



Segretariato Generale

Direzione Generale della Ricerca

PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2022 PNRR
Prot. P2022KLELT

***PART A***

*1. Line of intervention*

Main line/Linea Principale

*2. Research project title*

Digital cultural heritage: a participatory metaverse of the unbuilt architectures of Michelangelo Buonarroti (MetaMic)

*3. Duration of the project (months)*

24 months

*4. Strategic emerging Topics - 5. Related Cluster*

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|---|
| Strategic emerging topic: HUMAN WELLBEING |
| Cluster: Culture, Creativity and Inclusive Society |
| Sub Cluster:<br>4. Better value, access to, protection and sustainability of cultural heritage across Europe is ensured through innovative cultural and creative sectors. |

*6. Main ERC field*

SH - Social Sciences and Humanities

*7. Other ERC field*

PE - Physical Sciences and Engineering

## 8. ERC subfields

| | |
|---|---|
| 1. | SH5_12 Computational modelling and digitisation in the cultural sphere |
| 2. | SH5_6 History of art and architecture, arts-based research |
| 3. | PE6_9 Human computer interaction and interface, visualisation |

## 9. Keywords

| nº | Testo inglese |
|---|---|
| 1. | Digital 3d-platform for Cultural Heritage |
| 2. | Michelangelo Buonarroti’s architecture |
| 3. | digital modelling 3D of architecture |
| 4. | Human-centred design of interface |
| 5. | IT ecosystem and frameworks for web3d, webxr, semantic 3D, collaborative interaction, HCI, |
| 6. | digital Multimedial Communication of cultural content |

## 10. Principal Investigator


| | |
|---|---|
| **BELLINI**<br>(Surname) | **FEDERICO**<br>(Name) |
| **Professore Ordinario**<br>(Qualification) | |
| **26/10/1962**<br>(Date of birth) | **BLLFRC62R26H501O**<br>(Personal identification code) |
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## Declarations

☑ I declare that I have not participated as PI in PRIN 2022 call (n. 104 02/02/2022)

☐ I declare that I have participated as associated PI in PRIN 2022 call (n. 104 02/02/2022)

Current funding and applications submitted

*Age limits derogation*

The principal investigator and or the substitute are over 40 at the time of the publication of the call. They do not intend to benefit from the derogations to the age limits for the amount allocated to under 40 PI;

*11. List of research units (RU)*

| nº | Associated Investigator | Qualification | University/ Research Institution | Registered office (address) | e-mail address |
|---|---|---|---|---|---|
| 1. | BELLINI Federico | Professore Ordinario | Università degli Studi di CAMERINO | Via del Bastione, 2 - CAMERINO (MC) | federico.bellini@unicam.it |
| 2. | FERRETTI Emanuela | Professore Associato (L. 240/10) | Università degli Studi di FIRENZE | P.zza S. Marco, 4 - FIRENZE (FI) | emanuela.ferretti@unifi.it |
| 3. | ZANCHETTIN Vitale | Professore Associato confermato | Università IUAV di VENEZIA | Sestiere di Santa Croce, 191 Tolentini - VENEZIA (VE) | vitale@iuav.it |
| 4. | FANINI Bruno | Ricercatore | Consiglio Nazionale delle Ricerche | Piazzale Aldo Moro, 7 - Roma (RM) | bruno.fanini@ispc.cnr.it |

*12 - Substitute Principal Investigator (PI)* (To be identified among one of the associated PIs participating in the project).*

| | |
|---|---|
| **FERRETTI**<br>(Surname) | **EMANUELA**<br>(Name) |
| **Professore Associato (L. 240/10)**<br>(Qualification) | |
| **28/06/1971**<br>(Date of birth) | **FRRMNL71H68D612J**<br>(Personal identification code) |
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*13. Brief description of the proposal*

Metamic is a cross-disciplinary research project, involving expertise in the fields of history and graphic representation of architecture, communication design and IT. Metamic aims to innovate digital tools for the valorisation of cultural heritage, in order to broaden its fruition to a wider range of users, from the general public and tourists, up to students and scholars. The case study is the unbuilt architectures of Michelangelo Buonarroti: the choice of cultural artefacts that never existed in reality, but only in the mind of

an artist, is particularly challenging for a project that intends to build a purely virtual 3D reality.

The objective of Metamic is to experiment the use in a platform dedicated to cultural content, of some of the communicative and IT features currently used in metaverses: immersiveness in a 3D environment, augmented/cross-reality, interactivity, participativeness, FAIR (Findability, Accessibility, Interoperability and Reusability) requirements. Therefore, Metamic's users will not only be able to visit its 3D environments, but also interact with them, download and upload content, and exchange opinions with other users, making the platform a living place of cultural relations, not excluded some gaming experiences. For Michelangelo scholars, Metamic can become a place for the exchange and production of knowledge, open over time to external contributions. No similar experiences in the field of cultural heritage are currently known.

Michelangelo's unbuilt architectures, together with their original environments, will be philologically reconstructed on the basis of the original drawings and archival and iconographic sources; the philological reconstructions will be translated into digital 3D models, which will constitute the 3D environment of the platform; a dedicated interface will be designed, to make the platform immersive, experienceable in augmented reality, interactive and participatory (Interaction Design/User Experience); and finally, a digital ecosystem suitable for the project's objectives will be created, implementing the open-source ATON framework of the CNR-ISPC, which participates in Metamic with its own Research Unit.

Each scientific area composing MetaMic will have to obtain its own specific results to achieve the key-objective of the project: a historically controlled corpus of digital 3D models of Buonarroti's architectures, the related documentary database, the innovative interface and 3D ecosystem. Whether funded, MetaMic would constitute a prototype-experience, and a basis for future partnerships at national and international level, matching the explicit objectives of the PNRR (M1C3, domains 1, 4) and Horizon Europe (Cluster 2, Destination: Innovative Research On The European Cultural Heritage And The Cultural And Creative Industries).

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## *14. Total cost of the research project identified by items*

| Associated Investigator | item A.1 | item A.2 | item B | item C | item D | item E | item F | Total |
|---|---|---|---|---|---|---|---|---|
| BELLINI Federico | 80.250 | 0 | 8.000 | 16.000 | 12.038 | 0 | 7.000 | **123.288** |
| FERRETTI Emanuela | 36.250 | 0 | 8.000 | 20.000 | 5.438 | 0 | 7.000 | **76.688** |
| ZANCHETTIN Vitale | 12.000 | 0 | 4.000 | 4.000 | 1.800 | 0 | 3.000 | **24.800** |
| FANINI Bruno | 34.875 | 0 | 8.000 | 20.000 | 5.231 | 0 | 7.000 | **75.106** |
| **Total** | **163.375** | **0** | **28.000** | **60.000** | **24.507** | **0** | **24.000** | **299.882** |

N.B. The Item D and TOTAL columns will be filled in automatically

- item A.1: enhancement of months/person of permanent and temporary employees
- item A.2: cost of contracts of non-employees, specifically to recruit
- item B: cost of equipment and tools
- item C: cost of consulting and other services
- item D: overhead
- item E: materials cost
- item F: other costs

# *PART B*

## *B.1*

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## *1. State of the art*

Digital enhancement of cultural heritage and humanities:
In current platforms dedicated to cultural heritage offering 3D reconstructions, particularly used for archaeological sites (Dawson 2022, Fortini 2020, Ioannides 2020), the fruition is often immersive, but interactivity is restricted to movement in three-dimensional environments, rotation of the view, etc. IT progress (hardware and software) is now rapidly spreading immersive 3D digital ecosystems in which the user can not only move, see and hear (VR), but also interact with the digital environment (AR), and to some extent (regulated by the administrator) can modify it (XR); the user can also leave comments, communicate with other users, upload personal content (N. Pellas, S. Mystakidis, I. Kazanidis 2021, ). These are abilities of the metaverses, which at the same time

enhance the quality of 3D VR environments (Lee 2021, Sparkes 2021). However, the metaverse is to date a commercial or entertaining tool, which has not yet had an impact on cultural heritage.
The Covid-19 crisis accelerated the demand for remote enjoyment of cultural heritage (Black 2021, Kremer 2020); in the ensuing debate, the enhancement of digital humanities has been advocated, favouring above all the participative character of digital tools to support the direct experience of sites and museums, while respecting the reliability of the content in order not to lapse to the level of digital entertainment products (Cameron 2021, Efrat 2021).

Area of architectural history and design:
Michelangelo's architectural drawings have been collected in excellent printed repertories (Dussler 1959, Tolnay 1980); other partial repertories have followed (Maurer 2004, Thoenes 2007), as well as several reviews of drawings related to unbuilt buildings or frameworks, which have fuelled the debate on Michelangelo's graphic work (see biblioghraphy): both the original graphics and their textual commentary have remained in paper format, limiting their sharability among scholars.
Since the early 20th century (Frey 1911), scholars have attempted to reconstruct the architectures conceived by Michelangelo, representing them with the means available at the time: drawings, photocollages, rarely plastic models (which have never been published); even the few surveys of the places that would have housed Michelangelo's projects - which were, moreover, unreliable - were carried out in two-dimensional paper format. In the last twenty years, digital graphics have been applied to Michelangelo's architectures as a mere enhanced form of paper graphics (Ruschi 2007, Satzinger 2009, Bellini 2011); the few reconstructions attempted in 3D have been published in print as 2d figures, unverifiable and unreviewable by other scholars (Bellini 2011).

3D modelling of historical architecture and sites is a critical and philological act essential for scientific knowledge, and raises delicate questions of methodology. The scientific community has questioned the reliability of digital reconstructions, calling for the utmost scientific rigour to underpin them (Frischer, B., Niccolucci, F., Ryan, N., Barceló J. A., 2002). The publication of London Charter 2.1 (2009) set benchmarks in the digital visualisation of cultural heritage (http://www.londoncharter.org/), promoting principles of scientific rigour, comprehensibility and evaluability by users, while applying the concepts of web accessibility and sustainability of use for such modelling (Vannicola, 2011, p. 148). The London Charter in turn followed the second principle of the Ename Charter, a 2008 document of the ICOMOS on the interpretation and presentation of cultural heritage sites.. The guidelines established by the London Charter were further specified in the field of archaeological heritage by the Seville Charter (http://www.arqueologiavirtual.com).

IT
The web represents a great opportunity for universal access from mobile up to XR devices through WebXR (Jones, B.; Waliczek, N. “WebXR device API”. W3C Work. Draft 2019; González-Zúñiga, L.D.; O’Shaughnessy, P. “Virtual Reality…in the Browser”. In VR Developer Gems; CRC Press: Boca Raton, FL, USA, 2019), without requiring additional software.
International Web3D formats are being standardized, like glTF (https://www.khronos.org/gltf/ - now ISO standard), or Cesium 3D Tiles (https://www.ogc.org/standards/3DTiles) - an OGC standard designed for streaming and rendering massive 3D geospatial content such as Photogrammetry, 3D Buildings, BIM/CAD (also suitable for complex architectural content).
A few works investigate methods, interfaces and tools allowing multiple users to access the same virtual (immersive) space, through common web browsers. These solutions also motivated the establishment of the “Metaverse Standards Forum” (https://metaverse-standards.org/), that provides a venue for cooperation to foster the development of interoperability standards for an open and inclusive metaverse.

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## *2. Detailed description of the project: methodologies, objectives, and results that the project aims to achieve; indicate deliverables and milestones outlining the project coherence as to the strategic themes, indicating clear and innovative objectives, setting out the project sector relevance and its positioning with reference to the state of art, describing the role and contribution of each research unit*

Main objectives:
MetaMic is an interdisciplinary research project that aims to counteract the sectoriality, rigidity and lack of attractiveness of current platforms dedicated to the enhancement and dissemination of cultural heritage. To this end, it involves competences in the fields of history and graphic representation and building materials of architecture, digital communication design and IT. MetaMic is therefore a project consistent with the objectives of the PNRR and Horizon Europe 2021-27, aimed at performing digital tools used in the promotion of cultural heritage, for scientific, educational, as well as economic purposes.

MetaMic intends to address the following challenges:
- how and within what limits is it possible to create a 3D digital ecosystem that has some of the immersive, participatory features of the Metaverse (interactive VR and AR, possibly XR), dedicated however specifically to the enhancement and promotion of cultural content ?
- is it possible to create a digital tool for the enhancement of cultural heritage that is controlled in its scientific content, available for continuous data enrichment and at the same time accessible and attractive to the general public of non-specialists ?
- is it possible to create a collection of digital 3D models of Michelangelo's unrealised architectures, constituting a sort of virtual museum of Michelangelo's design thought accessible on a shared platform, so that international scholars can verify it and propose possible modifications and/or alternative 3D models ?

To meet these challenges MetaMic proposes two key-objectives:
Objective 1: to perform the communicative abilities of digital platforms dedicated to the promotion of cultural heritage, by adopting solutions currently used in Metaverses: in particular, to adopt immersive (3D environments), interactive and participatory features, in order to foster the widest public and social enjoyment of the cultural heritage being promoted, while preserving the strict scientific control of the content.
Objective 2: to make a decisive advancement in the knowledge of Michelangelo Buonarroti's architecture, by reconstructing in digital 3D models a selection of his unbuilt projects, set in the original building and urban environments; each digital reconstruction will be associated with a complete and up-to-date multimedia database of historical sources (graphic and documentary), site surveys and bibliography.

Concepts and detailed innovative objectives:
The innovative concept of MetaMic, which most differentiates it from the platforms currently used in the enhancement of cultural heritage, is the provision of a concretely interactive and participative digital ecosystem. MetaMic envisages one main cross-disciplinary result, which is also its final output: an immersive IT 3D platform, including a multimedia set of written, visual and audio contents, dedicated to the unbuilt architectures (buildings and architectural frames) of Michelangelo Buonarroti. The ecosystem, together with its communicative interfaces and contents (potentially bilingual Italian-English) will be designed to be entirely open to an audience of all social and educational levels, from tourists and amateur laymen, to school and university students up to specialist scholars.
To achieve this objective, the IT platform of will be interactive, participatory, modifiable, following the Interaction Design/User Experience and in compliance with FAIR requirements. The project will follow the principles of Human-Centred Design/User Experience and HCD methods (direct observation, interviews and questionnaires, co-design) for the evaluation and interpretation of user needs and expectations and concept validation.
Subject to the manager's control, the user - whatever his or her level of education - will be able not only to consult and download, but also to upload, edit and exchange content (including video and sound), leave comments and exchange opinions with other users, making the platform a living, albeit virtual, cultural place. Specific interface modes of use will be designed and dedicated to each level of users.
The platform will be designed for predominantly online web-based use; however, possible mobile applications will be studied, and, if resources are sufficient, experimental prototypes of installations on the physical site. Metamic will not take over the full capabilities of Metaverses in recreating a second, multi-sensory reality that can be experienced through avatars. Nonetheless, a single tactile experience experiment will be attempted, applied to a sculpted piece of the New Sacristy, to test whether and in what ways it is possible to offer users (especially the visually impaired) an otherwise unperceivable experience.

As a case study, Metamic has chosen Michelangelo's unrealised architecture (buildings and architectural frameworks), which will be philologically reconstructed from graphic and documentary sources, and then recreated in digital 3D models to be inserted into the original building and urban environments (also rebuilt in 3D modeling). The 3D models of the original architectures and sites will constitute the tridimensional immersive environment of the digital platform.
The 3D modeling forces a formal, metric and material definition of the architecture that is unknown to traditional and ambiguous two-dimensional reconstructions, taking a decisive step in the understanding of Michelangelo's architectural oeuvre. So that MetaMic will constitute a virtual site that will conceptually expand the number of known Michelangelesque architectures, updating - with the power of digital tools - the admirable but closed communicative model of the corpus of Buonarroti's drawings published by Tolnay 1980. The sharing with international scholars of the 3D models and associated databases (in file format and not on paper), promises to increase knowledge on Buonarroti's architecture even after the MetaMic project ends, making the proposed platform an open place of scientific and philological debate, hosting and making available the iconographic, documentary and bibliographic material useful for the future scientific implementation of the platform.

The case study offers the following opportunities:
- Michelangelo's unrealised architectures have never existed except in the artist's mind: it is a stimulating content for a cultural platform that adopts the immersive and interactive features of the Metaverse, turning purely conceptual forms into a 3D virtual reality;
- the specific skills possessed by the PIs, and by some members of the units, in the field of Buonarroti's architecture, which allow a rigorous control of the contents and their scientific credibility, as well as a significant advancement in the knowledge of Michelangelo's architecture, hitherto blocked to two-dimensional graphic analysis tools;
- the extreme notoriety of the artist and his work, both Italian and international, which on the one hand attracts the potential curiosity of the non-specialist public, and on the other meets with the foreseeable interest of the international scientific community, museums and public bodies managing Michelangelo's heritage (both architectural and archival); the MetaMic project intends to involve these bodies in the actions envisaged by the project, with the opportunity to enter into international partnerships for future joint European projects;
- the relatively low number of unrealised Michelangelo projects that can be reconstructed with sufficient scientific credibility (in terms of shape, size and materials), makes the operational feasibility of the project possible with the amount of funding that can be obtained.

Methodology and results:
The MetaMic project makes use of the synergic and cross-disciplinary collaboration between four areas of scientific and technical

expertise, listed below not in order of importance, but according to the logical and temporal consequentiality of their respective research contributions:

- historical-philological expertise (history of architecture, iconography, and building techniques);
- expertise in the visual representation of architecture (instrumental survey, 3D modeling, video-photographic representation);
- communication design expertise (Human-Centred Design/UX, user-interface design and development of concepts and mock-ups of digital interfaces);
- IT expertise (design and implementation of ecosystems and frameworks).

Each scientific competence contributes to the attainment of the objectives and the final result of the MetaMic project; at the same time, each area is engaged in a work-package of activities aimed at achieving specific results, each of which constitutes a relevant and objective advancement within the respective scientific and technological field.

The following table shows the sectoral results and expected key-outputs for each area:

| area of expertise | results | outputs |
|---|---|---|
| history of architecture | creation of an exhaustive and scientific controlled collection of graphic, documentary, iconographic and bibliographic sources relating to Michelangelo's unbuilt projects | Digital database of historical content for the 3D platform |
| | historical-philological reconstruction of the geometry, dimensions and materials of Michelangelo's unbuilt architectures, set in their original contexts | Scientific report of historical content to be published in Open-access |
| visual representation of architecture | digital collection of surveys and images relating to Michelangelo's unbuilt architectures set in their original contexts, supplemented by new video-photographs of their current state | et of digital 3D models for the 3D platform |
| | creation of digital 3D models of Michelangelo's unbuilt architecture inserted in the original contexts also digitised in 3D | Scientific report on representation to be published in Open-access |
| Human-Centred Design | Definition of project requirements based on Human-Centred Design/UX methods. | Project requirements |
| | Development of concepts, wireframes and mockups of the user interface from a cultural heritage accessibility perspective and according to the Inclusive Design approach | Mock up of the user interface for the 3D platform |
| | Design of the user interface and interaction with the 3D platform, according to the contributions of Interaction Design/User Experience | Scientific report on the representation to be published in Open-access |
| IT | Design and development of reusable front-ends, components and user services with different profiles, for accessing and querying semantically enriched online digital 3D environments | Creation of an ecosystem of open-source components and interoperable digital library, through the adoption of international guidelines and web standards |
| | Design of cross-device experiences with web tools for collaborative access and inspection of 3D models | Universal fruition of collaborative 3D environments on multiple devices (from mobile to XR devices) through common web browsers |

Deliverables and milestones:
The research activities proposed by MetaMic will follow an operational logic that will enable the concrete achievement of the expected objectives and results.
The research activities on cultural content (both historical and representative) will precede the design of the interface and the digital ecosystem. In any case, the different areas of expertise will have to liaise with each other to co-ordinate the progress of the research; they will have to provide assistance to the other expertises, contribute to the organisation of periodic seminar activities, dissemination and final open-access publications.
That said, each area is assigned a defined and assessable milestone, to be achieved through specific actions. The milestones and related actions (summarised in item B1.7), together with the planned sequence, and the verification of the results actually achieved, will be as follows:

1) Milestone historical area: Historical reconstruction of Michelangelo's unrealised architectures and their original settings.
1.1 research locations and utilities: specialised libraries (e.g. in Florence Kunsthistorisches Institut and Biblioteca Nazionale; in Rome

Bibliotheca Hertziana and BIASA); archives (Casa Buonarroti, GDSU, ASRFSP, British Museum, Louvre, etc.); monumental sites (San Lorenzo complex in Florence, Vatican Basilica, Porta Pia, Santa Maria degli Angeli in Rome). Direct consultation of original drawings, although desirable, can be effectively replaced by the analysis of high-definition digital copies (the excellent printed repertory by Tolnay 1980 is also always useful).
1.2 Actions:
- Preliminary selection of Michelangelo's architectural drawings (buildings or architectural frameworks), which can be reconstructed in terms of geometric form and dimensions with sufficient philological reliability. All simply sketched drawings will therefore be discarded: they will only be taken into consideration if they can provide suggestions for the philological reconstruction of the drawings chosen for their good definition;
- collection of all documentary and iconographic sources relating to the building and urban sites for which Michelangelo had envisaged the designs that were not realised: e.g. the San Lorenzo complex in Florence (façade, ricetto and secret room of the Laurentian Library); Sagrestia Nuova (exhibitions of the Magnifici and the Popes); St. Peter's in the Vatican, Porta Pia, Santa Maria degli Angeli, etc.
- historical and geometric analysis of the selected drawings, placed in their original contexts, in order to arrive at a collection of reliable philological reconstructions, represented in digital format or even just on paper.

2) milestone of the architectural representation area: digital 3D modelling of Michelangelo's designs and their original settings;
2-1 research locations and utilities: Lab#Multimedia Communication and digital production SAAD Ascoli Piceno laboratory (University of Camerino); monumental sites (San Lorenzo complex in Florence, Vatican basilica, Porta Pia, Santa Maria degli Angeli in Rome).
2.2 Actions:
- acquisition of already available instrumental surveys in digital format of the San Lorenzo complex, the Vatican basilica, etc.
- integration with new instrumental beats of any missing survey data;
- realization of new video-photographic campaigns of the current state of the sites aimed at integrating their geometric knowledge, and at the same time to update their iconography, also for educational purposes;
- realization of digital 3D models of Michelangelo's selected unbuilt architectures.

3) Milestones of Human-Centred Design area: Concept, wireframe and mockup of the user interface, in according to the Human-Centred Design and Inclusive Design approach:
3.1 research locations and utilities: Ergonomics & Design Laboratory (LED), University of Florence; DHIlab (CNR ISPC); Lab#Multimedia Communication and digital production SAAD Ascoli Piceno; PROS Lab, University of Camerino.
3.2 Actions:
- research and systematisation of the scientific literature on digital platforms for the dissemination of culture content and 3D IT platforms for the enjoyment of cultural heritage;
- research and systematisation of the scientific literature on the accessibility of 2D and 3D interfaces, with a focus on the accessibility standards of IT services in force in Italy;
- development of concepts, wireframes and mockups of the user interface from a cultural heritage accessibility perspective and according to the Inclusive Design approach.

4) Interactive 3D components and services milestones:
4.1 research locations and facilities: DHIlab (CNR ISPC), laboratory, University of Camerino - PROS Lab.
4.2 Actions:
- design of interactive Web3D/WebXR fruition components based on the open-source ATON framework (CNR ISPC) according to the outputs of the design activities in the milestone of U1;
- development of front-ends for accessing, visualising, inspecting and querying digital 3D models. - Study, definition and development of the mechanisms of interaction and collaborative intervention on the 3D models as well as cross-device user profiles for the MetaMic 3D platform accessible through common web browsers;
- deployment and technical assessment of the developed components and services. Experimentation and evaluation of the MetaMic platform with real users.

Periodic verification of actions and milestones:
The overall progress of the research will be continuously monitored by the overall PI, who will make use of bi-monthly internal reports provided to him by the PIs of the other units. Semi-annual seminars, open to external consultants, are also planned to objectively verify the achievement of intermediate targets and results, and to identify any corrective actions that may be necessary to achieve the MetaMic project's objectives and final results. For this purpose, an international seminar will also be organised at the end of semester 6 (scheduled to be held in Ascoli Piceno). The international conference to be held at the conclusion of the research (planned to be held in Florence), on the other hand, is intended both as an output of the project and as a dissemination tool. The interface concept will be tested with the HCD method (direct observation, interviews and questionnaires, co-design) for the evaluation and interpretation of user needs and expectations.

Role and contribution of each research unit:
The different competences required by the MetaMic project are distributed among the units, with the exception of U4 exclusively dedicated to IT. This is a consequence of the PRIN 2022-PNRR call for proposals, which allows components to belong only to units located in the structure they belong to: thus, components having different expertise but belonging to the same university/research body are forced to join the same unit, making it difficult to set up homogeneous work-packages.

The distribution of tasks in the MetaMic project is affected by this constraint, but still differentiates the tasks assigned to each unit.

The following tasks are assigned to the PI Unit (PI-U1, Camerino), which has a large number of members:
- overall coordination of the project;
- coordination of the historical-philological study of Michelangelo's unbuilt architecture in both Florence and Rome, in collaboration with the similar study carried out by U2 and U3;
- iconographic integration of the environments in their current state with survey and video-photographic tools;
- digitisation into 3D models of the selected projects and environments;
- contribution to the IT project of the digital ecosystem in collaboration with U2 and U4.

Unit 2 (U2-Florence) is assigned the following tasks:
- historical-philological study, in collaboration with PI-U1 and U3, of Michelangelo's unrealised architecture in Florence;
- definition of the modalities and mock up of visual communication tools suitable for FAIR fruition for users of different cultural levels, in collaboration with U4;

Unit 3 (U3-IUAV) is assigned the following tasks:
- historical-philological study, in collaboration with PI-U, of Michelangelo's unbuilt architecture in the St Peter's complex in Rome and his visual communication.

Unit 4 (U4-CNR ISPC) is assigned the following tasks:
- design and implementation of Web3D/WebXR components and services to access, explore and query digital 3D models on the Web, in collaboration with other units;
- implementation of user profiles and user interfaces (UIs) in accordance with milestone 3, to interact with online digital content;
- design and development of online collaborative interaction models, following FAIR principles and international standards;
- deployment and assessment of developed components and services on available RIs.

Project sector relevance and its positioning with reference to the state of art:
The MetaMic project intervenes in the sector of digital cultural heritage valorisation, which by its nature is cross-disciplinary. The use in the valorisation of cultural heritage of the advanced communicative tools of the Metaverses (3D immersiveness and participativity), places the MetaMic project at the forefront of the sector. Its final result aspires to a TRL 4 (Functional verification) grade. In the spectrum from 'idea to application', its positioning is closer to application, as it is to create a functioning digital ecosystem prototype, designed, however, for non-immediate use or commercialisation. However, the technological and operational experiences - even partial - acquired with the MetaMic project may set a precedent for operators and stakeholders engaged in the digital cultural heritage, both public and private; the foreseeable commercial implications contribute to the development of a field of activity with considerable economic prospects.
In Italy, a country that holds the largest UNESCO World Heritage Site, the socialisation of cultural heritage also has economic implications, which are, moreover, indicated in many points of the PNR and PNRR.

In addition to the final result of the digital ecosystem, MetaMic achieves the innovative results described above in each of the four areas of expertises it involves. In summary:
- it significantly increases our knowledge of Michelangelo's architectures, going beyond the two-dimensional tools currently used for their formal, geometric, material analysis;
- it constitutes an open (accessible and editable) digital corpus on Michelangelo's architecture, consisting of 3D models, graphic and documentary sources, historical and current iconography, and bibliography;
- creates participatory interfaces for 3D environments specifically designed to enable the use of cultural content open to users of all cultural levels;
- implements existing 3D digital ecosystems, providing them with an interactive database.

None of the expected results of MetaMic is currently achieved in the area of cultural heritage enhancement and promotion.

Consistency with the objectives and scopes of the European Programme 2021-2027 and the PNRR 2021:
The project mainly responds to the request of scope 3 of Cluster-2 (Culture Creativity and Interactive Society) of the European Programme Horizon 2021-27: "Better value, access, protection and sustainability of cultural heritage across Europe are ensured through innovative cultural and creative sectors"; it also responds to Cluster-2 Scope 4 ("Better protection of historic sites and monuments, cultural landscapes, museums, archives, as well as languages, customs and traditions is achieved through innovative policies, methodologies and citizen participation"); finally, the project also has relevance to Cluster-4 Scope 6 (Digital, Industry and Space): "Ethical and human-centred development of digital and industrial technologies, through two-way engagement in technology development, end-user and worker empowerment and support for social innovation".

MetaMic also complies with the objectives of the PNRR, adhering to the first mission Digitisation, Innovation, Competitiveness, Culture and Tourism; specifically, the project falls under the components M1C2 (Digitisation, Innovation and Competitiveness in the Production System) and M1C3 (Tourism and Culture 4.0), for which a total budget of 38.70 billion euros is planned. The MetaMic project contributes to the revitalisation of the tourism and cultural activities with an innovative and sustainable approach to improve access to and enjoyment of tourist and cultural sites. Indeed, it should be noted that the research product is offered to public and

private institutions that conserve Michelangelo Buonarroti's drawings and sources, as well as to the Soprintendenze and local authorities that manage Michelangelo Buonarroti's buildings (including the Museo del Bargello, Biblioteca Laurenziana, Roma Capitale, Fondo Nazionale Edifici di Culto, etc.). The proposed project, moreover, is a pilot experience that will be useful for the sustainable valorisation of other cultural assets, both tangible and intangible, constituting a concrete point of reference for institutions wishing to valorise the cultural assets they hold, with a managerial and economic return. MetaMic can therefore also contribute to the digital transition and to the strengthening of the digital skills of the PA itself (M1C1 component), both in the institutions that manage cultural heritage, and in the various levels of public education.
The MetaMic project is also part of the fourth mission Education and Research: it contributes to the M4C2 component (From research to enterprise), fostering the transfer of the most up-to-date digital technologies in the research chain to innovative business activities, in particular start-ups, that can offer themselves as providers of digital services for the valorisation of cultural heritage at various levels.

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*3. Detailed description of the project team and planning; indicating the research team components – PI and associated PIs - and their relative expertise/track record, gender equality of the composition, the interrelation and coherence of the team components. RUs- and the feasibility of the project, thus outlining the congruity between objectives, timing and costs*

The four RUs contributing to the MetaMic project, with their components (ordered by SSD), are as follows:

U1-PI, Università di Camerino
PI: Federico Bellini (Icar/18-Storia dell'architettura)
Giuseppe Bonaccorso (Icar/18-Storia dell'architettura)
Enrica Petrucci (Icar/19-Restauro)
Giovanni Puztu (Icar/19-Restauro)
Alessandro Basso (Icar/17-Disegno)
Marta Maganini (Icar/17-Disegno)
Nicolò Sardo (Icar/17-Disegno)
Daniele Rossi (Icar/17-Disegno)
Federico Oppedisano (Icar/13-Design)
Andrea Polini (Inf/01-Informatica)
Michele Loreti (Inf/01-Informatica)

U2, Università di Firenze
U-PI: Emanuela Ferretti (Icar/18-Storia dell'architettura)
Alessandro Brodini (Icar/18-Storia dell'architettura)
Francesca Tosi (Icar/13-Design)

U3, Università IUAV-Venezia
U-PI Vitale Zanchettin (Icar/18-Storia dell'architettura)
Emanuela Bonini Lessing (Icar/13-Design)

U4, CNR ISPC
U-PI: Bruno Fanini (Inf/01-Informatica)
Enzo D'Annibale (Icar/06-Topografia e Cartografia)
Emanuel Demetrescu (Ant/10-Metodologie della Ricerca Archeologica)

The percentage of female members (38%) in MetaMic respects gender equality, and is higher than the average in Italian academic and research structures for full and associatec professors and researchers (36%).

Expertise/track record of the team components
The Expertise and track records of the MetaMic research components are divided according to the different work-packages, which are transversal to the RUs. Regardless of the RU they belong to, components with related expertise will be able to exchange and compare their research results, thanks to the effectiveness of currently available remote communication tools.
Each scientific area of MetaMic is indispensable for achieving the final result; the tasks and expertise of the individual components are described below in an order reflecting the consequentiality of the actions to be performed and milestones to be achieved, as summarised in the GANT table under B1.7.

WP1, Historical and philological reconstruction of the unbuilt projects of Michelangelo Buonarroti
The historical and philological reconstruction of Michelangelo Buonarroti's projects, starting from existing graphic and written sources and bibliography, will be carried out by the group of historians belonging to the U1-PI, U2, U3 units. They include all the most accredited scholars of Michelangelo's architecture that the rules of the PRIN 2022-PNRR call for proposals allowed to be involved. It was not possible to include the other Buonarroti experts, who had shown interest in the project, because they are not structured in

the national academic system. However, it is planned to involve them as external consultants, together with leading Michelangelo scholars from foreign institutions.
- Main PI Federico Bellini is the author of several recognised contributions, including a two-volume monograph on the construction of St. Peter's Basilica from Michelangelo to Della Porta (2011), and several others specifically dedicated to Buonarroti's interventions in the basilica; is currently drafting a volume on Michelangelo's architecture in Florence (expected publication 2023) and editing another volume on Michelangelo's beginnings in architecture (expected publication 2024); he also has specific experience in the digital valorisation of architectural heritage, gained in the FAR-Unicam funded research on the basilica of Loret’s Santa Casa (2015-19), in which almost all the other members of the PI unit participated. The PI will also establish relations in Rome between the MetaMic project and external actors, such as the Bibliotheca Hertziana, the Accademia di San Luca, the Istituto Studi Romani, and so on.
- U1's PI Emanuela Ferretti has published numerous contributions on Michelangelo's Florentine work, as well as on the San Lorenzo complex, which hosts almost all of the artist's unrealised architecture in Florence; she also has specific experience in the digital valorisation of architectural heritage gained in the “MiSM-Art Museum research (Michelangelo Self Made Art Museum: technological innovation for the fruition and inclusive experience of the artistic and cultural heritage)” for the TIM call. Ferretti will also establish relations in Florence between the MetaMic project and external stakeholders such as the Bargello Museum and Biblioteca Mediceo-Laurenziana, Casa Buonarroti, Kunsthistorisches Institut and I Tatti.
- Alessandro Brodini is the author of several acknowledged contributions on Michelangelo's architecture, including a volume on Michelangelo's St. Peter's (2009) and several essays on the intervention in Santa Maria degli Angeli;
- U3’s PI Vitale Zanchettin is the author of several contributions on Michelangelo's architecture, both in Rome and Florence, and is currently in charge of the Soprintendenza ai Beni Architettonici della Città del Vaticano (the Vatican City Architectural Heritage Office, Vatican Museums sector), including St. Peter's, on which he has published several essays.
- Three other historians of architecture and traditional building techniques belong to the PI Unit 1, who do not have specific Michelangelo expertise, but who will make an indispensable contribution to the project: Giuseppe Bonaccorso will be responsible for the general historiographical analysis, as well as for maintaining contact with the numerous foreign research centres interested in the project; Enrica Petrucci will devote herself to the study of the transformations undergone by Michelangelo's rooms in the modern age, Giovanna Putzu to the study of their concrete building materiality that can be seen today.

WP2, Digital 3D modelling, surveys, graphic and video-photographic integration of the iconography:
The historical reconstructions will be transformed into digital 3D models under the direction of components with expertise in the visual representation of architecture. However, historical iconography is not sufficient to recreate in 3D the building and urban environments of Michelangelo's unrealised projects. The components of the design area must therefore integrate the set of visual representations of the places with instrumental surveys already available (or to be carried out with laser equipment and photogrammetry), 360° multi-camera video footage, and finally with special video-photographic beats useful above all for uploading the platform's integrative contents.
The iconographic materials thus produced will have to be converted into digital formats that the computer platform is able to manage; for this the components of the representation of the architecture will have to collaborate with components that have specific computer design skills.

The tasks described above will mostly be performed by the components of the PI Unit 1.
- Alessandro Basso has specific competences in 3D digital modelling of historical architectural heritage, and a long experience in practical applications, some of which carried out in collaboration with the CNR, forming the U4 of MetaMic;
- Daniele Rossi has worked extensively in digital visual communication, and has specific experience in the digital enhancement of intangible cultural heritage developed as PI in a FAR-Camerino funded research; Federico Oppedisano is an expert in communication design and has worked on appropriate methods for the graphic translation of 3D reconstructions of architecture;
- Marta Maganini has expertise in the field of the instrumental survey of architecture; Nicolò Sardo has expertise and long experience in the field of the video-photographic recording of historical architecture.
The contribution of the components of this area also extends to a useful aid to the historians of the PI-U1, U2, U3 in the comprehensive understanding of the traditional iconographic repertoire of places. In order to physically carry out the digitisation, however, external personnel will be employed, who will be called upon to carry out a purely executive activity.

WP3-Human-Centred Design:
The Human-Centred Design (HCD) approach and in particular the methods of investigation with users inherent to the HCD approach (direct observation, interviews and questionnaires, co-design) will make it possible to assess and interpret user needs, with specific attention also to the aspects of inclusion of fragile users, and to define the project requirements. This approach will also be used during the development of concepts and mock-ups for testing the proposed solutions with users. Based on these requirements, the concept and the subsequent mock-up of the interfaces will be defined, in accordance with the competences of IT (U4 and PI-U1);

- Francesca Tosi has published numerous books and contribution on Human-Centred Design and Inclusive design approach and methods, principles and design application in the field of products and services for social and cultural inclusion. She has carried out research in the field of design for the inclusion in cultural heritage (XALL-ALL ANOTHER GUIDE, funded by TIM Foundation" The art that welcomes: inclusion in museums through the use of innovative technologies” 2020-23 - PI) and in education (PUDCAD Practicing Universal Design Principles in Design Education through a CAD-based Game, Erasmus + Action Type, 2017-19 – PI WG);
- other research members will contribute to the interface design, developing digital visual communication issues within their RU: in PI-U1 Federico Oppedisano and Daniele Rossi, in U3 Emanuela Bonini Lessing, ql is an expert in visual and multimodal

communication design, mainly related to cities, territories, communities of people, identity and service systems.

WP4 - Interactive 3D components and services
This WP will design and implement Web3D/WebXR components and services targeting interactive 3D/4D visualization of 3D models/spaces for MetaMic. These components will be developed on top of the open-source ATON framework (CNR ISPC) according to the outputs of the design activities carried out in WP3. Different "liquid" (cross-device) front-ends with multiple user profiles will be realized to access, visualize, inspect and query 3D datasets with FAIR principles. Such components will also integrate collaborative interaction modes, built on top of existing functionalities offered by the framework, to share, access and enrich digital spaces with remote participants, through common web-browsers. Final phases of the WP will focus on deployment and assessment of developed components and services.

- Bruno Fanini (U-PI) is a researcher at DHIlab (CNR ISPC). PhD in Computer Science, focuses his activities on interactive 3D, immersive VR, spatial interfaces and WebXR for Cultural Heritage, designing and developing open tools for the community (such as ATON framework) within national and international projects. He is responsible for different interactive 3D projects, RI units and international agreements related to Web3D open standards and specifications.
- Enzo d'Annibale is a researcher at DHIlab (CNR ISPC). PhD in Geomatic, is a specialist in 3D photogrammetric reality-based reconstruction, immersive and interactive media, VR and Spatial AR technology. His main researches concern the design and development of technologies for immersive and interactive visualization of virtual scenarios. He has a long experience in creating interactive and immersive experiences for research laboratories, museums, schools. Through the use of creative coding methods and tools he designs and realizes applications based on real time data processing, motion graphic, natural interaction, projection mapping, physical computing, computer vision, AI.
- Emanuel Demetrescu, PhD in Archaeology, is a researcher at DHIlab (CNR ISPC). Specialist in Digital Archaeology, Building Archaeology and 3D source-based modelling, his main research regards the creation of theoretical and methodological links between scientific record in Cultural Heritage and creative industries (3D digital libraries, virtual museums, Open World games and VR experiences).

- The research activity of Michele Loreti (PI-U1) is focused on the study of formal tools for specifying and verifying qualitative and quantitative properties of concurrent and distributed systems. He is long experienced with Qualitative and quantitative semantics of process calculi, logics, tools and methodologies for system verification, Development of tools for system analysis and deployment. Andrea Polini (PI-U1) is an expert in the area of complex software system verification and testing, as approach to static and dynamic verification of real software systems. In the last years he focused on the SOA world, investigating on approaches for making verification and testing an on-line activity.

Feasibility:
The objectives and results foreseen by MetaMic, distributed among the tasks of the different RUs, are all concretely achievable in 24 months of work, according to the timing of the milestones detailed in item B1.7, and which is summarised in the following synoptic table:

| WPs | RU | Actions | 1st-year bimonths | | | | | | 2nd-year bimonths | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| history | PI-1<br>2<br>3 | Preliminary source collection | | | | | | | | | | | | |
| | | Philological reconstruction of projects and environments | | | | | | | | | | | | |
| | | Assistance to the actions of the other expertise areas | | | | | | | | | | | | |
| visual representation | PI-1 | Survey collection and iconography of the existing building environment | | | | | | | | | | | | |
| | | Integration of surveys and visual repertory of the existing building environment | | | | | | | | | | | | |
| | | Digital 3D modelling of reconstructed projects | | | | | | | | | | | | |
| interfaces | 2<br>4 | Preliminary research on available 2D-3D interfaces | | | | | | | | | | | | |
| | | Development of concepts, wireframes and mockups | | | | | | | | | | | | |
| | | interface design and verification of user interaction | | | | | | | | | | | | |
| IT | PI-1<br>4 | Design of components and web services for the cross-device platform | | | | | | | | | | | | |
| | | Front-end development and collaborative services | | | | | | | | | | | | |
| | | Deployment and assessment | | | | | | | | | | | | |
| workshops /conferences | All units | Organisation of quarterly internal workshops to compare and verify results | | | | | | | | | | | | |
| | | Organisation of two international conferences at the end of the two bi-monthly periods | | | | | | | | | | | | |

The economic resources, reported in item B1.5, are distributed among the various RUs due to the project's specific research needs. MetaMic does not require significant expenditure for materials and equipment:

- the use of processing materials is not envisaged, but at most of simple consumables;
- the RUs of MetaMic can rely on the hardware instrumentation already available in their respective laboratories (however, a usage charge is envisaged if required by the respective departments); the new hard instrumentation required is reduced to the purchase of computers and/or digital devices that have sufficient processing capabilities, graphics card and screen quality to verify the work carried out in the RUs;
- the MetaMic RUs can rely on the software instrumentation already available in their respective laboratories and RIs (a usage charge is expected, however); many applications and systems are also in the public domain, while the open-source ATON framework is made available by CNR ISPC's U4.

On the other hand, the greatest resources are allocated to human capital, which will actually have to perform the actions required by the research, both scientifically and operationally. MetaMic personnel are of two types:
- the project components, whose personal activity is financed by the Prin on the basis of their hourly commitment; it has been recognised in the budget that some members will have a higher commitment than others.
- the external collaborators, in turn divided into consultants and providers (so-called "fornitori di beni immateriali"). The MetaMic project budget allocates significant resources mainly to the providers, to whom it intends to entrust the purely operational actions (3D digital modelling, survey assistance, interface and IT platform digitizing) that are indispensable for achieving the project objectives.

At no cost components:
The budget (item B1.5) has been calculated considering the following components at no cost, as explicitely permitted by MUR's FAQ n.2 (FAQ 2022 PNRR - I.pdf):
Giuseppe Bonaccorso and Nicolò Sardo (PI-U1), Alessandro Brodini (U2), Emanuela Lessing (U3). The research activities of these components will be supported with overheads (item D - A14) and MUR funding of the hourly commitment of the other components (item A1 - A14), managed by the RU's PIs.

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## *4. Detailed description of the Project impact, as such; indicating knowledge improvements, technological innovation and/or industrial applications, scientific community reinforcement, level of research internationalization, dissemination and exploitation of the results*

knowledge improvements:
The MetaMic project aims at the following knowledge improvements:

- better historiographical understanding of Michelangelo's work as an architect, achieved through three results:
(a) philological three-dimensional reconstruction of a selection of unbuilt projects and the enviromnent for which they were intended; the subsequent 3D modelling requires the reconstructions to be congruent in terms of geometry, dimensions and materiality, and compatible with the original building sites, implying a decisive clarification of our knowledge of Buonarroti's architecture;
b) the constitution of an extensive, digital and accessible database of historic sources, images and bibliography relating to the individual reconstructions; this constitutes a drastic innovation with respect to the static printed repertories of Michelangelo's drawings, from Thode (1913) to Tolnay (1980), up to the most recent exhibition catalogues (Bambach 2017);
c) possibility, regulated by the platform administrator, of uploading new content by international scholars, who can thus participate in the future increase of knowledge through written comments, proposed corrections to 3D models, alternative 2D-3D models, etc.

- decisive improvement of the digital iconography of Michelangelo's projects, achieved through three results:
(a) collection of all the instrumental surveys available today, converted into homogeneous formats, and integration with new instrumental surveys and video-photographic shots, to create a set of 2D-3D visual representations that would be unprecedented;
b) creation of digital 3D models of the selected projects, in homogeneous format, to be shared with international users and scholars;
c) communicative improvement of the visual rendering quality (colours, textures, lights, etc.), to adapt it to the case of historical architecture of a high artistic level.

- improvement of the knowledge of the interaction modalities between people and digital interfaces and development of requirements and concepts aimed at 2D-3D visual representations, achieved through the application of Human-Centred Design/UX survey methods aimed at the systematic collection of the needs and expectations of sample user groups and the definition of the relevant requirements. Two results are envisaged:
a) definition of requirements aimed at 2D-3D visual representations;
b) definition of concepts and mock-ups.

- knowledge improvement of IT area:
reusable, modular and customizable open-source components available for target communities, focused on interactive, collaborative and immersive inspection and enrichment of architectural 3D models on the Web. Furthermore, open extensions enriching international standards specifically targeting unrealised architectures. These goals will be achieved through:
a) the application of FAIR principles and international web standards to 3D components and datasets
b) the application of existing formal languages and visual metaphors targeting reconstruction processes

c) the use of scalable frameworks

Technological innovation and/or industrial applications:
The MetaMic project aims at the following technological innovations:
- moving studies on Michelangelo Buonarroti's architecture and its representation from the age of bidimensional print on paper to that of 3D digital tools and media;
- defining the requirements for interaction with 2D-3D visual representations and defining concepts and mock-ups.
- building an ecosystem of reusable 3D components and services for the Web, targeting liquid (cross-device) fruition of enriched architectural models, ranging from mobile up to XR devices.
- developing reusable protocols and interaction metaphors for collaborative inspection, exploration and query of architectural 3D models on the Web, adopting international standards, providing: a) integration with existing platforms and metaverse ecosystems; b) open and interoperable digital library targeting interactive online solutions; and c) replicable pipeline for architectural Web3D/WebXR projects
Although MetaMic does not have any immediate commercial objectives, the platform will constitute a prototype, virtually patentable, that can be impeached in the development of the digital industry applied to the cultural market, particularly encouraged by the PNRR forecasts.

Scientific community reinforcement, level of research internationalisation:
The MetaMic project reinforces the scientific community and stands at a high level of research internationalisation in each disciplinary area participating in the research.

In general, MetaMic aims to offer the scientific community an innovative prototype of a digital platform dedicated to the enhancement of cultural heritage, in particular of architecture, city and landscape. Research groups currently active in the field of digital cultural heritage according to the Horizon 2021-27 Destination "Innovative research on the European cultural heritage and the cultural creative industry" are expected to be interested; whether funded, the MetaMic team will be accredited to forge scientific and operational relationships in order to compete in joint projects of EU calls (or of other countries such as the Swiss Confederation).
To give one example among many possible ones, the objectives of MetaMic overlap with the outcomes required in the call HORIZON-CL2-2021-HERITAGE-01-04: Preserving and enhancing cultural heritage with advanced digital technologies (https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-5-culture-creativity-and-inclus ); due to the maximum funding obtainable with the PRIN, the outcomes of MetaMic are naturally restricted to a case study that is much more limited – but qualitatively no less significant.

- In the area of history and visual representation of architecture, the MetaMic project's level of research internationalisation is implicit in its Buonarrotian theme, which has been attracting the attention of scholars all over the world for at least three centuries. MetaMic intends to exploit the international openness of its theme as a resource to involve foreign scholars, institutions and stakeholders, which the PRIN call does not allow to be included among the research components. International stakeholders will be involved in MetaMic's research activities as participants in the periodic seminar meetings to review the work carried out, or as possible external consultants. At the conclusion of the research, MetaMic will also offer international specialists a place for debate and disciplinary exchange on Michelangelo's architecture, enhanced by the operational capabilities offered by a digital 3D platform.

In the area of human-centred design, the interface of MetaMic will show new ways of using cultural heritage will be defined, capable of including the needs of different user profiles and usable as a model for further experimentation. The theme of 2D and 3D interaction with works of art makes it possible to develop design areas of particular topicality by attracting attention to the themes of full accessibility and usability of art by different social and cultural levels.

- In the area of IT the MetaMic project aims to offer a set of web-based 3D components as a digital platform, to interactively and collaboratively access, explore and query enriched architectural 3D models online. The resulting ecosystem will rely on robust international Web3D standards and open specifications, open-access policies and FAIR principles, providing sustainability, integration and replicability for projects sharing similar themes.

Dissemination and exploitation of the results:
The research results will be disseminated through three channels: seminars, publications and the platform itself.
- platform: the most powerful dissemination tool of the MetaMic project is the 3D digital platform itself, which is to be online and even partially functional. Access to the platform will enable MetaMic members to disseminate general and partial research results at seminars and conferences, and will be effective in attracting the attention of external scientific partners and stakeholders in order to promote national and international consortia for national and international calls.
- seminars: the first dissemination of the partial results of the MetaMic research will take place in an international seminar to be held at the end of the first six semesters of activity, at the seat of the PI-U1 (Ascoli Piceno-University of Camerino); a concluding international conference is also planned, to be held after the 12th semester in the RU2 of Florence;
- final publications: MetaMic plans to disseminate the theoretical and operational results of the research through a publication of the contributions of the single disciplinary areas, and of the proceedings of the international conference in Florence; the publications will be in Open-access online and free of charge, at least in green access mode as provided for by art. 14 of the call. Should the

resources be sufficient, a hard copy of the two volumes may be printed. MetaMic encourages research members to use part of the resources allocated for their personal commitment to the project, to increase the output of publications produced by the research in collective volumes, journals or other.

## *5. Financial aspects: costs of each research unit*

| nº | | Funds of the Ministry of University and Research (euro) |
|---|---|---|
| 1. | BELLINI Federico | 123.288 |
| 2. | FERRETTI Emanuela | 76.688 |
| 3. | ZANCHETTIN Vitale | 24.800 |
| 4. | FANINI Bruno | 75.106 |
| | | **299.882** |

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## *7. Time schedule of the research activities (GANTT CHART)*

*Milestone 1 historical reconstruction of Michelangelo's unrealised architectures and their original environments*

| ACTIVITY | ASSIGNED TO | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |
| selection of unbuilt Michelangelo's projects, taken as case studies, which can actually be reconstructed in terms of size, geometry and materials | BELLINI F FERRETTI E ZANCHETTIN V | X | X | X | | | | | | | | | |
| identification and collection of the graphic, documentary, iconographic and material sources of the selected projects and the original building and urban environments for which they were planned | BELLINI F FERRETTI E ZANCHETTIN V | X | X | X | | | | | | | | | |
| historical, geometric and material reconstruction of the original building and urban environments in which the | BELLINI F FERRETTI E ZANCHETTIN V | | | X | X | X | X | X | X | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reconstructions of the selected projects were to be placed | | | | | | | | | | | | | |
| historical, geometric and material reconstruction of the selected projects | BELLINI F FERRETTI E ZANCHETTIN V | | | X | X | X | X | X | X | | | | |
| creation of an abacus of functional elements for digital reconstruction | BELLINI F FERRETTI E ZANCHETTIN V | | | | | | X | X | X | | | | |
| scientific report on the philological reconstructions carried out, to be collected in a volume published in Open-Access | BELLINI F FERRETTI E ZANCHETTIN V | | | | | | X | | | | | | X |
| assistance to the digital 3D reconstructions, communication interface and IT platform | BELLINI F FERRETTI E ZANCHETTIN V | | | | | | X | X | X | X | X | X | |

*Milestone 2 Digital 3D modelling of Michelangelo's designs and their original environments*

| ACTIVITY | ASSIGNED TO | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |
| identification and collection of already available surveys of the building and urban environments that would have hosted Michelangelo's unrealised projects | BELLINI F FERRETTI E ZANCHETTIN V | X | X | X | | | | | | | | | |
| integration of new digital, photogrammetric and photo-videographic surveys of the original environments | BELLINI F | | | X | X | X | X | X | X | | | | |
| 3D digital modelling of the architectures and environments | BELLINI F | | | | | | X | X | X | X | X | X | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| scientific report on the digital 3D reconstructions carried out, to be collected in a volume published in Open-Access | BELLINI F | | | | | | X | | | | | | X |

*Milestone 3 Design of an accessible and inclusive user interface and interaction/user experience of a 3D platform*

| ACTIVITY | ASSIGNED TO | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |
| Research and systematisation of the scientific literature on digital platforms for the dissemination of culture and 3D information platforms for the use of cultural heritage | FERRETTI E FANINI B | X | X | X | X | | | | | | | | |
| Development of concepts, wireframes and mockups of the user interface, from the perspective of accessibility of cultural heritage and according to the Inclusive Design approach | FERRETTI E FANINI B | | | X | X | X | X | X | X | | | | |
| Design of the user interface and interaction with the 3D platform, according to the contributions of Interaction Design/User Experience | FERRETTI E FANINI B | | | | | | | X | X | X | X | X | X |
| Assisting U4 with the implementation of the digital ecosystem | FERRETTI E FANINI B | | | | | | | | | | X | X | X |
| scientific report on the philological reconstructions carried out, to be collected in a volume published in Open-Access | FERRETTI E | | | | | | X | | | | | | X |

*Milestone 4 IT ecosystem supporting MetaMic platform*

| ACTIVITY | ASSIGNED TO | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |
| Design of components and web services for the cross-device platform | BELLINI F<br>FANINI B | | | X | X | X | X | X | X | | | | |
| Front-end development and collaborative services | BELLINI F<br>FANINI B | | | | | | | X | X | X | X | | |
| Deployment and assessment | BELLINI F<br>FANINI B | | | | | | | | | | X | X | X |
| scientific report on the philological reconstructions carried out, to be collected in a volume published in Open-Access | BELLINI F<br>FANINI B | | | | | | X | | | | | | X |

*Milestone 5 verification and review of the research advancements, workshops, conferences*

| ACTIVITY | ASSIGNED TO | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |
| internal workshops for the verification of the reasearch activities and results | BELLINI F<br>FERRETTI E<br>ZANCHETTIN V<br>FANINI B | | | X | | X | | X | | X | | X | |
| international conferences on the ongoing and final results of the research | BELLINI F<br>FERRETTI E<br>ZANCHETTIN V<br>FANINI B | | | | | | X | | | | | | X |

*8. Time schedule of the expenses*

| nº | Research Units | Expenses | I year | | | | | | II year | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 | BIM. 1 | BIM. 2 | BIM. 3 | BIM. 4 | BIM. 5 | BIM. 6 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | BELLINI Federico | item A1 | X | X | X | X | X | X | X | X | X | X | X | X |
| 2. | BELLINI Federico | item A2 | | | | | | | | | | | | |
| 3. | BELLINI Federico | item B | X | | | | | | X | | | | | |
| 4. | BELLINI Federico | item C | | | X | X | X | X | X | X | | | | |
| 5. | BELLINI Federico | item D | X | X | X | X | X | X | X | X | X | X | X | X |
| 6. | BELLINI Federico | item E | | | | | | | | | | | | |
| 7. | BELLINI Federico | item F | | | | | X | X | | | | | X | X |
| 8. | FANINI Bruno | item A1 | | | X | X | X | X | X | X | X | X | X | X |
| 9. | FANINI Bruno | item A2 | | | | | | | | | | | | |
| 10. | FANINI Bruno | item B | | | X | X | | | X | X | | | | |
| 11. | FANINI Bruno | item C | | | X | X | X | X | X | X | X | X | X | X |
| 12. | FANINI Bruno | item D | | | | | | | | | | | | |
| 13. | FANINI Bruno | item E | | | | | | | | | | | | |
| 14. | FANINI Bruno | item F | | | | | X | X | | | | | X | X |
| 15. | FERRETTI Emanuela | item A1 | X | X | X | X | X | X | X | X | X | X | X | X |
| 16. | FERRETTI Emanuela | item A2 | | | | | | | | | | | | |
| 17. | FERRETTI Emanuela | item B | X | X | | | | | X | | | | | |
| 18. | FERRETTI Emanuela | item C | | | X | X | X | X | X | X | X | X | X | |
| 19. | FERRETTI Emanuela | item D | | | | | | | | | | | | |
| 20. | FERRETTI Emanuela | item E | | | | | | | | | | | | |
| 21. | FERRETTI Emanuela | item F | | | | | X | X | | | | | X | X |
| 22. | ZANCHETTIN Vitale | item A1 | X | X | X | X | X | X | X | X | X | X | X | X |
| 23. | ZANCHETTIN Vitale | item A2 | | | | | | | | | | | | |
| 24. | ZANCHETTIN Vitale | item B | X | X | | | | | | | | | | |
| 25. | ZANCHETTIN Vitale | item C | | | X | X | | | | | | | | |
| 26. | ZANCHETTIN Vitale | item D | X | X | X | X | X | X | X | X | X | X | X | X |

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| 27. | ZANCHETTIN Vitale | item E | | | | | | | | | | | | |
| 28. | ZANCHETTIN Vitale | item F | | | | | | X | | | | | | X |

*B.2*

*1. Scientific Curriculum of the Principal Investigator*

| | |
|---|---|
| - Researcher unique identifier: ORCID Id | 0000-0003-0943-7682 |
| - URL for web site: | https://saad.unicam.it/it/tags/federico-bellini |
| Academic age (years from the beginning of scientific activity, i.e. years from first publication or from the beginning of PhD or Medical Specialisation School) | 33 |
| Previous positions | 2008-on:full professor of History of Architecture (University of Camerino)<br>2000-08: associate professor of History of Architecture (University of Camerino)<br>1995-2000: researcher of History of Architecture (University of Camerino)<br>1990-93: Phd in History of Architecture and Town planning (University of Florence)<br>1989-90: CEEA (master) in Théories de l'Architecture (university of Paris-Villemin)<br>1982-88: MoA in Architecture (University of Rome-Sapienza) |
| Prizes and awards | 2012: Premio “Livio G. Borghese” per La basilica di San Pietro da Michelangelo a Della Porta, Argos, Roma 2011<br>1997: Premio “De Angelis d’Ossat” 1997 per Mario Ridolfi, Laterza, Roma-Bari 1993 |
| Visiting academic positions | 0 |
| Teaching activities and PhD supervision | 1998-date: academic courses of history of ancient, medieval, renaissance, barocque and contemporary architecture (Camerino and Roma-Sapienza).<br><br>2000-04: courses of History of contemporary art (Camerino and Roma-Sapienza).<br><br>2017-2022: "coordinatore" of the PhD board in Architecture, Design, Town Planning (International School of Advanced studies - University of Camerino);<br><br>2021-date: PhD courses (in english) of "Methodology of the scientific research" and |
| Other work experience (e.g. consultancy if any) | 1992-2003 CTU (consulente tecnico d'ufficio) for the Civil Court of Rome.<br>1994-96: consulent of CENSIS |
| - Administrative role and position responsibility | 2008-on:full professor of History of Architecture (University of Camerino) |
| - Scientific organisations/Coordination of academic activities | 2022 member of the scientific committee of the conference 1622. Being Universal in the Catholic World. Iberian Monarchies and the Papacy between management of the sacred, holiness, missionary practices and evangelisation (organised by ISEM-CNR; Escuela Española de Historia y Arqueología en Roma, EEHAR-CSIC; Pontificia Università Lateranense; Università degli Studi Roma Tre; Universidad de Murcia)<br>2019-20 Member of the Scientific Committee of the conference Architettura del Quattrocento nelle Marche, with Sabine Frommel (INAH-Paris) and University of Macerata.<br>2018 Curator with Martina Frank of the international seminar Architettura della Musica: spazi sonori negli edifici sacri del Rinascimento e del Barocco, curated by Federico Bellini and Martina |

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| | Frank, Venice, Ca' Foscari 27 November 2018.<br>2018 Scientific Committee for the enhancement of the historical-artistic-religious heritage of the complex of the International Shrine of the Holy House of Loreto (representative of the University of Camerino).<br>2018 Scientific committee for the international series Pensieri ad Arte, Edizioni Artemide Roma.<br>2017 Curator (with Giuseppe Bonaccorso) of the international seminar e-kphrasis. Digital tools for the knowledge and dissemination of architectural, urban, environmental heritage, SAAD University of Camerino - National Academy of San Luca, Ascoli Piceno 24 February 2017.<br>2014 Proposer and curator (with Paolo Portoghesi and Francesco Moschini) of the international conference Michelangelo, l'architettura e le altre arti, Rome, Accademia Nazionale di San Luca, 20-21 November 2014 (450th anniversary of Michelangelo's death). |
| Editorial activity | 2017 Scientific Committee of the publications of SAAD-Ascoli Piceno (University of Camerino).<br>2016 Scientific Committee of the journals 'Annali delle arti e degli archivi. Pittura scultura architettura" and "Atti dell'Accademia Nazionale di San Luca".<br>2015 Scientific Committee of the international online journal 'bfo-Journal'. |
| Membership of scientific societies | 2016-to date member of AISTARCH (Associazione Italiana degli storici di architettura) |

Funding (current and past)

| Anno | Project title | Person months | Funding organisation |
|---|---|---|---|
| 2017 | Il palazzo dei Varano a Camerino | 3 | Fondazione Intesa San Paolo (PhD grant) |
| 2015 | Smart-Heritage: Digital tools for the SMART enhancement of the cultural heritage of Marche. Case study: the sanctuary-city of Loreto. | 6 | Università di Camerino (FAR-2014) |
| 2011 | pubblicazione dei due volumi di "La basilica di San Pietro da Michelangelo a Della Porta", Argos 2011 | 36 | Selex spa |

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| Significant career breaks | 2017: coordinator of the new PhD in Architecture, Design Town Planning<br>2012: Livio G. Borghese prize<br>2011: publication of La basilica vaticana da Michelangelo a Della Porta (2 vols, Argos Roma), presented at the Accademia Nazionale dei Lincei by Ch.L.Frommel, P. Portoghesi C. Conforti and Peggy Haines);<br>2006: abilitation as full professor (University of Sassari)<br>2004: pubblicazione di Le cupole di Borromini (Electa Milano), presented at the Accademia Nazionale dei Lincei by Ch.L.Frommel, ... |
| - H-Index (in Scopus): | 0 |
| - Total number of publications in peer-reviewed journals | 0 |
| - Total IF | 0 |
| - n. and total IF of publications where the candidate is first author or equivalent (for the disciplines where the position in the list of authors correspond to the | 0 |

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| role in the work presented) | |
| - N. and total IF of the publications where the candidate is last or corresponding author (for the disciplines where the position in the list of authors correspond to the role in the work presented) | 0 |

*2. Scientific Curriculum of the associated PIs*

**1. FERRETTI Emanuela**

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|---|---|
| - Researcher unique identifier: ORCID Id | 0000-0001-7064-1311 |
| - URL for web site: | https://www.unifi.it/p-doc2-2015-0-A-2c2a35313430-0.html |
| Academic age (years from the beginning of scientific activity, i.e. years from first publication or from the beginning of PhD or Medical Specialisation School) | 18 |
| Previous positions | Researcher in History of Architecture at University of Florence (2016-2019) |
| Prizes and awards | 1. Regione Toscana, Department of Culture, 2005 The research a enhancement project of the "System of the fortified structures of Montalbano" edited by E. Ferretti and D. Turrini, was awarded first prize by the Department as part of the 2005 "Culture and Practices" initiative<br>2. Villa I Tatti - The Harvard Renaissance Center for Italian Renaissance Studies - International selection for the Grant - Lila Wallace-Reader's Digest, 2013-2014. |
| Visiting academic positions | 2012-2013 Annual post-doctoral fellowship at Villa I Tatti - The Harvard University Center for Italian Renaissance Studies - "Hanna Kiel Fellowship", title of research project: "Cosimo I and the First Aqueduct in Renaissance Florence". |
| Teaching activities and PhD supervision | 1.Professor of History of Architecture at the School of Architecture, University of Florence<br><br>2. Member of the academic board of the Doctoral School in Architecture, Design, Knowledge and Preservation of Cultural Heritage, University of Florence<br><br>3. Professor of History of Architecture at the School of Specialisation in Architectural Heritage and Landscape (postgraduate course), University of Florence<br><br>4. Professor of History of Architecture at Master “Museo Italia”, University of Florence, chief: Paolo Zermani. |
| Other work experience (e.g. consultancy if any) | - Scuola Superiore Sant'Anna of Pisa - Municipality of Livorno, Department of Culture, scientific consultancy for the drafting of texts and elaboration of contents for the virtual reconstruction of Livorno's urban development from Ferdinando I to Cosimo III dei Medici (2007)<br>- Biblioteca Leonardiana di Vinci, Assignment for the filing of Leonardo da Vinci's architectural drawings as part of the 'e-Leo' project. "Digital Archive of the History of Technology and Science" (2008-2009) https://www.leonardodigitale.com<br>- Development of new digital museographic design content for the Leonardo Museum in Vinci (2010)<br>- Romorantin, Musée de Sologne, Elaboration of reconstructive drawings of Leonardo da Vinci's |

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| | plans for the Royal Palace project in Romorantin for the exhibition “Léonard de Vinci, Romorantin, le projet oublié”, (2010)<br>- Opera di Santa Croce, Florence, Historical research for the museum itinerary in the function of new digital content (2012) |
| - Administrative role and position responsibility | Director of the Erasmus programme of the School of Architecture of the University of Florence |
| - Scientific organisations/Coordination of academic activities | 1. University of Florence and EHPE Sorbonne, for research activities on Renaissance architecture in Italy (From 2018 to the present)<br>2. Department of Architecture of the University of Florence and Opificio delle Pietre dure for 'Progetto Giotto': the painted architecture of the Bardi Chapel in the Santa Croce church (From 2020 to the present)<br>3. Department of Architecture of the University of Florence Regional Directorate of Museums of Tuscany for historical-architectural research on the Medici villas (From 2016 to the present)<br>4. Department of Architecture of the University of Florence and Regional Directorate Umbria Museums for historical-architectural research on Castello Bufalini complex-San Giustino, Perugia (From<br>2022)<br>5. Department of Architecture of the University of Florence and Opera di Santa Croce in Florence: development of new digital content for the Museum (From 2019 to the present).<br>6. Department of Architecture of the University of Florence and Publiacqua S.p.A (2019-2021) for research on historical aqueducts in Tuscany |
| Editorial activity | - Editor in Chief of the journal 'Opus Incertum', Florence university Press (Classe A Anvur). https://oajournals.fupress.net/index.php/oi<br>- Co-director of the Scientific Series “Presente Storico. Narrazioni e documenti di architettura” https://edifir.it/collana/architettura/presentestorico-narrazioni-e-documenti-di-architettura-e-design/ |
| Membership of scientific societies | - Member of the scientific board of the “Centro Internazionale di Studi e Documentazione Leonardo da Vinci”- Biblioteca Leonardiana di Vinci,<br>By appointment of the Rector of the University of Florence<br>http://www.bibliotecaleonardiana.it/bbl/bb-leo/centro-ricerche/bb-leo-centro-home.shtml<br>- Member of the scientific board “Centro Internazionale di studi sul Paesaggio in Toscana”- Università per Stranieri di Siena<br>https://www.centropatos.it/ |

Funding (current and past)

| Anno | Project title | Person months | Funding organisation |
|---|---|---|---|
| 2022 | Castello Bufalini | 2 | Polo Museale della Regione Umbria |
| 2021 | Progetto Giotto | 2 | Opificio delle Pietre Dure di Firenze |
| 2020 | Acquedotti storici della Toscana | 2 | Publiacqua S.p.A. |

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|---|---|
| Significant career breaks | No |
| - H-Index (in Scopus): | 4 |
| - Total number of publications in peer-reviewed journals | 10 |
| - Total IF | - |
| - n. and total IF of publications where the candidate is first author or equivalent (for the disciplines where the position in the list of authors correspond to the | - |

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| role in the work presented) | |
| - N. and total IF of the publications where the candidate is last or corresponding author (for the disciplines where the position in the list of authors correspond to the role in the work presented) | - |

## 2. ZANCHETTIN Vitale

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|---|---|
| - Researcher unique identifier: ORCID Id | - |
| - URL for web site: | - |
| Academic age (years from the beginning of scientific activity, i.e. years from first publication or from the beginning of PhD or Medical Specialisation School) | 20 |
| Previous positions | Associated professor |
| Prizes and awards | Hanno und Ilse Han Prize 2008 - Bibliotheca Hertziana Max |
| Visiting academic positions | Bonn Universitaet (2007-2009)<br>University of Viorginia (sept 2012) |
| Teaching activities and PhD supervision | Laura Solano, Mental gaze: architectural projections in the photographs of Gabriele Basilico. A new operational method, 2022.<br>Sara Bova, Marco Barbo e l'architettura: profilo di una committenza a Roma e nella Repubblica di Venezia (1420-1491). |
| Other work experience (e.g. consultancy if any) | Vatican Museum. Superintendence for Architectural Heritage |
| - Administrative role and position responsibility | None |
| - Scientific organisations/Coordination of academic activities | None |
| Editorial activity | - |
| Membership of scientific societies | Centro Internazionale di Studi di Architettura A. Palladio, Vicenza. Member of the Scientific Council |

| Funding (current and past) | **Anno** | **Project title** | **Person months** | **Funding organisation** |
|---|---|---|---|---|
| Significant career breaks | - | | | |
| - H-Index (in Scopus): | - | | | |
| - Total number of publications in peer-reviewed journals | 8 | | | |
| - Total IF | - | | | |
| - n. and total IF of publications where the candidate is first | | | | |

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|---|---|
| author or equivalent (for the disciplines where the position in the list of authors correspond to the role in the work presented) | - |
| - N. and total IF of the publications where the candidate is last or corresponding author (for the disciplines where the position in the list of authors correspond to the role in the work presented) | - |

## 3. FANINI Bruno

| | |
|---|---|
| - Researcher unique identifier: ORCID Id | 0000-0003-4058-877X |
| - URL for web site: | https://www.ispc.cnr.it/it_it/team/fanini-bruno/ |
| Academic age (years from the beginning of scientific activity, i.e. years from first publication or from the beginning of PhD or Medical Specialisation School) | 13 |
| Previous positions | 2022 - present: Researcher @ CNR ISPC<br>2014 - 2022: Research fellow @ CNR ISPC<br>2013 - 2014: Scolarship @ CNR ITABC<br>2010: Scolarship @ Padua University<br>2008: Term contract @ CNR ITABC |
| Prizes and awards | 2015 - Awarded by 2013 Digital Heritage International Congress and V-MusT.net as<br>"Best Exposition - Quality of Content" for "AiRome".<br>http://www.digitalheritage2015.org/awards/<br><br>2013 - Awarded by 2013 Digital Heritage International Congress and V-MusT.net as<br>"Best Exposition - Quality of Content" for "Imago Bononiae".<br>http://www.digitalheritage2013.org/awards/<br><br>2009 - eContent Award (eLearning category) for "Virtual Rome" project |
| Visiting academic positions | 2017 - Visiting researcher at Sheffield Hallam University (UK) under REVEAL european project. Topics: Educational Environmental Narrative (EEN) games in virtual reality<br><br>2014 - Visiting researcher at IKDC (Ingvar Kamprad Designcentrum), Lund (Sweden) under V-Move mobility program. Topics: 3D User Interfaces, Gesture-based Interaction, Game Interaction Design |
| Teaching activities and PhD supervision | 2022 - Course held at held at CINECA super-computing center (Casalecchio di Reno) under the 18th School of Computer Graphics for Cultural Heritage: “From Digital Ecosystems to Metaverses for Culture”<br><br>2021 - Lectures “Introduction to Unreal Engine 4” in the course “Digital Humanities and Digital Knowledge” (DHDK) – University of Bologna (Italy)<br><br>2014 - International course "Virtual Museum Academy", part of Keys2Rome project (http://keys2rome.eu/) on Natural Interaction applications, held at Trajan's Market (Rome)<br><br>2013 & 2014 - 40h courses "Open-source Applications and online Virtual Worlds" held at Istituto di Formazione e Ricerca della Federazione Italiana Club e Centri UNESCO (S. Giovanni Valdarno) within the master "OpenTech... |
| Other work experience (e.g. consultancy if any) | n/a |

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| - Administrative role and position responsibility | n/a |
| - Scientific organisations/Coordination of academic activities | Scientific responsible for unit #14 in SHINE DigiLab (Strengthening the Italian Nodes of E-RIHS - http://www.e-rihs.it/)<br><br>Responsible for servification and remotization tasks as WP leader in H2IOSC project (Humanities and Heritage Italian Open Science Cloud)<br><br>Scientific responsible for the agreement between CNR ISPC and Construkted Reality (Toronto, Canada) for research activities targeting processing and interactive visualization of massive 3D datasets on the Web through OGC standards and open specifications<br><br>Scientific responsible for collaboration between CNR ISPC and Dept. of Architecture and Design (Turin Polytechnic, Italy) for the creation of interactive Web3D/WebXR solutions targeting gamification and presentation of museum 3D collections |
| Editorial activity | Guest editor of MDPI Special Issue "Immersive Virtual Reality for Heritage and Museums" of Heritage journal (ISSN 2571-9408) https://www.mdpi.com/journal/heritage/special_issues/immersive_virtual_reality |
| Membership of scientific societies | n/a |

| Funding (current and past) | **Anno** | **Project title** | **Person months** | **Funding organisation** |
|---|---|---|---|---|
| Significant career breaks | n/a | | | |
| - H-Index (in Scopus): | 11 | | | |
| - Total number of publications in peer-reviewed journals | 28 | | | |
| - Total IF | 29,5876 | | | |
| - n. and total IF of publications where the candidate is first author or equivalent (for the disciplines where the position in the list of authors correspond to the role in the work presented) | n.4; 11,679 | | | |
| - N. and total IF of the publications where the candidate is last or corresponding author (for the disciplines where the position in the list of authors correspond to the role in the work presented) | n. 2; 3,482 | | | |

*3. Main Principal Investigator's scientific publications (Max. 20)*

1. BELLINI, Federico (2011). La basilica di San Pietro da Michelangelo a Della Porta. vol. 1-2, p. 1-920, ROMA:Argos, ISBN: 9788888690377 - **Monografia o trattato scientifico**
2. BELLINI, Federico (2013). Michelangelo, la strada e la Porta Pia. STUDI ROMANI, vol. LIX, p. 74-109, ISSN: 0039-2995 - **Articolo in rivista**
3. BELLINI, Federico (2012). Autografia michelangiolesca degli attici di San Pietro. QUADERNI DELL'ISTITUTO DI

STORIA DELL'ARCHITETTURA, vol. 0, p. 111-120, ISSN: 0485-4152 - **Articolo in rivista**

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*4. Main scientific publications of the associated PIs (Max. 20, for each associated PI)*

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2. Carrara, Eliana, FERRETTI, EMANUELA (2016). «Il bellissimo bianco» della Sagrestia Nuova: Michelangelo, Vasari, Borghini e la tradizione fiorentina come nuova identità medicea. OPUS INCERTUM, vol. 2, p. 58-73, ISSN: 2035-9217 - **Articolo in rivista**
3. Emanuela Ferretti, Davide Turrini (2020). Visualizing Leonardo and Michelangelo through digital humanities, reconstruction and interaction design. SCIRES-IT, vol. Vol. 10 (2020), p. 5-18, ISSN: 2239-4303, doi: 10.2423/i22394303v10n1p5 - **Articolo in rivista**
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11. FERRETTI, EMANUELA (2014). «La matematica del marmo». Michelangelo fra storiografia e architettura nell’Italia del primo Novecento. In: E. Ferretti M. Pierini P. Ruschi. Michelangelo e il Novecento. p. 17-39, CINISELLO BALSAMO:Silvana Editoriale, ISBN: 9788836629169 - **Contributo in volume (Capitolo o Saggio)**
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3. **FANINI Bruno**

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2. Fanini B, Ferdani D, Demetrescu E, Berto S, d'Annibale E (2021). ATON: An Open-Source Framework for Creating Immersive, Collaborative and Liquid Web-Apps for Cultural Heritage. APPLIED SCIENCES, ISSN: 2076-3417 - **Articolo in rivista**
3. Fanini B, Cinque L (2020). Encoding, Exchange and Manipulation of Captured Immersive VR Sessions for Learning Environments: the PRISMIN Framework. APPLIED SCIENCES, ISSN: 2076-3417 - **Articolo in rivista**
4. Ferdani D, Fanini B, Piccioli M C, Carboni F, Vigliarolo 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, ISSN: 1778-3674 - **Articolo in rivista**
5. LoTurco M, Piumatti P, Calvano M, Giovannini E, Mafrici N, Tomalini A, Fanini B (2020). Interactive Digital Environments for Cultural Heritage and Museums. Building a digital ecosystem to display hidden collections. DISEGNARE CON..., ISSN: 1828-5961 - **Articolo in rivista**
6. Luigini A, Fanini B, Basso A, Basso D (2020). Heritage education through serious games. A web-based proposal for primary schools to cope with distance learning. VITRUVIO, ISSN: 2444-9091, doi: 10.4995/vitruvio-ijats.2020.14665 - **Articolo in rivista**
7. Fanini B, Cinque L (2019). Encoding immersive sessions for online, interactive VR analytics. VIRTUAL REALITY, ISSN: 1434-9957, doi: 10.1007/s10055-019-00405-w - **Articolo in rivista**
8. Fanini B, Pescarin S, Palombini A (2019). A cloud-based architecture for processing and dissemination of 3D landscapes online. DIGITAL APPLICATIONS IN ARCHAEOLOGY AND CULTURAL HERITAGE, ISSN: 2212-0548 - **Articolo in rivista**
9. Fanini B, Pagano A, Ferdani D (2018). A Novel Immersive VR Game Model for Recontextualization in Virtual Environments: the µVR Model. MULTIMODAL TECHNOLOGIES AND INTERACTION, ISSN: 2414-4088, doi: 10.3390/mti2020020 - **Articolo in rivista**
10. Sara Gonizzi Barsanti, Saverio Giulio Malatesta, Francesco Lella, Bruno Fanini, Francesco Sala, Eloisa Dodero, Laura Petacco (2018). The Winckelmann300 Project: dissemination of culture with virtual reality at the Capitoline Museum in Rome. INTERNATIONAL ARCHIVES OF THE PHOTOGRAMMETRY, REMOTE SENSING AND SPATIAL INFORMATION SCIENCES, vol. XLII-2, p. 371-378, ISSN: 1682-1750, doi: 10.5194/isprs-archives-XLII-2-371-2018 - **Articolo in rivista**
11. Meghini C, Scopigno R, Richards J, Wright H, Geser G, Cuy S, Fihn J, Fanini B, Hollander H, Niccolucci F, Felicetti A, Ronzino P, Nurra F, Papatheodorou C, Gavrilis D, Theodoridou M, Doerr M, Tudhope D, Binding C, Vlachidis A (2017). ARIADNE: A research infrastructure for archaeology. ACM JOURNAL ON COMPUTING AND CULTURAL HERITAGE, ISSN: 1556-4673 - **Articolo in rivista**
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*5. Main staff involved (max 10 professors/researchers for each research unit, in addition to the PI or associated PIs), highlighting the expected time commitment*

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*List of the Research Units*

*Unit 1 - BELLINI Federico*

*Personnel of the research unit*

| nº | Surname Name | Qualification | University/ Research Institution | e-mail address | Months/person expected |
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| 3. | MAGAGNINI Marta | Professore Associato (L. 240/10) | Università degli Studi di CAMERINO | marta.magagnini@unicam.it | 1,0 |
| 4. | PUTZU Maria Giovanna | Ricercatore a t.d. - t.pieno (art. 24 c.3-b L. 240/10) | Università degli Studi di CAMERINO | mariagiovanna.putzu@unicam.it | 1,0 |
| 5. | PETRUCCI Enrica | Professore Associato (L. 240/10) | Università degli Studi di CAMERINO | enrica.petrucci@unicam.it | 1,0 |
| 6. | POLINI Andrea | Professore Associato (L. 240/10) | Università degli Studi di CAMERINO | andrea.polini@unicam.it | 2,0 |
| 7. | BASSO Alessandro | Ricercatore a t.d. - t.pieno (art. 24 c.3-b L. 240/10) | Università degli Studi di CAMERINO | alessandro.basso@unicam.it | 1,0 |
| 8. | OPPEDISANO Federico Orfeo | Professore Associato (L. 240/10) | Università degli Studi di CAMERINO | federico.oppedisano@unicam.it | 1,0 |
| 9. | LORETI Michele | Professore Ordinario (L. 240/10) | Università degli Studi di CAMERINO | michele.loreti@unicam.it | 1,0 |
| 10. | ROSSI Daniele | Professore Associato (L. 240/10) | Università degli Studi di CAMERINO | daniele.rossi@unicam.it | 1,0 |
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*Unit 2 - FERRETTI Emanuela*

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|---|---|---|---|---|---|
| | Alessandro | 240/10) | FIRENZE | | |

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*Unit 3 - ZANCHETTIN Vitale*

*Personnel of the research unit*

| nº | Surname Name | Qualification | University/ Research Institution | e-mail address | Months/person expected |
|---|---|---|---|---|---|
| 1. | ZANCHETTIN Vitale | Professore Associato confermato | Università IUAV di VENEZIA | vitale@iuav.it | 2,0 |
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*Unit 4 - FANINI Bruno*

*Personnel of the research unit*

| nº | Surname Name | Qualification | University/ Research Institution | e-mail address | Months/person expected |
|---|---|---|---|---|---|
| 1. | FANINI Bruno | Ricercatore | Consiglio Nazionale delle Ricerche | bruno.fanini@ispc.cnr.it | 3,0 |
| 2. | D'ANNIBALE Enzo | Ricercatore | Consiglio Nazionale delle Ricerche | enzo.dannibale@gmail.com | 3,0 |
| 3. | DEMETRESCU Emanuel | Ricercatore | Consiglio Nazionale delle Ricerche | emanuel.demetrescu@cnr.it | 3,0 |

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*6. Information on the new contracts for personnel to be specifically recruited*

| nº | Associated or principal investigator | Number of expected research contracts | Number of expected PhD scholarships | Overall expected time commitment (months) |
|---|---|---|---|---|
| 1. | BELLINI Federico | 0 | 0 | 0 |
| 2. | FERRETTI Emanuela | 0 | 0 | 0 |
| 3. | ZANCHETTIN Vitale | 0 | 0 | 0 |
| 4. | FANINI Bruno | 0 | 0 | 0 |
| | **Total** | **0** | **0** | **0** |

*7. PI "Do No Significant Harm (DNSH)" declaration, in compliance with article n. 17, EU Regulation*

*852/2020. (upload PDF)*

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Date 29/11/2022 ore 21:55