A SWOT Analysis of Software Technologies for Driving Museum Digital Transformation

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Abstract: Museums play a key cultural role in educating citizens through the immersive experience they provide. The recent lockdowns have awakened them to the need to accelerate their digital transformation and to propose new kinds of experience to their public. This paper performs a SWOT analysis considering the Strengths, Weaknesses, Opportunities and Threats from existing and emerging digital technologies w.r.t. the range of services and missions a museum is delivering both internally as a company and externally to the society. Our work relies on a number of technological evolutions reported in the literature and experienced in our computing heritage museum with a strong focus on the user experience and accessibility.

1 INTRODUCTION

The main mission of a museum is to preserve cultural artefacts and make them accessible for understanding to present and future generations. Museums achieve this goal through collecting, inventorying, restoring and exhibiting artefacts of their specific domain of expertise: art, archaeology, nature, science or technology among many other areas of human activities. Museums offer the public an immersive and structured access to culture mainly through exhibitions (permanent or temporary) and possibly through specific events such as conferences and workshops which can target a specific public (e.g. kids, schools, seniors). Museums remains essentially "brick-and-mortar" spaces and as such they have to legally meet physical accessibility requirements for their public areas with specific standards, regulations, assessments and tools for supporting this process.

Digital transformation can be defined as the "process through which companies converge multiple new digital technologies, enhanced with ubiquitous connectivity, with the intention of reaching superior performance and sustained competitive advantage, by transforming multiple business dimensions, including the business model, the customer experience and operations, and simultaneously impacting people and networks" (Ismail et al., 2017).

Museums have started their digital transformation a while ago, understanding that it would add a extra digital dimension complementing and not replacing the physical dimension, leading to the concept of Post-Digital museum (Parry, 2013). However, the pace and scope of transformation (e.g. focused on internal workflows vs visitors) can vary widely. By freezing physical access, the COVID-19 lockdowns have revealed the need for developing a digital presence and have accelerated the adoption of specific digital solutions such as virtual tours, efficient booking systems or online events (Dasgupta et al., 2021)(Zuanni, 2020).

Observing this transformation is helping to understand the nature of various technological factors that can have positive or negative impacts on its success, either from an internal point of view (i.e. Strengths and Weaknesses) or external factors (i.e. Threats and Opportunities). This results in a SWOT analysis. This paper is focusing on software technologies driving digital transformation.

Our paper is organised as follows. First, Section 2 details the main museum missions and impersonate them through a set of personas enabling us to clearly identify enablers and barriers to digital transformation. Section 3 then explores the four dimensions of the SWOT from the point of view of various existing and emerging digital technologies and the underlying software artefacts. It is illustrated by several published works and by our own experience with com-

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puter museums. Based on this, Section 4 discusses how to best drive a digital transformation in a museum context. Finally, Section 5 draws some conclusions and discusses future work.

2 MUSEUM MISSIONS AND PERSONAS

2.1 Main Missions

The main missions of a museum involve different kinds of stakeholders:

- purely internal; it is the work of the curator and specialised staff to gather, study, restore and preserve artefacts for future generations.
- interaction with other partners for exchanging expertise or artefacts.
- interaction with the public for setting up exhibitions based on a carefully selected set of artefacts, editing brochures/books, organising guided tours/workshops/conferences.

2.2 Key Personas

Personas are archetypal descriptions of users that embody their goals (Cooper, 1999). Their focus on typical fictional business users helps in elaborating specific user aspects that may be missed by other approaches based on generic roles. Personas have proven very effective with psychological evidence about our natural and generative engagement with detailed representations of people (Grudin, 2006).

A key issue is of course the selection process of the relevant personas. The selected archetypes must cover the broad spectrum of people with different backgrounds/experience/roles. The selected number should be kept minimal but ensuring the coverage of the museum missions. Related to museums, we can list the following interesting personas and characterise them with some user stories:

- Carine, as curator, would like to have an efficient museum inventory system in order to assess the quality and state of the collections.
- Cédric, as steward, would like to have the list of scheduled visits and workshop activities to prepare them in due time.
- Gaelle, as animator, would like to publish information on social networks and to specific targets.
- Ward, as director, would like to easily manage the various projects and schedules involving internal staff, external partners and/or volunteers.
- Chris, as researcher and Robert, as technician, would like to easily retrieve artefacts and related scientific and technical information.
- Alice, as 6 year kid, would like to enjoy a playful experience of the museum.
- Vincent, as wheelchair visitor, would like to easily register online, prepare his visit through a virtual tour and consult information in an accessible way.
- John, as foreign visitor, would like to benefit from translation in his language or in English .

3 SWOT ANALYSIS

In this section, we perform a SWOT analysis considering the four following dimensions:

- **Strengths.** Achievements/capabilities of current ICT in supporting museum missions and user stories, also identifying possible evolutions.
- **Weaknesses.** Challenges of current ICT in supporting museum missions and user stories.
- **Opportunities.** New possibilities enabled by maturing software-based technologies, illustrated by some early adopters.
- **Threats.** New barriers raised by those new technologies with a discussion on how to address them.

3.1 Strengths

Collections Management System (CMS) is software used by the internal staff of a museum or other collecting institutions like archive centers. They are typically used by the curator and technician roles. Early CMS were more cataloging databases, essentially digital versions of card catalogs, e.g. Filemaker (Claris, 1985). They evolved to more advanced systems providing specific profiles for each role and also improving communication between museum staff and directly supporting the collections-based tasks and workflows (Swank, 2008). They can also provide a web interface which can be expose the collection to the general public with a dedicated search engine. An illustrative Open Source solution is Collective Access (Whirl-i-Gig, 2012) depicted in Figure 1.

An area of further improvement is to connect the CMS to other software, e.g. for an interactive guide, using specific extraction and filtering which could help a visitor or a researcher to see beyond what is exposed in an exhibition.

Support for Accessibility for Mobility Impaired People is required in museum due to legal constraints. Like other places open to the public, museums have to comply with specific norms such as (ISO, 2011). This means adequate circulation for

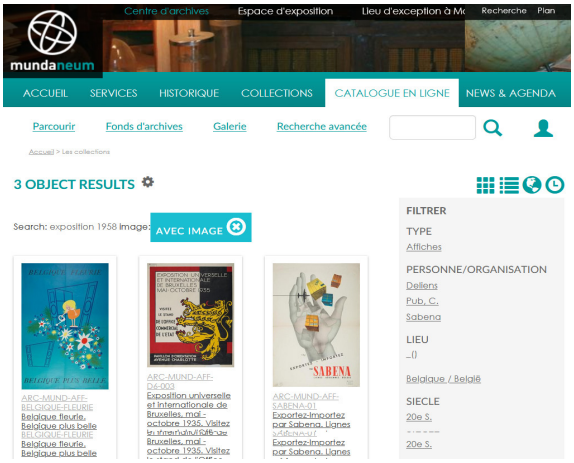

Figure 1: Web interface of Collective Acces CMS.

wheelchairs, adapted height of the displays, video subtitling, audio guides, visits in sign language, accessible toilets, etc. Methodologies to identify specific barriers are available as well as supporting information sharing platforms, e.g. (Jaccede.com,) or (CAWAB,) which are depicted in Figure 2 with pictograms for specific disabilities (mobility, visual, hearing and cognitive). Model-based digital tools are also available to support them (Ponsard and Darimont, 2017).

Figure 2: Access-i portal showing museum physical accessibility.

An area of further improvement is to go beyond the pure physical experience in order to provide more help in the preparation phase before the visit, increased digital support during the visit and possibly extended experience after the visit. Those issues will be elaborated in the next parts of the SWOT and are also detailed in (Ponsard et al., 2017).

3.2 Weaknesses

We list some important weaknesses that can be used as driver on how to provide an increased experience.
Physical Visit Can Be Limited in Many Ways. First, using a purely traditional scenography requires to organise the path to tell a specific story, thus with a specific angle and selecting on what to focus as shown in Figure 3. Details can possibly be overlooked but will still occupy some physical space. In the case of multilingual content in printed form, it will also increase constraint on the text length. Of course existing digital media can help: for example audio/video guides can provide different kind of tours for different profiles and enable to choose to have more details, but more immersive and interactive experience is usually missing.

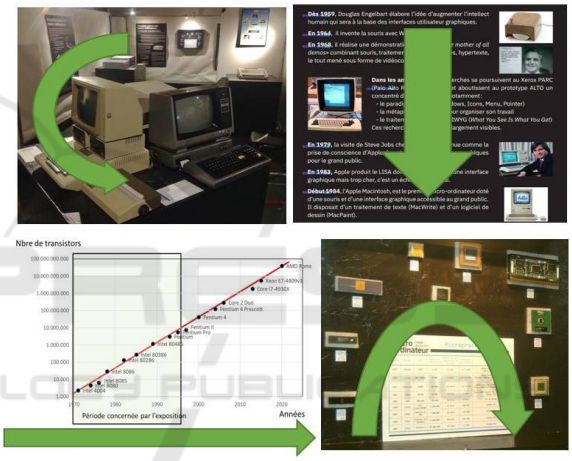

Figure 3: Physical constraints put on a museum visit.

Areas of new experience here would be to allow the visitor to define specific viewpoints in a controlled way and to construct his own exploration path, for example based on his area of interest. This process could be dynamic and adaptive based on the way the visitor is discovering the domain.

Lack of Online Experience. A related issue, it also that few museums provide an experience beyond their walls. For many museum, this resulted in a complete loss of contact with the public during the pandemics and triggered an awareness to address this issue. Reconnecting with the public means providing online experience, e.g. through social networks by triggering interaction on specific topics, animating live sessions and more generally maintaining a link.

3.3 Opportunities

In this section, we explore some emerging technologies and look how they can help improving the museum experience. This list is meant to be illustrative and do not claim to be exhaustive.

Mobile Applications are actually not so new but have become quite easy to develop including in a cross-platform way using open source frameworks like ReactNative (from Facebook) or Flutter (from Google). This can provide a cheaper alternative to the development and management of audio/video guides as the user can install it on its own smartphone. The link between the physical exhibition and the internal content can be maintained using identifiers or QR-code. The application can also include multimedia or interactive content like a quiz or a (serious).

Figure 4: Mobile application with an interactive timeline.

Virtual Reality (VR) can be used to reproduce the physical layout of a museum and provide a remote experience. This same experience can be useful to prepare or extend the physical visit, e.g. for disabled people or to check back later for specific aspects. For example Figure 5 shows a virtual tour of the IN2P3 computer museum. Another scenario is to showcase artworks in virtual spaces based on high quality scans or photographs of physical artefacts. Designing a VR space providing a good user experience is still an heavy and specialised work although some Open Source solutions are emerging such as as OpenSpace3D (I-maginer, 2020) or Marzipano (Google, 2016). Another extension is to host such spaces in the so called metaverse and being able to access it in a more easy and standard way but this technology is still emerging. The strong potential of such technologies as been identified at the European level, especially for the co-creation of value through Digital Innovation Hubs (EDIH) (Maurer, 2021).

Augmented Reality and Avatars rely on technology like a smartphone or smart glasses to superimpose

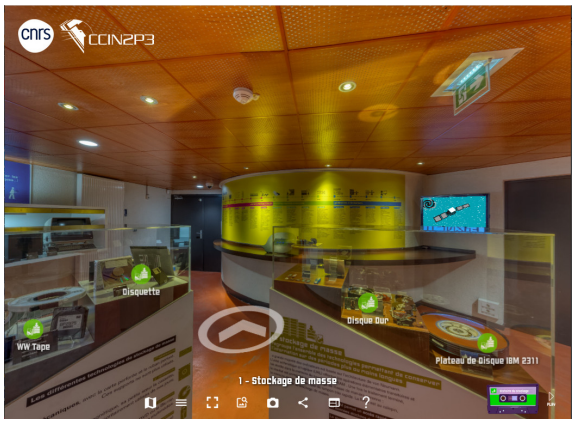

Figure 5: Virtual tour of the CCIN2P3 computer museum.

images, text or sounds on top of what a visitor can already see. This can be used in various ways. An obvious usage is just to add explanations relating to the viewed artefact, which can help in providing more details or multilingual content. A more artistic scenario can be to display the digital version of an artist next to its work and use it as an avatar providing a narration. An avatar can also be used to welcome the visitor and simulate a guided tour. Using chatbot technology can also increase the experience with some limited interactivity. It is also possible to bring things to live, for example putting flesh back on a dinosaur as depicted in Figure 6 or to simulate the operation of an artefact such as machine to see and hear it in operation even though the real artefact is inactive (Coates, 2021).

Figure 6: Augmented reality in a science museum.

3.4 Threats

In this section, we identify some emerging threats and how to deal with them.

Cybersecurity will become an issue as the museum is increasing it dependency on digital technolo-

gies and online presence. This can results in threats both on confidentiality (especially personal data), integrity (e.g. website defacing) and availability of the provide services (e.g. reservation, virtual tour). The impact can be damageable in many dimensions: reputation, financial loss (missed visitors) or legal (GDPR). This issue should be tackled by introducing a cybersecurity awareness and culture inside the museum in a similar way as it is done inside SME. The recommendation is to train an internal reference person which can rely on an external expert. A risk analysis must be performed as first step and then adequate measures must be deployed and monitored.

Digital Accessibility is already present with the web but will take increased importance with other technologies such as apps or immersive experience. The museum should start to comply with available standard for website accessibility. The Web Accessibility Initiative (WAI) (W3C, a) provides Web Content Accessibility Guidelines (WCAG) to help Web developers making Web sites accessible (W3C, b) while dynamic content is addressed through ARIA (Accessible Rich Internet Applications). Many useful evaluation and repair tools exist, including those for tailored and optimised usability and accessibility evaluation (Vanderdonckt and Beirekdar, 2005). The emergence of augmented/virtual reality experience might require new guidelines in an area which is still in its infancy and with incremental needs for learning and improvements.

Maintenance and Digital Obsolescence also becomes an issue in a fast evolving world. In response to this, relying on maintained and open (source) technologies is advised. It means the museum should be able to rely on an internal resource or have a long term relation with a close partner to help in developing and maintaining the software solutions. This can be done by collaborating with structures such as a fablab or a creative hub.

Last but not least, **adoption** is also an important barrier to consider regarding the success of digital transformation. Smaller structure maybe more flexible but have less resource and experience to conduct change. For addressing this, different tools can be considered such as the adoption of an adequate framework such as Training of Organizational Workers such (ToOW) which has been applied for digital transformation (Ferreira. et al., 2017). The integration into a creative hub mentioned earlier will also bring other expertise and help to overcome barriers. More specifically for a museum, it is also important to drive the transformation by keeping in mind the user experience as detailed in the next section.

4 DRIVING THE DIGITAL TRANSFORMATION

In order to embrace a digital transformation, it is important not to focus on current physical criteria which are bound to this dimension but also on higher level goals. For this purpose, it is worth considering the reference framework going from abstract to concrete (Mason, 2020) depicted in Figure 7:

- *User experience level*: covering goals, key messages, high-level narrative.
- *Experience framework*: based interaction framework and information architecture (i.e. scenography) which can be perceived differently by the public, especially for people affected by physical, sensory or cognitive impairments.
- *Structural level*: physical/digital aspects (layout, graphics, content...), which should provide a variety of access modalities for the same content.

Based on this, the most interesting issues relate to advanced technologies such as the development of virtual tours or mobile applications to support the museum scenography. Different approaches exist from the basic transposition of the physical experience: e.g. video of a guided tour or a paper guide made available online. The virtual museum is a more complex case. It might involve unusual controls which needs to be validated for accessibility and regarding the learning curve, e.g. through a tutorial or possibly through a virtual guide (avatar). The pure transposition of the physical world into a digital one is interesting for a hybrid experience (preparation before arrival) but it might also overload the user with uninteresting information/actions (corridor pictures, need to point in the right direction). It could be interesting to consider a higher level in our reference framework, i.e. goals and narratives. This can lead to developing a mobile application enabling to relate various artefacts, people, organisations, technologies through a timeline mechanism supplementing a physical visit. It will also help exploring other relationships beyond what is “hard coded” in the physical exhibition in a more open way allowing one to dig more into a domain and favouring learning (Ponsard and Desmet, 2022).

Another interesting and possibly complementary approach is gamification: it allows the user (not only kids) to engage more deeply with the content. The use of a persona, possibly reflecting user preference and (dis)-abilities, definitely helps to fine tune the interface to her needs. The profiling introduced for a visitor can be used as driver here.

From an accessibility perspective, the digital transformation mainly impacts the access to services which can be provided remotely (virtual tool) but

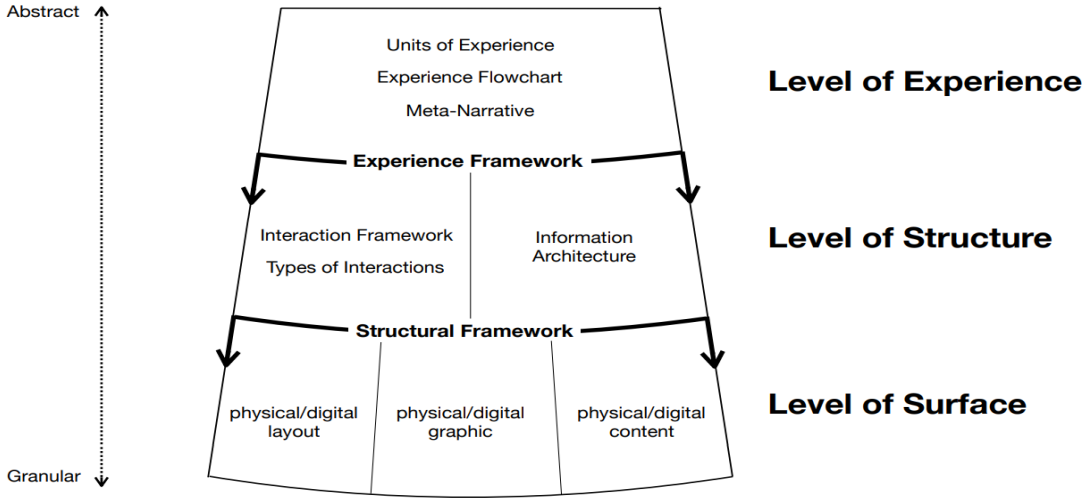

Figure 7: Conceptual framework structured in three levels(Mason, 2020).

also supports physical access, for example during the preparation phase (pre-visit, booking). Those extended and hybrid scenarios can open the way to an alternative experience but also possibly create new accessibility barriers which may frustrate specific users. Identifying them requires to perform validation and gather feedback from a variety of profiles, here again exploring and enriching the set of personas is recommended.

5 CONCLUSION AND NEXT STEPS

In this paper, we performed a SWOT analysis of software-based technologies in order to support the digital transformation of a museum. In order to drive the process, we identified the main missions and a set of representative personas. The SWOT analysis pointed out interesting directions and technologies to widen the museum experience beyond the physical space but also beyond the time spent inside the museum. Different scenarios using mobile applications, augmented reality and virtual reality were identified and some existing experiments in museums (with a focus on computer museums), were reported. Based on this we could also highlight some useful guidelines to drive a museum digital transformation and cope with some new barriers resulting from the extended use of digital technologies.

Our future work will be to continue the deployment of such software-based technologies in our museum. We also plan to extend our analysis to include more domains and to provide more detailed guidelines and lessons learned to overcome specific barriers like accessibility and also avoiding to “copy/paste” the physical experience to a digital one.

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