kind of interaction will be stimulated through a global classification system and small rewards (e.g. gadgets associated to SME-sponsored missions).

- The system triggers location-based notifications. For example, if the user is visiting a place and is near to a certain monument, then the c-Space application sends him a notification – I challenge you with a quiz. If the user doesn't know the answer then he/she is invited to visit the place for more information.

- The user is invited by other users to complete a quiz or mission, e.g. using QR codes or direct invitations through the application.

Gamers will transparently support the c-Space framework. For example, a game company (located in France) interested in reconstructing a certain monument (e.g. Mausoleum Cesare Battisti) can propose a mission that consists of a set of riddles leading to that monument's location. For example, first the user has to answer a certain quiz – Find the square in Trento where the following sentence is carved in stone "un popolo italiano ha creato col suo sangue …". The answer to this quiz is the author's name. After guessing the name of the author, the user receives the details of the next mission: now find the Mausoleum dedicated to the person whose name is the same as the name of this square (Piazza Cesare Battisti). After correctly answering the quiz, users need to proof that they were able to find the place. To do so, they will have to take a photo or a video of the place. The c-Space framework will use the information about the users' location to assess if the user completed the mission.

Through this approach, users are indirectly contributing with the material required to reconstruct the desirable monument (Mausoleum Cesare Battisti), while at the same time, they can discover and learn more about new places. Hence, gamification could be a useful approach to transparently promote crowdsourcing.

Additionally, quizzes can also serve as a strategy to prime/reward certain users 'through their profile. If users guess certain quizzes or complete certain missions then they will be awarded with virtual trophies in addition to the general game standings.

Expected results

The results expected as outcome for this pre-pilot are two. First, it will validate the use of the micro-projection technology, which has an important role in the c-Space vision. Users will use and interact with projected surfaces as a visualization screen. The system will focus on new metaphors to reduce the cognitive overload. It will put together mobile devices, projectors and augmented reality, which will serve as a "virtual stage" for ubiquitous media creation and sharing. It will enable the possibility to experience past events in a completely new way (e.g. how architecture has changed across time), or more interactive content that can describe old traditions.

Annex 2: Checklist for interviewing with stakeholders

The c-Space project is going to develop new devices focusing on augmented reality. The user will be able to use her/his mobile device (iPhone, iPad, Google glass or any future device) to have additional information (text, audio, pictures, video, 3D images, reconstruction of a building or a historical area as it was in past times).

What is your interest in the possible use of this technology ?	
What obstacles do you see in the use of this technology ?	
Do you know similar services ? Are they successful ?	
How this technology can help urban planners, architects, engineers or other users in creating services for ...	
- "Architecture and urban planning" ?	
or	
- "Mobile advertisement" ?	
or	
- "Individual content creation & cultural	

tourism"?	
A second tool going to be develop by the c-Space project concerns the possibility to capture the "emotions" of the user in different moments of her/his visit. In this way you could be able to measure how people emotionally respond in front of a picture, a situation, another person.	
What is your interest in the possible use of this technology ? What obstacles do you see in the use of this technology ? Do you know similar services ? Are they successful ? How this technology can help urban planners, architects, engineers or other users in creating services for … - "Architecture and urban planning" ? or - "Mobile advertisement" ? or - "Individual content creation & cultural tourism"?	

Another tool planned by the project is the possibility to define different user profiles, based on the interest, the time and money available, and other personal characteristics of the user, in order to prepare personalised services (e.g. a customised tour of the town, visiting the places that optimises the parameters defined by the user).

What is your interest in the possible use of this technology ? What obstacles do you see in the use of this technology ? Do you know similar services ? Are they successful ? How this technology can help urban planners, architects, engineers or other users in creating services for … - "Architecture and urban planning" ? or - "Mobile advertisement" ? or - "Individual content creation & cultural tourism"?	
Would you be happy to have these tools for	

applications to be used in your activities ? Do you think you could integrate such technologies in your own activities ? If yes please specify: - the framework and the specific context of the service you might provide; - the information content (including digital information, text, pictures, videos) that you can make available / would use; - any additional information and tools that would be necessary to set-up the system, not available yet in your premises. Would you be happy to be informed of developments in the project, participate to technical workshops and / or have the c-space technologies being showcased to you?	
Finally the c-Space project would like to run a pilot test of the device in real conditions, developing specifying tools where a selected (or volunteering) group of users will have the possibility to use the prototype in an "urban game" [5].	

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[5] Urban games are multi-player location-based games played out on city streets and built up urban environments. Various mobile devices can be used to play urban games.

Do you think an "urban game" is appealing for testing ? Whom could you involve to organise the pilot in "Architecture and urban planning" ? or Whom could you involve to organise the pilot in "Mobile advertisement" ? or Whom could you involve to organise the pilot in "Individual content creation & cultural tourism" ? Do you have any suggestions for other people or organisations who should be contacted and involved in the activities of c-space?	