

## MESCH: INTERNET OF THINGS AND CULTURAL HERITAGE

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### Abstract

This paper summarises the work carried out in the EU project meSch and presented at the 2<sup>nd</sup> Digital Heritage Expo held in Granada in 2015. meSch, Material EncounterS with digital Cultural Heritage, bridges the gap between visitors' cultural heritage experience on-site and on-line by providing a platform for the creation of tangible smart exhibits, that will enable heritage professionals to compose and realise physical artefacts enriched by digital content without the need for specialised technical knowledge. The platform includes an authoring toolkit for the composition of physical/digital narratives that map on interactive artefacts, and an embedded multi-sensor digital system platform for the construction of ad-hoc physical smart exhibits.

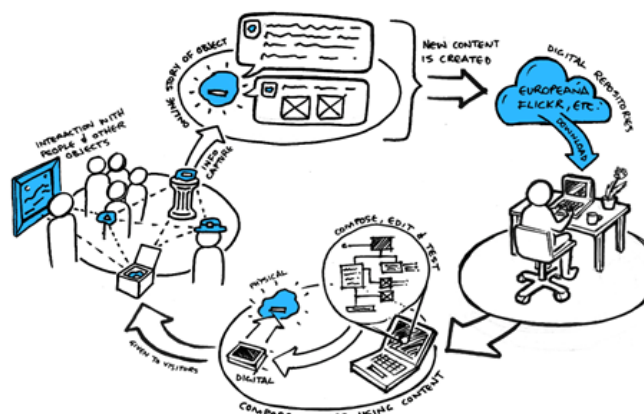
### Keywords

Internet of Things, tangible interaction, do-it-yourself, digital content.

### 1. Concept

The Internet of Things is a concept by which physical objects use embedded digital technology to connect to one another and the Internet in the same way as Web pages. The Internet of Things offers an opportunity for innovation in cultural heritage by taking advantage of the visitors' physical experience and integrating technology within it instead of creating a parallel and detached digital experience. The physical experience of the heritage can then be enriched with digital content delivered in place in a way that is unique for that particular visitor. The vision we seek in the meSch (Petrelli, Ciolfi, van Dijk, Hornecker, Not, & Schmidt, 2013) project is of a cultural space with smart objects, each with their own digital content embedded therein, which will be revealed if and when conditions are right, e.g. visitors have reached the right time in the storyline, or a group of them is acting in a certain way, or another smart object is close by. To fully achieve this goal and make smart tangible objects sustainable for heritage institutions, cultural heritage professionals need simple tools

to conceive, design and make as well as maintain interactive artefacts. meSch aims to create such a hardware and software platform that enables users to create tangible and physical experiences that best convey the value of the heritage institutions to their visitors.



**Fig. 1:** The creation of adaptive smart objects – the digital content, their form and interactive behaviour; their use in place by the visitors; the connection of material collections and online presence.

Fig. 1 illustrates the stages envisaged: (clockwise from right) (1) the author (a cultural heritage professional) retrieves digital content; (2) snippets of content are organized in a network, each node controlled by a context-of-use condition, and then downloaded into one or more smart objects; (3) smart objects interact with each other, the visitors, and the environment to deliver personalized content in context; (4) the smart objects have an online shadow that logs the visit for further use such as connecting with online heritage repositories or simply to social media or, from the curator’s side, analysing the visiting patterns to improve the exhibition. By shifting the focus from the audience to the curators meSch aims at fostering creativity and facilitating the creation of novel ways of using and communicating heritage.

The technology developed within meSch offers cultural heritage professionals new possibilities and hands-on tools to independently and relatively affordably, create unique experiences that cannot be created in any other way. Some examples of interactive experiences developed and tested so far in meSch are in Fig. 2: (a) a loupe that enables visitors to reveal content about an object; (b) a set of interactive cases that record the interest of visitors and enable the

curator to swap the least interesting for a new one; and (c) a set of narratives in place that sound-augment the remains of an archaeological site. These prototypes are discussed (Petrelli, Not, Damala, van Dijk, & Lechner, 2014) while two recent exhibitions and the process we followed to design can be found in (Petrelli, Dulakke, Marshall, Kockelkorn, & Pisetti, 2016). Further examples can be found on the project website ([www.mesch-project.eu](http://www.mesch-project.eu)), specifically:

- the Atlantikwall exhibiton at MUSEON was discussed in a series of blogs, e.g. <http://mesch-project.eu/presenting-the-hidden-layers-of-an-exhibition/> a video is at <https://www.youtube.com/watch?v=sK3AdQU9kkc>
- four multimedia and tangible installations in the artillery gallery at the Museo Storico Italiano della Guerra in Italy <http://mesch-project.eu/voices-from-fort-pozzacchio/> <https://www.youtube.com/watch?v=1qucGK9BlcI>
- the prototype in Fig. 2c is discussed in <http://www.mesch-project.eu/going-to-the-trenches-with-mesch-technology/> and a video recorded during user evaluation is in <https://www.youtube.com/watch?v=hLORDVpivhM>



Fig 2a: The Loupe uses augmented reality to reveal multiple layers of content to an exploring visitor.



Fig 2b: Objects from the museum deposit compete for the visitors’ attention; the least interesting is changed for a new one



**Fig. 2c:** An archaeological site (the remains of WWI trenches) is augmented by narratives and stories told in the place where they are relevant.

### 1.1 Approach

All the meSch interactives have been co-designed by multidisciplinary teams that included technologists and computer scientists, designers and museums, and have been tested in real settings with potential users. Three factors were fundamental in this process:

- **Tangible Interaction:** it is essential to design physical interactions that embed digital technology, sensors and actuators in such a way that the object, the device or the space react to visitors' behaviour in meaningful ways. At visiting time, digital content is progressively discovered and experienced by the visitors in the context in which it is relevant. As such tangible interaction can bring visitors closer to heritage (Dudley, 2010).
- **Personalization:** visitors enjoy different things (Falk, 2009) thus it is worth offering different things. Personalization can occur at two levels: personalization of content, when the author has prepared different stories for different audiences; and personalization in context, when the system dynamically decides which snippet of content is best for the current situation.
- **Do-It-Yourself:** to enable cultural heritage professionals to create new interactives and to manage them when in use, meSch has worked on the concept of interactive templates that describe how the stories will be delivered to visitors (Zancanaro, Not, Petrelli, Marshall, van Dijk, Risseeuw, van Dijk, Venturini, Cavada, & Kubitz, 2015). The cultural heritage professionals can then fill the bare interaction schema with content and create the multiple narratives.

In summary, meSch delivers an easy to use hardware and software platform that allows non-technical cultural heritage professionals to choose amongst a range of possible tangible interactives for their visitors, compose content into interactive narratives for a given visitors' experience, create the smart devices and install them in to their heritage. In addition visitors (and curators) will be able to see their visit online and continue to interact with the heritage remotely, as illustrated below.

The meSch suite includes an editor for composing the narratives and tools to deploy the structured content on the smart objects. The distinction between content organized as a set of interrelated narratives and the interaction context in which those narratives will be delivered is formalized in the experience schema.

An experience schema is structured into four main components:

- **The narrative:** a set of curated digital content items (that form parallel stories or offer different levels of detail) that refer to points of interests (i.e. objects on display or specific places); each content item is annotated (tagged) with the condition that controls its delivery;
- **The appliance:** an abstract specification of
- **the technology embedded in the smart object or the augmented space;** it formalizes what the technology must do to accommodate the story, e.g. to detect visitors' proximity in terms of distance and direction of approach;
- **The interaction script:** it links the narrative and the appliance and specifies the rules that control when the content should be delivered, e.g. a set of rules that describes the context in which the most appropriate content for a specific visitor will be delivered;

- The device: the physical form of the ‘appliance’, it describes the actual hardware components needed and its technical requirements, e.g. proximity sensors with proximity thresholds.

With this approach, meSch can separate the content (the narrative) from the technology (the devices); it can specify how the content is controlled and delivered (the interaction script) on the basis of the interactive features of the device (captured in the appliance).

Fig. 3 and Fig. 4 illustrate an example in which visitors wear a Bluetooth-augmented brooch that identifies the type of visitor (adult or child) and their language (Italian or English) and carry NFC-augmented historical postcards of the type of story they are interested into (soldier, civilian, propaganda). The case (Fig. 3) has an NFC-reader and detects the Bluetooth brooch; the combination of the brooch and card determines which content will be projected on to the small screen. Fig. 4 shows four key points in the process of creating the interactives and the narratives that map onto it. The meSch core concept is that of elements (recipes, content, devices) and tags that specify in which context an element is valid.

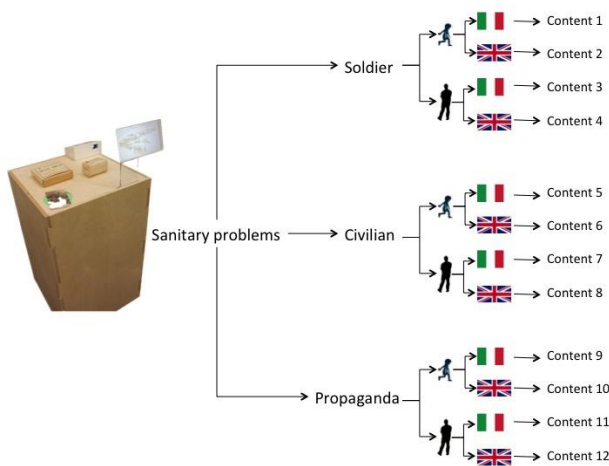


Fig. 3: An interactive case (uses NFC, Bluetooth, projection) and its content structure

### 1.2 Process

The process starts with the definition of the overall experience (Fig. 4, top left); this is where the tags are defined together with the appliances (an abstraction of the physical devices). Although the same content structure can be delivered onto different devices, it is important to decide earlier in the process the appliance to use. An ‘appliance’

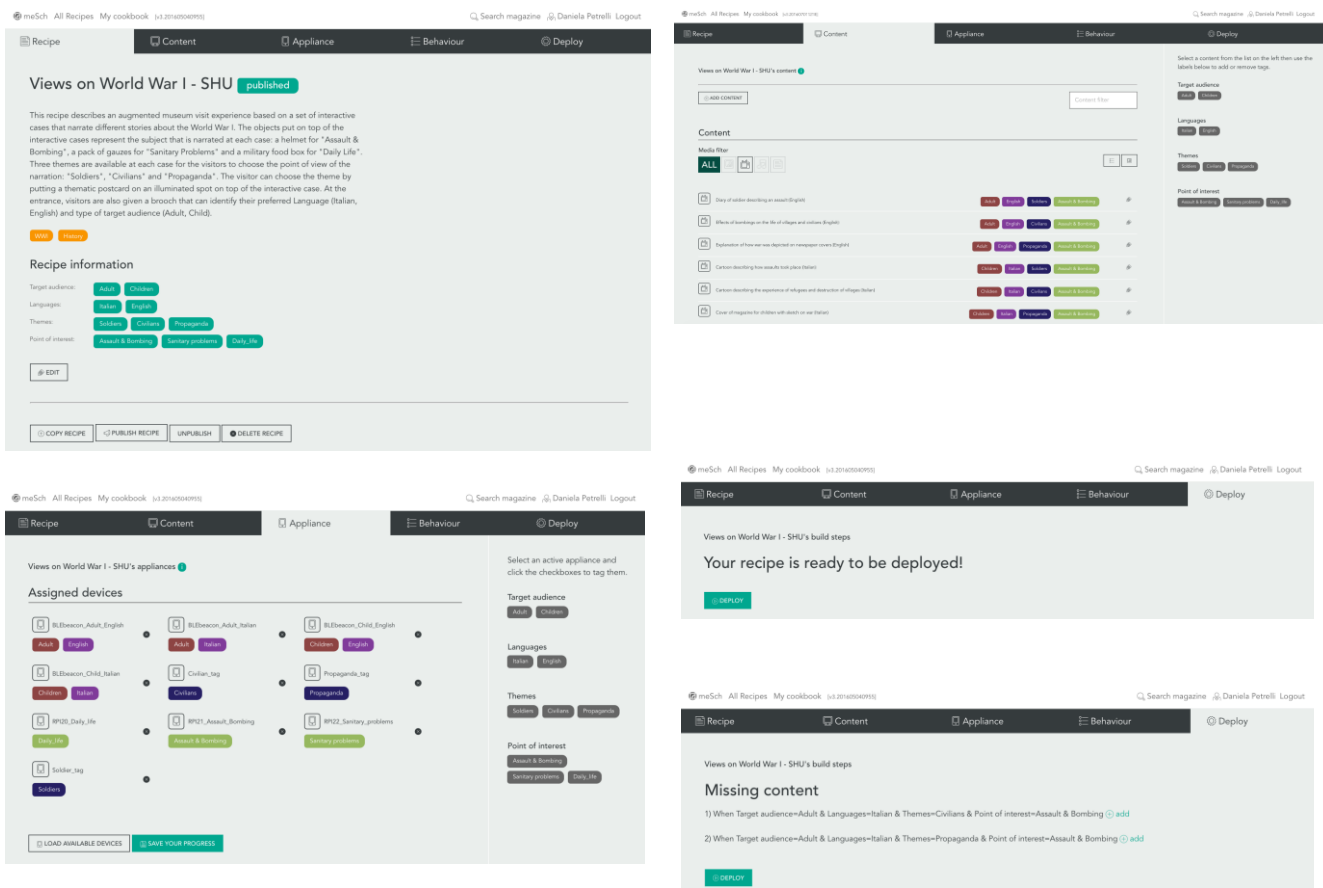
is an abstraction of a specific device to which a set of properties have been associated. Fig.4 (bottom left) the appliances defined for the interactive cases described above: a set of Bluetooth low energy devices (named ‘BLE...’) worn by visitors are tagged with ‘target audience’ and ‘language’; a set of NFC tags (named ‘...\_tag’) capture the ‘theme’ in each postcard; and finally the case is ‘RPI...’. Thus the Appliances define the interaction and the context for the content delivery.

The combinations of tags and appliances define the set of conditions that underlines the behaviour. Every unique combination of tags is associated to a single content file, i.e. when the condition is satisfied the file is delivered.

The Content tab (Fig. 3, top right) enables you to upload files (video for the interactive cases, many formats are possible); the file is then tagged to define the condition under which the content will be delivered. This maps the content onto the context. Given the context the system can check if a piece of content has been properly tagged. Indeed when the appliance is defined, it is possible to check if all the components to build the system are in place; in other words it is possible to check if, for each condition, there is a content file. Fig4, (bottom right) shows the deploy phase in two different situations, when content is missing for a condition and when content-condition pairs are complete.

The schema was explicitly created with the purpose of implementing the following properties:

- Reduction of complexity: authors can concentrate on the preparation of the content and the narratives for the visitors’ experience, ignoring all the technical details.
- Abstraction: the appliance formalizes the interaction elements and the behaviour events available to shape the experience, e.g. proximity maps onto ‘when the visitor is close by then’. It enables interaction designers to experiment with different solutions for the same narratives, e.g. to detect proximity via sensors or via cameras.
- Reusability: an existing experience can be reused with different narratives or different devices to create different instances. For example, the interaction script used for Fig. 2c was used with a book-like device instead of a belt. To reuse one changes the content items in the narrative, while the software and



**Fig. 4:** Four key steps in creating the interactive: the overall definition of the recipe (top left); the content annotated with rule tags (top right); definition of the appliances used (bottom left); and the checking all the content needed for each rule set has been provided (bottom right).

the device are the same. Modularity: parts of an experience schema can be replaced to create a new experience - the interaction script can be changed to introduce different rules for firing the presentation of the same content under different conditions e.g. inside the museums for specific exhibits that march a specific point of interest outside.

The core technology for creating the smart objects, the content that goes on them, and the behaviours that controls the delivery when the visitors interact has been completed. In the last 2 years of the project we have expanded the basic functionalities and run a set of tests and evaluation within and outside the consortium to validate our technology and collect many examples with the ambition to create a community of practice for the internet of things applied in museums and cultural heritage institutions.

## 2. Conclusions

meSch is a 4-years EU funded project (2013-2017) aiming at developing technology for the heritage professionals to create interactives that integrate digital content into material objects or physical experiences for the different kinds of consumers of heritage today. Via co-design and co-creation, in workshops, exploratory labs and prototypes making the multidisciplinary team shared experiences and created a common understanding on what is needed. This laid the foundations for the development of the meSch platform now fully designed and implemented and we start the involvement of the museums and heritage community outside at large. This prototype will then be used to enable cultural heritage professionals to create interactive exhibitions for the general public that will be substantial case studies for both assessing the value of tangible interaction for visitors as well as

the actual ease of use of the tools under development. meSch is also active in the dissemination of the on-going work and early results on the project website <http://www.mesch-project.eu>

#### *Acknowledgment*

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