# *Participation within and beyond museums with the help of digital technologies*

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## 1. Introduction

The preservation and sharing of cultural heritage is an important factor in maintaining societies. Museums are the main institutions for life-long learning about the customs and practices of the past, our culture, history and natural environment, not only as a basis for building a national identity, but also in a much broader context. In our globalized world museums may offer frames of reference and historical parallels to consider present-day issues such as environmental change or the movement of people and cultural diversity.  Hence it is vital for the outlook of a society that its members visit the museum and consider it worthwhile to invest into its future. However, in the 21st century, with its fundamental changes in Western societies for example in world-views and in everyday life, especially in the case of the internet generations, and the mixing of cultures (due to mass tourism but also to migration), the survival of museums is not self-evident[1]. Financing is not the only issue at stake (in many cases, a museum is funded by taxpayers), but even more, the function of the institution and its relevance for the society – that is, whether it attracts visitors. Museums must redefine themselves from being „temples of cultural heritage" to a forum for social discussions, where the visitor is an active participator, and not just a passive consumer of what the institution offers.

In this chapter we will show how design can help to sustain and expand this terrain of civic participation by exploiting the potentials of digital technologies.  We will focus on exhibitions as the major interface to communicate with the visitors, making references in due course to other important channels as marketing and making content available online.   First we examine the new audiences, their media consumption, communication and learning habits, relying on earlier researches and theories. Then we set out in what new ways museums should address their visitors in a participatory manner, from the level of triggering  their curiosity through engaging them actively and maintaining their dedicated interest over a longer period to enlisting their support in enriching their collection.  We provide a

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[1] A handful of large and world-famous museums, profiting from mass tourism, get record numbers of visitors, often also because of their new kinds of exhibitions. However, the smaller and less well known local museums have to fight to obtain visitors, and on a longer term to ensure their survival.

conceptual frame of reference to describe and judge individual digital installations and applications that are meant to serve these functions. Then, we introduce a series of case studies from our own projects, demonstrating how technology can serve the participatory attitude.  We will see that single applications may be of use in several aspects, as of activation a single visitor, and other people within the exhibition or outside the walls of the museum. We close the chapter by discussing some key issues of design, including the questions of evaluation and assessment of benefits.

## 2. Societal changes

### 2.1 New Media and Society

One of the most important aspects of information technology on society is that it changed how people seek out, obtain and use information, and how they communicate and organize themselves.   The media researchers of the McArthur Foundation, Jenkins and colleagues, sum up its characteristics in the following:

- increase in *civil participation*,
- tools in ease of reach for everybody's *creative self-expression*,
- support *to create and share content*,
- *self-organized support and mentorship* for novices to catch up with skills and knowledge, and organize the body of emerging treasuries,
- *emergence of informal and formal social networks and protocols* in course of the above activities, where the reactions by the community are of principal importance (Jenkins 2006, pp. 5-6).

The citizens of the participatory culture are bound to formal and informal groups, they are motivated to express themselves and contribute by sharing their (correct or incorrect) knowledge, and they are open for discussion and for cooperation to create new forms (e.g. blog, Wikipedia) and bodies of knowledge. (Jenkins 2006, p. 13) Joint, social activities are gaining dominance over individual achievements. (Jenkins 2006, p. 22) As the major enabling technology, the mobile phone is becoming an all-day companion for the new generations, the above phenomena become prevalent at work and school, as well as in personal and private life.  Thus the usage of online, virtual world gets interwoven with the every-day real life.  The internet generation is not only skilled in practicing this interwoven life (both in a technical and in an intellectual sense), but find it natural and even necessary to be constantly present in both the real and the virtual world. The real and the virtual do not exist in parallel, the physical and digital mediums shape every-day life in an interwoven way. On the other hand, the new media and enabling technologies do not automatically invoke a democratic, participatory culture (Buckingham 2000).

### 2.2 Learning in new ways

According to Henry Jenkins, in order to solve the gap between what the „enabling tools" make possible, and what these are utilised for, the methods and means of formal and informal learning must be

brought to level of the digital age. Following their argumentation with some re-formulation (Jenkins 2006, pp. 35-104), these are the characteristics of the envisioned new *media literacy:*

- problem-solving by playing,

- ability to create and interpret computer simulations of real-life processes,

- appropriation and creative reuse and remixing of (parts of) selected content,

- content creation in a community, by sharing knowledge,

- easy switch between modalities and media surfaces to trace information,

- multitasking, parallel attention to multiple sources, filtering important content,

- assessment of validity and reliability of information sources,

- communication and maintenance of contact, recognition and trust of communities with different cultural backgrounds.

The man of our age at the beginning of the 21st century is overwhelmed by new information and technologies. Competence-based education and life-long learning have become key concepts. Multimodal experiences are also encouraged during the learning process (Gardner 2011).

 The museum, just as well as the institutions of formal learning, the schools, are also challenged by these developments.

## 3. Participation and the museum

### 3.1 Museums in transition

The mission and instruments of the museum have been changing throughout history, in parallel with the change in the societies they are embedded in. It is enough to refer to a hundred-year old publication (Dana 1917), with  many still relevant  (and partly, still unsolved) issues, as well as to recent publications putting renewal on the agenda (Anderson 2012, Bényei and Ruttkay 2015a, Black 2005).  The fact that the ICOM reformulates its definition of the museum from time to time[2], is also an indication that the museum is not a static, frozen institution. However in our own age, the appearance of digital installations and mediated information transfer in the museum raised fears and opposition among traditional museum experts. While many reputable large museums developed methods and instruments that show that it was not justified to fear that digital installations would turn museums into a kind of Disneyland, in smaller museums – who often have lesser resources as well as fewer visitors - it is still necessary to discuss how the digital tools may serve their inherent goals, for example that visitors

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[2] http://icom.museum/the-vision/museum-definition/

should leave with good memories, pleasant and inspiring experiences, with new knowledge, maybe with new skills, and with the feeling of success and satisfaction. The hours spent in the museum should resonate, inspire for further learning, raise curiosity and awareness, or even, cause a change in daily routines or view on life. Moreover, the visitor should share the positive experience with others, propagate the museum, and feel responsible for its future and support its institutional existence. These goals have been around since the 19th century onwards – only the audiences are now different, in number, in variety and in cultural and communicational habits, as described above.

Nevertheless, in our time museums must also accommodate new roles besides the traditional one of being the "source of knowledge" (see the essays in Anderson 2012): they must provide a forum for society, engage in discussion with their audiences, give well-defined means and space for self-expression, and consider the additional role of being a place of leisure too, both with the exhibitions and programs, and the auxiliary services like shops and restaurants.

Recent theories of learning  (Kolb, 1984, Kolb et al. 2001, Bruner, 1961, Interactive Educational Systems Design Inc. 2017 ) and on the role of emotions  have opened up a space for playfulness, gamification and planning for emotional involvement, alongside the cognitive one. The visionary paper by Csikszentmihályi  and Hermanson gives a theoretical background for interaction and emotions in learning, especially in museums (Csikszentmihályi and Hermanson, 1999). Nowadays we witness that museums count on the active involvement of the visitor (Black 2005), that explanatory texts are being reduced, leaving more space to visual explanations (for example by info-graphics and animations), as well as to other sensory channels like touch and even smell (Levent and Pascual-Leone 2014), and museum strategists advise to plan for emotional involvement as well (Cundy and Pörzgen 2016, Del Chiappa et al. 2014).  These represent a drastic departure from the traditional self-image and practice of the museum, in which visitors make an effort to learn, in the language and communication methods of academic experts, and follow the traditional  protocol of the museum (walk around in silence, do not chat, express emotions, or touch anything).

### 3.2 Visitors as participants

Many traditional museums seem to have difficulty nowadays with reaching their ultimate goals outlined in section 3.1. Nina Simon in the introduction of her book, arguing for participatory practices in museums, sums up the five major components of public dissatisfaction (Simon, 2010, pp. i-vi):

1. Their offer is *irrelevant* for the every-day life and concerns of people.

2. They are *static*, offering the same (permanent) exhibition all the time, so there is no reason for repeated visits.

3. Their *authoritative* attitude prevents people from making their own interpretations or voicing their opinions.

4. They do not offer space for visitors' creativity of *expression and contribution*.

5. They are not a comfortable place where one would *converse about ideas*, with friends or strangers.

There are more and more museums – basically the biggest and most famous ones, particularly the science museums – for which this characterisation does not hold any more. The wave of restoration and extension of the 19th century or older museum buildings also urged these institutions to re-invent their way of operation, not only their spaces[3].   The necessity and means of change have been discussed on several forums of the museum world (Din and Hecht 2007, Drotner et al. 2013, Coburn 2013, Gottlieb and Nilsson 2005) in the past years[4]. But the image depicted by Simon still matches many of the museums. The above characterisation coincides almost to the words by a small empirical study carried out by us, where we asked design and art students to put down words as popping up in their mind about the museum[5]. The most frequently mentioned characteristic were: huge (both the space and the collection), static, lacking information, silent, guarded and exhaustive.

The above list of complaints about the museum can also be seen as a negated counterpart of the characteristics of the internet generations mentioned in 2.1: the museum lacks those qualities which are important for them. Thus the need for change, for offering a participatory role has an *immensely societal motivation*.  It is misleading to look at the application of technology simply as a change in fashion, without understanding what needs of the audiences they are to serve.

## 4.  Participation enabled by digital technologies

Having seen the societal aspects of the need for change in sharing cultural heritage in museums, we turn our attention to the role of digital technologies.  The renewal of the museum, change in attitude to participatory practices may be – and have been – implemented by "traditional" means, notably by excellent guides and by dedicated museum-pedagogical programs, exploiting physical, analogue devices (e.g. models which may be operated, flip-up sheets and drawers hiding information, costumes to facilitate role-playing, etc.).  However, the digital technologies not only allow a broader impact and novel means of interpretation, but also open ways to entirely new experiences and forms of expression. Particularly, we have been motivated to invent such novel installations, where – besides the technological skills – the creativity and aesthetic sense of the artist-designer play an essential role.

### 4.1 Framework of reference

It is not easy, especially for an outsider, to see digital installations in a context, not only as individual digital gadgets scattered around the exhibition. Below we provide a frame of reference, based on our own experience with about 30 different digital installations in a range of museums. This, we believe, is of general interest, but it will also help us to introduce a range of installations in a nutshell in 4.2. After

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[3] See the case of the Rijksmuseum, or the Cleveland Museum of Art http://www.clevelandart.org.
[4] NODEM, MuseumNext, Museum and the Web conferences.
[5] We have asked students of  our  Digital Museum course since 2010 every year.

the individual case studies, they will be compared along the dimensions of the frame of reference, in a concise table format.

When talking about *participation* in the museum, the actors, and the time and the space of action provide a good frame for reference for the digital installations. (We do not aim at an exhaustive list of factors here, but only focus on those which are relevant for digital installations.) As of *actor(s)*, the participation may take place between

- single visitor and an exhibit or piece of information
- several visitors of the museum, face to face triggered by some "social objects", and/or in a mediated way (e.g. via chats or game play actions) in the exhibition
- potential visitor(s) and the museum
- past visitors and the museum
- past and potential visitors

As of *time and space* of the participatory action, it may happen before, during or after a visit, in the building of the museum (or, in a broader sense, at the location of the cultural heritage), in its surrounding physical space (e.g. the town) or in the virtual space.

As *means of motivation* and *instruments for participation* the digital technology installations tap to *emotions* such as surprise, joy, curiosity, empathy or aesthetic appeal, the pleasure in play and creation, challenge to express, perform and succeed (physically and in a cognitive domain). They may combine *physical and cognitive skills*, and serve a broad audience with offering *multimodal* access.

Last but not least, all these instruments help to achieve the ultimate educational goals of the museum (or an exhibition), such as enhancing knowledge and change of attitude of the visitors (Bényei and Ruttkay, 2015a).

## 4.2 Case studies

We have designed and implemented – and occasionally, evaluated – over two dozens of digital installations in the past 8 years, either in the framework of the Digital Museum course (Bényei and Ruttkay, 2015b), where design students as co-creators proposed solutions for top museums, or as commissioned works by the TechLabFellows collective, for certain exhibitions. We have talked about the technicalities elsewhere (Bényei and Ruttkay 2015a). Here we look at a selection of them from the point of view of visitors' participation, to illustrate ways to trigger participation at exhibitions and beyond the walls.

### 4.2.1 Multimodal playful interaction: touch, blow, and stitch

The installations that we discuss here were developed to commemorate Sándor Weöres, a Hungarian poet, at the national literary museum. The curators wanted to offer something entirely different of the traditional genre of "pen of the author", "first edition of his work" type literary exhibitions. Instead, they gave us complete freedom in using new means to have visitors -particularly, youngsters and teenagers - interact with the textual oeuvre itself, with the aim of bringing the poet – and in general, poetry – closer to the public. Here we discuss 3 of the total 11 interactive digital installations, which formed the major body of the exhibition. Figure 1 shows the three installations. We encourage the reader to see further details and videos at the online documentation[6].

| a | b | c |
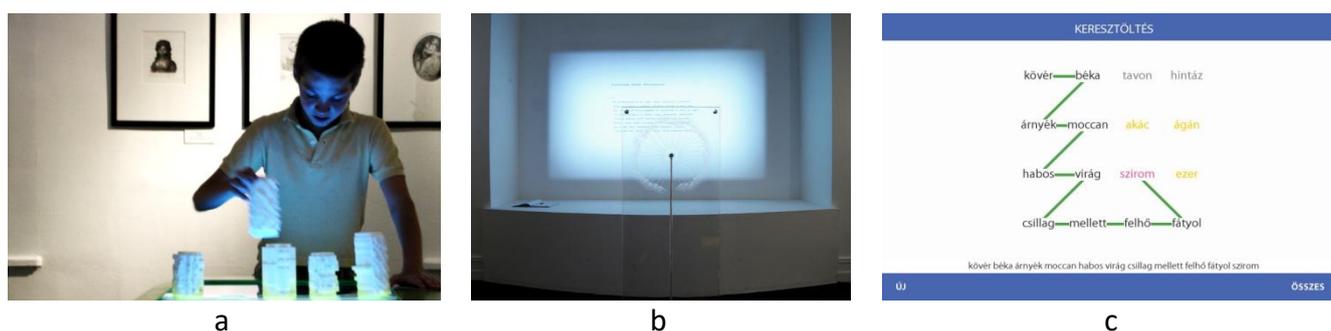
Figure 1: Three Weöres100 installations: a)Tangible poems, b) Blown thoughts, c) Cross-stitch

**Tangible poems** invites visitors to get the rhythm and melody of poems literally under their fingertips. One can sense the length and height of the syllable of the lines of the poems, and identify rhythmic patterns by taking into hand the 3d cylinders. These 3d printed objects as statues visualize the rhythmic characteristic of the lines one by one, in circular patterns. A demanding intellectual task to figure out the basis for the musicality of a poem becomes a playful multimodal experience. The installation may be also used as a two-person game, and the spatial setting inspires onlookers to reflect and to help out fellow-visitors.

**Blown thoughts** builds on childhood memory of the visitors of blowing a dandelion. In a literary exhibition, when blowing an enigmatic plexi dandelion, instead of petals letters fly gently and settle to lines of poems. Dancing letters emerge on the screen, which settle, eventually, to the lines of a poem. The personal and almost magical act makes visitors bound to the poems, which—according to our observations on the spot—they do read, and stay blowing (and reading) further poetic thoughts.

**Cross-stitch** is a touch-screen application, inviting visitor to craft new poems, by stitching together the 16 words put forward by a poet on a 4x4 grid under the title „Cross-stitch". Once a word chain is created, the visitor must decide if his/her own creation is to be considered a poem or not. The ever growing repository of visitors-created poems is displayed and may be browsed in a visual form, as a needlework. Hence visitors not only interact, but build themselves a repository of further poems inspired by the words of the original one.

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[6] See creators and more at http://techlab.mome.hu/weores100

### 4.2.2 Generating content by and discussion among visitors

**Reformed Congregations** installation is part of a huge exhibition celebrating the 500 years anniversary of the Reformation. It shows the reformed congregations on an interactive map of contemporary Hungary. All the content was provided by the congregations themselves and—after a minimal formatting—arranged into the application. The wording of the text sent, or even the lack of any information from certain regions reflect the activity of the Reformed Church in the country. We noticed that visitors were eager to spot their village, and if they did not find any (or good enough) information, they were to send in some. Hence the installation motivated visitors to create and evaluate content.

**Bikur Holim[7]** is a 185 years old donation book from a Jewish association in a Hungarian rural town, which is kept behind glass and may not be touched. But the installation allows the book—placed in a special glass box which has a transparent display front—to be studied, its pages turned. This happens by mapping the displayed content onto the real book. The interactive surface allows to touch the names appearing "in the book"—and facts and documents about the person and his offsprings gets displayed. This installation exemplifies civil participation in two ways: The entire content was collected by a local amateur historian, who gathered objects and data from descendants of the Jewish individuals mentioned in the book.  There are still many names without facts—the visitors are invited to extend the sporadic knowledge about the community.

**Preparing for Saturday** [8]  is an installation made for an exhibition on Jewish traditions.  It is a festive set table, as done on Friday evenings in Jewish homes. The projected short animation which appears on a table-top tells the story of a traditional Sabbath ceremony. The visitors can recognise the Friday dinner of a five-member family and their guest. However, the animation starts only if there are at least 3 people sitting round the table. This constraint on the participants (for which fellow visitors have to join in, even if they are strangers) refers to the very essence of the ceremonial dinner. The animation is in an artistic style, leaving space for self-reflection as well as for discussion on interpretation among the visitors—just like it would happen in real in a Jewish family.

### 4.2.3. Beyond the walls of the exhibition

In this section we give examples to motivate the public to engage with cultural heritage—also as alternatives to going to a traditional exhibition.

**ColourMirror[9]** is a semi-transparent dressing mirror, placed in a separate room leading to an unusual exhibition where artefacts—ceramics, glass, furniture, dresses etc.—are arranged in three rooms (red,

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[7] See creators and more at http://techlab.mome.hu/bikurholim.
[8] See creators and more at  http://techlab.mome.hu/preparingforsaturday
[9] See creators, photos and video  at http://techlab.mome.hu/colourmirror

green and blue), according to their dominant colours.  When a visitor stands still in front of the mirror, the magic lights change, his colours get scanned  and an object matching the most to the scanned colour pallet appears  next to the silhouette of the visitor.  This evoked object serves as a motivation and starting point to the exhibition. Besides, visitors can share „their" object via social media, and can explore results of past scans, ponder about the colour preferences of the public shown in animated data visualizations.  A report on an empirical study (Ruttkay 2017) reveals that people did enjoy the experience, found it funny and joyful, use the object as an entry point—and identified with their object much more than expected.
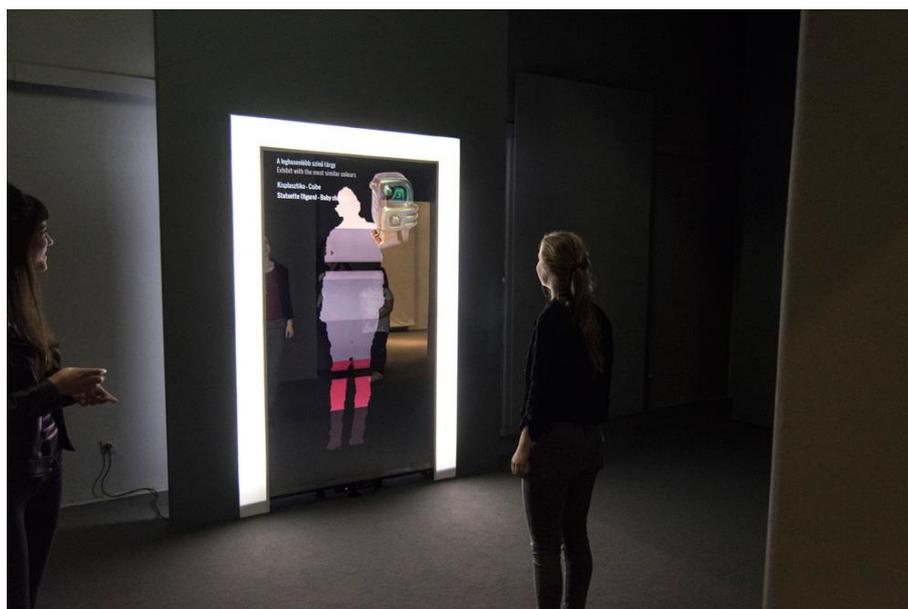


Figure 2: Visitor receiving an object in ColourMirror

**Rooftops at Dawn**[10] was developed as a mobile application to accompany an exhibition which had taken place in the Literary Museum of Budapest, to celebrate Géza Ottlik, a – by now not too popular, but excellent - writer. It was meant to address a teenager audience who would never go to the (traditional) exhibition itself, not even to the museum.  We designed a mobile locative walk, where a novel by the writer is the guideline to explore its (former, partly fictional) spots in Budapest. Walking with a mobile, one gets segments of the novel read out and/or in text form, accompanied by a wealth of additional associated materials: photos, films, music, and contemporary newspaper articles.  It is also possible to store and share quotes from the novel. A small-scale study with teenagers resulted in statements like "I will read the entire novel", and "We should get an entry to more literature in similar formats".

**WonderAround!**[11]  allows people to visit an enigmatic but - because of its physical condition and lack of resources -  closed monument: a Jewish cemetery hidden in Budapest.   It is unique in Central-Europe,

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[10] See creators and more information at : http://create.mome.hu/rooftops_at_dawn/
[11] Information on creators  and access to the virtual tour at: http://zsidotemeto.mome.hu/index_en.html

with some world-famous architectural solutions, and full of references to the bustling cultural and political life of the capital before WWII. The remote visit not only provides a full 3d experience, but the visitor may get textual and photo information attached to individual grave stones and deceased personalities. The cemetery has been decaying further since the creation of the virtual tour; hence it serves also as documentation. Also, it has been effective in raising interest and awareness in citizens and in local and international authorities for its future lot.

### 4.2.4 Comparing installations in a common framework

In section 4.1 we listed means and instruments of participation, and outlined actors, time and space as dimensions of references. In the table below, we sum up these characteristics of the above introduced applications. This helps to characterise and to compare them in a common reference framework of participation, and also, makes it clear that a single installation may exploit multiple means and serve multiple levels of participation.

| | framework | | | motivations and instruments | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **actors** | **time** | **space** | **physical challenge** | **intellectual challenge** | **playful/ emotional** | **learning by doing** | **creative activity for self-expressions** | **content creation** |
| **Tangible poems** | - 2 playing visitors opposite<br>- bystanders discussing | during exhibition visit | -exhibition | touch modality | interpret rhythmic patterns | -playful<br>-beautiful | metrics | challenge knowledge | - |
| **Blown thoughts** | - 1 visitor<br>- bystanders watch performance result | during exhibition visit | -exhibition | blow | - | - puzzling<br>- beautiful | read a poem | - | - |
| **Cross-stitch** | bystanders watch performance and evaluate result | during exhibition visit | -exhibition | everyday activity (in a different, medium) | - follow rules<br>- aim at "poem" | lyrical content | interpret "modern" poetry | logical and poetic skill | create and judge |
| **Reformed Congregations** | - 1 visitor<br>- bystanders help and comment | -during<br>- after<br>- before (some) | -exhibition | - | -spot location | - | explore content | - | all content is created by public |
| **Bikur Holim** | - 1-2 visitors with screen<br>- (remote) by-passers see attractive elements | -during<br>- before (in the museum) | - exhibition | - | -interpret Hebrew | -joyful<br>-surprising<br>-puzzling | explore content | - | send further content |
| **Preparing for Saturday** | - invite min 2 visitors in order to "get it working"<br>-discuss interpretation | - during | - exhibition | sit around a table (rest, focus, chat) | - interpret | surprising | learn about ritual by subjective perspectives | - | - |
| **ColourMirror** | -1-2 people<br>- guard and visitors<br>- visitors, also aliens<br>- potential visitors | - before (in museum)<br>- after (in museum)<br>- after (in social media) | - next to the exhibition<br>- in virtual space | surprising every-day life | - learn about objects<br>- find out principle | -playful<br>-surprising<br>- joyful | evoke content | mirror image may be shared | visitors data is collected and visualized |
| **Rooftops at Dawn** | - individual<br>- potential visitors via social media | independent of museum visit | in city | walk | - read novel<br>- interpret content | - | explore content | quotations may be shared | - |

| | | | | | - past-present<br>- fiction-reality | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Wonder Around** | - virtual visit by remote people<br>- access to information | - instead of visit<br>- before<br>- after | in virtual space | - | - explore monuments and personal lives | atmosphere, music are emotional | explore content | | send further content |

## 5. Design and evaluation

The goals of the museum, the characterisation of the societal context and the expectations of the target audience provide the setting for the design of digital installations for exhibitions. In this closing section we address some specific issues related to the design of successful digital applications for museums.

### 5.1 Design principles

The design of digital installations, with the purpose of triggering participatory behaviour, requires an interdisciplinary cooperation that takes into account all the players and stakeholders. From the *museums' part*, the curator is the key person who formulates the message of the exhibition and the envisioned audiences.  At this very abstract level, it should also be decided what will be the role of the visitors, which of the participatory attitudes will be encouraged and assured.  Other players in the museum – from communication, marketing and education units – may help to broaden the impact and outreach, by thinking of before and after-visit facilities, both in the physical and in the virtual space. The delivery of credible, legally clean and good-quality digital content is also the responsibility of the museum—which may require short-term extra investment, as well as a longer-term digital strategy.

The design must be *user-centred* on all levels, from the design of the user interface, the assumed actions from and paths of the visitor to the visual and textual language used.  Seldom done, but some representatives of the users should be included in the entire cycle of the design process, from the conceptual design to the testing of the technicalities. If the societal impact and longer-term effect is more important for the museum than the number of tickets sold, then those should also be considered who—either due to forbidding circumstances or out of a lack of interest — do not go to the exhibition. The ready to use materials for schools, the availability of the collection on-line, the means and campaigns for creative  re-use  are all possible ways to reach these people —,  and these means should also part of the design as well as of the strategy of the museum.  Often a single attractive installation in the exhibition space may be enhanced with some features which serve such purposes – if thought of in advance.

The digital installations themselves get designed by an *interdisciplinary team*, and in a process interwoven with the entire design of the exhibition (Knast, 2014). The ideas of exploiting the arsenal of digital technologies may  help the curator to design the concept of the exhibition, to address multiple audiences and to exploit new methods of interpretation. The physical space and visual appearance of the exhibition should be designed such that the digital installations fit well.  Preferably, the digital artefacts (computers, sensors, switches, cameras) should be hidden, preferably in furniture matching the topic and the visual design of the entire exhibition.  Finally, the operation of the installations—by providing the infrastructure, and performing regular service and maintenance of equipment (and even software)—must be ensured after the opening.

Sustainability of the design of digital installations—beyond the assurance of the daily functioning — requires one to think forward. After a few months of serving an exhibition, hardware (and even some components of the software) should be ready for re-use. It is also important to consider the service and support for the purchased hardware and software.  Another way of taking the most out of an installation is to think beyond the space and time of the exhibition. Digital installations may be more suitable than precious artefacts to be moved around in an exhibition bus to reach a remote public, and some installations may be used before/after the exhibition, or be offered online for permanent use.

Taking sustainability to an even broader context, the museum should think about sustaining its attractiveness for the public.  It is not sufficient to have individual up-to-date temporary exhibitions, but the permanent ones — which are often in place for a decade or two — should also be on a similar level. Finally, the constant renewal of technology itself is also a challenge. It can very well be that in a few years' time, with new devices and enabling technologies, yet more exciting and effective experiences can be designed.  This also underlines that the attractiveness of an installation does not depend on the technology itself, but it is related to its charm and wit and other qualities, such as evoking emotion and physical activity.

## 5.2 Evaluation and assessment

In case of such a prominent and usually expensive investment as the introduction of novel digital tools to a museum, it is very much desirable to get a realistic and sound picture of the benefit of the investment.  However, evaluation is yet the most neglected aspect of the life-cycle of digital installations in museums. In part this is because there are no people and resources to implement evaluation (the museum lacks the preparation to do so, while the designers are more strongly motivated to pursue a new design task than to monitor and evaluate the results of a previous one).  Often, the museum is happy enough with the increased media attention and the qualitative impressions of usage by and spontaneous feedback from (young) visitors.  But – especially as the investments are huge, as of financial and human resources – it is very much desired to get a realistic and sound picture of the benefit of the investment.  Also as the technology is still evolving and its usage is being experimented with, a clear picture of how visitors use the installations would help to improve design, on conceptual and detailed technical level.  It would be the museum who should take care of follow-up monitoring and evaluation of the benefits of the digital installations. A few museums show an example to follow (Jane 2013), also in not hiding negative results and the necessity for eventual improvements, even for re-design.

There are also fundamental difficulties in performing evaluation and assessment. While some characteristics – as of number of visitors, time spent with installations and the access to its  specific "regions" are relatively easy to log and evaluate, the more interesting questions would address the experience and motivation of the visitors, the  improvement in knowledge and attitude, also towards the museum. To answer such questions, methodological principles should be set down, a big apparatus

must be put into place, data should be collected on longer term, some baseline should be decided – which is very problematic independent of the topic, the setting and the – in time changing – visitors and society.  A couple of absolute measurements like time spent in the exhibition, especially with the "naked eye" observation of exhibits, the recall of information and the future plans for re-visit can be good indication of success. The analysis of failures, are just as insightful as success stories.

On a higher level and in a longer time-span, the societal impact is of interest. Does the museum succeed in fulfilling its societal roles, and to what extent is this to be attributed to the digital arsenal that it exploits? How do visitors see the museum? What are the implied changes within institutions (e.g. new attitudes, a new organisational structure, new roles—and new forms of education and training to prepare for the new jobs), in the creative design industry (e.g. are there instruments to help start-ups and young creatives to enter the new market)? One may also consider the impact of the museum as a stakeholder in (life-long) education. Related to the immense complexity of the design and assessment tasks, we should establish further academic forums to share and acknowledge interdisciplinary work in Digital Museology, on the intersection of design, technology and humanities.

**Acknowledgement**

We are thankful to all the creators of the installations discussed. Their names are available from the online references.

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