VREA PROJECT - A DIGITAL CURATOR FOR ARCHITECTURE AND DIGITAL PERSPECTIVES FOR HERITAGE MANAGEMENT AND ENHANCEMENT

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ABSTRACT:

Thinking about architectural education, one must face the challenges of the ever-changing and digital world and bear in mind the figure of the architect of the future - the curator of digital data. Nowadays the aim is to train specialists who know how to manage the production of digital products and are able to face the challenges of digital change in the field of architecture and architectural heritage management. Virtual Reality Engineering and Game Design for Architecture and Cultural Heritage (VREA) will be a new Master's degree course designed to generate a new professional figure in charge of the technological evolution and at the same time having critical sensitivity towards the architectural heritage, its conservation, and enhancement. These objectives received funding as part of the call of European Erasmus Mundus Design Measures (ERASMUS-EDU-2021-EMJM-DESIGN) for the development of new, innovative, high-level integrated transnational study programmes at the Master level. VREA project aims to create a basis for a new international joint Master level course to create a new generation of architects and engineers equipped with the cultural and technical knowledge for managing Digital Twins in the field of Cultural Heritage, outlining at the same time the future course of study for architects and engineers. The result of the work is an innovative, international and comprehensive programme, strengthening the competences of all project participants and aimed at educating architects and engineers of the future, prepared for the challenges of the 21st century.

1. INTRODUCTION

Nowadays, a lot of research as well as professional activities in the field of architecture require the multidisciplinary approach with the use of digital technologies (Caneparo, 2013; Eastman, et al., 2011, Salcedo-Galera, 2022, Green, 2016; Ratti, 2017; Tedeschi, 2011, Urbanowicz and Nyka 2016). In recent years a group of scholars has worked on the creation of a new programme combining architectural and construction engineering courses, formulating an innovative teaching proposal. The goal is to train specialised technicians who know how to manage the production of digital products and are able to face the challenges of digital change in the architectural field for heritage management. Virtual Reality Engineering and Game Design for Architecture and Cultural Heritage (VREA) programme will be aimed at educating a new generation of students on the cultural foundations and technical knowledge for the management of Digital Twins in the field of Cultural Heritage, Town Planning, and Architectural Design.

This approach is in line with the contemporary trends in Architecture and Cultural Heritage related to the development of digital tools (including Virtual Reality, Augmented Reality, Internet of Things, Big Data) (Ratti, 2014; Wang, 2009), revaluation of many aspects of social life in the context of the recent pandemic (including access to e-services) (Cheshmehzangi, 2021; Franczuk et al., 2022; Kowalski et al., 2020) and the threat of losing material heritage.

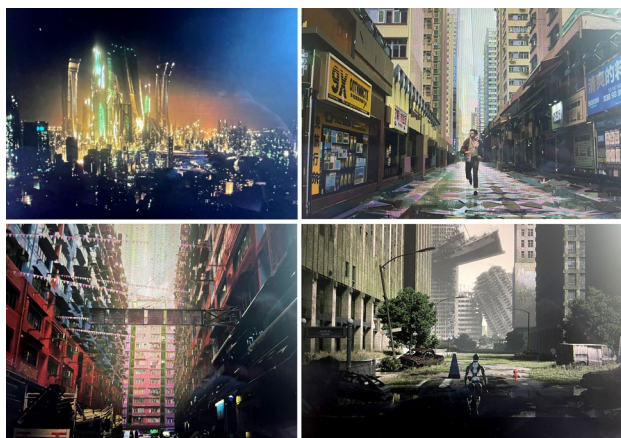The latter is particularly relevant in the context of the ongoing armed conflict in Ukraine and motivates the development of databases of "Digital Twins" of both objects and historic areas.(Fig.1)

With the advancement of technology, innovative tools and opportunities have emerged for the management of architecture objects and architectural monuments. Specifically, this has occurred in the areas of measuring, documenting, and creating digital databases of existing heritage resources (Parrinello et al., 2021; Parrinello, Dell'Amico, 2022). In the 21st century, the development of digital media, coupled with the pandemic lasting over two years, has created an increased demand for virtual tools and spaces. This demand extends to many areas of social life, including architecture, cultural heritage, and sustainable development. The emergence of digitisation, Big Data databases, Internet of Things interfaces, and simulation environments, such as Augmented Reality and Immersive Reality, has opened new avenues for innovative multidisciplinary research and education in architecture and engineering (Bertocci, 2020; Picon, 2010). This makes it possible to shed new light on current research and education. These tools enable in-depth analysis of the architectural context and examination of various data that can optimise the design, planning, and management process at both the architectural and urban level (Borucka et al., 2020). Exciting new opportunities are arising in the realm of representing and visualising both designed and existing architectural objects.

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The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
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Figure 1. Views of city settings and architecture extracted from the television series Love Death & Robots.The creative dimension on the representations of even imaginary architectural spaces finds its main application in digital products that give rise to immersed spaces in which to experience the architectural project. Real architectures or imaginary projects are carried out through a new digital space, a new dimension in which man lives and interacts and for which it is necessary to build a new architect able to dialogue, both from a technical and cultural point of view, with space and digital places.

Figure 2. The databases on heritage, on the city and on architecture in general configure archives in which the real space and the qualities of the environments are discretized and reconfigured through spatial characteristics and attributes that describe the character of the places. The digital space draws from the real dimension and digital duplicates, digital twins, today constitute a possibility for transferring and preserving the memory of places, as well as for increasing their narrative possibilities by favouring management and enhancement processes.

These possibilities extend beyond merely creating digital models and include dynamic animations and visualisations of objects using immersive and augmented reality technologies (Biocca and Delaney, 1995; Picchio and Galasso, 2022). The impact of these activities extends to the management of architectural Cultural Heritage and ensuring sustainable development. They make it possible to develop systems like H-BIM (Historic Building Information Modeling). These models represent intricate spatial structures, enabling the creation of "Digital Clones" (Digital Twins) of cities, districts, architectural objects, monuments, or archaeological sites. These advanced representation systems allow to generate new databases that safeguard and document Cultural Heritage (Dell'Amico, 2022).

In the face of the various threats to the current social structures, including armed conflicts, environmental disasters, and political instability, the need for digital documentation and preservation of Cultural Heritage is more crucial than ever. Professionals in the Cultural Heritage and architecture fields must possess the necessary skills and knowledge in digital technologies to address these challenges adequately (Hovestadt at al., 2020).There is also a need to emphasise the importance of digital technologies in Cultural Heritage and architecture, when shaping the future professionals. In the last decade, the amount of available digital data has grown enormously in several domains, including Cultural Heritage and digital humanities (Digital Humanities conference Oulu, 2008). However, creative reuse of data both within the scholarly community and within the cultural industry is still very limited. It is observed that it does not only depend on the limits of know-how in existing engineering technologies (Service Oriented Computing and the Humanities, AHRC ICT Methods Network, 2008), but also on several social and cultural topics that need to be fully addressed and integrated within digital practices (DH@WIT Digital Humanities for Undergraduate Design, Engineering and Management Students, 2013) in the educational curricula. An educational modernisation of teaching practices needs to occur in the way that digital knowledge on Architecture is produced, managed and disseminated.

VREA design measures are aimed at examining, from the perspective of Architecture and Engineering Faculties towards Digital Survey and ICT cutting-edge strategies, how the recent developments in service-oriented architectures could be used to enable new approaches to digital enquiry in the arts and Cultural Heritage.(Fig.2)

These objectives have been recognised and granted funding through the European Erasmus Mundus Design Measures (ERASMUS-EDU-2021-EMJM-DESIGN) call. The aim is to establish an advanced, integrated, and transnational Master's programme that will produce a new cohort of culturally and technically proficient architects and engineers capable of overseeing Digital Twins in the realm of Cultural Heritage. This initiative will set the groundwork for the future curriculum of architects and engineers. The design project is aimed at integrating knowledge and skills, organised into Thematic Panels, to interact with the world of digital production of artworks, cities, and architectural artefacts. The creation of databases, archives, 3D models, and in general the technical and scientific production, as well as artistic and cultural, is increasingly translated into languages and expressions that belong to the world of digital and creative industries (Savorra, 2018). VREA consortium consists of 7 higher education institutions (HEIs) from Italy, Poland, Germany, Argentina and Singapore, with high interest in developing a preliminary design strategy for a technical and sustainable programme related to the application of digital contents and virtual realities to architecture and Cultural Heritage. The action plan is developed during virtual but also physical meetings, due to the mobility of project staff to HEIs facilities. This creates opportunities for sharing knowledge and didactic mechanisms within 5 concept phases of Kick-off, Confrontation, Project, Third Mission and Results. The VREA Project team consists of both students and academic staff from HEIs, with a specific focus on the following groups: (i) 3rd year students who can provide insight into the desired features of a new Master's program, (ii) 4th and 5th year students who represent the target audience for the course, (iii) doctorate students who can contribute to teaching and provide support for innovative curriculum design, and (iv) senior and junior researchers who also serve as technical staff, all working in collaboration with administrative staff from the didactics and international relations offices.

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

2. TOWARDS NEW EDUCATION IN ARCHITECTURE

In recent years, the European digital sector has experienced strong growth: the process of digitisation of assets implies the development of innovative forms and strategies of interaction of the society with Cultural Heritage, engaging a wider and more varied target audience. It appears that there is a lack of a professional profile to effectively and consciously manage the digital languages of representation and communication of architectural heritage.

European Union (EU) is directing its member states to the formation of a "Digital Curator" capable of dealing with the different types of tangible, intangible, and digital heritage (DigCurV - Digital Curator Vocational Education Europe, funded by the Leonardo da Vinci programme (2011-2013) of the European Commission). The EU invitation to present projects related to the management of digital resources (DT-Transformations-12-2018-2020) found an answer in the creation of innovative methodologies for digital storytelling of tangible and intangible heritage (MINGEI - Representation and Preservation of Heritage Crafts– funding from the European Union's Horizon 2020 research and innovation programme under grant agreement, Project Start Date: 01 December 2018; VHH - Visual History of the Holocaust: Rethinking Curation in the Digital Age – funding from the European Union's Horizon 2020 research and innovation programme under grant agreement).

Despite these initiatives, the lack of a specific training programme for the digital management of architectural heritage is still recognised.

VREA programme is aimed at supplementing the current Master's programmes with the profile of a Digital Curator in architecture and engineering The construction of a new educational curricula for such a professional figure has a two-fold basis:

(i) developing a set of educational panels on transversal approaches to architectural heritage, from historical, technological, architectural fields to their application in information and communication technology (ICT) protocols and territorial policies;

(ii) developing research-oriented experiences based on the integration and experimentation of digital skills, combining them into cutting-edge strategies for communication and representation.

The design of the curricula has an innovative character due to the ways of approaching heritage. The goal is that the student completes the Master's training after not only acquiring comprehensive theoretical knowledge in the fields of history of architecture, urban planning, technology, etc., but also gaining application opportunities (field surveys , database management, three-dimensional modelling, etc.), and professional experiences (internships in research centres and laboratories or companies).

In line with the provisions of the European Higher Education Area (EHEA), the intention of the VREA is to build a high quality training programme and to create a new Master's level course with shared teaching and administrative parameters, that is compatible with the formulas of the different countries involved.

VREA is structured according to the following common objectives:

(i) to generate a competitive and attractive programme: the specific expertise of each HEIs becomes an instrument of exchange and institutional cooperation. The partners collaboration is aimed at producing particular cultural outcomes through the definition of guidelines for a new Master course design, attractive and implementable by other excellent HIEs;

(ii) to attract European and international students to Master's programmes: the partners studied dissemination strategies for the organisation of shared physical events (meetings, workshops), the use of university media channels (social pages of the universities and degree courses attended by students), and promotion through the partners' scientific journals;

(iii) to generate a strong consortium: in the first phase, HEIs evaluated the programme together; in the second phase, spin-offs, start-ups, small and medium-sized enterprises, and interested organisations contributed with their suggestions. Such a cultural and professional exchange of expertise creates a joint Master's programme with valid and recognised job opportunities in Europe and around the world;

(iv) to create an open and participatory dialogue: VREA employs existing and well-known forms of communication (e.g., "Researchers' Night" and other stakeholder events) to involve representatives from European and third countries;

(v) to create a common information platform: during the project, involved teams made a documentary, to tell the evolution of the programme development step by step. The documentary will be the basis for generating new shared paths and offering a constant opportunity for improvement.
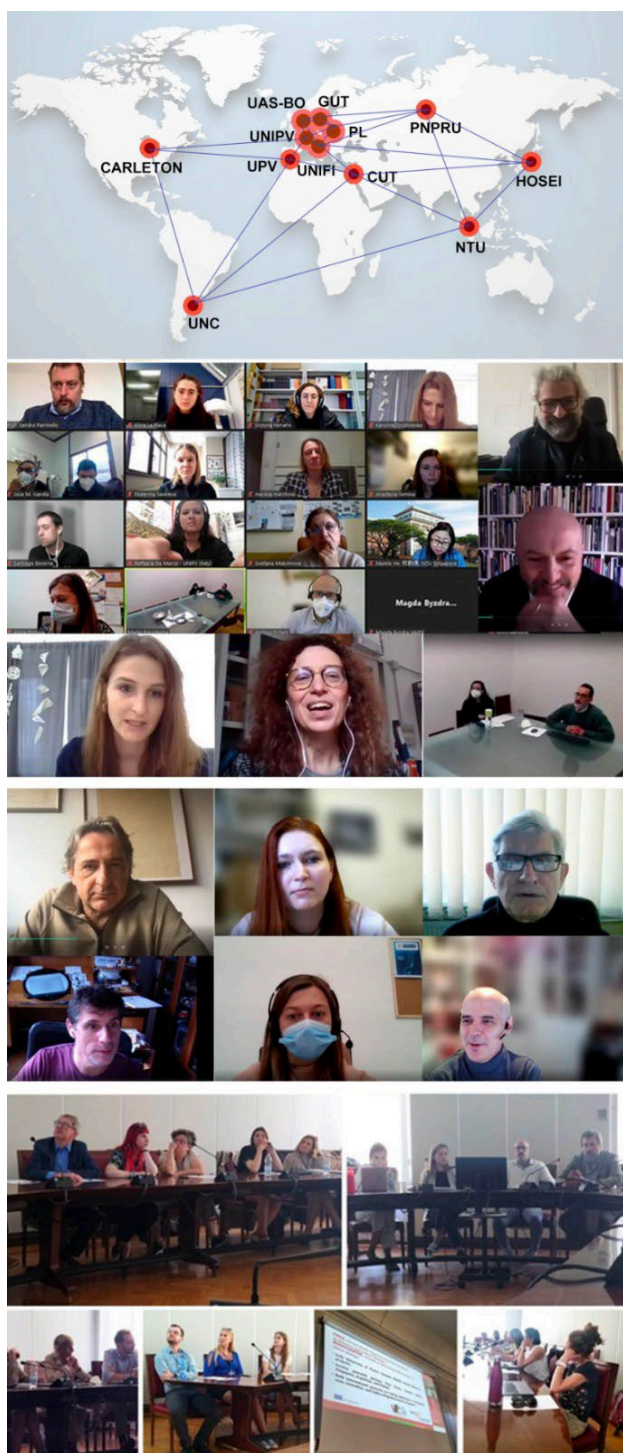
3. PROJECT DESIGN STRATEGY

The main goal of the project was to design a new educational offer in the form of a research-based transnational joint study programme at the Master level (2 years, 120 ECTS) to provide a cutting-edge knowledge on Digital Contents and Virtual Realities applied to Architecture and Cultural Heritage, based on cross-fertilization and exchange of experiences between international academies (7 HEIs) and Third Parties to optimise a "digital-oriented" learning experience and educational offer.

The course is aimed at the training of a professional-oriented profile characterised by competencies in the fields of engineering and architecture founded on digital skills, to obtain those specific research/technical expertises to manage Digital Twins for Cultural Heritage. The course promulgates technological competences in the field of Cultural Heritage, and integrates them with the relevant tools from Social Sciences to integrate and improve the cultural education offered by academies.

The involvement of experts from numerous universities allowed to draw from a vast pool of specific competences to develop a modern teaching approach in the area of Digital contents for Cultural Heritage. The complementarity of HEIs programmes is adopted in the new high-level study programme focusing on Digital Twins for Architecture and Engineering. The joint discussion tables between the HEIs facilitated the professionalisation of the Master level programme by orienting training through collaboration with research laboratories, small industries, and administrations.(Fig.3)

Considering the different institutional and educational structures in each HEI, an Erasmus Mundus action regarding Design Measures was necessary to facilitate the collaboration on the development and future submission of the joint Master-level programme.

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

Figure 4. Planning meetings between the groups of teachers of the various disciplines involved to discuss the distribution of credits and the specificities of the individual courses within the programme.

The activities envisaged during the project (15 months) were as follows: (i) design of shared services, procedures, and regulations, structured by the administrative staff of the international and didactic administrations of the participating universities to support training and mobility within the programme; (ii) design of didactic and training aspects of the future programme by senior and junior academics supported by administrative staff with the specific aim of obtaining formal accreditation; (iii) design of communication and promotion measures, to ensure worldwide relevance of the programme regarding the field of Engineering and Architecture and its EU attractiveness.

In order to design a strategy for the launch, promotion, and maintenance of the Master programme over time, the proposed action plan was aimed at making the afore-mentioned comparisons between the structures of the administrative and technical staff of the different HEIs in order to streamline the sharing of regulations and procedures between them.

The EMDM project also supports HEIs in the stipulation of Erasmus bilateral agreements for the mobility of students and teachers. Further, it focuses on defining interaction strategies with Third Parties to plan the development of agreements that meet the needs of the Master programme (e.g., considering employment capacities and R&I approaches to activate international training internships and foresee agreements for further research grants).

To ensure the innovative integration between technical and social skills that will support the new education programme on Digital Management of Architectural Heritage, Thematic Panels were organised to orient the Action Plan. Panels were composed of expert researchers, teachers, and lecturers of HEIs, and were divided based on the macro-areas of scientific competences that are foreseen by VREA educational strategy:

Panel 1 - Documentation (regarding the competencies for knowledge and representation of Heritage)

Panel 2 - Technology (regarding competencies for analysis and constructive evaluation of buildings)

Panel 3 - ICT Vision (regarding the competencies for 3D modelling and data animation for architecture)

Panel 4 - Conservation (regarding competencies for restoration practices and preservation policies)

Panel 5 - Territory (regarding the appliance of digital instruments and architectural planning measures).

Figure 3. The project network of the VREA programme. In order to favour planning that could take into account the greater cultural heterogeneity and a broader view of the international scene, even beyond the European borders, the working tables were opened to numerous international universities that expressed opinions and made contributions both to the definition of the programme and to the definition of the specific effects on the various local contexts.

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

Figure 5. The Pavia Digiweek 2022, including conferences, seminars and workshops, was an opportunity to experience the effectiveness of teaching from different points of view. Three workshops were organised allowing teachers to collaborate verifying each other's skills and noting the need to standardise the languages. At the same time, the different learning methods of the students with respect to the curricula of origin were verified.

All panels foresee the participation of experts from each HEIs, with the aim of comparing the respective courses and training skills, selecting or improving the more adequate solutions for didactic courses and curricula, and designing the educational plan for VREA joint Master programme.(Fig. 4)

The panels also discussed the involvement of Third Parties, the professional and administrative sphere, in the educational curricula, to ensure practical training experiences at the end of the 2nd year of the Master programme. Dialogue with Third Parties was necessary to understand the general and development rules of any internships. This macroscopic sharing will also be useful in the future to other interested companies. The training activities at Third Parties must prepare the students to develop the final research-oriented thesis required for the achievement of the degree.

In order to support a preliminary evaluation of the VREA programme, an International Workshop was organised to test a pilot presentation of the programme.(Fig.5) The workshop focused on: (i) drawing youth interest in the integrate programme on Digital management for Architectural Heritage, (ii) recruitment strategy for worldwide students, (iii) mobility network for students and teachers, (iv) appliance of digital tools for didactics and laboratories, (v) open-day and contacts with possible interested Third Parties. The presence of a well-distributed partnership in Europe (Italy, Germany, two Polish universities, one in the North that communicates with the Baltic countries and one in the South that has relations with central Europe) favours the development of cultural exchange, not only of the scientific strengths of each, but also of those of administration and management. In addition to this partnership, there are two non-European countries, Argentina, and Singapore, from targeted regions, which enrich the group by bringing their teaching and exchange experiences and promoting the design idea dissemination even outside the European Union.

Figure 6. Some of the students' works created during the international workshop

The goal of this proposed innovative and interdisciplinary educational offer is to address the growing skills shortage among young professionals around the world, who pursue a career in not only architecture and cultural heritage domains, but also in other creative industries related to the production of multimedia, gaming, and digital environments. Many tools used in the current practice of architectural design and cultural heritage management, such as the commonly applied computer-aided design or parametric modelling, and some more advanced, rapidly developing tools and systems, such as parametric and generative design, 3D and procedural modelling, visualisation techniques, multimedia creation, virtual reality (VR), building information modelling (BIM), or geographic information systems (GIS), are very useful for numerous other creative industries. Thus, the proposed programme responds to societal and labour market needs by creating new possibilities in educating future professionals in this field.(Fig.6)

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

Figure 7. Exhibition of the students' works created during the workshops, held in October 2022 at Gdańsk Tech.

Technological approach, complemented by a set of social and humanistic skills necessary for the comprehensive, responsible, and conscious transformation and renewal of historical and cultural urban space, provides vital tools for the creation of digital urban and cultural landscapes, focusing on the digital production of works, cities, and architectural artefacts. The main impact and ambition of the project is to create a new profile of the Master's programme graduate, holding the skills and knowledge necessary for such tasks, and to prepare them for a successful career in various creative industries.The impact and ambition of the project is considered from the perspective of three main target groups: the higher education institutions involved in the development of the Master's programme, the perspective of the students, future graduates from the Master's programme, and the academics (teachers, researchers) who will be responsible for the development and delivery of the study plan and particular courses. All these groups will benefit from new possibilities for development in order to foster interdisciplinary approach of the programme and international and intercultural exchange of members' experience related to enhancing networking and communication capacities of the students. It opens not only new possibilities for learning without barriers (moving between countries, mobility for the best students worldwide), but also for increasing the synergies between higher education, innovation, and research due to international researchers' cooperation both in teaching and research. As a result, the new network of institutions related to the use of digital tools for architectural design and protection and promotion of Cultural Heritage in the real context and in virtual reality - for the needs of gaming for instance, will appear. This makes a crucial contribution in widening international awareness of the new needs for Master programmes implemented in accordance with the contemporary, internationalisation strategy of the partnership. This "digital-oriented" Master's programme will educate students in accordance with the needs of the knowledge-based economy and society.(Fig. 7)

4. CONCLUSIONS

The proposed new Master programme is expected to provide an significant impact within 3 levels: at system level, at institutional level, at individual level. To develop this evaluation, 3 target groups are individuated to consider the expected impact control: institutions, students and academies.
The Digital Transformation, linked to cultural development and advanced by the Education Action Plan 2021-2027, should be reflected in the educational offer that academies can provide to students regarding Digital Strategies for Cultural Heritage. The key role of these educational programmes is to establish knowledge and research-oriented background for young professionals to enable them to interact and collaborate with the world of creative industries and the digital architectural dimension and heritage, with common languages and practices in advanced digitalization for tangible heritage (Borucka and Macikowski, 2017; Gębczyńska-Janowicz, 2020; Hajirasouli and Banihashemi, 2022; Życzkowska and Urbanowicz, 2019).
For many years the field of Architecture and Engineering was transforming accordingly, with cross-skill fertilisation of different disciplines, considering the joint contribution of knowledge in Survey, Restoration, History, Technologies, CH policies, and Territorial Planning as necessary for a competent and 360°-aware professional (Liberotti and Gusella, 2023; Urbanowicz and Nyka, 2012).
Numerous studies on Digital Databases and Information Systems have shown how digital practice can offer a common platform to integrate this different sectoral knowledge and to set a common basis of technical language and integrated 2D/3D products (Doria et al., 2022; Galasso et al.,2021). Digital Environments and Virtual Spaces were developed and are gradually being improved, producing increasingly realistic reproduction of contents from the object to the urban scale. 3D motion-capture, VR animations, and real-time immersion systems have been tested and supported by research-oriented institutions to extend from the ICT sector to other scientific applications, and in the last 2 years the COVID pandemic crisis has enhanced their application to the widening and sharing of cultural and creative contents from Digital Twins to Digital Humanities, Museums, Architecture, and Building Industries (Carretero Gomez et al., 2021).
The professional sector in which architectural design and management for Cultural Heritage are involved is increasingly adopting digital technologies. Such approach is recommended for many purposes, in particular regarding the immersive knowledge and project stimuli that digital replicas can provide instead of original, and often remote, Cultural Heritage objects. But it also regards the priorities to the access of buildings, sites, and monuments highlighted by the pandemic situation, which showed how digital replicas can be used to ensure the continuity of creative and labour activities even in critical conditions of social limits.
The opportunity presented by digital technology development, can be enhanced to extend the compatibility of practices from the academic education to the professional and industry application. With respect to future prospects, it involves the development of an educational ecosystem that enhances the international excellence of Digital Technologies applied in the Architectural and Engineering sector for Cultural Heritage.
In this regard, the VREA project will combine the experience of universities in the regulations of different countries in order to build common methodologies of didactic and administrative accreditation for the new Master's degree programme, developing multimedia guidelines to be shared also as EU reference for further experiences.

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

The result of the work is a new, innovative, international, and complementary programme, combining the competences and strengths of all project participants and aimed at educating the architect and engineer of the future, open to the challenges of the 21st century.

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