Global Database of Early Watercraft: Beginnings, Development and Future Plans

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Abstract

The management and presentation of cultural heritage over a given region requires a dedicated database which can store all relevant information (location, text, photography, 3D models, animations etc.) and an intuitive way of accessing this information (searching via different criteria such as geo-location, time-frame, type of find, state of preservation, etc.).

We decided to test a recently available open source platform, Arches 3.0, to construct a database of all known logboats and other early watercraft in the country of Slovenia: the Early Watercraft Database. The software platforms of existing inventories are mostly proprietary, expensive to maintain and difficult to interconnect and upgrade to new requirements. Existing database inventories are therefore difficult to combine and this makes the study of early watercraft finds on a global scale, independent of modern state boundaries, more difficult. By contrast, information stored in applications developed on the Arches platform can be easily merged.

The Early Watercraft Database application demonstrates the ability of the Arches platform to be employed for a wide range of applications; it can be used for small-scale solutions but it can also be extended to accommodate large-scale (global) inventory requirements. The Arches open source heritage inventory and management system is sponsored by the Getty Conservation Institute and the World Monuments Fund.

Keywords

Early watercraft, global database, Arches

Introduction

Early watercraft—logboats, reed boats, skin boats, bark boats, rafts and simple three to five-plank boats—are among the best known and oldest human inventions. The creation of early watercraft had far-reaching significance for navigation and led to a new form of human mobility, orientation and means of networking and communication, resulting in further migration and colonial expansion. This new mobility furthermore inspired and improved the development of other capabilities like trade, warfare or politics. Many types of early watercraft can still be found in use around the world (e.g. Arnold 2014, 2015, 2017).

The great story of water transportation, which is closely linked to humans' traditional coexistence with water and our life in aquatic environments, has a strong symbolic meaning (Erič 2014). Most people live near seas, lakes and rivers. In our current world heritage narrative of navigation, the vessel construction and watercraft typology of early watercraft have not been given the attention they deserve. But they represent the origins of humankind's navigational tradition, while also revealing that beneath an outwardly simple appearance lies a sophisticated example of design, construction and extraordinary cultural practices.

During the last two centuries, and particularly in the last two decades, the preservation and promotion of cultural heritage have advanced worldwide. Cultural tourism is increasing rapidly. The general public has a much greater awareness of the importance of cultural heritage and expresses a much higher demand for

experiences related to cultural heritage. Well-preserved and correctly presented cultural heritage is becoming a valuable tool for obtaining extensive appreciation of the ways of life of different cultures, communities and their people. Working replicas of early watercraft are particularly suitable for providing the public with relevant first-hand experiences. The unique position and contribution of early watercraft to the development of our cultural heritage should be highlighted.

Background

The oldest archaeological evidence for early watercraft includes a logboat, aged around 8200 years, from Pesse, Netherlands, Europe (Van Zeist 1957); an 8000-year-old logboat from Kuahuiqiao near Hangzhou, China (Jiang and Liu 2005); and a 7000-year-old logboat from Dufuna, Zimbabwe, Africa (Breunig 1996). A petroglyph from Quobustan Milli Parki near the Caspian Sea in Azerbaijan, around 12,000y old, depicts a reed boat with 20 paddlers! Even without any material evidence of the craft used, anthropological theory and migration indicate that watercraft must have been in use by Homo sapiens for at least 60,000 years. The beginning of this period saw the colonisation of Australia from the Asia-Pacific region, and at nearly the same time South America was colonised from Africa over the Atlantic (Watanabe *et al.* 2008). Some anthropologists have even put forward the theory that Homo erectus may have used watercraft as early as 800,000 years ago (Bednarik 2016). The fact is that without the invention of early watercraft many key human inventions such as compass, navigation, etc. would not have been invented at all. We think it unlikely that the study of astronomy would have developed at all had it not been necessary for navigation.

Information about cultural heritage, as with practically all application areas, is now stored in various computer-based information systems. The databases where cultural heritage data is stored are often already in their second or third generation. For compatibility, many international standards were developed in this application area. However, on an implementation level, very different software solutions have been developed for these databases. That makes the interchange and collection of data from various databases much more complicated and time-consuming for the end users who would like to study the development of cultural artefacts on a larger scale and in areas that are geographically more appropriate. Modern national and state borders, which typically determine the scope of such cultural heritage databases, do not coincide with the geographical regions relevant for cultural development in the time of early watercraft.

The Early Watercraft Initiative—a global perspective on invention and development (EWI)

To address these methodological problems, a global initiative entitled 'Early Watercraft—a global perspective on invention and development' was established in April 2015. The initiative aims to establish a systematic research environment for studying the origins of navigation in general, with an emphasis on the invention of the earliest indigenous vessels (logboats, reed boats, skin boats, bark boats, rafts and early plank boats) along with fire, housing and simple survival tools—all of which should be considered the most important early human inventions. At present, the initiative consists of 67 ambassadors from 35 countries around the world (Bockius and Erič 2015).

So far, the initiative has been very successful in connecting individual professional researchers and scientists as well as institutions, universities, museums, natural and cultural parks along with local and regional communities where early watercraft are still in use for trading and daily living. Finally, local communities and enthusiastic individuals from regions where early watercraft originate, or such vessels are reconstructed and redesigned, should also get involved. In such regions, modern reconstructions of early watercraft could be used for contemporary educational, sustainable, promotional, sporting and cultural tourism activities.

One of the initiative's initial objectives was to include all continents, i.e. without any modern geopolitical—local, regional, international and global—religious, ideological, economic, or any other divisions. From a scientific perspective, the broadest spectrum of views should be included. Early watercraft should be studied from different angles such as archaeology, anthropology, history, ethnology, art, geology, paleoenvironmental, physics, biology, geology, philosophy, computer and information science, technology, sociology, etc. The most significant long-term task of this initiative is to establish a framework for a permanently operating group of scientific researchers with the aim of researching one of the most important inventions of humankind and its early development. It has the following important goals.

The primary goals of the Initiative

To establish conditions for education and promotion of invention through an Early Watercraft Heritage Network of interconnected museums, heritage parks, tourism, sporting and other organisations responsible for the protection of cultural heritage as well as citizen scientists and amateurs active in reviving the tradition. All efforts should be directed towards an entirely new promotional format that would work uniformly across

the world and at the local, regional and global level with organisational units across the globe.

Calls for various projects will be designed to target different fields, such as science, culture, heritage protection, IT development, rural community development, sustainable tourism, alternative sports, traffic and transport, art, etc. A principal objective would also be to include and register early watercraft into the UNESCO list of Intangible Cultural Heritage as the oldest human invention, which is still flourishing all around the world. A web portal and an International Journal for Early Watercraft Research should be jointly established. To start off with, the journal would be issued only in electronic format. Once established, one of the major scientific publishers (e.g. Elsevier, Springer, etc.) will be contacted to take the journal under its wings.

Unfortunately, we have no idea when, where and which group of people in the evolution of humankind was the first to appreciate the benefits of using the world's water network. Therefore, the task of the Initiative is to promote scientific research, educational campaigns and promotional activities across the globe. Examining all known data on human evolution and migration models would enable us to hypothesise where and when early watercraft could have been used 800,000 years ago.

To develop ideas and extend research on the phenomenon and its development, it would be necessary to use all possible research methods and techniques from a variety of disciplines; this should help to promote scientific research, education, promotion and maintenance of traditional knowledge all over the world. This is the only human invention that has not changed throughout the history of humankind and is still in use in its original form.

Some of the activities of the Early Watercraft World Research Institute should also be undertaken on a more symbolic level, once some at least of the above-stated goals have been achieved. For example, one goal of the Cultural Centre of European Space Technologies is to bring culture into space, picking up from the point where the 'Fallen Astronaut' left off. The basic idea of the programme is to enable artists and scientists to engage in various research projects involving human activities in space and to create an environment for modern and memorable in-depth intercultural scientific research. On a symbolic level, the logboat is a prime human invention; it has significantly contributed to the symbolic liberation of the human mind and to the understanding that, in a physical sense, the water network system of the earth is synonymous with its communication and transportation network. Until the 19th century, transportation by water was the fastest means of transport and travel, enabling humans to explore the unknown. At the same time, the logboat is an implement with increased carrying capacity that considerably exceeds the physical capabilities of a human.

From the Slovenian cases towards a worldwide inventory

Since the Ljubljana Marshes, with its high density of finds (Erič 2008), is a region that has significantly contributed to the development of this idea, one of the centres of the global organisation could be in Slovenia (with departments on all continents around the world). As data and knowledge on early watercraft exist in all possible local and regional variations, they should be collected on every continent. This knowledge should be promulgated with interactive presentation systems, based on holograms and other cutting-edge information technologies which would in future, for instance, enable virtual interactive rowing in the so-called I-pool (pool managed by artificial intelligence) and detailed virtual observations of early watercraft from all around the world. Scientific research work could be supported by other units and collections in the Heritage Park. The Institute would also be involved in the experimental reproduction of vessels.

The early watercraft that have been preserved are either kept in museum collections or remain *in situ*. Some of those that have had to be moved into museum depositories because of pressure on exhibition space should be made accessible to the general public for educational purposes.

Sharing knowledge about the importance of the invention of early watercraft for human evolution is vital. This process should bring together academic researchers and broader groups and communities to exchange ideas, evidence and expertise. Within the initiative, the primary targets are groups which could contribute to our understanding of heritage and consequently provide many cultural and environmental benefits to society. In practice, all knowledge exchange engages across these audiences. Knowledge-sharing should include worldwide organisation probably under the auspice of UNESCO (ICOM/ICOMOS). However, in addition to early watercraft instructors and experts, a broad scientific research institute network with institutional and individual members from all around the world, a network of heritage parks around the world, scientific conferences, heritage public festivals, journals and web-based communications on different levels, all benefitting from a single worldwide meta-database of early watercraft knowledge, are crucial for the achievement of these goals.

Today's practice of using polyethylene glycol or melamine in the conservation of waterlogged wooden finds is unsatisfactory (Erič 2014; Erič *et al.* 2018).

However, to meet all requirements for protection, safeguarding and presentation of a selection of original vessels, we should investigate the possibilities of developing so-called I-aquariums—cells with controlled, biologically steered hydrological climates and the possibility of indoor and outdoor display of chosen artefacts. This idea should be put into practice by an interdisciplinary team of specialists in woodworking, microbiology, hydrology, mechanical engineering, computer science, etc. Its purpose would be to prevent the decomposition of wood in the course of physical, microbiological and chemical processes. That could be achieved with the help of cutting-edge technology, cavitation systems, a thermo-hydrological balance and carefully implemented adjustments in the microbiological balancing of water plants and animals.

The collection could expand gradually, from year to year. The reconstruction of the oldest watercraft found so far could mark the beginning: the Pesse canoe from the Netherlands or another logboat more relevant to a particular region. New copies or reconstructions of prehistoric logboats could be made at annual festivals every year. In a couple of years, dozens of logboats could be carved and fabricated all around the world. These collections would be managed by local communities of the countries that have embraced the idea of global heritage parks. The new boats could be used to organise educational trips or 'logboat treks'. In Slovenia they could, for instance, travel between Bistra, Vrhnika and Ljubljana. Each logboat would have a berth at Vrhnika, Podpeč or Ljubljana. The berths would be equipped with the data about the original boat: its discovery and the context in which it would have been used. Along the route, there could be places to stay. All logboats in the system would be equipped with high-tech navigational devices, enabling interactive 'real-time' monitoring from all over the world. One of the thematic collections in the heritage park would consist of originals, copies and reconstructions of typical watercraft from around the world.

In Slovenia, one could set up an exhibition of the earliest Roman barges made in the northern Mediterranean shipbuilding tradition, such as the Lipe ship and the Sinja Gorica ship. A minor permanent exhibition at the Visitor Information Centre could showcase miniature copies of Arles Rhone 2 from Marseilles, Yverdon 1 and Bevaix from Lake Neuchátel and Lipe. Full-size replicas of the vessels from Sinja Gorica and Lipe could be reconstructed. These could be used for tourist trips, cultural events and hiring. Next, an exhibition dedicated to the '*čupa*', a typical Slovenian north Adriatic fishing outrigger logboat, could be prepared. It is little known that in the 18th and 19th century, Slovenes used to have the biggest fishing fleet of more than 400 *čupa* logboats in the Gulf of Trieste (Volpi Lisjak 1996, 2005). This exhibition would pay tribute to this fishing fleet. Finally, a collection of the expanded *Notranjski drevak* logboats of the Notranjska region could be exhibited. Local inhabitants used this type of logboat in the basin of the Ljubljanica River during recent centuries. The latest studies of ship construction in Sinja Gorica indicate that this shipbuilding tradition may have originated in Slovenia and not in the valley of the River Po, the region where this type of boat is generally taken to have originated (Erič, Jaklič and Paskali 2017). These boats have, interestingly, a construction almost identical to the vessels on the Suwa Lake, south of Nagano in Japan (Robertson 2013), and on Lake Lugu in Yunnan province in China (Thompson 2007).

Thematic trails in the Ljubljana Marshes and around the world where local communities want to organise Early Watercraft Heritage Parks, could be laid out. All locations where logboats were found in the Marshes, or regions where other types of early watercraft are still in daily use, should be equipped with public information boards with descriptions of these unique finds. Advanced computer technology would allow virtual visits to these locations. The boards could be linked to a computer game devised for this purpose, for instance, 'Find the Early Watercraft discovery location'. The game format could be used to distribute bonuses/incentives for renting reproductions of early watercraft vessels in all parks around the world with available heritage facilities. Festivals organised by a worldwide team could also be used for promotion and education. They would include events for promoting early watercraft, e.g. an 'Early Watercraft Regatta', attended by celebrities, athletes, artists, scientists and accompanied by festivities. As an example, a 20km racing route could, for instance, be set up on the River Ljubljanica between Vrhnika and Ljubljana. These events could become a tradition, featuring workshops dedicated to the experimental reproduction of early watercraft. Sailing or paddling races could be transmitted to other continents, to locations with Early Watercraft Heritage Parks units. These centres would also be responsible for organising conferences and other educational activities. An early watercraft conference, early watercraft reproduction workshops or similar events should be held annually.

Future expectations and impacts of the initiative

One of the most important goals of the initiative is to create a globally integrated meta-database of all archaeological discoveries, anthropological and ethnological documentation relevant to traditional watercraft, reconstructions and copies of discovered watercraft which arise all over the world through the revival of the tradition of manufacturing.

One of the first challenges facing this initiative was to address the problem of the lack of transnational

connection of cultural heritage databases. As an example, early watercraft seem a good test case. We implemented a web-based system Early Watercraft Database (EWD: EarlyWatercraft.org). EWD is aimed at the global level, to combine records of all archaeologically researched early vessels around the world, thereby documenting all typological phenomena of early watercraft. These vessels are often still a significant economic navigational aid in various environments around the world. EWD is also intended to document innovative tourism efforts for sustainable conservation of cultural heritage. Such a database will serve as the foundation and the starting point for comprehensive, multidisciplinary and in-depth scientific research into the invention of early watercraft.

The EWD enables the storage and management of all relevant data about the finds for the specialist but, at the same time, presents early watercraft to the general public, which is alas a less well known subject of cultural heritage. For the technical implementation of EWD, we selected Arches, an open source platform for managing and storing data about immovable cultural heritage developed by the Getty Conservation Institute (Figure 1).

Early Watercraft Database (EWD): the Arches platform

The origins of Arches go back to 2004 when the Getty Institute for the preservation of cultural heritage (GCI) and the World Monuments Fund (WMF) formed the initiative for the preservation of Iraq's cultural heritage (Iraq Cultural Heritage Conservation Initiative). As the political and security situation in Iraq at that time did not allow for progress in that particular geographical area, an organisation linked to the Jordanian Department of Antiquities stepped into the project so that in 2010 the project MEGA-Jordan was successfully devised and is still in progress today. As the development of MEGA-Jordan was underway, other organisations dealing with the protection of cultural heritage became interested in the project. That was the motivation for both sponsoring organisations (GCI and WMF) to decide to develop a general open source software system for managing spatial data for all types of immovable cultural heritage. The project was named Arches (Carlisle *et al.* 2017; Myers, Avramides and Dalgity 2013).[1]

Experimental study and existing state-of-the-art EWD

The Early Watercraft Database is at this moment an experimental project on the Arches platform to study its functionality as a virtual collection of data in one place. The final version of EWD should support a worldwide database of logboats, grass boats, skin boats, bark boats, rafts and their accessories as indicated by the archaeological evidence. Thanks to Lars Kröger from Deutsche Shiffahrtsmuseum, EWD will shortly (in November 2018) accept a database of up to 3500 dated European logboats collected by several institutions with all relevant information. The database will include all published discoveries in Europe from the beginning of the early 19th century, and at least twenty researchers,[2] archaeologists from all over Europe will make a database on a national or regional level. The existing EWD is based on the Slovenian logboat database (Erič 2008). EWD should also be extended to include archaeological evidence from around the world.

Another part of EWD should include all available evidence for the contemporary use of early watercraft around the world, providing a description of the specific local or regional characteristics of these types of watercraft.

One component of EWD will be the *Journal of Early Watercraft* which will enable peer-reviewed publication of research and short articles about watercraft. However, there may also be many other possible functionalities of the EWD platform which will emerge in the future.

The functionality of the Arches platform

Based on the experience gained with the development of the MEGA-Jordan project and with the cooperation of many organisations around the world, the following principles formed the basis for the development of Arches:

- Design standards-based: The system should be based on established international standards in the field of cultural heritage (Figure 2) and information technology, thereby encouraging the exchange of data and longevity data, which will be independent of technological progress.
- Universal Access: To ensure the widest possible access, the system must be accessible via the Internet, and its use as straightforward as possible.
- Economical: As an open source system, it must be free, and its users must be allowed to adapt it to different requirements for local usage of the system.
- Scalability: The system must be built in a modular fashion to make adjustments as simple as possible. Also, the system must be capable

[1] Chapter 'Early Watercraft Database (EWD): The Arches platform' based on an unpublished Masters dissertation (Kastelic 2015).

[2] Béat Arnold, Jan Lanting, Christian Hirte, Sean McGrail, Waldemar Ossowski, Lars Kröger, Miran Erič, Niall Gregory, Karl Brady, Ole Kastholm, Thijs Maarleveld, Davorin Vuga, Jason Rogers, and many others.

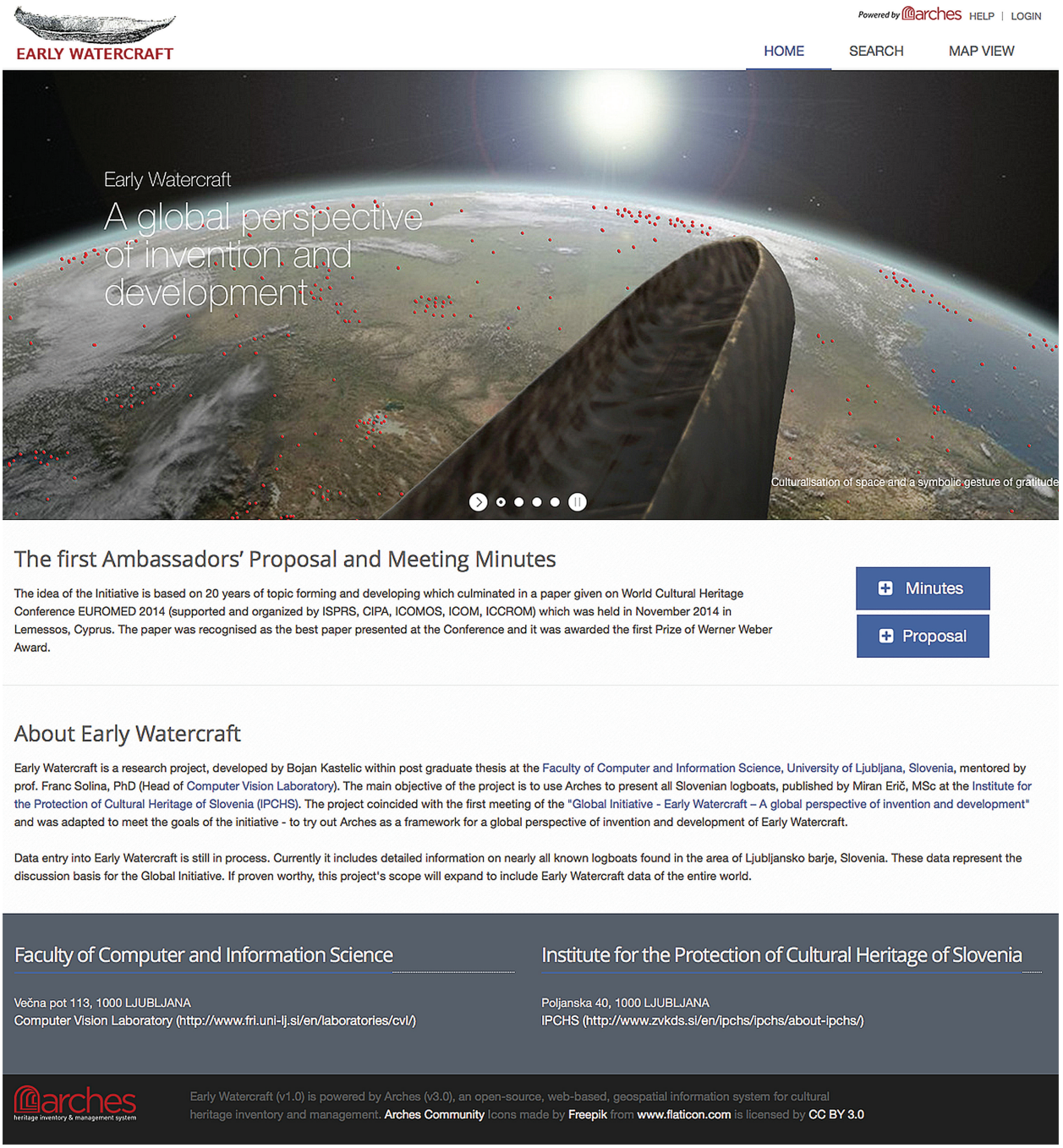

Figure 1. The entry page of EarlyWatercraft.org. At the moment the page based on Arches version 1.0 and does not work correctly. In 2019 it will be moved to the new version, Arches 4.0.

of multilingualism and being adapted for use anywhere in the world.

- Security: The system must allow any level of data protection—it can be fully opened to the public, completely closed or somewhere in between (a particular part of the functionality is open to the public, while another part is accessible only to users with appropriate rights).

The first version of the system Arches (1.0) was released in October 2013, and since then regular upgrades were undertaken. EWD is based on the third version (3.0) of the system, which was issued in April 2015.

Cultural heritage standards in Arches

From its very inception, Arches conformed to international standards in managing immovable cultural heritage. In particular, it is based on two CIDOC standards (DEF 2015): CDS (Core Data Standard), that covers the definition of data fields of the generic version of the Arches system, and CRM (Conceptual

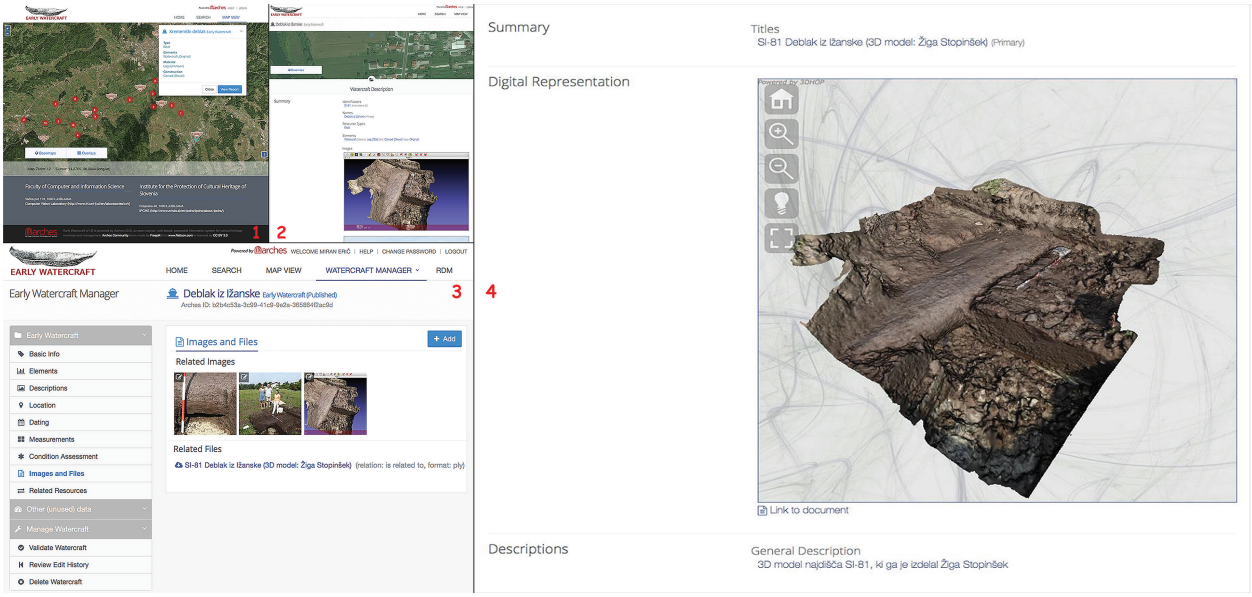

Figure 2. A public open map from EWD, showing a section from Ljubljansko barje, indicating positions where logboats have been found (1). A click on the logboat icon opens another window with all relevant data about the particular finding (2). Image 3 shows the administrator's working area for adding new finds where it is also possible to upload 3D models (4).

Reference Model), that covers the semantic framework of data usage. The CDS and CDI standards serve as the basis for a new international standard for essential data on archaeological and architectural heritage, which is currently in the final stages of preparation by CIDOC in collaboration with the international documentation council ICOMOS (CIPA).

As already stated, the CDS standard was used as a basis for the collection of data types for the first version of Arches. This collection of data types has expanded with subsequent versions of Arches. This integrates the set of original metadata (Dublin Core Metadata Element Set), which was proposed by DCMI from Dublin and is used for information resources used for storing digital as well as analogue data. The Dublin Core Metadata Element Set was also included in the ISO standard 15836-2009.

The CIDOC Conceptual Reference Model (CRM), which is also used in the Arches system, provides a basis for understanding concepts and how they are related; these are represented by data. CRM was initially designed as a tool for museums, libraries and archives, but could also be used in the context of immovable cultural heritage.

Arches includes the default mapping of its data into CRM classes and properties. In this way, different and distinct information can be represented and understood, while at the same time integration with systems using CRM is facilitated. CRM Special Interest Group developed CRM in the framework of CIDOC already in 1996 and in 2006 it was accepted as standard ISO 21127 (IAD 2006).

The use of Arches enables the free presentation of cultural heritage, which is not possible with standard databases since they usually require additional knowledge of implicit agreements. By enriching data with semantic content, CMR enables the generation of new apprehension from existing data and performing a powerful search, both inside the database, as well as among different databases. This allows easier migration of data to new systems and their preservation over time.

Although the CRM standard is comparatively complex and demands a steep learning curve, all implementation details in the Arches system are hidden from the end user. End users can communicate with the database using popular entry forms, which are also used in traditional relational databases.

IT standards in Arches

Arches also conforms to all key web and geospatial technical standards. For access and processing of geospatial data, Arches uses the open standard published by OGC (Open Geospatial Consortium), which ensures compatibility with all known GIS applications used in the area of cultural heritage and with the majority of web browsers and web maps currently in use. Arches also supports upcoming data formats such as GeoJSON and KML (Keyhole Markup Language) besides the currently standard GIS format (shapefile). Arches is also designed as an OGC web service so that it can be used in connection with other GIS applications such as ArcGIS or QGIS (Myers *et al.* 2012).

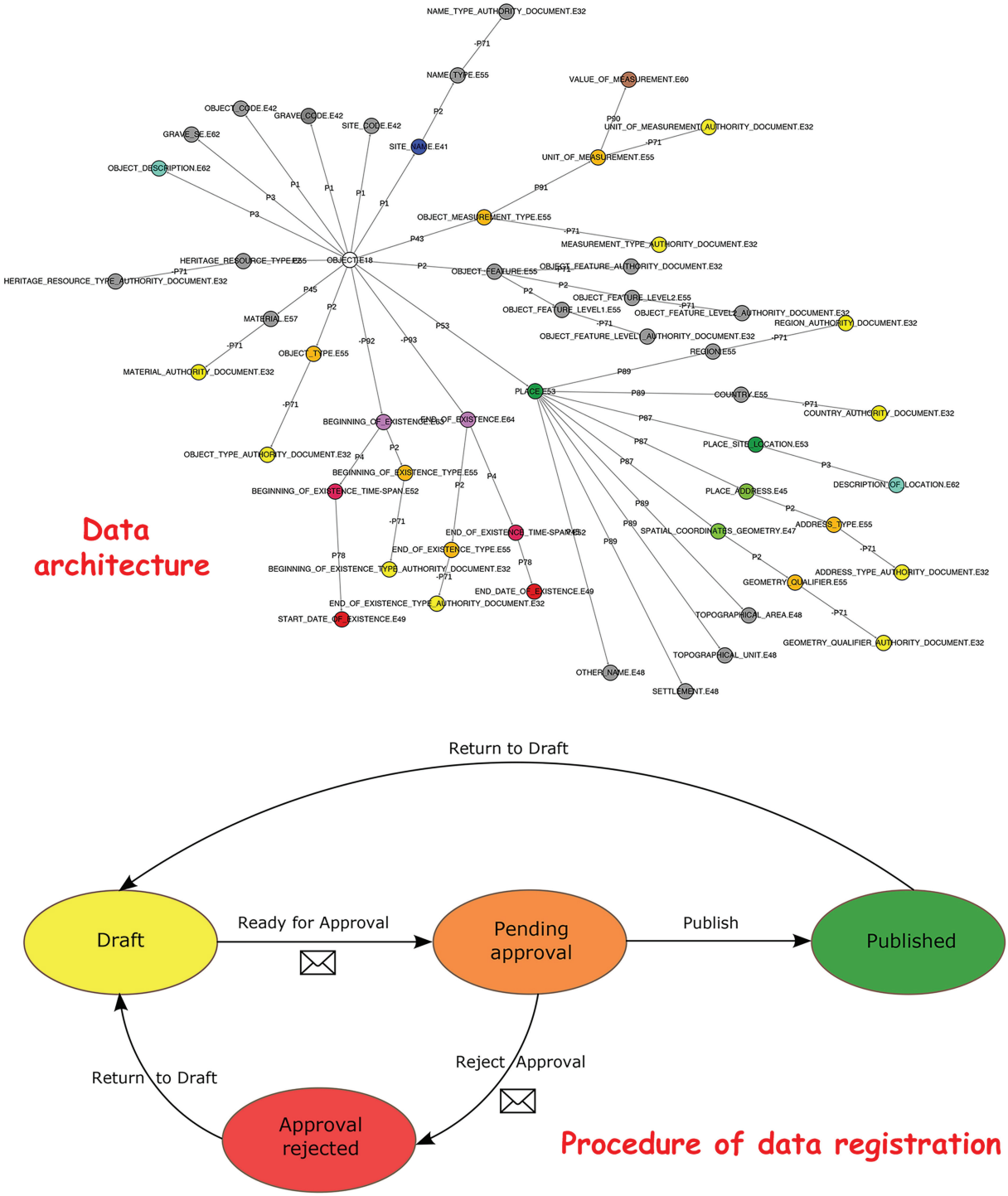

Figure 3. EWD based on all the latest standards for documenting Cultural Heritage (e.g. CIDOC and CDS) as well as on the latest information technology standards. It is possible to design and adjust the database architecture to any heritage, and create a more levelled control system for publishing.

Arches uses modern architectural concepts (Figure 3), based on RESTful interfaces and MVC patterns, so that data and their representation and processing can be independent. It is implemented in Python programming language in the open framework Django. For processing, Arches uses basic Javascript languages, such as Require.js, BackBone.js, jQuery and Bootstrap. PostreSQL is used as a data server (Myers *et al.* 2012).

Even in its basic configuration Arches enables all functionalities required for keeping the registers of immovable cultural heritage. However, its open

source system permits straightforward upgrades and modifications to local requirements.

The data model consists of three parts:

1. Ontology data stores the data graphs that in the framework of CICOC CRM standards store the records of permitted data types and their interconnections;
2. Reference data stores the hierarchically designed dictionaries that serve for the loading of selection lists. In Arches, records in the selection lists are called concepts, which beside data also store their metadata and connections between them; and
3. Resource data stores the actual data of the immovable cultural heritage. This data is divided into entities that store records of immovable cultural heritage, business data that store data about individual types, and relations, that store links between different entities.

The open library that arranges drawing of maps is OpenLayers in JavaScript, which supports all the leading record types and mappings from any source with the help of OGC standards. That in practice means that Arches supports all well-known systems of maps: Google Maps, Microsoft Bing Maps, ESRI ArcGIS, and open source OpenStreetMap. In Arches 3.0 the default support is for Microsoft maps, but that can be changed. Arches can be installed under Linux and Windows operating systems.

Results

EWD is built on the Arches platform to make the most out of its functionalities, such as built-in search, display and presentation of spatial data, but we explored, in particular, the possibility of extending data types within the Conceptual Reference Model (CIDOC CRM).

For example, we found especially beneficial for the implementation of EWD the following possible extensions:

- Support of multilingualism in the import and display data;
- Support of new types of documents (sites, graves, objects);
- Advanced search options, such as the separation of search by type of records, multi-layered lists and limitation of dimensions of artefacts or locations; and
- The reproducible preparation process for data transfer from a central database, which operates in the MS Access environment in Arches.

Within the EWD platform we implemented some new functionalities that we found relevant for our application:

- We added support for the process of releasing data, which covers the status of processed documents;
- Ownership of data is unbundled, to restrict a particular user to edit only their data;
- Distinct icons were designed to indicate on the map separate types of vessels in different colours to signal different materials; and
- Display of 3D models of vessels where these are available.

EWD is, therefore, an illustrative case study, demonstrating the rich possibilities of the Arches platform.

Discussion

Arches is an advanced application platform for management of immovable cultural heritage since it is one of the first that applies the CIDOC CRM standard not only for the definition of data but also for storing data. The sample application HIP, which is a part of the Arches release, is designed with an extensive set of functionalities so that it can be used in different areas and a wide range of contexts without any additional amendments. The use of this basic setup does not require any advanced computer knowledge. That makes Arches accessible also to organisations that do not have their own computer departments or have limited funds for information support.

For more advanced users, that is, institutions that wish to adapt Arches to their interests and requirements, the adaptation is very straightforward since open standards and open code enable this. Additional functionality built into the EWD (support for the process of data publishing, ownership of data, viewing of 3D models, etc.) testifies that Arches can be easily expanded beyond the initial framework. That is one of the most valuable benefits of using open source code. The ease of use and the low cost of the platform due to the open source code will hopefully motivate other decision makers to adopt this software solution for the next generation of data management tools in the area of immovable cultural heritage.

A combination of open source code solutions can be used to build information systems that can be easily compared to custom-developed solutions using commercial software platforms. For organisations and institutions that have difficulty allocating sufficient funds for information systems support, this represents a viable and attractive alternative. Like other open

source communities that spring up around particular application areas or network environments, the international Arches community is well organised and contributes additional tools and services for the community as well as help and support in solving problems and sharing of information.

Conclusions

The initial goal, to develop a flexible platform for inclusion of early watercraft into a database that can be transnationally connected was fulfilled. In the first instance of this database, all known early watercraft from Ljubljana Marshes were included, and information about them was made available both to specialists and to the general public, using up to date technologies and standards.

We have demonstrated that Arches can be applied on a local and global level. The members of the Early Watercraft Initiative will, thus, be able to use the same platform as described here at their local level almost without any modification, and ultimately all local databases could be connected into a global one.

In this way a much better-connected mosaic of world cultural heritage can be built, simplifying the exchange of data, allowing broader searches for information and supporting the development of conclusions from a geographically much larger dataset. Conclusions about and understanding of early watercraft can be, in this way, much more substantial and relevant.

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