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GIOVANNI CURIONI'S DIGITAL MUSEUM (2/2): POSSIBLE STRATEGIES FOR A DATA MANAGEMENT PLAN

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KEY WORDS: Digital management plan, Sharing platforms, FAIR, Data circulation, Interoperability.

ABSTRACT:

In recent years, the Politecnico di Torino (Italy) is undertaking actions to promote and disseminate its historical archival and material heritage, both with onsite events and with digital tools and platforms dedicated to its digital museum. One of its most important collections is the Curioni's one (1860-1887). It preserves reproductions of building structures used as teaching aids in the teaching of Construction Science. We are now working on the digitisation project of those artefacts, and we propose a study on the data management protocol structured to satisfy the FAIR principles (Findable, Accessible, Interoperable, Re-Usable). In fact, with the purpose of sharing and enhancing its materials, the Politecnico promotes the digitisation of its entire collection of Curioni's models, to create a new section of its virtual museum. To this extent, one goal of our research is to foster the accessibility of this tangible heritage in the digital domain. In accordance with the Italian national digitisation plan, PND, we defined a Digital Management Plan for the cultural heritage products, DMP, to guarantee FAIR principles in sharing 3D digital artefacts of the Curioni's collection. The DMP originated as public administration data management, but the result of this study demonstrates its usefulness also for digital cultural data management.

1. INTRODUCTION

The 'Giovanni Curioni' collection of wooden models hosted by the Department of Structural, Building and Geotechnical Engineering of the Politecnico di Torino (DISEG) bears witness to the commitment to the educational field of construction science made by Professor Curioni in support of the teaching content published in his volumes *L'arte di fabbricare. Costruzioni civili, stradali e idrauliche* (*The Art of Building. Civil, Road and Hydraulic Constructions*) published in 1870's. The didactic function of models is now being rediscovered as part of a project of valorization and vivification conducted by a composite research group[1]; specific skills and disciplines converge in it: in the field of construction science Professor Mauro Borri Brunetto; for the responsibility of the cultural and scientific heritage of the University the architect Margherita Bongiovanni and doctor Francesca Gervasio; on the sciences of representation and information modelling the Authors of the contribution; on geomatic and measurement skills Professors Marco Piras and Paolo Dabove and the engineer ...; as support to acquisitions and elaborations the DISEG technician Pierluigi Guarrera and the student engineers Jose Luis Reyes Mesias and Tommaso Verdier. The articulation of the research group testifies the intra- and multi-disciplinary interest of the collection to which it is intended to associate an intangible dimension related to the informational heritage of educational character that it is possible to update, consolidate and continue to transfer to future generations.

With the occasion of the CIPA 2023 conference, we wanted to propose two foundational aspects of the work being conducted, presented individually in two contributions, of which this first one represents the methodological setting and the approach to the subject from a point of view of the survey system and processing procedures, also with reference to material and digital products. The second contribution (Giovanni Curioni's digital museum: possible strategies for a data management plan) returns in a complementary way to this first one the relevant elements for data management and its organisation within information containers for knowledge.

The aspects of interest that will be highlighted in this contribution reside mainly in the nature of the tools employed, critically compared, and in the ways through which parametric digital models operating within integrated information systems are arrived at.

Recently, the Politecnico di Torino (Italy) is undertaking actions to promote and disseminate its historical archival and material heritage, even with digital tools and platforms. With Curioni's collection digitisation project we study a data management protocol to satisfy the FAIR principles (Findable, Accessible, Interoperable, Re-Usable). The Curioni collection, 1860 - 1887, presents 141 models, reproductions of building structures, such as retaining walls, foundations, reinforcements for the construction of bridges, railways, tunnels, building site structures, hydraulic constructions, and vaults, used as teaching aids in the teaching of Construction Science.

2. STATE OF THE ART

In the last decades, the issue of digital cultural heritage arose. In the last decades, the issue of digital cultural heritage arose. In

[1] Attribution note: all authors contributed equally to the research. In writing paper, MMB is responsible for paragraph 1; MPV and LG for paragraphs 4; MP for paragraph 2, 5; MP and LG for paragraph 3.

2002 the Library of Congress (Washington, US) questioned the need to preserve digital heritage (hence digital data) and presented one of the first projects focused on digital infrastructure and preservation. This project led to the definition of a digital preservation architecture or the »technical framework that specifies the structures, logical components, and logical interrelationships of a system that enables digital preservation through a network of partners». Later on, Zorich (2003) catalogued some digital cultural heritage projects within the US and found out that they were differing in (among many issues): missions (serving the needs of a particular profession or discipline, developing and maintaining a digital product, explore digital arena and promote beneficial digital cultural heritage policies, contribute to the public good); products (digital library and portals, e-publishing, online education and scholarly databases, online reference databases, software tools, supplemental resources); services (advocacy, consulting, education and training, funding, networking opportunities, pilot/tested/proof-of-concept projects, technical and user support, other services); organisational types (fee-based, content-based, consortial-based memberships, independent research projects and programs, independent research organisations); governance and staff models; needs assessment; founding history and financial support (such as private foundation grants, public grants, membership fees, etc.); business models; sustainability issues. This first example highlights the importance of defining the main characteristics of a multi-layered context where data must be acquired and managed.

Meyer et al. (2007) propose a strategy for building a virtual research environment for the management and dissemination of cultural heritage data and information. This project consists in a digital archive of archaeological datasets with innovative data inquiry through clickable maps and 3D models e attractive visualisation and communication of the site information thanks to thematic and interactive interfaces. The tool combines survey, modelling and imagery data, thus offering possibilities for new management and the dissemination of these data. Their contribution is of interest to us due to the vast diversity of data that constitutes the document 'folder' of the platform; among them we find pictures, 3D models, drawings, etc. (Meyer et al., 2007, p. 404).

Other issues related to data management are long-term preservation and permanent access. In these cases, we deal both with the necessity to maintain and refresh the hardware structure on a regular base and with the necessity to produce data complaining with international archival standards, such as the ISO Open Archival Information System (OAIS) which allow a careful registration of metadata (van Wijngaarden, 2007, pp. 103-104). Nonetheless, these processes deal with the notion of software obsolescence. In this sense, we must take into consideration the issue of interoperability within the digital preservation process which is defining digital preservation as an infrastructure service (Dobreva and Ruusalepp, 2012). An interesting example of a digital ecosystem applied to management and inventory of cultural heritage data and information is the Arches project, developed by the World Monument Found and the J. Paul Getty Trust (Carlisle et al., 2014). This project aims at «improving the management of heritage worldwide through the use of more effective inventory systems», especially in the 'long-term' perspective. The system is based on two CIDOC ISO standard: the revised International Core Data Standard for Archaeological and Architectural Heritage (CDS), defining the data fields in the generic version of the system, and the CIDOC Conceptual Reference Model (CRM), providing the semantic framework. Here, we find the difference between the system structure and the semantic framework of a data management plan.

Similarly, Christiodoulakis (2014) highlights the necessity to define a digital cultural data curation plan aimed at collecting, overseeing, and documenting (thus creating metadata) of and for digital cultural heritage, especially for its future sharing with the public and professionals/researchers. He recalls the different approaches already noted by Zorich (2003).

As stated by Nicholson (2013, p. 14), in recent years the massive digitisation allowed many scholars to research within 'unexplored areas' that were not questionable before the so-called digital turn. Nonetheless, such new kinds of research are now possible due to the increasingly accessible digital archives. In this sense, Haus (2016) underlines how digitization projects allow institutions that own cultural heritage collections to preserve them in the digital domain on their own. And this is true if we can formalise procedures and management of heritage digitization and sharing of data that can be dematerialized and then resynthesized, and data that cannot, either for physical reasons (i.e. 3D objects) or logical reasons (i.e. intangible information). Both of those information must undergo a data management plan, in order to be fruitfully preserved, accessed, and shared, thus highlighting data management as a global challenge (Simm et al. 2016, p. 215). For cultural institutions, especially for museum, this shift towards a digitization of data and its management appears to be a gradual process (Taormina, 2019), allowing data management to better face the sharing issues, and pushing the concept of digital museums not only to offer 'digital surrogates' made of images, database records and many other resources, but also to provide instant access to the latest knowledge about the museum collection (Marty, 2008, p. 84). Still, Poulopoulos and Manolis (2022) record that even the cultural heritage field is now led by data, because of a 'connected world' which is going towards the idea of 'cultural informatics'. The latter should face visitors' new demands of multi-level interactions with museums and heritage, where technology is the medium to achieve it.

The Council of Europe with its Resolution 474, point 8b (2021, p. 3) highlights the importance of digital technology on how cultural heritage is perceived and dealt with. Still, with its Recommendation 463, point 7, it makes clear the necessity to define «new tools and instruments to implement appropriate policies [for cultural heritage and digital technologies] at all levels of government (CoE 2021, p. 5).

Still, according to Europeana, cultural heritage and its stakeholders need to face the digital transformation, namely being «both the process and the result of using digital technology to transform how an organisation operates and delivers value» to reach digital maturity, which is the « ability to use, manage, create and understand digital, in a way that is contextual (fit for their unique setting and needs), holistic (involving vision, leadership, process, culture and people) and purposeful (always aligned to the institution's social mission)» by building the capacity to deal with such process (Europeana/Culture24, 2022, p. 3).

Another active research field addresses its interests towards the correlation between tangible heritage, its digital reproduction - often referred to as 'digital-twin' – and their metadata and data (Ćosović and Maksimović, 2022). In this field, a main issue is that of historical building information modelling (HBIM), that usually merges metric, historical and technological survey data of a tangible artifact with its digital and parametric models. In this sense, parametric objects contain geometric information and associated data and rules plus can link to or receive, broadcast, or export sets of data of different kind (Eastman et al., 2011). Representation of these sets usually generate: 2D or 3D

drawings, tables, and reports, digital explorable objects (via AR or VR) (Lo Turco, 2015; Palma et al., 2022).

These examples allow us to introduce another fundamental aspect of data management, which is related to common policies for data sharing. In this sense, the PARTHENOS project (Di Giorgio and Ronzino, 2018; European Commission, 2019), founded by the European Commission, provides good guidance by establishing the FAIR principles (Wilkinson, et al. 2016) for a fair data approach to be needed. To comply with the FAIR principles data must be:

- Findable – Easy to find by both humans and computer systems and based on mandatory description of the metadata that allow the discovery of interesting datasets;
- Accessible – Stored for long-term such that they can be easily accessed and/or downloaded with well-defined licence and access conditions (Open Access when possible), whether at the level of metadata, or at the level of the actual data content;
- Interoperable – Ready to be combined with other datasets by humans as well as computer systems;
- Reusable – Ready to be used for future research and to be processed further using computational methods.

A good data management plan must take in consideration all these properties. Moreover, if we look at the future usability of FAIR data, the issue related to interoperability of the digital data in the general sense lies in the facility of integration or linking with other existing or future datasets (UNESCO, 2003). Still, the definition of interoperability by the Italian Central Institution for Cataloguing and Documentation (ICCD, 2022) is a model based of 'Triennial informatic plan for the Public Administration' and composed of:

- the cataloguing standards of the ICCD, released incrementally in XSD (XML Schema Definition) format;
- the controlled vocabularies in use in the SIGECweb system published in open format on the basis of the SKOS (Simple Knowledge Organisation System) standard;
- ontologies, in particular the ontologies of the ArCo project.

It is not coincidence that one of the main pillars of managing a 3D model is its interoperability feature.

From the point of view of the discipline of Representation, we must recall the INCEPTION project (Maietti and Balzani, 2017). Based on the relation between 3D documentation and modelling of heritage assets, the project set up a common framework for knowledge management, advancement into the integrated 3D data capturing methodology facing the semantic modelling for Cultural Heritage buildings in a H-BIM environment. The main outcome of this project is the INCEPTION platform (http://www.inceptionhbim.eu/platform). This is an open-standard web semantic platform for accessing, processing, and sharing interoperable digital models and related digital data, integrated with on-site and off-site applications developed for a wide range of users (Balzani et al., 2018). In this case the focus is the data management and sharing.

2.1 Digital environments for digital museums and data sharing

Once data has been acquired and a management plan has been defined, we can evaluate how to present them to the public. To this extent, we have many solutions available, but they are closely related to the type of data we want to make FAIR. In our case study, we want to share visual data (historical drawings, 3D models, pictures) and textual data of Curioni's models; we also aim at integrating such data into the digital archival/museum of our Politecnico, https://collezionistoriche.polito.it.

In this sense, a first example of a digital archive with data sharing capabilities can be the Gallica project, which is the digital library of the Bibliothèque nationale de France and its partners. It has been online since 1997 and offers access to several million digitised documents such as manuscripts, books, maps, photographs, videos, audio records, and more. Each item is filed with standard data related to title, year, author, etc., and is described with digital images/files that are available to download by users in .pdf or .jpg formats (Bordier, 2023) (Fig. 1). This example is of interest for the implementation of data management between backend and frontend user interface. In fact, the structure of the online 'database' may host a multiplicity of visual and textual data.

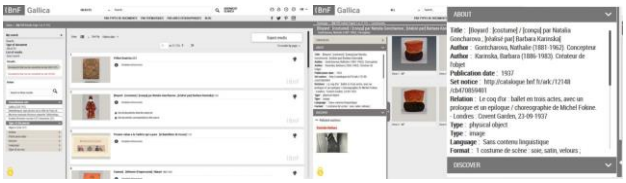


Figure 1. Example data sharing in Gallica.

Another interesting example is the Museo della Rappresentazione (Museum of Representation) of the Università degli Studi di Catania (Catania, Italy). Established in 1996, the museum now hosts an online digital twin of its exposition. In this case, there is no possibility to download any content, but the user can freely navigate into the digital museum and can even measure digital objects. Moreover, the website of the museum holds some digital explorable models of reconstructed architectures (Santagati et al., 2020), that are hosted via external services such as Sketchfab, a 3D model platform or implemented in the museum website with Unity and webGL protocols (hence VR ready) (Fig. 2).

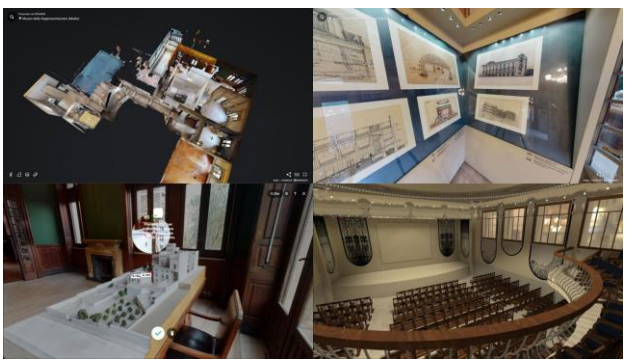


Figure 2. Examples of digital museum explorations of the Museo della Rappresentazione.

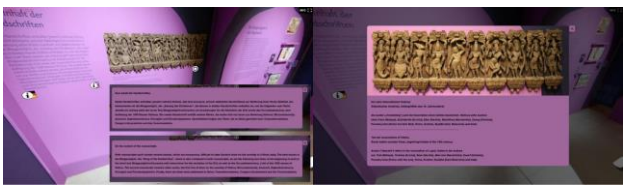


Figure 3. Example of textual and visual data enrichment of a digital museum environment (Universität Tübingen).

A third example comes from the digital museum of the Eberhard-Karls-Universität Tübingen (Tübingen, Germany). This museum is the digital extension of the physical one. It provides many types of data on objects of its collections. Those objects are filed and described with texts and pictures. Moreover, in the last years the digital museum started to implement 360° digital exhibitions (with 3D navigable models

enriched with textual and visual data on exposed artefacts) (Fig. 3) and it will host a 3D-museum (not yet available). 360° tours are VR ready.
These three examples allow us to define a framework of two main possible applications for data management and data sharing. First, we recognize environments specifically created for full data sharing (meaning that all data is available for users to download); then we find environments that favour a visual sharing of data (partially allowing its availability as 'off-line' sets).
The recently established digital archive and museum of the Politecnico di Torino (collezionistoriche.polito.it/) can be situated among the second type of environment. In this case, in fact, the site is based on the Archiui platform (www.archiui.com), which provides solutions for digitization, cataloguing and management of archival data. In this sense, the platform bases the catalogue of digital objects on a customised framework (collective access) like one of ICCD, so that digital archives/museums can be structured on digital catalogues and collections. The example of the Politecnico's digital museum provides many data on some collections (filed online) such as texts and images (Fig. 4). Nonetheless, the structure of the site is still ongoing, so our goal is to implement its database with other kind of information, such as 3D models enriched with other visual data.
It must be noted that this site is the third declination of the online digital archive and museum of the Politecnico di Torino. The previous two examples are still online. We discuss them in Paragraph 4.

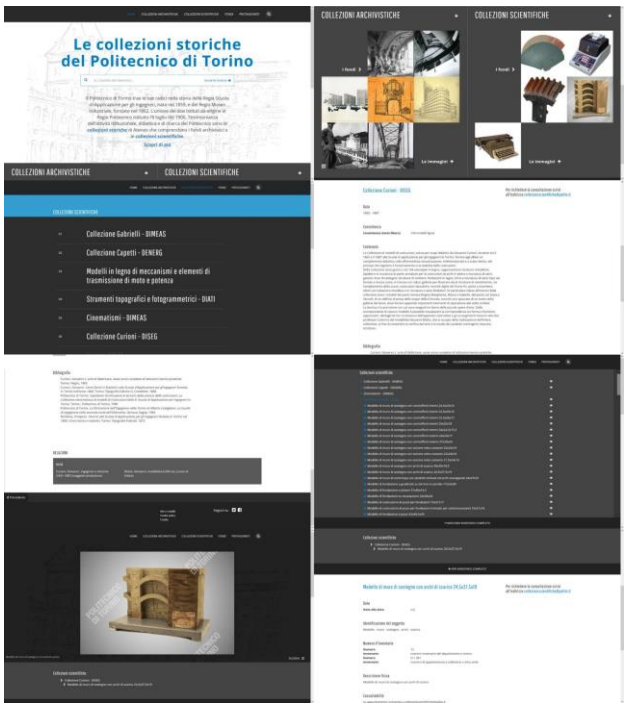


Figure 4. Example digital archive/museum of the Politecnico.

3. METHODOLOGY

With the purpose of sharing and enhancing its materials heritage, the Politecnico di Torino is promoting the digitisation of its collections of scientific artefacts. The main aim is to create a digital archive and a digital museum. Among its collections, we find that of Curion's models. To this extent, one goal of our research is to foster the accessibility of this tangible heritage in the digital domain, in the sense of Hylland (2017), so by promoting its digitization and its popularisation through online sharing. In this way there are new possibilities of documentation, representation, and communication of cultural heritage (Sullivan at. al, 2017).
In this sense, the preservation and exploitation of this kind of cultural heritage led us to acquire and generate various and diverse datasets: digital survey data, digital 3D models, digital pictures, etc. In light of the premises expressed in the previous paragraph, the administration of these data is a crucial duty, not only in the acquisition phase, but also in the management one. So, for us a prominent challenge is the creation of computerised data management systems for the storage and the utilisation. In this sense, our contribution focuses its attention on the digital data management plan as a key issue in the digitization processes of tangible heritage (Fig. 5), thus in the whole set of actions focused on leading tangible heritage into the digital domain. It is useful to specify that our work omits to discuss digitization of intangible heritage, since our Politecnico is now working on a digital archive/museum dedicated to its tangible heritage.
The work involved the search of the best workflow to adopt for the definition of a data management plan that would focus, not only on the mere management of the data, but also consider the possibility of dynamically intervening in its maintenance and updating over time, thus making it possible to take full advantage of future technological and methodological innovations.

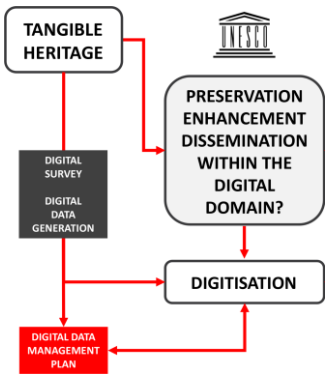


Figure 5. Cultural heritage in the digital domain.

This objective was pursued bearing in mind that the greatest difficulty encountered in the management of data turns out to be its correct classification, whether we are talking about the metadata related to it or the format with which the data is stored. It is historically evident that with technological evolution new data formats appear and others fall into disuse. It is therefore necessary not only for the format to be continuously updated, but also for the metadata associated with the 3D object to conserve the updating of the various formats to which that same data has been subjected (Blundell et al., 2022, pp. 158-202).
Working with this methodology, it is possible to understand how it is necessary to consider throughout the life cycle assessment (LCA) of the data the various intermediate products that were used to the generation of the 3D model. These intermediate products must be archived not only to have an effective backup in case of need, but also and above all to allow the various researchers and operators who will interact with the same data in different time to intervene at different levels, thus being able to create an archive that allows, for example, the identification of best practices for the specific case. It is unthinkable that all objects require the same acquisition procedure, which is why in this way it would also be possible to analyse the various procedures, taking, archiving, and updating

carried out used in the past, identifying best practices in the specific case. Every museum reality has its own intrinsic peculiarities that require certain attention to make a Data Management plan effective (Fig. 6).

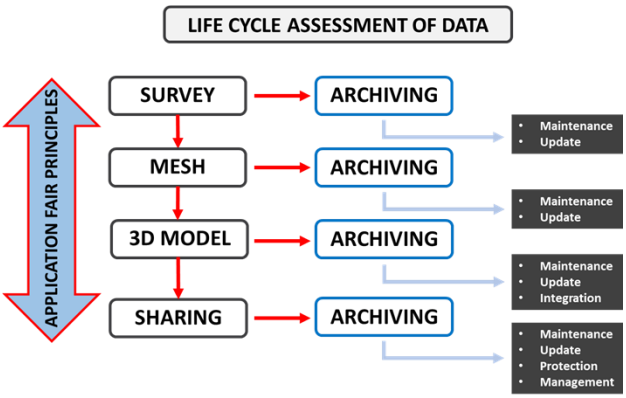


Figure 6. Archiving in life cycle assessment of data

Working with this conception, it's immediate to understand how not only the local reality influences the preservation of the data itself but the definition of final public is the first step to define the methodology of data acquisition, the period of updating of the same and the choice of the final format of publication in relation to the digital platform created and/or used.
These choices have a direct influence on the management costs that an organisation has, for example an object destined for a public of researchers must transmit not only the geometric details but also the texture in the best possible quality, such data will probably require the application of the most innovative acquisition techniques that will lead to a finished product that will certainly occupy a large storage space. On the other hand, an object intended for a different public, for example a curious people with no need, may not require such a detailed reading of the details, thus decreasing the size of the final product (Fig. 7).



Figure 7. data sharing processes in the context of the National Digitisation Plan (Authors after ICCD). **I)** digital model construction and enrichment; **II)** model inserted into data management plan; **III)** verification of model compliance to set standards; **IV)** model sharing.

4. APPLICATION

The research conducted developed in parallel with the phases of the realisation of the digital models of Professor Curioni's collection of material models stored at the Politecnico di Torino. Already during the first phases of the analysis of the documentary sources for the realisation of the models, not only the archive documentation and the available physical models were analysed, but at the same time a survey and analysis of the digital heritage already realised by the offices in charge of the University was carried out. From the initial investigations, it was possible to understand how this digital heritage presented 'structural' criticalities, first of all found in the redundancy of the data and in the absence of their correct indexing, which consequently led to a jumbled overview of the existing digital heritage, but above all represented an incorrect and ineffective management/consultation of it by insiders and end users.
It is very important to reflect on this first aspect, i.e. the difficulty of reading the data as a whole and their redundancy: today the digital heritage of the Politecnico di Torino is hosted, catalogued and archived on several digital platforms, independent of each other, but above all, completely unrelated to each other. Virtual museum sections may be hosted, depending on the type of asset, within more than one of the University's own sharing environments, such as, to name but a few (Fig. 8):

- https://areeweb.polito.it/strutture/cemed/museovirtuale/index.htm;
- https://areeweb.polito.it/strutture/cemed/001/Index2.htm;
- https://collezionistoriche.polito.it/,

thus compromising the overall reading of the sources and invalidating the work of cataloguing data.
This criticality is due to the lack of a unique internal DOI (Digital object identifier): the sharing environment must possess different features, one of these is DOI, that when assigned to a digital object may provide a unique identity. The fragmentation and duplication of data within multiple sharing environments, belonging to the same data owner, are therefore a testimony to how, to date, data management is entrusted to the greater or lesser temporal capacity of data preservation within one's own digital archives; in accordance with what Munster also wrote, data, be they of various nature and origin, but especially 3D models are rarely preserved for more time, their online existence and usage have a typically short-lived. (Munster at. al, 2016). In fact, the biggest problem is not the acquisition of data itself, but its management: repository, depository and sharing platforms and all digital data face long-term maintenance and compatibility issues (van Wijngaarden, 2007).

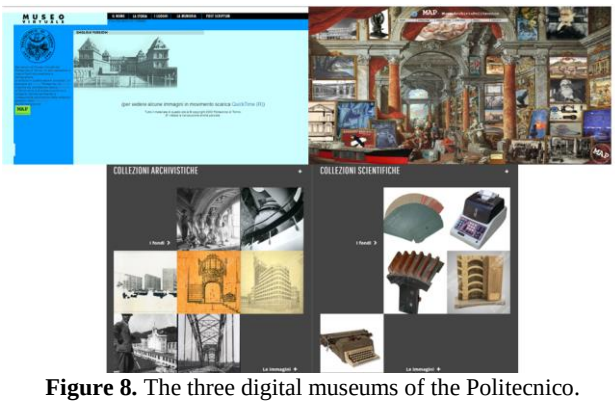


Figure 8. The three digital museums of the Politecnico.

Therefore, having analysed the state of the art of the digital heritage of the Politecnico di Torino, but above all, having

understood the critical points on which to work in order to optimise the management of existing data and to be able to realise a digital museum based on correct data management strategies, it was essential to start from the definition of the main objective to be achieved, i.e. to put the end user, the final user/fruiter of the museum, at the centre, in order to apply a correct data management strategy. Within this context in fact, the digitisation of cultural heritage enables cultural development in different contexts, allowing access to a wider audience, from the student to the researcher or a simple enthusiast or curious; in this way there are new possibilities of documentation, representation, and communication of cultural heritage (Sullivan et. al, 2017). It is very important to remember how the creation of virtual museums becomes a means of communication, where the scientific basis of the reconstruction must be contaminated by playful aspects, linked to gaming, in order to reach a non-specialised target, and how the definition of the target influences the creation of the virtual museum. Interactive technology, typical of the entertainment industry, is therefore in some cases adapted to the cultural heritage domain (Bellotti et al., 2011), developing edutainment models (Ferdani, 2020) with the aim of disseminating cultural and historical content and involving a wide and heterogeneous audience in the communication.

Once the end user has been defined, it is possible to characterise the type of model to be realised, the quantity and quality of data to be stored, the type of experience to be lived during the exploration and, consequently, the sharing platform to be used. The choice of assigning the realisation of digital models to a specialised public, such as researchers and scholars in the field, requires greater detail and quality of data than that intended for a more heterogeneous public, made up of onlookers and students. It is therefore necessary, already during the early stages of virtual modelling, to define the final target for which the digital twin is intended: in the case of models and data archives intended for a specialised public, it will certainly be necessary to create data sharing environments and virtual models capable of representing the object and its associated data and metadata in a complete and systematic way, in order to allow scholars to access correctly and quickly all the information related to the analysed artefact; in the case of models and data archives intended for a less specialised public, such as students and the curious, on the other hand, simpler models can be used, but it is of paramount importance to create paths and ways of visualising the object that are appropriate to the user's level of knowledge.

Specifically, for the models of the Curioni's collection, the final target user of the virtual museum had not been defined at first, and for this reason, the first phases of the realisation of the virtual models had seen the research group engaged in the experimentation and realisation of heterogeneous virtual models, having geometric properties, quantities of data and metadata, of different nature and size. Since the main objective of the research is to reach a heterogeneous audience, but above all to use digital models in the educational field, as a best practice for the realisation of excellent architectural and civil artefacts, the research group standardised a workflow capable of cataloguing the data from the different processing phases of the virtual model: archival data, survey data (point cloud), mesh processing, virtual model, sharing platform, etc... in order to have a single accessible and shared repository, within which to be able to analyse, update and modify (for those who have the properties to do so) the data coming from the different processing outputs. The possibility of storing the "raw" data used during the creation phases of the virtual model, can be useful not only for possible future comparisons of the same artefact, to read, for example, its degradation, but also to carry out analyses comparing different data survey techniques.

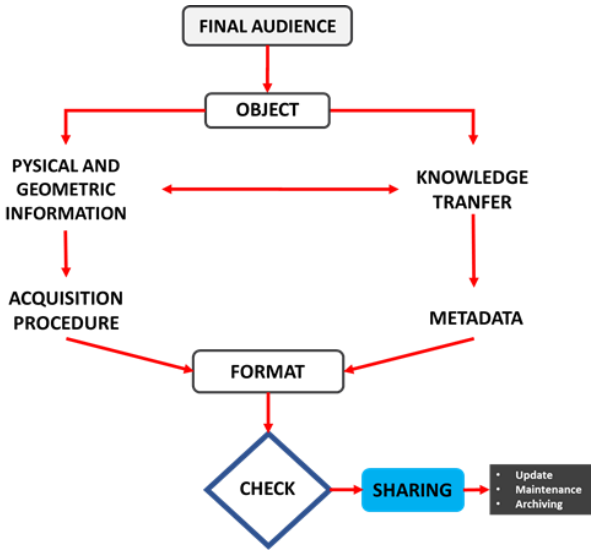


Figure 9. Workflow Diagram

5. DISCUSSION, CONCLUSIONS AND FUTURE DEVELOPMENTS

Our project arose from the idea to create data for defining 3D artefacts of tangible heritage related to our Politecnico and to use them to enhance its online digital collections. In this sense, the digitisation of cultural heritage enables cultural development in different contexts, allowing access to a wider audience, from the student to the researcher or a simple enthusiast or curious (Fig. 10).

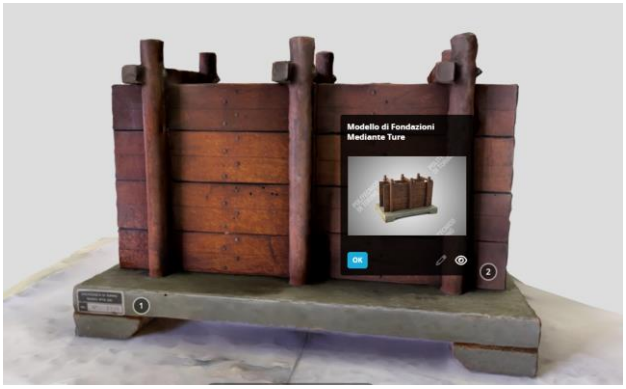


Figure 10. Final Product - Digital Model with consultable information on SkechFab (https://sketchfab.com/3d-models/modello-di-fondazione-mediante-ture-8eaf8235978d4abcb8d0e34afb5aa2f1)

But these processes of digitization and sharing must undergo a structured data management plan. This must take into consideration both the data acquisition/usage/sharing and the management of the final output via online platforms. In this sense, our research highlights the necessity to manage each output of every single process, even intermediate ones, as complex data to be stored, updated, maintained, and protected. From the point of view of the discipline of Representation, this means that each data might be used to define visual artefacts to be stored and shared online, within an open-access platform and compelling with the FAIR principles. Still, we highlighted how these processes can be tailored on the final user's necessity,

rather than on the initial data 'potentialities'. In fact, we can propose a workflow centred on users, thus selecting digitization tools and procedures based on this aspect and not on the survey techniques. Nonetheless, this workflow should take into consideration how digital cultural heritage projects should be focused on a mission and on a set of final products, as well as on a precise data governance model. Still, these kinds of projects will benefit from a focus on a sustainability data workflow and management.
A final remark suggests that future developments of our research will deal with a data management plan structured with the idea of providing a «peer-reviewed 3D archive», as postulated by Koller et al. (2009, p. 7:15).

REFERENCES

Balzani, M., Maietti, F., 2017, Architectural Space in a Protocol for an Integrated 3D Survey Aimed at the Documentation, Representation and Conservation of Cultural Heritage. *diségno*, 1(1), 113-122. https://doi.org/10.26375/disegno.1.2017.13.

Bellotti, F., Berta, R., De Gloria, A., Panizza, G., Pellegrino, M., Primavera, L., 2011, *Designing serious games for cultural heritage purposes*, Digit. Games Learn.

Blundell, J., Clark, J. L., DeVet, K. E., Hardesty, J. L., 2022, Metadata Requirements for 3D Data. In Moore, J, Rountrey, A., Scates Kettler, H. (Eds.), *3D Data Creation to Curation: Community Standards for 3D Data Preservation*. Chicago: Association of College and Research Libraries, 158-202.

Bordier, C., 2023, Gallica: Bibliothèque nationale de France (BnF), https://gallica.bnf.fr/. *American Journalism*, 40(1), 131-132. https://doi.org/10.1080/08821127.2022.2164752

Carlisle, P. K., Avramides, I., Dalgity, A., Myersc, D., 2014, *The Arches Heritage Inventory and Management System: a standards-based approach to the management of cultural heritage information*. English Heritage, World Monuments Fund, and the J. Paul Getty Trust.

Christodoulakis, S., 2014, Trends in Digital Cultural Heritage Management and Applications. *Digital Presentation and Preservation of Cultural and Scientific Heritage*, 4, p18-25. https://doi.org/10.55630/dipp.2014.4.1

Ćosović, M., Maksimović, M., 2022, Application of the digital twin concept in cultural heritage. In Amelio, A., Montelpare, S., Ursino, D. (Eds.), *Proceedings of the 1st International Virtual Conference on Visual Pattern Extraction and Recognition for Cultural Heritage Understanding*. CEUR.

Council of Europe, 2021, *Culture without borders: Cultural heritage management for local and regional development*.

Dobreva, M., Ruusalepp, R., 2012, Digital preservation interoperability ad modum. Chowdhury, G., Schubert, F. (Eds.), *Digital Libraries and Information Access Research Perspectives*, Facet Publishing, 193-216.

Di Giorgio, S., Ronzino, P. 2018, PARTHENOS Data Management Plan template for Open Research in Archaeology: In *2018 3rd Digital Heritage International Congress (DigitalHERITAGE)*, 1-4.
DOI:10.1109/DigitalHeritage.2018.8810039

Eastman, C., Teicholz, P., Sacks, R., Liston, K., 2011, *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, second ed., John Wiley & Sons.

Europeana/Culture24, 2022, *Guide to Digital Transformation in Cultural Heritage Building capacity for digital transformation across the Europeana Initiative stakeholders*.

Ferdani, D., Fanini, B., Piccoli, M.C., Carboni, F., Vignaloro, P., 2020, 3D reconstruction and validation of historical background for immersive VR applications and games: The case study of the Forum of Augustus in Rome. *Journal of Cultural Heritage*, 43, 129-143.
https://doi.org/10.1016/j.culher.2019.12.004

Koller, D., Frischer, B., Humphreys, G., 2009. Research Challenges for Digital Archives of 3D Cultural Heritage Models. *ACM Journal on Computing and Cultural Heritage*, 2(3), 7:1-7:17. http://doi.acm.org/10.1145/1658346.1658347

Haus, G., 2016, Cultural Heritage e ICT stato dell'arte. *DigitCult*, 1(1), 9-20.
http://dx.doi.org/10.4399/97888548960242

Hodson, S. et al., 2018, *FAIR Data Action Plan: Interim recommendations and 45 actions from the European Commission Expert Group on FAIR data* (Version Interim draft). http://doi.org/10.5281/zenodo.1285290

Hylland, O. M., 2017, Even Better than the real Thing? Digital Copies and Digital Museums in a Digital Cultural Policy. Culture Unbound. *Journal of Current Cultural Research*, 9(1), 62-84. https://doi.org/10.3384/cu.2000.1525.179162

ICCD, 2022: *Linee guida per la redazione del patrimonio culturale*. Versione n. 1.0 - giugno 2022. https://digitallibrary.cultura.gov.it/linee-guida/ (last access 23/04/2023)

Library of Congress, 2002. *Preserving our digital heritage. Plan for the National Digital Information. Infrastructure and Preservation Program A Collaborative Initiative of the Library of Congress*.

Lo Turco, M., 2015, *Rappresentare e gestire patrimoni immobiliari: il BIM per il Facility Management*. Roma: Aracne.

Maietti, F., Di Giulio, R., Balzani, M., Piaia, E., Medici, M., Ferrari, F., 2018 3D Data Acquisition and Modelling of Complex Heritage Buildings. In: Ioannides, M. (Eds.), *Digital Cultural Heritage.Digital Cultural Heritage. Final Conference of the Marie Skłodowska-Curie Initial Training Network for Digital Cultural Heritage, ITN-DCH 2017*. Cham (CH): Springer. https://doi.org/10.1007/978-3-319-75826-8_1

Maiwald, F., Bruschke, J., Lehmann, C., & Niebling, F., 2019, A 4D information system for the exploration of multitemporal images and maps using photogrammetry, web technologies and vr/ar. *Virtual Archaeology Review*, 10(21), 1-13. https://doi.org/10.4995/var.2019.11867

Marty, P. F., 2008, Museum websites and museum visitors: digital museum resources and their use. *Museum Management and Curatorship*, 23(1), 81-99.
doi:10.1080/90647770701865410

Meyer, É., Grussenmeyer, P., Perrin, J-P., Durand, A., Drap, P., 2007, A web information system for the management and the dissemination of Cultural Heritage data. *Journal of Cultural Heritage*, 8, 396-411. doi:10.1016/j.culher.2007.07.003

Münster, S., Pfarr-Harfst, M., Kuroczyński, P., & Ioannides, M. (Eds.), 2016, *3D research challenges in cultural heritage II: How to manage data and knowledge related to interpretative digital 3D reconstructions of cultural heritage*. Cham (CH): Springer. https://doi.org/10.1007/978-3-319-47647-6

Nicholson, B., 2013, The Digital Turn. Exploring the methodological possibilities of digital newspaper archives. *Media History*, 19(1), 59-73. DOI:10.1080/13688804.2012.752963

Palma, V., Spallone, R., Capozucca, L., Lops, G., Cicone, G., Rinauro, R., 2022, Connecting AR and BIM: a Prototype App. In Giordano A., Russo M., Spallone R. (Eds.), *Representation Challenges. New Frontiers of AR and AI Research for Cultural Heritage and Innovative Design*. Milano: Franco Angeli, 391-398. doi.org/10.3280/oa-845-c236

Poulopoulos, V., Manolis, W., 2022, Digital Technologies and the Role of Data in Cultural Heritage. *Big data and cognitive computing*, 6(3):73. https://doi.org/10.3390/bdcc6030073

Santagati, C., D’Agostino, G., Garozzo, R., La Russa, F. M., Galizia, M., 2020, Participatory approach for the enhancement of architectural archives funds: the experience at Museo della Rappresentazione in Catania. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLIII-B5-2020, 99-106, https://doi.org/10.5194/isprs-archives-XLIII-B5-2020-99-2020

Scopigno, R., Callieri, M., Dellepiane, M., Ponchio, F., & Potenziani, M., 2017, Delivering and using 3D models on the web: are we ready? *Virtual Archaeology Review*, 8(17), 1-9. http://dx.doi.org/10.4995/var.2017.6405

Simm, S., Strong, M., Jones, S., Ribeiro, M., 2016, The Future of Data Management Planning Tools, Policies. International *Journal of Digital Curation*, 11(1), 208-217. http://dx.doi.org/10.2218/ijdc.v11i1.413

Sullivan, E., Nieves, A.D., & Snyder, L.M, 2017, Making the model: Scholarchip and rhetoric in 3-D-historical reconstructions. In Sayers, J. (Ed.), *Making Things and Drawing Boundaries: Experiments in the Digital Humanities*. Minneapolis: University of Minnesota Press.

Taormina, F., 2019, Musei, patrimonio digitale e questioni organizzative: stato dell’arte. *DigitCult*, 4(2), 51-62. http://dx.doi.org/10.4399/97888255301485

Ugo, V., 2008, *Mimesis. Sulla critica della rappresentazione dell’architettura*. Sant’Arcangelo di Romagna (IT): Maggioli.

UNESCO, 2003, *Charter on the Preservation of Digital Heritage*. www.unesco.org/en/legal-affairs/charter-preservation-digital-heritage (Last access 23/04/2023).

van Wijngaarden, H., 2007, Long-term preservation and permanent access: How to ensure the long-term reuse value of your digital assets. *Journal of Digital Asset Management*, 3, 102-109. https://doi.org/10.1057/palgrave.dam.3650064

Wilkinson, M., Dumontier, M., Aalbersberg, I. et al., 2016, The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(160001). https://doi.org/10.1038/sdata.2016.18

Zorich, D. M., 2003, *A Survey of Digital Cultural Heritage Initiatives and Their Sustainability Concerns. Managing Economic Challenges*. Washington, DC: Council on Library and Information Resources.

https://www.archiui.com (Last access 23/04/2023)

https://areeweb.polito.it/strutture/cemed/001/Index2.htm (Last access 23/04/2023)

https://areeweb.polito.it/strutture/cemed/museovirtuale/index.htm (Last access 23/04/2023)

https://collezionistoriche.polito.it/ (Last access 23/04/2023)

https://gallica.bnf.fr (Last access 23/04/2023)

http://www.inceptionhbim.eu/platform (Last access 23/04/2023)

https://www.unict.it/it/terza-missione/musei/museo-della-rappresentazione (Last access 23/04/2023)

https://www.unimuseum.uni-tuebingen.de/en/ (Last access 23/04/2023)