**BItFROST- Bridging Research Across Heritage Studies**

**Short description of the research infrastructure**

BItFROST will define an infrastructure for creating and using 3D models for supporting multimodal interaction and advanced research. This will be accomplished through creating a synergy between different departments at UiO and by building an international collaboration with the Visual Computing Lab (<http://vcg.isti.cnr.it/>) in Pisa.

The recent diffusion of three-dimensional recording and visualisation technologies has opened incredible opportunities within the Cultural Heritage (CH) sector. Since 2000, the Museum of Cultural History (MCH) invested considerable resources in developing acquisition methods for the 3D digitisation of sites and artefacts, to be used in support of research and dissemination. MCH is also publishing 3D models with 3D HOP (<http://3dhop.net/>) at https://humgis.UiOcloud.no/.
The opportunities offered by 3D models for supporting advanced studies are significant, and the possibility to use these new data as media for linking different sectors of cultural heritage (CH) represents an incredible opportunity for defining novel investigation strategies, identifying further information as well as improving digital CH communication.

BItFROST will cooperate with the Department of Media and Communication and the Department of Archaeology, Conservation, and History to create a platform for using the affordances of 3D in research, teaching, dissemination and outreach, and explore the potential in the combination of AR/VR in teaching at higher level.

3D models are revolutionary data; if adequately produced and published, they can be used to simulate multi-dimensional representations of physical environments and single objects, which provide researchers and specialists with the opportunity to test investigation paradigms never experienced before. In order to facilitate cross-disciplinary reuse, these datasets must meet specific quality standards, need to be linked and related with shared concepts and **need to be published using platforms capable of facilitating reuse.**

Several objects from various museum collections are digitised and available online on commercial platforms designed for publishing, sharing, buying and selling 3D contents (e.g. Sketchfab). Despite their diffusion, these tools don’t support advanced interaction, don’t guarantee long-term data preservation, and have very little impact on research (Scopigno et al., 2017). The BItFROST infrastructure based at MCH will be a 3D web infrastructure supporting advanced research across multiple areas of cultural heritage documentation and dissemination. By reviewing and mapping how different specialists interact with artefacts and materials, this project will design a 3D web archive for providing CH specialists, scholars and students with an infrastructure capable of efficiently providing high-resolution 3D contents to develop cross-disciplinary research.

BItFROST has four research goals (RG):

**(RG1)** Identify novel protocols for the generation and diffusion of 3D cross-disciplinary digital models constructed upon different research agendas and specialists’ needs

**(RG2)** Design a 3D web-archive for making available multiple types of 3D data currently stored at the Museum.

**(RG3)** Create web instruments for supporting multimodal interaction and advanced research in heritage and material studies.

**(RG4)** Establish a new task-force for the creation and curation of 3D web contents.

**Research infrastructure plan**

The project is organised across three interlinked work packages and will run from January 2021 to December 2022 (2 years). The project will involve specialists from various departments of UiO with contributions from different international institutions. In particular, researchers from the Visual Computing Lab, (<http://vcg.isti.cnr.it/>), - a world-leading laboratory in advanced 3D acquisition and visualisation of cultural heritage - will actively participate in the development of the infrastructure.

***Work package 1* MAPPING (WP1):** This work packagewill develop a critical framework for the evaluation of the potential offered by 3D models in the archaeological and cultural heritage sector. It will also define protocols and guidelines for producing 3D models that will allow data to be reused in multiple ways by future researchers. By studying the different documentation methods developed within the scope of several specialists working at MCH, a baseline will be defined for the generation of procedures required for future production of 3D cross-disciplinary models. The investigation method in this phase consists of an in-depth analysis of the process developed for different mapping aspects of CH information, and an assessment of how the models produced by the various experts are employed to generate new knowledge. Through the collaboration with IAKH, this work will also influence the curriculum for archaeology at the University of Oslo.

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| **Expected findings:** (1) Definition of the scientific needs for interpretation of 3D models and evaluation of how 3D models can be used to support advanced research in CH **(RG1)**. (2) Identification of the critical elements specialists regard as crucial for generating and visualising 3D models **(RG1/RG4)**. |

***Work package 2* ARCHIVING (WP2):** This work packagewill focus upon building a database incorporating meta/para -data, interlinking and storing 3D information and supporting narratives. The database will be modelled according to CIDOC-CRM (<http://www.cidoc-crm.org/>) also used by MUSIT and ARIADNE+ (https://ariadne-infrastructure.eu/). It will be linked to the databases developed by MUSIT and the NFR-project ADED (Archaeological Digital Excavation Documentation). Presently, the data for the 3D models of archaeological sites created through photogrammetry are stored in the MUSIT media database. 3D models of artefacts created through Structured Light Scanning (SLS) or photogrammetry are stored on UiO servers. WP2 will bridge these archives, making it possible to search through a large number of 3D models (from artefacts to excavations) and to detect information across different areas of cultural heritage. The system will be designed to bridge elements already part of the MUSIT portfolio. The infrastructure itself will not need large storage capacity, but make the existing archive more accessible.

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| **Expected findings:** (1) defining the requirements of 3D archiving that will facilitate future cross-disciplinary reuse **(RG2)**. (2) Gain a deeper understanding of the dynamics which foster 3D data reuse **(RG1)**, (3) Construction of the archive **(RG2)** |

***Work package 3* ACCESS, VISUALISING AND ANALYSING (WP3):** This work package will develop a 3D web platform incorporating instruments for advanced visualisation and analysis. The platform will be used to give access on the web to the 3D models in the archive constructed in WP2, providing visualisation and interaction tools to study, measure, and annotate the 3D objects, following the requirements defined in WP1. To overcome the limits of many similar platforms, the visualisation tools should be able to work on multiple objects at the same time, to facilitate comparative studies, or to build a narrative presentation based on the 3D entities both for scholars (for research), for teaching students and for the broad public (for dissemination). The system will be implemented using the open-source web-based visualisation framework 3DHOP -3D Heritage Online Presenter- (<http://vcg.isti.cnr.it/3dhop/>), through direct collaboration with the Visual Computing Laboratory, CNR, Pisa, Italy, who has developed 3D HOP. In the frame of WP3, an interdepartmental task force for 3D data curation will be established at MCH.

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| **Expected findings:** (1) Creation of tools for supporting multimodal/cross-disciplinary interaction **(RG3)**. (2) Definition of a task force for 3D data curation and accessibility **(RG4)**. |

Within the framework of BItFROST, several visualisation experiments will be performed to assess the limits and potentials of the 3D models in supporting cross-disciplinary research. Through direct collaboration with the Department of Archaeology and the Department of Media and Communication at UiO, the BItFROST infrastructure will be used both to support higher education and to develop experiments in visualisation (VR and AR). Virtual/Augmented reality platforms and immersive systems will be used to test different levels of engagement and interaction in order to study future use of 3D Archives and what characteristics 3D models and visualisation tools need to facilitate and promote novel interaction methods and knowledge production.

The infrastructure will be available to teachers and students at UiO, and during the project, it will be used in support of teaching courses in archaeology and artefact analysis, and in this way influence the curriculum. Experiments with students and teachers will be carried out to gain a deeper understanding of the impact that such tools have within on-line teaching. During spring 2020 MCH submitted several EU applications (CEF-TC, MSCA, DT-TRANS) which included production and use of 3D models.

**Budget and planning**

The BItFROST infrastructure will be established over a two-year period, with 3 mainly consecutive WPs. The funding will be used to involve the expertise on 3D HOP at ISTI CNR (WP1-3), and to build knowledge at permanent staff at MCH (WP2-3).Extra staff will be hired to assist in the WPs, especially WP1 – mapping. The IMK institute will also provide own financing in addition to the UiO BItFROST funding.



**Argumentation for the application incl. scientific needs**

A single 3D model embodies a large number of information. For this reason, the definition of a method of good practice for its production, archive and use (or reuse) is far more complicated than any other type of graphic datasets. Three-dimensional models are the result of several choices made by the operator/s, and their affordances reflect the research needs posed before their acquisition. So far many efforts were made by the European community to increase the production of 3D contents in the CH sector (EUROPEANA and 3D-ICON http://3dicons-project.eu/) as well as establishing 3D recording as an affordable, practical and effective mechanism for long term documentation of tangible cultural heritage, (3DCOFORM, http://www.3d-coform.eu/; scan4reco, http://www.scan4reco.eu/scan4reco/; CARARE http://www.carare.eu/; PARTHENOS, http://www.parthenos-project.eu/).

**However, very few progressions were made for defining visualisation strategies capable of bridging different research approaches and supporting knowledge production.**

To address this issue, Europeana recently created a task-force for updating Europeana’s publishing framework and for providing guidance and examples of good practice for cultural institutions, data creators and aggregators on publishing 3D assets (<https://pro.europeana.eu/project/3d-content-in-europeana>). Their work encourages the development of 3D acquisition and visualisation frameworks capable of fully supporting aspects such as standardisation, description, content labelling, accessibility and interoperability. More recently, several pilots were developed for testing deeper forms of engagement with virtual objects, and the results proved the capacity of such tools to support research in various disciplines (Ponchio et al., 2019; Nobles et al., 2019).

The significant results achieved in the frame of these (and many other) projects undoubtedly highlighted the challenge related to the way this media type is impacting current investigation paradigms within the cultural heritage sector; or the effect it has, upon the way in which specialists construct, publish and use (or re-use) 3D models.  **BItFROST addresses these issues by proposing a cross-disciplinary web platform capable of bridging different research approaches within the cultural heritage domain.**

**Description of the research environment (approx. 10-20 lines)**

MCH has over several years created 3D models of artefacts and archaeological excavations, but they need a better structure to be considered “FAIR” data. MCH wants the 3D models created for the Viking Ship Collection made available for research and as highly detailed documentation of the fragile objects conserved through alum conservation. Besides, the documentation will be used in exhibitions and digital public outreach. MCH is also using 3D as documentation of archaeological excavations, this year including the Gjellestad Viking ship excavation. The documentation of sites and excavations are georeferenced, and the hub-node structure HumGIS has been instrumental in increasing the understanding and availability of georeferenced 3D documentation of excavations. The models will be used in teaching students of archaeology, and they will also be used in exploring the possibilities of VR and AR. VR and AR are in a process of convergence and will soon be applied as interchangeable modes based on the same hardware. With the use of Indirect AR (situated simulations) it is also possible to combine the two modes with on and off location access and presentation. This opens for a wide variety of uses and applications, for special research purposes as well as dissemination to the general audience (museum and CH site visits, education and tourism) (Liestøl 2020). The creation, documentation and the issue of how to ensure the long time sustainability of 3D models is in itself a research question. Through the MCHs cooperation in ARIADNE+ and SEADDA (https://www.seadda.eu/), BItFROST will contribute to the international research in these fields.

**Collaborating environments, internal and external**

The DigDoc group collaborates with USIT and all the other departments at the Museum of Cultural History (MCH). MCH collaborates with IAKH, UIO and IMK, UiO. Nationally, MCH collaborates with the other university museums through MUSIT and the ADED project. Internationally, MCH cooperates with DarkLab at the University in Lund, Sweden and ISTI, CNR in Italy. MCH and Lublin Museum have applied for EEA-funding to develop 3D documentation. MCH is also a partner in the EU archaeological infrastructure project ARIADNE+ and the COST Action SEADDA (Saving European Archaeology from the Digital Dark Ages).

**Making the research infrastructure accessible**

The research infrastructure BItFROST will secure long term preservation of 3D documentation and aim to make the models Findable, Accessible, Inter-operable and Retrievable online, following the FAIR principles. BItFROST will share the collections nationally and internationally.

**Strategically importance - to the Faculty /Entities and UiO's strategic plans**

This infrastructure will support groundbreaking research, digitalization in teaching and international research cooperation. Integrating digitalisation in learning processes and disciplines is an element in the UiO strategy 2030. The MCH strategy 2030 states that MCH shall actively contribute to systematic development and sharing of research infrastructure of data resources nationally and internationally.

The long term MUSIT cooperation and the ongoing ADED project has given Norway a leading position in digitalization and availability of archaeological data, and this infrastructure increase the FAIR data from the disciplines at MCH. The HubNode structure HumGIS, funded by UiO has increased the awareness and availability of georeferenced data, and BItFROST will increase the use of 3D GIS data in research. In addition, multilingual tagging will respond to the goal in the MCH 2030 strategy that the collections shall be available in Norwegian and English.

**Data storage and continued use**

MCH is creating and curating 3D models, but mainly for documentation and outreach.

After the project period the BItFROST infrastructure will have established a platform that opens new venues for research on Cultural Heritage, as well as a better and more efficient environment for curating and sharing 3D data. There will be no additional operational costs involved in maintaining the archive as the cost of maintaining the infrastructure will be included in the cost of storage for MCH’s 3D data and the working hours at the group for Digital Documentation at MCH. BItFROST will not demand extra working hours, but make the curation more efficient.

**References**

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