

# Chapter 13

## Transforming Heritage Crafts to Engaging Digital Experiences



Nikolaos Partarakis, Xenophon Zabulis, Margherita Antona  
and Constantine Stephanidis

**Abstract** **Heritage Crafts** (HCs) involve craft artefacts, materials, and tools and encompass craftsmanship as a form of Intangible Cultural Heritage. Intangible HC dimensions include dexterity, know-how, and skilled use of tools, as well as identity and traditions of the communities in which craftsmanship is, or was, practiced. HCs are part of history and have impact upon the economy of the areas in which they flourish. Despite their **cultural significance**, efforts towards HC digital representation and presentation are scattered. In this chapter, as a first step towards the **Representation** and **Presentation** of Heritage Crafts as cultural heritage (CH), pertinent requirements and needed technological components are investigated. **Representation** is expected to capture the wide spectrum of knowledge that a HC covers, from objects and their making, to hand gestures and tool uses that define craft motor skills, to the societal value, economic impact, and historical significance of HCs. **Presentation** is expected to address the need of exploiting **Representation** to conserve cultural resources, contribute to their accurate interpretation, provide essential and authentic experiences, as well as stimulate revenues of cultural resources through thematic tourism. This chapter lays the foundations and envisions the further development and formalisation of a suitable approach to HC representation and presentation in the form of a generic protocol that together with the appropriate technological tools can be applied to any HC instance.

---

N. Partarakis · X. Zabulis · M. Antona · C. Stephanidis (✉)  
Institute of Computer Science, Foundation for Research and Technology – Hellas (FORTH),  
100 N. Plastira Str., 70013 Heraklion, Crete, Greece  
e-mail: [cs@ics.forth.gr](mailto:cs@ics.forth.gr)

N. Partarakis  
e-mail: [partarak@ics.forth.gr](mailto:partarak@ics.forth.gr)

X. Zabulis  
e-mail: [zabulis@ics.forth.gr](mailto:zabulis@ics.forth.gr)

M. Antona  
e-mail: [antona@ics.forth.gr](mailto:antona@ics.forth.gr)

C. Stephanidis  
Computer Science Department, University of Crete, Heraklion, Crete, Greece

## 13.1 Introduction

Cultural Heritage (CH) is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. Such physical artefacts are items of Tangible CH (TCH) and include buildings, historic places, monuments and artefacts, as well as objects significant to the archaeology, architecture, science or technology of a specific culture (Kalay et al. 2007).

Intangible CH (ICH) regards the practices, representations, expressions, knowledge, skills—as well as the instruments, objects, artefacts and cultural spaces—that communities, groups, and individuals recognize as part of their CH. ICH is transmitted from generation to generation, and is constantly recreated by communities and groups in response to their environment and their interaction with nature and history. ICH provides a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity (UNESCO 2003b). Thus, in contrast to TCH, ICH requires its practice by human participants, in order to exist, or otherwise, be preserved.

ICH includes oral traditions, performing arts, social practices, knowledge and practices concerning nature and the universe, as well as the knowledge and skills to produce traditional crafts (UNESCO 2003b). Crafts are defined as “an occupation or trade requiring manual dexterity or artistic skill” (Meriam-Webster on Craft). Crafts are characterised by a certain type of making, in which objects are created by hand through the skilled use of tools (Donkin 2001), to make or repair objects of functional use (Jennings 2012) and not solely of ornamental value. Nevertheless, very often, craft and artistic creation are related and craft products may be also works of art (Markowitz 1994). Often, a craft is medium specific or characterised by a type of product, as well as the handicraft or technologies required for its making (Metcalf 1993). Craftsmanship differs from industrial production as “the quality of the result is not predetermined, but depends on the judgement, dexterity and care which the maker exercised” (Pye 1968). In this chapter, we call Heritage Crafts (HCs) the crafts that are of significance to Cultural Heritage. A baseline towards the definition of HC is “practices which employ manual dexterity and skill, and an understanding of traditional materials, designs and techniques” (Jennings 2012).

In this chapter, we also aim to describe the requirements towards a systematic approach for HC representation and presentation. Moreover, we aim at defining additional requirements that stem from using such representation to:

1. Contribute to CH with technically appropriate and scientifically correct representations for craft preservation, as well as captivating and accurate narratives for CH audiences.
2. Stimulate revenues to fund craft preservation. Global trends in valorisation of CH indicate that the digital representation of CH is recommended<sup>1</sup> and of significance to support the economic resource yielded through heritage and thematic tourism.

---

<sup>1</sup>UNWTO Annual Report 2017: <https://www.e-unwto.org/doi/pdf/10.18111/9789284419807>.

3. Provide engaging educational tools, as well as attract interest to craft practice, thus increasing motivation for craft conservation. Part of the demotivation of younger generation towards the practice of HC is the lack of certification. Using a craft representation can provide the basis of certifying authenticity and traditional making of a product.

Prior to reviewing the state of the art and proposing requirements towards craft representation and presentation, we make more specific the scope of craft. Crafts include materials, tools, and products, while also knowledge, dexterous skill, know-how, traditions, as well as the sense of identity belonging to the communities in which they are, or were, practiced. Crafts of significance to CH, such as traditional crafts, are called **Heritage Crafts** (HCs). HC preservation is nowadays particularly urgent, as “several are threatened with extinction, due to the declining numbers of practitioners and apprentices” (UNESCO 2003b) (UNESCO), which is caused by lack of interest in younger generations, lack of authenticity certification, and urbanization (UNESCO 2003b).

Craftsmanship has been interwoven with mythology, religion and folklore of communities. Like any form of ICH, HCs are performed by persons. As such, they include historic, geographical, artistic, traditional, economic, and religious dimensions. HCs have a cross-border nature and are objects of cultural exchange. They are part of the history, the economic life and progress of the communities in which they have flourished.

Craft communities and guilds have been relevant to state and religious politics in the past, and avail a historic understanding of the formation of common origins of modern societies, cities, and nations since the Renaissance. They are also relevant to the distribution of wealth, the formation of social classes and, thereby, social and political changes.

Craftsmanship has contributed very significantly to change and progress in the history of humanity, from the first making of tools, to their mechanisation and automation that led to the Industrial Revolution, to the Arts and Crafts movement that retained art in usable items, to contemporary industrial design. The significance, the materials, the tools and practice of crafts, varies over time. The study of HCs can provide essential knowledge in historical, societal and economic topics, and the significance of HCs can only be understood against these contexts, which have a strong interdisciplinary nature.

## 13.2 State-of-the-Art in Craft Representation and Presentation

HCs cover a broad spectrum of tangible and intangible dimensions, whose representation requires the contribution of multiple scientific disciplines. Correspondingly, multiple dimensions related to multiple types of tangible and intangible content which, in turn, may require different ways of presentation or may concern different audiences.

### 13.2.1 *Historical Research on the Practice of HCs*

Existing works on the description of specific craft instances include literature studies, documentaries, and inscriptions (Hecht 1989; Geijer 1979). A wide range of textual HC descriptions are available online from the UNESCO's World Heritage Portal.<sup>2</sup> UNESCO identified the need of testimonies in the "Living Human Treasures" programme, which encourages official recognition to talented tradition bearers and practitioners. Accordingly, UNESCO has been recording and archiving intangible forms of cultural expressions, including HCs.<sup>3</sup>

Efforts towards appropriate treatment of preservation and curation of HC knowledge have emerged, through the collaboration of a wide range of experts by UNESCO, providing a theoretic basis towards the representation of ICH (UNESCO 2003b). Tangible and intangible craft dimensions have been outlined in Donkin (2001).

International projects underpin the need for documentation and preservation of craft knowledge. The Erasmus+ EU programme "Discovering Traditional Crafts across Europe" aims to such traditional crafts, some of which are slowly disappearing from today's societies. Several national projects have been funded in China through the "Chinese Craft Project" that targets promotion and preservation of Chinese ICH. Folk art preservation has the focus of national projects in Italy (Barra 2012).

### 13.2.2 *Digitization of TCH*

Progress during the last two decades in standardizing TCH digitization has provided guidelines on how to digitize printed matter and 3D objects, as well as monuments of cultural heritage. Guidelines regarding file management, digital preservation, online publication, and IPR management have been elaborated,<sup>4</sup> as well as by online heritage repositories, such as Europeana (Aloia et al. 2011).

The most common digitisation modality is **photographic documentation**. It is relevant to the digitisation of 2D (i.e. documents, paintings) or 3D items (i.e. materials, man-made objects). Good practice and strategic guidelines have been compiled as a result of digitisation projects (ETH-Bibliothek 2016; Brosseau et al. 2006; CARLI Digital Collections Users' Group 2016). The development of technologies for the **3D digitisation** of artefacts and monuments has allowed the representation and documentation of geometrical and structural information. Several modalities have been developed, each of which addresses different circumstances and requirements and records different characteristics of the scanned physical object including scanning techniques, authenticity, realism, complexity, documentation, lightweight web deployable scans, etc. (Arnold and Geser 2008; Scopigno et al. 2011; Pratikakis et al. 2018; Kasnesis et al. 2019; Vico 2018; D'Andrea et al. 2012). Furthermore

<sup>2</sup><https://whc.unesco.org/en/list/>.

<sup>3</sup><https://unesdoc.unesco.org/archives>.

<sup>4</sup><http://www.minervaeurope.org/>.

research efforts have resulted to digitisation guidelines to assist new digitisation efforts (3D-ICONS 2014). Besides digital preservation, the significance of accurate digitisation is important to the conservation of TCH.

### 13.2.3 Digitization of CH Activities

Digitisation of ICH has included human activities as well as the capture of semantic concepts and contextual knowledge (e.g. historical, religious, economic, and social). **Human motion** is a key component of many forms of ICH such as dances, crafts, and rituals. Human motion has been the target of ICH digitisation with research efforts targeting singing, dancing,<sup>5</sup> theatrical performances<sup>6</sup> traditional crafts, etc. (Dimitropoulos et al. 2014; Camurri et al. 2016; Giannoulakis et al. 2018; Dimitropoulos 2018; Doulamis Anastasios et al. 2017). The context of crafts binds together the intangible dimension of human motion, skill and design, with tangible objects such as tools, materials and artefacts. Digitisation of human motion has been achieved by a number of methods. Two main method categories are **Motion Capture** (or MoCap), which requires human subjects wear technological items (Brigante et al. 2011), such as markers or sensors, and **Visual Tracking** methods, which do not impose such requirement. MoCap technologies measure the movement of subjects in 3D. Two main technologies are used: optical and inertial measurement. The results encapsulate human motion in 3D with great detail and provide a complete representation of the recorded motion. Visual Tracking methods use visual sensors to record human subjects (Cao et al. 2017). Motion is estimated in 3D by processing of the visual stream. The cost of the unobtrusive nature of these methods is the confrontation with the problem of treating visual occlusions and the inference of subject motion missing from the acquired images, due to these occlusions. Visual tracking is of particular importance for documentation of CH, because it means that a 3D representation of motion can be obtained from documentaries and archive footage.

Intangible heritage also includes **audio assets** such as testimonies, songs, and music. International digitisation projects have provided guidelines and standard for audio recordings and their digital preservation (IFLA/UNESCO 1999; Bradley 2006; UNESCO 2003a, 2016; Bradley et al. 2007).

### 13.2.4 Representation of Contextual and Semantic Knowledge

The representation of semantic knowledge is important as it can capture both abstract and contextual information (e.g. historic, social, economic and political context).

---

<sup>5</sup><http://www.modul-dance.eu/wp-content/uploads/2015/02/Modul-dance-book.pdf>.

<sup>6</sup><https://www.europeantheatrelab.eu/>.

One of the most important efforts towards knowledge representation in CH provided an approach towards making knowledge sharable between communities of people, culture, languages and computers through an open platform for mining facts (Vossen et al. 2010). In the same context, representation of collections of heterogeneous data (Carmel et al. 2012) and the provision of ways to access and to preserve cultural and scientific resources (Giaretta 2008; Doulamis 2017) remains crucial.

As sources of such knowledge include records and historical documents, relevant efforts include the conversion from digitised conventional and historic documents to text. In this context, the use of tools for the digitisation of historical documents (scans) into textual information, through state-of-the-art OCR (Neudecker and Tzadok 2010), is considered important. Furthermore, tools and approaches for the indexing, search and full transcription of information from historical handwritten document images were developed in (Sánchez et al. 2013) and are available through a web portal for structured crowdsourcing transcription projects.

From an ICT perspective, the use of ontologies for describing and classifying objects is now a well-established practice in the CH sector. The Getty vocabulary databases, maintained by the Getty Vocabulary Program, provide a solid basis that is a de facto standard in the area.<sup>7</sup> These databases are thesauri compliant with the ISO standard for thesaurus construction. They comprise: the Art & Architecture Thesaurus (AAT), the Union List of Artist Names (ULAN) and the Getty Thesaurus for Geographic Names (TGN). The AAT, in particular, contains more than thirty thousand concepts, including terms, descriptions, bibliographic citations and other information relating to art. The AAT is organized as a hierarchy with seven levels, called facets, in which a term may have more than one broader term. The Getty Research Institute has also developed a metadata schema, called the Categories for the Description of Works of Art (CDWA), for describing art works. CDWA includes 381 categories and sub-categories, a small subset of which are considered core, in the sense that they represent the minimum information necessary to identify and describe a work. Complementary to CDWA, the Conceptual Reference Model (CRM) of the International Committee for Documentation of the International Council of Museums (ICOM-CIDOC) has emerged as a conceptual basis for reconciling different metadata schemas.<sup>8</sup> CRM provides definitions and a formal structure for describing the implicit and explicit concepts and relationships used in cultural heritage documentation. CRM is an ISO standard (21127:2006) that has been integrated with the Functional Requirements for Bibliographic Records (FRBR) and the Europeana Data Model,<sup>9</sup> which plays the role of upper ontology for integrating metadata schemes of libraries, archives and museums.

---

<sup>7</sup><http://www.getty.edu/research/tools/vocabularies/index.html>.

<sup>8</sup><http://www.cidoc-crm.org/>.

<sup>9</sup><http://pro.europeana.eu/web/guest/edm-documentation>.

### 13.2.5 *Knowledge Based Narratives*

The emergence of rich methods for the representation of contextual and semantic knowledge calls for new approaches to the presentation of such knowledge in various contexts and for various purposes, such as education and training. Narratives can be used to construct explanations and make sense of the world (Mulholland and Collins 2002). In this chapter, narratives are referred to as particular ways in which stories can be told. A story can be considered as a conceptual space representing events, people and objects that may be presented in alternative ways, to create different effects and to target different user categories (Brooks 1996).

Computational narratology (Mani 2012) studies narratives from a computation perspective. In the Artificial Intelligence field, computational narratology refers to story generation systems, i.e. computer applications that create a symbolic (written, spoken, or visual) presentation of a story, typically based on a story grammar. Recently, ontologies were used to generate narratives. For example, MAKEBELIEVE (Liu and Singh 2002) uses common sense knowledge, selected from the ontology of the Open Mind Commonsense Knowledge Base (Singh 2002), to generate short stories from an initial one given by the user. ProtoPropp (Gervás et al. 2005) uses an ontology of explicitly relevant knowledge and the Case-Based Reasoning method over a defined set of tales. In FABULIST (Riedl and Young 2010), the user supplies a description of an initial state of the world and a specific goal, and the system identifies the best sequence of actions to reach the goal. **The concept of event is a core element of narratology theory and of narrative.** People conventionally refer to an event as an occurrence taking place at a certain time at a specific location. Various models have been developed for representing events on the Semantic Web, e.g. Event Ontology (Raimond and Abdallah 2007), Linking Open Descriptions of Events (LODE) (Shaw et al. 2009), and the F-Model (Scherp et al. 2009). More general models for semantic data organization are CIDOC-CRM (Doerr 2003), the ABC ontology (Lagoze and Hunter 2006), and the Europeana Data Model (Doerr et al. 2010). Narratives have been recently proposed to enhance the information contents and functionality of Digital Libraries, with special emphasis on information discovery and exploration. For example, in Lopez de Lacalle (2012), a system is proposed that acts as an interactive personalized tour guide through existing digital library collections. In the same context, in (Wolff et al. 2012) a system is proposed that allows describing stories that span museum objects while (van den Akker et al. 2012) developed methods and techniques to support the narrative understanding of objects in VMs collections.

### 13.2.6 *Presentation of CH Through Digital Experiences*

Telling stories through immersive cultural experiences provides the feeling of being inside the story (Stogner 2011). Although the reader of a book often has the feeling of being immersed in the story, new technology offers additional potential as the reader

can explore a virtual world, perhaps from the viewpoint of one of the characters in the story (Mulholland and Collins 2002). Furthermore, immersive experiences provide a “sense of place” and a “sense of time” contributing to the creation of memories that bind the audience to the story. Examples of engaging storytelling experiences include (a) exploring collections by creating conceptual paths, linking the items (Clough et al. 2011); (b) exploring digital collections as part of coherent narratives, which included the knowledge structures that connect them and give them meaning (De Polo 2011); and (c) exploring collections through interactive stories for visitors of cultural sites, authored by curators (Pujol et al. 2012).

In this section a short overview of immersive technologies currently exploited in the presentation CH content is provided.

### 13.2.6.1 Interactive Technologies

Cultural Heritage Institutions seek new ways to attract and engage new visitors. One of the ways to obtain competitive advantage is the investment and implementation of interactive experiences on site (Tscheu and Buhalis 2016). Over the years, several technologies have emerged each of which provides different forms of interaction and different level of immersion, but also poses different requirements in terms of space, setup and deployment. In this sub-section, the most prominent of these technologies are presented.

**Virtual Reality (VR):** An example of a high immersion VR environment for CH is Kivotos, a VR environment that uses the CAVE® system, in a room of 3 m by 3 m, where the walls and the floor act as projection screens and in which visitors take off on a journey thanks to stereoscopic 3D glasses.<sup>10</sup>

**Augmented Reality (AR):** AR exhibition offers more advantages to museum visitors as virtual information is overlaid upon video frames captured by a camera, giving users the impression that the virtual cultural artworks actually exist in the real environment. AR has been experimentally applied to make it possible to visualize incomplete or broken real objects as they were in their original state by superimposition of the missing parts (Liarokapis and White 2005). The ARCO system (ARCO 2013; White et al. 2004) provides customized tools for virtual museum environments, ranging from the digitization of museum collections to the tangible visualization of both museum galleries and artworks.

**Mixed reality (MR):** MR relies on a combination of VR, AR and the real environment. According to Milgram and Kishino’s virtuality-continuum, real world and virtual world objects are presented together on a single display (e.g. the screen of a mobile phone) (Milgram and Kishino 1994) that displays the visual representation of both the real and the virtual space (Hughes et al. 2005). An example of the use of MR techniques in a museum environment is the Situating Hybrid Assemblies in Public Environments (SHAPE) project (Hall et al. 2001) that uses hybrid reality technology

---

<sup>10</sup>Foundation of the Hellenic World: <http://www.ime.gr>.



to enhance users' social experience and learning in museum and other exhibition environments, with regard to cultural artworks and to their related contexts.

**X-Reality:** AR, VR and MR applications when coexisting in a physical context are referred to as X-Reality (Extended Reality) or XR applications (Fast-Berglund et al. 2018). The use of such technologies has the potential to enrich the information of cultural heritage artefacts and museum exhibits and turn passive visitors into active participants engaged in an interactive and immersive blend of physical and virtual as if it was a single unified "world" (Margetis et al. 2019).

### 13.2.6.2 Storytellers

Virtual characters can be well suited as museum storytellers, due to their inherent ability to simulate verbal as well as nonverbal communicative behaviour (Jung et al. 2011). This type of interface is made possible through multimodal dialog systems, which extend common speech dialog systems with additional modalities similarly to human-human interaction (Jung et al. 2011). The visual representation of a character including its perceivable behaviour, from a decoding perspective, such as facial expressions and gestures, belongs to the domain of computer graphics and likewise implicates many open issues concerning natural communication. However, employing virtual characters as personal and believable dialog partners in multimodal dialogs entails several challenges, because this requires not only a reliable and consistent motion and dialog behaviour, but also nonverbal communication and affective components. Over the last decade, there has been a considerable amount of success in creating interactive, conversational, virtual agents, including Ada and Grace, a pair of virtual Museum guides at the Boston Museum of Science (Swartout et al. 2010), the INOTS and ELITE training systems at the Naval Station in Newport and Fort Benning (Campbell et al. 2011), and the SimSensei system designed for healthcare support (DeVault et al. 2014). There is also some precedence for the use of virtual agents in facilitating anti-bullying education, such as the FearNot! application developed by Aylett et al. (2007).

## 13.3 Requirements of Heritage Craft Representation and Presentation

In this chapter, as a first step towards the **Representation** and **Preservation** of HCs, pertinent requirements are investigated. These high level requirements have been solidified through an extensive literature review and an iterative requirements elicitation process, based on multiple collection methods, as outlined below.

**Brainstorming**, where mixed groups of ICT experts (interactive technologies, semantic knowledge representation, storytelling, narratives authoring) and domain experts (HCs professionals, museum personnel, curators) participate in order to define the basic steps towards craft representation and presentation.

**Focus groups** with experts. These groups target a single technology or single step to elaborate technical requirements.

**Scenario building**, following a co-design process where experts and end users are formulating scenarios of use. These sessions focus on how perceivably users wish to interact and experience HCs.

### ***13.3.1 Representation***

**Representation** is required to capture the wide spectrum of knowledge that HC cover, from objects and their making, to hand gestures and tool uses that define craft motor skills, to societal value, economic impact, and historical significance of HCs.

#### **13.3.1.1 Collection of Digital Assets for HC Documentation**

HC **Representation** involves the definition of information regarding both the tangible and intangible dimensions of HCs. Indicatively, tangible dimensions regard materials, artefacts and tools. Intangible information regards the way of making, the skills required, the teaching process, as well as personal creativity. Intangible information would furthermore answer questions about religious or political dimensions, the role of guilds, and the impact of the HC on local communities and society. As HCs have an economic dimension, such information should provide answers to questions about the origin of materials, the cost of the products and the ways these products are sold (e.g. local craft stores, festivals), trade and export of products, and impact on economy, culture, and the lives of people. Archives, documentaries, literature, and linked data repositories are important and can be enriched with artefact reconstructions. Contributions from human resources and LHTs should also be collected through workshops, collaborative and participatory activities with craft practitioners, testimonies and demonstrations.

**Technical requirements:** Digital assets identification, identification of Linked Data Repositories, digitization of new content using existing asset digitization technologies (scanning, 3D reconstruction, photography, etc.) and implementation of basic asset storage facilities prior to knowledge representation.

#### **13.3.1.2 Basic Knowledge Representation**

Basic knowledge representation regards the gathering, annotation and documentation of content from heterogeneous sources, such as 3D digitisation, motion capture, textual, records, documents, etc. This requires the definition of a Crafts Ontology (CrO) that includes a vocabulary of terms to be used upon data entry. Information will be comprised of existing digital assets or new digitisations, such as in the case of expert motion capture. The CrO should represent tangible and intangible knowledge

of the HC. Entries should contain knowledge about tangible aspects, human motion representation, processes as sequences of motions, and intangible aspects extracted from sources such as records, descriptions and testimonies. An authoring interface for annotating and inputting the digital assets into the HC repository can assist this phase.

**Technical requirements:** Definition of a crafts ontology (CrO), usage of advanced digitization technologies (e.g. Motion Capture) and implementation of the appropriate authoring tools to provide access to scholars, researchers and communities to the CrO.

### 13.3.1.3 Semantic Representation of Knowledge

The basic knowledge representation is not sufficient. Establishing semantic links between the digital assets and contextual information (e.g. historic, social, economic and political context) is required in order to instantiate the model of a HC into a HC representation. Information should be encoded using the HC vocabulary and should conform to the CrO. The Semantic representation of Knowledge can benefit from a collaborative or participatory approach in authoring descriptions and HC attributes, ensuring that complementary stakeholder perspectives are included in the HC representation. The outcome of these activities would comprises the digital representation of the HC.

**Technical requirements:** The CrO and vocabulary should be extended and or modified to address new representation requirements. Pertinent tools should enable: (i) authoring semantic descriptions, (ii) establishing links between model entities, and (iii) connect digital assets.

### 13.3.1.4 Definition of Semantic Narratives

The rationalisation of the vast amount of information around a HC should be assisted by the formal semantic representation and linkage of content. This should result in fundamental text based narratives for the following reasons: (a) rationalisation will lead to links between threads and shreds of history; (b) rationalisation can lead to the emergence of new links that can form storylines; and (c) rationalisation will help the creation of a well-defined and thus ease to manage knowledge base. The first step for authoring semantic narratives is the definition of text based narratives to act as a baseline of information for their technical implementation in the semantic model. Then the **authoring of semantic narratives** should be aided by narrative generation tools that capitalize on the achieved HC representation. Narratives should contain links to digital assets and multimedia (i.e. motion-driven narratives, documentaries, 3D digitisations) in order to create engaging storylines and bind stories with traditions, items, testimonies, etc.

**Technical requirements:** A narrative authoring environment that is based on the HC representation and assists the authoring of comprehension and motion-driven narratives, which include links to CrO entities and instances. Possibly this environment could be an extension of the authoring tools.

### **13.3.2 Presentation**

**Presentation** addresses the need of exploiting the representation described above to preserve cultural resources, contribute to their accurate interpretation, provide essential and authentic fruition experiences, as well as stimulate revenues of cultural resources through thematic tourism.

#### **13.3.2.1 Informational Applications**

HC representation and narratives could be availed through the authoring tools providing access to general and scientific audiences. Both access types could support appropriate querying and browsing capabilities on the HC representation. Research access could expose query mechanisms for digital assets and semantic information. Composite queries could also be available, such as ones targeting the monitoring contextual information in time, or comparative assessment of HCs.

Access to HC communities, makers, tourists and the general public could be available through a portal view of the repository and HC representation. Online applications for practitioners and HC communities could provide an opportunity for virtual promotional exhibitions, documentation of product authenticity, and collaboration with local tourism industries. Such a platform could also host virtual exhibitions authored by curators. All represented content, digital assets, authored narratives, and educational experiences could be customized for on-line access and provided through the platform.

**Technical requirements:** a portal view of the authoring tools for providing access to communities to HC knowledge advanced querying mechanisms, co-designed applications for practitioners.

#### **13.3.2.2 Storytelling Applications**

Storytelling applications can acquire content from the produced narratives and the HC representation to provide multifaceted presentations of HCs. These presentations can provide comprehensive views of HCs and be enriched with digital assets. Contextualized and personalised versions of these narrations are authored to tell the story from multiple perspectives (e.g. geographic, technological and contextualize the economic and societal impact and its evolution along the course of time. Presentations can also be personalized according to user context and multiple profiles

(e.g. practitioner, customer). Storytelling can be availed through mobile platforms and a virtual character playing the role of an interactive narrator and, also, through the authoring environment. AR can augment real exhibits showing illustrated annotations upon digital assets (e.g. human motion and tool handling upon documentaries or practitioner recordings).

**Technical requirements:** Storytelling components utilize narratives to create HC presentations and stories. Storytelling may be implemented through augmentations of the craft workspace with virtual characters acting as guides, VR environments that provide immersive storytelling experiences, dissemination through online virtual storytelling applications, etc.

### 13.3.2.3 Educational Applications

Educational applications could target HC skill-learning and introductory experiences to HCs. First-person acquaintance applications to basic skills can be implemented through MR, which could allow the manipulation of virtual and real objects and tools. The educational scenario could be mediated by an interactive virtual character playing the role of the craft master, while the visitor assumes the apprentice role. A version of the educational applications could be adapted for access through the online authoring environment.

Potential applications include demonstrations of skills and processes, powered by intuitive visualizations of practitioner movements and techniques, as well as illustrated and animated instructions. The craft master uses instructions and motion-driven narratives to explain the task to the user (apprentice), who needs to exercise. User hands are tracked and gesture recognition is utilized to produce actions in the virtual world. Hand-tracking and gesture recognitions can be registered, and compared with recordings from LHTs or documentaries. The craft master may optionally provide feedback and advice on the performance of the technique. Depending on the application, HC, and user context, accurate achievement of dexterity may be optional; e.g. may not require accurate mimic master dexterity and may utilise approximate gestures, or simply required issuing of appropriate commands that implement a crafting process.

**Technical requirements:** Augmentation of expert motion and summative visualisations for educational purposes. MR applications that host educational experiences and allow users to learn and replicate basic craft movements. Real-time motion tracking monitors user skills. Motion registration visualizes and compares user motion with digitised functional testimonies. The authoring tools are facilitated as a means of providing access to educational material such as tutorials, step by step guides, books, etc.

## 13.4 Discussion and Future Work

This chapter has presented the significance of HC as CH and the urgent need for HC representation, preservation and conservation. HCs are related to the origins of modern societies, their history, and culture, have economic and societal impact, as well as, impact on gender roles. HCs have a paramount cultural value and offer a thematic thesaurus of stories and narratives of which general audiences can relate to. As such, they exhibit potential for valorisation due to the captivating content of stories, memories, and meaning that a representation of HCs can offer. Although technically many of the basic ingredients to achieve such a representation do exist they remain unconnected.

Preservation of HCs calls for a systematic process of their **representation and presentation**. To this end, this chapter has defined the basic requirements. This remains a work in progress with the envisioned outcome to be formalised in the near future in the form of a protocol. This representation should: (a) cover tangible and intangible HC dimensions; (b) adhere to digitisation standards for CH documentation; (c) formally represent knowledge and semantics; (d) aid the capture characteristic craft qualities; (e) provide computational ways to create narratives for HC documentation and preservation; and (f) contribute to the design and implementation of applications that: (i) aid CH professionals in digital curation and CH research; (ii) support HC educators in the transmission of HC knowledge, and (ii) provide stimulation for revenues of cultural resources through thematic tourism.

Limitations of the proposed approach relate to the extent that technology can be used to represent and present intangible dimensions of HCs. Such a dimension lacking is the type of “felt” or sensory knowledge based on the sensory perception of practitioners. This is the practitioner’s interpretation of his/her own qualia,<sup>11</sup> to perceive the materials and her makings. Examples are the haptic sensation of a material (i.e. plaster dampness of the potter, or roughness of a textile), the sensations of heat and smell (i.e., in the glassmaking process), or the colour of an object, which are exploited by a skilled practitioner.

Another limitation is the representation and assessment of artistic content embedded in craft products. Although the representation of the artistic dimensions can be further elaborated in multiple ways by including e.g. the principles of composition in art (unity, balance, movement, rhythm, etc.) there will always be a difficulty on representing and therefore presenting how someone can become an artist and therefore produce new art.

**Acknowledgements** This chapter reports research work conducted in the context of the EU Horizon 2020 research and innovation programme under grant agreement No. 822336 (Mingei).

---

<sup>11</sup>Qualia are subjective, conscious experiences or “the ways things seem to us” (Dennett 1988).

## References

- 3D-ICONS (2014) Guidelines & case studies. 3D-ICONS is a project funded under the European Commission's ICT Policy Support Programme, project no. 297194
- Aloia N, Concordia C, Meghini C (2011) Europeana v1. 0. In: Italian research conference on digital libraries. Springer, Berlin, Heidelberg, pp 127–129
- ARCO (Augmented Representation of Cultural Objects) consortium (2003). <http://www.arco-web.org>
- Arnold D, Geser G (2008) EPOCH research agenda for the applications of ICT to cultural heritage. EPOCH project
- Aylett R, Vala M, Sequeira P, Paiva A (2007) FearNot!—an emergent narrative approach to virtual dramas for anti-bullying education. *Lecture Notes Comput Sci* 4871:202–205. [https://doi.org/10.1007/978-3-540-77039-8\\_19](https://doi.org/10.1007/978-3-540-77039-8_19)
- Barra G (2012) Chinese craft project, Politecnico Di Milano, M.Sc. thesis
- Bradley K (2006) Risks associated with the use of recordable CDs and DVDs as reliable storage media in archival collections: strategies and alternatives
- Bradley K, Lei J, Blackall C (2007) Memory of the world: towards an open source repository and preservation system. In: Conference: meeting of the international advisory committee of the memory of the world programme, Pretoria, South Africa
- Brigante C, Abbate N, Basile A, Faulisi A, Sessa S (2011) Towards miniaturization of a MEMS-based wearable motion capture system. *IEEE Trans Ind Electron* 58(8):3234–3241
- Brooks KM (1996) Do story agents use rocking chairs? The theory and implementation of one model for computational narrative. In: *ACM Multimedia '96*, Boston, MA
- Brousseau K, Choquette M, Renaud L (2006) Digitization standards for the Canadian Museum of Civilization Corporation. Version 1.1
- Campbell JC, Hays MJ, Core M, Birth M, Bosack M, Clark RE (2011) Interpersonal and leadership skills: using virtual humans to teach new officers. In: *Proceedings of interservice/industry training, simulation, and education conference (I/ITSEC)*. IITSEC
- Camurri A, Canepa C, Ferrari N, Mancini M, Niewiadomski R, Piana S, Volpe G, Matos J-M, Palacio P, Romero M (2016) A system to support the learning of movement qualities in dance: a case study on dynamic symmetry. In: *BodySenseUX workshop*, held in conjunction with *UBICOMP*
- Cao Z, Simon T, Wei S, Sheikh Y (2017) Realtime multi-person 2D pose estimation using part affinity fields. In: *Proceedings of CVPR*
- CARLI Digital Collections Users' Group (2016) Guidelines for the creation of digital collections. Consortium of Academic and Research Libraries at the University of Illinois
- Carmel D, Zwerdling N, Yogev S (2012) Entity oriented search and exploration for cultural heritage collections: the EU cultura project. In: *Proceedings of the 21st international conference on world wide web*, pp 227–230. ACM
- Clough P, Ford N, Stevenson M (2011) Personalizing access to cultural heritage collections using pathways. In: *International workshop on personalized access to cultural heritage*
- D'Andrea A, Niccolucci F, Bassett S, Fernie K (2012) 3D-ICONS: world heritage sites for Europeana: Making complex 3D models available to everyone. In: *2012 18th international conference on virtual systems and multimedia*. IEEE, pp 517–520
- De Polo A (2011) Digital environment for cultural interfaces: promoting heritage education and research. In: *Proceedings of museums and the web 2011*. Arch Mus Inform. Toronto
- Dennett D (1988) *Quining Qualia*. In: Marcel A, Bisiach E (eds) *Consciousness in modern science*, Oxford University Press. In: Lycan W (ed) (1990) *Mind and cognition: a reader*. MIT Press (Reprinted). In: Goldman (ed) (1993) *Readings in philosophy and cognitive science*. MIT Press

- DeVault D, Artstein R, Benn G, Dey T, Fast E, Gainer A, Georgila K, Gratch J, Hartholt A, Lhommet M, Lucas G, Marsella S, Morbini F, Nazarian A, Scherer S, Stratou G, Suri A, Traum D, Wood R, Xu Y, Rizzo A, Morency L-P (2014) SimSensei Kiosk: a virtual human interviewer for healthcare decision support. In: Proceedings of the 2014 international conference on autonomous agents and multi-agent systems. IEEE, pp 1061–1068
- Dimitropoulos K et al (2018) A multimodal approach for the safeguarding and transmission of intangible cultural heritage: the case of i-Treasures. *IEEE Intell Syst* 33(6):3–16
- Dimitropoulos K, Manitsaris S, Tsalakanidou F, Nikolopoulos S, Denby B, Al Kork S, Tilmanne J et al (2014) Capturing the intangible an introduction to the i-Treasures project. In: 2014 international conference on computer vision theory and applications (VISAPP), vol 2. IEEE, pp 773–781
- Doerr M (2003) The CIDOC conceptual reference model: an ontological approach to semantic interoperability of metadata. *AI Mag* 24(3):75–92
- Doerr M, Gradmann S, Hennicke S, Isaac A, Meghini C, van de Sompel H (2010) The Europeana data model (EDM). In: World library and information congress: 76th IFLA general conference and assembly, pp 10–15
- Donkin L (2001) Crafts and conservation. Synthesis report for ICCROM
- Doulamis Anastasios D et al (2017) Transforming intangible folkloric performing arts into tangible choreographic digital objects: the terpsichore approach. In: Proceedings of VISIGRAPP (5: VISAPP)
- Doulamis N et al (2017) Modelling of static and moving objects: digitizing tangible and intangible cultural heritage. Mixed reality and gamification for cultural heritage. Springer, Cham, pp 567–589
- ETH-Bibliothek (2016) Best practices digitization (Version 1.1, 2016)
- Fast-Berglund Å, Gong L, Li D (2018) Testing and validating extended reality (xR) technologies in manufacturing. *Procedia Manuf* 25:31–38. <https://doi.org/10.1016/j.promfg.2018.06.054>
- Fernie K, Griffiths J, Archer P, Chandrinou K, de Polo A, Stevenson M, Lopez de Lacalle, O et al (2012) PATHS: personalising access to cultural heritage spaces. In: 2012 18th international conference on virtual systems and multimedia (VSMM). IEEE, pp 469–474
- Geijer A (1979) A history of textile art. Pasold Research Fund, p 141
- Gervás P, Díaz-Agudo B, Peinado F, Hervás R (2005) Story plot generation based on cbr. *Knowl Based Syst* 18(4):235–242
- Giannoulakis S, Tsapatsoulis N, Grammalidis N (2018) Metadata for intangible cultural heritage: the case of folk dances
- Giaretta D (2008) The CASPAR approach to digital preservation. *Int J Digit Curation* 2(1)
- Hall T, Ciolfi L, Fraser M, Benford S, Bowers J, Greenhalgh C, Hellstrom S, Izadi S, Schnadelbach H (2001) The visitor as virtual archaeologist: using mixed reality technology to enhance education and social interaction in the museum. In: Spencer S (ed) Proceedings of the VAST 2001 conference, Greece, Nov 2001. ACM Press, New York
- Hecht A (1989) The art of the loom. British Museum Publ
- Hughes CE, Stapleton CB, Hughes DE, Smith E (2005) Mixed reality in education, entertainment and training: an interdisciplinary approach. *IEEE Comput Graph Appl* 26(6):24–30
- IFLA/UNESCO (1999) Survey on digitisation and preservation. Emerald Group Publishing Limited
- Jennings H (2012) Towards a definition of heritage craft, creative & cultural skills
- Jung Y, Kuijper A, Fellner DW, Kipp M, Miksatko J, Gratch J, Thalmann D (2011a) Believable virtual characters in human-computer dialogs. *Eurographics (STARs) 2011*:75–100
- Jung Y, Kuijper A, Fellner D et al (2011) Believable virtual characters in human-computer dialogs. *Eurographics 2011—state of the art report*, pp 75–100
- Kalay Y, Kvan T, Affleck J (eds) (2007) New heritage: new media and cultural heritage. Routledge
- Kasnesis P, Kogias DG, Toumanidis L, Xevgenis MG, Patrikakis CZ, Giunta G, Calsi GL (2019) An IoE architecture for the preservation of the cultural heritage: the STORM use case. In: Harnessing the internet of everything (IoE) for accelerated innovation opportunities. IGI Global, pp 193–214
- Lagoze C, Hunter J (2006) The ABC ontology and model. *J Digit Inf* 2(2)



- Liarokapis F, White M (2005) Augmented reality techniques for museum environments. *Mediterranean J Comput Netw* 1(2):90–96
- Liu H, Singh P (2002) Makebelieve: using commonsense knowledge to generate stories. In: *Proceedings of AAAI/IAAI*, pp 957–958
- Mani I (2012) Computational modeling of narrative. *Synth Lect Hum Lang Technol* 5(3):142
- Margetis G, Papagiannakis G, Stephanidis C (2019) Realistic natural interaction with virtual statues in X-reality environments. *Int Arch Photogramm Remote Sens Spat Inf Sci* 42(2/W11)
- Markowitz S (1994) The distinction between art and craft. *J Aesthetic Educ* 28(1):55–70
- Metcalf B (1993) Replacing the myth of modernism. *American Craft*
- Milgram P, Kishino F (1994) A taxonomy of mixed reality visual displays. *IEICE Trans Inf Syst*. Special issue on Net- worked Reality E77-D (12):1321–1329
- Minerva Project Editorial Board (Minerva Project 2003–11). Last revision 2005-09-12. [www.minervaeurope.org/structure/nrg/documents/charterparma.htm](http://www.minervaeurope.org/structure/nrg/documents/charterparma.htm)
- Mulholland P, Collins T (2002) Using digital narratives to support the collaborative learning and exploration of cultural heritage. In: *Proceedings of 13th international workshop on database and expert systems applications*. IEEE, pp 527–531
- Neudecker C, Tzadok A (2010) User collaboration for improving access to historical texts. *Lib Q* 20(1)
- Pratikakis I, Savelonas MA, Mavridis P, Papaioannou G, Sfikas K, Arnaoutoglou F, Rieke-Zapp D (2018) Predictive digitisation of cultural heritage objects. *Multimed Tools Appl* 77(10):12991–13021
- Pujol L, Roussou M, Poulou S, Balet O, Vayanou M, Ioannidis Y (2012) Personalizing interactive digital storytelling in archaeological museums: the CHeSS project. In: *40th annual conference of computer applications and quantitative methods in archaeology*. Amsterdam University Press
- Pye D (1968) *The nature and art of workmanship*. Cambridge University Press, Cambridge
- Raimond Y, Abdallah S (2007) *The event ontology*. Technical report
- Riedl MO, Young RM (2010) Narrative planning: balancing plot and character. *J Artif Intell Res* 39(1):217–268
- Sánchez JA, Mühlberger G, Gatos B, Schofield P, Depuydt K, Davis RM, de Does J et al (2013) Transcriptorium: a European project on handwritten text recognition. In: *Proceedings of the 2013 ACM symposium on document engineering*. ACM, pp 227–228
- Scherp A, Franz T, Saathoff C, Staab S (2009) F—a model of events based on the foundational ontology DOLCE+DnS ultralight. In: *Proceedings of the fifth international conference on knowledge capture*. ACM, pp 137–144
- Scopigno R, Callieri M, Cignoni P, Corsini M, Dellepiane M, Ponchio F, Ranzuglia G (2011) 3D models for cultural heritage: beyond plain visualization. *Computer* 7:48–55
- Shaw R, Troncy R, Hardman L (2009) Lode: linking open descriptions of events. In: *The semantic web*. Springer, pp 153–167
- Singh P et al (2002) The public acquisition of commonsense knowledge. In: *Proceedings of AAAI spring symposium: acquiring (and Using) linguistic (and World) knowledge for information access*
- Stogner MB (2011) The Immersive cultural museum experience—creating context and story with new media technology. *Int J Incl Mus* 3(3)
- Swartout W, Traum D, Artstein R, Noren D, Debevec P, Bronnenkant K, Williams J, Leuski A, Narayanan S, Piepol D, Lane HC, Morie J, Aggarwal P, Liewer M, Chiang J-Y, Gerten J, Chu S, White K (2010) Virtual museum guides demonstration. In: *Proceedings of the 2010 IEEE spoken language technology workshop*. IEEE. <https://doi.org/10.1109/JPROC.2012.2236291>
- Tscheu F, Buhalis D (2016) Augmented reality at cultural heritage sites. In: *Information and communication technologies in tourism*. Springer, Cham, pp 607–619
- UNESCO (2003a) National Library of Australia. Guidelines for the preservation of digital heritage. CI.2003/WS/3
- UNESCO (2003b) Text of the convention for the safeguarding of the intangible cultural heritage

- UNESCO (2016) Digitization and online accessibility of cultural content and digital preservation, Latvia
- van den Akker C, van Erp M, Aroyo L, Segers R, Van der Meij L, Legêne S, Schreiber G (2012) Understanding objects in online museum collections by means of narratives. In: Proceedings of the third workshop on computational models of narrative (CMN'12)
- Vico L (2018). Authenticity and realism: virtual vs physical restoration. McDonald Institute
- Vossen P, Rigau G, Agirre E, Soroa A, Monachini M, Bartolini R (2010) KYOTO: an open platform for mining facts. In: Proceedings of the 6th workshop on ontologies and lexical resources, pp 1–10
- White M, Mourkoussis N, Darcy J, Petridis P, Liarokapis F, Lister PF, Walczak K, Wolciechowski R, Cellary W, Chmielewski J, Stawniak M, Wiza W, Patel M, Stevenson J, Manley J, Giorgini F, Sayd P, Gaspard F (2004) ARCO—an architecture for digitization, management and presentation of virtual exhibitions. In: Proceedings of the CGI' 2004 conference, Hersonissos, Crete, June 2004, Los Alamitos, California. IEEE Computer Society, pp 622–625
- Wolff A, Mulholland P, Collins T (2012) Storyspace: a story-driven approach for creating museum narratives. In: Proceedings of the 23rd ACM conference on hypertext and social media. ACM, pp 89–98