Representation of socio-historical context to support the authoring and presentation of multimodal narratives: The Mingei Online Platform

PARTARAKIS NIKOS, EFFIE KARUZAKI, VOULA DOULGERAKI, ILIA ADAMI, STAVROULA NTOA, FORTH-ICS, Foundation for Research and Technology Hellas - Institute of Computer Science, Greece

DANIELE METILLI, VALENTINA BARTALESI, CARLO MEGHINI, CNR-ISTI, Istituto di Scienza e Tecnologie della Informazione (ISTI), Consiglio Nazionale delle Ricerche (CNR), Italy

XENOPHON ZABULIS, FORTH-ICS, Foundation for Research and Technology Hellas - Institute of Computer Science, Greece

This paper presents an authoring platform for a semantic representation of cultural and socio-historic context encompassing a given, focal, topic of interest, such as a Heritage object, collection, site, or practice. This representation is employed in the contextualised presentation of the given topic, through documented narratives that support its explanation to diverse audiences.

CCS CONCEPTS • Insert your first CCS term here • Insert your second CCS term here • Insert your third CCS term here

Additional Keywords and Phrases: Semantic Web, Knowledge Representation, Narrative

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1 INTRODUCTION

Heritage can be thought of as a collection of essential elements, entrusted to succeeding generations for remembrance and preservation. The collection and care of heritage objects and sites is a universal practice of persons, families, and social groups to support their memory, transmit values, and hand-over wisdom. In the same context, HCs have a paramount cultural value and offer a thematic thesaurus of stories and narratives related to the origins of modern societies, history, culture, origins of industrial development and design, economic factors and societal outcomes, as well as, personal and family memories, all of which general audiences can relate to.

In the Mingei project[1], we focus on representing tangible and intangible content due to Heritage Crafts (HCs) [1]. Heritage Crafts 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, tradition, and identity of the communities in which they are, or were, practiced.

[1] http://www.mingei-project.eu/

The Mingei Online Platform (MOP) is an online system for the systematic representation of socio-historical context of collections and sites. The purpose is to: (1) Document, represent, and preserve tangible and intangible knowledge, (2) Contextualise the knowledge of of heritage, (3) Present the knowledge in new ways, (4) Explore and promote World Heritage and (5) Stimulate interest through educational and fascinating content, (5) Promote and enhance the documented information by establishing a linkage between MOP and other relevant publicly available Knowledge Bases such us Europeana[2].

The project has selected three pilots that cover tangible and intangible dimensions, span from handicraft to industrial craft, and have historical and societal significance. The three pilots are: (a) Glass, represented in the project by the Conservatoire national des arts et métiers (CNAM) in Paris, France; (b) Silk, represented by the Haus der Seidenkultur (HdS) in Krefeld, Germany; (c) Mastic, represented by the Chios Mastic Museum in Chios, Greece.

1.1 Definitions

A **narrative** is an abstraction that represents a set of facts that have happened in the real or in an imaginary world. In a narrative, these facts are connected to each other in a way that makes them a story. This story can be narrated in chronological order or in a particular order chosen by the narrator.

An **event** is something that occurs in space and time, including actions by individuals, by groups of persons. More formally, an event is a change of state in cultural, social or physical systems, brought by phenomena or influenced by other events [1]. We consider events to occur within a time interval delimited by time instants.

A **fabula** is a sequence of events that entertain a topic in a chronological order [20]. Historians create historical fabulae by studying primary or secondary sources.

A **narration** is the way that a certain narrator has told the story. There can be many narrations of the same story, focusing on different aspects of the fabula, or presenting events in different order. The encoding of the event sequence in the narration is called the plot of a narrative.

Presentations are alternative ways a narration can be presented. A narration is semantically linked to one or more presentations, which can be broken into one or more presentation segments. Each segment presents an event of the fabula using a fragment of a media object that can change based on the kind of user and on the channel through which the presentation is visualised.

Channels are the medium through which the information flows. For example, when we watch a movie, we are simultaneously receiving information from several channels: the video channel transmits the images to us, and the audio channel sends us the words of the actors and the music. However, in Mingei we consider the channel as a whole, without decomposing it in its subparts.

2 BACKGROUND AND RELATED WORK

2.1 From Aristotelian narratives to computational narratology and semantic narratives

An antecedent to the modern science of narratology could be found in Aristotle's Poetics (Kenny, 2013). Aristotle defines a narrative as an imitation of a real action that constitutes a logical argument. At the beginning of the 20th century, Russian formalists distinguished between the series of events that compose the story (fabula) and the particular way that story gets narrated (syuzhet). The work of Russian formalists is the basis for the development of narratology as a field of study.

In the context of this paper, we are particularly interested in studying narratology in a computational perspective. Humans can interpret the narrative by reading (or watching, or listening to) the narration and reconstructing the fabula in their minds. On the other hand, computers cannot do that because they lack the required understanding of the world. In order to allow computers to interpret narratives as humans do, narratology has been examined both as a computational problem and as a representation problem.

Computational narratology [2] 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,

[2] https://www.europeana.eu/en

spoken, or visual) presentation of a story typically based on a story grammar. Some of the early storytelling systems are TALE-SPIN [3], UNIVERSE [4], GESTER [5] and JOSEPH [6] which changes the story grammars to create new stories. Other storytelling systems are MINSTREL [7], MEXICA [8], and BRUTUS [9]. These are hybrid systems that implement a computer model of creativity in writing. Recently, ontologies were used to generate narratives. For example, MAKEBELIEVE [10] uses common sense knowledge, selected from the ontology of the OPEN MIND COMMONSENSE KNOWLEDGE BASE [11], to generate short stories from an initial one given by the user. PROTOPROPP [12] uses an ontology of explicitly relevant knowledge and the Case-Based Reasoning method over a defined set of tales. In FABULIST [13] 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 the narratives. 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 [18], Linking Open Descriptions of Events (LODE [14]) , the F-Model [15]. More general models for semantic data organization are CIDOC-CRM [17], the ABC Ontology [18], and the Europeana Data Model [16].

From a semantic representation point of view several projects and research works targeted the transmission of knowledge through semantic narratives. The PATHS [33] and CULTURA project [34] created interactive personalised tour guides to present digital library and cultural heritage collections respectively. In the same context, Storyspace system [35] allows the creation of curatorial narratives in a museum exhibition through events. Each digital object has a linked creation event in its associated heritage object story.

Regarding authoring of stories with new and existing content the CIPHER project [36] developed a set of tools to facilitate the development of meaningful stories allowing authors to establish semantic relations between different contents.

Regarding visualisation of narratives the DECHO framework for the acquisition, ontological representation and visualisation of knowledge [37] based on CIDOC CRM [1] displays narratives by linking together images or 3D representations of archaeological objects via semantic hotspots [38]. Another visualisation tool is provided by the CADMOS suite of applications [39] that adopts a computer-supported semantic annotation of narrative media objects (video, text, audio, etc.) and integrates with a large common sense ontology (YAGOSUMO). Additionally, The Labyrinth project is an ontology-based system for the visualisation of narratives [40]. In 2015, the Labyrinth system was extended with a three dimensional interface [41]. A similar project is Invisibilia, which is focused on the domain of contemporary public art [42]. Invisibilia takes as input an ontological representation, constructed using a CRM-based ontology for intangible art [43], and outputs a 3D layout featuring the artworks.

Several tools exist that allow the visualisation of data on a particular topic contained in existing knowledge bases (e.g.Wikidata, Freebase) in form of narratives. For example, Thinkbase and Thinkpedia [44] are two applications which produce visualisations of the semantic knowledge contained in Freebase and Wikipedia, respectively, allowing the user to explore the semantic graphs of the two knowledge bases in an accessible and interactive way. Histropedia[3] allows users to create or view timelines on topics of their choice by importing statements from Wikidata. Links to relevant Wikipedia articles and Wikimedia Commons images are automatically added, resulting in rich spatiotemporal visualisations. The scope of the project includes research, education, tourism and proprietary applications [45].

2.2 Knowledge representation for CH

Cultural Heritage is a domain where Semantic Web technologies are considered standard tools [54]. There is a significant history of pertinent approaches, since the pioneering work of Europeana, which triggered the model of CH with semantic technologies in 2007 [55]. In this, three phases of the adoption of semantic technologies in the CH sector can be distinguished:

During 2000-2010, projects relied mostly on existing approaches to knowledge classification, stemming from library and archival science. Existing work focused on catalogues and collections and the artefact descriptions, in approaches that were exclusively object- or collection-centric (MINERVA [57], Europeana Rhine [56], etc.). This required an immense data integration effort due to the heterogeneity of the source descriptions. The supported innovation was the semantic

[3] http://histropedia.com/

search, which allowed asking queries based on semantic categories, but in return produced a list of metadata that were not exploited adequately to deliver innovative applications.

During 2010-2015, focus shifted towards richer, event-centric representations, in response to the realization of the drawbacks and scarce utility of object-centric representations. The class Event is one of the basic classes that the Europeana Data Model [58] inherited from the CIDOC CRM [1]. This shift has not led to significant improvements because, at the time, building representations of events and connecting them to object-centric representations was very difficult. Events could not be found in institutional repositories, and extracting them from external sources such as Wikipedia or Freebase did not lead to significant results. In this respect, Europeana is a case in point: the class Event was not populated in the Danube release in 2011 [59].

Since 2015, significant changes have been observed. ICT has contributed to this change (1) by providing breakthroughs in knowledge extraction from texts (e.g. [60], [61]) and other media via deep learning methods and improved signal-processing techniques, (2) through scalable semantic systems based on solid implementations of Semantic Web standards and the evolution of Semantic Web technologies (e.g. [62]), and (3) by consolidating existing ontologies, notably the CIDOC-CRM, to provide higher expressivity and domain coverage. Furthermore, this was supported by the development of new representations of CH artefacts, based on new digitization techniques, able to exploit the above-mentioned technological advances [63].

2.3 Contribution of this work

MOP is developed in the context of the recent advancements on CH representation reported above. MOP uses a narrative-centric representation for describing CH artefacts. This representation is focused on the notion of narrative that exploits both semantic and structural aspects of a story. Using the semantic narratives created in MOP, computers can automatically interpret and query them in order to extract knowledge to show to the users. In particular, computers can explore the fabula of the narrative as a semantic network of events, and the entities that participated in them, and the fragments of the narration associated to the events (e.g. text, audio, video). In this paper, we provide a formal representation of narratives and we present the tools that are necessary to transform socio-historic contextual information into narratives. Furthermore, in order to validate or even enhance the generated narration, it exploits publicly documented resources from Europeana. The linkage with Europeana is bilateral in the sense that, the latter enables also the exposure of the information documented in MOP, in a Europeana-compliant schema.

The Web-based narrative authoring tool allows the user to create a narrative starting from the creation of the fabula that is related to one or more narrations and to digital assets that enrich the narrative. The tool is built on top of an ontology providing a vocabulary to represent the narrative and its components. The ontology harmonizes in a coherent vision the following reference ontologies: (a) the Narrative Ontology, based on an extension of the CIDOC-CRM [22][23] with narratological concepts, (b) FRBRoo, to represent the structure of the narration [REF], (c) the OWL Time ontology to represent temporal knowledge [27]. Furthermore, the implementation of the ontology is based on Semantic Web standards: (a) RDFS [REF] as basic data model for knowledge; (b) OWL [REF] for axiomatising the represented knowledge; (c) SPARQL [REF] as knowledge query language. The architecture of the MOP is based on open-source software implementing the standards at the basis of the ontology. In addition, we have designed the required mappings between our ontology and Europeana Data Model (EDM). This will allow “linking” particular instances of our ontology with Europeana resources, enabling therefore the validation as well as the enrichment of MOP resources, and the ingestion of the latter in Europeana.

Furthermore, the MOP includes a set of authoring tools for the creation of multimodal narratives.

3 THE PROPOSED APPROACH

Mingei aims to represent stories and tales about a place and its people, and the project is particularly focused on stories that are relevant to traditional crafts. The wide breadth and variability of stories that need to be represented call for a generic and systematic approach to the representation of real or imaginary stories. The proposed approach relies on narratological methods to represent stories.

We follow the work of a CH professional, i.e. a curator, during the conceptualisation of narratives about individual objects, object collections, or heritage sites. The curator studies primary or secondary sources that contain accounts or narrations of events relevant to the topic. Based on this study, the curator conceptualises a chronological representation and interrelation of the events, giving account of what happened in reality. Upon this representation the curator composes a narrative and its presentation. This presentation may be verbal like a story that a guide would recite, but may be also in other forms, such as an illustrated document, a Web page, a slide presentation, or a documentary video. The result of the curator's work includes the selection of the events that comprise the fabula, the definition of their causal or part-of relations and their temporal ordering.

Our proposal includes a system that facilitates the authoring of the fabula, as well as that of pertinent narratives and demonstrations. [SPECS (standards) that make it available in the community] The incentives of following this approach rather than the aforementioned conventional are multiple.

- Formal representation:
    - Preservation
    - Machine-interpretable advantages
    - Link to existing sources
    - Avail created sources
- Collaboration between professional and across institutions (academic research and repositories)
- Presentation: systematic
- Scalability and repositories:

The result of this digital curation process is conceptualised as the transduction of words, images, and multimedia into logical statements that define events, fabulae, and narratives. Since the original sources remain linked with the conceptual entities that represent events and stories that account for them, it is possible to arrive in a representation that is human-comprehensible and machine-interpretable.

To ensure that this process is relevant to the scientific discipline of the curator, we have designed the proposed system based on advanced user-based design methods that bring the pertinent actors in a key role in the design of the system.The workflow of the system is the product of this design process and is proposed as an iterative development circle [ref] sequence following phases: (a) collection of knowledge and basic knowledge representation, (b) representation of historical fabulae, and (c) authoring of narratives and presentations.

The proposed system, the MOP, enables and facilitates this process providing [good UI] and auxiliary tools to treat the heterogeneity of relevant media types involved.

3.1 Collection of knowledge and basic knowledge representation

3.1.1 Events

3.1.2 All the rest

MOP allows the collection of knowledge and, through an authoring environment, supports curators in the formal representation of knowledge about Persons, Regions, Enterprises, Places, Heritage Objects and related media objects, Digital documentation, Tools, Products, and Materials. In particular, the authoring environment facilitates the curators in transforming verbal and visual content to formal knowledge. In Figure 1 and Figure 2 we reported two examples regarding the collection of data to support the creation of a narrative about the history of textile weaving at Krefeld.

Figure 1: Collection and analysis of visual data relevant to textile weaving at Krefeld.

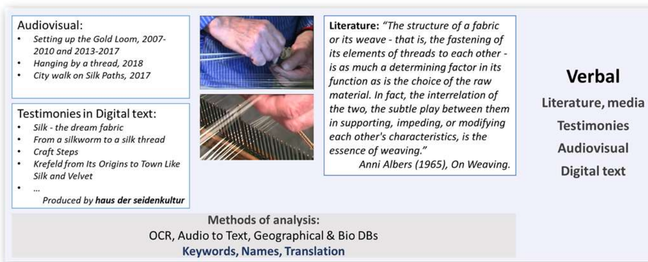
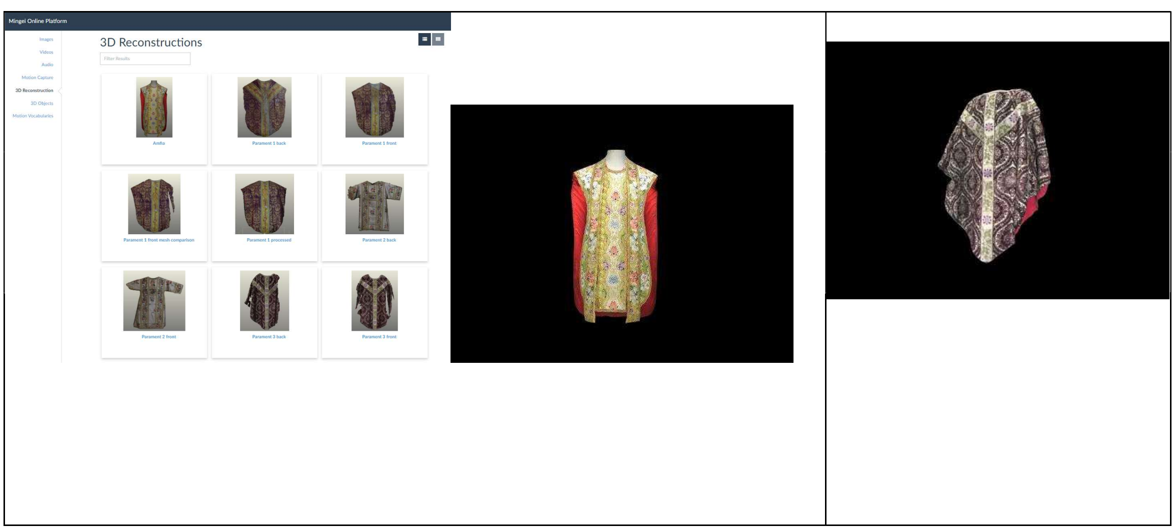


Figure 2: Collection and analysis of Verbal data relevant to textile weaving at Krefeld.

Furthermore, MOP allows integrating in the narrative the results of the use of digital media and digital capturing technologies including motion capture and 2D and 3D digitisation . Figure 3 shows an example of integration in the MOP of 3D reconstructions of ecclesiastical textiles produced in Krefeld.



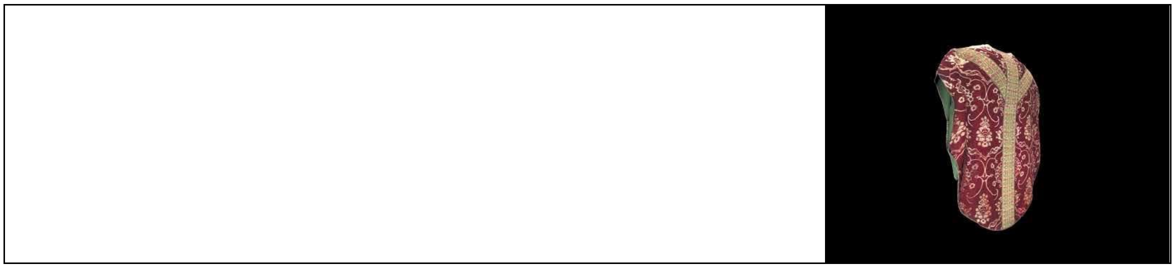


Figure 3: Integration of 3D digitizations in MOP.

Another functionality of the MOP is the semantic representation of events in the time-space continuum as shown in Figure 4. In terms of knowledge representation, the principal components of an event are: (a) Time, (b) Place and (c) Participants. MOP supports the connection of events through three kinds of relations:

1. A **mereological** relation, relating events to other events that include them as parts, e.g., the invention of the flying shuttle is part of the Industrial Revolution.
2. A **temporal occurrence** relation, associating each event with a time interval during which the event occurs. Relations between events are formalised using Allen’s temporal logic [19].
3. A **causal dependency** relation, relating events that in normal discourse are predicated to have a cause-effect relation in the author’s opinion, e.g., the Industrial Revolution resulted in a reduction of the number of weavers.

Moreover, MOP provides support to link these events to fragments of text, audio, video, etc. that contextualise them.

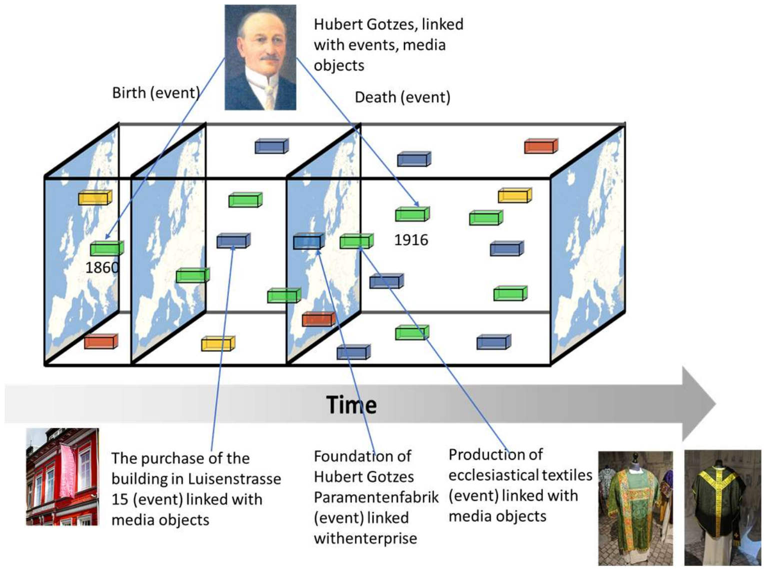


Figure 4: Time space representation of events and association with data

3.2 Representation of Context and formulation of fabulae

The next step of the process implemented by MOP is the organisation of events into fabulae, presenting the temporal sequence of events that are the backbone of a story. To this end, MOP facilitates the creation of context representations through links between events and their components. Computer-aided representation of context is provided through an **authoring environment** that serves as a **conceptual interface** to the knowledge base. Through this authoring environment, **basic knowledge elements are transformed into fabulae which are series of events** that entertain a contextual topic in a chronological form as schematically shown in Figure 5.

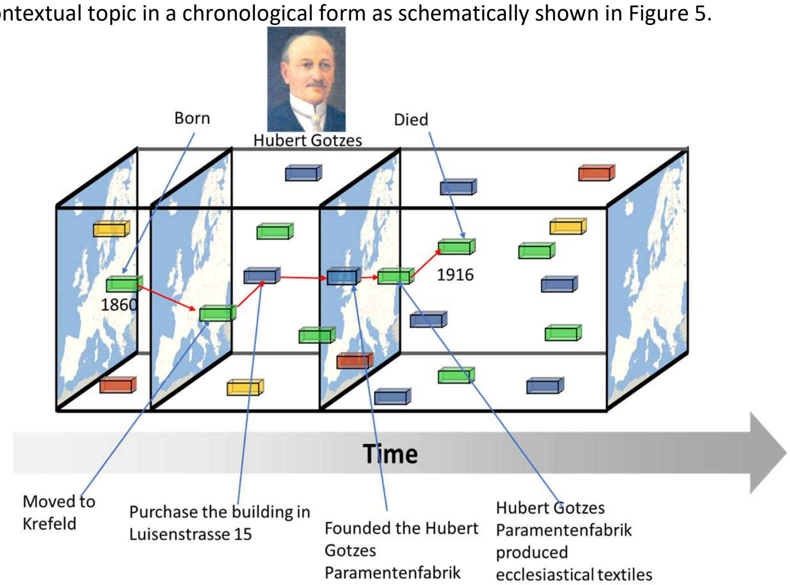


Figure 5: Representation (simplified) of a fabula

3.3 Authoring Narratives and Presentations

For narratives, MOP provides a method that allows curators to transform the collected knowledge into **narratives**. To this end, MOP uses the term narration and **narrator** who is an actor that presents a narrative. In this context, **textual, audio,** and **visual media objects and channels** are of fundamental importance. A textual media object can be exported as a narrative for a person or an avatar to read, or may be exported as a formatted document with illustrations. A narrative consists of three main elements: (1) A reference to the representation of a **fabula**, (2) One or more **media objects** and (3) a **reference function** that associates events of a story with a fragment of a media object that describes them and allows deriving the plot. The "**presentation**" components define the way, in which narratives are "narrated" in "narrations" by "narrators" (see figure 6).

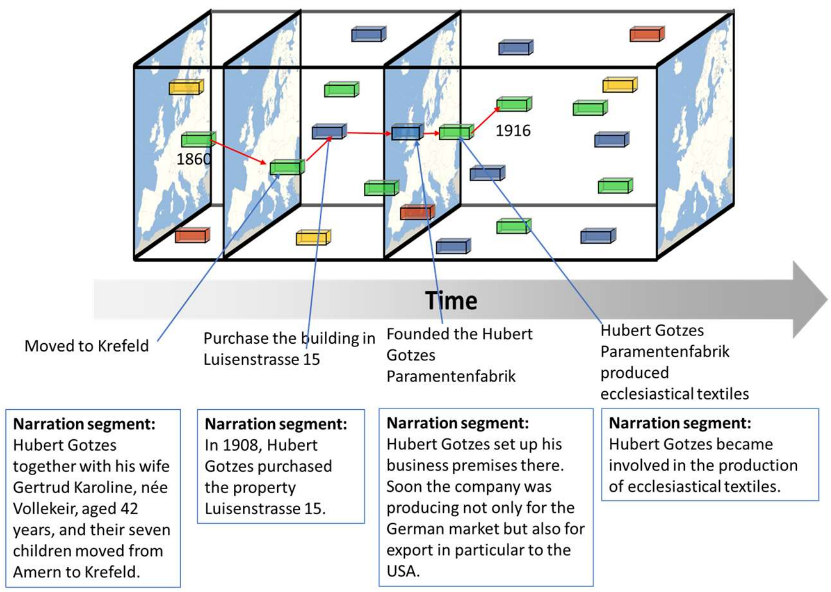


Figure 6: Narration (simplified) in text of the "The story of Hubert Gotzes' company"

It is important to note that narrations are device independent. They essentially follow a plot to present the story of the fabula. However, they can be presented differently depending on the destination platform and the end-user profile (personalization). That makes presentations dependent on the channel and the kind of user.

4 IMPLEMENTATION

4.1 Design principles

The MOP implementation has adopted the best practices of the User-Centred Design (UCD) process (ISO 9241-210:2010) [6]. Using this methodology, all relevant stakeholder groups participate in all phases, including staff from CH organizations as well as representatives of the stakeholder groups. UCD is an iterative design process for interactive applications, systems, and products. Its main characteristic is that it places the end-users and other identified stakeholders' needs at the centre of each design and development phase of the system (tool, application, or product). The main goal of this process is to ensure that the resulting system meets the user's needs, supports his/her goals and objectives, and it satisfies the main parameters of usability: ease of use, learnability, effectiveness, efficiency, and satisfaction. There are four main stages in the UCD process: 1. Understand and specify context of use, 2. Specify requirements, 3. Design solutions, and 4. Evaluate solutions, which will be described in the next paragraphs.

The UCD approach is empowered by co-creation and co-creation activities results are considered during the implementation of the four main stages. Figure 7 depicts the four stages of the UCD method in relation to the co-creation strategy. Central to the UCD method is the iterative design process which allows the development and design team to return at any point to any of the previous stages and repeat any of the activities included in that stage, when needed. There can be as many design iterations as needed until the desired result is reached.

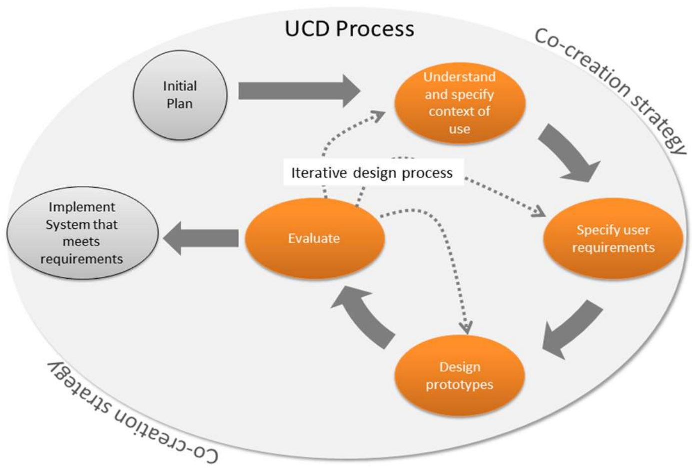


Figure 7: UCD Process in relation to the Co-creation strategy.

The design process of MOP components has gone through **three design iterations**. Design techniques used in these iterations included implementing minor improvements on the working version (based on agile development approach) and production of high-fidelity prototypes for targeted UI improvements when needed. Evaluation techniques used were 'beta' testing and expert-based evaluations in the form of cognitive walkthroughs and heuristics analysis.

In the **first design iteration**, the initial UIs of the authoring component were implemented using the UI design and development toolkit of ResearchSpace. This resulted in the initial functional version of the MOP authoring components, which were released for actual use to Mingei Consortium partners for the authoring of basic knowledge elements. Feedback from the actual use of the MOP components ('beta testing') was collected and used to improve the original version of the components. Feedback concerned general UI problems encountered, missing functionality, functionality that was not understood, and misinterpretations of components in the Web forms used for the authoring of the new knowledge elements. Improvements based on the feedback were implemented directly on the MOP. No prototypes were produced as the improvements involved minor changes and bug fixes.

In the **second iteration**, the improved version went through a thorough expert-based inspection by two Human-Computer Interaction (HCI) usability and interaction design experts. The evaluators used the cognitive walkthrough and the heuristics analysis inspection methods taking into account traditional usability evaluation guidelines, such as Nielsen's heuristics [51], to identify potential usability problems in the application. A report of the identified problems and suggested solutions was produced from this inspection. In addition, **high-fidelity design prototypes were designed and provided for each of the suggested solutions** to allow the development team to visualize the suggested changes, make adjustments, and study their impact, before implementing any costly changes in the working version of MOP. High fidelity UI mock-ups were produced using the free online design and prototyping tool Figma [52], as shown in Figure 8.

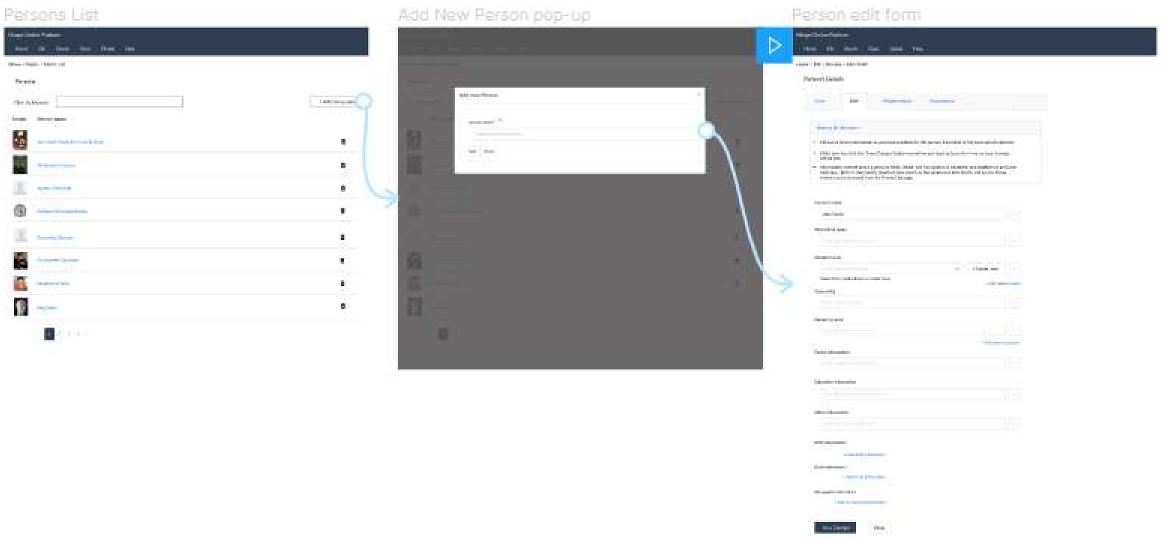


Figure 8: High fidelity functional design mock-ups depicting suggested workflow adjustment for adding a new element. Example shown for adding a new person

In the **third iteration**, the suggested improvements from the previous iteration were implemented leading to the release of the third functional version of the MOP authoring components. The improved UI elements are currently in the process of being re-evaluated by the three heritage partners to validate the implemented improvements. The following design iteration were conducted:

1. Production of MOP UIs using the ResearchSpace design toolkit and the defined requirements for these authoring components. First version release.
    1) Feedback from 'beta testing' by Consortium heritage partners.
2. Release of second version
    1) Expert-based usability inspection by two HCI usability and interaction design experts
    2) Design of high-fidelity prototypes for suggested improvements
3. Release of third version

4.2 Conceptual architecture

At a conceptual level, the MOP adopts three knowledge representation steps, each one contributing to the creation of narratives on CH in accordance with the proposed approach as presented in Section 3.

The first step regards the collection of knowledge and, through an authoring environment, supports curators in the formal representation of knowledge about Persons, Regions, Enterprises, Places, Heritage Objects and related media objects, Digital documentation, Tools, Products, and Materials.

The second step regards the semantic representation of events in the time-space continuum. Events are basic elements of stories in general and, in particular, of the type of "stories" we wish to capture in our craft representation.

The third step concerns the organisation of events into fabulae, presenting the temporal sequence of events that are the backbone of a story. To this end, MOP facilitates the creation of context representations through links between events and their components.

In the following, we describe the three components that implement the three knowledge representation steps in MOP. These steps are implemented in MOP on top of ResearchSpace (RS) [49] [50], a cultural heritage research platform, which provides an integrated environment for contextual data and tools designed to reflect research methods. RS is a British Museum project, funded by the Andrew W. Mellon Foundation that uses Semantic Web technologies to support cultural heritage research. "The emphasis is on a representation of information that integrates, preserves multiple perspectives, and promotes collaborative research. The long term goal of ResearchSpace is to build a community of researchers that open and share their data, knowledge, research practices, and arguments with each other." [REF]

Authoring knowledge elements. The primary objective of the MOP component responsible for authoring knowledge elements is to promote collaborative interdisciplinary authoring of knowledge that relates to and reveals different aspects of CH. Using the authoring components of the platform, CH professionals (i.e. curators, museum professionals, researchers, academics, etc.) can author knowledge elements related to the craft. This component also allows defining events according to the Mingei ontology. Each event is linked to its components and to other events using semantic relationships.

Authoring fabulae. Another component of the MOP allows the creation of fabulae composed of events. Each fabula is linked through semantic relations with the events that compose it.

Authoring narratives. The authoring of narratives in MOP is supported by similar workflows as the ones for authoring events and fabulae. The narrative authoring component allows a heritage professional (i.e., curator, craft researcher, etc.) to create a story using the knowledge collected in the Mingei repository. Furthermore, recognising the diversity of target audiences and presentation technologies used in the project, this component supports the creation of different narration styles. This means that the user can "narrate" the same story in multiple ways according to the context of use.

The conceptual relationships between the fabula, the narration(s) and the presentation(s) are illustrated in Figure 9. Each narration can be communicated through presentations that are made of presentation segments. These segments are the building blocks that, when put together, tell the plot of the narrative. Presentation segments can refer to a media object such as text, image, video, 3D motion capture, etc. and also provide information regarding what to do with that media object, i.e. when to play it (start/end point) and where to play it (channel). They can also be combined if they are on different channels in order to offer a richer end-user experience – for example, to demonstrate a craftsman's move, a virtual avatar (motion capture) can be played together with a video, a text (as subtitles or side-explanations) and one or more audio files (music, sound effects).

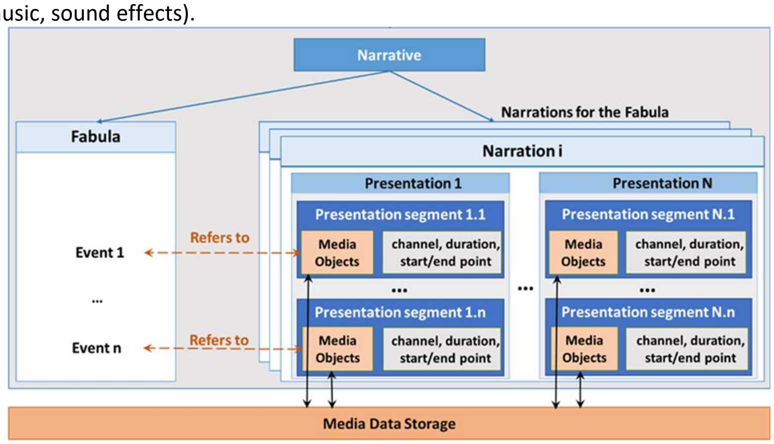


Figure 9: The structure of the narrative and storytelling authoring tools.

4.3 Technical implementation details

4.3.1 Mappings to Europeana Data Model (EDM)

The overall aim of Europeana Data Model (EDM) is to bridge the gap among the various cultural heritage resources that exist worldwide and have been stored and maintained with respect to different metadata standards. In order to make

Mingei ontology compliant with EDM, we have developed the required mappings for aligning particular class instances between the two schemata. Despite the rich structure of classes and properties of the Mingei Ontology, we have created the mappings for a particular subset of these resources. Some resources were not mapped to EDM, mainly because their scope was outside the scope covered from EDM. The following table shows some indicative mappings for classes and properties between the two schemata. The full list of mappings is given in the appendix of the paper. As depicted in the table below, there are certain paths in Mingei ontology that are mapped to a particular in EDM. This happens because of the event-centric philosophy of Mingei Ontology, compared to the simple and more fine-grained metadata of EDM.

Mingei Ontology	EDM
cro:MObject	edm:WebResource
cro:hasMOType à cro:MOType	ebucore:hasMimeType
crm:P94i_was_created_by à crm:E65_Creation à crm:P14_carried_out_by à crm:E39_Actor	dc:creator
cro:Narrative	edm:ProvidedCHO
crm:P3_has_note	dc:description
cro:has_action	edm:isNextInSequence
crm:P129_is_about	dc:subject

4.3.2 User interface

Taking into account the implementation platform, the entire front-end was implemented using the ResearchSpace toolkit, which provides HTML5 components for structuring Web authoring forms, template pages, navigation menus, content panels, and other interaction and presentation elements (i.e., buttons, searches, drop-downs, table grids, etc.). It also provides additional presentation features such as, interactive maps for displaying locations related to various knowledge elements, a timeline component, which displays chronologically ordered events in a graphical format, various image gallery components, etc. The RS toolkit allowed the implementation team to follow a rapid prototyping approach for producing prototypes in the first design iteration, as the Web pages were initially implemented based on the provided components of the RS. However, targeted design prototypes were produced thereafter, to visualize suggested design solutions and improvements stemming from the results of the design iterations.

The Mingei Ontology [29] is used as the knowledge representation system of the RS instance used in MOP. The ontology is an application ontology [21] obtained by integrating several existing ontologies, notably: (a) the Narrative Ontology, a domain ontology focused on the representation of narratives [24][25] that is an extension of the CIDOC-CRM standard vocabulary [22][23], (b) FRBRoo, a domain ontology for bibliographic records, resulting from the harmonization of FRBR with CRM [26], (c) OWL Time, a domain ontology recommended by W3C for the representation of time [27]; and (d) Dublin Core for simple resource description [28].

For example, using the RS framework, a representation of a particular person can be typed according to the ontology model as, for example, being of type E21 Person (http://www.cidoc-crm.org/cidoc-crm/e21_Person). Templates have been created to define generic views which are being automatically applied to entire sets of instances, for example, to all instances of type E21 Person.

Furthermore, MOP consists of a large number of application pages. These are pages that are not associated with any entity in the knowledge graph. An application page will not be rendered according to some automatically inherited templates, but rather using static markup which will be parameterized dynamically. For application pages, HTML5 semantic components are used, which are custom HTML5 Web Components which operate on the result of SPARQL queries being executed over the knowledge graph. HTML5 Web Components allow formatting and structuring the content of application pages and templates providing functionality that goes beyond what native HTML markup elements support (e.g. tabs, grid elements). MOP implements application pages using a variety of HTML5 Web Components.

4.3.3 Semantic forms

Authoring forms for knowledge graphs is done by the semantic form component that the RS framework provides. This component is configured as follows. The field definitions are used to instruct the form how to read and update values within the graph. A field definition has some main attributes (id, label, domain, range, insertPattern, selectPattern, deletePattern, etc). Field definitions are being defined on an abstract level. All field definitions have an RDF representation and can be stored in the database (Field Definition Catalog). RS framework uses backend template functions for reading the definitions from the database.

Furthermore, a semantic form receives data through input elements. Forms and input elements are instantiated using HTML Components including references to the field definitions.

4.3.4 Data storage & repository platform

The MOP uses GraphDB for data storage [REF]. GraphDB is an enterprise Semantic Graph Database, compliant with W3C Standards. Semantic graph databases (also called RDF triple stores) provide the core infrastructure for solutions where modelling agility, data integration, relationship exploration and cross-enterprise data publishing and consumption are important. GraphDB is a family of highly efficient, robust and scalable RDF databases. It streamlines the load and use of linked data cloud datasets. GraphDB implements the RDF4J framework interfaces, the W3C SPARQL Protocol specification, and supports all RDF serialization formats.

GraphDB is the preferred choice in MOP because of its community and commercial support, as well as excellent enterprise features such as cluster support and integration with external high-performance search applications. Furthermore, GraphDB supports semantic inferencing at scale, allowing MOP users to derive new semantic facts from existing facts. It handles massive loads, queries, and inferencing in real time. Finally GraphDB is used in MOP to provide a SPARQL end-point for end users and applications that wish to directly access the knowledge base, connect and extract data

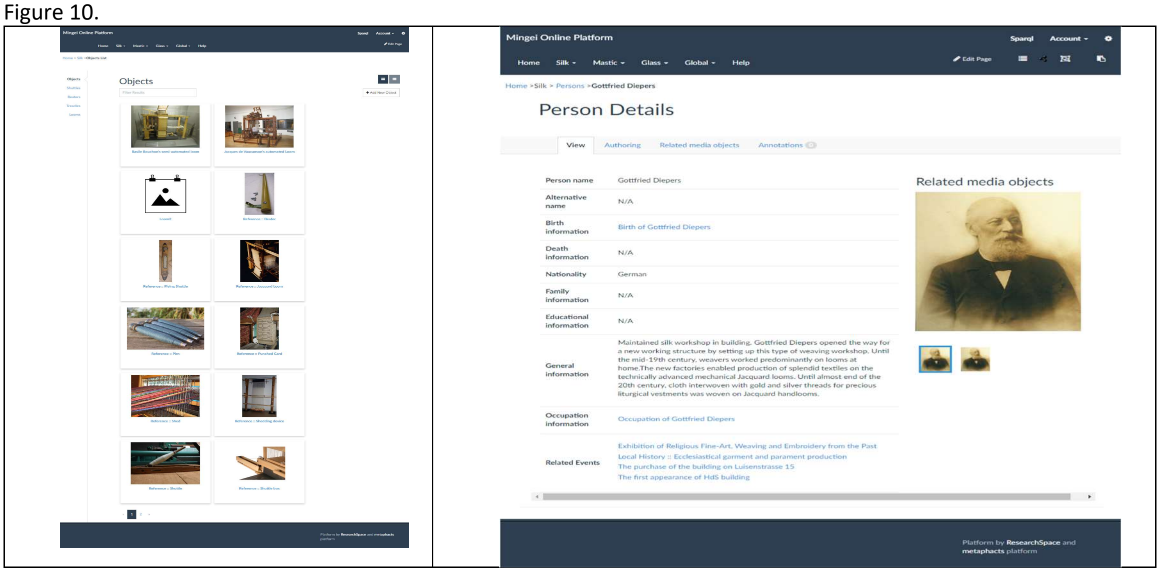
MOP uses a flexible, modular, open source repository platform with native linked data support by integrating a Fedora platform based Web storage. Fedora is a robust, modular, open source repository system for the management and dissemination of digital content. It is especially suited for digital libraries and archives, both for access and preservation. It is also used to provide specialized access to very large and complex digital collections of historic and cultural materials as well as scientific data. Fedora has a worldwide installed user base that includes academic and cultural heritage organizations, universities, research institutions, university libraries, national libraries, and government agencies [53]. Fedora was selected for a variety of reasons. The most important is that it allows MOP to distinguish between the asset storage, the triple storage and the UI, and thus offering end-points for the asset storage and a SPARQL endpoint via GraphDB.

5 USE CASE

In this section, the experiment of creating a narrative is presented to demonstrate the usage of MOP. A narrative from the Silk pilot is selected. The authoring workflow is as follows. First, the **basic knowledge elements contributing to the narrative are collected**. Then, the **main events** that will be eventually narrated are **authored** and subsequently are **organized into a fabula**. Based on the formulated fabula, **a narrative is established** to act as a container for alternative narrations. **Narrations are authored**, using the represented knowledge and digital assets. Finally, **a presentation** that **determines how a narration will be presented** on a specific channel and for a particular audience is created and the presentation is made available through a Web page.

5.1 Basic knowledge elements

Basic knowledge elements comprise of basic statements that annotate or explain the role and significance of the acquired digital assets. These elements include any existing curated information or description about the asset. Most importantly they are to contain curated annotations and descriptions of the relevance of the item to the craft. At this stage, knowledge statements forming the descriptions of the individual entities involved in narrative are formed, mostly manually, by the knowledge curators. The involved entities are objects, actors, actions, concepts, tools, places, and media objects (texts, audio-visual objects, images, audio messages, and the like) that document various steps of the craft process. Examples of the use of the platform for authoring documentation for an artefact and person are provided in Figure 10.



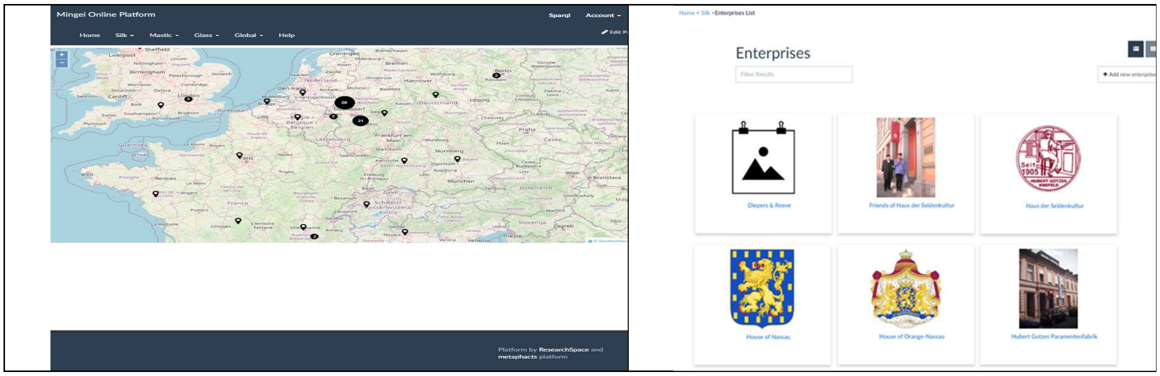
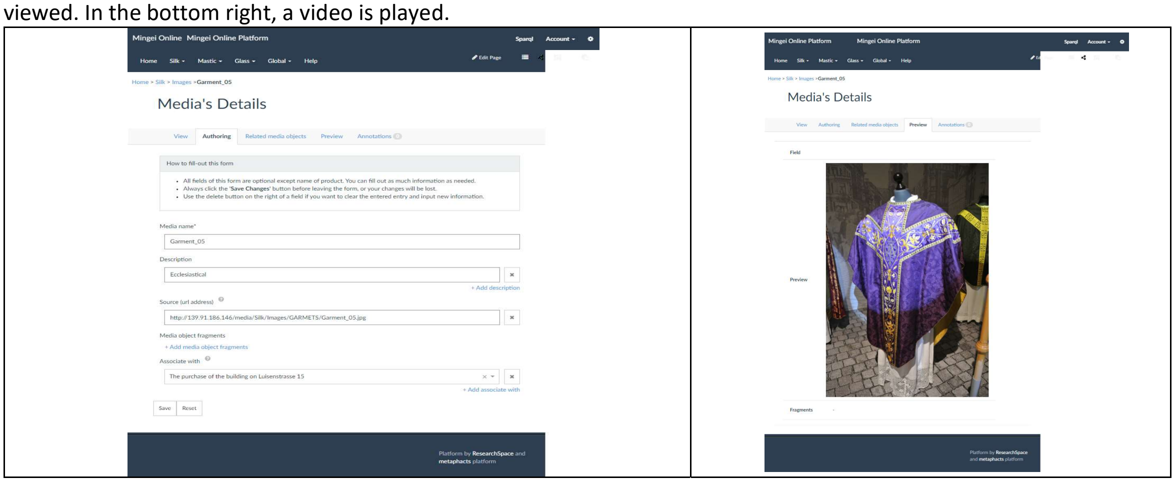


Figure 10: Examples of the use of the platform (basic knowledge elements demonstration available at: https://youtu.be/7g10-a_2ky0)

Multimedia file management is supported through facilities that allows inserting, editing, and deleting media objects. Media objects are classified in seven categories: Images, Videos, Audio files, Motion Captures, 3D reconstructions, 3D objects and Motion Vocabularies. Media files can be linked to MOP from any valid URL. We have set up a media storage server to host new media files created in the project, or legacy files not in online repositories (see 5.2.5 Repository platform). In addition, we replicate some of the online assets, to avoid relying on third parties about the media availability. Each media object has a name, a description, an image, a source file and one or multiple media object fragments. Media object fragments are continuous subsets of media objects, e.g. a snippet of text, audio or video, an image region, etc. The source file of the media object is referenced by a URL that contains the location of the respective media object on the Web. The media preview tab contains the appropriate media player for the media type previewed; a video player previews videos, 3D render visualizes 3D reconstructions, etc. The "players" facilitate interaction and exploration with the digital asset, such as playing the video, or rotating the 3D object. This is demonstrated in Figure 11. In the top left, shown is the authoring tab. In the top right, an image is previewed. In the bottom left, a 3D model is viewed. In the bottom right, a video is played.



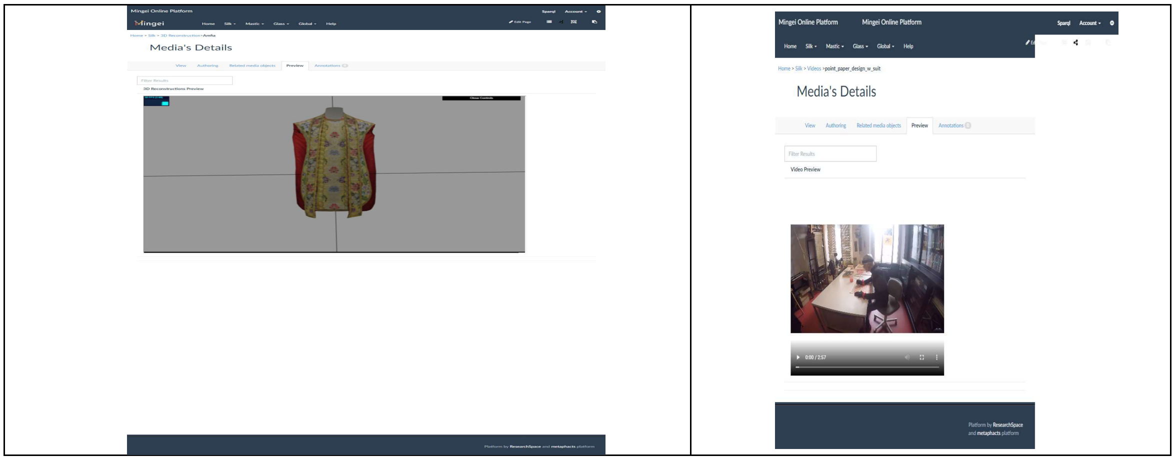


Figure 11: Media objects authoring

Each media object can be associated with events, fabulae, and other semantic elements of the narrative. This association links media objects that annotate these elements. These annotations are quite useful for visualization and presentation purposes, providing a better overview of the data. Including preview simplifies the establishment of references to media objects.

5.2 Authoring events & fabulae

MOP provides an interface to create the events of the narrative. This interface is shown in Figure 12, left. The process of creation of the events is iterative and new events can be added at any stage of narrative development. This approach enables curators to iteratively re-evaluate the knowledge required for the formulation of their narrative.

After creating the events, the curator can define the fabula of the narrative. The fabula authoring page is structured as follows. Initially the curator is requested to provide a title and a description for the new fabula. The fabula is created and the curator selects it from the fabulae menu to access the authoring tool (Figure 7 right). The curator proceeds to add events using the drop-down fields. Finally, the curator saves the data and a corresponding SPARQL query is executed to add the new fabula to the Mingei knowledge base.

5.3 Authoring a narrative

After creating the fabula, the curator can author a narrative and link a set of narrations that tell the story of the corresponding fabula. In the narrative form, they can provide a description, image(s), media objects and the fabula of the narrative. Figure 13 shows the narrative of "History of Krefeld Silk Industry". The curator can also create and add new narrations to the narrative within the narrative authoring form. This is possible by using the combo box, shown at the bottom of Figure 13. More specifically, they can author the narration name and the description, while they can also add existing presentation segments to the narrations. The fields that lie within the combo box affect the narration, while the fields outside the combo box affect the narrative.

5.4 Authoring a presentation

Once the curator has created a narrative and linked it to its narration, he/she can create a presentation based on this narration. This process starts by authoring the presentation details within the "Authoring" tab (see Figure 14, left). The curator can add any number of presentation segments and link them directly to the presentation he/she is authoring. Figure 14 (right) shows an example presentation segment that we created for the "Krefeld textile history presentation".

MOP automatically creates a Web page for each presentation of a narrative. In the example, we show one narration, titled "The Krefeld textile industry", which is linked to a narrative about the "History of Krefeld Silk Industry". The Web page is created by performing SPARQL queries to fetch and display the collected data. The result of the page is displayed in Figure 14, right. On the left the whole Webpage is displayed. On the right a page fragment is displayed.

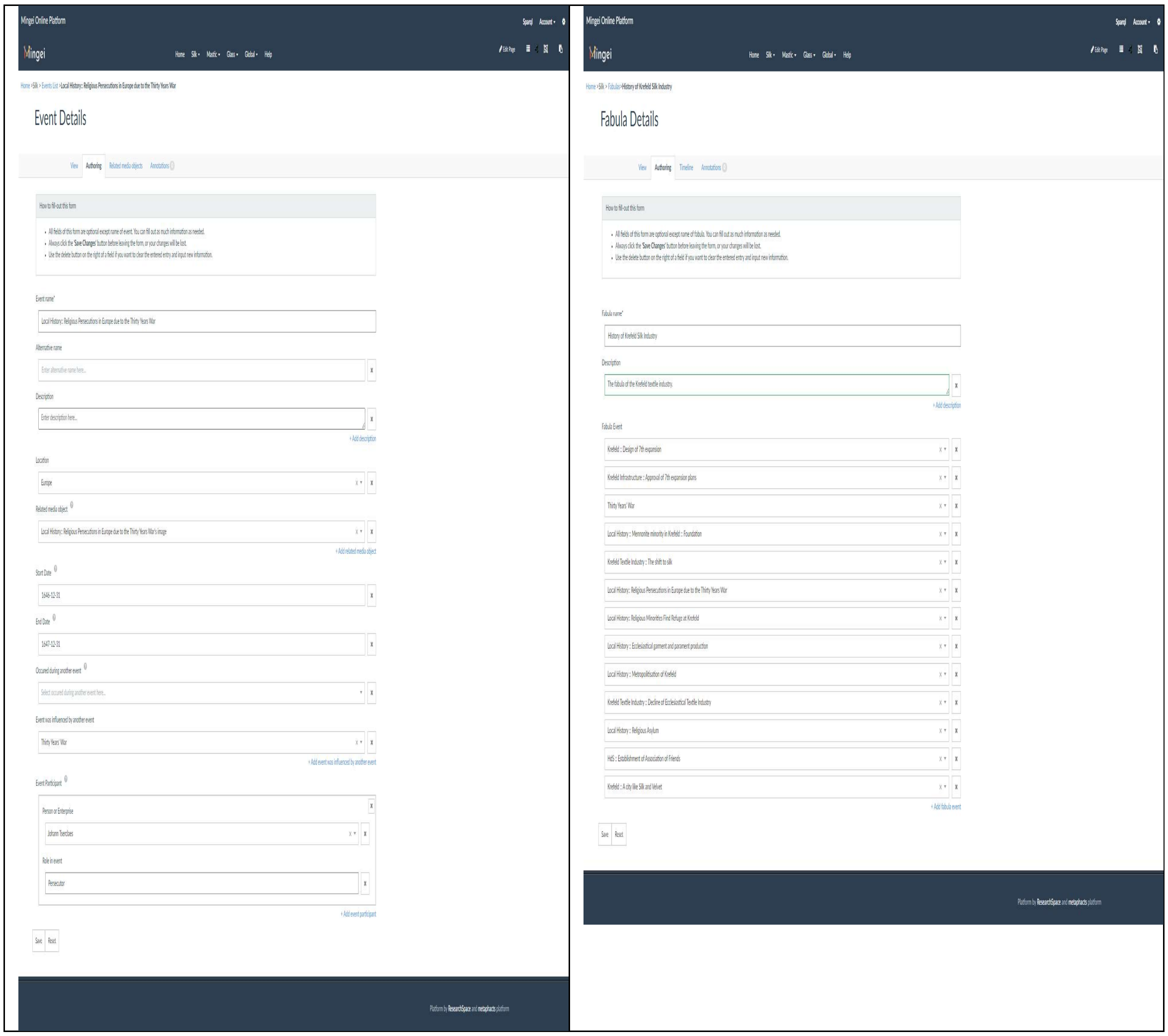


Figure 12: (left) Authoring an Event - The Thirty Years' War, (right) Authoring the fabula regarding the Krefeld textile industry.

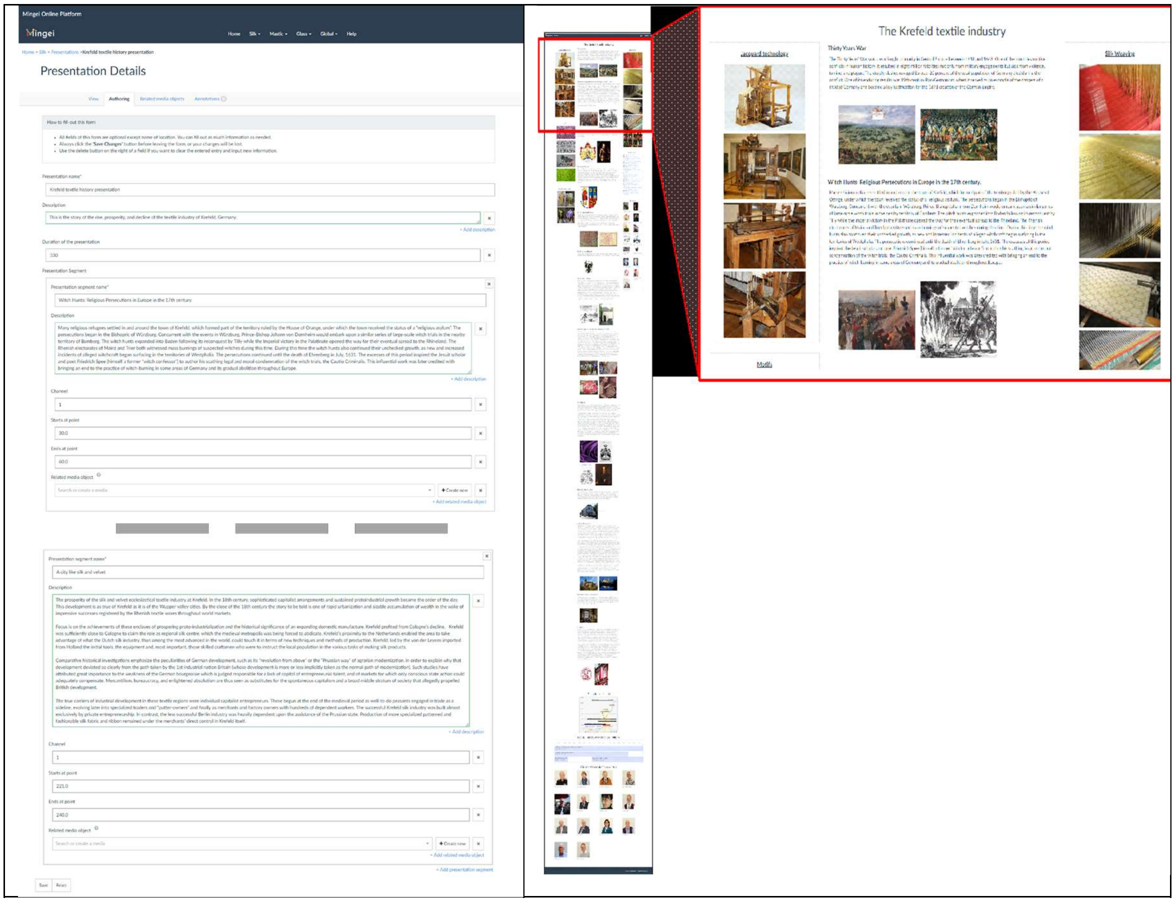


Figure 14: (left) Authoring a presentation for the Krefeld textile industry, (right) The Krefeld narrative presentation Webpage (Web-based narrative demonstration available at: https://youtu.be/zENuV_1KCxk)

6 CONCLUSIONS & FUTURE WORK

In this paper, the Mingei approach towards narrative authoring was presented with the objective to help curators compose digital narratives and end-users to understand and appreciate their content. To this end, a description of the MOP implementation and authoring tools were provided, followed by a step-by-step demonstration regarding how the "Textile weaving at Krefeld" narrative was created. It is envisioned that these tools will be utilized by curators and end-users to create narratives and to present them to various audiences in different ways, and to inspire people from all over the world to become familiar with – and appreciate – CH.

Regarding future amendments, narrative authoring tools will be extended and exhaustively tested in the context of the formulation of the Mingei pilots. This process will involve the implementation of context presentations for various devices, including desktop and mobiles, also exploring alternative interaction modalities. Finally, the MOP functionalities will be further enhanced to support narrative personalization based on user profile information, preferences and technological platform.

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