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Digital Technologies and the Role of Data in Cultural Heritage: The Past, the Present, and the Future

Vassilis Poulopoulos *,† and **Manolis Wallace** †

Knowledge and Uncertainty Research Laboratory, University of the Peloponnese, 221 31 Tripolis, Greece; wallace@uop.gr
* Correspondence: vacilos@uop.gr; Tel.: +30-6972-700-533
† These authors contributed equally to this work.

Abstract: Is culture considered to be our past, our roots, ancient ruins, or an old piece of art? Culture is all the factors that define who we are, how we act and interact in our world, in our daily activities, in our personal and public relations, in our life. Culture is all the things we are not obliged to do. However, today, we live in a mixed environment, an environment that is a combination of "offline" and the online, digital world. In this mixed environment, it is technology that defines our behaviour, technology that unites people in a large world, that finally, defines a status of "monoculture". In this article, we examine the role of technology, and especially big data, in relation to the culture. We present the advances that led to paradigm shifts in the research area of cultural informatics, and forecast the future of culture as will be defined in this mixed world.

Keywords: big data; culture; cultural informatics; museum informatics; mixed environment; social media

1. Introduction

We live in an era that is defined by technology and its advances. Every aspect of our everyday life includes a kind of a machine. The type of machine that Turing and Von Neumann described [1,2], where people explicitly or implicitly provide inputs which a machine processes and then outputs results. Explicitly, in the cases where people are aware of the information shared, information that is intentionally provided to any kind of machine in order to fulfill a job; implicitly in any other case, in which technology collects information in order to "predict" and aim towards a better world. However, when it comes to culture, to the past that defines who we are today, and how we will progress for the rest of our lives, then it is based upon every single person's selections, on how to respond to technology; we define—or should define—the way, and not technology or algorithms.

Technology and culture is not a novel combination. More than 50 years ago, people in the humanities, primarily in museums, were seeking for technological assistance [3,4]. Simple databases were the beginning of the need for a technological presence in cultural institutions [5]. While the technology was emerging, the technologically unexploited area of museum informatics was gaining attention. Museum informatics was the "beginning"; it was the noble area that technology could explore. A first 'touch' between technology and humanities; actually a large part of humanities.

As technology was advancing, it was not only cultural spaces that attracted the attention of innovation. Culture is spread all around us; new types of culture were defined, and as this kept happening, technology was finding a new area of application. The simple—yet advanced for its age—research on databases and cultural spaces started to shift with the domination of the world wide web. It was the time that the Internet started to seem an ideal space for virtual museum tours and multimedia presentations [6]. Despite the fact that the humanities declined to follow the pace of technological advances, technology still remained present in several aspects of culture. Virtual reality, augmented reality, social media, 3D

representations, aerial photos (scanning), personalization, mesh networking, IoT, and automated guidance, and more technological advances will define the next two decades.

Today, we should be thinking of modern culture, everyday culture, and "online" culture. That is, because, over the years, our perspective towards culture is changing. It is not only technology that makes us change, but it is the medium (technology) that led to a more universal environment, in which we are eventually forced to live. People are, more than ever, closer to new cultures, behaviours, religions, socio-economical approaches, music, art, movies and more. One could claim that the internet has generated a new type of culture, though, it seems to be very flat.

People tend to use technology in order to overcome problems, to do their job faster, but at the end of the day, they remain out of time. The amount of data generated and targeted towards people is such that they are unable to process them, to give them the period of time data deserve (and people deserve). Technology is the solution to problems, but was provided to the people without any guidelines; ending up as a means of a universal monoculture generation.

Technology today is capable of uniting the whole world. We are able to "travel" to places that we would not be able to in our real life. We can talk, discuss, learn, and exchange culture with people from the other side of the Earth. However, the ease of access generates the problem of huge amounts of information that no human being is able to process; at least in real time. We live the era of big data and culture. Technology is the medium to communicate and spread culture; cultural organizations need to define their presence in this world, and people should be able to "survive" in this world without losing their roots. As such, we need to review the position of technology in culture, especially when it comes as a massive stream expressed through big data.

In this manuscript, we examine the effect of technology on culture, how the advances of technology emerged and altered the way culture is accessed by a broader audience, the way culture is presented, recorded, and spread. In parallel, we envisage a future of culture spread among people and discuss how cultural related organizations should adapt their processes in this future. The next section presents technology in culture from its very beginning, until today and the connection to data. It is also focused on big data, projects related to culture, as well as the role of social media. We present a view of what is expected from the combination of technology and culture in the future. Finally, the discussion on technology and culture is presented.

2. Technology in Culture

The advances of technology are vast. Many of them are directly or indirectly related to culture in any of its forms. A great deal of research is being conducted on the combination of technology and culture, having many different perspectives. Researchers tend to support that there is a two-way relationship between technology and culture [7–10]. Of course, they are precise, as civilizations that dominated parts of the world in history are directly related to advanced technologies for their era. As mentioned, a large number of efforts examine the connection and the effect between culture and technology [11–14]. Furthermore, it is obvious that culture and arts were part of the past civilizations that managed to have their "basic problems" solved; and in order to do so technology must had been very advanced, at least for their era.

In the modern world we need to narrow down the relation of technology to culture, only to what is related to computers and the internet. It is this kind of technology that altered the way we got used to face culture and react to it.

2.1. The First Steps

The first recorded efforts in the modern world can be found in the 1970s. R.G. Chenball discussed museum cataloguing in the 'Computer Age' [5], while J.D. Wilcock tried to establish the role of the computer in archaeology [15]. It is obvious that researchers were trying to interconnect advances in technology with culture and, as a first step, several

efforts were focused primarily on museum cataloguing [16] or even systems to classify any man-made object (e.g., nomenclature [17,18]). Still, the problem is close to the one we face today, there was no common language for the standardization of the systems and processes. As D.C. Stam [19] states in 1989, "the already reaching 20 years of research on museum informatics had not ended up with a common standard". So, a first generation of cooperation between culture and technology in the modern world is directly related to databases.

2.2. The Internet

Not very far from this first approach, technology started entering several different areas of the humanities and affecting culture. With the internet era rising, the relation between culture and technology started its path on the Net. Cultural informatics became more extrovert, a number of conferences started focusing on technology and culture (museums) and a shift has started by considering the interaction with the visitor as an equally important factor. D. Bearman, editor of 'Archives and Museums Informatics', was a pioneer in the field with numerous research on the issue of hypermedia and interactivity, as well as the presence on the web [6,20,21]. We are entering an era of technology where a huge number of changes are happening. The wide adaptation of the Internet and emerging technologies, such as digitization, object visualization, 3D representations, Virtual Reality, Augmented and Enhanced Reality, Artificial Intelligence, Semantic Representations, and Ontology Specification are only some of the factors that affect cultural informatics. People do not hesitate to adopt the Internet, and cultural informatics has to follow [22,23]. W. Schweibenz examines both the perspective of the Internet as a knowledge-base and as a communication system [24]. He is also referring to the cultural spaces as the "virtual museum". The term is not something novel for the museums [25]. Many years after his first approach on the "virtual museum" he still thinks that museums are standing still. He states: "The idea of becoming virtual might not be a pleasant one for some museums, but this development is inevitable because of the increasing digitisation of cultural heritage and the demand to make collections more accessible" [26]. It is obvious that it is a matter of accessibility. The stakes for the museums are clear: either they follow the river or they remain a sterile space.

2.3. Virtual Worlds

The changes in museums and cultural spaces are huge. The first decade of the 21st century is almost monopolized with Virtual and Augmented Reality in the museums [27–34]. This "differentiated reality" can be found in several forms, named Virtual, Augmented, Mixed, or Extended (referred to as XR from now on). It all refers to "photorealistic representations of places, people and sites that do not exist, never existed, or may not be easily experienced" [28]. In parallel, it is possible to provide a lot of data (information) and enable interactions. The most extraordinary about this technology seems to be the "immersion", which is the "illusion of being in the projected (author note: idealized) world, in such a way that makes you believe that you are really there", that leads to the assumption that it may offer a "better than real life" experience [28].

The facts about virtual, mixed, and augmented reality are simple. The visitor can have an alternative enhanced experience, either it is on-site or online (remote) as well. Moreover, XR takes advantage of the digitization of objects, places, and cites, a procedure that was and is already underway, but possibly not utilized. Virtual exhibitions can be multiple instead of the single exhibition that is formed by the original objects. It is a matter of fact, that only a small amount of the objects that a museum owns are exposed to public. XR may provide information about "hidden" objects and artefacts as well. A survey at the end of the decade proves that the steps being taken are numerous [35].

Virtual Reality and Augmented Reality have never lost their glamour till today. In fact, research on the field is such that the number of XR solutions for museums is huge [36–41]. The idea of XR in museums does not change from its very early roots: enhancing the visitor's

experience. Throughout the years, research includes several different factors, either related to personalized content (better applied to AR), differentiated environments (worlds) in which the user navigates, presentation of different objects, representation of the past and rebuilding ancient ruins (e.g., Ancient Olympia (https://inculture.microsoft.com/arts/ancient-olympia-common-grounds/, accessed on 27 June 2022—Digitally preserving and restoring Ancient Olympia as it stood over 2000 years ago) and more. We have already been informed that the future of one of the most well-known social media platforms will emerge in virtual reality. We are talking about Meta from Facebook (Meta—https://about.facebook.com/meta/, accessed on 27 June 2022 which is referred to as "...the next evolution of social connection".

2.4. Metadata

Another important aspect of museum informatics is related to information representation. As digitization is continuous and unstoppable there is a strong need of a common "language" for data recording. Ontologies try to provide a solution to this issue. The CIDOC conceptual reference model provides a generic solution [42], while, other conceptual models proposed are not that widespread. The CIDOC CRM represents an "ontology" for cultural heritage information, i.e., it describes in a formal language the explicit and implicit concepts and relations relevant to the documentation of cultural heritage. On the other hand, one can find a large number of protocols that are constructed in order to describe cultural related objects. However, when one deals with information recording there is a strong need to define metadata that accompany such a kind of object. According to [43], four aspects of the cultural data have to be discussed and taken under consideration when dealing with metadata of museum and cultural objects. These are:

- Data structure standards;
- Data content standards;
- Data value standards;
- Data format/exchange standards.

For each of the aforementioned sections, there is a set of information that accompanies and provides useful information. The important part of this analysis is not only the fact that technology is hugely affecting the way that cultural information is recorded, but the fact that we are facing a completely differentiated analysis of the approach of database creation; and this is because we are facing an occasion where the audience does not have a technological background—instead the audience is related to humanities—but still the effort of technology adoption is great.

Talking about metadata, there is a strong need to realize their importance for the multi-level analysis of data deriving from cultural objects. Metadata are information related to an object and provide answers to questions that can be considered "additional information". For example, trying to "explain" or "understand" a piece of art from an artist, our work could be made easier if we new when and where he was born, not to mention their personal and family status or socio-economic conditions. This (add-on) information is the medium to interpret parts of the work, as well as make connections with the past, the present, and the future of the artist, and ours. So metadata are the information carrier that demolishes any barriers that block the universality of culture.

The actual part related to metadata is the numerous efforts worldwide to record information about objects, thus creating large sets of scattered databases. Within these grounds, Europeana holds the largest artefact database in Europe, trying in parallel for two aspects [44]. First of all, empower the recording of cultural related information and secondly, establishing a prototype so that the information is not only "saved" and "preserved" digitally but also be portable and readable; ultimately, accessible to everyone.

2.5. Content Digitization

Apart from the information that is related to an object's metadata we should also stand on the digitization part. Although metadata can be considered the information carrier for an object's digital existence, the digitization is the part that holds the actual "image".

Applying only to tangible cultural heritage the power of images is such that digitization is considered to be one of the major branches of the research related to cultural informatics, having a great impact on the combination of technology and culture [45].

Talking about digitization, one can consider that taking a picture of an artefact is sufficient to talk about digitization. This is not very far from being true apart from the fact that the digitization process is also a process that has specific standards and protocols. The European Commission has once more invested a large number of projects related to digital cultural heritage focusing on the digitisation processes. https://digital-strategy.ec.europa.eu/en/policies/cultural-heritage, accessed on 27 June 2022. Projects like VHH (Visual History of the Holocaust—https://www.vhh-project.eu/, accessed on 27 June 2022) which is an innovation action that focuses on the digital curation and preservation of film records relating to the discovery of Nazi concentration camps and other atrocity sites, or such as GRAVITATE (Geometric reconstruction and novel semantic reunification of cultural heritage objects, https://cordis.europa.eu/project/id/665155, accessed on 27 June 2022 and Scan4Reco (Multimodal scanning of cultural heritage assets for their multilayered digitization and preventive conservation via spatiotemporal 4D reconstruction and 3D printing, https://scan4reco.iti.gr/, accessed on 27 June 2022) put the research efforts on the cultural objects and the procedures for preservation and digitization.

Although these efforts are considered to be "modern" the need for digitization started together with the efforts of information recording and it started the decade of the world-wide web expansion. Reproducing the words from [46] back in 1996 we understand the level of innovation at that time. Mannoni states when analysing the organisation, publishing and distributing large collections of materials online: "We used Kodak photo CD technology for digitalization and CERN World-Wide Web technology for the HTTP daemon linked to a WAIS research engine to query the database". It was—once more—"the Internet", the need for online presentation, publishing and sharing of our history and culture that brought digitization to an advanced level. Other efforts refer to practices and techniques for digitization [47,48], till reaching the point where the procedures for digitization include 3D, photogrammetry, and point clouds [49–61], making the digitization process reach very high levels of representation fidelity.

The digitization procedure provides a "picture" of the cultural objects. However, technology has emerged and digitization procedure together with artificial intelligence and 3D technologies can be used to restore [62], redesign, and regenerate objects. The possibility for rapid prototyping of such objects inspired and intrigued research [63–65].

However, digitization and publishing on the Internet generates a number of side issues especially related to copyrights which remains a field of huge discussion till nowadays [66–70].

2.6. Adaptation on People

In the last decade, we have witnessed a paradigm shift that is directly related to data generation and culture spread. Culture in the modern world, from the perspective of a museum, has gone through many different stages. Starting from the object-centric approach, to the museum-centric, leading today to people-centric approaches.

Having all of the world in their pockets, or more precisely in their hands, people are the centre for some cultural informatics approaches. Customization, personalization, personality of the people are only some of the "keywords" that lead to this change of stance towards people [71–73]. The museum is not just an information carrier, the object is not only a masterpiece, the work from curators and guides is not only static, but we are designing experiences and their maximization, brain stimulation, immersion of different levels, and total adaptation to the needs of the visitors. The efforts being made are based upon the existing technologies (XR, Digitized material, metadata, web), but they are tailor-made for each user. A whole new generation of application related to museums and cultural spaces is born, including user personalization, adaptive content, custom storytelling even procedures in order to combine physical with digital narratives. Apart

from the aforementioned, the research works presented in [74–76]. are typical examples of research approaches targeting on the connection of user profiles with the museum visit.

Personalization becomes a matter with the evolution of the web in the early 2000s, where user generated content begins to be large enough to enable users to be producers of information. It is the time when web personlization is established as part of a museum's online presence as well [77]. P. F. Marty, a pioneer in museum informatics does not stop to mention the personalization as an important factor in a user's experience [78]. Many cases start to appear in several museums around the world [79], while the parallel rise of online games makes it possible to create personalized experiences in the online virtual worlds, such as Second Life [80]. As we approach the present, a combination of technologies occur for the personalization, including visitors' personal devices, as well storytelling and narratives [81–84].

Machine learning, especially through artificial intelligence has played important roles in the scope of adding algorithmic approaches to the process of interconnecting people with culture. An extensive survey on machine learning for cultural heritage has recently been presented by Fiorucci et al. [85]. They conclude, however, "in most cases that ML is applied to culture, it is a 'black box' for the research community" and that it is usually focused on "visual or textual features". In parallel, despite the fact that CH data are created so as to be publicly available for everyone, still, only some of the large cultural organizations enable access to large sets of data.

2.7. Projects Related to Culture and Technology

Europe has performed enormous steps towards supporting the interconnection of culture and technology. A huge amount of funding has been and keeps being invested in cultural informatics and cultural heritage. Europeana (Europeana, Discover inspiring European Cultural Heritage, https://www.europeana.eu, accessed on 27 June 2022) is a main axe in founding a place of common grounds. A place to define a common language, to dig for our roots, to search for interconnections. According to its website, Europeana "provides cultural heritage enthusiasts, professionals, teachers, and researchers with digital access to European cultural heritage material". This is performed in order "to inspire and inform fresh perspectives and open conversations about our history and culture". This is achieved with the support of the European countries' local authorities that force digitization procedures to follow the model defined by Europeana for the metadata description (Europeana Data Model (Europeana Data Model, https://pro.europeana.eu/page/edm-documentation, accessed on 27 June 2022). An equally important project is CLARIAH [86,87] which is established by the merge of projects CLARIN [88] and DARIA [89]. DARIAH project "develops, maintains and operates an infrastructure in support of ICT-based research practices and sustains researchers in using them to build, analyse, and interpret digital resources", while CLARIN project "creates and maintains an infrastructure to support the sharing, use and sustainability of language data and tools for research in the humanities and social sciences". It is obvious that they both serve similar roles within the research field of humanities and supporting IT tools. This is the reason they were merged into CLARIAH project, which scope is to "provide researchers with access to large collections of digital data and to innovative and user-friendly applications for the processing of these data" (https://www.clariah.nl/about-clariah, accessed on 27 June 2022).

Apart from Europeana, that leads the way to digitization and access to culture and cultural heritage, an important procedure in order to interconnect with our roots, during the last two decades, a large number of research projects have been funded in order to tackle problems in the field of cultural informatics. The efforts being made in order to create a bridge between informatics and humanities are enormous. Starting from simple steps mainly in museums in order to offer a better experience to the visitor, or attract more people, leading to complex AR systems, technology remains a powerful tool for both "front-end" and "back-end" activities as well.

The ARCHES project scope was to help people in environments where inclusion is an important issue. People with difficulties or differences was the main target in order to associate with perception, cognition, communication, and memory (Project ID: 693229). The project outcomes include recognition of data on how people interact with cultural related incentives. CROSSCULT intends to target the understanding of European common history, which is achieved by providing advanced experiences and entertainment through social learning [90]. Within the scope of this project, a number of factors, including analysis of large data, were researched [91].

GRAVITATE (GRAVITATE: Discovering relationships between artefacts using 3D and semantic data. EU H2020 REFLECTIVE project) focuses on geometric reconstruction. Apart from that it researches novel ways of displays (e.g., virtual or tangible) in order to present and communicate relationships of past societies.

Virtual museums and "emotive storytelling" is the main research outcome of EM-TOIVE project. Supporting the creation of virtual spaces, especially for the creative industries, is the main objective and it is achieved by defining and researching new tools and methodologies [92]. In this case, the project acts as a medium of good practices for content generation in the online world. PLUGGY supports citizens in shaping cultural heritage and being shaped by it. Amongst its goals is to look at new approaches of presenting cultural resources, and new ways of experiencing them [93].

Another important project trying to support virtual museums is ViMM. It focuses on supporting the world's leading public and private sector organisations, using high-quality technical approaches [94]. Although ArchAIDE aims to serve mainly archaeologists, it also has a number of outcomes related to visualization that can help the access to archaeological heritage. It actually deals with large scale data in archaeology [95].

The fact that Europe keeps changing, and people that live or inhabit in it, or deal with the digital world are largely unaware of the heritage is the main targte of Rices project [96]. Digital heritage in a mixed environment, as well as identifying the differentiation between cultures in Europe, is the main objective of CulturalBase social platform (CulturalBase EU project, https://culturalbase.eu, accessed on 27 June 2022). The INVENT project (INVENT EU project, https://inventculture.eu/, accessed on 27 June 2022) sets out the identification of the social and cultural prerequisites in order to achieve the key aspects of the New EU Agenda for Culture. CHIEF project (Chief Project—Cultural Heritage and Identities of Europe's Future, https://cordis.europa.eu/project/id/770464, accessed on 27 June 2022 is also concerned about the EU agenda related to cultural heritage and identity. Understanding the new environment in which creative and cultural industries will work, and how the spread of the Internet and digital technologies will impact this industry is the main focus of inDICEs (inDICEs EU Project—https://indices-culture.eu/, accessed on 27 June 2022). Empowering policy-makers and decision-makers in these sectors is a main purpose.

UNCHARTED (UNCHARTED EU Project—Understanding, Capturing and Fostering the Societal Value of Culture, https://uncharted-culture.eu/, accessed on 27 June 2022) aims to identify, contextualize, understand, measure, and analyse the emergence and conformation of the values of culture from an interdisciplinary, collaborative, and pluralistic perspective. SPICE project aims to promote citizen curation of cultural heritage by providing a set of state-of-the-art tools so that people can share their own interpretations of culture and engage with a diverse range of perspectives [97]. CultureLabs investigates and proposes the use of digital services and tools for facilitating the access to Cultural Heritage through tailor-made novel experiences, creative reuse, enrichment, and co-creation [98]. CREARCH is a project the intends to show to the public the development and building of shared values and common heritage as a result of trading or migrations within Europe. It is based on digital storytelling based on visual, digital, and transmedia performances [99]. Advanced methods in cultural heritage digitization is the scope of the VAST project. It achieves that with the provision of methods, techniques, and tools in order to support collaboration in studying, to enable annotation in digitization procedures and to exam-

ine significant moments of European culture/history [100]. The projects mentioned are only some of the numerous projects related to arts, culture, cultural heritage, and their connection to cultural informatics or technology in general. Table 1 has a collection of all the aforementioned projects followed by their main focus.

Table 1. List of projects related to culture.

Project	Start Year	Focus
ARCHES	2016	Inclusive Culture
CrossCult	2016	Reflective Societies
Gravitate	2015	3D Modelling
EMOTIVE	2016	Virtual Museum
PLUGGY	2016	Social Platform
ViMM	2016	Virtual Museum
ArchAIDE	2016	Technology to Support Archaeology
CulturalBase	2015	Social Platform
Riches	2013	Engage with heritage in the digital world
INVENT	2020	Inclusive Cultural Policies
CHIEF	2018	Cultural Literacy
UNCHARTED	2020	Societal Value of Culture
inDICE	2020	Impact of Digitization
SPICE	2020	Collaborative Approach to CH
CultureLabs	2018	Participatory Approaches
CREARCH	2019	Archives through storytelling
VAST	2020	Digital Assets & Advanced Digitization

2.8. Big Data and Cultural Heritage

The new "trends" in technology usually affect the research branches that are attached to it, and so, cultural heritage is examined from the perspective of big data. Big data usually derive from social media, online gaming, data lakes, logs, or frameworks that either generate or use large portions of data. For example, the authors in [101], examine cultural recommender systems in order to enhance user profiling. Talking of (user profiling), the tender on social media is a culture that includes user personas. The authors in [102] analyse how the data from the medium itself can possibly help upon building on this cultural trend of personas. Another interesting sector of culture and cultural heritage is games. The authors in [103] explain an algorithm for user clustering in cultural games. Intangible cultural heritage and the analysis on social media is the main theme of [104]. Specifically, the authors analyse the Transmission of the Feminist Intangible Cultural Heritage on Twitter. The perspective of multi-faceted analytics in the cultural heritage domain is researched in [105]. The authors present a data lake that offers both fundamental and advanced user and data/knowledge management functionality for big cultural data management.

However, one should think, why is big data examined as a different perspective. It is in fact the way that technology emerged and the interconnection of technology with humanities in this case brings to light huge amounts of data and their usage. Therefore, technologically we live in the era of big data, but theoretical sciences (e.g., cultural sociology) generate theories without technical background. A connection between the interdisciplinary field of both is thoroughly described by Bail [106]. In his research work, he tries to narrow the gap between theoretical sciences and technological advances, both related to data. He applies big data algorithms in order to extract information based on cultural sociology theories but concludes to big challenges, which can be summed up by the lack of metadata.

Many recent works try to tackle problems related to culture, cultural heritage, and cultural informatics from the perspective of big data [107–113]. The real question is why issues that keep existing in cultural informatics for years, are now being investigated from this perspective. The answer is quite simple. Like when the "Internet" offered a novel approach and paradigm shift to the museums presence, the same change is happening

today with the trending term "Big Data". People, worldwide, are directly connected to each other using the Internet, while the ability of them to be both consumers and producers of data gives birth to the term Big Data. The museums and cultural institutions should be present in this shift, either by applying algorithms and technological advances related to big data or by becoming part of the big data stream. It is inevitable that the role of social media in this change is significant.

2.9. The Role of Social Media

As we may observe, the advances of technology towards the role of data and their value affect directly fields like culture. In fact, if we dig deeper, we will realize that it was the social media that forced this change, this paradigm shift. However, what do social media have to do with culture. Prensky is the one that mentioned the terms digital natives vs digital immigrants in order to separate the generations of people who were born with technology in their hands versus people that faced technology sometime in their lives [114]. Despite the fact that Prensky mentioned the term considering the educational system, it is the part of technology that has to do with our everyday culture that leads the way. It all comes down to social media and how people react, discuss, share, behave, and express their inner culture, digital religion, economy, and culture. Understanding culture in social media, popular and celebrity culture, participatory culture, creator culture [115–120] are only some of the different angles from which to explore the influence of social media on people. What has changed with social media is not only that people have turned into prosumers on the web, but they also have the feeling of knowledge sharing that can turn everyone into an "influencer" with "followers"; of course, this feeling alters the "culture" of people. The aforementioned need to be considered when trying to analyse the future of culture in the online world, as the power of the medium—transferred to people—can possible guide the advances in technology.

3. The Future of Culture in the Online World

The future of culture in the online world is a matter that has concerned the research community for decades. It is not an issue or a problem that we came up with today and have to find a solution. On the contrary, culture and cultural heritage management remains in the discussion of how we should deal with it in each era and its modern world. Every time, this issue has to be tackled by trying to foresee what is the factors that lead both the research part, the advances that affect the research, as well as the issues that are related to the audience.

3.1. The Role of the EC

As already mentioned, a large number of European projects have been conducted over recent decades, having as their main topic culture, cultural heritage, a combination of humanities and technology, and so on. Actually, behind this huge funding on behalf of the EU, there is a strategic plan concerning culture and cultural heritage. There are two ways to examine the strategy of the EU towards culture. The first one is to directly analyse the strategic framework and the second one—the indirect—is to analyse the axes of funding for cultural related projects for the upcoming period. As it is expected, the first one will be based on more generic pillars, while the second one will specialize on what is expected to be the future of research and innovation.

According to the strategic framework of the EC (https://culture.ec.europa.eu/policies/strategic-framework-for-the-eus-cultural-policy (accessed on 5 June 2022)) for the period 2019–2024 there are six political priorities that affect the key themes of European cultural cooperation.

- A European Green Deal;
- A Europe fit for the digital age;
- An economy that works for people;
- A stronger Europe in the world;

- Promoting the European way of life;
- A new push for the European democracy.

All these political approaches for the future of Europe define the agenda for culture by introducing three strategic areas.

- Social;
- Economic;
- External.

These very generic areas are further analysed into work plans, coming to the actual vision for the needs of CH and its future. These include:

- Sustainability in CH;
- Cohesion and well-being;
- Ecosystem supporting artists and professionals;
- Gender equality;
- International cultural relations;
- Culture as a driver for sustainable development.

By analysing the funding tenders of the Pillar II (https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/cluster-2-culture-creativity-and-inclusive-society_en (accessed on 5 June 2022)) it is possible to recognize how these work plans will be supported and implemented. It is obvious that EC recognizing issues related to governance and democracy. As such, a proportion of funding is based on protection and nurturing of democracies, as well as reshaping them. The second part is directly related to cultural heritage and includes green technologies, new ways for sustainability in museums and cultural institutions, advanced technologies for preservation and enhancement of CH. Furthermore, connection and engagement with stakeholders is considered to be an important factor while a number of innovative research is based on the changing trends of technology and future. The latter includes support in a changing world of work and protections; key drivers for inequality trends; skills and early school problems; new technologies in education; public policies for well-being and sustainable development; spatial mobility; gender and social, economic, and cultural empowerment; and development of skills matched to needs. It is obvious that the EC is focusing on the problems that concern more and more people, not only in the EU but worldwide. The role of technology to achieve the aforementioned work plans should be crucial. Technology is the medium to resolve these issues in a more efficient way.

Despite the fact that the EC strategic plan seems to be focus on people and communities, there is a strong need of analysis of the peoples' trends towards culture and technology in order to recognize which should be the best approach towards approaching the issues raised.

3.2. An Institutional Approach

The European Commission leads the research based on political key themes and approaches. It is important to analyse the issue of culture and technology from an institutional approach. This approach is considered to be closer to the stakeholders, as well as the daily trends of people in the changing world. An interesting report published in 2016 by New Media Consortium [121] tries to predict the technological changes in the museum. The reality that is described through challenges, trends and technology developments envisages a future of museums that are very much related to technology. The challenges have to do with effective digital strategies, and improvement of the digital literacy of museum professionals. It is obvious that the report believes the strong attachment of culture to technology, such that professionals (mainly with a humanities background) need to adapt to technology. It furthermore states that some challenges may seem impossible to tackle, such as privacy and knowledge obsolescence. Finally, difficulties that are reported and should be taken under great consideration is the accessibility for disabled people and the measurement of the new technologies' impact.

The approach is accompanied with the technology trends that could help improvise the challenges. These include focus on mobile (content and applications), personalization, and participatory experiences, as well as data analytics as part of the museum operations.

All the aforementioned deal with a large amount of data within a museum or culture generally. However, the aforementioned also introduces another axis which is the universality of the "system"; this related to cultural heritage and cultural informatics when it comes to people-centric approaches. Data cannot be encountered as an autonomous piece of information or as part of a small collection of objects. Nowadays, culture is universal, people are able to communicate and exchange information fast and universally. This is the reason the report focuses on long-term trends, such as collaboration between institutions and new roles for museum professionals. At the end of the day, culture belongs to people, not only the ones that are able to access a museum exhibition (on-site or online). The situation today is such that the visitor-centric model has to be re-introduced.

In parallel, it is important to recognize what is the strategic plan of the universal cultural institutions. For example, the Smithsonian Institution (https://www.si.edu/sites/default/files/about/smithsonian-2022-strategic-plan.pdf (accessed on 5 June 2022)) has clear goals for the future of culture: engage, inspire, and impact. These goals are fulfilled by having a digital-first strategy (mainly focused on mobile-first), understanding the 21st century audiences, driving visionary interdisciplinary research, preserving natural and cultural heritage, providing a more efficient administrative infrastructure, and by looking out-of-the-box on a global level.

Another important institute, the Getty Institute having as its core mission: "...working internationally to further the appreciation and preservation of the world's cultural heritage for the enrichment and use of present and future generations", has as its strategic plan to put the focus on:

- Society's role in conservation decisions;
- Respect for diverse cultural values;
- Research;
- Education;
- Exploration;
- Sustainable solutions;
- Communication;
- Inclusiveness;
- Continuous learning and renewal.

These axes are absolutely aligned to the strategic plan of the EC, as well as with the report from NMC and the Smithsonian Institute. We should not forget to mention the two large initiatives by the technology giants Microsoft and Google, the first one with its initiative called AI for Cultural Heritage (https://www.microsoft.com/en-us/ai/ai-for-cultural-heritage (accessed on 5 June 2022)) and the second one with its platform called "Arts and Culture", launched 11 years ago, which intends to incorporate high-end technological advances to arts and culture in order to provide unique experiences to people around the globe (https://artsandculture.google.com/ accessed on 5 June 2022).

It is inevitable that there is a huge turn to a model that puts humans in the centre. In fact, today, the audience is broader than ever, including the whole universe. The multiculture of the Internet, the capability to be in any place in the world at any time, and sharing and receiving information has eliminated any barriers, physical or not, that could limit cultural exchange. Additionally, despite the fact that this sounds like an ultimate wish, in contrary it leads to devastating results. The speed with which information is shared and transferred is such that any piece of information has a very short period of life. This short period of life is catastrophic for any kind of culture on the medium. This is because it does not let people think, realize, and absorb any kind of information. What can be done in order to encounter this problem is a matter to be discussed. Firstly, the research has to put its focus on this issue and perform detailed interdisciplinary research in two axes: The first

one, an horizontal axis, needs to examine the spread of culture across the world, while the second one, a vertical axis needs to focus on the locality of culture.

3.3. Horizontal Analysis

The horizontal analysis can also be thought as an holistic analysis, whose scope is to examine how the culture is spread from country to country, how it is transformed and how it is identified. It is the culture of the online world, the world where information is transferred in high volumes and speeds, such that people are unable to observe it and understand it. In order to understand culture in the online world, there is a need to define it and analyse it. The types of culture that derive from the online world, usually, are expressed by each times trends. However, in fact, the trends are constantly changing, creating the belief of the ephemeral. Talking of which, it seems like a cultural trend of our era is to get used to the ephemeral.

This horizontal analysis is missing from the approach and it seems to be a prerequisite in order to recognize the culture as a whole.

3.4. Vertical Analysis

The vertical analysis, also known as the analysis of the natives, has as its scope the recognition of the connections of the fast changing online culture to each area's culture of the past. Each individual person is defined by his or her past. On these grounds, there is a strong need to empower and highlight the connections of what is considered as modern culture to the inner culture of each individual. This analysis will help people understand that their roots, their own definition, have a part in the globalized world. In addition, it is the mix of cultures that helps the evolution and, as such, we need to know our roots and how they are connected to our present and the stimulation of our reflections by the objects (real or digital) that we come across daily.

3.5. Technology as the Key to Unlock the Future of Our Culture

As technology advances more and more, and as the expectations of people become higher and higher, culture needs special attention and treatment. It seems that the limitations deriving from lockdown due to COVID-19 put pressure on cultural organizations to modernize their procedures in order to provide better experiences for people.

Although 15 years ago we were introduced to the "virtuous circle" as the noble procedure that has to be followed in order to achieve maximization of experience using a combination of online and on-site tools [122], the situation today has changed significantly. What we believe is the future of culture on the web relies on three factors:

- Recognize the types of culture of our era;
- Interconnect the different cultural categories;
- Intervene to the cultural circles in order to create a "virtuous spiral".

First of all, as part of every era there is a strong need to recognize the different types of culture. Either we are talking about "high culture" or subculture and "trash", there is a need to identify the culture and connect it with socio-economic conditions. The new medium (internet) has changed the way we produce culture in speeds that is impossible to follow. The digital natives [114] live and create in a different cultural environment, while digital immigrants deny this change leading to a wider generation gap. The different types of culture synthesize our lives, either online or offline, and the sooner we understand it, the sooner we will decode it. In this procedure, technology can play an important role as most types of novel culture is produced digitally or at least a digital medium is used for their transfer and spread. Every new generation needs to segregate, usually carrying a culture of the past, integrating into it a new "feature". However, in the era that we live in, it seems that there is a total denial and renunciation of any past type of culture, which proved to be catastrophic in the past. Technology is the medium to help us recognize and record all the new types of culture in order to understand the future and shape it. It is obvious that we have the underlying technology; the variety of the research projects' approach is the proof.

It is also obvious that we have the willing; the strategic plans from the EC are clear both from a political and socio-culture perspective. Finally, the cultural institutions' approach.

Secondly, it is important to recognize the monoculture of the web, the straight line that does not have ups and downs and does not have something to offer to an individual (educational, social, psychological, etc.). The speed of information, the constantly changing trends and the nihilism of everything does not enable a person to get accustomed to a type of culture, leading to incomplete personalities or personalities without any interest. In this case, we need technology to stand by people and create interconnections with the past. What we are is our roots, and how we behave is our culture. The indifferent culture of the online world will create indifferent generations. Technology can play the role of the culture carrier and connector. All kinds of emerging technologies, especially those with high levels of immersion, are a perfect example of the connection of the cutting-edge technological features (which produce the higher stimulation to the new generations) with the culture of the past. This, of course, means that the cultural spaces and organizations need to enter the technological era, produce digitized objects and tons of metadata so that technology can play its role. Now it becomes clear, that technology together with understanding all new types of culture-online included-will become a carrier of information in order to interconnect the future of culture to the past.

Third, and most important, we believe that we live in the era of the "virtuous spiral" (Figure 1). Although the virtuous circle is a procedure that always leads to the same spot, it remains a two-dimensional shape. The Internet proved to be the medium that actually connected all the world in a common culture. It is the place to expose common roots and common paths together with the differentiation of the individual. Through the virtual spiral, each individual remains in a state of continuous acquisition of new incentives in order to explore cultures so that a person can shape its character. In fact, the ultimate goal is a multi-spiral shape with each spiral emerging, while, in parallel, connecting to each other in a never-ending shaping of the personality. The spiral includes the steps of:

- Searching;
- Growing expectations;
- Visiting (either online or on-site, or any other form);
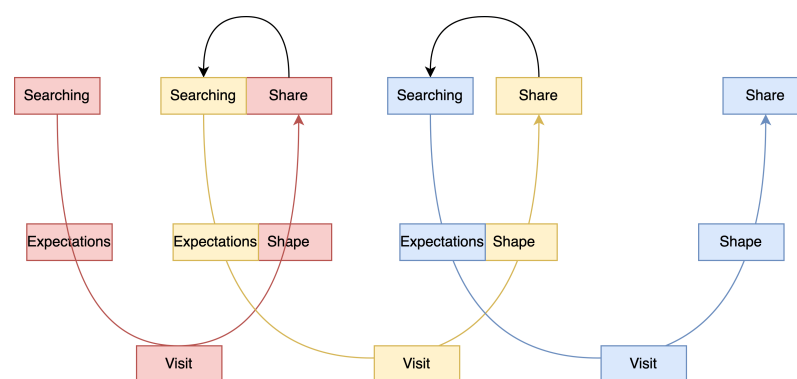- Shaping reflections;
- Sharing of information.

Figure 1. Virtuous spiral.

Analysing the steps, the part of sharing of information is the one leads to the results of searching for another, creating in this way the never-ending spiral. On this occasion, there is a strong need to understand that, despite the fact the on-site visiting of cultural objects may be considered as the ultimate experience, the direct contact with the object could not be considered as indispensable in our era. On the contrary, the experience can be acquired with the help of technology. In other cases, which are more frequent as time passes, the "object" does not exist to be exhibited in a real environment but has solely digital form (e.g., NFTs).

The fourth and fifth steps reveal the importance of "crowdsourcing" for our common grounds. On this occasion, crowdsourcing stands for shaping and sharing. It is obvious that culture flourishes with the exchange of information. Although people tend to become prosumers, technology can provide the essential tools to record the shaping of reflections for every time someone has a contact with a cultural related object (online or offline); this is the important information that has to be shared across the huge network that interconnects all people, the Internet. The spiral closes with the fact that a person's searches for information is someone else's sharing of information.

The role of data in the shaping of the proposed model is critical. We live in an era in which people are bombarded with big data deriving from the Internet. People are either of a state of connected (awake) and disconnected (sleeping), and during their connection they are interacting with information that is largely related to culture. In this notion, the amount of data that are formed, the role of the advances of technology, the contribution of the projects in order to end up in this status, reveals a strong need for a reformation of the way we think of a user-centric model in culture. The main condition of the proposed model is a united model for culture under a common infrastructure. Additionally, while the Internet provides the infrastructure, large steps are still needed by the cultural organizations in order to shape a universal model to confront the universality of culture.

4. Discussion

The expansion of the web that lead to culture spread across the globe in little time changes the way we face our multi-cultural universe. In fact, we are entering a mixed culture world in which people are changing their cultural approaches very quickly and directly. The "direct" part is the desired one, but the factor of speed (fast) is not. On these grounds, the cultural exchanges cannot be possibly understood and if absorbed there is no clear evidence or awareness of the habits or behaviors.

This world is shaped by the changes and advances in technology. Despite the fact that technology analysis leads to a large number of different approaches, nowadays it is obvious that everything is lead by data. We described the different aspects of data in cultural informatics. Starting from the large paradigm shift of the Internet, progressing the Virtual World, the analysis of data and metadata, as well as the digitization (i.e., the production of digital assets—data). Furthermore, we discussed the algorithmic approaches and the adaption of the visitors, and described a number of important EU funded projects related to culture and technology. Finally, we described big data and the role of social media in the shaping of today's culture.

Talking about the future of culture in the "connected world", we examined the strategic plan of the EC, as well as the approaches from institutions. It is obvious that all of them believe that culture must play an important role in the connected world. We need to redefine our view of people in cultural informatics and follow strategic plans that involve everyone as a unity and as a whole in a museum's procedures.

It seems that the term "big data" will follow several aspects of our lives and culture is not to be excluded. The trends to be followed should include a universal approach with free, open, connected data, collaboration between institutions and definition of new, important roles within the procedures of a museum.

As per the user perspective, the universal character of our future, leads as to a model that keeps "spinning" around culture; culture all over the world. Each one becomes the consumer of cultural experiences, and producer of reflections, feelings, and information for herself and everyone else. We believe in a novel culture approach by defining the spiral of culture. Technology can help us identify culture and create never-ending connected experiences.

In conclusion, we believe that the sector of cultural informatics should put the focus on the universal, holistic, data driven, user-centric approach. The approach is affecting all technologies used to create experiences for visitors, either on-site or online. The "tradi-

tional museum" remains a unique experience, but visitors demand multi-level interaction, and technology is the medium to achieve it.

Abbreviations

The following abbreviations are used in this manuscript:

NFT	Non-fungible tokens
CI	Cultural Informatics
VR	Virtual Reality
AR	Augmented Reality
ER	Enhanced Reality
XR	Extended Reality
MR	Mixed Reality
ML	Machine Learning
AI	Artificial Intelligence
CH	Cultural Heritage
EU	European Union
EC	European Commission
NMC	New Media Consortium

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