Electronic Imaging & the Visual Arts

EVA 2021 Florence

PROCEEDINGS

Editor: Vito Cappellini

Electronic Imaging & the Visual Arts

EVA 2021 Florence

14 June 2021

Edited by
Vito Cappellini

EDIZIONI POLISTAMPA

Electronic Imaging & the Visual Arts: EVA 2021 Florence : 14 June 2021 / edited by Vito Cappellini. – Firenze : Leonardo Libri srl

http://digital.casalini.it/9788859621591

ISBN 978-88-596-2159-1

www.polistampa.com

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PROGRAM

Electronic Imaging & the Visual Arts

'The Foremost European Electronic Imaging Events in the Visual Arts'

The key aim of this Event is to provide a Forum for the user, supplier and scientific research communities to meet and exchange experiences, ideas and plans in the wide area of Culture & Technology. Participants receive up to date news on new EC and international arts computing & telecommunications Initiatives as well as on Projects in the Visual Arts field, in archaeology, history and other Culture Activities. Working Groups and new Projects are promoted. Scientific and technical demonstrations are presented. Technology and Art Exhibitions are promoted.

Main Topics

- European Commission Projects and Plans regarding Cultural Heritage
- Mediterranean Initiatives in Technology for Cultural Heritage: Synergy with European & International Programmes
- 2D – 3D Digital Image Acquisition
- Leading Edge Applications: Galleries, Libraries, Archaeological Sites, Museums & Historical Tours
- Integrated Digital Archives for Cultural Heritage and Contemporary Art
- Management of Museums by using ICT Technology: Documentation, Access, Guides & Other Services
- The Impact of New Mobile Communications on Cultural Heritage and Modern Arts Area
- Cloud Networks
- Semantic Webs
- Ontology Systems
- Human - Computer Interaction for Cultural Heritage Applications
- Copyright Protection
- Secure Electronic Commerce (Anticounterfeiting)
- Cybersecurity
- Culture and *e-government*
- Activities and Programmes for *e-learning*
- Digital TV and films
- 3D Developments and Applications in the Cultural Heritage Area
- Augmented Virtual Reality for Culture
- Virtual Galleries and Exhibitions
- Digital Art
- Digital Music
- Digital Theatre
- Cultural Tourism & Travel Applications
- Impact of Culture in the Smart City
- Art and Medicine
- Climate Change
- Environment Protection
- New Technologies for Environment Protection
- COVID 19 Pandemic

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10,40 **SESSION 1 – STRATEGIC ISSUES**
Chairman: *Paolo Blasi, University of Florence, Florence, Italy*

"Towards a Cultural Digital Twin Paradigm. The Isabella D'Este Virtual Studiolo Challange"	Antonella Guidazzoli, Maria Chiara Liguori VisitLab Cineca Bologna, Italy
"The Elephant in the Room: from the Field to the 3D Model"	M. Caine[1], R. Rabinovich[2] [1] Dept. Photographic Communications, Hadassah Academic College Jerusalem, Israel [2] National Natural History Collections, Institute of Earth Sciences, Institute of Archaeology, The Hebrew University of Jerusalem Jerusalem, Israel
"3D Modelling for a Virtual Visit of the Ark of St. Augustine"	V. Cantoni, C. Davite, M. Mosconi, A. Setti, E. Venturini Computer Vision and Multimedia Lab (CVML), University of Pavia Pavia, Italy
"A Proposal of Surface-Based FTV"	Masayuki Tanimoto[1], Hirokuni Kurokawa[2] [1]Nagoya Industrial Science Research Institute Nagoya, Japan [2]University of Aizu Aizu Wakamatsu, Japan
"Museums at the Crossroads: Between Digitality, Reality, and COVID-19"	Tula Giannini[1], Jonathan P. Bowen[2] [1] School of Information, Pratt Institute New York, U.S.A . [2] School of Engineering, London South Bank University London, U.K.

11,50 **SESSION 2 – NEW SCIENCE AND CULTURE DEVELOPMENTS & APPLICATIONS**

Chairman: *Vito Cappellini, University of Florence, Florence, Italy*

"Patterns of Existence: Discovering Order Through Visual Music"	T. Trickett Trickett Associates London London, U.K.
"Heterotopia, show business as a "non-place". Advanced technologies during the pandemic: "Circle""	Jean Paul Carradori, Qing Li Shanghai International Interior Design festival Shanghai, China
"Visualising Music Gan Outputs Using Structural Harmony Method"	Anna Shvets[1], Anthony Trzepizur[2] [1]FabLab by Inetum Paris, France [2]iMSA Toulouse, France
"Artificial Intelligence, NFTs and The Epocal Transformation of Artist and Art Collectors"	Bruno Cerboni Visual & NFT artist Rome, Italy

12,40 – 13,40 **C O V I D - 1 9**

and

INTERNATIONAL EVA NETWORK

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14,40 **SESSION 3 – NEW TECHNICAL DEVELOPMENTS & APPLICATIONS**

Chairman: *Enrico Del Re, University of Florence, Florence, Italy*

"Advanced Digitization for the Promotion of the Moral Values Underlying the European Union"	Marco Berni, Natacha Fabbri, Elena Fani, Carmen Gagliardi, Sofia Sasopoulou Museo Galileo - Istituto e Museo di Storia della Scienza Florence, Italy

"Generative Technologies, Generic Anthropology"	Nina Sosna Institute of Philosophy, Russian Academy of Sciences Moscow, Russia
"Digital Transformation and Challenges in 5G Networks"	Giovanni Gasbarrone Board of Intellectual Professions Rome, Italy
"New Interpret and Interactions in Heritage - Related Game: a Case Study of Hundred Scenes of Jiangnan"	Shiqi Liu Chinese Museums Association Beijing, China

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Chairman: Jonathan Bowen, London South Bank University, London, U.K.

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"Smarticon: Innovative Technologies for the Enhancement of Museum Activities and More…"	Sara Penco Sipal Penco S.r.l. Turin-Rome, Italy
"Accessible Immersive Platforms for Virtual Exhibitions Involving Cultural Heritage"	Lily Diaz-Kommonen, Gautam Vishwanath Department of Media, Aalto School of Art, Design, and Architecture Espoo, Finland
"Digital Cultural Mapping of the Lake Constance Cultural Heritage Using Participatory GIS and Story - Maps"	L. Leuschen[1], P. Laube[2], S. Helbling[2], F. Eitzenberger[3], T. Thimm[3] [1]Center for Arts Management, Zurich University of Applied Sciences ZHAW Winterthur, Switzerland [2]Institute of Natural Resource Sciences, Zurich University of Applied Sciences ZHAW Grüental, Switzerland [3]Department of Business, Cultural, and Legal Studies Constance University for Applied Sciences HTWG Konstanz, Germany

"RESTORE: Smart Access to the Digital Heritage and Memory"	E. Degl'Innocenti, C. Di Meo, A. Spadi, F. Spinelli Consiglio Nazionale delle Ricerche, Istituto Opera del Vocabolario Italiano Florence, Italy
"An Unexpected Absence: The Scarce Presence of Digital Art on the Websites of Contemporary Art Museums"	Helena Barranha Instituto Superior Técnico, Universidade de Lisboa, IHA, FCSH, Universidade NOVA de Lisboa Lisboa, Portugal

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Chairman: Enrico Del Re, University of Florence, Florence, University

"UNCHARTED – Understanding, Capturing and Fostering the Societal Value of Culture "	A. Fresa, E. Debernardi, P. Masi Promoter S.r.l. Peccioli - Pisa, Italy
"Innovation through Tradition enables Radical Innovation. Priorities and Prospects For Dante's homeland"	Filippo Queirolo Da Vinci Foundation, Organising Committee Florence, Italy
"Personal Meaning Mapping in Context of Digital Humanities Pedagogics"	A. Claudio Lucchiari[1], C. Elena Gaevskaya[2], B. Raffaella Folgieri[2], D. Nikolay Borisov[2] [1]Department of Philosophy, Università degli Studi di Milano Milano, Italy [2]Dept. Arts, St Petersburg University Saint Petersburg, Russia
"Art-Centrica: a new Experience with Art and more"	Marco Cappellini, Paolo De Rocco, Paolo Romoli CENTRICA Florence, Italy

PROCEEDINGS

STRATEGIC ISSUES

TOWARDS A CULTURAL DIGITAL TWIN PARADIGM

THE ISABELLA D'ESTE VIRTUAL STUDIOLO CHALLENGE

Antonella Guidazzoli, Maria Chiara Liguori
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Abstract - Is the Digital Twin concept suitable for Cultural Heritage environments? Isabella d'Este Virtual Studiolo represents a paradigmatic case study in order to explore this new perspective.

INTRODUCTION

The concept of Digital Twin (DT) was initially applied in a manufacturing context and it is based on three elements: the physical element, the virtual/digital one and the relationship/connection between the two. There is no forced birthright between real and digital. Data flows from the physical to the virtual/digital context and vice versa [1]. The Digital Twin, as a logical construct, may not have actual data and information in itself, which can instead be hosted elsewhere (e.g. in other external platforms from which they are retrieved). The Internet of things (IoT) and the following diffusion of sensors have given the final push to the inevitable spread of Digital Twins which are always seeking for real data [2].

In this flow, we are facing a continuation of the colonization of the *overworld*, as conceived by Baricco [3]. Real and virtual are two realities that interpenetrate and coexist in a world that has developed two hearts through a process defined by the author as a *Webing* process, which has made it possible to "set up a digital *overworld* and put it in rotation with the first world, to set up a single system of reality founded on a double driving force", with a continuous rebound between the world and the *overworld* to better manage our life and its complexities [3]. Moreover de Kerckhove, in the year 2000 already identified the affinity between mental space and virtual space that are joined together by the concept of virtuality [4]. Starting from this assumption, it has become inevitable that the concept of Digital Twin reaches the world of Cultural Heritage [5]

Regarding the industrial process, Digital Twins allow design optimization, process control, life cycle management, predictive maintenance, risk analysis and more. Digital Twins integrate together model- and data-based approaches [6]. In short DTs, managing complexity in a factory or a production line, can also be thought of as a real "control room" in the context of a museum or a large cultural site. Starting from a 3D interface, it is possible to replicate the physical environment by receiving data from sensors to monitor the flows of visitors, detect the temperatures of the rooms, and, in an anti-pandemic strategy, of people as well or check the security systems. In this way, obsolete interfaces, such as 2D CADs, are overcome, also improving the user experience in the management and monitoring of cultural sites.

However, a Digital Twin set in the field of Cultural Heritage must not be just a digital replica, but a tool capable of returning a context, a sense - for example by applying analytical solutions such as *sentiment analysis* - as well as the evolution of the complexity of interactions, of the temporal dynamics of both the physical container and the historical and cultural contents. It must therefore be

able to become both an enjoyed architectural space, with all its data, and a space for organizing resources, designing and setting up events and, also, connecting to users, interacting with visitors and facilitating crowdsourcing and crowdfunding. An exploitation that allows users to interact with Cultural Heritage through new and less rigid interpretative frameworks, compared to those traditionally used in museums. A path that can also be approached starting from simple and low-cost solutions, such as 3D printing which, in its process of democratization of Cultural Heritage, while safeguarding the original artefacts, at the same time invites the audience to live more holistic experiences [7]. Digital Twins can be considered as real ecosystems, using 3D as an interface, an access point to a simulation, not a simple reconstruction, since it goes beyond the simple material replica and conveys the complexity of the original, delivering even its atmosphere [8]. It can therefore be a valid support for museums but, also, for something more immaterial, such as the recreation of a mental space.

CULTURAL DIGITAL TWINS: SOME EXPERIENCES AT VISITLAB

In the early 2000s the Virtual Museum of the Certosa di Bologna tried to recreate, partially at least, the many relationships of a rich and complex cultural context [9]. Starting from a real site, namely the Certosa cemetery, the 3D modeling of some of its parts was connected to three very rich multimedia databases in order to tell not only the lives of the people commemorated in those tombs or monuments, but also the cultural, historical and artistic *milieu*, related either to the buried person or to the funerary work of art. Ideally, the project would have been ready to become a real digital twin, with a connection to the cemetery management database. Unfortunately, the time was not yet ripe for such a leap to be accepted, and the connection with the three-dimensional interface has also dissolved. Currently, in fact, the significant database dedicated to the Fallen soldiers of the Great War, those of the liberation struggle during the Second World War and the dead civilians of nineteenth-century Bologna, continues to expand as an application in its own right. Only the part related to the First World War linked to the Lapidarium of the Santo Stefano complex maintains a 3D interface as a further point of access to data (tinyurl.com/4cwj4cp2).
A more recent experience is regarding the CSAC archive in Parma (https://www.csacparma.it/). The project foresees the reconstruction of a real exhibit space, located at the abbey of Valserena, with the aim of virtually recreating all the exhibitions that are being set up thanks to the collections housed in the archive, while allowing at the same time querying and archive consultation starting from the objects displayed in a digital form. The project, currently ongoing after the creation of a first prototype, should provide with future releases the opportunity for the curator to set up autonomously virtual exhibitions and transposition of real ones. This is certainly a partial accomplishment, but the planning of real exhibitions and the simultaneous virtual multiplication of new visiting tours is already an example of the opportunities offered by a cultural digital twin (see some more examples about the topic in [10; 11; 12; 13]). The latest example is given by the project dedicated to Isabella d'Este's Studiolo on which we will dwell more on [14].

ISABELLA D'ESTE VIRTUAL STUDIOLO: A PROTOTYPE WITH INCREASING COMPLEXITY

The real starting point of this project has its roots in a tiny space: two small rooms in the Palazzo Ducale in Mantua. This is the study that Isabella d'Este set up in the early 1520s, transforming two simple "dressing rooms" into a point of attraction for objects of art and antiques, for music, books

and reflections woven into the dense network of relationships of power and culture of Renaissance Italy. This part of the project, belonging to the broader IDEA project (http://isabelladeste.web.unc.edu/), aims to virtually reconstruct the two rooms, called Studiolo and Grotta, trying to enrich the digital version of at least part of the many objects that furnished and filled them at the time of this enthusiastic patron. The collection, listed in an endless sequence by Stivini a few years after the death of Isabella d'Este [15], has been dispersed or destroyed over time, managing only in some cases to reach some museums around the world. Objects, those that can be traced, will gradually become part of a cataloged whole that is connected, at the same time, to the vast collection of letters already available in a database (http://idealetters.web.unc.edu/). The project dedicated to Isabella d'Este, anyhow, has the potential to transform over time into an interesting prototype of a cultural Digital Twin [16].

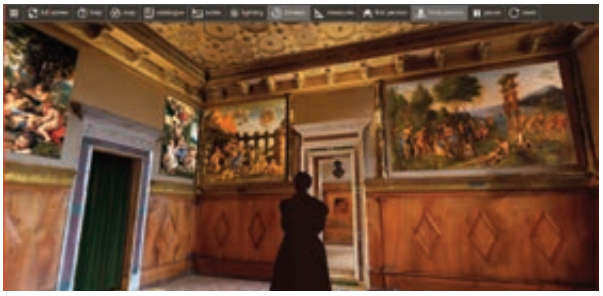

Image 1 - Isabella d'Este Virtual Studiolo - 3DWeb desktop application.

HOW TO MAKE A BLITZ INSIDE ISABELLA'S WELTANSCHAUUNG?

A multifarious personality like Isabella's, with such a versatile culture, requires both holistic perspectives and targeted approaches, new processes and workflows to explore the richness and the profoundness of her thoughts, allowing us to grasp some flashes of her vision of the world (WeltanSchauung) and, in general, to give new insights into and new ways of dissemination about the Italian Renaissance.

To inspire new research frameworks, the **Digital Twin paradigm** can be borrowed from the leading edge technological world and can give us some unexpected hints in order to create frameworks that can be effective when applied in the humanistic field [5], increasingly populated by growing challenging requirements. This perspective, applied to Isabella d'Este's project and in particular to Isabella's world represented by her Studiolo, can be summarised in the diagram n. 1, with the expansion of data sources, expressed along the Y axis, and the collection of simulations and knowledge, expressed by the X axis. Hence, on one hand we can have more contents, more artworks, more databases, more structured and unstructured data; on the other hand, we can gather more scholarly expertise, more simulations - covering different aspects and deepening more and more partial, specific aspects - and even see them in one *ensemble of models*, a normal approach to weather forecast models (Mistral project: https://youtu.be/4ARDf75diEE), that can give us a greater value than the sum of the single parts.

Where is the Isabella d'Este project positioned on this graph at the moment? It is just at the beginning of an early minimal simulation stage, ideally aiming at the top right side of the graph. The

first release of the 3D on-line Virtual Studiolo has already given us some insights and opened new perspectives and suggestions that encourage us to go further towards this direction (Image n. 1).
Even if the project can be considered as still being somewhere on the bottom left part of the graph, the on-line application delivers a sense of being overwhelmed by such a richness of colours and artworks thanks to a, even if partial, sense of embodiment given by the 3D navigation and the perception of all the different layers of interpretation that, both physically and conceptually, are hidden inside the studiolo. The sensation is multiplied whenever music of the time is added to the experience.

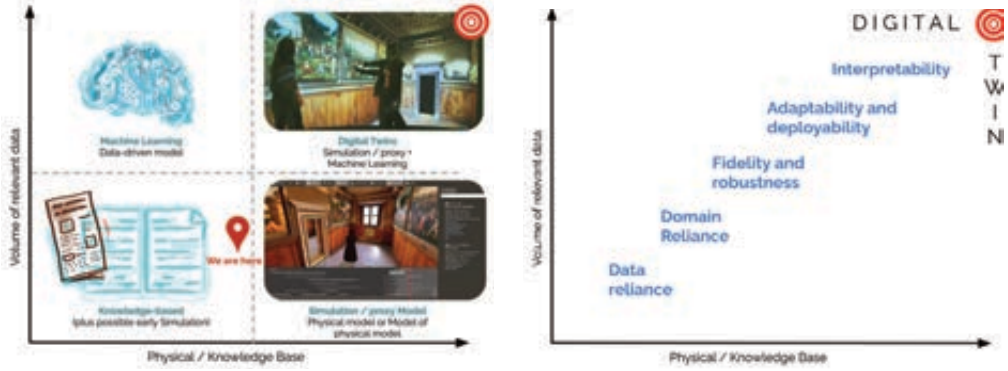

Diagram n. 1 and n. 2

According to Stivini's list, our first reconstruction is just a pale image of the real set up of Isabella's "camerini", crowded with an incredible number of assets that should have crammed in the Studiolo and Grotta, in a blend of contemporary and classical art.
In the next paragraphs we are going to widen and deepen the concepts expressed in the Diagram n. 1, presenting the contents that gradually accumulate while sliding along the two axes and approaching the ideal last step of a faithful and complete Digital Twin (Diagram n. 2). As said before, on the X axis we follow the creation of a Physical / Knowledge based Virtual Studiolo Model; meanwhile, the Y axis describes the process, from bottom to top, for a Data driven Virtual Studiolo Model. Currently we can create digital ecosystems to enable a data driven approach. This schema, subdivided into five steps - data reliance; domain reliance; fidelity and robustness; adaptability and deployability; interpretability - has an unattainable goal, since so much information and pieces of the collection are forever lost or, as during the process following the Y axis, is envisaged the use of AI applications that are yet to be conceived. Notwithstanding, the final target of a Digital Twin of the Studiolo remains the ideal landing point of the IDEA project.

Data reliance

Physical/Knowledge based Models: Relatively **small data.** In the Virtual Studiolo project, the starting point consists of the existing and nearly empty rooms in the ducal Palace in Mantua and in the artifacts scattered in some worldwide museums and archives and attributed with certainty to Isabella d'Este's collection.

Data driven Models: Notwithstanding adversities and the passing of time, the quantity of physical data available can be considered and processed as Big Data. More than 28,000 letters and copies of letters, ceramics and music scores have been digitised and it is already possible to query

and study different databases, each one devoted to a different kind of content. We can optimistically call this starting nucleus a form of Big Data for this particular intimate space.
We can situate at this level also the 3D models of the Studiolo as it is and of some reproductions of the art pieces hosted in some museums made available in digital form up to now.
Nowadays new semantic levels can be created by connecting ontologies through scholarly knowledge and by machine learning tools. For example, neural networks can be trained for finding new links among different cultural contents (i.e. CrossCult project, http://tinyurl.com/hravk3mt).

Domain Reliance

Physical/Knowledge based Models: Deep Domain Expertise. At this level the experts increase their relevance and knowledge is produced by the interaction of many scholars in different disciplines covering different aspects. Lately the intersection of knowledge and interdisciplinary debate has been fostered by the spreading of scientific sharing platforms, such as *academia.edu* and *researchgate.net*, that also enable the opening of discussions on academic topics. This liveliness favours the possibility to obtain different specific simulations on many aspects. As for the Isabella project, for example, during the production of the concept demo video, created in 2016 in order to promote the project and obtain additional funding, a wax seal simulation was added and used on the reproduction of the philological folding of a letter. In that small case several competencies were gathered and the archivist's knowledge was transferred to the 3D modeller. The 3D model had to simulate some physical characteristics of real seals, real wax and real paper since these influence the final output. The wax, for instance, has precise features, such as viscosity and aspect, that need fluid simulations in order to reach the right credibility. It is possible to follow a tutorial on this precise aspect (tinyurl.com/mvctxk32). The archivist's competencies are relevant for the folding of the letter and the validation of the final rendering of both seal and wax [17], that could possibly be analyzed at a chemical level for its typology and the intrinsic characteristics of that precise material.
The musical interests of Isabella have already led to the use of the real Studiolo as a backdrop for musical events, events transformed into digital videos and further scholarly reflections (http://ideamusic.web.unc.edu/). Besides the simulations of events, it is already possible to develop virtual acoustics studies inside spaces [18;19; 20]. In this case, the space is still physically available but needs an additional dose of hypotheses for balancing the missing furnishings, tapestries and works of art. Environmental simulations enable also lighting representation at different times of the day of the year or the creation of, at least, bounding boxes, for perceiving the size and encumbrance of the incredible collection that was hosted inside just two small rooms. Anyhow, any other existing mathematical model, that is reasonable to be imported within the Virtual Studiolo, can be adopted.
Data driven Models: At this level, little domain knowledge is needed. Algorithms and deep learning networks can be used without particular effort. At the same time, however, it is possible for scholars to train networks with specific knowledge in order to satisfy humanistic requirements. Neural networks could be trained, for example, for reading ancient handwritings. The difficulty, on such historic sources, lays not only on the capability of interpreting the specific handwriting, but also on the understanding of the meaning of words used centuries ago. By now, sentiment analysis algorithms, for example, are well developed but, if scholars would try to apply them to the 28,000 letters and copy letters related to Isabella and gathered in the State Archive in Mantua, there would be the need to tune them as precisely as possible to the concepts and words proper to a Renaissance court. Algorithms are usually trained on contemporary language or contemporary iconography; therefore, there is a need for training them in different contexts. Using already trained networks leads them to find what they have been initially trained for. Therefore, as happened during the I-Media-Cities project, if they locate a skateboard in a late 19th century photo, it is not proof of a

malfunctioning, it depends on them not being trained for analysing images of a period during which no skateboard had been yet invented [21]. It is true that they are indefatigable assistants, but they do not have a brain; systems are agnostic regarding the input. They must be guided and the researchers are in charge of doing the interpretations. Otherwise, if the photo of a rotting fish is analyzed by a network trained to classify galaxies, the network will classify the rotting fish according to the rules applied to galaxies [22]. As said for the *Physical/Knowledge based Models* at this same level, automatic metadata search can also be performed in order to retrieve information from scientific papers coming from different disciplines.

Fidelity and robustness

Physical/Knowledge based Models: At this level we can get highly nonlinear and complex relations among different knowledge domains.
It is an unavoidable step to grasp the complexity proper of any original cultural context that is to be digitally duplicated. An example can be found in the interconnection among different fields of knowledge, such as the analysis of musical aspects by studying the intarsiae set inside the Grotta, or the linking of letters and paintings or other art works of the collection.
The bridge among different scholars' expertise creates an added value result, the so-called *ensemble*, as seen before. It is this mixing that enables the perception of a symbolic hint, that is, a lute with a missing string, from the intarsia depicting the group of musical instruments.
Data driven Models: Model complexity increases. Algorithms and neural networks are further fine-tuned; after this stage the AI could perform even better on a specific task. The semantic levels overlap, going deeper and deeper. Symbolic and hidden layers within which to descend and venture, as in a sort of lair of the White Rabbit into which the scholars, new Alice in Wonderland, fall precipitously. It is only in the next step that the scholars, with their reflections, finally put order in the multitude of information processed by the mathematical models.

Adaptability and deployability

Physical/Knowledge based Models: Complex and time consuming setup. Starting from what has been accumulated up to this level, the scholar, with a long work of pondering, deepens the relationships between different fields.
Data driven Models: Models rapidly adapt to specific problems. Whenever there is suitable content available for training, it is possible to look for the appropriate neural network.

Interpretability

Physical/Knowledge based Models: Once this level is reached, therefore, the process is well documented and it is possible to be aware of the set of knowledge that has led us to this point, whether it is the physical laws of simulations, such as that of sealing wax, of light, or the virtualization of sound, or all those connections made up to now by scholars between the various elements. The physical objects that fall into this level are those of which scholars have full knowledge. Models come from consistent physical and meaningful references that can lead to virtual or, better still, hyper real reconstructions, with the possibility of touching real objects, similar in shape to the originals, digitally disguised with also the appearance of the originals, in a powerful mix among physical and digital experiences such as in the VOID (https://www.thevoid.com/). In theory, at this level, the maximum knowledge on the physical universe of Isabella and her Studiolo and the

maximum level of numerical simulations available could be reached.
Data driven Models: Surrogates are possible. The Terra Mars experience, with the artistic terraformation of Mars by an AI trained on topographical data and satellite imagery of Earth, is a simulacre of this kind of solution [23; 24]. This level reaches peaks of extreme complexity, the creation of a sort of *Isabellian* algorithm, capable of simulating her personality and knowledge, which we could ask to rearrange her own Studiolo starting from two new environments, different from the original ones. But of course it is an impossible goal. The algorithm should have the ability to interact with other people, with artists, secretaries, artisans, intellectuals and this would only be possible by reconstructing all those people with AI. The final goal, therefore, would lead to a titanic and impossible project and only art, as in Terra Mars in fact, might possibly approach.

CONCLUSIONS AND FUTURE TRENDS

To move towards Cultural Digital Twins new cooperation, involving different scientific and technological communities, have to be started and obstacles have to be overcome. In particular, novel deep learning networks and computer science technologies are required to be adapted to the complexity of digital humanities, bridging many different disciplines and involving different perspectives. Moreover, precisely to defuse the fears that AI can arouse, there is nothing better than facing them with transparency, also thanks to the involvement of professionals with different skills [25].
In the meantime, a bit in all sectors, we are moving in this direction, aware of its great potential. As with the creation of the Digital Twin Earth, that is a digital replica of the planet Earth that monitors its state and makes it possible to simulate future scenarios as precisely as possible.
(https://ec.europa.eu/jrc/en/research-topic/digital-earth; http://tinyurl.com/9w756esh)
The Digital Twin Earth, starting from past and present data integrated with artificial intelligence, will be able to outline the future changes of our planet. But if this is an ambitious, titanic goal, rich in perspective, the developments for the specific world of Cultural Heritage are no less. With Isabella d'Este Virtual Studiolo, VisitLab has entered this path. Erik Champion has started to focus attention on some basic characteristics of these evolved digital realities. Champion, as mentioned, does not talk about reconstructions but rather about simulations, which have their roots in fragmentable 3D models, in order to be able to connect them to insights related to the single element. Insights that are related to the level of accuracy and the method used to create the "simulation" and capture the data; related to georeferencing and the limitations given by the format; in addition to ownership (rights); to license and authenticity. The format must be robust, durable and suitable for importing, exporting in many formats and, without losing too much information, recycling and configuration. The audience must feel themselves involved, also having the opportunity to create, test and share hypotheses [8]. What Champion already outlines as the salient characteristics of scholarly ecosystems and audience-oriented learning systems can be seen as the starting point of Cultural Digital Twins, which will be developed according to what is schematically seen in diagram n. 2, to rejoin the artistic intervention along the way, capable of amplifying the creative space.
To sum up the Digital Twin paradigm suggests new spaces that can collect, distribute and create knowledge. The Digital Twin becomes an environment for the development and the epiphany of collective intelligence, a concept that Pierre Levy anticipated in 1994 by describing the new anthropological space of cyberspace as a place for collective knowledge. A Digital Twin environment is now able not only to create interactions between different skills of deterritorialized intelligent collectives [26], but also to collect, visualize and integrate AI suggestions that can be taken into account even demanding to know the AI paths in a transparent way.

ACKNOWLEDGMENTS

The authors wish to thank Deanna Shemek and Anne MacNeal, co-directors of the IDEA project, and all the Virtual Studiolo team at Cineca: Giovanni Bellavia, Beatrice Chiavarini, Daniele De Luca, Federica Farroni, Silvano Imboden, Luigi Verri, Paolo Zuzolo for their ceaseless and inspiring work.

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THE ELEPHANT IN THE ROOM
FROM THE FIELD TO THE 3D MODEL

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Abstract

During survey and excavations in the Negev desert, some 130 fossilized fragments were uncovered by a team of researchers. These were determined to constitute the majority of an 18-million-year-old early extinct Proboscidean**, who roamed during the Early Miocene period. Following a meticulous restoration process, it was decided to attempt to digitally rebuild the specimen and print it, in its true-life size and in full colour.**
We discuss here the challenges, the problems and the solutions employed in achieving this massive task.

INTRODUCTION

Animal bones (i.e., fossils) when found in a known geological setting are the bases of past environment reconstruction. We can follow after faunal dispersal events, evolution of species, species turn over and species displacement and even extinction. One of this faunal dispersal events that took place millions of years ago, shaped the basis for the current African and Eurasian mammalian species. The way out and into Africa passed through the Levantine corridor. Israel is one of the few only places where paleontological evidence from this land bridge currently exists. Following former reports [1], Savage and Tchernov. 1968; [2], Tchernov et al., 1987, we launched a project of survey and excavation of the major Early- Middle Miocene exposure in Israel. New localities were found, where both micromammal and macrofauna were found [3], López-Antoñanzas et al., 2016; Rabinovich et al., 2014; [4], Grossman et al., 2019.

During survey of one of this new early Miocene locality in the Southern Negev (Kamus Junction), specimens were recovered that include crocodiles, a tryonychid-like turtle, proboscideans, a giraffid (*Canthumeryx* sp.), anthracothere (*Sivameryx*) and an almost complete skeleton of an early extinct Proboscidean. The environment was very different then nowadays, with nearer shore line (ca. 30 southeast), and with large drainage system flowing from the east.

The deposition of the this early extinct proboscidean_includes upper jaw, complete mandible, limbs and trunk parts. The elements were almost complete, yet an extensive effort was required to make them ready for research. After careful conservation at the field during the excavation, continues treatment was required at the lab.

Since this specimen is so unique, having most parts complete in a defined geological setting, we had to ensure varied and secure methods suitable for research and display.

Thus, 3D photogrammetry of each element was chosen as the next stage. While doing so, more aspects of elements deposition were observed, requiring further conservation. Looking in detail to the 3D

images has shown in detail the bone surfaces and enhanced their morphology. The aim is to have high resolution specimens for future research for the entire community (as a Type specimen).

The new find, along with other recent finds, demonstrates that the Levantine Corridor facilitated faunal dispersal events that shaped modern biotas as early as the early Miocene.

This paper will not dwell in any length on the paleontological and scientific aspects of the specimen, but rather on the vision of resurrecting it digitally. This undertaking has thrown up a multitude of challenges, some of which have been met successfully, while others still await us.
All being well, we hope to have it fully reproduced, printed, and erected at the new entrance to the Hebrew University, in time to be presented at the next EVA.

Stages of the project

The resurrection of the specimen involves several essential stages. Each stage being conditional on completion of the former one. These include:

- Identification
- Restoration & Conservation of the fragments
- Photogrammetric modeling
- 3D Printing & Treating for permanence
- Reconstruction

Identification and Restoration & Conservation of the fragments

(Conservator: Gali Beiner (MA, ACR)

The identification is done on the bases of comparative anatomy, both in the field and mainly after conservation at the lab. Handling, measuring, examining in detail each morphological trait is the basis of the method. When large and fragile elements need to be studied, additional measures need to be taken. First the meticulous conservation during the exposure, when the equilibrium is disturbed and the bones are uncovered.

The finds had been buried in a matrix consisting of greenish heavy clay deposit, which had preserved them in very good condition in terms of bone contour. However, the bone matrix itself displayed a network of fine cracking, with some deeper cracks often crisscrossing long bone shafts (Fig.1). Consequently, the finds were very weak and could not be lifted out of the surrounding clay matrix in one piece without previously being treated and consolidated (Fig.2).

Fig.1: Large objects such as this femur cannot be lifted out without jackets because of their fragile nature: Without the support of the earth matrix and with quick processes of cracking and decay following exposure, they break into small fragments. Fig. 2: After lifting in a custom-made

polyurethane jacket the underside is now visible and the entire object can be packed and transported to the laboratory.

The network of cracks was consolidated *in situ* with 10% Paraloid B-72 (a co-polymer of ethyl methacrylate) in acetone. Acetone was selected for a solvent due to it being safer than most other solvents for use in the field and because of its fast evaporation rate. Paraloid B-72 (PB72) was chosen for a consolidant because its properties are well-known, following wide use in the field of conservation. The known properties of PB72 include suitability to work with dry material, and chemical inertness so that it does not chemically react with the fossil material. Since fieldwork had to proceed speedily within a limited amount of time, most bone surfaces were also coated with a layer of medical gauze wetted with 10% PB72 in acetone. The gauze acted as a fortifying layer, keeping cracked parts together until arrival to the lab.

Fig. 3: Careful removal of earth matrix exposes both bones. The femur and the vertebra found attached to it. Fig. 4: Continued cleaning exposes further details. Temporary jacket supports enable turning over and working on both sides of the bones.

Larger bones and complex bone groups (e.g. vertebrae) needed further support before lifting out of the matrix. For example, a polyurethane jacket was created in the field for the right femur found with a vertebra stuck to one side, so that it could be lifted out. A plaster jacket was made for the group of carpal bones found in the first excavation season (Fig.3,4). Other large or complex bones were likewise jacketed either in polyurethane or plaster, according to size, expected weight and complexity of shape. These jackets were removed in the lab, following initial consolidation, and their contents cleaned and further consolidated as necessary. Gaps were filled with glass balloons and 30% PB72 in acetone, or with crumpled LenSX Rayon tissue in 30% PB72 in acetone. The filled gaps were then coated with Cosmolloid 80H microcrystalline wax to protect the fills (Figs.6-9).

Fig. 5: The femur after conservation, separated from the vertebra and after filling of gap. lying on a final support jacket. Fig. 6: The vertebra separated from the femur and after conservation.

Finally, the treated bones must still be considered weak objects, because they no longer have the tight support of earth/clay matrix surrounding them. The exposure both to gravity and to open air, with sharper changes in temperature and in relative humidity, makes the bones extremely fragile. Therefore,

most bones had special jackets made for them for long term storage and handling. These jackets are made of fiberglass matting and fine art Gypsum. Some of the larger jackets include metal screws to hold the two parts of the jacket together and to facilitate turning over without harming the object within.

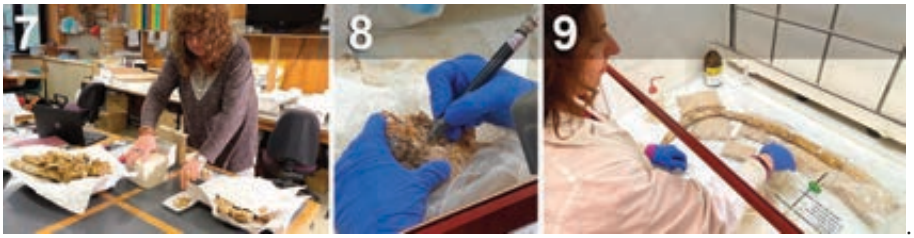

Fig. 7: Identifying the fragments. Fig. 8: Removing deposit from bone. Fig. 9: Joining the broken segments of a rib.

Photogrammetric modeling

The task of digitizing some 130 bones proved complex and time consuming. Prior inspection of the specimens threw up questions regarding the techniques and procedure. As outlined above, the bones are extremely fragile and brittle. Handling them was virtually out of the question and a non-invasive digitizing process was clearly necessary. Of the two main digitizing techniques, scanning and photogrammetry, the latter was chosen as the preferred method. This was due to the emphasis placed on the high texture quality that photogrammetry offers, rather than the geometric accuracy of (expensive) high end structured light scanning. Furthermore, continual improvements in camera optics, sensor size and photogrammetric software algorithms have reduced the gap whereby close-range photogrammetry is now capable of yielding sub millimeter accuracy. [5], HossamEl-Din Fawzy., 2019), well within the tolerance necessary for practical measurement and far in excess of that necessary for 3D printing. [6], D'Amelio, Salvatore & Lo Brutto, Mauro. 2009).

One of the main obstacles to full photogrammetric model construction was the difficulty in obtaining a full 360 X 180-degree coverage. In 3D imaging this is usually performed by digitizing the said object twice. First from one side, then by turning the object over and imaging from the other side. Finally, the two sides are registered and fused together to form one complete 3d model (Fig.10).

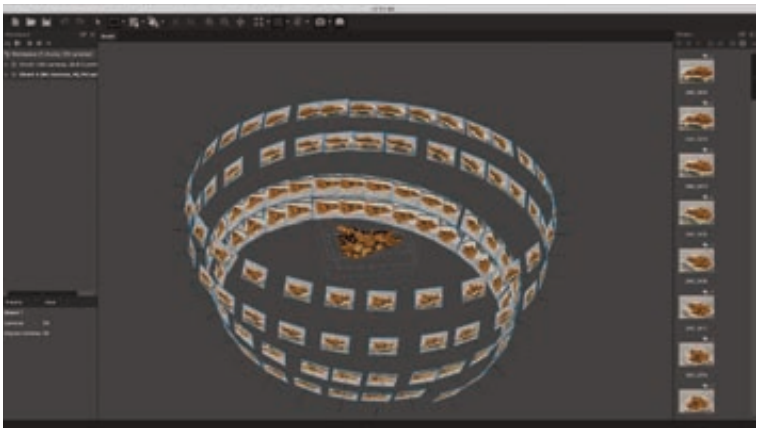

Fig. 10. Full photogrammetric model. 2 chunks combined, 60 images each chunk.

In practice, some fragments, usually the smaller and shorter ones (Fig.11), were deemed solid enough to turn over. However, in other cases, especially the case of the long and narrow bones such as ribs, this was extremely difficult, bordering on the impossible (Fig.12). Indeed, on several occasions, attempts to gently do so, resulted in their snapping into two or even three pieces, necessitating further restoration (Fig. 9).

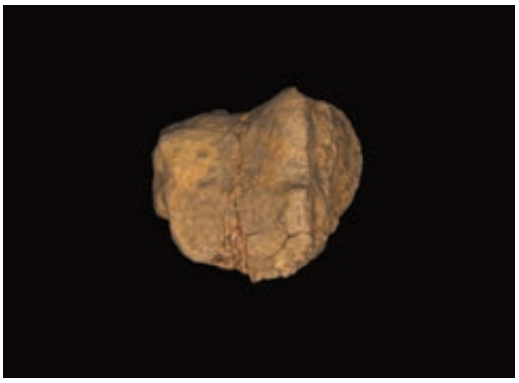

Fig. 11: Small segment of foot. Fig. 12: rib

In other cases, it was clear from the outset that the bones could not be removed from their individually molded cradle. Thus, it was decided that the photogrammetry would be performed while the bones remained inside their cradle. After on side was imaged, the entire two-sided cradle would be rotated and the other sided exposed and modelled. This was especially the case with the large and heavy femur bones (Fig.13). However, in practice, this situation posed an even greater challenge, as the fusion of the two sides of the model demand a fair overlap of surface area for the positioning of reference markers. The molds in which the bones were placed were deep and provided virtually no overlapping surfaces. This made the photogrammetry especially demanding.

Fig. 13: Preparing a femur for photogrammetry. Fig. 14: Preparing the lower jaw for photogrammetry. Note how the tusks have collapsed inwards.

Software

Most advanced photogrammetry software tools today allow for some type of marker registration. After several tests it was decided to go with the [7], Agisoft Metashape Pro software (https://www.agisoft.com/features/professional-edition/). Nevertheless, even then, registration in most cases proved extremely difficult, as the meagre overlaps were very hard to determine. Ultimately it was decided to carefully place tiny coloured putty markers on the problematic bones, to ease with marker identification. These were later cleaned up in post processing, both in [8], Autodesk Meshmixer (https://www.meshmixer.com/) for the surface model, and in [9], Adobe Photoshop (https://www.adobe.com /products/photoshop.html) for the photographic texture map.

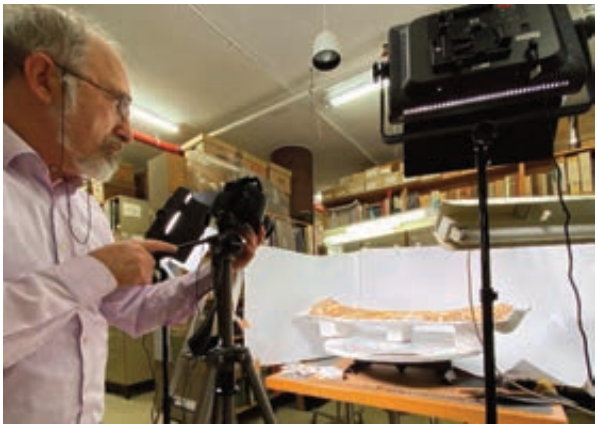

Fig. 15: Photogrammetry of the femur. Note the bone supported in cradle.

Each model consisted of 60-120 photographs. 30-60 each side, depending on their curvature and geometric complexity (Fig.10). All images were shot with a Nikon DSLR in RAW format. The colour-referenced images were then optimized in [10], Adobe Lightroom and exported as full resolution JPG images.
As mentioned previously, all the photogrammetry software outputs were then post-processed in Autodesk Meshmixer, to check and correct defects, and to make watertight for printing.
Accurate length, width and height measurements of each fragment was performed, and the data inserted into the final model, ready for printing. The full data set resulted in just over 270 GB of information.

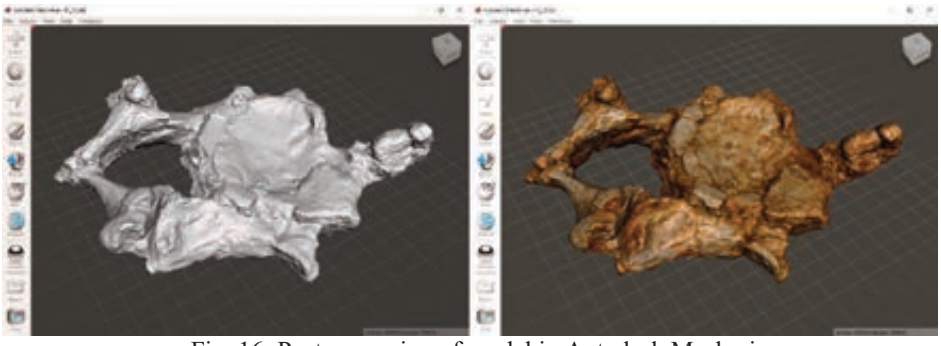

Fig. 16: Postprocessing of model in Autodesk Meshmixer.

FUTURE STAGES

3d Printing

Printing the full-size skeleton of an elephant is no easy task. The three main challenges to this involve size, colour fidelity and climatic permanence.

From the outset it was obvious that printing the fully assembled beast was not viable. The approach chosen was to print each of the 130 individual fragments and bones and then assemple the complete model (Fig.17) . Even then, size was still an issue for several of the larger segments, which reach up to 115 cm. in length. Whilst several such commercial printing services are available localy, few if any are capable of doing so in full colour. To complicate matters further, it is imperative that the printed model be able to withstand outdoor conditions for a great length of time. From the outset, the vision of this project was to errect the life-size 3D model at the entrance of the Hebrew University. The heat of the Jerusalem summer, the very strong ultra-violet rays, and the cold of winter, all constitute an enormous challenge to this endeavour. PETG, ASA Polycarbonate and Thermoplastic Elastomer or TPE, are all 3D printing materials suitable for outdoor. Their filaments are insensitive to changing temperatures and UV rays. [11], They are perfect for use in extreme conditions without deforming shape or appearance. However, the question remains as to their suitability for full colour printing.

Fig. 17: The boxed fragments in the laboratory

Reconstruction & Errection

Once printing is complete, the final stage will be the reconstruction of all the parts. This is akin to a complex 3D jigsaw or lego without instructions. As many parts of the original skeleton do not exist, the process of identifying the exact relative positions of the existing and missing parts will be a

difficult one. Furthermore, in line with standard restoration practice, a clear distinction will be made betwee the existing and non-existing parts. Those missing parts will be constructed with a clearly different material, possibly with a wire frame, epoxy, perspex, or other form of support.
At the time of writing, we are currently researching the possibilities.

As stated, if all goes according to plan, the completed 3D printed skeleton will be errected and placed near the Institute of Earth Sciences at the entrance of the Hebrew University in Jerusalem, not far from where the beast once roamed these parts, 18 million years ago.

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3D MODELING FOR A VIRTUAL VISIT OF THE ARK OF ST. AUGUSTINE

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Abstract – Regarding cultural heritage enhancement, digital 3D models can be used for: reconstruction of ruined or destroyed artifacts, re-interpretation by coloring and animation, replication for printing 3D tangible models for the original artwork preservation, for special exhibitions, for edutainment or commercial purposes. Goal of this project has been the 3D modeling of the Ark of St. Augustine, located in the church of San Pietro in Ciel d'Oro in Pavia (Italy). This precious artifact of the second half of the fourteenth century is made up of 95 statues and 50 bas-reliefs of different complexity, for a total of about 400 characters.

INTRODUCTION

The effective use of information technologies and 3D applications in the cultural heritage domain creates added value for museums and archaeological sites, enhancing the user experience in a personalized and interactive way [1] and increasing knowledge of cultural heritage [2]. Over the last years, several museums and exhibits have adopted new solutions, offering multimodal visits [3] not only to enhance the visitor's experience on-site, but also to expand their audience through online visits [4], the only one allowed during the COVID-19 pandemic outbreak. The application of 3D modeling techniques [5, 6] and the use of 3D printers have also been experimented to make the artistic heritage more accessible, for example with 3D printing of tactile images [7, 8], that are 3D conversion of 2D images that can be read and interpreted by touch. Also technologies that allow the user to interact with computers by means of gestures, voice, and eye input, opened to new opportunities with the development of new applications [9, 10].

In general, 3D digitization can be a useful tool for archeology and museums and it plays an important role in cultural heritage protection and dissemination. It has become a mean to revitalize works of art [11] that have been lost, stolen, destroyed, or that are intentionally temporal. For example, after the destruction of world heritage sites and artworks in Mosul (Iraq), in February 2015, initiatives such as *Rekrei* (formally known as "project Mosul" [12]) or *Scan The World* [13] emerged, focusing on building precious archives and creating virtual museums.

A fundamental shift operated in reshaping the relation towards art and how to experience it having access to computer and Internet [14]. Since 2000, our research group have carried out several projects [15], based on different technological solutions, for promotion, dissemination and accessibility of cultural heritage. Most of them have been realized in an educational context, often generating links with the local community, and creating chances for business

opportunities. The project here described focuses in the 3D modeling of a single monument conceived as viewable on all four sides, but whose height (about 3 meters) and location above the altar make it difficult to be observed, not allowing a full appreciation of its beauty and the great variety of bas-reliefs and decorations that it contains (Fig. 1). Hence the idea of digitally reproducing the Ark of St. Augustine from different viewpoints, with different types of lighting and not excluding 3D printouts. The results have been obtained thorough an experiential learning approach [16].

Figure 1. The Ark of St. Augustine in the church of San Pietro in Ciel d'Oro, in Pavia (Italy), located above the altar and an enlargement of its vault.

Advances in technology contributed to a transformation of social relations and enabled communication and sharing of multimedia formats. The innovative use of interactive digital technologies can be exploited in new approaches to digital humanities practices. Basic principles and tips for 3D digitisation of cultural heritage have been outlined [17] to help achieving the best results in 3D digitization projects. In the "2019 Declaration of Cooperation on advancing the digitisation of cultural heritage" [18], 27 European countries signed to «better use state-of-the-art digital technologies in addressing the risks that Europe's rich cultural heritage is facing, enhancing its use and visibility, improving citizen engagement, and supporting spillovers in other sectors».

The DCHE (Digital Cultural Heritage and Europeana) Expert Group has developed common guidelines to draw up a list of basic principles and suggestions, such as: value and need for 3D digitization, clarification of copyright aspects, plan for open and broad access. Other tips include the determination of the minimum quality needed and the use of the right equipment and methods, the formats to be used and the plan for long-term data preservation. These basic principles contributes to a comprehensive and holistic documentation of European 3D cultural heritage assets.

The main issues to face up during the task of 3D reconstruction of ancient architectural artifacts are: i) difficulty in finding sources documentation and reliability of the representations when straightforward digital acquisition is not possible; ii) application of new technologies that often demand high professional skills and long development times, bearing heavily on

project costs; iii) need to incorporate added value into reproductions to guarantee optimal reception by end users, offering a high level of entertainment that goes well beyond merely reproducing an artifact; iv) multidisciplinary collaboration involving teams made of experts from very different research fields. For example, purposes such as preservation and reconstruction require high-quality geometrically correct 3D models, while for visualisation or VR and AR applications, optimised 3D models are more suitable [19].

THE SCULPTURE DESCRIPTION

The entire marble sculpture of the Ark of St Augustine can be divided into four horizontal levels (or orders) that design the four sides of the monument (Fig. 2).

Figure 2. The four sides of the Ark of St. Augustine, from left: front, right, rear and left side, reproduced in a print by the brothers Cesare and Giovanni Ferreri (1823).

The first three levels are subdivided into quadrants by statues; starting from the lowest level, they represent virtues and, going to the upper levels, popes, bishops, and hermits. These statues, one above the other, distinguish eight columns which, starting from the base, reach the top of the Ark. In the fourth order, the highest, in the front and in the rear side, eight Dante's angelic hierarchies are represented. In the first order, that is the base of the ark serving as a container for the sarcophagus, inside the quadrants, there are representations of apostles and saints. The second order is the most elegant part and represents the sepulcher of St. Augustine. The cell inside, as it were a small room, contains the statue of the saint, depicted in detail, lying on his deathbed and holding an open book with hands covered by chiseled gloves. At the four corners, inside, there are the statues of four doctors of the Church. This small temple is covered by a richly decorated vault. In the center, Christ dressed in a tunic, goes out from top to bottom in the gesture of welcoming the spirit of St. Augustine into the kingdom of heaven. The narrative part begins in the third order, where bas-reliefs represent, in nine panels, scenes from the life of St. Augustine. In the fourth order, the miracles of the saint are depicted within tympanums separated by eight statues that represent the celestial hierarchies [20].

THE 3D MODEL OF THE ARK OF ST. AUGUSTINE

This project embraces the field of Virtual Heritage and lies halfway between the needs of cultural experts and the tools available to information technology professionals. Relief-based

3D modeling defines characters through relief and models characterizing morphological and chromatic details. Visitors' judgment on the value of a relief character does not simply depend on its graphic and pictorial qualities, but also includes recognition of the character's mood in a specific context. A 3D modeled character can become dynamic by moving it in a virtual context created for this purpose.

A hundred students participated in this three-year project, developed as final exam of the academic course in "Computer Vision" taught with an experiential learning approach, focused on the realization of a real project, thus improving the students' involvement and, at the same time, encouraging synergies and collaborations between the world of education and local communities, fostering social and economic development. The students adopted different 3D modeling software, at their convenience; just to quote some, Cinema 4D, 3ds Max, Maya, Rhino, ZBrush, but mainly two − available for independent developers − have been extensively considered during the lecturing and final phase: Adobe Fuse CC and Blender.

An important step during the development phase has been the application of textures and materials, as well as the rigging phase i.e., how to assign the model a pose consistent with the one assumed in the original bas-relief (Fig. 3). Finally, the rendering phase allowed obtaining, starting from the 3D model elaborated on the computer, a very realistic image in 2D (Figg. 4 - 9).

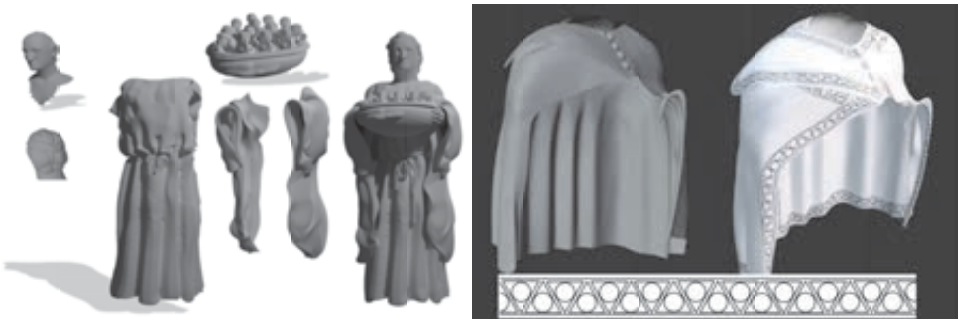

Figure 3. Some example: left, a 3D model of one of the angelic hierarchies. The components are made separately (face, hair, tunic, sleeves) and finally they are integrated; right, a 3D model and rendering of a friar vest and the decorative motif applied on the final result.

Figure 4. A rendering version of the bas-relief of the third order "Augustine teaches rhetoric in Rome and Milan".

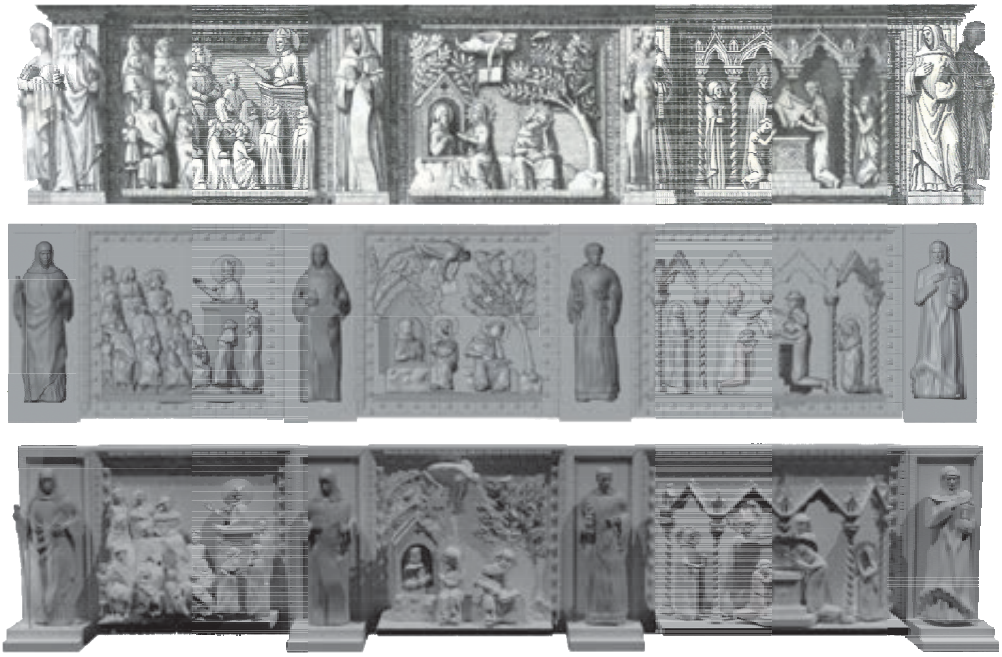

Figure 5. Third order, front side. From top: an historical print, the 3D model, the final rendering. The three bas-reliefs and the four friars, made separately by different teams of students, have been integrated in the front view.

Figure 6. Final rendering of the forth order, rear side: miracles and celestial hierarchies.

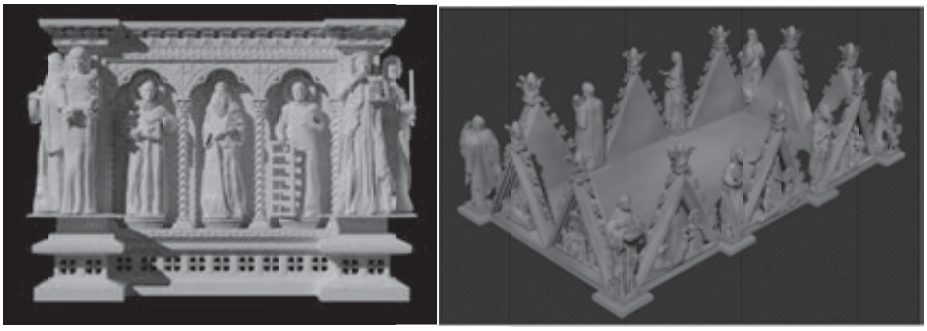

Figure 7. Rendering of the overall structure of the first and the fourth level of the Ark.

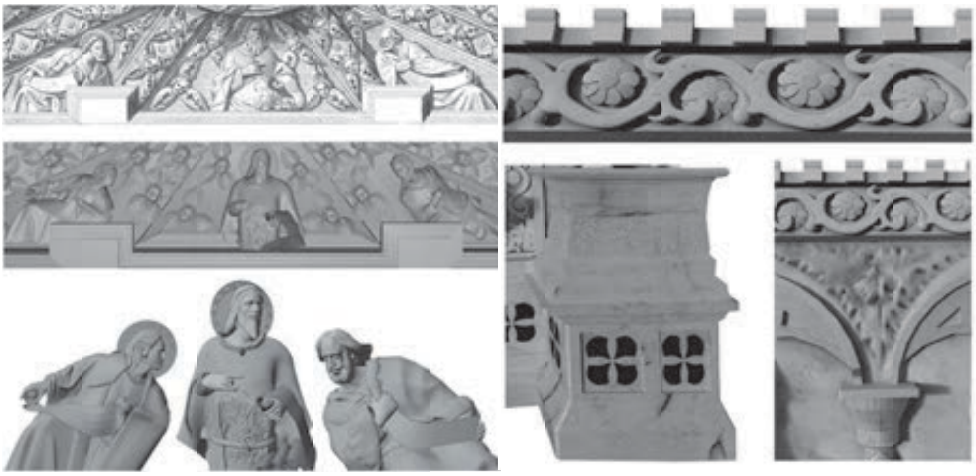

Figure 8. Left: a part of the vault of the Ark of St. Augustine − from top: an historical print, a rendering of the area, the images produced during the rendering phase of the three main characters. Right: some architectural details of the 3D reconstruction.

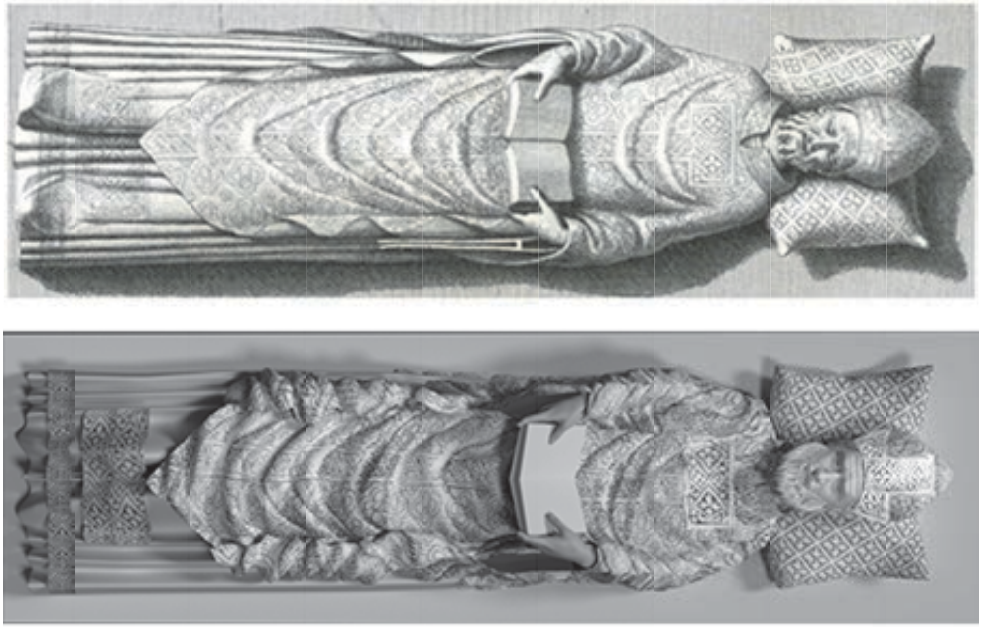

Figure 9. The statue of St. Augustine lying on his deathbed: above, from an historical print, below, a rendering version.

CONCLUSION

New technologies are changing the way we live. In the context of digital humanities, the widespread connectivity and the new interfaces, that are increasingly powerful, simpler, and more natural, fruitfully integrate the knowledge of users. With this goal, new and effective proposals have been developed for the presentation of artworks, in which participatory

experiences favor self-motivation and subjective discovery. In particular, 3D modeling, virtual 3D reconstruction, simulation, and Augmented Reality can be exploited to create innovative tools for cultural heritage dissemination purposes, while visitors can be more involved into cultural topics with the combination of education and entertainment (edutainment) offering them a new way to be prompted with additional material. We proposed a solution for a virtual visit of a fourteenth-century artwork of great richness and complexity, normally visible with difficulties, implementing tools that are now of daily use. Furthermore, the development of this project in an educational context, for its targeted interdisciplinary nature, that combined historical, artistic, architectural, and computer science topics, stimulated the students inspiring more creativity and engagement, and established a link between the University and the local community. The proposed innovations involve customers at multiple levels and if the IT impact is such that young people are often more likely to feel involved than adults, often motivation plays an opposite role. The new technologies have so been employed in a useful direction for both needs: on the one hand, the natural interaction that simplifies the technological impact, and on the other, a gaming version that facilitates the impact with self-motivation.

ACKNOWLEDGMENTS

We would like to thank all the students of the "Computer Vision" course of the academic years 2017/2018, 2018/2019, and 2019/2020 of the Master's degree in Computer Engineering of the University of Pavia (Italy) for their enthralling commitment, their enthusiasm and the efforts that they put in to make this initiative successful. Special thanks also to Luca Lombardi and Piercarlo Dondi of the Computer Vision and Multimedia Laboratory (CVML) for their project supervision and to Luigi Santangelo for most of the final rendering.

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A Proposal of Surface-Based FTV

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Abstract – We are developing a new principle for next-generation FTV with photo-realistic images and wide viewing zone. The idea is to integrate image-based FTV with photo-realistic images and model-based FTV with wide viewing zone. In the new principle, 3D scenes are represented by surfaces. Relation between rays from a surface and views captured by cameras are analyzed. Based on this analysis, a surface is detected from orthogonal and perspective views in three directions. It enables surface-based FTV to use both ray and surface information for view synthesis.

1 INTRODUCTION

FTV (Free-viewpoint Television) [1]-[8] is visual media that enable immersive viewing of a 3D space as if we were actually there. MPEG has been developing FTV standards in the first phase (MVC) [9], second phase (3D Video) [10] and current third phase (MPEG-I) [11]-[13].

Fig. 1 shows two directions in the progress of visual media. The horizontal axis of Fig. 1 denotes the progress in number of pixels or field of view (FoV). Visual media have already achieved great progress in this direction. However, these media transmit only a single view, and users cannot change the viewpoint. The vertical axis of Fig. 1 denotes the progress in number of views or viewing zone. Although 3DTV transmits two or more views, its viewing zone is very limited. Thus, conventional visual media are still far from our natural viewing in the real world. On the other hand, FTV allows users to view a 3D scene freely from any viewpoint because it has an infinite number of views.

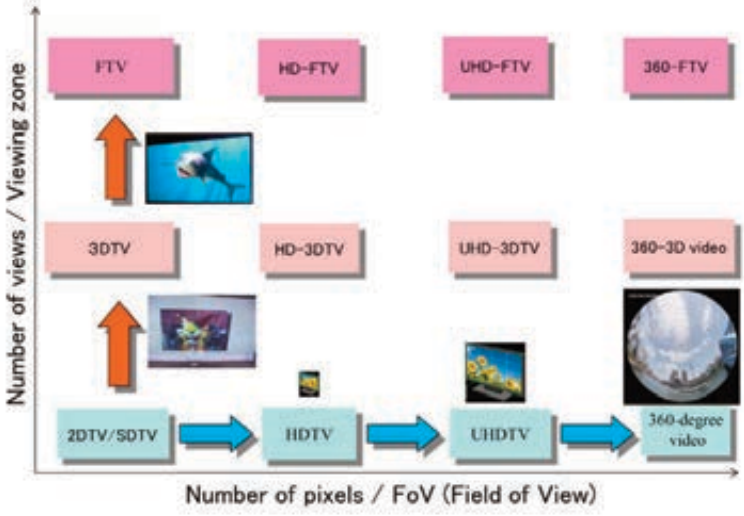

Fig. 1 Two directions in the progress of visual media.

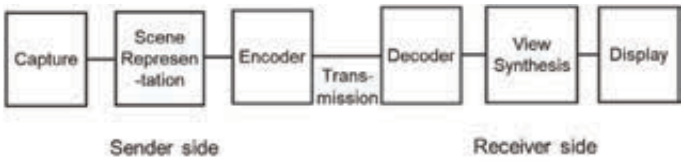

Fig. 2 Configuration of FTV.

Fig. 2 shows configuration of FTV. At the sender side, a 3D scene is captured and converted to scene representation data. At the receiver side, free-viewpoint images are generated by view synthesis from scene representation data. Therefore, scene representation is a key to determine features of FTV.

There are two types of FTV, image-based FTV and model-based FTV. Image-based FTV represents a 3D scene by rays and model-based FTV represents it by a 3D model. Image-based FTV and model-based FTV have complementary features. Image-based FTV generates photo-realistic images but its viewing zone is narrow. On the other hand, model-based FTV generates less photo-realistic images but its viewing zone is wide. FTV that has advantages of these two types of FTV has never been realized.

There are intermediate scene representations between rays and a 3D model. They are depth-based scene representations such as Point Cloud, MVD (Multiview plus Depth) and GVD (Global View and Depth) [14]. Depth-based FTV using these representations is sensitive to depth error.

Ray-space [15]-[18] is an image-based scene representation. If surfaces are detected from ray space, both rays and surfaces can be used for view synthesis. It means that image-based FTV and model-based FTV can be integrated. It will bring a breakthrough for the next-generation FTV. In this paper, surface detection from rays is studied and surface-based FTV is proposed.

2 FROM DEPTH-BASED FTV TO SURFACE-BASED FTV

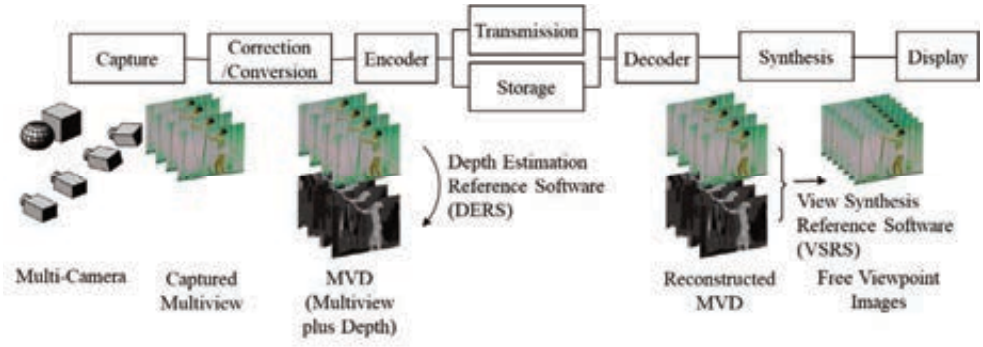

Fig 3. Configuration of depth-based FTV (FTV reference model for MPEG 3D Video standard).

Depth-based FTV was developed in the second phase of MPEG-FTV. Configuration of depth-based FTV is shown in Fig. 3. This is FTV reference model used for MPEG 3D Video standard. Here, MVD is used for scene representation. Depth Estimation Reference Software (DERS) [19] was developed to obtain depth data and View Synthesis Reference Software (VSRS) [20] was developed for view synthesis.

MVD and Point Cloud are equivalent scene representations because one point is obtained in a 3D space from one pixel of MVD by tracing a ray back to the source as shown in Fig. 4. Global

View and Depth (GVD) is an alternative data format of MVD. GVD is a compact version of MVD and obtained by removing the inter-view and inter-depth redundancy of MVD as shown in Fig. 5.

MVD and Point Cloud represent an object by many points. These points lack consistency as a surface since they are determined independently. It doesn't cause visible degradation in synthesized views if the object is viewed from the front or slightly different directions. However, a surface of the object cannot be synthesized correctly if the object is viewed from very different directions. Therefore, a different type of scene representation is needed for FTV with wide viewing zone.

We are developing MVS (Multiview plus Surface) as a new scene representation for the next-generation FTV. It is surface-based FTV, where surfaces are detected from rays and both rays and surfaces are used for view synthesis. Scene representation data and spatial information of FTV are shown in Fig. 6. MVS has surface information as spatial information and views are synthesized by surface-based image rendering. Since rays and surfaces are used for view synthesis, surface-based FTV has photo-realistic free viewpoint images and wide viewing zone.

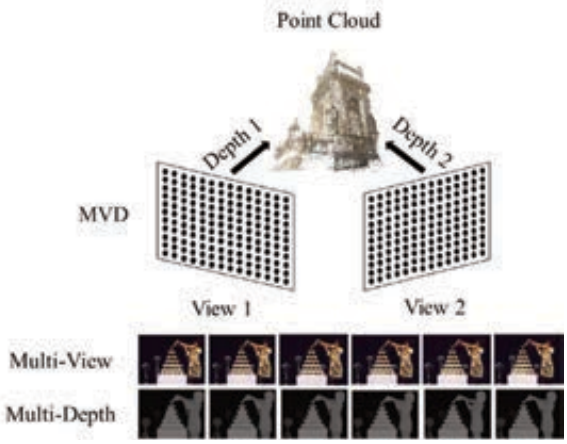

Fig. 4 Relation between MVD and Point Cloud.

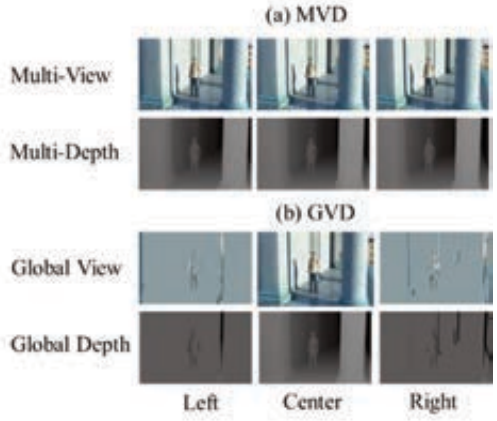

Fig. 5 GVD removing redundancy of MVD.

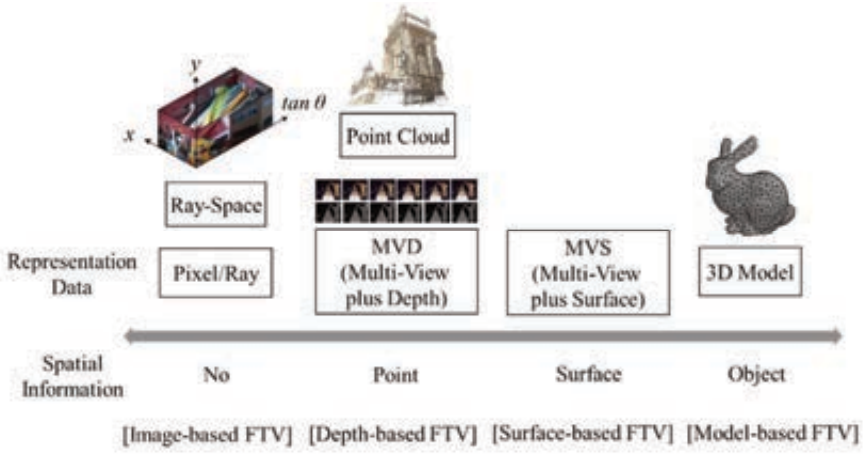

Fig. 6 Scene representation data and spatial information of FTV.

3 SURFACE DETECTION

3.1 Surface Detection from Orthogonal Views

When surface $\mathbf{S}_0$ with a normal vector (θ_0, φ_0) and area S_0 is seen in (θ_1, φ_1), (θ_2, φ_2), (θ_3, φ_3) directions as shown in Fig. 7, the areas S_1, S_2, S_3 of orthogonal views $\mathbf{S}_1, \mathbf{S}_2, \mathbf{S}_3$ are given by

$$S_1 = S_0[cos(\theta_1-\theta_0)\cos\varphi_1 cos\varphi_0+sin\varphi_1 sin\varphi_0]$$
$$S_2 = S_0[cos(\theta_2-\theta_0)\cos\varphi_2 cos\varphi_0+sin\varphi_2 sin\varphi_0]$$
$$S_3 = S_0[cos(\theta_3-\theta_0)\cos\varphi_3 cos\varphi_0+sin\varphi_3 sin\varphi_0].$$

By solving above 3 equations, direction (θ_0, φ_0) of the surface is derived as

$$tan\theta_0 = -\frac{(S_3 sin\varphi_2 - S_2 sin\varphi_3)cos\theta_1 cos\varphi_1 + (S_1 sin\varphi_3 - S_3 sin\varphi_1)cos\theta_2 cos\varphi_2 + (S_2 sin\varphi_1 - S_1 sin\varphi_2)cos\theta_3 cos\varphi_3}{(S_3 sin\varphi_2 - S_2 sin\varphi_3)sin\theta_1 cos\varphi_1 + (S_1 sin\varphi_3 - S_3 sin\varphi_1)sin\theta_2 cos\varphi_2 + (S_2 sin\varphi_1 - S_1 sin\varphi_2)sin\theta_3 cos\varphi_3}$$

$$tan\varphi_0 = -\frac{S_1 cos(\theta_2-\theta_0)\, cos\varphi_2 - S_2 cos(\theta_1-\theta_0)\, cos\varphi_1}{S_1\, sin\varphi_2 - S_2\, sin\varphi_1}$$

Thus, surface direction (θ_0, φ_0) is detected from areas of three orthogonal views.

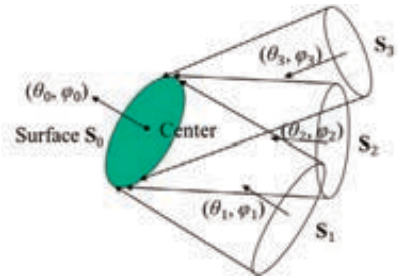

Fig. 7 (θ_0, φ_0) detection from three orthogonal views $\mathbf{S}_1, \mathbf{S}_2, \mathbf{S}_3$.

3.2 Surface Detection from Perspective Views

If cameras are set far from an object, captured views can be regarded as orthogonal views. However, cameras are not far from objects, captured views become perspective views.

Rays of perspective views form cones as shown in Fig. 8. Sections $\mathbf{S}_1, \mathbf{S}_2, \mathbf{S}_3$ are obtained by cutting these cones by a plane. If a normal vector (θ, φ) of the cutting plane is equal to the normal vector (θ_0, φ_0) of the surface, all sections $\mathbf{S}_1, \mathbf{S}_2, \mathbf{S}_3$ are similar.

(θ_0, φ_0) is detected by using this similarity. When $(\theta, \varphi) = (\theta_0, \varphi_0)$, all of the normalized sections $\mathbf{S'}_1 = \mathbf{S}_1/S_1, \mathbf{S'}_2 = \mathbf{S}_2/S_2, \mathbf{S'}_3 = \mathbf{S}_3/S_3$ have the same shape as shown in Fig. 9. (θ_0, φ_0) is obtained by changing (θ, φ) so that difference among $\mathbf{S'}_1, \mathbf{S'}_2, \mathbf{S'}_3$ becomes 0.

Fig. 10 shows relation between perspective view $\mathbf{W}_1$ of camera 1 and section $\mathbf{S}_1$. A point $(x_0, y_0, 1)$ on $\mathbf{S}_1$ is given from a point $(x_1, y_1, 1)$ on $\mathbf{W}_1$ by

$$\begin{pmatrix} x_0 \\ y_0 \\ 1 \end{pmatrix} = \frac{1}{P(x_1,y_1)} \begin{pmatrix} x_1\cos(\theta_0-\theta_1)-y_1\sin(\theta_0-\theta_1)\sin\varphi_1-\sin(\theta_0-\theta_1)\cos\varphi_1 \\ x_1\sin(\theta_0-\theta_1)\sin\varphi_0+y_1(\cos(\theta_0-\theta_1)\sin\varphi_0\sin\varphi_1+\cos\varphi_1\cos\varphi_0)+(\cos(\theta_0-\theta_1)\sin\varphi_0\cos\varphi_1-\cos\varphi_0\sin\varphi_1) \\ P(x_1,y_1) \end{pmatrix}$$

and

$$P(x_1, y_1) = x_1\sin(\theta_0-\theta_1)\cos\varphi_0+y_1(\cos(\theta_0-\theta_1)\sin\varphi_1\cos\varphi_0-\cos\varphi_1\sin\varphi_0)+(\cos(\theta_0-\theta_1)\cos\varphi_1\cos\varphi_0+\sin\varphi_1\sin\varphi_0)$$

These equations are used to determine $\mathbf{S}_1$ from $\mathbf{W}_1$.

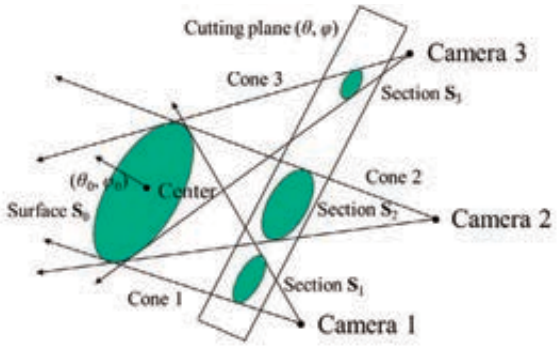

Fig. 8 Rays of perspective views form cones.

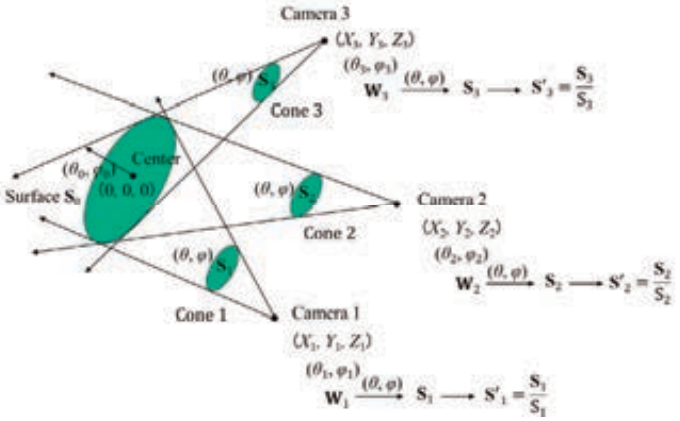

Fig. 9 Surface direction is detected from normalized perspective views.

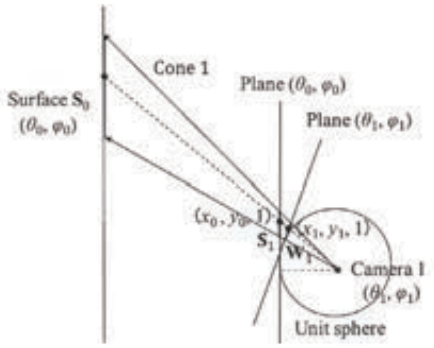

Fig. 10 Relation between perspective view $\mathbf{W}_1$ and section $\mathbf{S}_1$.

4 EXPERIMENT

Surface detection from orthogonal views and perspective views is verified experimentally. Fig. 11 shows converging process of (θ_0, φ_0) to a true value from various initial values by iteration in case of perspective views. As seen in this figure, (θ_0, φ_0) is successfully converged to the true value after several iterations.

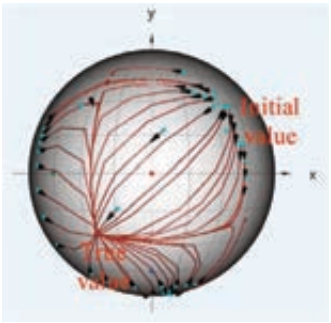

Fig. 11 Converging process of (θ_0, φ_0) to the true value from various initial values by iteration in case of perspective views.

5 CONCLUSION

We are developing a new principle for next-generation FTV with photo-realistic images and wide viewing zone. The idea is to integrate image-based FTV with photo-realistic images and model-based FTV with wide viewing zone.

Relation between rays from a surface and views captured by cameras are analyzed. Based on this analysis, a surface is detected from orthogonal and perspective views in three directions. It enables surface-based FTV to use both ray and surface information for view synthesis. Thus, image-based FTV and model-based FTV are integrated. It will bring a breakthrough for the next-generation FTV.

ACKNOWLEDGEMENTS

This research is partially supported by JSPS KAKENHI Grant Number 21K04072 and Hoso Bunka Foundation Grant.

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MUSEUMS AT THE CROSSROADS: BETWEEN DIGITALITY, REALITY, AND COVID-19

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Abstract – When Covid-19 rushed into our lives, it sent shockwaves across the globe – suddenly we faced "lockdown" – we said goodbye to the way it was but did not understand what this brave new world of isolation and separation would mean and how it would the impact life as we knew it– our identity, relationships and freedoms we enjoyed, and wondered what daily routine post-Covid-19 would look like, while the experiences defining life itself were up for grabs. With social distancing, masks and work from home mandates, the arts and performing arts from theatres, museums, galleries and the public square were shuttered – their very existence challenged and spiralling out of control as staff were laid-off, exhibitions cancelled while concurrently creating an urgency to go online to dwell in cyberspace, the new daily destination.

INTRODUCTION

The crisis of the pandemic, now converged with critical sociocultural movements and technological advances in AI, robotics and computing in ways that question human identity and purpose, are trends that had already intensified by summer 2019. As the world sought to navigate through this unprecedented and life changing disruption, the rising digitality of our states of being pushed us evermore toward virtual life. With remote work, we witnessed the emptying out of the public square leaving a lacuna of human activity and social interaction. The social forces already at play of diversity, equity, and inclusion, burst into this deserted space and filled it with protest fuelled by social movements most prominently, Black Lives Matter. This paper explores these issues through the lens of museums and cultural life, where art pervades the fabric of life, and is heard and seen on city streets, in galleries and museums. We look at how arts and cultural life have evolved from 2019 to 2021 and how museums might survive during this time of dramatic change and uncertainty, accelerated by the social forces influencing human identity and relationships.

Covid Commons
by T. Giannini
Alone
At home
Just my smartphone
What are my choices
TV voices
Fake news
That's your muse
Netflix
Take your picks

Don't tweet
or take the heat
You're in retreat
Escape from Amazon
End the marathon
Ask Google
Where's life gone
Mickie and Minnie
could be Winnie
a dream sequence –
with no evidence

Can't get back
to reality
Stuck in virtuality
Main menu
No venue
for physical experience
The materiality
of holding hands
Kissing
Missing
you

Fig. 1. Illegal graffiti in Glasgow, by Daniel Naczk, 9 April 2020. This Covid graffiti symbolises emotions behind the mask – the illicit and the illegal. That which is natural becomes taboo. https://commons.wikimedia.org/wiki/File:Glasgow._Bank_Street._Graffiti._jpg.jpg

Well before the pandemic, museums had already made a paradigm shift from being collection-centric to user centric in the context of human participation and interaction. When Covid-19 struck, museums had no choice but to turn to digital transformation, although there was little digital to be seen onsite – even digital art was mostly excluded. Suddenly, museums faced with the Corona virus crisis, saw their doors shuttered, the visitors gone – and so was their main revenue and income. Libraries also closed but the stakes were not the same as their main menu, the book, is served well by the digital book, a great surrogate of growing popularity, surpassing the physical book in many ways. Whereas the physical collections of museums, their main menu, is defined by their physicality, their size, shape, colour, texture, materials and the spaces they occupy in galleries, all of which are central to how we experience a work. As the tension between physicality and digitality grows the longer Covid-19 continues, the more human behaviour adopts to altered states of being digital while the public square, the place where people gather and socialise, shrinks, we find ourselves in retreat from the life we knew as big tech and big government occupy the void. When the pandemic ends, that life that once was, will end too, invoking somewhat of a Rip Van Winkle effect.

What will happen to the public places we abandoned during Covid-19, and what will motivate people to come back, and will museums be able to attract new audiences. Enter digital artists, designers, and museum curators – those who know how to use digital to make art and engage audiences, to tell stories and be contemporary and relevant. Digital artists, whose presence in museums seems sorely lacking must now assume a more central role in digital integration and visualisation of human digitality and identity. While information and technology services can be outsourced or remote, curators remain at the heart of defining collection content and context and more than ever, recognise the need to collaborate with artists on new narratives, which in turn opens up museums to reimagine collections in ways that encourage them to engage with more diverse communities, artists and audiences.

COVID-19 AND DIGITAL LIFE

Remote work and online education confines people to their homes. People retreat as cities seem lifeless and begin to die and have themselves become diseased. People begin to leave city centres to seek their own space saying goodbye to those tall buildings with hundreds of apartments and offices that begin to look more like prisons. Cars, like private spaces on wheels, are the refuge between here and there as we avoid public space at all costs while public transportation seems deserted. Being locked-down in our homes and locked-out of real-life causes feelings of disorientation, displacement, and dissolution of life as we knew it. Seeing art, seeing life and human interaction moves to digital screens, as our sense of physicality fades, replaced by virtual experience, as when the size of an artwork becomes the size of the screen – digital simulation of physical attributes replace the real and are lost to digitality.

Seeing Digital in Art Museums – Immersive Reality and Virtuality

As we progress through the 2021 pandemic, seeing digital in art museums and in exhibitions still has not been broadly conceptualized and accepted, lacking regular space, place and purpose as digital mainly serves museums' online presence, and seemingly disappears entering the physical museum where digital is generally represented by visitors' smartphones or iPads. Extending physical reality in museums using VR, AR, MR, and 3D awaits broader use and regularization. Where VR has been cultivated to a high degree to enhance visitor experience, for example the 2018 Modigliani Exhibition at the Tate Modern, the Louvre's Mona Lisa Exhibition as part of the 2019 da Vinci Exhibition celebrating 500 years since his death [4], it has received wonderful results and wide acclaim. For both of these exhibitions, the museums partnered with VIVE Arts. Now in 2021, a new foray into VR and integrated digital, arrives with the V&A (Victoria and Albert) Museum's exhibition, *Alice: Curiouser and Curiouser,* planned to be on view from 27 March 2021, features a VR experience created by VIVE Arts that can also be viewed in an online version [5].

At the heart of the V&A's exhibition's Conjuring of Alice, are curators, digital artists, and designers of the creative industries working collaboratively. The overwhelming critical success and broad public enthusiasm for the VR components of these exhibitions as well as other digital enhancements, points to the need for museums to cultivate inhouse digital artists/curators to be part of their team for exhibitions, working onsite and online in ways that heighten visitor experience while also accounting for their digital behaviour.

Post-Covid, the playing field of exhibitions and visitor experience will have forever broadened its scope to include an ever-expanding range of virtual technologies that in the first instance expand the artistic palette for creating exhibitions and other visitor experiences serving to inspire public learning and emotional engagement, as museums tell new stories in relevant ways. The Alice exhibition does just that, while bringing new and thought-provoking interpretations, it takes the visitor on a journey spanning 156 years, beginning in 1865, the year *Alice* was first published, arriving at 2021, a moment of global pandemic, when we all, to some extent, have fallen down the rabbit hole of virtuality.

The Digital Abyss
by T. Giannini
The past fades
As we wade
deep into a rabbit hole
down under the grassy knoll
of the digital abyss
Following Alice into Wonderland
take my hand
entering remote identity
in virtual reality
It's all a sham
Can't recognize where I am
Virtual life seems out of hand
Exhibitions and legacy systems
Old traditions
Falling apart
Cancelled ambitions
New renditions
disappearing the past
The die is cast
Can't hear your voice
No choice
Time's run out

Fig. 2. Left: 1865 illustration by John Tenniel for *Alice in Wonderland*, 1st ed., Morphing identity.

The topsy-turvy world of Alice finds deep concordances with life in the virtual world. Alice leaves her real world and enters a simulated virtual world of "wonderland," as contemporary life has fallen down the "rabbit hole" of Covid-19.

Museums – Integrating Real and Virtual

When we re-emerge from the void of Covid life, how will we put reality back together? The lacuna in the public square left by Covid has veered from occupied to empty, stranded between lockdowns and protests. Filling that void in a physical sense, and in our hearts and minds presents an existential challenge to human existence – life as we knew it and what it might become. Museums are now asking, what will be a sustainable model of the future under the impact of the emerging principles of digitality. The book *Museums and Digital Culture* [3] takes up the notion of the museum beyond its walls, bridging to community, local and global, and merging the museum's online identity with that of the physical museum, and re-thinking how museums can generate income, and what might be the new partnerships, new roles for government and philanthropy. Some initial considerations might be found in those that build on existing resources and strengths. The book devotes a chapter to museum education through the lens of the Master's in *Museums and Digital Culture*, introduced by Giannini at Pratt Institute, which in many ways explains and looks beyond 2021.

As AI and machine learning prevail in this moment of crisis, for the first time in human history artificial intelligence challenges human intelligence as humans bow to the machine power of the fourth industrial age. Humans and machines working together are engaging millions if not billions of people – but as AI invades more of the things of the mind, human thinking, imagination, and creativity, – what will be left to humans – will we need to be more than human? The first to go is repetitive, make-a-day work, which is broadly embedded in our institutional legacy systems including those for archives and libraries. At the very moment university students turn to technology as the answer to "getting a job", will some of those jobs go to AI and human personification – robots. Learning to write and operate programs, soon will be dominated by big tech and communication corporations, most humans will simply follow program instructions, buy the product, play the games, and watch the shows.

Art and artists are the future in a future where creativity, critical thinking and free expression can exist. Digital art now moves to centre stage – using digital tools to expand our mind and vision and interpreting through computational culture, we seek a new sense of aesthetics that speaks to all cultures as cultures worldwide see themselves and others through a digital lens. How much will humans morph to live side by side with robots and see the world through screens.

COVID CONFLICTS AND IDENTITY

Information and communication corporations are becoming larger, offering each person their place in the digital ecosystem. Governments are being cowed by giant-technology companies (Google, Facebook, Twitter, etc.), social order is disintegrating, and the large news media corporations represent the reality of social and cultural revolution through a digital lens – we were not prepared. During Covid, some cities have become centres of protest witnessing a new movement of migration from large cities and life at the precipice of a radical shift where each human is at the centre of creating their identity – choose your gender, choose your religion, choose your age – but you can't choose to live outside of the digital ecosystem – where there's still lots of room at very little cost – life in the cloud, on a platform – where being unplugged means death – who are you anyway – a place where big tech corporations are all about serving individual customers and consumers. What are they serving – information – products –

experiences – entertainment – services – customization. But we wonder, are humans the customer or the product?

The End of Reality – Simulating Life, Art, and Identity

Like many other periods of transformation, revolution and re-invention, in the early stages are attempts at simulation of what was and then using a new media – for example, in 1968, Harriet Avram changed library catalogue cards to machine readable cards – and the MARC record is still be used! In our computational culture, we are trying to simulate the real experience of education on location at a school to online as a sort of virtual classroom, but we increasingly see that online courses have little in common with the totality of real experience, one that is highly complex existing in time and space between where physical and digital converge, and where the digital is used to heighten the human experience in the physical world. Now, during Covid, the new goal is to create a digital simulation of what was reality and convince people that it can and will be an improvement. There is a sense that reality is a thing of the past and is "old school".

The key symbol of Covid, the mask covering the nose and mouth produces a sense of fear and isolation, and potential punishment for not following rules, like "go to your room" – do not come out until we tell you the coast is clear and it is safe to step out. In the past, we had "masked balls" but the mask did not cover the mouth. Instead, it concealed identity, while communicating intrigue and an invitation to become acquainted. Acquaintance has not been acquitted, but rather seems omitted from daily life reinforcing feelings of isolation. Museums depend on academe to prepare students for careers in museums at the heart of which is curatorship and cultural leadership. Looking back over centuries, we see that apprenticeship has yielded the most significant and tangible results. This long-established mode of learning has been significantly curtailed and will impact students' ability to understand the curatorial side of museum work.

DIGITAL CAPTURE AND CURATION

Digitization remains foundational for museums and the humanities generally. Recent advances in computing as computer recognition across media – image, text, sound, video, 3D, VR, AR, and MR, offers new opportunities for creative, innovative and integrated processes and applications on a large scale, moving from the legacy labour-intensive models and systems that take item by item approaches tied to human selection, tagging, cataloguing, organizing, etc., when there are digital tools using AI and machine learning that can automate these processes. Importantly, this would greatly increase capacity, access, and use. Museums, archives and libraries need to collaborate and share across institutions to find ways to automate their processes to be more plug and play. Given that digitization is a repetitive process, it lends itself to AI and machine learning that can accommodate the intelligent aspects normally assigned to human intelligence such as metadata schema and search.

Covid has raised the stakes on implementing and investing in new intelligent systems with the promise of reduced labour costs and increased productivity, while for archives it addresses hidden collections, broadens selection reducing prejudices inherent in individual selection and in authority knowledge systems. Soon, repetitive work will be superseded by automated systems, and this will be the case in the museum, archive and library world, freeing-up professional staff to focus on critical tasks requiring high-levels of human intelligence,

creativity and abstract thinking as museums become more welcoming to digital innovation, fresh interpretations and socially relevant storytelling. With this approach, collections come alive and are open to discovery from the dual-perspectives of curators, visitor and users – so, a more inclusive democratized systems with sharing for cost-reduction of routine activities that are not main menu, while favouring more investment in artists, exhibitions, curatorial, creative computing and research.

Between Two Worlds – Real and Virtual

We have entered a new period of experimentation and research at the crossroads where before us, are an unprecedented number of choices all leading to degrees of transformation of our ways of being and knowing ourselves and the word. As we leap into the fourth industrial revolution of AI and machine learning under the forces of Covid, social and cultural revolution – it seems we have little choice but to accelerate change and dive into the future. However, lockdown has limited our choices as it imposes a more artificial and virtual life, dependent on new digital services from the realm of education to shopping, dining, entertainment, and in the first instance – communication. Some sectors of society are raking in more money than ever – digital entertainment, communication and online commerce – while others, libraries, archives, museums and education are in search of a new order, which most likely appears to be a huge leap towards digital dominance, shifting to digital frameworks beyond information management systems – but rather extending to human behaviour and interaction systems – not big data per say, but increasing levels of digital embedded in day to day life – the "Internet of Behaviour" that guides, monitors and controls human behaviour. For example, emerging from the Covid crisis, systems have developed for "contact tracing" a huge experiment in imposing specific behaviours on the global population that seem unprecedented.

Museums are being lured by the big corporations such as Disney, Netflix, and Amazon – not just for sponsorship but rather collaboration. Social justice movements receive top billing in art and education. Digital globalism fuelled by the Internet's digital ecosystem over platforms and networks and created by the new phenomena of digitality dominating human behaviour and interaction, wildly increased by Covid, so that we are propelled into unknown territory challenging human identity. The so-called fourth industrial revolution challenges traditional notions of living, communication and interacting in the world as AI and ML become embedded systems for day-to-day human functioning simulating, reinventing and assuming roles once reserved for humans. This emerging collaboration between humans and computing machines using AI and robotics – means that human abilities for creativity, innovation and critical thinking take on new importance as does human judgement, values and ethics. Rapidly increasing levels of digitality in day-to-day life, almost imperceptibly are transforming the nature of human experience and what it means to be human. Between elation and fear, digital engagement and isolation, the old and new order, the unstoppable force of the digital revolution is mirrored by a new social revolution of human identity and equality driving social unrest.

Museums – A Prelude to Covid-19

In the current crisis-leaden environment, the old road is rapidly aging and being replaced by a new Internet highway constructed around AI and neural networks for virtual life in cyberspace and physical place as we reach out through Zoom in a world where legacy systems

are disappearing and being replaced by digital infrastructures simulating human experience and senses from the IoT to the IoB (Internet of Behaviour).

Looking to the future from the vantage point of the present, a period of extreme change is before us, during which Internet communication, computing and AI are the key drivers of a new social order, as human behaviour and experience under the weight of Covid-19 is causing a surge of digitality in everyday life. For example, education moving *en masse* to online, shopping online reaching unprecedented levels of participation and e-books and other forms of digital information holding sway among users. During the same time, museums, libraries, and archives were forced to close and move online leaving behind their traditional modes of operating in the physical museum for a virtual presence on the Internet. Thus, these institutions, especially museums, are scrambling to find alternative paths to financial sustainability [6].

Although ultimately, the answer will be in an integrated model of onsite and online, during the next year or two. One approach might be partnerships with corporations such as Netflix and Disney as well as seeking commercial sponsors of exhibitions who might also contribute to the show itself. Museums might consider fee-based programmes by expanding their education programmes to include credit degrees such as a master in museums drawing on existing resources, collections and curators, and having deepened their online presence and connection to their audience, museums are becoming more adept at using 3D, AR, VR, MY, and AI. Over time, such degree programmes could become hybrid, adding focus to experiential learning onsite. Further, there is a need for museums programmes that prepare professionals to engage the social and curatorial challenges of the field as they strive to speak to a more diverse audience and can be especially effective in visual modes of communication, the modes du jour as the old text-dominated world fades.

Despite the advance of digitality being unstoppable, as noted in our articles on digitalism [1] and digitality [2], there are critical choices in how and where it is applied, why and for what purpose and outcomes, how it serves and enhances human experience, education and quality of life, and importantly, the roles and responsibilities reserved for human work and participation, that will more and more be a measure of human relationships with AI systems and robots.

McKenna [7] poses the question: “At a time when museums and art galleries have closed their doors to art lovers, has the time come for digital art? Art that has been digitized, but also Art that is born digitally, especially video art?” The Israeli start-up company, Niio, is developing a platform for digital art that draws on the Netflix and Spotify platform model to publish and view digital art that bonds artist and artifact using blockchain and AI. The founder and CEO of the company “believes Covid-19 has sped up the growth of digital art, and that technology holds the key to the future of the art sector.”

CONCLUSION

What remains to be addressed were museums to embrace digital – what would that look like? At this critical juncture, what seems most needed are fresh insights for new conceptual models that bring creative ideas to identify structural change and a move away from old-school notions, legacy systems and identifying digital tasks that can be outsourced while others are redefined. Still the question remains, how will museums accommodate rapidly evolving human digital behaviour and expectations? What museum activities sit at the core of museum transformation. How will museums marshal their precious resources so that when post-

pandemic visitors return – things will not look the same – but rather, more exciting, visually engaging in ways that integrate digital life and that define a spirit of creativity and innovation – so not dusty, not old, not unconnected to the current environment presenting fresh museum stories, narratives and relationships past to present, that show awareness of social issues of diversity, inclusion and equity.

Much emphasis has been afforded social media in particular Twitter and Instagram to understand museum audiences, yet social media sits in the realm of visitors, while social media analysis goes to Google – and mapping and searching collections, can go to Google and Microsoft. So, what can museums do that plays to their strengths and values. The answer is somewhat before us – look at what visitors see and experience and ask how museums can enhance and expand that visual and social experience.

The greatest challenges for museums will be finding new models for sustainability, able to respond to the complex challenges posed by the contemporary cultural landscape. Designing these models that encompass onsite and online, inside, and outside, and their integration while focusing on visitors and community relationships, understanding and inclusiveness. Museums need to play a greater role in education and consider its income possibilities, for example, offering master's degrees to prepare museum professionals to meet the critical challenges of digital and cultural transformation. While libraries and universities are hugely subsidized by public funding, museums have relied on financial models that seem more akin to amusement parks and entertainment. Museums need to realign their missions in ways that increase social engagement, teaching and learning, and reaching out to more diverse audiences, while not being so dependent on tourism, especially since Covid has greatly reduced travel.

Museums must now broaden their mission to include contemporary contexts of art, education, human identity, and life itself. By so doing, they move to being an essential part of the social fabric of urban life, to arrive at a general recognition that without museums, we are surely less human, less informed about our past and what our future might be. Yes, we are at the crossroads of an unprecedented digital and cultural transformation rapidly emerging from the Covid crisis, and we can see that museums are responding with a new sense of purpose and connection to diverse audiences and cultures. Buoyed by the diversity of the global digital ecosystem, museums are poised to embrace digital artists and digital culture as intrinsic to a new sense of identity and purpose – surely a museum renaissance is in the offing [4].

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NEW SCIENCE AND CULTURE DEVELOPMENTS & APPLICATIONS

PATTERNS OF EXISTENCE: DISCOVERING ORDER THROUGH VISUAL MUSIC

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Patterns are a means to an end, the starting point for gaining understanding and formulating action. I describe how patterns have impinged on my life as a patternist with reference to two pieces of Visual Music,'Turingalila' and 'Brainwaves'. My approach knows no barriers; scientists and artists alike share the same patternist route in uncovering emergent order as it occurs in many organisms, eg. the brain. A third piece, 'Citirama', is concerned in finding order from the twin sources of sight and sound. To conclude, I illustrate how a sense of renewed order is much needed in today's world where a parasitic invasion has taken us to the brink of disorder.

INTRODUCTION

Recently, I came across the word 'patternist' where an author claimed he was one such. Although I'm not convinced on the validity of the word, if it exists then I too am a patternist. I've now realised that the weaving of patterns, the interpretation of patterns, the recognition of patterns and the analysis of patterns are all pivotal in providing a common thread linking both natural events and all forms of human enterprise. But I don't want to overstate my case; I regard patterns as a means to an end, not in themselves the answer but, more, the starting point for gaining understanding and formulating action.

TWIN SOURCES OF ORDER

At the cosmic level, I'm reminded by a recent re-reading of Stuart Kauffman's '*At Home in the Universe: The Search for Laws of Complexity'* that order or pattern occurs as the result of the unexpected triumph of natural selection acting not alone but together with the emergence, over billions of years, of self-organised systems [1]. Such systems spontaneously generate much of the order of the natural world. It is only later that selection comes into play, further moulding and refining.

".....the origin of life itself comes because of what I call 'order for free' - self-organisation that arises naturally. But I believe that this order for free, which has undergirded the origin of life itself, has also undergirded the order in organisms as they have evolved and has even undergirded the very capacity to evolve itself."

Stuart Kauffman's conjecture that it is twin sources of pattern making order, and not a single source, that has produced not only us but, also, everything we experience that surrounds us, changes our perspective on recent discoveries. In the early 1950s when, on the day they first dimly perceived the double helix of DNA, Watson and Crick announced to astonished drinkers in a Cambridge lunchtime pub that they'd solved the mystery of life, this was at most a half truth. They had indeed found an undergirding pattern but the realisation came only later that their uncovering of the geometry by which chromosomes are arranged in the nucleus of every living cell was just one of two sources of life in the biosphere. If scientists and, in particular, biologists have been slow to take on board the other half, self-organisation, it is because of the difficulty in grasping the idea that living systems can be governed simultaneously by two sources of order. Almost certainly the answer on how life was formed, once it's known, will involve the coming together of 'order for free' with Darwin's laws of natural selection.

A system of self-organisation will be shown as being subject to continual change, over aeons of time, by evolutionary processes which continuously check, adapt and give added meaning to the initial starting pattern of self-organisation.

PATTERN, THE STARTING POINT FOR MAKING VISUAL MUSIC

It's now time for me to descend from Mount Olympus, from where I've looked down on the biggest patterns of existence, to more earthly concerns and the ways by which patterns have impinged on my life as a patternist. As a means of coalescing patterns and searching for meanings in the intricacies they take on, I find that my comparatively recent preoccupation with the new media art form of Visual Music has unleashed my often long held interest in a wide range of subjects ranging across architecture, design, science and art. Sometimes, the inspiration for a piece is primarily musical; a work for solo clarinet (because that's the instrument I play) might conjure up imagery in my mind that I feel I must explore. It's as I develop a chosen theme, both musically and visually, that it becomes a very personal and sometimes controversial expression of something I care about. But pattern is usually the starting point of my visual interpretation. This was the case when I indulged my fascination with Turing patterns by producing Visual Music on the theme of morphogenesis [2].

'Turingalila'

Alan Turing's 'The chemical basis of Morphogenesis', submitted to the Royal Society just two years before he died in 1954, explains not only how tigers get their stripes but also provides a scientific explanation for the spontaneous miracle of development before birth. It's the theory that underpins Stuart Kauffman's view that the range of spontaneous order in the biosphere is enormously greater than is often supposed. My piece, *Turingalila,* celebrates Turing's idea by perturbing just two Turing patterns to reveal processes of self-organisation reminiscent of those found in nature (Figure 1). The importance of Turing's morphogen theory in today's world becomes increasingly evident as demonstrated by the work of Professor Jeremy Green, a developmental biologist at Kings College, London.

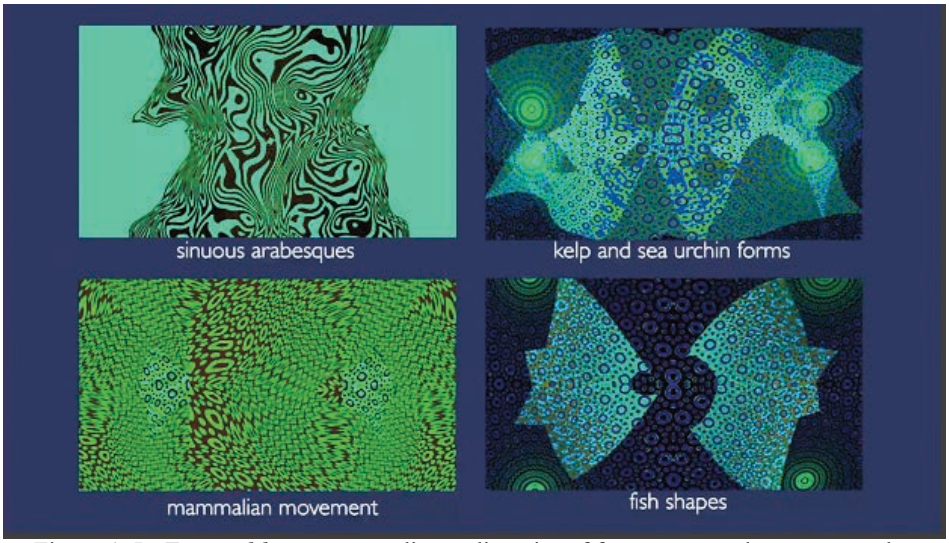

Figure 1. In *Turingalila*, an extraordinary diversity of forms emerged spontaneously. It appeared that I'd discovered a purposeful tool for simulating natural processes.

Jeremy is a biologist who has fully embraced the concept of self-organisation in genomic regulatory networks occurring in tandem with the chance outcomes of Darwinian selection. In a meeting with Jeremy, sometime after the completion of *Turingalila,* he pointed out to me that, at first sight, Turing's disparate inspirational ideas may seem disconnected one from another; what, for instance, is the link between the mathematical biology of his morphogen theory and artificial intelligence? But, where, we see separation, Turing would have seen only continuity; the overarching guiding principle of all his work was directed towards modelling the human mind as a machine. For him, the way morphogens drive hundreds of simple steps that make one part of the embryo different from another was an integral part of his lifelong search to establish the mathematical basis of how we think, how human intellectual abilities can be replicated using artificial neural network [3].

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'Brainwaves'

Little did Jeremy know, at the time, that it was his comments on *Turingalila* that set me off on a subsequent search into the patterns that underlie how our brains work. Years earlier, I'd met Igor Aleksander, Professor of Neural Engineering at Imperial College, London, who regarded the brain as being dependent on an unexplored form of engineering – one inspired and controlled by an astonishingly intricate structure or architecture [4]. It was these twin influences, therefore, from the realms of biology and engineering, that set me on a course to explore for myself the astonishingly intricate pattern that underlies our ability to think.

To find a clue to the neural pattern of connections hidden within the human brain, I turned to Islamic geometry. Islamic designs can not only 'confound the eye of the beholder' with their complexity but also they can provide a geometric clue to solving complex spatial problems. An examination of Muslim buildings in Istanbul, Afghanistan, India and elsewhere reveals patterns based on the knitting together of complex identical geometric forms The result is a network, where the lines of the mathematical scheme can be regarded as systems of neural communication. By taking a very small section of the brain as an example, we can begin to see a pattern producing a multitude of ribbons that interweave, one with another, in designs of dazzling complexity (Figure 2L) . This is not what we see when presented with the brain's grey matter which is why, in a Visual Music piece called *Brainwaves,* I attempt to show just a few of the brain's 100 trillion or so synaptic interconnections entering into a coherent system of activation – a system which, in spite of appearances, is still determined by a precise Islamic pattern of connections (Figure 2R) [5].

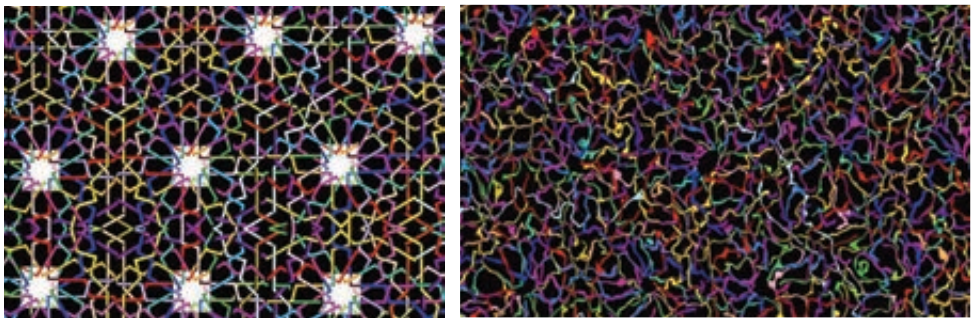

Figure 2. L: By taking a small section of the brain as an example, we can see a pattern, based on Islamic geometry, that produces a multitude of ribbons centred on a series of hubs. (Details of a single hub are shown in Figure 4B.)
R: In spite of appearances to the contrary, this is the same pattern distorted by the brain's gyri (hills) and sulci (valleys).

PATTERNS AS CONJECTURES

Of course, all of this is conjecture, a shot in the dark in defining our brains' geometry. But Jeremy likes the Islamic parallel; he sees it more as posing a question than a model of what might exist in reality (if only we could see it). How many neurons does a given neuron actually connect with locally? He posits the idea that, if the answer were known, you could envisage a variety of textures that might vary across different brain regions, so there would need to be more than one pattern type. Clearly, my patternist conjecture is not a conclusion but, potentially, just another step towards making the invisible visible.

Scientists and artists who are proponents of conjectures must accept the often short-lived and transient usefulness of their ideas. Only very few will give some indication that they merit further and often expensive investigation to become, eventually, the basis of general scientific theory. Conjectures have usefulness and meaning because they bring to the surface the 'not quite obvious': they can offer a distortional twist that succeeds in throwing some new light on a problem obscured by a surfeit of information or burdensome detail.

Figure 3. At Harvard University's Lichtman Lab, the neuroscience of 'connectomics' enables every synaptic connection between nerve cells in the brain to become visible [6].

As an outsider I see the path to uncovering the mysteries of the brain's network proceeding from biological discovery to topological calculation and then to some form of geometric rationalisation. Recent processes of biological discovery have revealed glimpses of the brain's networks which demonstrate a far greater complexity than has ever previously been imagined (Figure 3). But such 'big data' presents a paradox; in the process of gaining ever more information on what we are seeking, we lose sight of where we are going. The biological route has reached an *impasse.* Now, more recent conjectures, spun off by mathematics in the form of algebraic topology, are beginning to provide further insights into the pathways that link the many separate components of the brain.

The brain's 'cliques' and 'cavities'

What's been discovered so far is the existence of all-to-all connected nodes called '*cliques'*[7,8]. Using the language of algebraic topology *cliques* become '*simplices'* or hyper tetrahedrons, which acting in dimensions from 2D to 11D can be expressed as directed graphs (Figure 4A). They're called directed graphs because they trace the pattern of information flow within the brain's microcircuits. There's a distinct resemblance between *cliques* and the hubs of my Islamic parallel - a similarity that must be regarded as coincidental, of course, but non the less remarkable (Figure 4B). I'm encouraged in this idea by reports of *in vivo* investigations that have noted 'starlike' configurations within the brain's network; stars appear to be useful

configurations for achieving fast communication along short paths and between the 83 regions of the brain [8]. These starlike elements signify not only *cliques* but, also, *cavities.* In its simplest form a *cavity* can be formed within a geometric object defined by 2 tetrahedrons. At the other extreme, the formation of a net of tetrahedrons can generate a vast number of potential synaptic communication routes (Figure 4C). Together, the topological notions of dense *cliques* and information distributing *cavities* are beginning to unravel the complexities of an exceedingly complex system. What remains to be discovered is a new type of geometry which, in putting the parts together, can shine a light on how a multi-dimensional synaptic network can accommodate ever changing patterns of neural density, as they occur in different regions of the brain.

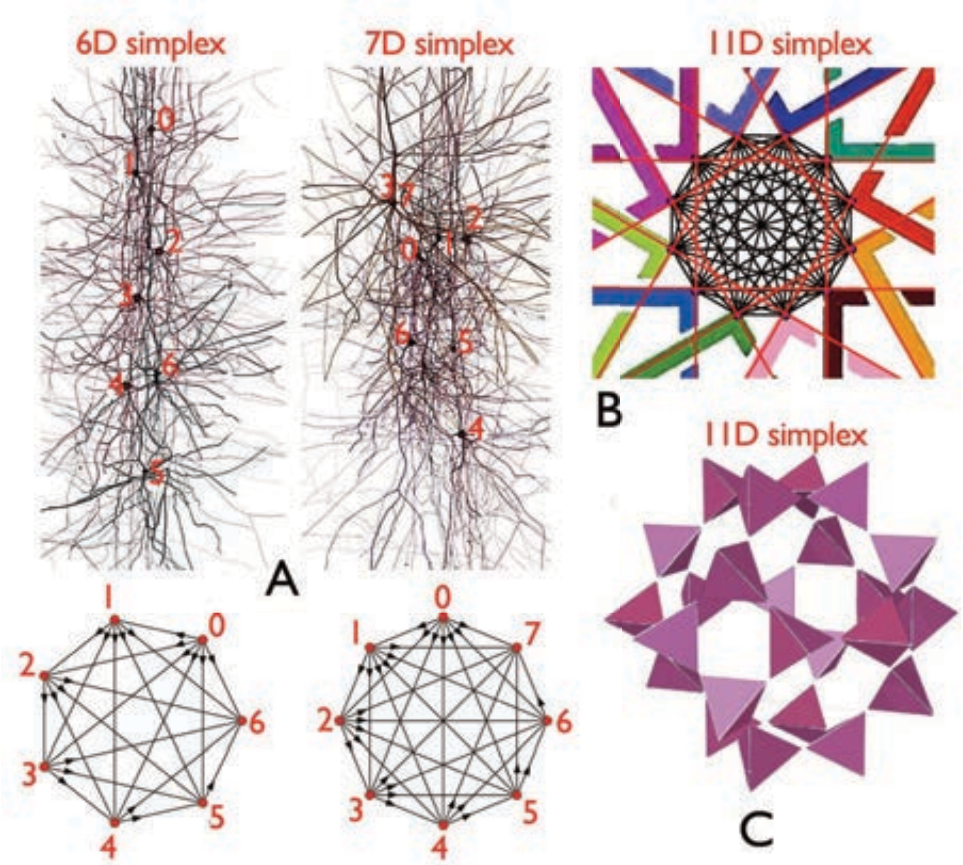

Figure 4. **(A)** Simplices of dimensions 6 & 7 represented as directed graphs (bottom) and as reconstructed microcircuits (top). **(B)** Simplex dimension 11 forming a 'cavity' within one of the many hubs formed by the Islamic pattern shown in Figure 2L. The cavity contains a vast number of synaptic communication routes providing links to the 83 regions of the brain. **(C)** Realisation of an 11D simplex where the geometry of a net of tetrahedrons (shown in part) defines a multi-dimensional cavity. (Diagram A courtesy of Reimann et al [7].)

Now, I don't want you to get the wrong impression; I'm not claiming that my Islamic pattern provides a geometric answer. Far from it. It is only one of many conjectures, conceived during a long and continuing process of discovery, that might merit some further investigation. The fact that the idea has emerged from the realm of new media art rather than science is significant.

A patternist approach knows no barriers; scientists and artists alike share this same route to uncovering a type of emergent order that, according to Stuart Kauffman, "*underlies much of the order seen in organisms today".* Jeremy Green, as a research scientist and biological mathematician, compares his own working method to that of an artist wrestling with the constraints of a medium, whatever it might be, as a creative act that brings out novelty and insight. As he says, "*if data doesn't match any given conjecture, then one of them must be wrong and you have something to learn"*[3]. Of the many conjectures needed during the long process of penetrating the mysteries of the brain, it might be just possible that my Islamic pattern is one of them.

DISCOVERING ORDER THROUGH VISUAL MUSIC

My explanation of pattern as a means of discovering order in apparently random systems cannot be complete without now turning to a subject that has acted as a lifelong corollary of my life as a patternist – ie. music. All my Visual Music pieces involve processes of pattern creation generated not only by what our brain's visual systems enable us to see but, also, by what our brain's auditory systems enable us to hear. Always, I'm concerned in finding order from the twin sources of sight and sound; it's through these two systems that our brain's pathways and neural mechanisms enable us to make sense of the world around us. Visual Music is just one outcome of this biological phenomenon which I'll now explain further with reference to a piece where I joined the patterns of architecture with the rhythms of music.

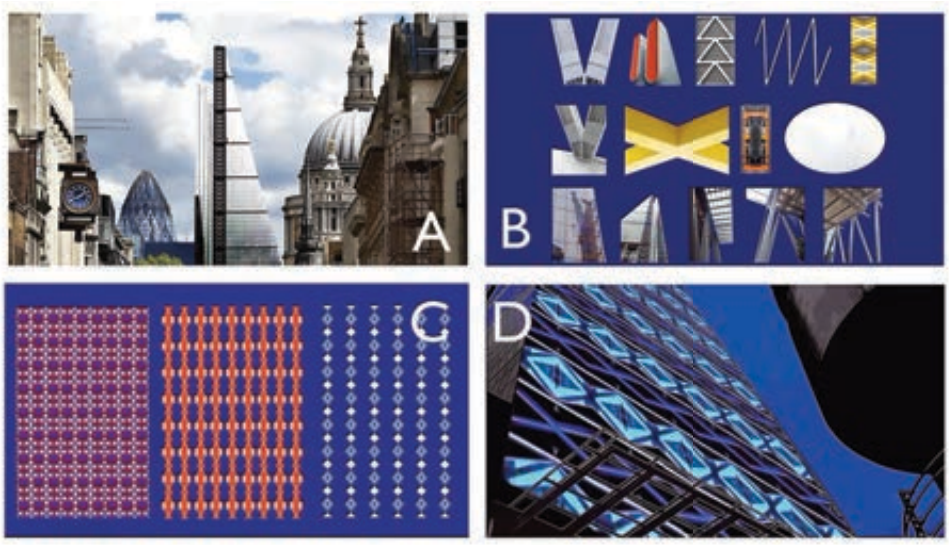

Figure 5. **(A)** The 'Cheesegrater' offered rich sources of pattern making material. **(B)** Glimpses of these sources provided the *leitmotifs* of a piece called *'Citirama'*. **(C)** Repeat patterns derived from the *leitmotifs*. **(D)** Animated repeat patterns projected on to the façade of the Cheesegrater as an expression of the building's intrinsic musicality.

'Citirama'

In *Citirama*, my aim was to throw some light on what it is that makes a building musical, a quality that is manifest in just a few buildings and that I sensed, unexpectedly, in the Leadenhall Building, colloquially known as the 'Cheesegrater', located in the City of London

(Figure 5A) [9]. The realisation that this building possessed the qualities of music came when I visited the site before the building was finished and during discussion with one of the two project architects involved. The architects, Rogers Stirk Harbour + Partners, had not set out to produce a building with a musical agenda, but it had happened anyway in a structure that generated its own harmony, pattern, discord, repetition and silence. I could tell straightaway that the Cheesegrater offered a rich source of pattern making material. But what were these patterns? How could I identify just those components of the building that might somehow communicate its musicality? This was a task that I performed with relative ease without being aware, at the time, that my brain was engaged in processes of extreme complexity.

Recent advances in the Science of Auditory and Visual Scene Analysis are beginning to penetrate the methods by which our brains' pathways and neural mechanisms recognise shapes and hear sounds [10]. Although the sensation of seeing occurs extremely rapidly and is seemingly effortless, the visual input to my brain during my search for the Cheesegrater's patterns would have been highly complex and dynamic, changing with each fixation as I moved my eyes from one aspect of the building to another. It was the entry of these glimpses, or 'snapshots', into my brain's short term memory, combined with the automatic activation of visual matches in my long term memory, that enabled me to produce a set of images I called '*leitmotifs*' (Figure 5B). There's more than one theory on how all this happens but I subscribe to the conjecture of a Global Conscious Workspace [11]. It's by means of this 'global workspace' that conscious contents appear to be disseminated globally to the great multitude of cells that are unconscious. The result is a consciousness network, including the auditory and visual cortices, that create access to the knowledge sources of the brain contained in the long-term memory. Is it possible, therefore, that this configuration represents just one of many starlike 'cavities' providing a global measure of information flow in the whole of the brain's network? There is much yet to be discovered.

So far, science shows us that every auditory signal has a visual counterpart, and vice versa which explains why, for some of us, the worlds of architecture and music are fused inevitably together. In Citirama, I make play of this conjunction by producing a set of repeat patterns all derived from my *leitmotifs* (Figure 5C). Then, as each pattern changes and evolves, it is projected virtually on to the slanting façade of the Cheesegrater as an outward expression of the building's intrinsic musicality (Figure 5D). It's through the making of Citrama that I've realised the validity of Daniel Liebskind's comment that *"architecture is a world of relationships very close to that of the performing musician"* - an idea that I've developed further in *'A stride towards sentient cities: Architecture as performance Art'* [12, 13].

WHAT THE FUTURE HOLDS

In this present paper, by drawing together patterns which range from the cosmic to the mundane and seeking, through the perception of patterns, common links between the tensions of music and systems of neural pathways, I've covered a lifetime of experience. On the biggest of canvasses, a picture emerges of patterns achieving the miracle of life by working in pairs; self-regulatory systems combining with natural selection to produce order which, in teetering on the edge of chaotic disorder, engenders processes of continual renewal and invention. But sometimes disorder takes us over the edge as in today's parasitic invasion, when life itself is threatened. At such times, we search for new ways to restore systems to a natural state, somewhere nearer the order we remember although, inevitably, still finely balanced on the edge. No doubt, it is this thought that has inspired me to tell my own story of how the new media art form of Visual Music has provided a point of entry to a whole gamut of complex systems.

In particular, I've given some account of the challenges to understanding presented by the brain - an exceedingly complex system. These may appear to differ radically from the task of tackling an equally daunting system, climate change, but as I've related, through the adoption of novel and imaginative process of research, the seemingly impossible can be tamed. The ramifications of climate change now pinpoint the urgency for taking action which requires that the two great ways of knowing, understanding and discovery – art and science - become creatively harnessed together as never before [14]. In my own experience I've found that the creative processes of art and science are similar to the point of being virtually synonymous. New media artists think and create like scientists, scientists think and create like new media artists and the digital tools of discovery and expression that they each use are one and the same. Given a chance, it's not too late for nature to restore itself: it has the self-regulatory wherewithal to make this happen but it will take a giant imaginative leap forward by world leaders, acting in cohort with a multitude of scientists and artists, all possessing a patternist's frame of mind, to find a way of confronting the intractable issues raised by climate change.

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Heterotopia, show business as a "non-place".

Advanced technologies during the pandemic: "Circle".

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Introduction

The world of culture and show business has been hard hit in this unprecedented time, in fact it has been devastated by the pandemic. The loss of everyday working life has forced us to think seriously about the new reality and the near future. The elements that make up the creation of a show need to be thought through, and new ways of making shows need to be considered.

The term Heterotopia, coined by philosopher Michel Foucault, opens up interesting scenarios for reflection. Heterotropic are those spaces that characteristically connect to all other spaces, but in such a way as to suspend, neutralise or even reverse the set of relationships that they themselves design, reflect or mirror. An example is the mirror through which we see where we are not, but also hospitals, theatres, asylums, etc. They are places that are "open" onto other places whose function is to make spaces communicate with each other. Heterotropies are the symmetrical inverse of Utopias and while the latter are consoling (even if they are chimerical) the former are disturbing because they undermine language by devastating the "syntax" of the union between words and things, contesting, in the final analysis, the grammar. Also connected to this is the concept of Heterochrony, when spaces and times overlap.

The non-place in which heterotropy ideally merges with heterochrony, in which time folds into space and cancels all distance, is the non-space in which everything takes place in real time: the perfect synthesis of heterotopy/heterochrony of our time is: the internet, the mirror of the world in which we live. We are talking about "other spaces", about ”NON-PLACES” (neologism, as coined by the anthropologist Marc Auge), non-place as a space of transit without relationship, the metaphor of our modern society that is increasingly connected but at the same time more alone. The ship, the journey..... is an expression of a heterotopic state, the crossing of a non-solid surface, in movement, you, the traveller, are suspended in a non-place, a new Ulysses in search of a homeland. The latest suggestion, in an article written a few months ago by Francesco Morace (1),an Italian sociologist, makes some interesting observations on the post-pandemic time, from which I will quote a few fragments: "The challenge for designers will not be to design distancing but breathing". Communication will face the great challenge of the ‘true’. You have to do what you say and say what you do, otherwise you erode your credibility". "Proxemics will be more fundamental than ever for a designer: the size of objects, the experience of spaces and their perception will become important components in creativity. The dynamic between physical and psychic distance will be part of the design challenge". In this period artists have used technological means so as not to break the communication thread with their audience, we have all used and abused the various means of communal connection. But I 'feel' a conflict that I would call 'analogue/digital'; technology must be a means not an end, and I, as an 'artist', do not want to put on a show with products that are automatically generated through algorithms, I do not want to 'reduce'

'analogue' emotion (something I call analogue) to something that is more or less complex. Art, therefore, is as an "organism" that "starts" from a heterotopia to reach (through the journey, pathway, exile, hope) the person - understood in the most exhaustive of their reality.

Key word: the dialogue between analogue and digital components, conceived and designed in an overall vision to guarantee uniqueness and togetherness. These reflections have led to the creation of the "**ETEROTOPIE**", an Artistic Collective that combines cultural written music, the work of actors (using the ancient practice of the Commedia dell'arte masks) and the use of digital technology with new performance technologies: video art, sound design, interaction design.

The collective directs its research towards other places, suspended in time and space, which have become "subtracted memories" for the community; places on which it operates a reflection through Site Specific projects to recreate a connection with contemporary society through art. The members are the composers **Antonio D'antò** and **Riccardo Di Fiandra**, the actor/writer **Duccio Barlucchi**, the sound designer **Simone Zeta Saccomandi** and the light/visual and set designer **Jean Paul Carradori**, lined up with the interaction design group **O3 lab** from Milan and the architect **Carmelo Zappulla** from the studio **External Reference** of Barcelona.

The website of collective is https://www.eterotopie.eu/eterotopie/

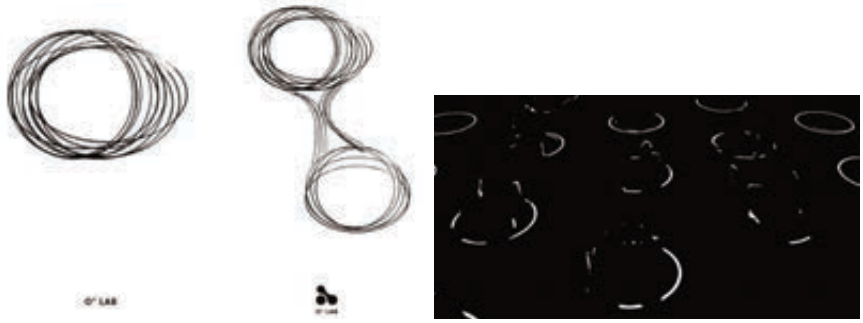
The first project that was born from these synergies is **CIRCLE,** a project that analyses isolation,limits and the search for liberation from the oppressive "circle" of habits. It made its debut in Rome in its first guise on 4th March 2020.

A performance that talks about man and his condition and limitations (sometimes physical but above all mental). It is a journey; we could describe it as a NOSTOS (the return of the Greek hero).

A new Ulysses who, after the dramatic events, returns home free. The music composed for this performance was performed by a quintet: piano, violin, cello, bass clarinet, percussion, plus live electronic music. The writing is what we could define as cultured with references to the contemporary 20th century

Key concept: isolation, limitation.

The audience is spaced out in circles of projected light however these circles interact through sensors, on the viewer. Every movement (even the unconscious ones) are reflected on the structure



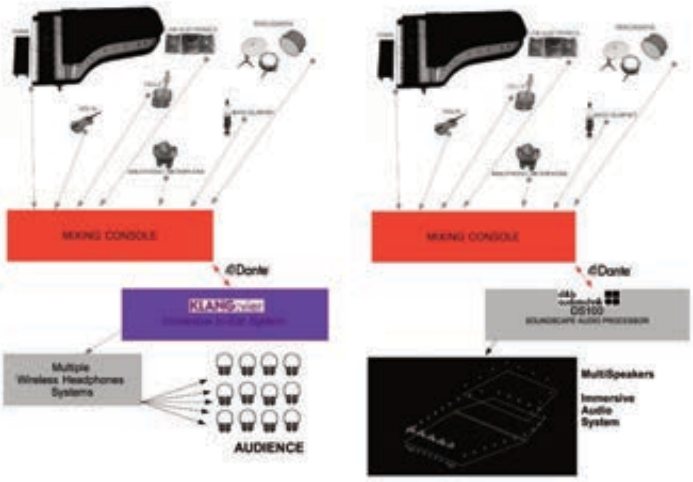
of the circle, which therefore deforms and alters.

In some cases, if stimulated further, it can even "connect" for a moment, touch a circle and therefore a nearby spectator. The spectator, therefore, slowly learns this "new language" and creates new ways of communicating.

Sound design

The spectators has a wifi headset, inside all the sounds, voices and effects are reproduced in holophony. Holophonics is a binaural recording system created by Hugo Zuccarelli that is based on the claim that the human auditory system acts as an interferometer. It relies on phase variance, just like stereophonic sound. The sound characteristics of holophonics are most clearly heard through headphones, though they can be effectively demonstrated with two-channel stereo speakers, provided that they are phase-coherent. The word "holophonics" is related to "acoustic hologram".

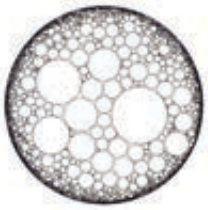
This allows a complete spatialisation, the viewer is inside the sound, the sound is inside his head. Some parameters (such as equalisation filters, reverbs, effects) are linked to the interaction system previously described. So the spectator with his behaviour will "modify" the personal listening.



Holophonic and 360°

Audience

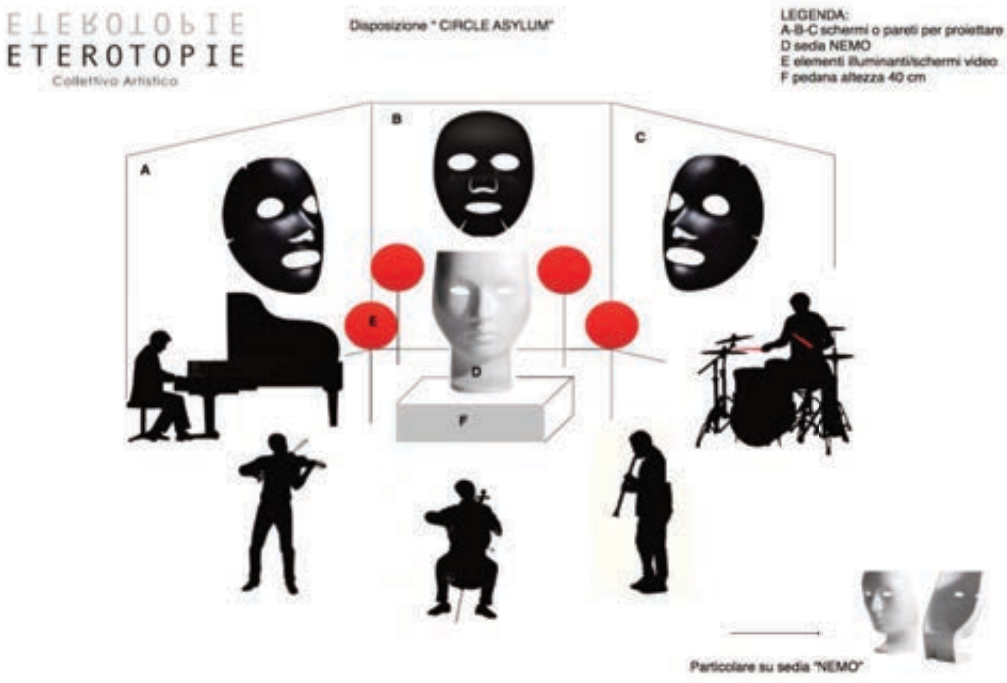
The spectators will be distributed according to an organic system that originates from the studies on circle packing.



In geometry, circle packing is the study of the arrangement of circles (of equal or varying sizes) on a given surface such that no overlapping occurs and so that no circle can be enlarged without creating an overlap. The associated packing density, η, of an arrangement is the proportion of the surface covered by the circles. Generalisations can be made to higher dimensions - this is called sphere packing, which usually deals only with identical spheres.

The stage.

The visual background with 3 screens undergoes alterations through the various inputs. The actor in the centre "dialogues" with himself and the audience by means of video cameras, and in real time changes, visual distortions occur according to the volume of the vocal emission.



The actor uses a mask that will slowly fall apart during the performance.

When the actor finally reveals his true face the circles of the audience will break, there will be no more need for limitations because we will have achieved…**individual freedom in the community.**

Acknowledgements:

- Sarah Finch (actor/theatre maker London))
- Arch. Carmelo Zappulla (External Reference Barcelona)
- Ing. Massimiliano Zanoni (O3 lab Milano)

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VISUALISING MUSIC GAN OUTPUTS USING STRUCTURAL HARMONY METHOD

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Fast development of generative neural networks for music creation poses a question of the output analysis, in order to estimate the network performance. Due to the processual nature of the music art, manual listening to all of the generated instances might become time consuming. In this paper we present the application of structural harmony method to visualise the output of a custom GAN (Generative Adversarial Network) model used for tonal harmonic sequences generation. For demonstration of the analytical potential of the structural harmony method, an example analysis of *The hours* music track and *Metamorphosis* piano cycle by Philip Glass is shown.

INTRODUCTION

The recent tendency in artificial music generation involves the use of the artificial neural networks. Such deep learning neural networks architectures as Recurrent Neural Networks (RNN), Generative Adversarial Networks (GAN), Autoencoders and Variational Autoencoders (VAE), Convolutional Neural Networks (CNN) and Transformers, were proven to be effective in sequential data generation, including music generation [1, 2, 3, 4, 5]. However, with the high potential of this music generation strategy, a series of problems appears, such as a limited number of music examples per specific composer, difficulty in measuring the correspondence between input and output material, due to the processual nature of the music data and, as a consequence, difficulties in the output's stylistic consistency acquisition. The music structure issues were also highligthed [6].

These problems, though, might be mitigated with the application of effective music visualisation methods, capturing the features of music material, such as harmony, melody and rhythm. The structural harmony method was designed to represent a harmonic logic of a music piece in a clear and concise manner and will be used to analyse the input and output to the custom Generative Adversarial Network.

METHODOLOGY

In order to understand the advantages of the structural harmony method application to the neural network inputs and outputs, let's first start with the method presentation.

Levels of structural harmony

Structural harmony method comprises two levels of representation, such as a system of graphs and a schematized representation. The system of graph embraces

functional correlations between chords, consisting of the Roman numerals, representing the degrees of the scale, placed in a specific order [7]. A harmonic sequence is therefore represented as a path within the system, connecting the nearest instances of the chord in the system of graphs. The second level of representation is shadowing the graphical configuration of the harmonic path within the system of graphs, however, instead of Roman numerals, the degrees are represented using a specific colour scheme, which follows the logic of the functional grouping of chords (the group of a dominant is presented in the green part of the spectrum, a subdominant - in violet colour with variants for the group siblings - a rose colour for a submediant and blue colour for a supertonic). The figure 1 presents the example of the structural harmony mapping.

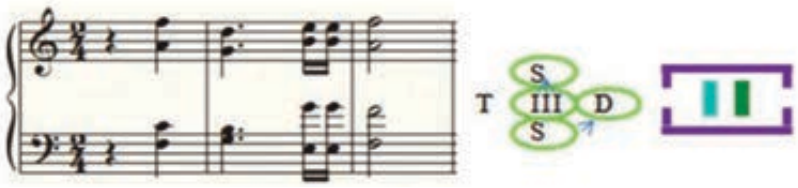


Fig. 1. Example of the harmonic sequence transformation to the graph and scheme representations.

In this example the harmonic sequence S – D – III – III – S on the left is presented as a path within a graph with upwards direction of movement in the centre of the image, and with the corresponding scheme representation of the right (cyan colour represents the III degree of the scale).

The system was designed to capture functional correlations in a diatonic scale inside a given tonality, however the chromatic alterations of the chord may be expressed on the first level of representation by application of a colour to the oval frame, used to designate a chord of the specific harmonic sequence. Therefore, a green colour is used for degrees with no alterations, blue colour is used to frame the chords containing flat chord tones and orange – sharp chord tones, finally, violet colour on the first level of representation is used to mark natural dominant chords (d, VII in minor keys). The shape of a triangle is introduced to designate a dominant of the specific degree, if it placed just before the degree. If the dominant to a specific degree is used without resolution (elliptic progressions), the dominant is still designated with a triangle and the presumable resolution – with a dashed frame.

Analysis example

The soundtrack *The hours* from the original album has been written to the film with the same name in 2002 and was lately published in a sheet music book. The piece begins in C-dur, passes through a-moll (parallel tonality to C-dur) and finishes in g-moll (minor dominant tonality to C-dur). All the tonalities changes will be marked on the first level of representation by shades of a green colour: clear green will mark the progressions in C-dur, normal green will mark a-moll and dark green – progressions in g-moll. The two-level representation of the piece progressions is presented below (fig.2 - 10).

Fig. 2. The 1st harmonic progression from *The hours*: S–D–III–S * 2 (in C-dur).

Fig. 3. The 2nd harmonic progression from *The hours*: S6–D5-#5–T–D->(II) –S6–D–(S) (in C-dur).

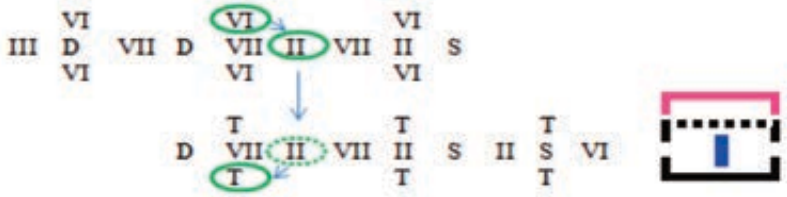


Fig. 4. The 3rd harmonic progression from *The hours*: VI–II–t (in a-moll).

Fig. 5. The 4th harmonic progression from *The hours*: S–D46–VII56–D–T–D5-6-5-7->(II) –S–D–(S) (in C-dur).

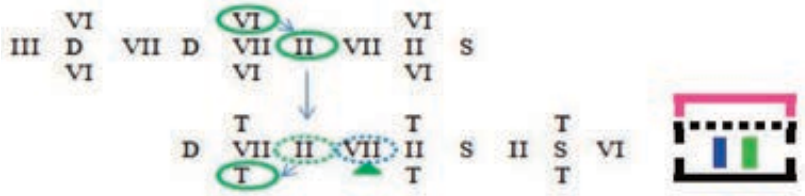


Fig. 6. The 5th harmonic progression from *The hours*: VI–II–t–D-3->(VIIb3) (in a-moll).

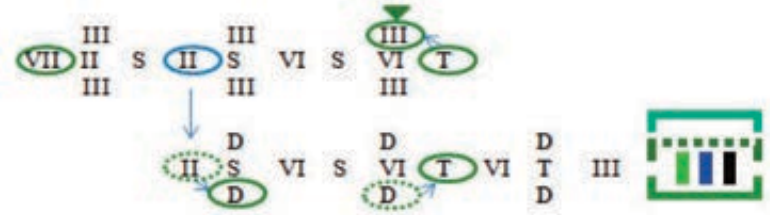


Fig. 7. The 6th harmonic progression from *The hours*: t–VIb5->III–D->(VIIn)–IIb–D7—t *3 (in g-moll).

Fig. 8. The 7th harmonic progression from *The hours*: [t–VI–t] *2 (in g-moll).

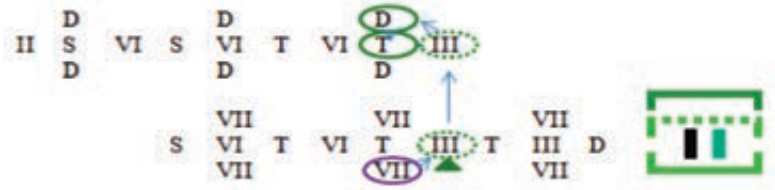


Fig. 9. The 8th harmonic progression from *The hours*: VIIn–D2->(III)–D7 *2 (in g-moll).

Fig. 10. The 9th harmonic progression from *The hours*: t–VIb5->III–DD–IIb–D7–t *2 (in g-moll).

The graph structures № 1 (fig.2), 2 (fig.3), 4 (fig.5) have a similar construction and derive from the first structure. The III degree from the first graph path is replaced by the tonic degree with addition of the II degree in the second scheme. In the fourth scheme yet another degree is added – the VII degree, reinforcing the dominant function present in all three structures with its fundamental degree representation (the V degree), and balancing the subdominant-dominant correlation within the structure.

The graph structures № 3 (fig.4) and 5 (fig.6) also show the similarities in their construction. Only the added VII degree (presented with its dominant) to the 5th graph path distinguishes it from the 3rd structure. The 7th (fig.8) graph structure may be treated as a reduced version of the 3rd and 5th structures, considering the use of the tonic horizontal triad is already seen in the previously indicated structures with the VI degree. The graph structures № 6 (fig.7), 8 (fig.9) and 9 (fig.10) are characterized by a different configuration of the same degrees. The schemes range of the whole piece from *The hours* is presented below (fig.11).

Fig. 11. Scheme structures on the second level of representation of *The hours*.

These scheme structures may be presented logically with the use of an alphabetic representation:

A A1 B A2 B2 C B3 C1 C2

where the group of A structures stands for structures enclosed in the subdominant brackets; the group of B structures stands for the structures enclosed in tonic brackets and the group of C structures – for dominant brackets. A gradual movement from the subdominant area

to the dominant area can be observed. Having understood the mapping principle of the sequence to the system of graphs and to the scheme representation, let us consider a cyclic example of the same composer, presented as harmonic schemes only.

The *Metamorphosis* piano cycle is written for the 1988th theatrical adaptation of Franz Kafka's *The Metamorphosis* and consists of 5 pieces. Each piece of the cycle is written in its own tonality (e-moll, a-moll, d-moll, c-moll, e-moll). The tonalities of the first and last pieces are repeating and in sense of the used thematic material, create an arc in the cycle. The logic of the harmonic development of the whole cycle in shown in figure 12.

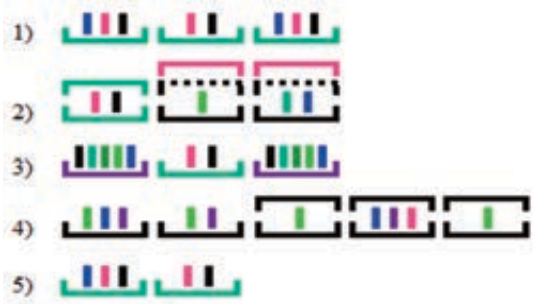


Fig. 12. Scheme structures of all 5 pieces from *Metamorphosis* piano cycle.

Using alphabetic representation we may present the structures as follows:

A B A => ***B C C1*** => ***D B D*** => ***E E1 C2 E2 C2*** => ***A B***

The following regularities of the harmonic structures replacement and permutations can be observed:

1. The chess-like order is visible on an example of the *B* structure replacement from the first to the third pieces;
2. The substitution of the ***A*** structures occurs in the third piece in comparison to the first piece;
3. The ***C*** elements appeared in the second piece are farther transformed in the fourth piece, creating a structural arc;
4. Each new piece within the first four pieces brings the insertion of a new group of elements.

Based on the regularities described above the reduction of the logic structures can be made and the harmonic development of the whole cycle may be presented as follows:

A B A1 B1 A

where **B1** is treated as derived from **B** because of the arc created by ***C*** group and **A1** – as derived from **A** because of the ***B*** structure repetition in a previous alphabetic representation of the harmonic development logic. Therefore harmonic development of the whole cycle can be reduced to a rondo form with elements of variations and symmetry.

Application in deep learning

The analysis example shown earlier with corresponding visualisations were made manually, however a manual approach is not scalable to the larger datasets analysis needed

for deep learning. For this reason, we have developed a custom algorithm for the second level of visualisation of the structural harmony method. The algorithm takes harmonic sequences extracted with *Music21* python library [8] and produces the schemes similar to the schemes showed earlier. The sequence must comprise from two to seven chords and the chords repetitions are removed for the sake of the visualisation consistency. The visualisation algorithm is applied to sequences taken from real examples and after the training of the generator is finished – to the generated samples.

TRAINING PROCESS

For this experiment a Kaggle dataset *Classical Music MIDI* has been used. This is a small dataset, consisting of classical music examples in a MIDI format, covering the style range from baroque to impressionism. Most importantly, the dataset has a separation of music to specific composers (19 composers in total), which facilitates the style consistency in the received results after the training process. We will focus on a single harmonic style – classicism, specifically on the works of its first representor – Joseph Haydn. The library contained 21 MIDI files of music by a specified composer, which resulted in extration of 193 chords.

The data preprocessing consisted of two steps: reading the MIDI files and preparing them to become the input to the generative neural network. The first step comprised a conversion of MIDI files to the chord and note objects with the aid of above-mentioned *Music21* python library for computational music analysis. The same library allows transposing the sequences to one tonality (C-dur), converting chord objects to Roman numerals representation. Therefore, in the end of the conversion we receive an array of strings (textual data), containing all the chords in a Roman numerals representation.

A basic GAN model was built using Keras framework, containing generator and discriminator parts. A discriminator consisted of Long Short-Term Memory (LSTM) and Bidirectional LSTM layers (due to a sequential nature of the input data), followed by a fully connected and Leaky Rectified Linear Unit (LeakyReLU) layers (with a slope equal to 0.2) and final fully connected layer with a sigmoid activation function. A generator was constructed of three stacks of layers (fully connected, LeakyReLU and BatchNormalization) and a final fully connected layer with tangens activation function. A standard Adam (adaptive learning rate optimization algorithm) optimizer and binary cross-entropy loss were used to calculate weights for back-propagation (learning of the generator by using the output from the discriminator). A training process comprised 100 epochs with a batch size equal to ten samples. After the training, the predicted indexes are mapped back to the Roman numeral representation of chords, which are then used to produce a visualisation and MIDI files.

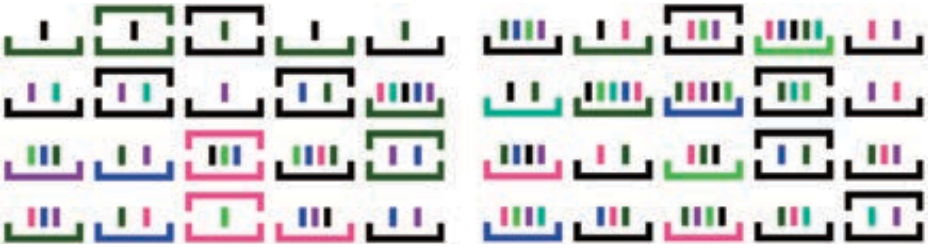
RESULTS

The goal of GAN architecture training is to receive the same values for the loss function for both – discriminator and generator, which means that the generator model was able to produce the examples so well, that the discriminator wasn't able to distinguish the generated examples from original ones. It is also known that GAN architecture is very unstable during training, and that the convergence in this type of architecture is very hard to achieve [9]. The evaluation of the loss function of the model trained on music by Haydn

during 100 epochs showed a great amount of instability, indicating that the model hardly converges through the training process. Nevertheless, an overage level of conversion happens at 0.7 of loss for generator and discriminator (which is close to 0.5, an ideal rate).

Comparison of the original and generated samples

Below is an example of the visualisation using custom visualisation algorithm, based on structural harmony method, presenting sequences taken from Haydn's original music (fig.14, a) and from the generative model, trained on the examples of his music (fig.14, b). In this visualisation mapping algorithm, the square brackets stand for the first (bottom bracket) and the last (upper bracket) chord in a sequence, the other chords in a sequence are represented by vertical lines, ordered from left to right.



a) b)

Fig. 14. Harmonic sequences visualisation of Haydn's music: a) original sequences; b) generated sequences.

Each of displayed sequences in original and generated examples consist of precisely seven chords. One scheme represents a single sequence and there are five schemes in the row. The total of four rows, which gives 20 sequences in each of the columns for original and generated examples.

Knowing, that the sequence contains seven chords and having only two chords displayed in the scheme, means that these chords are repeated and therefore the dynamic of the harmonic development is not intense, which is the case for the first row and second rows in the original examples. The domination of tonic-dominant relations (black and green colours) in the original sample is a sign of the tonal stability. The VII degree (light green colour), which in classical music style is represented by dissonant chords, such as diminished triad of diminished seventh-chord, appears rather rarely in the original example.

Comparing generated sequences to the original ones, we observe a higher intensity of the harmonic development, and higher dissonance level (with a lot of the light green colour, representing VII degree). A doubled presence of the III degree in generated sequences compared to the original is rather a style deviation, which indicates that the model performance is not yet ideal in mimicking classical harmonic style. Thus, without hearing the generated examples we were able to assess model performance, detecting the issues to fix. It is also should be mentioned, the easiness in finding the outlier from visual representation for further detailed music analysis.

As the goal of this article is a presentation of the visualisation method in a context of music generation using GANs and not a training of the production level GAN model,

the small size of the dataset was not an issue. Moreover, a limited number of examples allowed detailed comparison of the original and generated data. Although the generated schemes capture the main functional correlations, an important aspect of the harmonic style inherent to a particular composer is the chord alterations. Therefore, the implementation of the first level of visualsation and its inclusion to the model performance analysis is reserved for future work.

SUMMARY

The presented structural harmony method of visualisation allows to interpret the results of the processual art generation in a more efficient way, showing the highest hierarchy of the functional harmonic development, which is one of the most important formative component of music generation. This method is suitable for conditional and controllable generation of music using GANs, as shown in the article, and may be applied to other generative deep learning architectures. Furthermore, the transcription of music data in a visual manner allows the application of classification and data augmentation stategies inherent to a visual domain, mitigating the music style coherence issues while training deep learning generative models.

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ARTIFICIAL INTELLIGENCE, NFTs AND THE EPOCAL TRANSFORMATION OF ARTISTS AND ART COLLECTORS

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INTRODUCTION

The Author presents a personal case that reflects the epochal transformations in the art sector, due to the adoption by many artists of the tools offered by the Third Millennium. He then goes on to examine the NFTs Platforms, the NFTs Market and the exposure of cases in which NFTs Artists have exceeded the values of traditional auction sales. The new Collectors are also focused, new patrons with a different profile from those of the past, who invest millions of dollars in this sector. Finally, the possible reaction of Museums towards NFTs is analyzed. Will the Museums know how to keep up with the times or will the Collections of the new NFTs art forms be held exclusively by individuals?

THE CHANGE SEEN TROUGHT A PERSONAL CASE

Bruno Cerboni. Engineer, Innovator, Entrepeneur, Visual & NFT Artist. For eight years I have been carrying out my very personal artistic research exploring different forms of expression thanks to the tools available in this era, including Neural Networks and Artificial Intelligence. So I created some exclusive processes, called SMART-ART, which allowed me to update, in a completely renewed way, styles of the glorious tradition of mosaics, stained glass windows, trencadis, opus sectile, marble inlays. I consider myself a link in the chain, which has its roots in the legacy of the past and expresses itself in its own original way, creating a language that can capture attention and excite thanks to completely new and exclusive tools. My background is that of an engineer, industrial manager and entrepreneur in the innovation sector who has found a way to combine a passion for art and his own technical skills. My process of creating the works is completely digital, but I have made my works on canvas, FOREX, porcelain stoneware, backlit LED panels physical by participating in prestigious exhibitions in Italy, USA, Spain, Switzerland and India and abroad. I am an official member selected by the Mondial Art Academia as a talented painter and mosaicist. NFTs are a logical addition to my entirely digital processes. I am creating interactive 3D Virtual Galleries in which I set up Personal Exhibitions and Exhibitions for other Artists and Galleries. My works are visible from my website https://www.brunocerboni.it and from my links to my social networks https://linktr.ee/brunocerboni

The NFTs Platforms

The NFTs Market

The NFTs Collectors

The Museums and the NFTs collections

NEW TECHNICAL DEVELOPMENTS & APPLICATIONS

ADVANCED DIGITIZATION FOR THE PROMOTION OF THE MORAL VALUES UNDERLYING THE EUROPEAN UNION

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Abstract – The European Union shares common moral values with its members from the beginning of its history along with its cultural heritage. It is highly important to track these values, to study their meaning's evolution across space and time and finally to diffuse them in a concrete and well-organized way. The newly launched VAST project will contribute to the promotion of these values using advanced digitisation, based on three distinct time periods of the past and will combine a storytelling platform with crowdsourcing, facilitating the platform's users to create their stories and re-use the provided contents, disseminating these moral values.

INTRODUCTION

European history counts many centuries back, proved by a myriad of cultural resources and values crossing and evolving through the centuries. The use of technology and especially of the advanced digitization can contribute to a type of unified, coherent 'data collection' supported also by enriched metadata of high quality. Museo Galileo has extensive experience in this type of digitisation including several integrated archives and resources such as the Gallileo//thek@ [1] and virtual exhibitions [2].

MORAL VALUES IN THE EUROPEAN UNION

The values' main characteristic is that they reflect people's identity and vice versa. The common legacy, the collective memory and the perception of oneself and of the others are shared in a similar way by every European, indicating simultaneously that these characteristics that connect them prevail those that divide them. This sense of unity derives from the combination of numerous values that have evolved in the history of time functioning in a common and fundamental way for the European Union such as: human dignity, freedom, democracy, equality, rule of law, human rights [3]. Accordingly, a European research project focused on moral values started before the end of 2020.

EUROPEAN PROJECT: VAST – VALUES ACROSS SPACE AND TIME

In December 2020, a new Horizon 2020 European research project named **VAST,** acronym for **Values Across Space and Time,** was launched [4].

Eight partners from five European countries collaborated at an international level for the VAST project; two from Italy, the Museo Galileo which will collaborate closely with the Università degli Studi di Milano, three from Greece among which the National Center for Scientific Research Demokritos in the role of the project coordinator, as well as one of each of the following countries: Cyprus, Portugal and Slovenia [5].

The ambition to bring the values on the cutting-edge of the advanced digitization field, is in the core of the VAST project. As far as the timing to discuss them and diffuse them, the present time is considered to be the most appropriate. As EU President Ursula von der Leyen recently said in her Agenda for Europe: "We must defend our common values and uphold the rule of law ... and export our values across the world" [6].

The use of state-of-the-art technologies will lead to the digitization of tangible and mainly intangible assets such as stories, personal experiences, folktales, fairy tales, etc. VAST aims to address how the values have been changed or evolved across space and time and how they are communicated and perceived by audiences in cultural and educational activities related to theatre and educational programs.

In order to achieve this objective, at first level, VAST will analyze the European values in the narratives of three very important periods of the past which also involve three different forms of communication: the time period of the ancient Greek tragedy and comedy, the Natural Philosophy texts of the 17th Century and the Folktales. This categorization is very important since during these timelines great changes have been made in people's perception that concerned numerous values and their transformation.

At a second level, using a methodological process, VAST will expose the audience to moral values, collecting and digitizing the experiences of three main categories: a) the experts in the narratives of different time periods and geographies, mainly from the social sciences and humanities' sectors, that will identify and annotate the incorporated moral values included in the resources, b) those in charge to communicate/transmit values i.e., artists, directors, culture and creative industry institutions, museum curators, storytellers, educators, etc. and c) the respective audiences like spectators, museum visitors, students, pupils.

This will lead to the creation of a storytelling platform [7] combined with crowdsourcing. VAST will provide the storytelling application allowing the users to remix the content together with pre-selected tags of values, reinforcing its dynamic characteristics for the future observations too.

Pilot cases

In VAST three pilots will be implemented, showing the benefits of the project's technologies in the field of advanced digitisation and assessing its impact regarding the target users: i) scholars and researchers, ii) the communicators of moral values and iii) the general audience. Each pilot will deal with moral values detected in the narratives of the already mentioned periods: the Greek tragedies and comedies and their modern adaptation, the 17th century books of natural philosophy and utopian thought and the European folktales.

Every Pilot is divided in two parts, the past of values and their present. Regarding the past, the aim is the analysis and digitization of the values' evolution at that period of time. The 'present' part, will include the use of the previous findings as a guidance for the creation and enrichment of special programs for the museum and theatre audience. As a next step, the public's gained experiences will be recorded through questionnaires and other monitoring processes and digitized.

The scope is to trace if the values of that past still exist nowadays, how they have been transformed through time and space and if the activities organised by the pilots could have an effect on the understanding and perception of the studied values.

Metadata enrichment

Another aspect of the great importance of the VAST project is its significant contribution in the long-term effort of the different stakeholders in the metadata enrichment.

It is true that numerous cultural organizations (i.e. museums, libraries, research projects and institutions) have invested a lot of their resources to create digital copies of their cultural assets. The goal was dual; maintaining intact the appearance of the artefact and at the same time use effectively any web applications and virtual exhibitions for presenting them to a wider public. In some cases, the digital asset is correlated with a set of basic metadata, curated in a non-automated way, in order to regain the digital copy of these cultural objects. These metadata encode simple properties of the objects, already available in most collections, facilitating their standardization in machine-readable formats, with the scope to reduce the existing fragmentation and collect them under a common catalogue.

VAST invests on the idea that the enrichment of the current metadata with additional information layers focused on the moral values, will increase the knowledge for the existing artefacts, resulting in a more complete picture. For this reason, VAST proposes a "new data format", based on semantic Web technologies. These will enable the annotation of the digital artefacts with new types of knowledge, built on the moral values that are considered fundamental for European Union and are common for all member states, such as the respect for human dignity and human rights, freedom, democracy, equality, and the rule of law (as defined by the Treaty of Lisbon, signed in 2007 [8]) including also additional key values such as dialogue and tolerance.

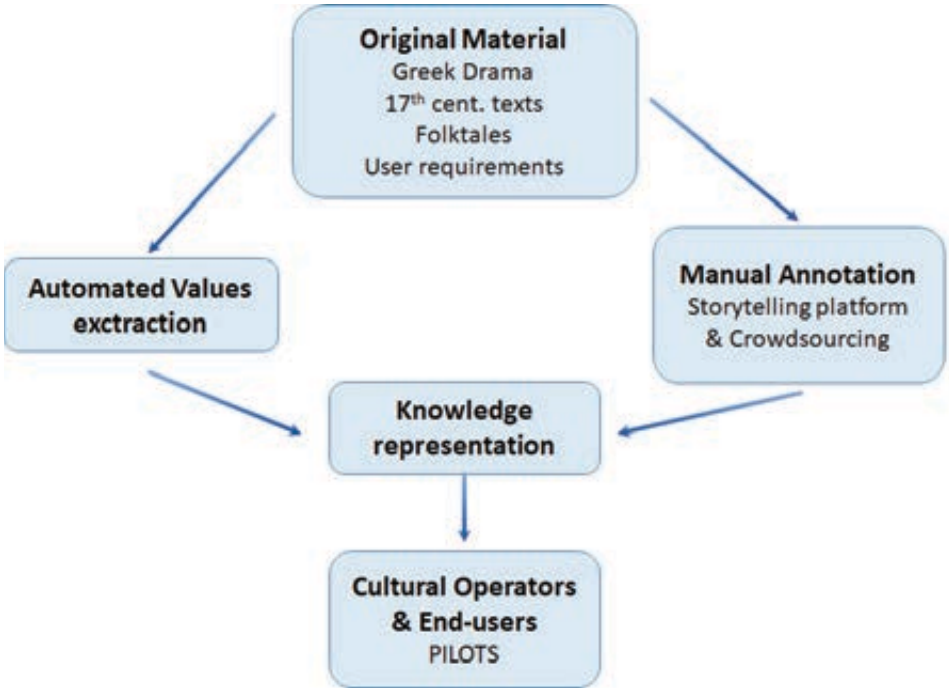

Figure 1: VAST methodology

MUSEO GALILEO'S ROLE

The Museo Galileo is a partner of the VAST project as the heir of a European scientific tradition promoted by the Grand Dukes of Tuscany between the 16th and 18th centuries.

For this reason, the museum's participation in the project is very important, since it will implement educational activities and exhibitions based on values found in 17th century resources.

Museo Galileo will collaborate closely with Università degli Studi di Milano, -in charge of the study and annotation of 17th century texts- to the creation of VAST Pilot ''Values in 17th century books of natural philosophy and utopian thought''; its scope is to trace if these past's values, inherent in the scientific instruments and texts, still exist nowadays and make comparisons with reference to the popular existing image of science.

The importance of the role the Museo Galileo plays in this project lies in two main points. Unlike folktales and Greek tragedies, natural philosophical writings were not conceived to deal with moral values, but rather to analyze scientific laws and instruments, discuss new methods of research, as well as spread scientific novelties. Explaining to a public of students and families the moral values that emerge from these texts requires the adoption of new strategies of communication and innovative tools. Moreover, these same moral values will be conveyed not only through texts/words but also and mainly through scientific instruments, which will thus embody a rather different set of meanings.

These concepts will be addressed by analyzing works that involve the early modern idea of the discovery of new lands and new earths in the sky, the 17th-century lunar travels and utopian thought, as well as the emergence of the concept of tolerance and equality in scientific writings. These subjects will be dealt with by drawing on three main sources: scientific instruments preserved at the Museo Galileo, texts, and visual materials (i.e. engravings, maps, paintings).

Furthermore, Museo Galileo will contribute to the creation of a methodological tool to be used in the forming of the digitisation process of VAST, at an advanced level. This will be achieved by conducting a user survey focusing on three types of key actors: the researchers, the educational staff as well as the audience. Through it, the user requirements and expectations will be detected and as far as the technical aspect is concerned, the functional and nonfunctional elements will be exposed. Finally, these findings will help to extract information about the impact of the transmitted values and their evolution, enriching at the same time the metadata of its content.

CONCLUSIONS

VAST project will help to foster Europe's tangible and intangible cultural inheritance using advanced digitization. Through it, there will be a better understanding of the shared common values that characterise the European Union. The conducted research of values' past will help to better understand their present, through their well-structured maintenance and analysis, shaping simultaneously the path for their spread with the application of future activities and metadata enrichment.

This digitisation process will not only help to preserve and diffuse this European common culture and values in a more efficient way, observing and measuring their changes simultaneously, but can also have, in a holistic way, a positive impact on the different development sectors: economic, social, environmental and sustainable.

ACKNOWLEDGEMENTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004949.

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GENERATIVE TECHNOLOGIES, GENERIC ANTHROPOLOGY

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Implementation of algorithms serve today not only a spread technique to produce and process images but also as a sort of cultural model of interaction with computer generated environment. The background for its description in the article is formed by other 3 models: impersonal (simulation) and «human friendly» (prosthesis and «contact zones»). Considering them consistently, the author comes to conclusion that only ideas about «contact zones» (D.Haraway) correspond to the model of algorithm by its renewable time sessions of training, open ending and transformation potential. The final part presents performance project as illustration of algorithmic «reworking» of participants.

“Why simulate the reality?” - this question seems strange to hear from a young artist and designer who is engaged in algorithmic processing of dance performance data using motion capture technologies and video camera to generate an environment that affects the perception of time, space, and one's own body. Isn't such a designer exactly the one who is responsible for the production of artificial environments, simulative and synthetic? More then, is there anything new in the characteristics of this environment compared to the already known art works seen at many art exhibitions (by Ryoji Ikeda, Olafur Eliasson, etc).?

Let's pause for a moment and take a closer look at some examples to define more accurately what is new in relation to technical devices and generative environments *at present*, let's recall some ideas from yesterday about the models of interaction with technically generated objects to adjust in a more proper way our perception of what seems new.

Models I have in view might be considered in two dimensions at least: in a human-friendly perspective, through "quasi-objects" such as prosthesis or cyborg, and impersonally and operationally, that is, in a narrow “technical” sense, through such characteristics as simulation or immersion. Despite the fact that the latter seem to better suit technological studies of environmental effects and appeared chronologically later than the former, that is, relatively recently, already in the 21st century, rather the former, upon closer examination, also do not act as stable units and can characterize (and today do largely characterize user platforms, interfaces, etc.) the mechanisms of “entanglement" with environmental structures. And perhaps they do better characterize also how the interaction with the technical world is percepted by humans at the physical level in an unmediated way, that is, with no distance to conditions of limited time and space that simulation impose on its viewers. Having considered these two groups of models, I will then turn to examples from the field of dance performance to show how today environmental effects acquire bodily characteristics and vice versa, how bodies get oriented to technology.

Simulate to better control the reality

Studies of the impact of modern technologies on the field of visual data already made it obvious that an image perceived by eyes is only the final result of processing, intentionally adapted for the human eye [1], [2]. It is also recognized that calculations are not only a “technical” characteristic of a technically produced image, but an essential part of it which affects the conditions of its perception.

The work on art historian and explorer of simulation Inge Hinterwaldner [3] is the example of reconfiguration of links that were maintained between image, representation, “real time”, optical phenomenon, intersections of natural sciences and Humanities, since simulation systems describe

values that are different from the visual ones. Hinterwaldner insists that simulation achieves more (or achieves something else) than earlier images, because it produces digital images bringing together patterns and internal relationships, taking into account the productivity of images, and those images are to be considered from the point of view of the generating process. Thanks to this basic structure of computer-calculated digital simulation, new dimensions are opened up to the image sphere, and unlimited options are available to the spectrum of links. Simulation points at almost "infinite potentiality of transformations" and is "actualized in one of its many aspects» [4, 190]. Thus simulation is then a modifiable whole consisting of modeling and computation.

Referring to the article "Behavior, purpose and teleology" (Norbert Wiener, Arturo Rosen-Bluth and Julian Bigelow, 1943), which sets the bases for the new science of Cybernetics, Hinterwaldner underlines the direction of interpretation, which focuses on behavior, or more precisely, on the structure of the manner of behavior. The authors put as their task to justify the logic of events. And here it is important for us to emphasize two aspects. On the one hand, the behavior directly refers to the notion of interaction : “there is no other reality than that which is created by the relations of phenomena to each other.” Which is undoubtedly actual today. But on the other hand, the foundation principles of cybernetics equalize the agents of these relations with each other: “ Due to the fact that this method paid attention primarily to the behavior of objects, *regardless of the physical nature of the elements they consist of*, it made it possible to compare any "objects", especially the comparison between a person and a machine” [5, 142-143].

Without, however, taking a further step towards post-humanistic studies of the possibility of “fusing” human and machine components, Hinterwaldner prefers to talk about simulation in terms of the model that is needed to "calculate" possible better options. It has a specific temporality. Referring to Couchot, Hinterwaldner writes that the time of the simulation (even if the images in it appear in “real time”, that is, without delay for the human eye) is neither present, nor past, nor future, it is outside of chronological time and therefore in her opinion "achronical". Since the matrix image must always be generated anew, it cannot indicate what Roland Barthes called "it was" in reference to photography (ça-a-été), but what "may be". However, this “could be,” this hypothetical dimension of the simulation is always distanced from our reality, the boundaries of staying in the simulated environment are very clear, as well as escaping from it. Simulation is needed then in order to provide control. Simulation consists in digitally reproducing the existing model and conditions, i.e. varying the main parameters, in order to study the" trajectory of behavior "of the model or to obtain an acceptable solution to the problem. On a global scale it is not reality that is being replaced by simulation, but rather the ultimate goal is to replace simulation with (better controlled and calculated) reality. The ultimate goal of simulation research is not to dissolve reality, but to gain more control. That is, it seems that the simulation so treated is purely instrumental.

C**ollecting “something small with the frightening fingers of Victorian girls»**

Without setting myself the ambitious task of reviewing the entire history of technological development in the perspective of articulation human and alien (or inhuman) components, including inorganic ones, let's take as a starting point one of the key theses of the representative of the Canadian School of media studies, M. McLuhan, on the "expansion of man"[6]. He believed that each new type of media, each newly invented technical device first causes a shock, then, after learning how to use it, is appropriated by humans, appropriated to such an extent that it contributes to the stretching of the human body to ever increasing distance in space. McLuhan also used such a characteristic for this outward expansion as prosthesis. At the same time, it is important to note that a certain human essence he assumed to be unchanged, and the effects of shock and extension is correct to describe as peripheral, since these processes occur in the border areas of a fairly clear separation of human and environmental, to put McLuhan thesis in another terminological language.

These ideas are radically opposed to the idea of a cyborg, traditionally ascribed to the work of Donna Haraway [7]. One of the main differences that catches the eye is a rejection of rigid boundaries, notably those separating "human" from "animal" and "human" from "machine. She is not talking about "violations" or "shock", but rather about "new normality " of technical conditions

in which the cyborg functions. Although Haraway writes that "a cyborg is a cybernetic organism, a hybrid of a machine and an organism, a creation of social reality and at the same time a creation of fantasy» or «the cyborg is a condensed form of both imagination and material reality – two combined centers that structure any possibility of historical transformation», it is not quite clear how such a cyborg should be defined. As assembly machine, following the spirit of the era (by analogy with the approach of Deleuze and Guattari, transversally-Guattari's term-collecting various characteristics of different environments, from imagination to material interaction with technology, as if cutting them through) ? Or as a metaphor ? Indeed, Haraway continues her terminological inventions by adding in 1990s "diffraction"to point at histories of interaction, interference, reinforcement, difference, and «mud» in 2010s (both notions also slide between different "discourses", from scientific to political).

Although in the Manifesto she insists on the blurring of boundaries, on anti-essentialism, it is still possible to impute to her the use of some organic wholes, which is to a certain extent continued further in her subsequent works, for example, «When species meet» . Compare what she writes in Manifesto: "The cyborg does not dream of community .. would not recognize the Garden of Eden; *it is not made of mud and cannot dream of returning to dust* " with recent book on mud "Staying with the trouble". The geological-historical space she investigates as "short/thin as possible" is obvious. And this is a characteristic way to approach the compatibility of scientific, technical, material and social: despite the idea of mud reassembling, there seems to be almost no mechanical stochasticity of assemblies. It appears only now, in works of generations following Haraway. Yes, she has her new operational terms such as "companion species" or "contact zones". But in a way they continue to be "all too human", though set by a quite critical human. Ironically refusing to make trips under waters into big fish minds and bodies with the help of special cameras, she proposes to describe a far modest experience of training with her dog, Cayenne. Readers find many things here: the history of the game, co-players, illustrations from a book for players, money she spent on everything it took to train, travel, and compete. She writes that training requires calculation, method, discipline, science. But adds that training is for *open-ing up what is not known to be possible*, but might be, for all intraacting partners. Apparently having no illusions to share her thoughts with a dog, she tries to describe how their capacities were mutually changing. Dozens and dozens of pages approaching a hint how to find proper ways and proper words to describe what she felt. «Training together, a particular woman and a particular dog, not Man and Animal in the abstract, is a historically located, multispecies, subject-shaping encounter in a *contact zone* fraught with power, knowledge and technique, moral questions—and the chance for joint, cross-species invention that is simultaneously work and play. . it is not a one-sided affair» [8, 205].

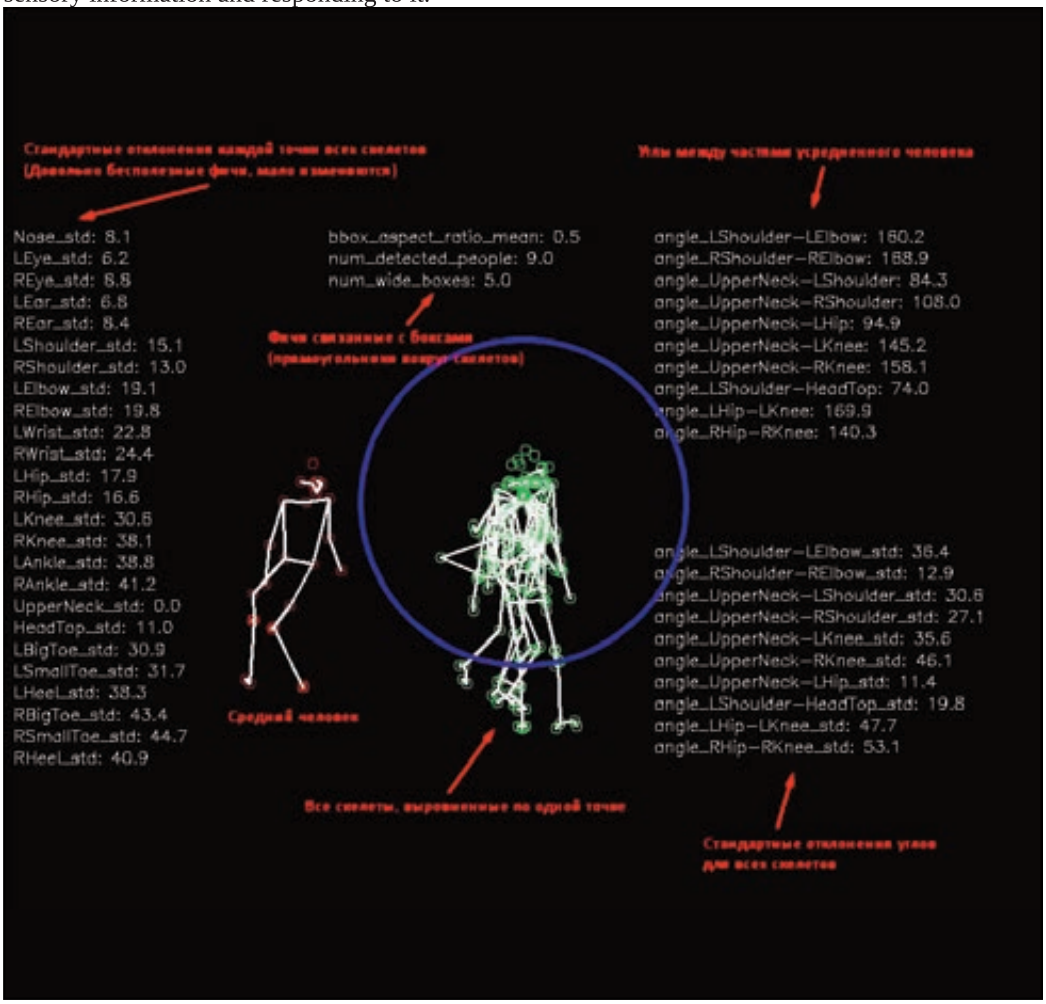
Thus we observe various degrees of radicalism concerning the influence of technical (or, as it is now preferred to formulate, "algorithmic"; note that Haraway's training could be considered in a certain sense algorithmic, too) and types of connectedness to it. In the Hinterwaldner's model, the connection is not visible: the simulation is only a model that remains sufficiently abstract, guided by control. In McLuhan's "prosthetic" model, the connection is thematized, but the model tends to overcome the connection: the ideal of the prosthesis is "mastering", in this sense it means normalization, in principle also" taking under control". Haraway's model is much more open and concrete, and in that sense one may say also material – towards other" agents " of the environment, as well as towards other discourses (scientific, game, quasi-literary, using metaphors). In "reality", her soberly evaluated critical maximum is the idea of "contact zones", although it should be recognized as radical: even if these are zones of contact between representatives of different species only, which do not change much, but those zones, which include fields of emotional and material interaction, still shift something in each of them. Perhaps that's why Haraway comes to talk about Whitehead and time. Her interpretation of Whitehead is probably less important then the symptomatology of the reference itself. Pay attention, says Haraway, it is about time.

Algorithm as a model

The situation that seems important to show further against the background of these models, is characteristic to actual moment in time and can be considered in two ways: technical, simulative,

impersonal (thus it would seem to pass the frame proposed by Hinterwaldner), and zones-attentive and collective, since it practically “contains” performers in itself, changing their biological states and bypassing their control mechanisms (which is more like Haraway's model, though what performers interact with is not species at all, in a certain sense even not a being, however familiar (like a dog) or alien (like a wolf) it may be, but, as they say, radically different: an algorithm.

Examples are provided by projects of the *Shift* studio in collaboration with Ilona Borodina (St. Petersburg): dance performances in an immersive digital environment created by generative graphics and sound tools, in the Media Center of the New Stage of the Alexandrinsky Theater. The project does not have a fixed time frame, continues to exist in the format of "sessions" - practical art works, involving collaborative interactions, a consistent expansion of technological tools and the transformation of artistic forms. The data of body positions of session participants in space and their movements are recorded using motion capture technologies and video cameras, then algorithmically processed and then affect the digital audio-visual environment generated in real time. In turn, this responsive environment, affects personal perceptions of time, space, their own body and the presence of other participants, often affecting hidden, unconscious mechanisms for processing sensory information and responding to it.



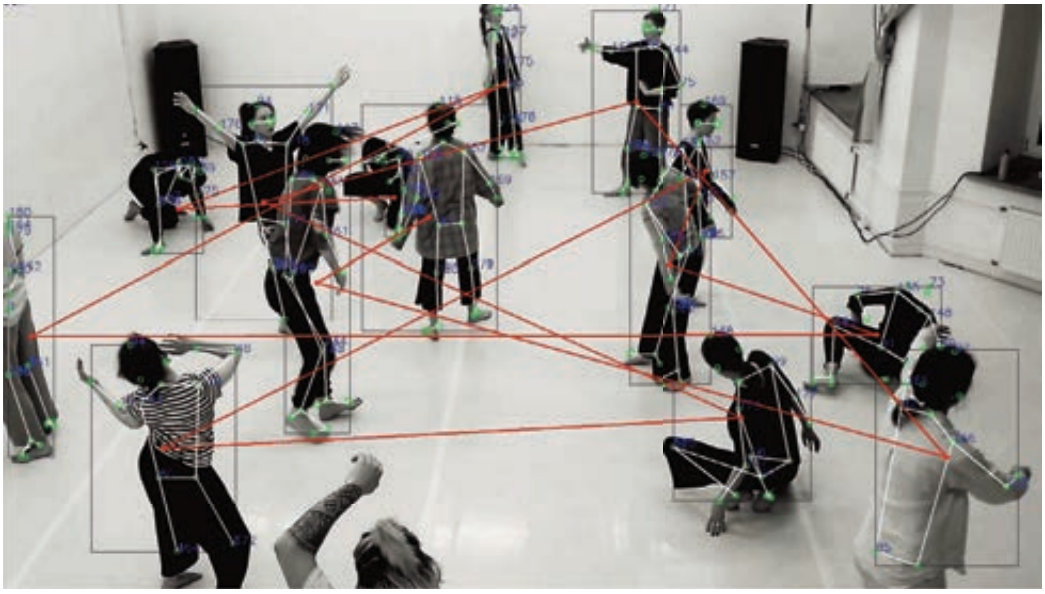
Ilona Borodina, performance documentation, rights reserved

skeletons aligned to a single point,

standard deviations of angles for all skeletons,angles between parts of the average person

Observations of the performers, which they gave after the sessions (some of them were marked by the majority, others more individual), include:

- The ability of the digital environment to radically change the spatiality, dominating the perception of other factors of space. The inability to ignore the presence of digital factors. Immersiveness;
- Orienting towards the potential of an event: understanding that something is happening every moment and anticipating the next moment, which is impossible to predict;
- A strong sense of presence of the camera in the space as a participant, identification with it: to look from the camera, to become the camera. And back again: a camera "absorbes" performers and reworkes them into an image;
- There is a sense of interaction with the environment, but the result of it and the personal contribution to the resulting image are not obvious, which causes relief, getting rid of the sense of responsibility;
- "Everybody suddenly become united";
- Projection is the background for the process of dissociation of dancers into fragments. The dancers as bodies are being randomly formed into fragments of legs, feet, and torso;
- Feeling of a common body mass as a whole.



Ilona Borodina, performance documentation, rights reserved

We can practically see from these descriptions how the algorithm "gathers" a united single common skeleton: the algorithm catches the eye, becomes to dominate, absorbing more and more in the reverse movements of the dancers from and to the camera. By breaking up into fragments and

seeing how the algorithm gathers all the bodies into one common contour, as if performing a defragmentation, the dancers literally feel physically united. In a sense, it is similar to training with renewable time sessions, open ending and transformation potential, although it is being done purely technically, without fantasy or imagination.

The reality is only one. So it is in a way anti-Hinterwaldner characterized. Common terms of «psychophysiological mechanisms", "closed feedback loop between a person and the digital environment" also do not seem appropriate to describe such an algorithmic reality. Therefore the ability to raise to the surface, to discover and peer into the aspects and principles of the existence of the resulting system, perhaps, to try to consciously work with them, creating situations of direct sensory experience are vectors of interest of the project. Other vectors of interest of the project are focused on "metastability" or "false equilibrium" of a tense reacting system, in which the relationship of generative algorithms and affective human reactions create a sense of the potential of an unpredictable real-time event. In this systeIn is detected no center, in which what could be called its elements, whether it is a person, an algorithm, digital data embodied in sensory information, a space containing what is happening, - they lose their usual boundaries, cease to be perceived by the elements as such, creating a kind of unfixed integrity that can exist due to the processes of formation and constant transformations of the relationships within the system that last over time.

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Digital transformation and challenges in 5G networks

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Abstract - 5G business models meet a growing market demand for ultra- broadband-enabled data applications within vertical market segments including Finance, Cultural Heritage, Tourism, Public transportation, Energy and Defense. Cyber security is a critical issue. **Keywords : Business modelling – Vertical markets - Internet of Things – Smart cities – Cyber security.**

Introduction

The Telecommunication industry is playing a crucial role in enabling this digital transformation that is affecting all vertical markets (Finance, Automotive, Public Sector, Healthcare ...).

The increasing availability of technological platforms in a perspective of convergence between Mobile, Artificial Intelligence, Cloud, Big Data / Analytics is dramatically changing the way we live, work, and interact. This trend is part of the Fourth Industrial Revolution, called "Industry 4.0".

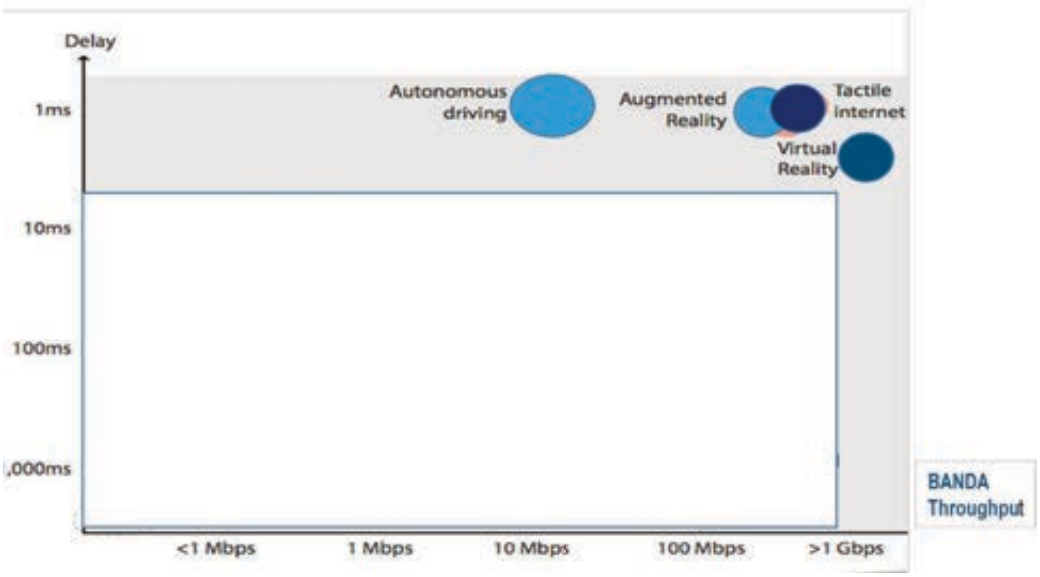
Telecom operators' share of the industry profits show a constant decrease in revenues, despite their fundamental role in enabling digital transformation in all industries and public sector

The new investment and business opportunity scenarios for ICT enterprise, professionals and engineers are linked to the development of LTE and 5G technologies in the mobile and in the fiber infrastructure and Cloud with the emergence of Software Defined Network architectures in networks whose security and resilience are at the centre of the Investments. The new business models respond to the growing market demand for "ultra-broadband-enabled mobile data applications" which are central to the vertical markets of Industry Finance, Tourism, Public Sector, Automotive, Energy, PA-Defence. Industry 4.0 is at the centre of the "digital Transformation" of Telecommunications and benefits from the new 5G network architectures envisaged in the 5G operators development programs The telecommunications industry has provided all the building blocks of the infrastructures: fixed and mobile broadband access network, core infrastructure, interconnection and cloud application platforms.

Digital Transformation & Telco Industry

The whole process of digital transformation will depend on the Telecommunication Industry which is enabling changes also in the organization of work as in the case of smart working. Operators tend to differentiate themselves both in business models and in the services offered to Business and Consumer customers. However, despite the role played by the Telecommunication Industry is fundamental in the acceleration of the digital transformation in business processes, we do not find a similar advantage with a significant confirmation in the increase in value for the Telco operators that have contributed to this development. This despite new investments in networks and infrastructure innovation. The closer the performances of the Telco operators are, thanks to better performing networks, the more difficult it is to stand out, thus leading the industry to search for new business models and meet customer needs through innovation. An explosion of services, however,

that does not generate an equally significant growth in benefits for telecommunications operators caused by the migration of revenues from Telco operators to Over the Top. We are thus witnessing rapidly changing business models, a paradigm leap in technology with IP and SDN infrastructures, and the convergence of Cloud, Mobile, Social and Big Data platforms. Everything is changing in the telecommunications industry with unprecedented acceleration that is taking shape with 5G.-
5G business models meet a growing market demand for ultra- broadband-enabled data applications within vertical market segments including Finance, Tourism, Public transportation, Energy and Defence. Furthermore, enterprise mobile applications will receive benefit from lower latency and improved spectrum efficiency (i.e. Software Defined Radio and Cognitive Radio in a increasing overall network capacity). Delay and latency are fundamental to developing new services in 5G market: 5G is not only an evolution of the current 4G - LTE but it is presented as a paradigm leap that will lead to the opening of new scenarios and to the development of services and business models in vertical markets.

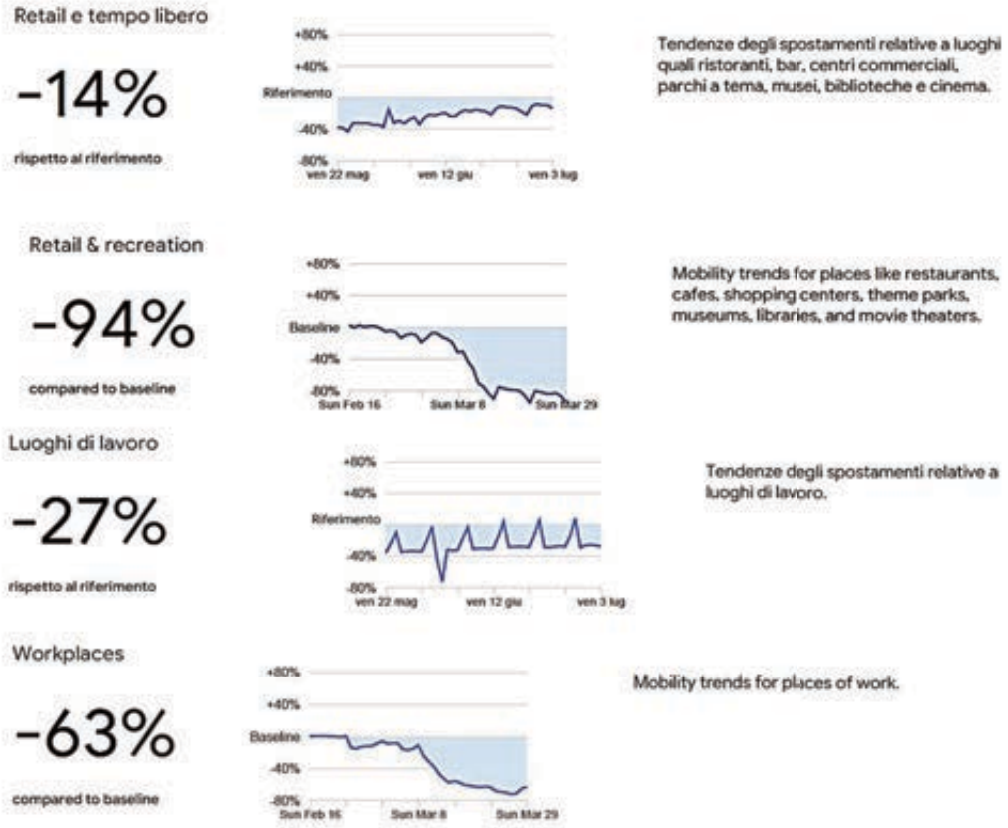


Delay vs Throughput in 5G services

The new 5G mobile network will increase connection speeds by integrating more access modes, far superior to 4G, and will guarantee very low latency times, and in consideration of high performance will enable the connection of wireless devices and sensors in the architecture IOT. The 5G network is designed for the new cyber security scenarios by offering resilience and mitigating attempts to violate the mobile telecommunications infrastructure. With these characteristics, 5G will lead to the creation of services that will change the way people live, produce, work and move. For these reasons, the advent of 5G is an integral part of the Fourth Industrial Revolution, Smart cities and smart working. A series of articles are available on line in the framework of the technical magazine IoRoma, published by the Order of Engineers in Rome: TELECOMMUNICATIONS INDUSTRY: How telecommunications enable the fourth industrial revolution

https://rivista.ording.roma.it/industry-4-0-come-la-digital-transformation-incide-nella-rivoluzione-industriale/

In the mobility area we envisage a new scenario with 5G: public transportation will improve and mobile applications for local authorities and citizens will be ultra-broadband During COVID previous period mobility changes and smart working were key to enable an entirely new scenario.



Source : https://www.gstatic.com/covid19/mobility/2020-07-10_IT_Mobility_Report_it.pdf

The techno economic analysis of LTE and 5G evolution is mandatory for a 3G-like success story across Europe. The economic figures for these kinds of services are quite positive under specific circumstances. Tools and methodologies for market and business case modelling will be presented, in order to be aware about this research area.

A fundamental issue is to think long-term scenarios and to provide true market projections for the 5G next generation wave. To this purpose, specific tools and business models with a particular stress on the economics and revenues drivers have been developed in the best practice The use of simulators will facilitate the understanding of the initial situation and its possible evolutions, as well the identification of the future economical potentialities.

The purpose of this market model is to construct a system that can provide with preliminary market forecasts for a range of major telecommunication businesses. The model is able to provide market forecasts for a range of wireless telecommunication businesses including 5G, existing wireless as well as new opportunities to form part of the overall business plan. The business model tool provides good results based on the input information. However, high quality and

reliable results will require intervention from a skilled analyst to input and interpret other factors such as likely competitive environment - therefore the user will need to be highly skilled in understanding telecommunications markets.

Today big players in 5G emerging market are defining strategic priorities and business models

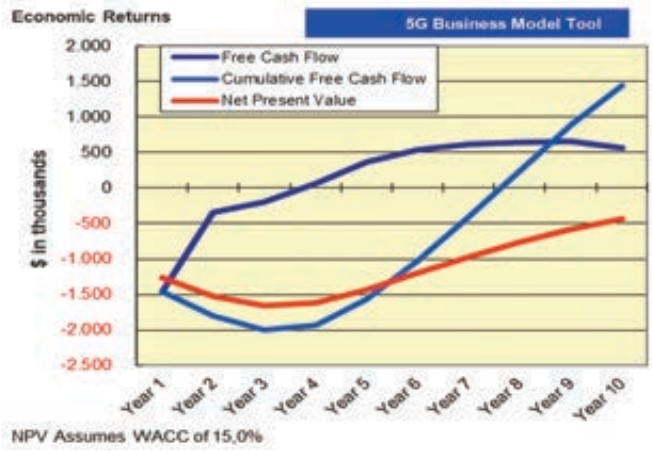
"A careful examination of potential 5G scenarios, use cases and business models is urgently needed along with a realistic assessment of the complications that may just have LTE's market development due to revenue stream overlapping."

There is indeed a need for preliminary analysis on potential 5G use cases, and forecasts are not based on linear mobile evolution. In 5G scenarios, we envisage a market disruption and a new paradigm jump: a Sun rise approach!

We need to reinvent 5G business model in a Cloud Centric Network Sharing Platform, furthermore we need to imagine the role of the Wireless Service Provider of the Future.

Key words are ICT Cloud centric network sharing platforms and Internet of Things

Use cases need to be described in vertical markets: Smart cities and urban mobility / connected cars. We envisage a new market push in 5G due to Telco infrastructure enhancements to broaden the opportunity for IoT and M2M applications.



ICT trends and 5G: Maintaining the promise

The digital transformation in vertical markets and public sector shows that these interdependent trends are "transforming the way people and businesses relate to technology"

The Industry 4.0 transformation process must however be placed as a piece of the more general process of technological change that will affect, sector by sector, all segments of the economy: from Public Administration to energy industry, from tourism to pharmaceuticals. A process of transformation that will be characterized by an important process of technological deflation, inevitably connected to the progressive dematerialisation of production processes and products. Business models are key to understand future market developments.

The impact of the smart factory will bring organizational changes and therefore to labor contracts and industrial relations. In a scenario characterized, thanks to the domination of technology, by

greater collaboration and the presence of high professionalism, rather than the mere elaboration of orders and directives, a work paradigm emerges in which the very dimension of the contract and the dependency relationship between worker and company is revolutionized.

5G: the big picture

5G will provide intelligent access in IOT and broadband wireless connections. Big Data and mobile will be key in enterprise market development. Social media and IOT platforms will be a disruptive wave. New social analytics and mobile tools will be key in the digital transformation scenario. The new ways of communicating, of people and companies, and the explosion of applications made available intuitively through the app store model, cause not only a continuous growth of data traffic, but also variations in the mix of types of traffic and more stronger end-to-end quality requirements.An in-depth analysis is available in the IoRoma technical magazine:

https://rivista.ording.roma.it/digital-transformation-2/

In urban mobility, we understand that mobile device interactions are passive as users accept information from social media and mobile apps, delivered from intelligent systems in cloud architecture. Next generation communication systems are expected to be intelligent in nature, as well as providing a platform for operators to effectively exploit their network resources in an era where spectral resources are at a premium.

The smart cities can be designed based on cognitive radio which is meant for spectrum sensing and spatial sensing. It also uses the massive MIMO and the heterogeneous network which uses small cells called Femto / Pico cell. The Digital Transformation and the 5G are two sides of the same coin and enable the new revolution of Industry 4.0 as examined in the article taken from the event on Industry 4.0 that is available on the journal IoRoma

Evolution of Telecommunication transmission infrastrutture Beyond 5G: Software Defined Radio and Cognitive Radio technologies.

The Evolution of Telecommunications transmission infrastructures beyond 5G will be influenced by cognitive radio technologies & self-organizing functionalities.

The possibilities of integration between 5G technology and Cognitive Radio, will provide a series of benefits including greater energy efficiency, a reduction in interference and greater coverage both in the spectrum of licensees and in that of non licensees. The topic of Dynamic Spectrum Access (DSA) is thus treated in university research and regulatory activities in Software Defined Radio and Cognitive Radio communications in Italy and in international organizations, presenting the Cognitive Radio technology as an evolution of the SDRs and as valid solution to overcome the limit of availability of the radio spectrum. In general terms, Cognitive Radio is the intelligent technology that explores the spectrum by exploiting the holes of the unlicensed or underused frequencies and their spatial availability. In the 5G communication network, devices such as smartphones interact with the base radio stations of the cellular network and receive indications in which spectrum they can find more favorable conditions in terms of greater availability for frequencies and bit rates. This technology, capable of guaranteeing dynamic and no longer static access to the radio spectrum, however, presents complexities for its implementation, linked in particular to the aspects of legislation and regulation of access to frequencies.

One of the main problems of a Cognitive Radio (CR) and SDR architecture for 5G systems is the enormous energy requirement to support the cognitive abilities of mobile devices. CR has a high complexity linked to implementations with artificial intelligence chips and applications. Furthermore, there are further limitations related to the realization of CR for 5G that require devices with high computational complexity to analyze and perceive the entire spectrum range with good sensitivity and quality. However, this evolution of 5G with the integration of SDR / CR in its radio architecture, even if it now appears an uphill road, will become unavoidable to fully implement the IOT architectures. Smart City and for the smart factory in the Industry 4.0 scenario. The new “Next generation” communication systems are already born intelligent, and will provide operators with a platform that will allow them to make the best use of the scarce spectrum resource thanks to an etergenic network architecture that requires Cognitive Radio to be implemented. Smart cities may be designed based on cognitive radio which uses "spectrum sensing" and "spatial sensing". The “massive MIMO” antennas and the “heterogeneous networks” using the Femto / Pico cell “small cells” are used.

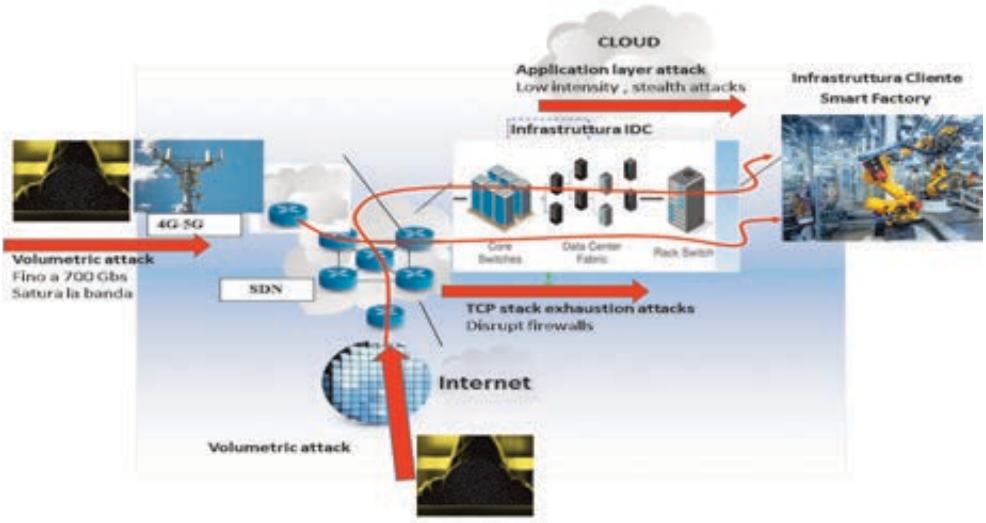
Dynamic Spectrum Access (DSA)

Both cognitive radio (CR) and the fifth generation of wireless networks with 5G standards are considered the new technologies that will enable new business models: while on the one hand, Cognitive Radio offers the possibility to significantly increase the efficiency of the spectrum. used by end users (CR users) thanks to the use of unlicensed frequency gaps and the level of use of the available bands, on the other hand, 5G enables ultra-broadband interconnection with applications with Quality of Service (QoS) services defined for user classes differentiated for purposes and scenarios.

The growing demand for multimedia and internet access in portable devices has led in recent years towards an ever greater demand for access to the spectrum in certain bands, causing an overload of the frequencies involved. Cognitive Radio: regulation issues and Mobile Industry vision .In GSMA the debate is still open and starts from GSMA Mobile Policy Handbook The main concern is that Cognitive Radio and SDR technology will in no way reduce the need to harmonize and regulate the radio spectrum: “Cognitive radio technologies will not reduce the need for harmonized mobile spectrum anytime soon.

5G Cyber security challenges in a post-pandemic world

Accessing corporate resources remotely through virtual private networks (VPN) has traditionally led to a more secure access policy; the need to introduce remote work has resulted in more permissive VPN access policies, which is creating security risks that provide severe threat to corporate networks. We need to improve security based on passwords and move to multi-factor authentication. We can take this COVID threat as an opportunity to improve our security policy and delete old practices, such as passwords without security strong authentication rules, we have the opportunity to move on to more secure technologies. However, "multi vector" DDOS attacks occur at various levels and affect all architectural components according to precise strategies that aim to overcome defenses by saturating them to reach the user application such as in the smart factory. The figure expresses the coexistence of "multi vector" attacks at a conceptual level. Therefore, a cyber-attack on user applications affects 4G-5G mobile infrastructures with SDN, NFV and Cloud infrastructures



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NEW INTERPRET AND INTERACTIONS IN HERITAGE-RELATED GAME: A CASE STUDY OF HUNDRED SCENES OF JIANGNAN

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When the physical facilities are losing effectiveness, people turn to online or hybrid projects in this post-epidemic era. A Chinese simulation game Hundred Scenes of Jiangnan(HSJ) provide new perspectives about how to interpret the traditional cultural elements by game and how can heritage-related games use this as a reference to build new interactions. Players can rebuild several historical Chinese cities in this game and experience city life and historical customs.

Simulation game. Chinese game industry. Heritage.Porcelain pagoda.

1. BACKGROUND

1.1 How the pandemic affects the operation of the museum and heritage.

The covid-19 affect the whole world in different ways. According to a survey host by the ICOM, around 94.7% of museums （who participated in this survey) around the world were closed[1].The closure putting enormous pressure on museums no matter for the museums are self-financing of the government-financing. In this survey, many museums enhanced their digital activities.

Though many museums have their digital activities or programs, like engaging their audience on social media or build their digital collection database. Pandemic force the museums to go further on the online or the hybrid projects. The V&A start their 3D online exhibit: Curious Alice: the VR experience [2] to help the audience visit the exhibit hold on-site. With the methods like this, museums work to engage and attract audiences. For Chinese museums, the situations are similar. Online educational project for schools and live streaming which could attract the audience from the social media.

All of these projects and activities usually focus on leading the audience to come to the museum. Most of them used to be not ‘attractable’ as they want the user to concentrate on the exhibitions and objects instead of interacting with their devices all the times. But in the post-epidemic era, the interpret and interactions are forced to transform. The Hundred Scenes of Jiangnan (now changed its name into Canal Towns)is an inspiring case.

1.2 A brief introduction of HSJ

HSJ is a simulation game produce by the Coconut Island Game. It won the 2020 TapTap Best Visual[3]and 2020 Google Play Best Indie Game [4] award.

As the introduction from its official website said, ‘You will be the architect of the city, drawing the blueprints, building the buildings, planning the layout, and making money.[5]’The game is set in a

world in a painting. The player is a governor of several towns and helps the residents to rebuild their towns and lives from the war.

In essence, it is a simulation game based in a Semi-fictional historical setting （around the 1300s to 1600s, but they're still some element from different historical phases) .The most attractive part is that it combines the traditional Chinese elements with the simulation game element perfectly.

The game takes the player back to the virtual worlds, in the storytelling of this game, all these stories and works happen in a painting. From this setting is really Chinese style as there was so much traditional literature and also deconstruct the whole story in both reality and virtually. The setting also supports this game an outstanding version as some of the architecture refer to the antique Chinese Landscape painting which also complies with this background setting, the world in a painting.[6]

2 INTERPRET IN THE HSJ

2.1 Visual expression

The visual expression also shows the duality of the game. All the images are based on reality with Chinese Landscape painting features. The recognisable painting style is different from the Mainstream painting styles (American or Japanese etc.). An important reason for the success of the game is the unique visual style (especially in China)(Figure 1).

Figure 1:ONE TOWN IN THE GAME

2.1.1 Agricultural production site

As a simulation game, it followed the regularity like for the agricultural work the players have to pay the equivalent， the time and the supplies. There also have two sets of visual expressions of the agricultural production site. In later editions, there are more details of the production process showing in the images. Like the silkworm farm(figure 2), you can even see the working silkworms in the production status.

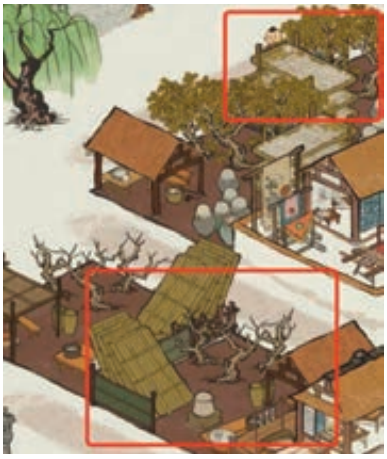

Figure 2: SILKWORM FARM

These details added realism and make the game more playable. The more details, the more time players would like to spend in this game, the play feel more connections between themselves and the game.

2.1.2 Living Facilities

Most of the living facilities could find references to antique Chinese Landscape painting. There was already some research about these part. Noteworthy, the process of discussion and discovery also give a sense of participation to the players like they solve puzzles with the game producer and other fans.

2.1.3 Special structures

Special strictures in this game usually real presence in reality.

For example, at the beginning of the game, the level tasks of the players are to rebuild the Porcelain Pagoda of Nanjing.

The pagoda is a special and striking architectural form. It is an important Buddhist building. The building of pagodas is an act of expressing devotion to the faith and accumulating merit for oneself. The porcelain pagoda of Nanjing is built from 1412 to 1431 by the Ming Taizong to commemorate his mother[7.]

Apart from the element of religious belief, it is capable of creating a visually impressive impression. Johan Nieuhof, a Dutch traveller who travelled in China and South Asia around the seventeenth and eighteenth centuries have recorded it in his book[8](Figure 3)

Figure 3:JOAN NIEUHOF'S DRAWING OF A CHINESE TEMPLE

Ernst Boerschmann, a German architect travelled through China and made an in-depth study of the pagoda, which resulted in the publication of several books like Chinesische Pagoden(Boerschmann,1931) The pagoda was decorated with porcelain tiles, it is a popular aristocratic style. Some of these are still extant. There (Figure 4) is a porcelain tile collected by the British Museum[10].

Figure 4:PORCELAIN TILE COLLECTED BY THE BRITISH MUSEUM

However, the pagoda was damaged during the Qing Dynasty and was only rebuilt in 2010[11]. It matched the game setting that the whole town is ruined by the war and players need to rebuild the buildings and lives.

During the rebuilding of the Porcelain Pagoda, players need to produce a wide range of materials that give the motivation of game-playing. All the material are focus on real supplies like timber, paper, cloth, elixirs which will be needed in ancient engineering construction. All these needs accelerate the whole play.

Besides that, the pagoda also has a religious meaning in the reality. In the real world, people build these structures with the purpose of wish their haplessness for their present life and the afterlife. In the game, the rebuild of the pagoda also has these mental cues because of the Chinese cultural background. It is another combination between the game and Chinese culture.

As the pagoda used to exist in the real world, the players of the game get interested in the Grand Baoen Temple. With the popularity of the game, the site began to organize related events with the game themes.

These game-related events develop into a fixed pattern which could find more detailed in 3.2.

2.2 Auditory expression

As a 2D game, the auditory expression gives a wealth of details. The players could click different building and heard different background music. The sound could enhance the immersion of the game, like if the players click the market they could hear the cacophony of hawking, Taoism, the voice of the Daoist priest, Lotus Pond, the voice of birds and winds.

The auditory expression gives a more complete gaming experience to the players.

3. Interaction of HSJ

3.1 Roleplay

Players vicariously through the eyes of the governor of the town. They need to take the responsibilities to rebuild the town and healing the wounds of war.

The game tries many ways to let the players build emotional connections with the in-game characters who also the residents of the town. Players choose to hear the conversations between the characters which are usually some very tiny and daily issues. Players have to arrange the accommodation and work of the residents. Characters also have their random marriage, conflict and death (Figure 5&6)just like real life. Players need to pay for their cemeteries which give the feeling of loss.

Figure 5:NOTIFICATION OF CHARACTER DEATH

Figure 6:THE GRAVES

3.2Folk Festivals

Ghost festival, also known as “yii-lan-p’en.” , has been a major holiday since ancient times. ‘The festival combined the interests of monks, householders, and ancestors in an annual celebration of renewal. Most residents of the city, laypeople with no exclusive religious affiliation, provided for the salvation of their ancestors by making offerings to the monasticism unity .[12]’From 2 September 2020 to 8 September 2020, the game hosts a limited time Ghost Festival-themed event. Lotus-shaped lamps representing the memory of someone who has passed away appear in the waters of the game. Also, some in-game ghost hangs on the street and make the players feel that the residents who died came back in this festival.

Zhong Kui is a ghost hunter whose story was first mentioned in Taishang Dongyuan Shenzhou Jing an important Taoist Classics From(2nd and 3rd centuries AD). An important reason for the importance and longevity of Zhong Kui's stories is their close relationship with Taoism and ancient Chinese folk beliefs[14]. He is a cultural symbol closely associated with the underworld. （Figure7）

Figure 7:ZHONG KUI IN THE GAME

In addition to this limited-time event, the game also introduces a new in-game character, Zhong Kui, and a new special building, the Gate of Hell.

Gate of Hell (鬼门关 in Chinese) used to be a synonym for a treacherous and remote place[14].It gradually becomes the entrance for entering the underworld in literature. In HSJ, this concept is reified. (Figure 8)

Figure 8:GATE OF HELL

These two new elements will continue to remain in the game after players have acquired them through other means such as completing quests and paying for them. This nicely combines the folklore festival and the game.

4 Evaluation of the HSJ

4.1 Downloads and comments

HSJ" was launched in July 2020 and had over 7 million downloads on TapTap by the end of 2020. Coconut Island Game, the developer of HSJ, has received tens of millions of RMB in strategic funding from TapTap[15,1].

In addition to the two awards mentioned above(1.2), it was recommended by Apple Store(October 2 2020).

Its official Weibo(a Chinese social media like Twitter and Facebook) account has 82 followers. On Weibo, the topic was discussed 5.534 million times and read 5.41 billion times[16].(Figure 9)

Figure 9:DISCUSSED AND READ NUMBER ON WEIBO

4.2 Game and Heritage

With the gradual maturity of the game industry and the external influence (e.g. people could not go

out during the epidemic), the scale of the game industry gradually expanded.

The actual sales revenue of China's mobile game market in the first half of the year was RMB10.4673 billion, an increase of 35.81% year-on-year, with the growth rate of the handheld game market scale pulling the overall online game market growth rate. By the first half of 2020, the scale of Chinese game users reached 657 million, an increase of 1.97% over the same period last year[15,2].With the rapid development of the gaming industry, the collaboration between cultural heritage and gaming links will be able to bring new energy and attention to cultural heritage.

On the evening of July 25, the "Changganli Street" was officially opened by Coconut Island Games co-organised by the Da Dao En Temple Site. (Figure 10 长干里潮玩街） At this event, visitors can take photos with HSJ's game-themed wall and the characters from the game. A game concert will be held at the event[17].

Figure 10:CHANGGANLI STREET EVENT

4.3 The shortcomings of the HSJ

HSJ has a rich traditional Chinese cultural connotation, which is combined with the game in a dynamic way, and this is an important reason why it has received so much discussion and popularity in the Chinese market.

However, this also requires players to have a deep understanding of, or at least a strong interest in, traditional Chinese culture. This has limited the development of HSJ outside of China.

In terms of gameplay, HSJ's gameplay is rather homogeneous and limited to the existing gameplay, resulting in a relatively short life span. Till April 2021, HSJ offers players five towns to run, but the core gameplay is almost indistinguishable from when the game started with just one city.

5 Conclusion

HSJ is a great combination of heritage and mobile gaming. The game offers a new interpretation and expression of historical and cultural elements, and the market has shown a positive response to this attempt.

In this new era, the museums and heritages need to proactively cooperate with new industries. This collision may bring new inspiration to the interpretation and expression of cultural elements.

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CULTURAL ACTIVITIES - REAL AND VIRTUAL GALLERIES AND RELATED INITIATIVES

EXPERIENCING ARCHITECTONIC DESIGN PROCESSES THROUGH INTERACTIVE VIRTUAL REALITY APPLICATIONS

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In 2019, we presented our method of visualising uncertainty in knowledge [1], and in 2020 we deepened it by means of the implementation of this method to support building research at Berne Minster [2][3]. This year's paper presents one of the most important responses to our method, the design in architecture. It illustrates this with the example of the visualisation of the "Ideal Church of Julius Echter" as part of the 2017 European Year of Monument Conservation, "Sharing Heritage". The main difference between this project and our former projects Pergamon, Palatine, Bern Minster or Cologne Cathedral, is that it does not show hypotheses about an architectural plan that was at least in principle realised in the past. Instead it shows the hypothesis of a pure idea, i. e. an ideal image of a church that itself was never realised, but which, according to the hypothesis, may well have existed in its creator's mind – considering the about three hundred realised churches that are remarkably similar in essential features. And just because the church is a hypothetical design idea, the design idea can well be communicated in an experimental way. Virtual Reality provides the necessary tools for this, as it allows – in contrast to physical reality – both guided interactivity and an instantaneous switching between different scales.

INTRODUCTION

During the Counterreformation in the early seventeenth century, the archbishop of Würzburg, Julius Echter von Mespelbrunn, built or transformed several hundred mostly village churches that seem to follow a common principle that by itself has never been realised due to the varying preconditions. Prof. Dr. Barbara Schock-Werner, the former master builder of Cologne Cathedral, verbally described this hypothetical ideal church originally in her habilitation treatise.

The presentation of the project exhibited by an interactive Virtual Reality experience introduced by a narrative film and a physical model of the ideal church.

The Virtual Reality experience is devided in four phases. In the first phase the operator learns how to compose the basic elements of the churches from a given set of building. The user composes the elements by selecting, arranging and positioning. As he operates in the virtual space, he handles the virtual objects by controllers simulating hands. The objects themselves are represented in the scale 1:100 that calls for experimental interaction. As they behave physically correct, the user is encouraged to experiment intensively. When the user matches one of the predefined sets, the visual

impression switches to an original scale representation that allows around the churches. The ideal church can also be visited from the inside.

This turns out to be one of the most important benefits of Virtual Reality not only to simulate space and interact with its elements but to deliberately switch between different states, which can be scales, levels of details, levels of abstraction or even varying alternatives of design.

Considering the amount of about three hundred churches, Julius Echer manifested his responsibility for form and design of all building projects within his bishopric. This general responsibility led to a certain homogeneity in the exterior and interior of the churches. Some of the churches were built as a replacement or an extension of existing churches. In a number of cases he took over and integrated existing church towers.

In general, his new or transformed churches resemble each other to a rather high degree. Even the overall colouring design of walls and decoration is very similar. It seems obvious that there must have been a clear vision, a primordial idea of the churches before they have been built.

THE RECONSTRUCTION OF AN IDEA

The historic ideal has not survived, if there has ever been a formal description at all. The verbal hypothesis describes every single feature as if it was built. The reader can imagine visiting the ideal church. But the description does not use formal abstraction as the authors have executed in the cases of the urban texture of the antic metropole of Pergamon [4] or the urban texture around Cologne Cathedral [5] where very little is known about the single buildings, so that a rough and obvious geometric abstraction clearly explains this uncertainty in archaeological knowledge [6]. In the case of Julius Echter's churches the idealisation is realised as a series of descriptions of rather subtly idealised single features of existing churches, an assemblage of the most common and typical single components, a combination of existing parts that in reality have not been built as part of one single church. This also comprises the standard surrounding buildings school and parish house (Fig. 1).

Fig. 1 Julius Echter's ideal church with school and parish house in a paradigmatic village context

Based on these prerequisites and on occasion of the envisaged exhibition on Echter's cultural impact on his era, the idea arose to visualise this idea of a church that would become the origin of several hundred instances, to create a visual counterpart to the existing verbal description.

A geometric translation of a verbal scientific hypothesis requires a particular and new architectonic design. That is, the translation of the hypothesis from a verbal to a visual form is to create completely new objects, new pieces of abstract geometry that obviously resemble to a high degree of architecture in its appropriate historic context. But the design process also concerns the differentiation between realised architecture and an appropriate degree of abstraction, not only to illustrate the churches' own hypothetical design ideas but also to clearly demonstrate that the ideal church an idea and not a realised building. The challenge in this approach is to achieve an appearance that credibly represents a supposed design idea of Julius Echter and that also recreates Echter's idea of architecture in the imagination of the viewer of the visualisation (Fig. 2).

Fig. 2 Julius Echter's supposed ideal church

Most supposedly Julius Echter's concept is restricted on those elements that define the construction, its technical issues as well as principle visual and economic concerns, that is the overall form and the proportions of the major building elements, the number of tower floors, axes of windows and entrances, the colouring of interal and external walls, the construction of the vaults and the overall composition of the interior decoration. He might most probably have invested less efforts concerning deviations due to local building techniques or less experienced craftsmen. This is why the ideal church does not represent the ubiquitous defects of the realised churches but instead an accurate and – idealised – appearance. In the same sense any of the usual changes that the realised churches underwent are not considered, that is deformations during or after the construction, destruction, conversions or refurbishments. This also lets the visualisation appear as a visualisation of hypotheses and not as a simulation of built architecture. On the contrary, and this is the main purpose of a visualisation as such, an idea is supposed to be perceived as an idea.

Perception and examination of these visualisations are intended to engage with Julius Echter's architectural vision, but also to appreciate the quality of his overall architectonic contribution. This also leads to a deeper understanding of any of the individual built churches when visited after the perception and understanding of the ideal church. As nearly all churches have some of the features of the ideal church, the differences between any particular built church and the ideal church are

noticed more clearly and may even lead to a deeper understanding of the conditions and prerequisites of the particular building's site and circumstances. All together the mediation of the ideal church as a hypothesis strengthen the identification of the local community with their local church.

MEDIA OF THE EXHIBITION

In the exhibition, three different ways of representation complemented each other, each performing on a different level of perception to fulfill a most complete understanding of the three-dimensional design idea. Three dimensional space perception in reality depends mainly on stereoscopy, that is one projection for each eye. This has been accomplished by virtual reality glasses but also by an autostereoscopic screen, that carries a foil of small prisms that separate the visibility of the two integrated projection for each eye. Real spatial perception is given by a 3D print. Not comparable to original scale at all, the print is still half a meter tall (Fig. 3). It is the virtual reality projection that offers interactivity. This approach allows to experiment with the churches' design and understand it. This also leads to a deeper understanding of the mechanisms of architectural design in general.

Fig. 3 3D print of Julius Echter's ideal church

THE CONCEPT OF INTERACTIVITY

The user is generally allowed to combine the building's components and functions without restrictions. The achieved compositions created by the user will be compared with Julius Echter's ideal church and with in total eight selected realised churches. The task after free experimenting is to match one of eight realised churches or the ideal church. Visual feedback supports the user in accurate positioning (Fig. 4). Experimenting allows for an infinite number of possible combinations and by this it allows the visitor of the exhibition to overcome the general distance between exhibits and visitors that also arises from the temporal distance over five centuries.

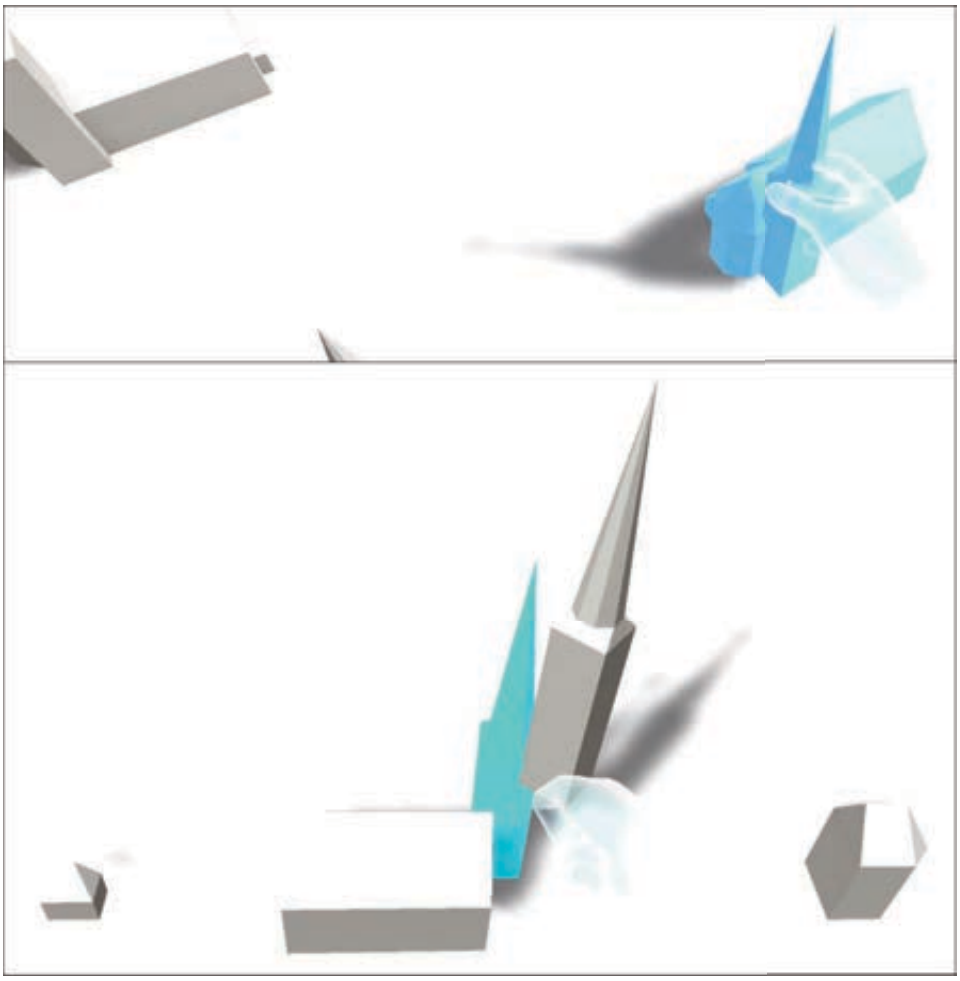

Fig. 4 Interactive optical user guidance, screen shot from Virtual Reality

In the first phase of the interaction the user gets to know the eight realised and one ideal churches and selects one of those in order to recompose it in the second phase from a set of building parts, that is nave, choir, vestry and tower with special controllers that represent hands. The objects in these two first phases of the interaction are represented in the common model scale 1:100. This suggests the user an easy handling of the building parts, supported by a physically correct behaviour. That is, if the user opens the hand, the building held in the hand falls back down to the ground. As a non-realistic addition to physical behavior, dropped building parts automatically turn back upright to their initial orientation. The physical simulation of the parts' handling and behavior encourages the user to freely experiment and combine without restrictions. When the user changes from experimenting to reconstructing and successfully composes a predefined church's set, the third phase of the interaction is entered, that is the same church as original scale model.

In this original scale model the user can walk around the churches. In the case of the ideal church even the inside of the church is accessible (Fig. 5). In original scale a change of the building parts' geometry, position and orientation would contradict the familiar architecture's behavior and irritate the user. The colouring on the contrary does not harm, so some elements are editable. As most of Julius Echter's churches had mouldings and edges in either yellowish or reddish colour, this feature

is interchangeable by pointing, just as the windows' traceries, one of the famous features. And as almost all window traceries in Julius Echter's realised churches are individual, each virtual tracery provides five alternative shapes. This allows to mediate versatility as a key feature of Julius Echter's design in one single ideal church. This tracery's versatility of probably the most concise feature of Echter's churches, at most outperformed by the iconographic tower helmets (Fig. 6).

Fig. 5 The gallery of Julius Echter's ideal church

Fig. 6 The parish church St. Peter and Paul in Schönau

CONCLUSION

The user understands that different scales demand different details and consequently different modes of interaction and manipulation. It is one of the specific strengths of Virtual Reality not only to simulate space and interact with it, but to deliberately switch between different states. This can be scales as realised at the transition from the second to the third phase of the interaction, but this can also be levels of details or, most important, abstraction.

At Julius Echter's churches all of these features are combined when the user enters the third phase. Particularly abstraction, if carefully designed, allows to demonstrate, explain, illustrate and understand concepts that otherwise can only be perceived subtly [7].

Virtual Reality setups turn out to be a development that allow a deeper understanding of architecture especially in the case of lost or hypothetic architecture, and this not only because of the spatial experience that is more explicit than flat projections and not even only because of the interactive movement through space, which already enhances the spatial experience substantially, but because of the seemingly realistic interaction, the near to real grasping of objects and touch sensitive surfaces, altogether a combination of different perceptions and the impressive experience of effective intervention and actual impact. Interactive Virtual Reality will most probably enhance and simplify the mediation of design concepts, if performed accordingly (Fig. 7).

Fig. 7 The gallery of Julius Echter's ideal church

The project has been realised for the exhibition „Julius Echter. Patron der Künste. Konturen eines Fürsten und Bischofs der Renaissance", exhibited in the University of Würzburg's Martin von Wagner Museum in the Würzburg Residence from June 25 to September 24, 2017 [8][9][10].

Picture credits: all figures by Lengyel Toulouse Architects, Berlin, www.lengyeltoulouse.com.

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SMARTICON: INNOVATIVE TECHNOLOGIES FOR THE ENHANCEMENT OF MUSEUM ACTIVITIES AND MORE…

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Abstract

The world of art, today more than ever, must be enhanced, protected and promoted through the aid of innovative tools, harbingers of that synergy which is essential to restart the recovery after the worsening of a crisis already underway and significantly worsened by the mechanisms triggered from the pandemic. The recovery implies the need to initiate the processes dedicated to the digital transformation of companies and entities committed in Cultural Heritage to encourage the increase in tourism and the related economic sustainability.

INTRODUCTION

The dramatic historical moment that we are experiencing has seriously worsened a pre-existing situation of crisis and has inevitably triggered a mechanism of sudden and unexpected aggravation of the economic recession.

This situation requires us to react, with extreme concern, through initiatives aimed at both "bureaucratic" simplification rather than an exponential and determined acceleration of the growth, strengthening the synergies that derive from innovation.

It is essential to plan actions aimed at ensuring the survival of our competences, avoiding their precariousness and ensuring their stability projected towards economic recovery and safeguarding the resources that make our Country a worldwide excellence.

Cultural Heritage is the beating heart of Italy and occupies a strategic role within our cultural, social and economic ecosystem. Cultural Heritage also represents an essential milestone for the sustainability of our economy, which is able to and must still grow very much.

Culture is one of the most effective tools to tackle the crisis and to establish a climate of global cohesion and collaboration.

WHAT IS HAPPENING IN THE WORLD

It is estimated that the health emergency and the related lockdown, requiring the closure of museums throughout Italy, caused, only in 2020, a lack of turnout of almost 19 million visitors and an economic loss of approximately 78 million euros.

In the last quarter of 2019 alone, the state museums facilities had registered over 17 million visitors, producing gross revenues of 69 million euros.

In the past we have already witnessed the occurrence of the alarming consequences triggered by the economic crisis and, although the devastating effects that they would have implicated were foreseeable, the process did not stop due to the urgent need to face immediate survival.

At the beginning of the third millennium, especially in the United States, a policy of "*deaccessioning*" (alienation) was implemented, of works of art belonging to important collections to buy new ones in an attempt to reverse the trend, to attract attention and, last but not least, to send out a signal.

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In 2018, the director of the *Baltimore Museum of Art* decided to sell some paintings by Warhol, Rauschenberg and Kline to buy contemporary works of art (*accessioning*) by female artists or men of colour.

In 1972 the New York Times harshly criticized the *Metropolitan Museum of Art* in New York, which had sold a series of paintings from the modern art collection such as Manet, Cezanne, Moore, Gauguin, Picasso, to purchase the "Portrait of Juan de Pareja" by Velázquez. The "scandal", and the events that followed, imposed the need to regulate deaccessioning and the best practices on a correct museum management.

Equally indisputable is the fact that, according to the "ICOM Code of Ethics for Museums" [3] drawn up by the International Council of Museums [4], museums, as a service to the community and to society in general, are responsible for Heritage Cultural: intended both from a material and immaterial point of view. Museums are therefore the keepers in charge of fulfilling all the best practices preparatory for ensuring and guaranteeing the conservation and enhancement of the collections guarded by them for the exclusive enjoyment of the entire community.

For this purpose, the ICOM Code of Ethics was established, the International Council of Museums, adopted in 1986, amended in 2004 and translated into 38 languages.

Against the disposal of works of art - the term used for the disposal of artworks of museum collections is "deaccessioning" [1] - in 2010 the Association of Art Museum Directors [2] (AAMD) had already ruled, as this policy was in contrast with the principles enshrined in the aforementioned Code.

Unlike the museum systems of other nations, the Italian one is essentially public and is characterized by a strongly guaranteed legislative framework and the concept of *deaccessioning* is not customary of our museum policy.

However, there is a mechanism with similar effects that involves the entire chain of Cultural Heritage.

In fact, it is frequent that important private collections (also coming from noble families), over the centuries, have been dismembered to fulfill needs that, often, have implicated the loss of the historical path of the artefact; that is, the destruction of the intangible assets of the good and essential information for its identification and enhancement: ***the genetic code of the work of art***.

Consider also the dramatic alienation of ecclesiastical assets which, until a few years ago, were totally out of control and were sold for "a few pennies" to inexperienced art dealers, maybe just to buy new benches for the Church. Not to mention the devastating consequences of the illicit market of works of art, with theft and clandestine exports.

It is therefore indisputable that Cultural Heritage is one of the most critical and severely suffering sectors.

SAFEGUARDING, ENHANCEMENT AND FRUITION OF THE CULTURAL HERITAGE OF HUMANITY.

Art represents the tool for cultural growth and socio-economic development **not only for the nation that owns it, but for all humanity.**

This new concept is becoming a "custom" in collective thinking and is giving rise to the concept of "***planetary humanism***" which translates into Sipal Penco's mission, which aims to transform theoretical concepts into *strategic technological tools*.

Times are changing radically and quickly due to the increasing demand for innovative technologies.

This metamorphosis is evident in the new generation, which marks an era in which the need to respond to modern requirements has become inevitable. It suffices to note the furnishings of the

teenagers' rooms, where old fluffy puppets and toys so dear to us have given way to the highly speculative market of video game consoles. A complete monopoly, which regulates supply and demand dedicated to free time for this age group but which, increasingly, also involves adults.

But the emergency caused by the pandemic has caused the decisive turning point, triggering a process of irreversible renewal that involved everyone, forcing even the most reluctant to adapt to modern times. This situation has definitively affirmed the implication of technologies as an essential tool of our daily life and has raised awareness in the society in order to find suitable solutions to accelerate the "alignment" of the differences in height between social classes.

This current "normality" obliges society to dictate new imperatives in all areas and that of Cultural Heritage cannot and must not delay in adapting to the modern rules of survival: the imperative of society is in the "safeguarding and enhancement through 'innovation' which, for the institutions that manage Cultural Heritage, translates into the imperative to "encourage *everyone* to access knowledge and the fruition of culture".

Sipal Penco has accepted the challenge and has developed an innovative software solution, based on a scientific method and on new technologies (Cloud, Computer Vision, Blockchain).

THE COMMITMENT OF SIPAL PENCO

The main resource to meet the new needs consists in the adoption of innovative technologies such as artificial intelligence, cloud, big data and blockchain.

Sipal Penco has created a methodology called Smarticon that arises from the encounter between the world of art and the most innovative engineering technologies, based on a proprietary patent.

The solution uses artificial intelligence to help experts, institutions and tourists in understanding and enhancing the works of art with which they come into contact, offering a method based on the iconographic recognition of the objects present in the artifact.

The goal is to renovate the sources of knowledge so that they do not remain fragmented and separated and to enhance accessibility to knowledge through ***dynamic tools***, which make it easy to use globally according to individual needs and skills.

In the year 2020/21 Sipal Penco, before releasing the Smarticon method, has made a further effort in the implementation of the project, with the aim of adapting this tool to the most varied needs (from experts to enthusiasts), preparatory to offer a ***fruition of dynamic knowledge***, through solutions based on the assumptions of *inclusion and sharing*.

THE SMARTICON METHOD: A FLEXIBLE AND DYNAMIC INSTRUMENT

Innovating means responding to the need to **establish the rules** to put **order** among the information with the aim of enhancing the usability of the data, since these represent the synergy in charge of the **comprehension** and **knowledge**.

Aspiring to the creation of an **ecosystem designed for Cultural Heritage**, even more so if it can be **shared on a global scale**, necessarily implies the passage through the concept of ***scientific method***: the ability to know how to observe, identify the problem, break it down into its parts, collect data, formulate hypotheses, verify them through experimentation and validate the results.

The scientific method, through its repetitive and methodical processes, is the modality through which science arrives at the knowledge of objective, reliable, verifiable and shareable reality but, above all, it is the tool for the collection of empirical data and for their rigorous analysis through processes applicable to any topic.

Sipal Penco has given life to a unique know-how so far, based on the development of an innovative scientific method called Smarticon: "Method for the classification, cataloging and

tracing of valuable assets, in particular works of the world of art" (Italian patent for method n.102015000006508 granted by the Ministry of Economic Development on October 13th, 2017).

Smarticon is an innovative knowledge model dedicated to the enhancement of the knowledge lavished by experts which, through the method and a cognitive search engine, becomes usable and applicable to any type of artefact on a global scale (among its credentials Smarticon has won one of the two available places in the ranking based on merits for the HULBric project. The realization of the project has been organized by Lazio Innova, in collaboration with CNR-ICVBC and UNESCO WHITRAP: "Historical Urban Landascape: Bridging Cultures". The candidate companies were selected by a commission formed by CNR and Tor Vergata University).

The Smarticon method is **the first sprout of a *holistic planetary ecosystem***, which makes dialogue between different cultures possible: restoring ruptures and all forms of fragmentation and regenerating the scientific and humanistic environment in a creative dimension.

The recovery of the *cognitive heritage* connected to the artefact will become the "*genetic code of the work of art*" and will also be preserved within the method thanks to the help of new technologies such as the blockchain.

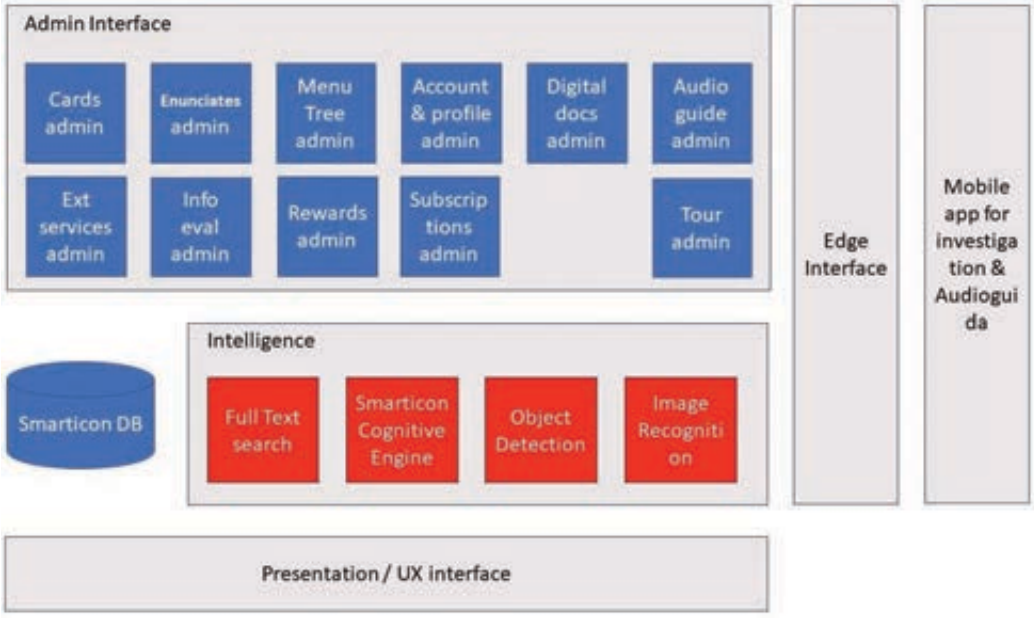
The ambition is to adapt the source of knowledge to the needs of modern times.

INCLUSION AND SHARING: DYNAMISM AND VERSATILITY

The mission of the Smarticon method is to act as an innovative and current scientific tool, able to face and manage all those "*complexities*" that characterize the Cultural Heritage sector.

At the same time, the method allows everyone, even those who are not experts, a pleasant fruition of knowledge in search of the truths hidden behind the image.

Below there is a diagram of the logical architecture of the system:



Working from a PC

Smarticon provides, in the cloud, a valuable *knowledge-database* composed of all the information, transformed by the method into enunciates, which originate from the sources of knowledge lavished by the world of experts and attributable to all the registered artworks.

The term "information" refers to all those "objective data" related to a work of art (such as iconographic symbolism, the composition of the canvas, the pigments used, etc.) which, at the state of the art, are in disorder (they lack an order).

The enunciates are all the validated assertions attributable to the work of art and ordered within the digital information assets of Smarticon through a process of inductive, deductive and empirical logic that confers them the properties of establishing reciprocal relationships and correlations to discover the truth.

This methodology provides a strategic tool for the codification of the iconographic interpretation, for the possible dating and attribution of the artistic field, for the recovery of the lost historical path, as well as the comparison with artworks, even of different manufacturers, with which they may have some links: the comparison between a preparatory drawing, a “sketch”, a definitive artwork, an engraving, and much more.

The application component consists of administrative functions for the expansion and maintenance of the knowledge database and a user interface dedicated to the consultation and retrieval of information relevant to a specific work of art.

The heart of the Smarticon system is the cognitive engine which, through repetitive and methodical processes, not only allows the generation of reciprocal relationships and correlations between enunciates, but also and above all to bring out the contradictions and manage them: that is, transforming the current "criticalities" in that aspired product, currently precluded, which generates the recovery of knowledge and its constant implementation.

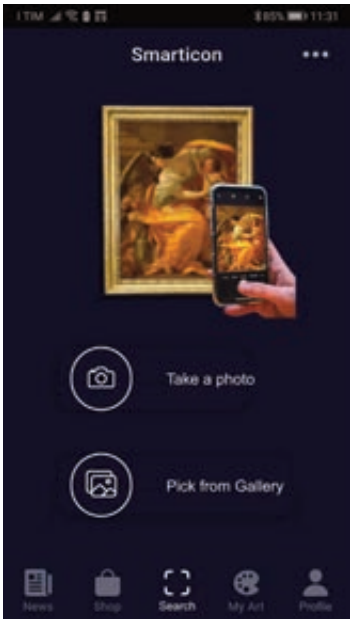
All this information is easily searchable and can be consulted through a Web application, accessible via PC.

One of the profound innovations inherent in this solution is the high level of the share of information through multi-user access: more "entities" (museums, institutions, consultants, etc.) can connect to the system both to consult it and also to contribute to the enrichment of Smarticon's enormous knowledge heritage.

Having fun with a smartphone

Smarticon applies the technology of visual recognition based on apprenticeship (Deep Learning Computer Vision) to art, with the aim of making the fruition of art simple even for less experienced users, stimulating the desire for knowledge through simplicity in the use of information: recognize the iconographic symbolism, cover its meaning by recognizing the framed subject and much more.

It is important to highlight that this system is able to identify the iconographic details known by itself, allowing to identify the subject depicted *even on unpublished artworks* thanks to the click of a simple photograph:

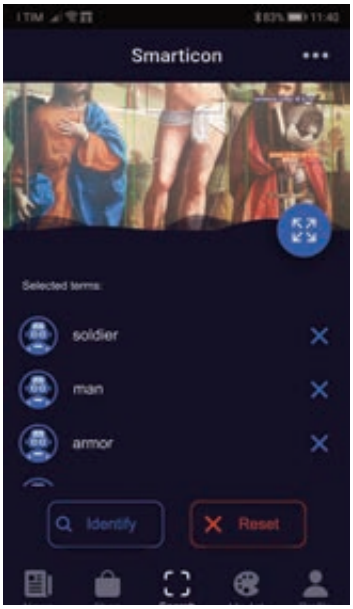


Smarticon proposes the result of the analysis of the objects: a list of the enunciates that it has recognized.

The user has the right to integrate the information manually, adding other terms that arise from the visual results of the user himself.

By starting the search, Smarticon starts the process of comparison of the information within the digital information assets and suggests a list of results with which the user can interact, further integrating the search until he reaches a satisfactory result.

When the set of enunciates satisfies the description of what has been photographed, it is possible to search the Smarticon knowledge database to identify the subject:



Once the subject (in this case Saint Sebastian) has been identified, it is possible to consult the card, which provides full knowledge and awareness of the subject of study. For example, the subject's biography, detailed information, associated iconography in time and space, etc. are provided. It is also possible to recall, through external archives connected to the application, eventual artworks associated with the subject with the aim of being able to examine contextualized comparisons with other similar artworks:

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[1] This phenomenon is regulated in the guidelines of the Association of Art Museum Director, according to which the funds obtained from a deaccessioning activity must be destined to new acquisitions and works of maintenance.

[2] The Association was founded on July 6th, 1916 by a group of art museum directors - including Harold Brown, Cornelia Sage, Joseph Breck and NH Carpenter, elected as first president, Clyde Burroughs - gathered together at the Art Institute of Chicago, with the aim of cooperation in museum administration, promoting common professional standards. Not to be overlooked is also that the US museum system was created to protect and enhance private collections, and its management is private. To date, it includes 220 directors of art museums from the United States, Canada and Mexico.

[3] Elaborated and adopted during the XV ICOM General Assembly, held in Argentina, in Buenos Aires in 1986; subsequently amended, first in 2001 during the XX General Assembly, held in Spain, in Barcelona, and then in 2004 during the XXI General Assembly in Seoul (South Korea). It is a deontological tool on minimum standards concerning both practice and conduct for the staff of the entire international museum community.

[4] ICOM is an international non-governmental organization of cooperation between museum institutions and professionals and within the UN Economic and Social Council it plays the role of a consultative body. In Italy, the Italian National Committee of ICOM was established on May 17th, 1947 on the initiative of the Democrat Guido Gonella, Minister of Education in the 3rd Da Gasperi Government, just six months after the constitution of the International Council of Museums, which took place during the 1st general Conference of UNESCO held in Paris in November 1946.

ACCESSIBLE IMMERSIVE PLATFORMS FOR VIRTUAL EXHIBITIONS INVOLVING CULTURAL HERITAGE

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In recent years, several digital platforms such as Mozilla Hubs have emerged and are rapidly growing since the COVID-19 era. Taking advantage of its ease and accessibility, our team designed a Hubs-based experience titled Chronicles of an Art and Science Collaboration and demonstrated it at Arts Electronica 2020 media festival. This immersive experience documented a collaborative project between artists and scientists dealing with the use of bio-cellulose for art and design purposes. Upon conducting a survey, we learnt about the experience from a user's perspective, and these learnings serve as guidelines for our immersive cultural heritage-based projects envisioned in the future.

INTRODUCTION

Recent trends seem to indicate *Mozilla Hubs* as an emerging and accessible platform for 3D computer graphics image (CGI) digital content development [4, 14]. As a platform, we examined that Mozilla Hubs offers several advantages such as:

- Ability to share and participate in 3D-CGI experiences via a browser-based link on different types of devices such as desktops-laptops, smartphones-tablets, and virtual reality headsets.
- Accessing and interacting within simulated 3D environments as avatars and meeting other visitors there.
- 3D editing capabilities via browser-based *Spoke* software currently used also for creating and designing hubs-based experiences.
- Open-source framework for creation and modification of tools inside Hubs and the Spoke editor.
- Possibly GDPR compliant experiences that allow visitors to enter the simulated environment anonymously without logging in.

Mozilla Hubs has been increasingly used in the COVID-19 era by festivals such as *Ars Electronica 2020* [4] in their *Kepler Garden* [1,11] installation where a variety of 3D experiences distributed throughout the planet enabled participants to exchange and participate in myriad activities including artistic, scientific as well as heritage related. A group of researchers and students from the Department of Media at Aalto University participated in Ars Electronica 2020 and created an initial prototype of a Mozilla Hubs-based experience titled *Chronicles of an Art and Science Collaboration* [3]. The results of this experience aim to serve as guidelines and considerations for the design of museum-based immersive experiences in the field digital cultural heritage.

RELATED WORK

Over the past decade, one can witness a noticeable increase in immersive 3D experiences due to the technological capabilities such as virtual reality (VR) devices and platforms that allow creation and experiencing of simulated 3D environments [5, 6, 7, 8, 12]. Without a doubt, we can witness an acceleration in this trend particularly due to COVID-19 era limitations in physical engagement due to regional lockdowns and restrictions on travel. Some of the prominent digital platforms that allow creation of immersive simulated environments include *AltspaceVR*, Mozilla Spoke, and *OpenSimulator* [15]. There are also several noteworthy immersive experiences exploring cultural heritage in detail and some examples of these works are *A journey to the Gulag* [10] and *Interactive diorama: A virtual reality (vr) reconstruction of the anatomy lesson of doctor nicolaes tulp by rembrandt, 1632* [2]. However, many of these experiences and platforms are not always accessible on different types of devices providing the ability to run immersive experiences [13]. In this regard, *Chronicles of an Art and Science* Collaboration was created for Mozilla Hubs thereby adhering to the norms of greater accessibility and was demonstrated at Ars Electronica 2020's Kepler Garden.

DESIGN AND RELEVANCE

The *Chronicles of an Art and Science Collaboration* documented the work done in a collaborative project between artists and scientists dealing with the use of bio-cellulose for art and design purposes. A 3D immersive gallery space includes a 15-minute documentary film depicting the self-reflections of three scientists, elicited using an autoethnographic approach. The narratives are complemented by a photography exhibition documenting works by the scientists, images of their countries of origin as well as related images of art and design works done using bio-cellulose. A catalogue of works is accessible for consultation in the virtual space and visitors are free to navigate within it and interact with others in the space.

Fig.1. A screenshot of the 3D environment in *Chronicles of an Art and Science Collaboration.*

An interactive object place in the exhibition displays a feedback questionnaire used to gauge the following:

- What devices were used by the visitors to enter and experience the simulated environment?
- How was the user experience of the participants and what aspects could be improved?

Visitors could answer these questions anonymously in case they wished to do so. Based on their feedback, our aim was to understand the best approaches for designing accessible immersive experiences on portable VR-headsets within the *SPICE* consortium project [9].

SPICE is an EU-H2020 funded cultural heritage research project that seeks to promote social cohesion, participation and inclusion by developing citizen curation methodologies and tools [9]. One of our main tasks in SPICE is aimed at designing a *Pop-up Museum* experience on portable headsets for Design Museum Helsinki. The Pop-up Museum is envisioned for the translation of Design Museum Helsinki's collections and narratives into a virtual space experienced by the end-user communities of SPICE EU-H2020 project. These end-user communities include senior citizens, rural dwellers, and asylum seekers. Due to its accessibility and convenience, Mozilla Hubs is strongly taken into consideration as the platform for designing the experience of the Pop-up museum.

RESULTS

The initial results based on survey participants' responses to *Chronicles of an Art and Science Collaboration* showed that most of the visitors accessed the experience through their desktop-based devices rather than phones or VR headsets. It also indicated that most of the visitors were satisfied with the contents of experience and fascinated by the technology that enables accessible virtual exhibitions.

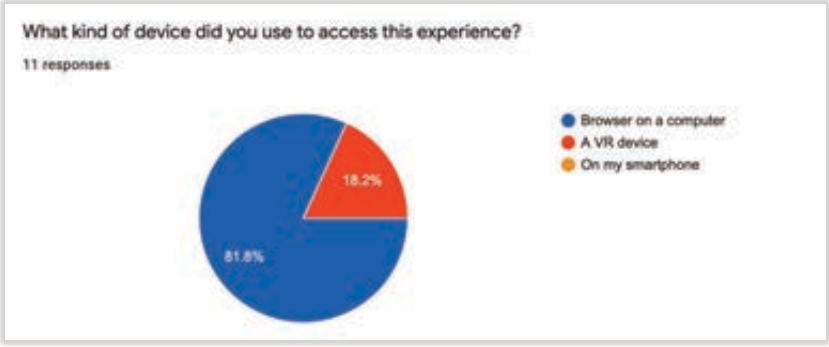

Fig.2. Devices used by the participants to access the experience.

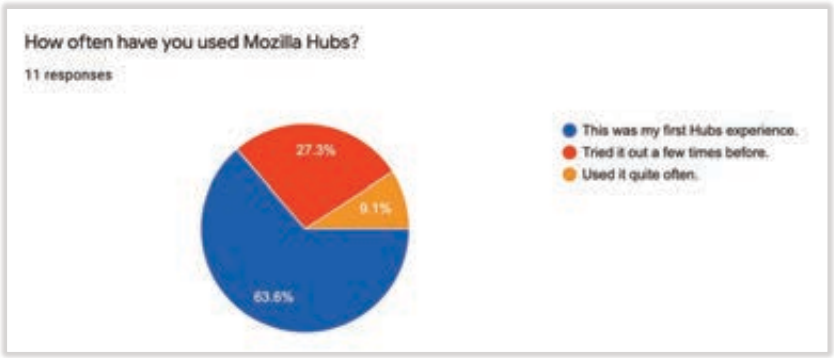

Fig.3. Most of the participants were using Mozilla Hubs for the first time.

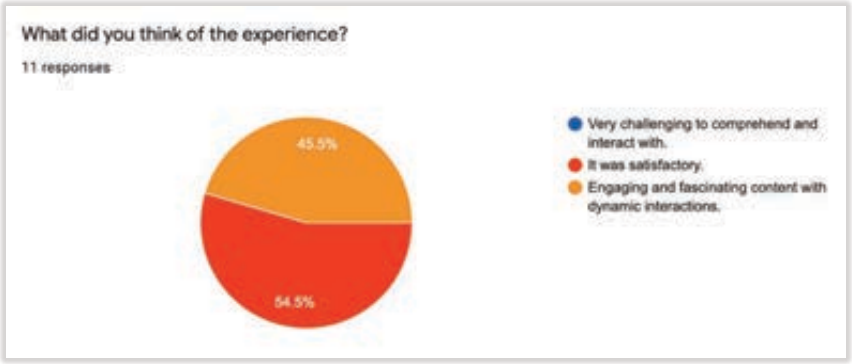

Fig.4. Most participants found the experience to be satisfactory and a significant minority declared that the content in it was engaging and fascinating involving dynamic interactions.

Participants also provided comments and suggestions in the questionnaire and some of the drawbacks include navigation in the space for newcomers who are not accustomed to traditional first-person controls. Other suggestions included shortening the video, creating a more immersive environment through audio, and improving the perspective of the 3D environment. These suggestions would be strongly considered and are slated to be improved in the design of the Pop-up Museum through user-friendly mechanisms for navigation and interaction.

LIMITATIONS

Key challenges remain within Mozilla Hubs, such as managing the framerate to run on low-end devices with a limited polygon count, images and textures, videos and other environment-based assets. This could pose a threat to adding some high-poly 3D cultural heritage artefacts. Another point to note is that the controls used to navigate inside a Hubs experience are not always intuitive to newcomers and may require getting used to, especially to those who are not familiar to first-person digital games, which may include many of the end-user community groups in the project. These challenges need to be tackled creatively through minimal and

focused design along with spacious environments wherein the navigation is assisted through waypoints.

The survey is ongoing, therefore the small sample size but focused enough to understand the direction of the design and experience. Further user testing is required through the course of development. When carried out periodically and iterated based on it, it would likely strengthen the design of *Chronicles of an Art and Science Collaboration* from the purview of user-experience.

CONCLUSION

In conclusion, Mozilla Hubs might open several possibilities and offers a tremendous potential for designing accessible interactive virtual exhibitions in cultural heritage. However, working with this technology requires a pragmatic approach involving recognition of the technical limitations and maximizing seamless as well as intuitive user-experiences. If this criterion is met, the platform could be ideal for accessible immersive experiences for museums as well as within digital cultural heritage.

ACKNOWLEDGEMENTS

Many thanks to Professor Orlando Rojas, Juan Duarte Regino (video editing), Luiz Greca (photography), Janika Lehtonen (photography), Emil Lindfors (software development, Mozilla Hubs), and Daina Silina (Ars Electronica 2020).

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DIGITAL CULTURAL MAPPING OF THE LAKE CONSTANCE CULTURAL HERITAGE USING PARTICIPATORY GIS AND STORY-MAPS

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The Lake Constance region is one of the oldest cultural landscapes in Europe. It is considered a popular leisure and tourism destination with which a diverse cultural and natural landscape is associated. Situated on three national borders in the center of Europe, the Lake Constance region is characterized by its spatial structural and cultural diversity. The region's diverse cultural heritage and wide range of cultural offerings attract residents and tourists alike and represent an important location factor for other stakeholders such as regionally based companies, cultural institutions or regional planning and tourism and city marketing. Despite the region's strong transnational cooperation, restrictions imposed by the Corona Crisis in the last year showed that national borders still strongly influence cultural perceptions. The project Cultural Mapping 4.0 tries to map these differing perceptions on culture by digitizing cultural mapping using participatory GIS and by visualizing regional cultural heritage using story-maps, an innovative geodata-based form of storytelling.

According to Duxbury et al. (2015), cultural mapping is a method that uses different techniques to capture not only cultural resources but also local histories, memories and rituals, among other things, and is used in the fields of urban planning, sustainable cultural development and community development. The digitization boost sparked by the Covid-19 crisis offers new opportunities for the capture, collection, analysis and dissemination of such data, most of which has a spatial dimension. Geoweb platforms such as Open Street Map make data available free of charge and even laypeople can easily publish their local knowledge in the form of photos, texts or audio files tagged with geotags. Furthermore, mashups, i.e. the combination of data and functions, can be implemented relatively easily through "application programming interfaces" (APIs) on geoweb platforms.

With our research, we propose "participatory cultural mapping" as a novel digital strategy of maintaining relationships with key stakeholders in regional cultural development. In addition to reviewing the state of research on the still young field of cultural mapping, the aim of this paper is to fuse conventional cultural mapping with digital participatory mapping and story-maps (Brown et al. 2018, Kerski 2019). As a central contribution, our paper will feature a practical guide for the preparation and implementation of geoinformatics-based cultural mappings as a novel and timely way to visualize cultural resources and heritage for regional cultural (tourism) planning and development.

The paper first offers a comprehensive literature review of the relevant contributing areas in cultural management, cultural and tourism development, and geographic information science. Second, the paper proposes the combination of economic and social science methods with new participatory data capture procedures, and geoinformatics and geo-visualization approaches. The article thus provides an introductory classification of the research field of cultural mapping and explains the benefits, challenges and opportunities using practical examples of application based on the case study for the Lake Constance region, spanning the border triangle between Germany, Switzerland and Austria. Our literature research and the exemplary application of the outlined GIS methods will show that, compared to traditionally collected spatial data, more detailed contextual information can be provided and changes can be depicted very promptly or even in real time.

Properly applied (digital) cultural mapping does identify, generate, distribute, visualize and preserve cultural resources and heritage and thereby strengthen communities, foster regional cultural identity, strengthen resilience and contribute to collective solutions which can be used in cross-border cultural development.

This project is financed by the International Association of Lake Constance Universities.

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RESTORE: SMART ACCESS TO DIGITAL HERITAGE AND MEMORY

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Abstract: RESTORE is a project coordinated by the OVI-CNR Institute and co-funded by the Regione Toscana that focuses on the recovery, integration, accessibility and reuse of digital resources, provided by GLAMs (Galleries, Libraries, Archives, Museums) and Research Institutes. Materials are collected, mapped and stored for access and reuse, according to the CIDOC-crm ontology. RESTORE will release a digital platform for mapping, integration and reuse of heterogeneous datasets provided by the project partners. This paper provides an overview of the project goals with a focus on the development of a toolkit for heterogeneous data management - from ingestion to publication through processing - to be reused in other similar contexts.

1. INTRODUCTION - General premises

RESTORE (smaRt accESs TO digital heRitage and mEmory, 2020-2022), <http://restore.ovi.cnr.it/index.html> is a 2-years-project coordinated by the Istituto Opera del Vocabolario Italiano (Consiglio Nazionale delle Ricerche) and co-funded by Regione Toscana, aimed at the recovery, integration, accessibility and reuse of datasets produced by past digitisation activities of archival, catalographic, and textual resources. The project consortium includes Research Centers (CNR-OVI), GLAMs institutions and offices playing a key role in the preservation of the city's cultural history (Archivio di Stato di Prato, Museo di Palazzo Pretorio, Soprintendenza Archivistica e Bibliografica della Toscana) and local SMIs (SPACE SpA), providing technological support. The digital resources provided by the partners - documenting the legacy of a prominent figure of the financial and cultural prosperity of Prato at its height, the famous merchant Francesco di Marco Datini (1335-1410) - will be collected, mapped and modeled according to the RESTORE reference ontology (CIDOC-crm) and eventually published as Linked Open Data. The RESTORE knowledge base - providing both advanced digital tools and original editorial contents - will be made accessible to citizens, researchers, and cultural heritage professionals interested in exploring the history of the city of Prato and its institutions, the development of its economic and entrepreneurial system, the role of women in the development of the city welfare network.
The RESTORE project is participating as a pilot case in other european infrastructural development projects, such as SSHOC [1], and IPERION-HS [2] and in the EOSC [3] implementation. A first working release of the platform is planned for September 2021.

2 - MATERIALS AND METHODS. THE RESTORE KNOWLEDGE BASE

2.1 - Materials

The RESTORE project consists in the realization of a multiservice digital infrastructure, capable of merging heterogeneous data coming from different sources, including historical

and lexicographical resources, archival records, as well as datasets and digital objects produced by heritage scientists working in the fields of cultural artifacts conservation and restoration using different tools and techniques.

Currently the project is focusing on resources (data and metadata) provided by research and memory institutions, described below. During the second year of the project other datasets - including resources provided by the Museo di Palazzo Pretorio and other Heritage Science datasets - will be integrated.

Here follows a brief description of the resources provided so far:
a) Archival descriptions from the Archivio di Stato di Prato, related to the "Datini" and the "Ospedale della Misericordia e Dolce" fonds, preserved by the institution. They consist of XML files based on the EAD (Encoded Archival Description) and EAC-CPF (Encoded Archival Context-Corporate Bodies, Persons and Families) standards;
b) Descriptive records provided by the Museo di Palazzo Pretorio, related to Datini's commissions and to the aforementioned "Ospedale della Misericordia e Dolce", based on the ICCD standard (Italian Central Institute for Cataloguing and Documentation) for the description and cataloguing of the works of art, exported in XML format. Together with images (jpgs) of the Museum's collections. A small nucleus of materials is composed of historical catalogues only partly available in digital format (as pdfs).
c) A corpus of lemmatised texts concerning Datini's correspondence, provided by the Istituto Opera del Vocabolario Italiano, consisting of TEI (Text Encoding Initiative) encoded texts with data on various lexical items (22 categories) including anthroponyms and toponyms.

Figure 1. The project's webpage

2.2 - Methods

At the current stage the project is focused on the mapping and conversion of the partners' resources to the RESTORE reference ontology (CIDOC-crm). To achieve this, a workflow that comprises different steps - from data ingestion and storage (in the CKAN datastore), down to the actual data mapping and ontology population with information coming from SSH and Heritage Science (in the Virtuoso triplestore) - has been developed (cfr. Figure 2, below).

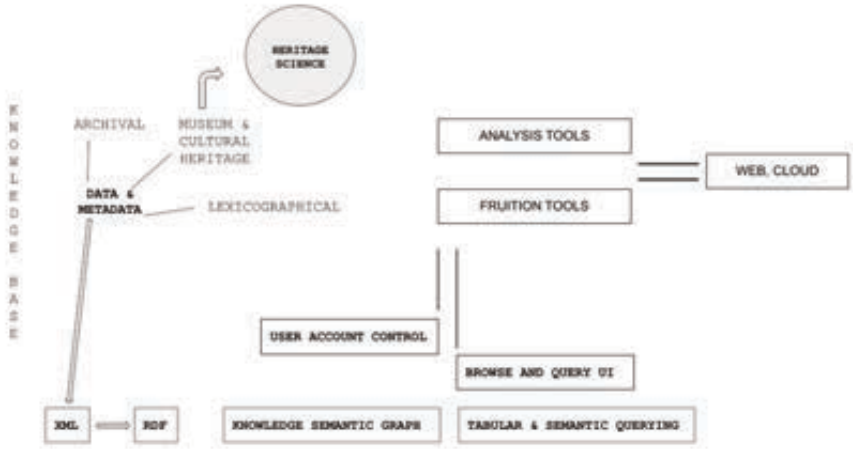

Figure 2. The project's workflow: prospect

The workflow developed by the OVI-CNR team focused on the normalization and semantization of the partners' datasets, to reach a high level of integration: the selected digital resources were uploaded, organized and described in CKAN, then mapped to the CIDOC-crm ontology, using free and open access tools such as KARMA, X3ML and others (cfr. Table 1, below) to map the entities used in different disciplinary standards (EAD, EAC-cfp, ICCD, TEI) to the CIDOC classes and properties.

step #	step description	candidate tool(s)	standard(s)
1. data ingestion	collection of the partners' data, upload to the datastore, basic metadata editing.	CKAN [4]	-
1.1 archival data authoring tools	tools used by the partner ASPO to describe archival resources in digital format.	XDAMS [5]	EAD [6] EAC [7]
1.2 cultural heritage data authoring tools	tools used by the partner MPP to describe cultural heritage artifacts in digital format.	TOLOMEO [8]	ICCD [9]
1.3 lexicographical/textual data authoring tools	tools used by the partner OVI to encode digital lexicographical resources.	GATTO [10]	TEI [11], custom tags

2. data modeling/integration	partners' data mapping, normalization and transformation to CIDOC-CRM[12].	KARMA [13], X3ML [14]	-
3. data dissemination	endpoint(s) for data access, including machines (interfaces, services etc.) and human agents.	VIRTUOSO [15]	SQL [16], SPARQL [17]

Table 1. The project's workflow: tools

3 - DATA DISSEMINATION

The resulting LOD will be made accessible through a Virtuoso endpoint, allowing semantic queries on RDF data through SPARQL. Furthermore a set of user-friendly interfaces for data search, browse and visualization will be implemented, allowing users to perform both traditional queries and conceptual navigation in the RESTORE knowledge graph. The UI, designed by CNR-OVI, will be implemented with the support of the SME partner (SPACE S.p.A.) and validated from a focus group of domain experts on the basis of a protocol validated by the Italian Ministry for Public Affairs called *eGlu* (2018) [18].

4 - FUTURE IMPROVEMENTS

The final release of the RESTORE platform will integrate the actual knowledge base (i.e.: GLAMs data) with information coming from the Heritage Science domain, produced by different types of instruments and platforms (e.g.: the E-RIHS MOLAB [19] platform) with analytical techniques used in conservation labs and institutes (RX, XRF IMAGING, Infrared thermography, XRD - data in the XRDML format-, multispectral information in the ICCD-based format, colorimetry, photographs, radiographs, 3D models, multispectral and OCT - RAW, TIFF -, Raman spectra, and so on). In order to accomplish this goal, the current platform will be interoperable with other tools used for online visualization and data analysis, such as *MOVIDA* (MObile laboratory VIsualization DAta [20]) developed by the ISPC-CNR [21].

ACKNOWLEDGEMENTS

RESTORE (2020) is co-funded by Regione Toscana (POR FESR 2014-2020). The development of the RESTORE digital platform will be aligned with the *Social Sciences and Humanities Open Cloud* - SSHOC project (EU grant n. 823782), the reference ESFRI Social and Cultural Innovation thematic cluster for the EOSC, and the *Integrated Platform for the European Research Infrastructure ON Heritage Science* - IPERION-HS project (EU grant n. 871034).

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AN UNEXPECTED ABSENCE: THE SCARCE PRESENCE OF DIGITAL ART ON THE WEBSITES OF CONTEMPORARY ART MUSEUMS

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Over the past few decades, contemporary art museums have considerably invested in digitising their collections and making them available to broader audiences. At the same time, the crossovers between art and digital technologies have become a key theme in contemporary culture, inspiring multiple exhibitions, festivals, conferences and publications [1]. In different geographies, the increasing relevance of media art has even led to the creation of museums, galleries and cultural centres specifically focused on these new artistic practices.

Nevertheless, there seems to be a gap between the public interest for digital technologies and the institutional integration of artistic and curatorial practices based on such media. In fact, two distinct speeds tend to coexist within the museum sector: one, faster, which is characterised by the wide presence of museums on the Internet (through their own websites, social media and common platforms such as Wikipedia, Europeana or Google Arts & Culture) and another, slower, marked by the scarce representation of digital art in the museum collections. Moreover, the digitisation of traditional formats tends to be privileged in detriment of the acquisition of born-digital artworks and the websites of many contemporary art museums afford very little, if any, visibility to net art [2]. More often than not, digital art is relegated to specific curatorial projects or specialised art centres, rather than incorporated in the collections of contemporary art museums. However, this segregation becomes increasingly questionable because, as Claire Bishop pointed out: "Contemporary art, perhaps more than any other art form, is entirely embroiled in digital technology: it permeates the production of work, its consumption and circulation." [3].

This dual reality is quite evident in Portugal where, although the most important museums of contemporary art have significantly reinforced their online presence, digital art is still scarcely visible on the institutions' platforms. Based on a critical analysis of institutional websites, this paper compares five leading Portuguese museums of contemporary art (National Museum of Contemporary Art – Chiado Museum; Calouste

Gulbenkian Museum; Serralves Museum of Contemporary Art; Berardo Museum and MAAT - Museum of Art, Architecture and Technology). Through the observation of these five examples the paper investigates and discusses the possible reasons behind the lack of references to digital and net art on the museum's websites. Is such invisibility a mere reflection of the underrepresentation of these recent artistic practices in the museums' programmes and collections? And, more importantly, what can be the consequences of this absence for the future of contemporary art collections?

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ACCESS
TO THE CULTURE INFORMATION

UNCHARTED - UNDERSTANDING, CAPTURING AND FOSTERING THE SOCIETAL VALUE OF CULTURE

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Abstract - UNCHARTED is a Research and Innovation Action funded by the European Commission under the topic "The societal value of culture and the impact of cultural policies in Europe" of Horizon 2020 Programme. The project is led by the University of Barcelona with the participation of partners from seven European countries, representing eight academies and one professional company that supports communication, dissemination and exploitation planning. Society, culture and economy became intertwined in a complexity of values and roles. UNCHARTED project aims to explore the social values associated with culture, focusing on the valuation practices of the actors involved in cultural life.

INTRODUCTION

Three areas are targeted in the research: cultural participation, cultural production and cultural administration. In each field, various actors participate in the creation of the value dynamics: citizenship is the protagonist in experimenting and implementing participatory approaches, the professionals of creation and preservation are the ones who take the initiative in the heritage domain, experts and politicians decide about cultural administration.

Considering the participation of these actors in the mentioned areas, a range of factors determine the development of policy lines in the European sphere, demonstrating often tensions among the values that the different actors represent, with a need to gain a better awareness of the rationale and of the implications of these processes. For this scope, the UNCHARTED project takes the three areas of cultural participation, cultural production and cultural administration and the basic typology of the involved actors as the starting point to structure its research.

The factors studied in UNCHARTED can be grouped as it follows:

1. Gender equality in European societies matters
2. Urban development and the social processes of gentrification, touristification and segregation have consequences on urban heritage preservation and on the society at large
3. Globalisation and digitalisation have a strong influence on choosing future directions for cultural valuing
4. Neoliberalism affects the cultural policy regimes of the thirty European Countries (the EU 27, plus Switzerland, Norway and the United Kingdom)
5. Historical and political experience in the last 20 years plays a relevant role in shaping cultural values in Europe today

Along these factors, the project is working towards four main objectives. The first objective is to examine how the values of culture are shaped in Europe. The second objective is to identify the plurality of values that emerge in cultural practices, including economic, public and personal dimensions. The third objective is to understand the tensions relating to how the different actors in the cultural field construct, measure, compare and rank the values they attribute to culture. The fourth objective is to assess the strategies and effectiveness of cultural policy.

The project has a four years duration and completed its first year of work in January 2021. This paper aims to illustrate the review conducted during the first year, looking at research literature and existing data. The resulted analysis synthetises, in a global view, the circumstances that are producing the emergence of values of culture in Europe, reflecting on the configuration of a value order and on the political impulse that these values can generate.

On the basis of this review, the first policy brief has been delivered. This policy brief is part of a series of three documents that the project aims to offer as 'food for thought' to policy makers who have a stake in formulating or influencing policies about valuing culture in all its forms.

The capacity of the project to exploit its outcomes and to deliver its impact depends on the results of the project being available to the widest audiences. UNCHARTED targets the whole value-chain of the cultural sector, from the academic research to the widest civic society. The audiences therefore include public and private funding bodies and programme owners, research infrastructures, cultural and creative enterprises, memory institutions, artists, researchers, education sector, practitioners and amateurs. Representatives of these interest groups are invited to participate in the UNCHARTED network of common interest.

The UNCHARTED portal [1] is the main entry point to the information and services developed by the project. Multiple outputs are provided through the portal: evidence-based policy reports and recommendations for the use of policy makers, a wide range of practical resources made available to researchers, guidelines and examples of good practices for communities engaged with production, management and use of culture.

Mechanisms to target the public are put in place to increase the awareness of citizens, young people, students, artists, practitioners about the new opportunities available through culture and to encourage them to engage in new cultural experiences.

The private sector is targeted, too. In particular, the results of the research are of interest to small and medium enterprises working in the digital economy, especially those at the forefront of innovation in software development, web design, serious gaming and the creative industry overall.

Keeping stakeholders and potential users constantly informed will be useful to create a leaving network, which is eventually instrumental also to prepare the exploitation of the results at the end of the EC-funding period. In this light, one important outcome is the plan for a major public event, to be held after the conclusion of the project. Such planning will be the occasion to reflect on the most effective ways to advocate the adoption of the UNCHARTED recommendations by policy makers, to continue the research and to promote the UNCHARTED results beyond the academic sector.

Shift in the values of culture

A shift in the values of culture is occurring today in Europe. Along the five groups of factors indicated in the Introduction, in the previous section, the project is exploring the following challenges.

The growth of the role of diversity and gender equity in determining cultural values. Short- and long-term socio historical factors and social movements transformed the values of culture, with new positive values emerging in the society. These values became part of the institutionalized culture - including cultural administrations and cultural policies – as well as of the citizen culture. Tolerance and respect towards ethnic, cultural, linguistic, religious and sexual orientation differences have grown. Furthermore, the trend towards increased diversity of artistic and cultural contents and repertoires from different origins and their legitimization in consecrated spaces (such as museums, festivals, biennials, etc.) contributes to valuing culture, representing different existing diversity profiles in Europe.

The processes of urban regeneration is permeable to neoliberal logics and characterized by gentrification phenomena. Cities are becoming a "brand", involved in powerful marketing campaigns, in search for authenticity, but at the same time prey to standardizing concepts and commercial strategies. Houses, factories and traditional markets are rehabilitated and transformed into artistic residences and cultural centres. Consequently, public space is privatised and the former popular residents and workers are expelled from these places. Finally yet importantly, urban spaces are major hubs of human mobility, including migrations and growing tourism. They are multicultural places, where heritage, cultural industries and multi-ethnic neighbourhoods are economic assets of the tourism industry, while this trend is creating also socio-spatial segregation, as much as overtourism.

Globalization influences the configuration of the values of culture. Multiple and sometimes contradictory conceptions of cultural globalization exist. Does internationalisation – and the values it carries - imply homogenization of culture, hybridization, or even rejection through effects of cultural resistance?

The development of the internet during the 1990's, as a global access to information, gave new shapes to cultural globalisation. Digitisation increased the complexity of the values of culture, in particular relating to cultural administration, production and participation. Digitization of culture is perceived as offering new opportunities to take part in cultural expressions. Within the digital sphere, access is considered as a tool for inclusion, cultural democracy and democratization. Participation and engagement might lead to empowerment and identification at community level. On the contrary, from the angle of the cultural producers, the overall stance of digitisation risks to become more negative than positive: after an initial, mainly positive, attitude towards the early phases of digitization, the effects of technological development, moving towards robotization and AI, raised critical voices within the field of culture.

A broad correlation between the centrality of market-based logics in cultural policy and the importance of civic and politico-economic cultural values is recognised. The deployment of civic values increases with greater cultural participation, but it declines with increased expenditure on culture as a percentage of total government spending, and this impacts also the effects of Europe's subsidies to cultural fields. A challenging comparative analysis of cultural policy regimes in the European countries indicates that existing cultural policy typologies do not reflect either the hybridised nature of government intervention or the universal dissemination of market-based logics in the contemporary European cultural field. For Western European countries, the justification for state support of culture has moved from elitist conceptions of art's intrinsic value to a marketed regime of justification, which legitimatises state expenditure in the cultural field. Post-Communist Eastern European countries have also arrived at similar marketed justifications. Moreover, the European Union is explicit in promoting instrumental rationales for cultural expenditure across its member states.

Through a thorough analysis of a wide range of resources - scientific articles, books and research reports, press articles – numerous values emerge in the history of cultural policies in Europe.

Reflecting on this literature, shows that values already present in the 20th century are becoming increasingly important in cultural policies, without taking precedence over values with which they can compete or, on the contrary, find a form of compatibility.

Policy implications

Understanding how cultural values are constructed in European societies today is very important for the development of effective cultural policies. The notion of cultural heritage is more and more complex, moving from conservation oriented approaches (objects) to subject oriented ones (values). Furthermore, the number of heritage sites is growing and, at the same time, due to new concepts of cultural heritage preservation (intangible heritage, cultural diversity, sustainability, resilience), the range of values to be preserved is expanding as well. In this situation, the role of local communities and participatory approaches can help to avoid undesirable outcomes, such as gentrification.

Heritage can not only act as an enabler on transformation of cultural spheres but it is gaining an increasingly important position in contemporary political and professional discourse on urban development and on urban configurations. These processes are accelerated by the diffusion of globalisation and digitisation of culture, which is producing often-contradictory reactions by different actors, including cultural heritage institutions, cultural producers, researchers, students and the citizens.

The research in UNCHARTED highlighted four key aspects that have policy implications in the construction and definition of cultural values in Europe and the tensions that are implied:

i. Intrinsic values vs. extrinsic values
ii. Economic orientation vs. social orientation
iii. Homogenisation vs. cultural diversity
iv. Impositions (top down) vs. resistances (bottom up)

With regard to the first point, it should be noted that the intrinsic values of culture, linked to the autonomy and independence of art, are losing centrality in favour of extrinsic values, linked to the instrumentalisation and use of art and culture for other economic and social purposes. This creates new opportunities for experimenting participatory approaches, but it implies also new roles and new competences that need to be developed in the cultural heritage sector. The experience of the pandemic has accelerated the reflection on this theme, in particular with regard to the role played by the digital experiences during the COVID-19 crisis where digital technologies proved to be a very valuable means to access cultural assets during the extended period of confinement.

The instrumentalisation of culture opens up a set of tensions between its social and economic purpose, which is reflected in the orientations of cultural policies and appears at the centre of disputes in the urban sphere and in the relationship between urban and rural territories. Understanding the key drivers of increasing territorial inequalities become fundamental to identify the policy factors, at different governance levels, that can determine more sustainable and successful interventions for tackling urban and rural decline. Also in these cases, the digital services play an important role and the development of wider and more equal access to the digital infrastructures become very relevant.

The emergence of a global culture, accentuated by digitalisation and the concentration of major cultural industries, is leading to the appearance of standardised cultural products. However, on the other hand, cultural diversity is legitimated in the field of specialised culture and cultural administrations. Authenticity of the cultural experiences, for local citizens and in the ambit of cultural tourism is a key factor in the development of innovative cultural policies.

The plurality of values in different cultural contexts often generates tension and conflict among the representations of their respective relevant values. These tensions reflect unequal structures between the social agents that participate in different cultural environments: actors with an interest in the status quo and actors with an interest in subverting the reference values. The development of European cultural policies, at local, national and trans-national levels should be based on a solid awareness of the implications coming from the transformations that are occurring in the contemporary society and those deriving from the trends and tensions discussed in this paper.

Research plan

The research focuses, in the first place, on the inquiry on the values of culture, by assessing and evaluating the practice of cultural actors and by starting from a basic structure of actors and their typical environments for action. The work addresses two areas of analysis: the social and historical factors of configuration of cultural values and the cultural policy strategies. Two basic objectives are identified: the elaboration of a general vision of the societal value of culture, and the elaboration of a road map for cultural policy action favourable to the plurality of cultural values.

The research design is complex and eclectic, for the variety and ambition of its objectives, as well as cognitive and practical, with an exploratory character, working on an almost uncharted terrain. A wide range of research techniques are used, mainly qualitative (interviews, focus groups, observation, documentary analysis, etc.), although statistical information bases are exploited and survey quantitative data are used when appropriate. For the rest, the research work has an eminent comparative character throughout its development, and an important participatory component of co-creation with stakeholders.

As a whole, the design of the research acquires methodological consistency through the structuring of the project in workpackages, as illustrated below:

- Workpackage 1 ‘Understanding the societal value of culture’ is devoted to the analysis of the configuration of the values of culture, through an in depth literature analysis
- Workpackage 2 ‘Identifying the emergence of values of culture’ analyses the emergence of values linked to culture in practical contexts, via a set of case studies
- Work package 3 ‘Measuring and imagining’ works on valuation and evaluation practices of social actors within cultural information systems
- Work package 4 ‘Analysing Political Intervention and Impact’ focuses on the comparative analysis of public intervention in culture

Workpackage 5 ‘Experimental demonstrations’ organises a number of hand-on activities, covering live arts, media, cultural production and heritage management, and cultural administration, with a space where citizens, professionals, administrator and policy makers can participate.

Networking and exploitation

The project brings together several communities to consider the complex relationship between research, practice and governance. Because of the nature of the project, networking with communities and exploitation of results is particularly important and it represents the necessary liaison between the two components of the Horizon 2020 project that is in fact a research and innovation action.

While the core of the research part is on the investigation described in the previous sections, the innovation part is implemented through the communication, dissemination and exploitation activities that include networking, online activities and exploitation planning.

Collaborations are established with other projects and initiatives, aiming at establishing a living network of common interest to share good practices, lessons learnt and success stories. The project's online presence is used to share information and results with the widest audience by the UNCHARTED portal, the blog and the social media channels. A solid plan for the exploitation of the project's outcomes is developed to foresee the continuation of UNCHARTED beyond the end of the EU funding period.

Main aim of the dissemination and exploitation activity is to engage stakeholders and users outside the project's consortium, to keep them informed and updated about the project's activities, to illustrate the results and eventually to maximise the project's impact by promoting and delivering its outputs to the widest range of audiences. This is achieved with specific mechanisms aiming, on one hand, to inform the project's audiences and, on the other hand, to seek their feedback and action.

The target audiences of UNCHARTED, in their various forms and channels, belong to the whole value chain of the research on culture and cultural heritage, including academies, scholars, cultural heritage curators, creative industry and interested citizens, belonging to associations, interest groups and the civic society in general. A number of organisations, projects and researchers have been contacted during the first year to present the project and to encourage collaborations. These collaborations are promoted on the project's website and on the blog, as terms of reference for new associate partners. Altogether, the organisations and the projects linked with UNCHARTED constitute its network. The promotion of UNCHARTED is carried out both on the UNCHARTED channels and on the channels of the organisations and projects that joined the UNCHARTED network.

Exploitation is the final purpose of the efforts spent in communication and dissemination. It is through fostering the interaction with targeted communities and through the actual exploitation planning that the UNCHARTED project aims to trigger the use and re-use of the project's results as much as possible, on a long-term perspective of research and innovation.

The contacts with organisations and projects that have an interest are very important to be established and to be kept alive by following up the initial contacts with customised communication actions. In addition to online bilateral contacts, both physical and digital encounters are at the basis of the networking activities. Unfortunately, due to the Covid-19 pandemic, all physical events planned for last period have been cancelled and this was a rather difficult issue to overcome. Online meeting have been attended by the consortium and new plans are made for the next year in view of a better situation.

Partners have already agreed and expressed their commitment to organize a large public event after the end of the EU funding period, to present and promote UNCHARTED recommendations to policy makers, and to disseminate the results of the UNCHARTED research both within and outside the academic sector. The event planning is a core component of the exploitation plan.

During the next periods of the project, being confident that the COVID-19 crisis will be over soon, a program of public events is already planned. The programme includes two workshops: the first one will take place in Porto in September 2021, focusing on the results of the project's case studies. The second workshop is planned to be held in Barcelona by mid-2023. The participation in the workshops is focused on scholars and researchers from the consortium, and other relevant organisations, to review the progresses of the investigation.

Another important element of the programme of the UNCHARTED events is the so-called 'central event' that is planned to be organised in London at the beginning of 2023. It is foreseen a large participation of key stakeholders in the research and cultural sectors. The event is the occasion to carry out a discussion about consistency, accuracy and scope of the research, involving

representatives of cultural information institutions, cultural administrators and other cultural professionals.

The creation of liaisons with policy makers aims to consolidate the relationships with interlocutors in the public administrations at various levels, with a focus on the European level. A policy seminar is foreseen in Brussels by the end of 2023, towards the conclusion of the project. The seminar will be the occasion to share lessons learned and good practices with policy makers. The seminar will target European, national and local policy makers, together with representatives of international organizations and Commission officials.

Results from other completed and current projects are promoted through the UNCHARTED stakeholders group, crossing social, economic, cultural, national and disciplinary boundaries. Special attention is devoted to connect UNCHARTED with existing projects and network, including those supported by the EC's programmes (Horizon 2020 and Creative Europe in particular).

Project's online presence

The project is promoted online, on its website, on the blog and through the social media channels.

The website is both the cornerstone of the project dissemination strategy and the access point to the main outcomes. Furthermore, it serves as an internal collaborative space for the project's partners via the implementation of a reserved area. The landing page of the website is the access point from which all further navigation begins. The implementation is based on a very simple logic and a fresh web design, which is intended to drive the user's attention on the main function of the portal, namely: (i) the project, its research areas and outcomes, (ii) the link to the reserved area that serves as an internal collaborative space for the project's partners; (iii) the news area that provides a preview of the articles published in the blog.

The project blog is hosted on digitalmeetsculture.net, the interactive online magazine of Promoter S.r.l. dedicated to the theme of digital technologies applied to cultural heritage and the arts. The UNCHATED blog promotes, of course, events and outputs produced in the framework of the project's activity, but also information regarding other projects and organizations that joined the UNCHARTED network and activities and initiatives of external parties, when the peculiarity of their themes and objectives raise a specific interest for the project.

The portal and the blog are linked to the most popular social networks. This facilitates the spread of information from the project to its target audiences. The outcomes of the project are made available on the portal and promoted in the articles published on the UNCHARTED blog, which are then rebounded on UNCHARTED's Facebook and Twitter page, opening the possibility to all partners and networked organisations to share/re-tweet and add comments to them.

Conclusions

The investigation conducted during the first year highlighted a range of tensions that exist with regard to several aspects of the values of culture, and in particular in relation to their implications at social and economic levels. A range of basic tensions exist between the cultural sector and the other sectors of the society, which are reflected on the evolution of intrinsic values – such as those connected with aesthetics and cultural production – and the development of more general extrinsic values. This is the case for example of the relevance that economic values have taken on other values in the latest years.

A plurality of factors are emerging from the research, demonstrating the need to combine different values and to contrast the risk of applying unidimensional foci. However, the initial results after the first year of the project do not yet allow deducting general normative perspectives. Nevertheless, a wider recommendation is proposed to policy makers, that is to play attention to problems and contradictions that can be provoked by not-resolved tensions.

Further research will be conducted in the coming period by the project in the context of specific case studies that are currently under development. This is expected to offer a better identification of the processes that bring to the emergence of values of culture from which more deductions will come. In particular, the next priorities of the research will focus on the understanding of the emergence and plurality of values linked with cultural participation in live arts, media, cultural production, cultural administration and heritage management, identifying tensions, conflicts and public controversies in these domains. The behaviours of different actors will be studied in the cultural field, to explore how citizens, professionals and public administrators construct, measure, compare and rank the values they attribute to culture. Strategies and the effectiveness of cultural policy and institutions interventions will be assessed in practical terms, to understand how they are taking full advantage of the potential benefits of culture for society, including in the digital sphere. These analysis and investigation will be demonstrated in a range of experimental actions that will be the occasion to engage in open discussions with the UNCHARTED community.

The core range of policy recommendations are distilled in three policy briefs that represent, in parallel with the research results, the main exploitable outcome of the project. A first policy brief was produced at the beginning of 2021 [3]. The second and the third policy briefs are expected respectively by summer 2023 and beginning of 2024 to recapitulate evidences gathered via observations and consultation, and recommendations distilled from the analysis and investigation carried out in case studies, in road mapping exercise and through experimental demonstrations.

ACKNOWLEDGEMENT

The Authors would like to express their gratitude to all the partners participating in the UNCHARTED consortium and in particular, to Prof. Arturo Rodríguez Morató of the University of Barcelona who coordinates the project with outstanding leadership capacity.

Special thanks go to the European Commission for the funding granted to the project and the support in the promotion of its results on the CORDIS portal with a dedicated webpage [4].

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Innovation through Tradition enables Radical Innovation. Priorities and Prospects for Dante's homeland.

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Abstract – All communities have become aware of the need to research and define a new paradigm. Eva Network is a community of scientists and researchers who express skills in various disciplinary fields and devote commitment and attention to the representation of complex problems.
Eva Network can play a central role in this process. This is due to the fact that a community must share the same vision in order to undertake a path of radical innovation that realizes over time.
Flagship projects can be developed in Tuscany, with a real benefit for the local communities and great global impact.

INTRODUCTION. How difficult times could become opportunities.

The realization of projects characterized by social impact is based on a common will to undertake a path of radical innovation. Each process of this kind is carried out starting from the widespread awareness and the common intention of seeking a new lifestyle, a new normality.

This process is often associated with uncertainty, typical of any innovation process.

In periods of economic contraction, of social tension, of widespread understanding of the need to search for a new way, it is possible (and necessary) to open up to new ways, evaluating in advance implications, resilience and durability of the new model towards which we tend.

Tuscany played a central role in the history of the Renaissance, a period in which the elaboration that took place in the previous centuries of the Middle Ages reached a flourishing expression. Today, given the much more rapid succession of events and mutations, we live in a similar condition, characterized by a period of contraction, difficulties, elaboration and consolidation of a widespread awareness of having to move towards a deep renewal, a radical innovation.

The protection of existing conditions or simply the fear of moving towards what is not known, lead to hesitating and slowing down a process of change which, on the other hand, can only be successfully addressed if undertaken proactively: the best way to anticipate the future, is to build it. We are all authors of our future.

In this scenario, Tuscany is observed as a place where the conditions exist to start a process of renewal, based on overcoming outdated, perhaps even archaic schematizations, and moving towards new concepts based on the history and morphology of the territories on one hand. and on the quality of life and the processes according to which it can be realized, in a manner consistent with the principles of environmental and integrated sustainability.

This article offers some food for thought, without any indication of a strategic direction to follow, but rather considering the method by which the need for change is interpreted and implemented as decisive.

Being authors of your future. Methodological ideas.

In order to participate in radical change processes, it is certainly necessary to intervene and proceed in order to achieve active participation of the members of the community involved in the change. To this end, it is necessary to:

- Realize cultural innovation and innovation of people's needs;

- Encourage and sustain the presentation of proposals and ideas in which the proponents are committed and directly involved.

This process must be accompanied, observing the possibility of involving authoritative and enabling partners. Similarly, it is necessary to guide the stakeholders' intentions of a complex project on the basis of the opportunities to carry it out. In a schematic way, reference is made here to:

- Qualified partners, who can integrate the skills of local operators;
- Financial engineering, aimed at encouraging the participation of members of the local community;
- Forms of multi-source financing.

In order to proceed in this sense, various constraints must be overcome and among them we mention:

- Overcoming forms of territorial aggregation based only on administrative borders;
- Search for relationships between territories, associated with history and morphological characteristics;
- Identification of points of excellence, active and dormant;
- Identification of existing and potential connections between local attractors and points of excellence in the territory and other similar centres of mass, which are related to them at national and international level.

This vision therefore takes shape in terms of strategic directions that a territory can assume and collaborations and relationships that it must develop in order to realize these purposes in a net of global networks.

On the one hand, this process must take place with the involvement of civil society and members of the territorial community; on the other hand, enhancement plans and ways in which such complex projects can be implemented should be defined.

These purposes are often discussed, usually not in an integrated way but only partially. Obstacles to this way of proceeding are:

- The times in which an administration remains in office;
- The reluctance to activate broad forms of collaboration;
- The limited habit of dealing with complex projects and relating local visions with interdisciplinary cooperation networks, extended at a global level.

These constraints must be overcome and to do so it is crucial to build representation models of complex systems. Such models will be effective if accessible to all, in a different and coherent way with one's cultural profile.

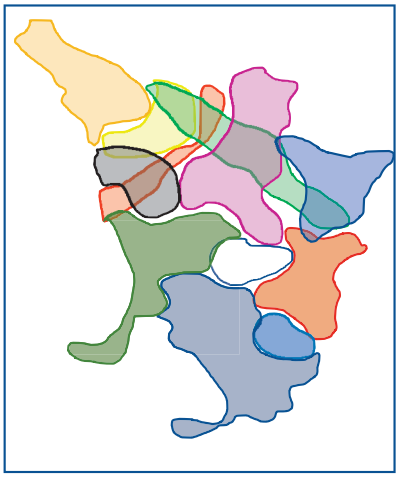
This must be possible because we all live in the same world and we all share resources and means. In an age of complexity. The environment and the use of resources determine our way of acting and are the basis of a new ethics, based on integrated sustainability.

From Urban History to Urban Biography

The analysis of the territory of the Tuscany Region leads to the visualization of different territories. Here below a possible division of the territory into areas is presented, that must be identified on the basis of the narratives that distinguish the local history and morphology. They identify:

- Florence, Chianti and Mugello
- Versilia, Garfagnana and Apuan Alps, Lunigiana;
- Lucca, Prato, Pistoia;
- Pistoia, Florence, Arezzo;
- Pisa;
- Livorno, Empoli, Prato;
- Etruscan Coast and Elba Island;
- Maremma;
- Mount Amiata;

- Chianciano Terme and the surrounding lands;
- Arezzo and Casentino.



Florence and surroundings, with Chianti and Mugello

The attractiveness of urban destination, even those of art, has been affected by the COVID-19 pandemic. A modification of the preferences of tourists and a variation of tourist flows are expected. It is the case of Florence.

This process is associated with a growing attention to the relationship between man and Nature and it identifies the affirmation of a new driver in the tourism industry, which integrates food, wine and culture. It is about well-being, understood as the relationship between the human being and the environment, sport, meditation and inner well-being.

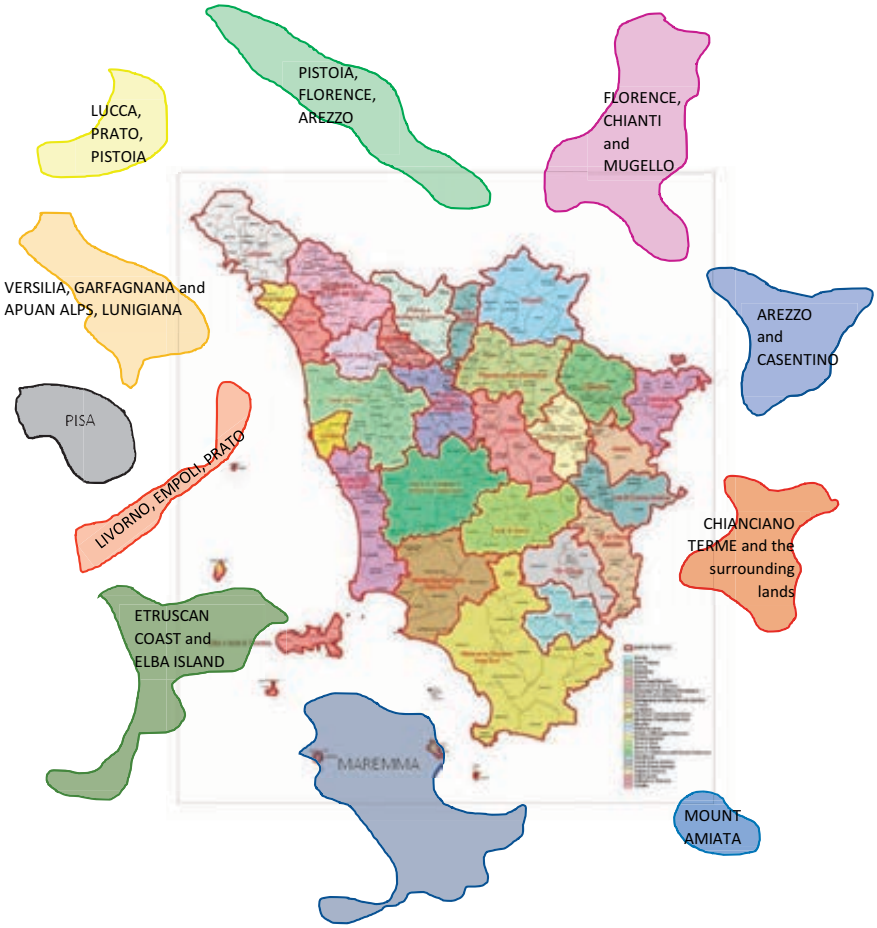
The activation of these services in the areas surrounding Florence can make it possible to enhance the tourist offer of the city, in a manner consistent with the current preferences of visitors (and in many cases also of residents).

This kind of program, which can be easily presented for funding, is based on the creation of a fast connection with Pisa and on the activation of an airport that enables the movement of passengers on a ring outside Florence, limiting the arrival at the Santa Maria Novella station.

This is associated with the design of an infrastructural network that enables radial movements from the periphery to the centre of Florence, using (electric) public transport: reference is made to a ring made up of radial lines that feed flows from smaller peripheral urban areas to Florence downtown. The creation of a second ring-shaped infrastructural line, located on the outskirts of the historic centre, integrates this picture.

The improvement of urban logistics in the metropolitan city opens up space for urban redevelopment and interventions aimed to enhance the areas surrounding the historic centre and the city of Florence. This can be achieved by making use of building concessions (renovation, facades, eco-earthquake bonus, and the next 75% super bonus). The design of these interventions is closely associated with the principles of energy efficiency and decentralized energy generation from renewable sources, moving towards the new paradigm that will be realized with the energy communities. Attention is paid to the importance of an advanced and exemplary energy community project, which activates energy efficiency and builds the relationship between the various areas of the territory, on the basis of a logistic infrastructure capable of supporting energy generation, distribution and final use.

In order to really undertake projects of this magnitude in Florence, the proposition shall be presented in a broad and general way, stimulating interest and activating debate and interest. To present that broad vision, it is important to know the new technologies and the potentialities that are made available by science and that have been tested in different places and territories. On this basis, it is then necessary to give shape to a participative process of design thinking through art and creativity. The vision, its principles and its narrative can be presented and disseminated through visualization and gamification, enabling accessibility to what has been formalized.



Pistoia, Florence, Arezzo

The Renaissance of Italy and the world had a seat in the area that hosts these municipalities. In 2020, a paper was proposed aimed at celebrating and promoting progress towards the activation of a cultural district in Florence, Pistoia and Arezzo.

Following this presentation, interest was stimulated in members of Eva Network in order to encourage the activation of an international work group, motivated and capable of visualizing, present and disseminate the purposes of the cultural and artistic district of our Renaissance.

Properly reviewed, those purposes are still relevant today, to be reiterated here.

Versilia, Plain of the Apuan Alps, Lunigiana

Structuring of an enhancement plan based on the resources of the territory: the Lunigiana wood and the villages, as well as the large buildings that were used in summer for the children of the employees of Northern Italy corporate group, are currently poorly used - or even abandoned. Several actions have been largely discussed and should take place: it is the case of the nourishment of the beaches, the regeneration of internal water flows, the redevelopment of the architectures.

A requalification plan shall be formulated for coast side, from Viareggio to Massa and Carrara, passing across Versilia: the seaside offering and the touristic services, hospitality and restauration, and the whole entertainment industry are foundation of this process. The Marinella Estate has special relevance and it could represent a flagship project. The activation of tourism and training centres has particular importance in this large area.

High relevance has technological innovation in this process, based on a new approach to local excellences and territorial enhancement. The nautical sector plays a relevant role in this framework. It is also true for arts and for the cultural sector: they complete the picture, to be developed by extending and developing Pietrasanta piloting project and the related initiatives, in accordance with principles and guidelines usually indicated by referring to the "Future of Museums".

Lucca, Prato, Pistoia

Pistoia has a strategic role in this territory due to its role. It is the largest plant nursery district in Europe, which extends over an area almost identical to the Silicon Valley.

The integration of the territorial communities living in Lucca, in Prato, and in Pistoia appears highly strategic and the large presence of cooperatives and associations in Pistoia lays the foundations for activating this process with great attention to the third sector.

The industrial centre of Prato is a representative intercultural (and inter-religious) ecosystem: it appears useful to support the enhancement of the third sector, in order to accompany the effective activation of new valid models of inclusion.

Montecatini, Monsummano and the Val di Nievole are located in this territorial area. These cities form an independent area configured as a cultural district, which is based on its own specificities and which is featured by a high potential. With more details:

- The city of Montecatini is featured by a highly relevant heritage that shall be preserved and expressed, in order to improve its attractiveness in accordance with an innovative method for territorial enhancement, based on the redevelopment of 160 hotels, relaunching local spas according to a new operating model and a new business model, the creation of a citadel of health, the activation of an energy plan, based on existing renewable sources;
- Monsummano is an industrial centre where Gucci has the role of centre of mass: it is a polo that emulated the role of Montecatini on the spa front. These aspects lay the basis for launching a program to regenerate the whole area, made up of Monsummano, Montecatini and the Val di Nievole.
- Val di Nievole is configured with an ecosystem that can develop large urban redevelopment projects (by referring to governmental support) and support these purposes by developing the agricultural sector and by enhancing the enological heritage. Valid and amusing tourist services, associated with well-being and the relationship with Nature.

Special and institutional events represent a possible important basis in this area, to be integrated with a strong renewal of the entertainment sector. The activation of gambling platforms is questioned, with advanced technological solutions that enable digital traceability.

Pisa

Well-known universities, excellent research centres, the medical health centre lay the foundations for the activation of a platform able to support complex projects in the whole region, from the technological systems on the Etruscan Coast and Elba (aimed to improve sustainability, monitoring capability, and to realize territorial enhancement) to the activation of a new service model in the medical-health and social-care ecosystem of the Province. The well-recognized value of local research centres and universities shall make easy to have access to large European funding in line with the strategic guidelines indicated with Expo 2015.

The relationship with the US centres of excellence certainly facilitates the activation of technological innovation projects. While Pisa maintains the compact size typical of a Tuscan municipality, on the other hand it can operate as a forge of scientific thought and a centre of technological innovation in the wide area of Tuscany Region. It distinguishes above all for the unique landscape of this naturalistic area, which extends since Arno river to Livorno, along the Tyrrhenian coast, which includes large tracts of pine forest, several opportunities for tourist, and the activation of health and wellness services in the area.

Livorno, Empoli, Prato

The port of Livorno has a particularly important role in central Italy. In order to develop it, a valid intermodal logistics hub shall be established, activating cooperation and reaching synergies among the front and rear ports, the industrial area of Prato and the green residential area of Empoli.

Empoli's housing model allows us to imagine the creation of an ecosolar village with a positive energy balance and soft mobility (think also to energy community). Prato too has embarked on an important path in this direction, thanks to the commitment of the local administration.

A valid regional plan is needed, formulated with far-sightedness, by conceiving the evolution and the development of the port in order to lead this area of Tuscany to become an economic and industrial platform, featured by high efficiency and enabled by digital innovation, big data processing, and data protection. That territorial plan shall be consistent with 2030 Agenda and with Horizon Europe guidelines, in order to realize the territorial enhancement of the area where those municipalities are located, in accordance with a global perspective (i.e. net of networks). Achievements and outcomes of these processes shall be pervasively disseminated in order to facilitate awareness and seek interest and participation.

The town of Vinci can surely achieve high visibility and it can assume a central role in the international debate about arts, culture and radical innovation, by leveraging on the Tuscan genius Leonardo da Vinci and the relationship he has with several international centres of excellence (either scientific and humanistic) and with other famous cities.

Chianciano Terme and the surrounding lands.

In Italy, the era of thermal spa ended with the cessation of public funding for these services. In Italian thermal spas, the renovation of the sensory baths was not enough to sustain their attractiveness. It was the case of Chianciano Terme.

In Chianciano Terme, two important medical centres are nowadays located. They are UPMC (University of Pittsburgh Medical Center) and Chianciano Salute, which is a fertility centre.

There is still a great potential in terms of hospitality, but many hotels are now up for auction and a structured intervention is needed to redevelop the urban structures of the municipality on the basis of an innovative master plan, based on a broad vision that includes not only Chianciano but also Montalcino, Montepulciano, Val di Chiana, Val d'Ombra and few other extraordinary villages.

A broad vision lays the foundations for thinking about a territorial program that has a hospitality pole in Chianciano Terme, essential for the digital enhancement of the area. The surrounding lands are associated with Chianciano Terme and they are characterized by numerous attractions and by a growing number of services for tourists.

Effectively thinking of municipalities and territories is an opportunity. Complementary medicine is a possible direction for relaunching Chianciano Terme and the neighbourhood towns: it is for instance the case of an outdoor health centre, in which to activate lifestyles and services for health and well-being, suitable for attracting visitors, tourists and new residents.

Maremma

Maremma excellences are well recognized, but no real redevelopment and enhancement programs are formulated. In the Maremma there are ample attractions, based on a simple and rural local modus. The connection systems of the different areas of the Maremma can be radically innovated, by introducing different types of new vehicles, useful for enabling the movements of families and small groups.

The intervention in Maremma can easily benefit from the authorization for construction and European funding from the Green Deal. The cultural level of the local community is closely linked to the history of the area. As previously anticipated, it is necessary to encourage and to support cultural innovation, in order to lead towards a common vision of a Maremma that can preserve tradition, innovating through the implementation of methods, tools and resources.

Etruscan coast and Elba

In 2020, Etruscan Coast and Elba attracted numerous Italian tourists.

Elba is not easily accessible and certainly fragmented into numerous administrations and non-completed projects. In the same geographical area, technological innovation initiatives have been launched by Sant'Anna and other national and international research centres.

The Green Deal provides ample space for intervening on the environmental monitoring and environmental sustainability. New infrastructures have been proposed to facilitate the connection between Elba and the Continent.

A historiographical study and the creation of touristic paths, associated with narratives, can represent a basis for the formulation of extensive enhancement actions, supported by technological innovation and therefore the introduction of digital humanities and edutainment solutions, designed to illustrate and make known the history that has characterized these places. It seems interesting to think also to new gamification models to be proposed in this area, being associated with pilot projects of smart territorial networks.

Mount Amiata

Mount Amiata is characterized by numerous debates and various vicissitudes, associated with natural heritage and minerals and renewable energy sources.

Dialogue must be facilitated and this can be done through the construction of proposals capable of gathering resources and funding. Those projects can certainly be placed among the priorities of the European Community in the new Horizon Europe framework program.

Arezzo and the Casentino

Arezzo and the Casentino are located in a strategic geographical position on the border of Tuscany, opening up space for integration beyond the regional administration. It is interesting to evaluate the enhancement of this geographical area in projects involving more than one region.

The Casentino is characterized by its relationship with Nature. The local community is linked by common principles and, thanks to some proactive associations, redevelopment initiatives are promoted.

In this sense, redevelopment projects of villages and valleys are identified, as well as initiatives strongly associated with Franciscan thought and the relationship between man and the forms of creation. In Casentino, examples of representative projects are for instance indicated by referring to ecosolar villages and the programs that have been formulated and carried out, in favour of the preservation of the aquatic biodiversity of the rivers and fish farming.

Some industrial areas that are now abandoned are suitable for becoming business incubators, aiming to fostering innovation in Casentino, both in the cultural and scientific fields. Local companies can support this project. They well known corporate groups, operating both in the blue economy and in the digital field.

Two fundamental drivers have been further identified. They are associated on environmental sustainability and energy communities. The creation of smart territorial networks could support the effective development of these processes by enabling and sustaining the local companies that are interested in investing in the intellectual property and making possible to monitor the condition of the territory and to support innovation along the agricultural supply chain, the preservation of soil regeneration and the enhancement of the territory.

THE WORLD IS A NET OF NETWORKS: A possible role for Eva Network and the importance of representing the future.

The construction of a shared vision is a prerequisite for people to undertake a lasting path, marked by common proposals. Eva Network is made up of numerous scientists and researchers, practitioners and disseminators of knowledge, who - in different ways - address the issues of visual arts and technological innovation, paying particular attention to the IT and electronic fields.

These skills and tools can make it possible to represent future scenarios in different ways and can provide multidimensional representations, useful for transforming the contents of intercultural dialogue and interdisciplinary dialogue into images, which is the basis of a process of community aggregation.

Integrated sustainability is one direction. It is divided according to various guidelines, such as:

- Social respect and inclusion;
- Ecology and environmental sustainability;
- Economic sustainability;
- Financial sustainability;
- Safety and health condition;
- Relationship between man and machine, with particular reference to artificial intelligence.

Each of these factors can be studied on the humanistic and scientific sides. Specific indicators can be adopted. In various ways it is possible to share complex information and to represent quantitative evidences in order to describe future scenarios. All this is a prerequisite for the formulation of shared visions and for the achievement of a form of comparison, dialogue and cooperation, on a large scale. These themes indicate the priorities of this millennium and the members of the EVA Network can collaborate and commit themselves in this direction, for example starting from a project related to Tuscany, Dante's homeland.

Personal Meaning Mapping in Context of Digital Humanities Pedagogics

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Abstract — The study aimed at assessing visitors' learning and perception using the Personal Meaning Maps methodology. The study was conducted within the course "Museum Information Systems", implemented under the Program "Applied Informatics in Arts and Humanities..." of Saint Petersburg State University according to the University requirements. Thirty-five third-year bachelors (19–22 years-old) took part in the experiment.

Quantitative and qualitative analysis of the collected data showed interesting results. Indeed, we can state that PMMs allow studying new knowledge of specialists in the field of Digital Humanities. Also, we observed that PMMs, used as a pedagogical and research tool, activates both common theoretical knowledge of learners and the students' personal experience, allowing them to gain a more complete picture of the scientific phenomenon as well as of a historical fact.

Keywords: Personal Meaning Maps, Digital Humanities, Blended Learning

1. INTRODUCTION

In this paper, we aimed at assessing visitors' learning and perception about a topic or a masterpiece when visiting a museum. With this aim, we used the Personal Meaning Maps methodology, commonly used for museum experiences and thoughts. The study presented here started by a previous study [19] on a scientific museum adapting and extending the methods implemented to fit the requirements of a cultural museum.

This approach consists of a qualitative investigation that takes into consideration the background of a visitor before the visit and the gained knowledge and changes after the visit itself.

It is also used not only to assess knowledge, but also as an expression of personal perception about the topic or tour. The results, thus, may be interpreted through a quantitative analysis.

Also, other works [2] have been presented on this topic, particularly taking into consideration the priming approach and the application of EEG-based Brain Computer Interface [7, 10] to collect EEG-data from visitors and quantitative methods to analyze changes in focusing and memory ability. Brain-Computer Interface devices, which are a simplification of medical EEG, allow collecting brain signals related to users' response to specific stimuli in real-time, through dry or wet sensors positioned on individuals' scalp. The devices are connected to a computer via Bluetooth enabling real-time data collection and analysis, this latter performed by Artificial Intelligence (Machine Learning) algorithms.

The Personal Meaning Maps methodology is particularly useful because it encompasses a more situated and contextualized vision, which takes into account also perception, emotions, cognitive biases, social interactions, and motivations, as equally important in the learning process [3]. Traditional approaches, that do not take situational aspects into consideration, come, for examples, from cognitive psychologists [8] who see the learning approach as a top-down teaching where learning would be simply mean storing an abstract code in the mind.

Instead, a more complex vision deems learning as a process of negotiation between the participant and the environment [6].

For instance, considering scientific concepts, learners develop flexible and coherent representations [4, 15,17] that allow connections among different conceptual and experiential domains. In this way, a concept is not only the result of deductive and inductive processes, but they also include contextual characteristics and personal experience as well, which help to build a rich representation of the phenomenon.

For this reason, a change in the teaching methods is needed, to a more situated, active and engaging approach, which would promote the learner's own sense-making and learning [18].

A natural context in which this can be more likely achieved is the museum, which is an informal context that may push for «free-choice learning» [9].

Moreover, museums are social context with a strong role in lifelong learning, and such learning is multi-faceted, rich and complex, thanks to the multiple stimuli and factors at play. However, the impact of the museum experience of learning is not easily measurable, also because each individual plays an active role in shaping his or her own learning path.

Further complexity comes from the need to implement distance or blended learning settings. In fact, the recent Covid-19 pandemic has forced many educational agencies to adopt methods that, if not entirely new from a technological and applicative point of view, are certainly innovative with respect to the methodologies adopted by traditional university courses as well as museums. This has forced practitioners to move onto new horizons, with the need to adapt their methodologies to the emerging context. Similarly, students as well as museum visitors have had to adapt themselves to the new situation without a real support about how actually to adjust to the new situation. It is well known that distance learning, in all its different forms, can heavily affect cognitive processes, especially memory and attention. However, at least from our point of view, it is the interactive dynamic between teachers and learners and between peers that were mostly affected by the new education setting with a great impact on the pedagogical process [11] In this sense, the use of methodologies such as those used in this study can be particularly effective in stimulating meta-cognitive processes underlying a work that involves reflection, divergent thinking and convergent thinking, thus placing itself at a level somewhere between a creative work in the strict sense and a didactical one. This kind of cognitive work is precisely what is often missing in at-distance education. Moreover, such methodologies can be used as an effective tool to stimulate teacher-learner and peer interaction [16] becoming an important compendium to at-distance or blended learning.

For all these reasons, the visitor's learning in such a context must be evaluated with a methodology capable to grasp the qualitative and multi-faceted nature of knowledge development, that is, must be able to capture the individual perspective of each visitor.

2. PMM APPLICATION TO BLENDED LEARNING AT UNIVERSITY

The study was conducted within the course «Museum Information Systems», implemented under the Program «Applied Informatics in Arts and Humanities» of Saint Petersburg State University according to the University requirements. The Course objectives are the development of students' competencies aimed at designing, presenting, evaluating various digital humanities resources. Peculiarities of pedagogical approaches allow promoting

knowledge and skills that reflect equally humanitarian and technological components of cultural objects. This is one of the current issues of contemporary digital humanities pedagogy.

Training sessions include thirty-two hours of face to face classroom work and thirty-two hours of self-study. The independent student activity is carried out in the virtual section of the course, which is published on the Saint Petersburg State University e-learning platform (LMS BlackBoard). The face to face part of the course is held as lectures, seminars, discussions whose topics include the following units: Introduction to Museum Studies, Main directions of Information Technologies Application in a modern museum, Digital Cultural Heritage. A special place is given to the specifics of information technology deployed for exhibiting of museum objects in the museum space and the Internet. In this regard, the "virtual museum" is one of the significant terms of the course.

Fifteen years cooperation between the State Russian Museum and Saint Petersburg State University in the framework of the international project «Russian Museum: Virtual Branch» opens up broad opportunities for understanding the theoretical aspects of the phenomenon and their practical implementation at the modern museum.

The students are provided with media library materials, which include almost 3000 electronic and print publications. Also, students can attend the virtual lecture hall of the Multimedia Center of the Russian State Museum. At the same time, face to face meetings with the museum's specialists at the University or the Museum are of particular importance. This common work served as the basis for the implementation of an experiment to explore the prospects of PMMs application to the educational process.

A guided tour around the thematic multimedia exhibit «Our Romantic Emperor», dedicated to the era of Paul I, was held at the Multimedia Center of the Russian Museum. Students have presented in detail the works of painting, drawing, applied art, filmed in the highest quality, the bachelors' learned about the types and genres of fine art, artists and styles, as well as the process of restoration, attribution of paintings. During the visit of the exhibition, there was an expert who accompanied and introduced the visitors to the life of Emperor Paul I, members of his family and courtiers on the basis of historical facts recorded in works of art and museum objects. The guide's story was completed by an individual study of the exhibits, based on interaction with them.

Thirty-five third-year bachelors (19-22 years-old) took part in the experiment.

They were asked to complete two types of PMM: one dynamic and one static. In this case, a dynamic PMM refers to a map that is filled during the semester, and a static PMM is a map that is designed within 2-3 hours before and after the tour. A set of control materials was then created based on a static PMM, and a set of experimental materials was formed starting a dynamic PMM.

3. DISCUSSION and CONCLUSION

As a result of the experiment, it was revealed that PMMs allow studying new knowledge of specialists in the field of Digital Humanities. At the same time, it is necessary to take into account that the filling out of PMM is intended to have the museum visitors reflect and think about information and about the transformation of their knowledge. In a university context learning situation, the use of PMMs is a valuable method to obtain significant and rich feedback. This last phase of the learning process represents a fundamental component of the pedagogical process, alongside with the participation in lectures and seminars, and independent work in an electronic environment.

Therefore, in order to achieve success as university education goals, an adaptation of the PMM method was carried out. Two groups of PMM were defined, namely, dynamic and static. Dynamic PMMs (dPMMs) are used to reflect the student learning outcomes in the learning process which includes museum guided tours. Static PMMs (sPMM) are applied to

record the results of only the museum guided tour. In this experiment, sPMM (static maps) performed the function of control materials, allowing to evaluate the experiment results.

Firstly, based on the fact that students present scientific concepts as flexible and consistent statements [4,15,17] , which allow establishing connections between various theoretical and experimental areas, PMMs allow to follow the process of gradual development of four knowledge levels of the students: from repetition and conceptualization at stages 1 and 2 to demonstrate the capabilities of strategic and advanced thinking at stages 3-4. It is significant, that this pedagogical tool activates not only common theoretical knowledge of learners but also the student's personal experience, which altogether allows them to gain a more complete picture of the scientific phenomenon as well as of a historical fact.

Secondly, PMMs allow each student to create a "baseline" as the starting step for a discussion, thus allowing the development of knowledge by a peer-to-peer interaction as well as other significant interactions. This is coherent with the idea that knowledge follows from a negotiation between an individual and the environment [16].

Finally, museums are natural environments, which allow acquiring knowledge in an informal context of learning and realize «learning by choice» [9]. PMMs assist students to enhance interaction's competencies in a cognitive environment, the museum's collections in this case. Museums can play an important role in lifelong learning. Here lies the third advantage of PMM implementation/application to university education.

One of the most significant trends in the information society education is the possibilities of each person to play an active role in designing a life long learning trajectory, determining its content, duration, location and so on. In this situation, traditional approach to learning as "top-down" process of creating repositories of abstract and common to all codes in students' brains is adjustable by on-demand educational paths.

This new is based on concepts aimed to train professionals in the use of methods, which allow the creation and monitoring of their own path throughout their lives. In this regard, the view of a pedagogical system as a whole, with a particular focus on the feedback system, is rapidly changing.

In this context, the research of experts' groups with pedagogical skills, considered in this paper as a community of novice professionals, becomes relevant. Every beginner scholar has individual characteristics, perceptions, emotions, social interactions and motivations that affect the learning process and generate cognitive distortions. Identification of the characteristics of each student (future scholar) allows them to take into consideration all these features when organizing feedback based on peer-to-peer assignments, discussions of educational topics, etc., which leads to the student's knowledge development. Such an approach, in turn, allows developing innovative methods aimed at the growth of the students' competencies, that are demanded in the modern academic community. One of such techniques is the Personal Meaning Maps, which may be used at different levels with different goals. In particular, as shown in this study, PMMs may be used to assess the personal experience, the enrichment of specific knowledge as well as emotion and other social aspects. Furthermore, PMMs may be used to measure changes in knowledge organization and consolidation at short, medium or even long run. Finally, PMMs can be considered a valid and easy-to-use method to be applied to a variety of contexts. In this view, PMMs are also educational tools that the students will be able to use in their future professional life.

Further development will consist in performing a quantitative analysis of the collected data and in designing and developing a tool allowing to fill a digital version of PMMs. This way it will be possible to test the hypothesis that PMMs may be used in at-distance setting both to stimulate cognitive and interactive processes. We believe that digital PMMs might be useful both for higher education and museum didactic pathways. Also, we intend to continue the study by including in the research the collection of EEG data from visitors. This further step could be done using dry sensors EEG-based BCIs which appear to be the best choice in our case. Indeed, thanks to their low cost and especially to their communication protocol, users would be free to move without feeling stressed or limited. The collected signals wouldn't, so,

be influenced by noise due to factors different from the response to the stimuli we are interested in.

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"ArtCentrica: a new experience with art, and more"

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ArtCentrica is an EdTech solution that addresses e-learning market, a growing sector, reinforced by the situation created by the Covid-19. ArtCentrica lets teachers and students visualise in intimate detail, compare, virtually measure, correlate artworks inside and outside the classroom.

Schools, Institutions, Universities pay an annual fee to access high-quality content and features. ArtCentrica is a cloud application containing a great part of the artistic heritage of the Uffizi Galleries in very high resolution, up to 10 GigaPixel, a selection of artworks from the Brera Museum in Milan. More art collections coming from Italian museum and other countries will be added in the future.

The fee is sized according to the connected devices and the number of years of the contract. A percentage of 30% of our revenues is provided directly to the museums that are inside ArtCentrica.

ArtCentrica solution creates engagement in art appreciation, understanding and learning. Art expresses our feelings and our ideas. It testifies how mankind has represented beauty and society over the centuries. ArtCentrica brings features like artworks discovery starting from the interest of teachers and students, driven by ontologies and AI, generating knowledge processes and ideation.

The problem addressed by ArtCentrica is to make possible to appreciate, compare, learn and teach art with super high quality content and features. For example it is possible to appreciate intimate details of masterpieces from Leonardo da Vinci, Botticelli, Caravaggio and other hundreds of artists, due to GigaPixel images and enabling technologies, with a quality and knowledge that is not available in the market. ArtCentrica allows users to compare artworks coming from different collections (at this stage Uffizi Galleries, Florence and Brera, Milan), to retrieve visual suggestions starting from a detail (i.e. a jewel or a gaze), that is interesting for the teacher/students. Moreover it is possible to use existing lessons or creating new ones using the ArtCentrica back office. The mix of technology, high quality content and user interface makes ArtCentrica a tool engaging students and opening new teaching possibilities for teachers.

The pedagogical approach inside ArtCentrica is based on discovery and learn-by-doing. The interface has been designed so that it is very easy to use all knowledge paths. The quality of content and easiness of use brings more concentration in the students. Pedagogical content is inside the prepared lessons ("Follow the scent of flowers and fruits", "Comic Stories in Sacred and Secular Paintings from the Middle Ages to the Renaissance", “Love between Passion and Conflict" and other 20 lessons) or with the lessons that can be created by the teacher.

Art discovery brings in children the ability to understand their own potential. Art suggestions brings the possibility to be independent, choosing the desired correlations between the thousands available. The quality of content brings the joy to learn. ArtCentrica is designed to fully encourage children self-motivation and ability to develop their hidden competences, preparing them for the future development of intellectual skills.

ArtCentrica has been recognized among the ***best ICT tools for teaching and learning*** by **Reimagine Education 2020** (December 2020).

ArtCentrica has been awarded by **National Geographic** in **GESAwards** *That's Geography* **special track (January 2021).** For more info http://www.artcentrica.com

You can test for 10 days for free ArtCentrica registering at http://art.centrica.it

References

http://www.centrica.it

LUAN Emotional Museum event "Portrait of plants: Exploring nature in Leonardo da Vinci's works through ArtCentrica" with Valentina Zucchi https://youtu.be/DmXSnKbZgKE

LUAN Emotional Museum event "The Goddess and the Influencer" with Marxiano Melotti https://youtu.be/77IuemyaaOs

"Art in an half hour", planned by Muse, "Florence of the eighteenth century in the views of Giuseppe Zocchi" https://youtu.be/EpbQVpbNWNU

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