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Abstract	

This is the final evaluation deliverable for the CHESS project. It integrates summative and formative usability and user-experience work conducted in Y3 of the project, together with validation work that considers the core technical components of CHESS. The deliverable evaluates CHESS authoring technologies and user experiences that make use of them and considers the personalisation and adaptation facilities of CHESS. It presents technical validation work provided by technical project partners, and also assesses the coverage of final user requirements and functional specifications that has been established by these components.

CHESS is a project co-funded by the European Commission within the 7th Framework Programme –. For more information on **CHESS**, please see www.chessexperience.eu

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Acronyms

AM	The New Acropolis Museum
CITE	Cité de l'Espace
NKUA	National and Kapodistrian University of Athens
No.	Number
UCD	User-Centred Design
UNOTT	University of Nottingham
UX	User Experience

Preface

Cultural heritage institutions nowadays face the important challenge of making their collections more engaging to visitors, especially the young 'digital natives', while exploiting, in new forms of cultural interactive experiences, the recently developed digital libraries. An approach for cultural heritage institutions (e.g. museums) would be to capitalize on the pervasive use of interactive digital content and systems in order to offer experiences that connect to their visitors' interests, needs, dreams, familiar faces or places; in other words, to the personal narratives they carry with them and, implicitly or explicitly, build when visiting a cultural site.

The principal objective of CHESS is to research, implement and evaluate an innovative conceptual and technological framework that will enable both the experiencing of personalised interactive stories for visitors of cultural sites and their authoring by the cultural content experts. Essentially, CHESS proposes to create narrative-driven cultural "adventures" through hybrid structures, which adapt continuously to their visitors, extend over space and time, and involve multiple users with different interfaces. To achieve this, CHESS will integrate interdisciplinary research in personalization and adaptivity, digital storytelling, interaction methodologies, and narrative-oriented mobile and mixed reality technologies, with a sound theoretical basis in the museological, cognitive, and learning sciences. This tightly integrated framework will be applied and tested in different types of cultural heritage sites; most notably two world-renowned museums, the New Acropolis Museum, and the Cité de l'Espace in France. Access to end-users will be further enhanced through the international User Group, a diverse body of cultural institutions and organisations.

The **CHESS** project kicked-off in February 2011 and is planned to be completed by March 2014. The project is co-financed by the European Commission's Seventh Framework Programme.

Executive summary

This is the final evaluation deliverable for CHESS. The following five sections are present:

- Section 1: Evaluation of the CHESS authoring methodology
- Section 2: Evaluation of CHESS user experience deployments
- Section 3: Evaluation of CHESS personalisation and adaptation facilities
- Section 4: Technical validation of CHESS components
- Section 5: Coverage of user requirements and functional specifications

Here, sections 1, 2 and 3 specifically relate to research work that has been conducted in year 3 of the project, whilst sections 4 and 5 are broader in scope, and present individual assessments of CHESS components, which collectively represent a research effort that has been distribute across Y1, Y2 and Y3. Section 5, in particular, makes an assessment of core CHESS components against the initial set of user requirements and functional specifications that were established in Y1 of the project, and identifying those requirements and specifications that have been covered, and providing reasons where they have not been.

A principal achievement of Y3 of the project is that the CHESS Authoring Tool (CAT) has matured, and is now usable for the construction of museum experiences. As such, a substantial part of the evaluation work presented in sections 1 and 2 can be related directly to the process of evaluating the CAT. Specifically:

- Section 1.3.1 analyses the usage of the CAT through creativity workshops attended by two groups of museum authors associated with AM. These provides an understanding of how professional museum practitioners orientate themselves to the tool, which is then important in understanding how it will be adopted within the cultural heritage sector
- Section 1.3.2 provides a summative evaluation of the usability of the CAT, as evaluated by two museum authors associated with AM. This will guide improvements to the design of the CAT beyond the end of the project. A summary of issues identified is included in Appendix 7.1.
- Section 1.4 provides a broad case-study of the use of the CAT to author an experience at CITE. This considers in detail the various working practices that emerged around it. It identifies key questions to consider in relation to the uptake of the CAT by the cultural heritage sector, and also provides a detailed estimate of the resources required to author experiences using the CAT. This is contextualised through a comparison with the cost of conceptualising and realising a typical museum exhibition at CITE. Section 2.3 then provides an ethnographic evaluation of the deployment of this experience.
- Section 2.4 provides an evaluation of the deployment of a CAT-authored experience at AM. This focuses more on issues uncovered through observational- and interview-based studies of the user experience itself, but does provide further evidence for the efficacy of the CAT with respect to the authoring of user experiences.

A key focus of CHESS is on supporting the authoring of stories that are personalised to their users, and adaptive to their needs. Technological support for personalisation and adaptation has matured in Y3, and has been integrated directly into the user experience described in section 2.4. A specific evaluation of the personalisation and adaptation facilities of CHESS has therefore been provided in section 3, drawing on the deployment presented in section 2.5.

As well as maturation of the CAT, Y3 has also seen the development of an authoring component with the specific purpose of supporting the early phases of conceptualising an experience. This component was first envisioned in D06.2 CHESS Beta Authoring Tool Detailed Design, where it was referred to as the “Story Planner”. Through work with museum authors, we have observed that story planning often requires multiple iterations of sketching on paper, and hence the implemented tool is referred to as the “Experience Sketching Tool” (shortened to “Sketching Tool”). The design and implementation of this tool has been led by UNOTT, in collaboration with other partners, and it has been integrated directly into the case study presented in section. A formative evaluation of this tool is presented in section 1.2, which draws on media produced through the case study presented in section 1.4.

User experience evaluation has continued in Y3 of the project, but with a specific focus on key questions that are of interest to the project and to the cultural heritage sector. Two user experiences produced by the CAT have been evaluated, as described above, providing evidence for the efficacy of the CAT in producing workable user experiences. A user experience authored by CITE using the CAT was deployed in the Autumn of 2013, and was used by an experimental school group known as the “classe tablette”. This then provides evidence for the usage of the CAT to author experiences that are appropriate for groups of visitors. A user experience authored by NKUA in collaboration with AM was deployed in January 2014, with a focus on issues around storytelling and personalisation.

How to integrate location into visitor experiences is still an open question for the cultural heritage sector, and inspired by the work of the CHESS project, CITE have implemented a mobile app that integrates both indoor and outdoor positioning, working outside of the project. A detailed ethnographic evaluation of this app is included in section 2.2, and provides insights into the impact of this location system.

Section 4 presents a technical validation of key components produced by CHESS partners. The production of this validation incorporates validation work produced by all technical partners, and comprises of quantitative assessments of performance and qualitative assessments of usability and completeness. Validation work has been led by partner responsible for each component, and is presented for the following components:

- The Hub (DXT)
- The Asset Adapter (RF)
- The Storytelling Engine (NKUA)
- The CAT (DXT)
- The Mobile Experiencing System (IGD)

For each component, a SWOT analysis is included to support an assessment of current capabilities and future opportunities.

Section 5 presents the set of user requirements and functional specifications that were established in *D03.12 Final User Requirements Analysis* and *D03.42 Final Release Functional Specifications*. For each user requirement or functional specification, an assessment as to coverage has been made, and comments have been provided to indicate the manner of coverage, or to provide a rationale where a requirement or specification has not been covered.

1 Evaluation of the CHESS authoring methodology

1.1 Overview

Public museums and private collections have existed for much of human history, and there is a long tradition of scholarship that has supported the effectiveness of their work. Through efforts that have been sustained over several centuries, professional and amateur curators have developed and integrated a repertoire of effective tools and technologies to support the work of collecting and presenting material, which are well understood within the profession. Digital technologies offer exciting new opportunities for cultural heritage institutions, but are inherently disruptive, potentially requiring very significant changes to well-understood working practices. As well as exploring new possibilities for technology, research work can support this process of institutional change by documenting effective processes for working with new technologies, thereby supporting a growing understanding of how to use them effectively.

A substantial proportion of the work of CHESS has involved researching a methodology to support the authoring of personalised and adaptive user experiences for the cultural heritage sector. This work has then been instantiated in the CHESS Authoring Tool (CAT), an authoring component that has been designed and developed by the CHESS consortium. That CAT has matured through work in Y2 and Y3, and can now be used to construct visitor experiences. A significant focus of evaluation work in Y3 has therefore been on assessing the CAT, and determining its properties in relation to usage in the cultural heritage environment, through studies of realistic usage in this environment. Realistic evaluations will support the uptake of CHESS in the future, and require involvement from cultural heritage experts who can play the role of end-users. A series of realistic evaluation activities relating to the CAT and presented in this deliverable are summarised in Table 1 on the following page.

Although the CAT is a major piece of work, it does not in of itself represent the entire of the CHESS authoring methodology, and work has also continued to explore other facets of this. As part of this work, UNOTT have designed and implemented an initial version of a tool intended to support early design work around mobile visitor experiences, known as the "Experience Sketching Tool" or "Sketching Tool". This builds upon analysis work presented in D06.2 CHESS Beta Authoring Tool Detailed Design, which identifies the need for a "Story Planning" component. The design of the Experience Sketching Tool draws on the Trajectories Framework (Benford et al, 2009). A formative evaluation of this tool has been provided in this section.

The CAT has been used to produce a final user experience deployed at AM in January 2014. A detailed evaluation of this user experience has been provided in section 2.4 (although this evaluation does not consider the usage of the CAT itself in detail.)

Table 1 Summary of evaluation work conducted in year 3 of the project that relates to the authoring of experiences

Work	Description
Formative evaluation of experience sketching tool (section 1.2)	This provides a formative evaluation of the Experience Sketching Tool, drawing on interactions with CITE and AM, and also with the broader CHESS user group. The evaluation considers four iterations of the design of the tool. Iteration 2 was informed by work with CITE, iteration 3 by work with an art gallery local to UNOTT, and iteration 4 by work with AM.
Creativity workshops with museum authors (section 1.3.1)	Two groups of seven museum authors from the CHESS user group attended two facilitated full day workshops at the AM, and developed some interesting interactive stories which were then expressed using the CAT: • Workshop one – ideation, asset collection • Workshop two (follow-up 2 weeks later) – CAT integration The workshops are detailed in *D03.53 - End-user Workshop #3*, submitted in September 2013. Further commentary on the results of these workshops, highlighting practical experiences with the CHESS authoring methodology, is included here.
Summative CAT interface evaluation (section 1.3.2)	Two authors from AM and a CAT expert from the NKUA performed an evaluation of the CAT interface during the course of several sessions. This has been used to produce a list of issues and suggestions for improvement which have either already been taken up or will guide the future development of the tool.
CITE authoring case study (section 1.4)	CITE worked with the CAT to produce a new user experience, which was then tested by a school group. Documentation collected throughout this experience was used to produce a case-study of the authoring process. This includes detailed estimates of the resources that were used.

1.2 Formative evaluation of experience sketching tool

As part of the work of year 3 of the project, UNOTT have been prototyping and conducting a formative evaluation of a tool that can be used to sketch and explore early ideas about an experience – henceforth referred to as the "sketching tool". The design of this tool has been informed by the concept of a trajectory (Benford et al, 2009). It is also strongly related to the concept of a "Story Planning" component provided in ***D06.2 - CHESS Beta Authoring Tool Detailed Design***, and should be seen as a first exploration of this concept.

This section provides a description and a formative evaluation of the trajectory sketching tool.

1.2.1 An overview of the trajectory framework

In accordance with the general observation of visitors to any kind of interactive experience, the conceptual framework of trajectories was conceived [Benford, et al, '09]. This catered for the expression of a number of visitor pathways, not only the observed routes taken through the exhibition space but an expression of *intended* routes. A detailed insight into these concepts is more-thoroughly explained on the Trajectorize website (www.trajectorize.com).

We are concerned with allowing the expression of this framework to be realised via a web-based trajectory sketching tool that would allow for the creation and organisation of user-defined trajectories whilst being accessible to a wide audience.

A brief summary of these concepts is given below in order to address the minimum requirements that a trajectory sketching application ought to implement to be considered useful and as a means to inform the design of the tool.

Three types of trajectory currently exist to support the designated path through an experience (canonical trajectory), the actual path through an experience (participant trajectory) and then subsequent analysis of the accumulation of such visits (historical trajectory).

During the traversal along the user experience journey, participants may well encounter differing aspects of the visit, such as moments of interaction, observation, or the general progression between the different phases of the exhibit. In trajectory theory these are known as transitions; moments where the particular experience becomes interrupted or disturbed.

The particular instances of where these trajectories overlap are also of importance as these may denote encounters or potential social interaction between participants.

With this theoretical framework established we can then address an initial list of requirements that a trajectory sketching/authoring tool ought to implement:-

- Ability to sketch trajectories and denote which type (canonical, participant, historic).
- Show moments of transition and interaction.
- Annotate sketches to provide additional information relating to the experience or elements of a trajectory that may be deemed significant.
- Provide an intuitive user interface that lets practitioners easily manipulate the elements of the sketch as well as zoom and pan around the sketching canvas.
- More generic application functionality such as the ability to save/load sketches to an appropriate file format.

This then enables us begin the design and development phase.

1.2.2 The design of the trajectory sketching tool

The tool has undergone a number of phases of design and modification with input from both project partners and additional parties who have an interest in expressing their work via the trajectories methodology. The evolution of this process is outlined in the following sections.

1.2.2.1 Initial Iteration

The initial iteration of the tool centred on implementing the basic functionality previously outlined. An example of the user interface is depicted below:

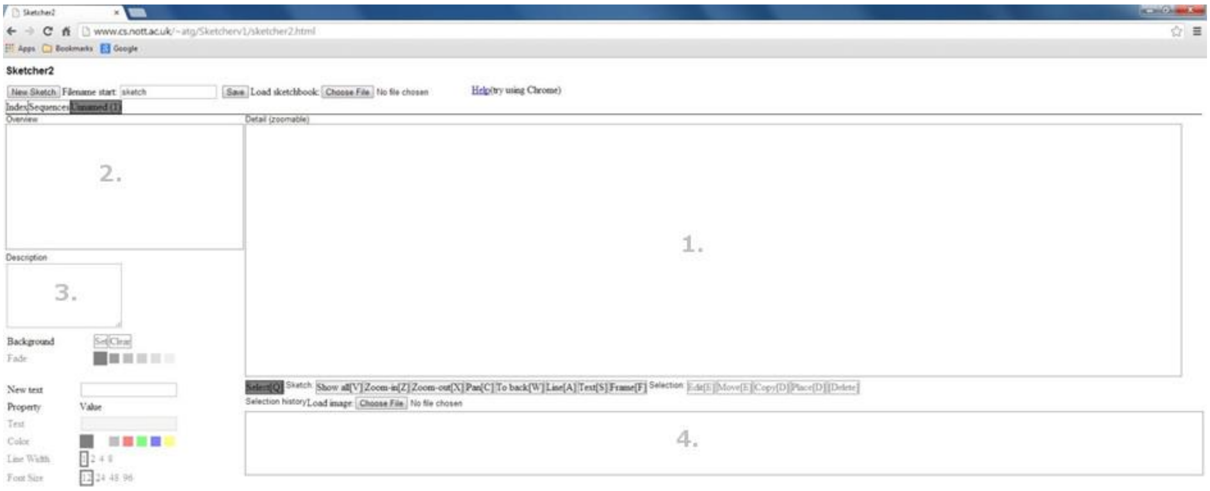


Figure 1 Initial interface design for the trajectory sketching tool

This offered a basic level of functionality with the ability to construct a number of drawing elements and combine these elements to convey further information relating to the experience.

The drawing canvas (depicted as **1.** in the diagram above) is the main interactive area within the tool and allows users to create such elements as lines, frames (rectangular areas to represent differing types of interaction) and text by interacting directly. Images may be imported and subsequently copied onto the main drawing area. These could then be used to define trajectories, transitions and layers of annotation.

An overview window is provided (denoted as **2.** in the figure) that shows a subsection of the entire sketching canvas. A description of the sketch can also be associated (entered in section **3.** in the figure).

The styling of these attributes was limited and typically took the form of selecting an option from a list of properties (in the lower left section of the above figure), but nevertheless offered such abilities as altering the line colour or text height. This can either be pre-selected before the element is drawn on the main canvas or altered upon selection. All elements that are selected within the main canvas appear in the selection history (denoted as **4.**).

It was also important that such a tool provided the capabilities that would be expected of applications of a similar genre; namely the ability to save and load sketches, manoeuvre the sketch around the canvas and zoom in/out to view the content at the appropriate level of detail. Although the interface was quite limited all these features were implemented to some degree.

1.2.2.2 Additional Functionality

Creating numerous trajectories and associated sketches potentially generates a lot of information. One of the features that distinguishes the current tool from other applications that are solely concerned with drawing, is the ability to organise and annotate such information in an intuitive manner. This potentially allows users to encapsulate information and interpret or visualise the details in differing ways.

Before we can express the data structuring we must address the naming conventions within the tool. A user is free to create as many individual sketches as they like, i.e. a number of drawing elements, images, annotations, etc. Whenever they save their work all the individual sketches are saved in a file, denoted as a sketchbook (if you require a sketch in isolation then you can open another browser tab). An index of all the available sketches for each sketchbook is provided within the tool.

The first method of data organisation involves the ability to incorporate sketches into other sketches. This feature caters for the ability to encapsulate information in a potentially more intuitive manner, such as hierarchically for example. This would allow each individual experience to be constructed independently and then added to an overall “master” sketch that shows the whole course of the visit. Any additions to an individual sketch are automatically updated in any sketch that they are contained within, so the master sketch is always updated automatically.

The second feature consisted of the ability to create sequences. These consisted of creating frames (analogous to camera frames) within the sketch by denoting rectangular regions of interest. These could then be labelled and ordered such that a user could click through them in sequence and generate an understanding of how the experience may have unfolded for the participant.

1.2.2.3 Initial Evaluation

In order to get a better understanding of how the development of the tool may evolve we undertook an initial evaluation with partners at CITE. This was particularly pertinent as they actively undergo a process of designing exhibits. Not only did we need to evaluate the sketching tool to determine its relevance but we also wanted to try and gain an insight into the methodology of the whole process of interaction design by experienced practitioners.

Cite were working on a design of an exhibit for school children that addressed the concept of travelling into space to one of Earth’s nearest neighbours; either the Moon or going further afield to the planet Mars. Their initial sketch of the design looked like the following:-

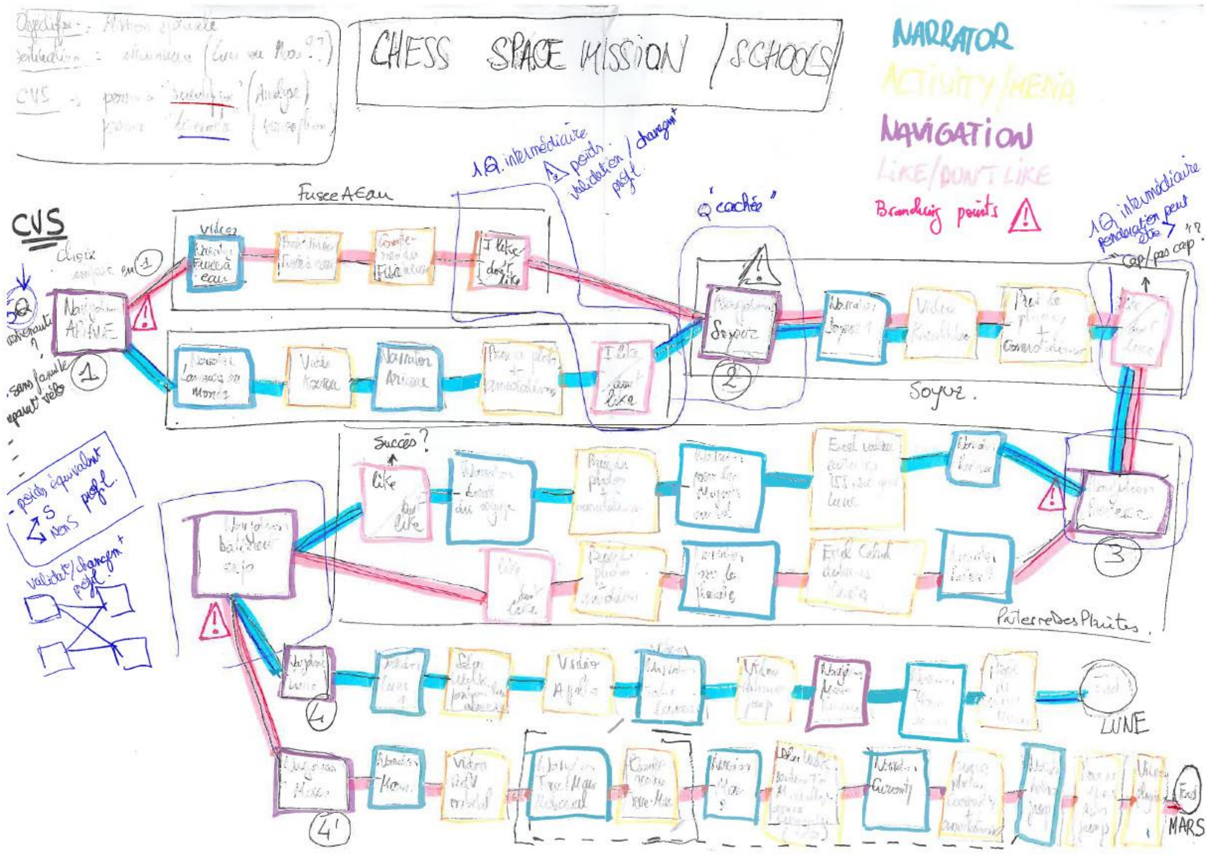


Figure 2 Paper-based sketch of CITE experience design

The design shows a number of routes through the experience with numerous interactions along the way denoted by the coloured rectangles. Individual phases of the exhibit are also grouped together via larger rectangles and there is a lot of annotation to either describe what is occurring at all the relevant points or supplemental information. All the potential journeys are numbered and colour-coded to denote the order and category of the traversal.

The initial reaction to the design is that the representation is already very similar to that of a trajectory-based counterpart; namely there are a number of trajectories denoted with clearly-defined points of interaction that may ultimately become transitions.

It is also encouraging that all of the symbols and annotations used are capable of being implemented in the sketching tool.

With this in mind the following figure depicts the preliminary sketch implemented within the tool:-

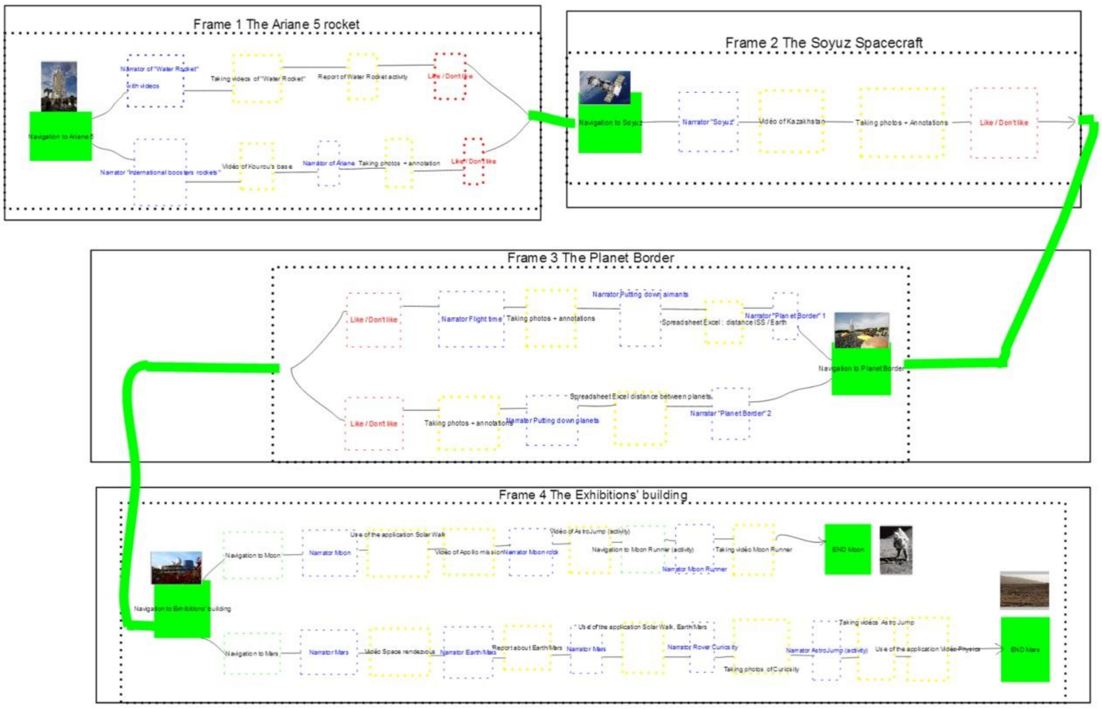


Figure 3 Digital sketch of CITE experience design, produced through the sketching tool

1.2.2.4 Initial Conclusions

The initial thoughts from the Cite design team were mainly favourable. As can be seen the design in the tool bears a resemblance to the paper-based design and the annotations, trajectories and labelling are all incorporated in a clear and precise manner. The addition of images also adds an extra level of information to the design, which cannot readily be incorporated in the original document. The main flaws were perceived to be the lack of export options, the most problematic being that the sketch cannot be exported to an image, subsequently printed and then annotated further. It is worth noting that the Cite team design primarily on paper as this gives the benefit of allowing a number of collaborators to add to the design simultaneously and add annotations in an ad-hoc manner as they see fit (which should be noted for future enhancements to the application). It is also worth noting that the trajectory sketching tool is not designed to replace any paper counterpart, it would be difficult to replicate all the intricate possibilities of pencil and paper. What the sketching tool can do is offer the ability to arrange all this information in an intuitive manner and then present this data in more formal way whilst offering some level of functionality that cannot be reproduced very easily with paper, such as copying, pasting and moving elements. One process that may also be implemented with the tool is the capability to reproduce templates of a design that may offer a convenient starting point for future work.

1.2.2.5 *Modifications Arising from the Initial Design Phase*

The next iteration of the tool attempted to incorporate the recommendations from the Cite experience as well as some more general enhancements from everyday usage. The following illustrates an example of the interface:-

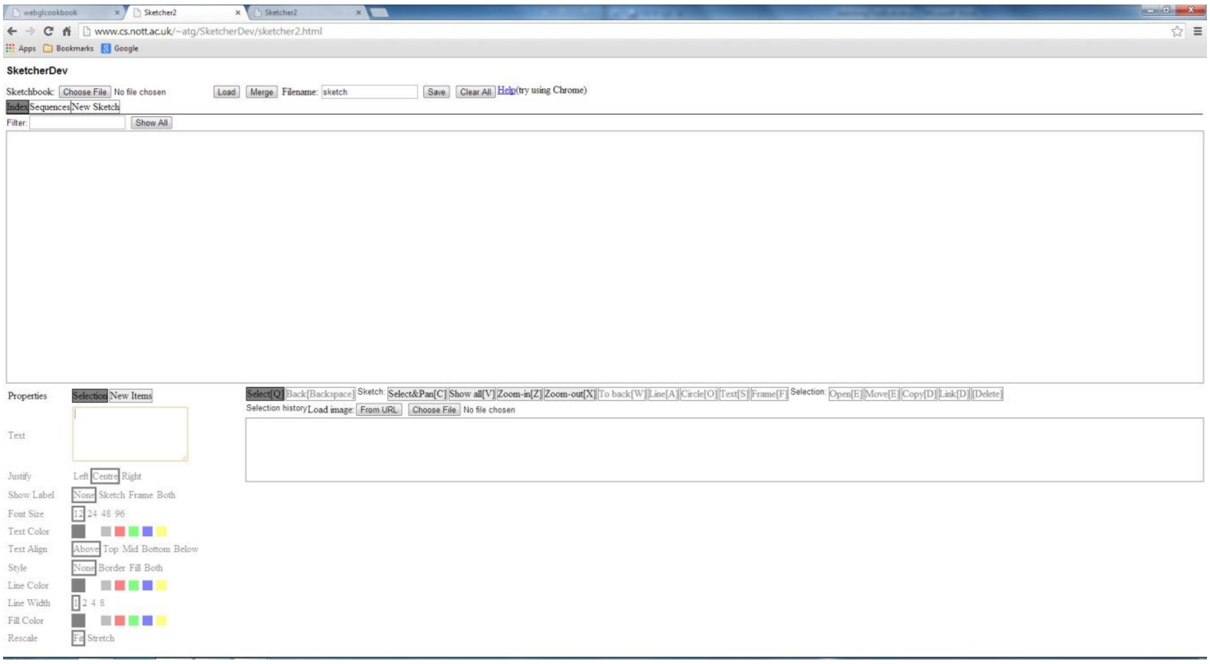


Figure 4 Updated trajectory tool interface, encompassing CITE feedback

There are some additional drawing elements added (beneath the main drawing canvas), such as circles to represent transitions, and an extended set of styling options (on the lower left) to better control the range of representations afforded, such as better annotation options, text alignment, line width etc.

One significant development implemented at this stage was the ability to associate descriptive tags with a particular sketch. This took the form of adding a hash tag followed by the relevant text, #music for example. This information can then be filtered and only those sketches with the relevant tags would be displayed. The following figure shows a number of such tags within a sketchbook:-

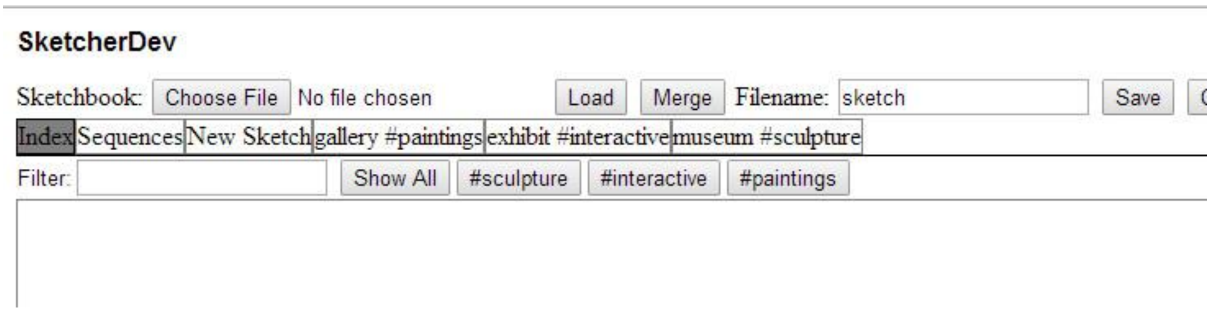


Figure 5 Specific interface component relating to descriptive tags

Each of the sketch descriptions above has an associated hash tag (multiple hashtags can be associated with a sketch). For example the original sketch described as gallery has had a #painting tag associated with it, the exhibit sketch has had a #interactive tag associated and so on. The tool then generates a filtering mechanism for each of the tags in the form of a button displaying the descriptive text. Now if the user clicks the #sculpture button then all sketches with an associated #sculpture tag will be displayed, all other sketches are hidden for the moment. Pressing the Show All button resets the filter. This represents a powerful mechanism for grouping content according to some user-supplied metadata. Potentially more complex cross-referencing relationships are also achievable as sketches can have multiple tags representing shared themes or points of interest.

Armed with the enhancements users were now better equipped to complete more detailed and informative sketches that represented actual participants' experiences when visiting interactive exhibitions.

1.2.2.6 Sketcher Capabilities at the Current Time

The following screenshots depict a couple of examples of sketches constructed within the tool at this time in its development. They show user trajectories taken around an art gallery, with sufficient annotation to denote the order in which the exhibits were visited, accompanied by images and textual descriptions of participants' reactions to the pieces.

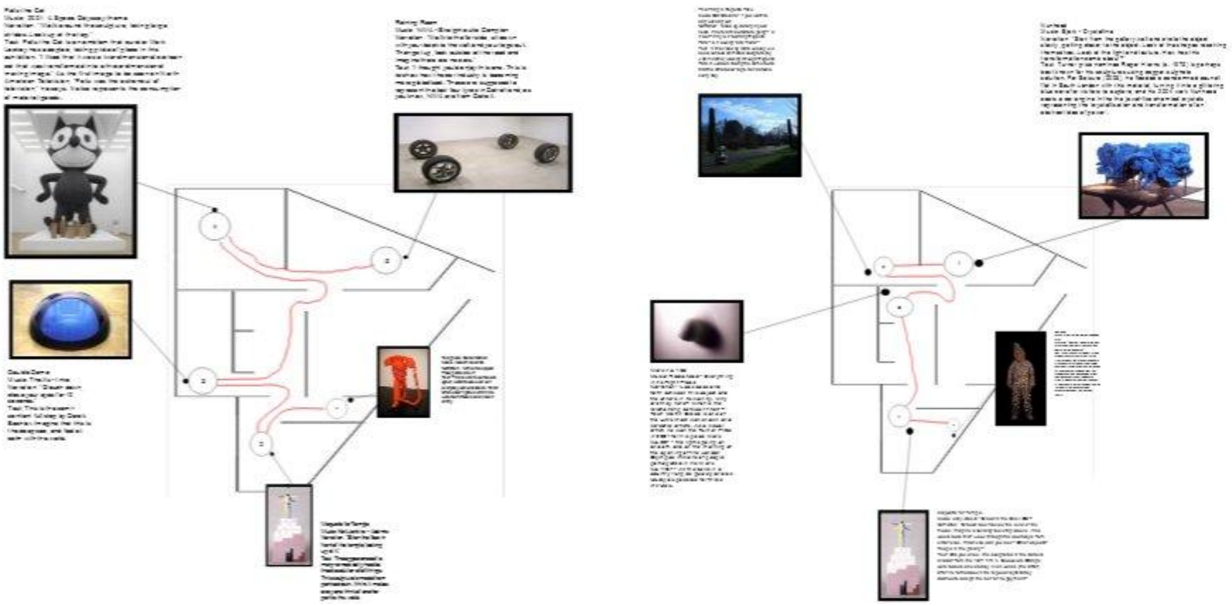


Figure 6 Trajectory sketches of art gallery

1.2.2.7 Further Informed Design

In addition to the evolution of the sketching tool, the trajectories concept was also being introduced to more parties in an effort to gauge its usability in more practical and real-world situations. A number of trajectory workshops have been undertaken culminating with a two-day intensive course being held at the University of Nottingham in the Summer 0f 2013. This involved several commercial parties each of which had a user experience that they wished to develop. The course provided an ideal experience to apply the concepts to genuine user experiences but also to further evaluate the core trajectory theory to assess its merits and apply any necessary refinements. Although the use of the sketching tool was limited due to time constraints the process of creating paper prototypes was still valuable in terms of informing the design of the web based application.

A separate strand of user evaluation was also being undertaken in the form of two MSc student projects. These attempted to address aspects of user interface evaluation and usability.

Two user evaluation studies were performed with prototypes of new interface designs and some additional functionality.

The most prominent output of the studies clearly outlined the need for a new interface that increased the usability of the application and generally enhanced the "look and feel" of the application as a whole.

The user evaluation findings may be classified as follows:-

- The use of icons was preferred over textual representations for button functionality.
- Better use of the available screen space could be made by utilising the functionality of modern UI widgets such as drop down menu items and colour pickers.
- Definitive background colours for the available sketching space.
- Ensure that pertinent information is portrayed to the user on occasion of errors or where they should generally be aware of the configuration options that they have chosen.
- The ability to "share" sketches by sending the representations to other users. This may also serve as the basis for a server backend to the application to allow for a repository of sketches available to all users.

With these findings in mind an updated interface was constructed as depicted below:-

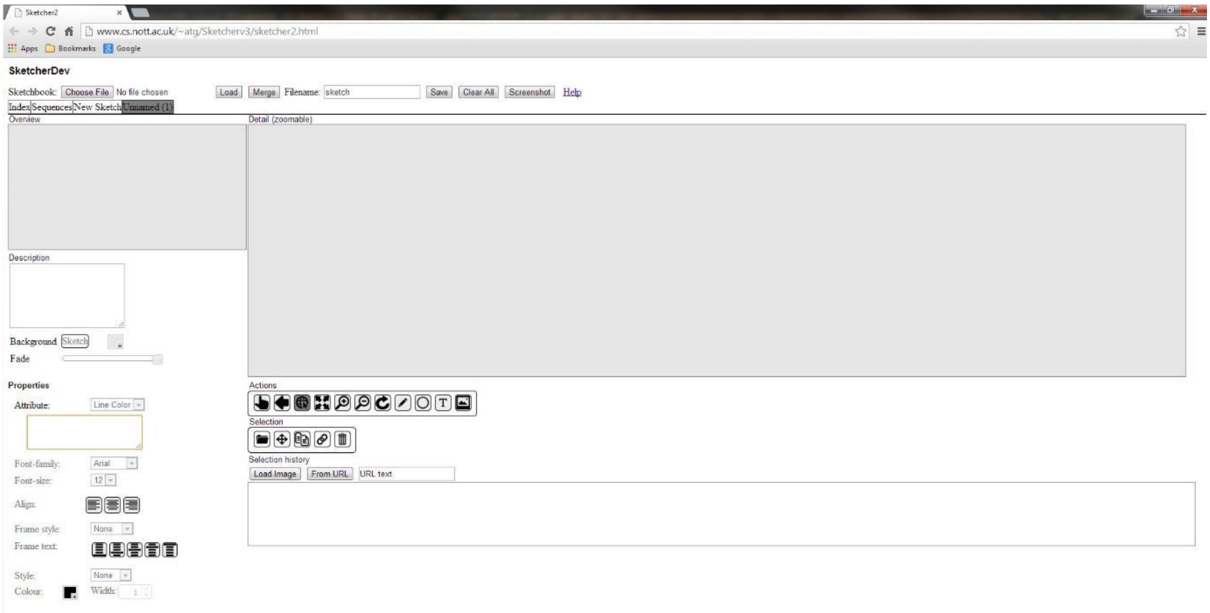


Figure 7 New trajectory tool interface

1.2.2.8 Sketcher Capabilities at the Current Time

Following on from the above design modifications we are now in a position to create more feature-rich sketches. The following depict the outcome of a trajectory-based workshop at the Acropolis Museum in Athens and represent the equivalent paper-based sketches produced during the design phase. Several enhancements can be seen in the sketch such as a different default background colour, subtle colour changes to denote relevant areas of text and the addition of straight lines. The efficiency of the tool has also increased; common drawing elements may be duplicated for increased speed of use, straight lines provide quick and accurate ways to label objects and the canvas itself is easier to manoeuvre due to keyboard shortcuts and mouse wheel scrolling.

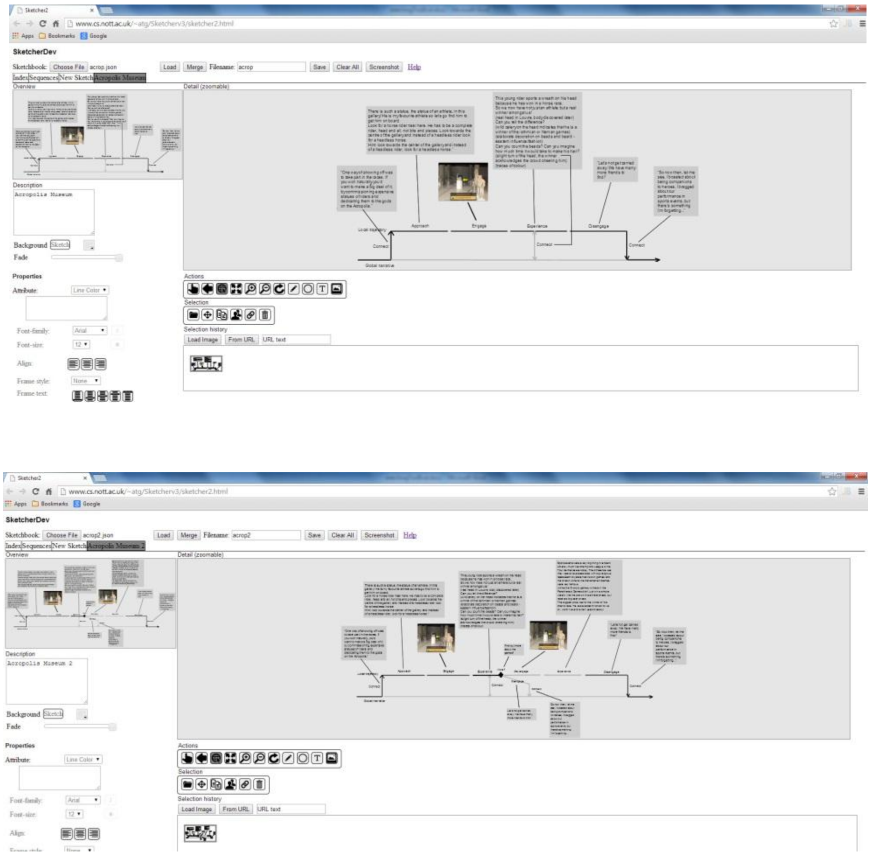


Figure 8 Trajectory sketches of Acropolis Museum exhibit

1.2.3 Conclusions

The interface has now undergone a complete redesign in order to incorporate the recommendations from the user evaluations. The most notable features are:-

- All operations may be executed by clicking on the relevant icon. Icons are enabled/disabled automatically according to which tasks the users are undertaking at any given time.
- The operations are grouped according to new actions and actions that may be performed upon the selection of an element. This separation is aimed at making the list of available interactions clearer.
- The properties associated with an element are selected from a group of widgets on the lower left of the interface. These have been constructed to allow for greater flexibility in terms of attempting to re-use widgets for as much common functionality as possible. For instance there is one drop down list to select three different colour types, and the style drop down applies to the style of multiple elements (circle, line, frame, etc.).
- Colours are now selectable from a palette and therefore potentially allowing any colour to be applied to an element style.
- The background colour and sketch are now implemented via widgets allowing for a range of colours to be selected and the transparency of background sketches can be applied within a range as opposed to a number of pre-set values.

1.3 CHESS authoring at the Acropolis Museum

The evaluation of the CHESS authoring process and tools with museum authors at the Acropolis Museum consisted of a series of creativity workshops at the Museum and more focussed follow-up sessions of the CAT. This effort, which began in September of 2013 and has continued to the end of the project, is described in the following sections.

1.3.1 3rd User Workshop at the Acropolis Museum and follow-up

A creativity workshop organized by the University of Athens (NKUA) and held at the Acropolis Museum on Sept 23, 2013 was designed as a first event aimed at evaluating the authoring of CHESS stories, from start to finish, especially focusing on the support provided by the CAT with a goal to collect a set of potential improvements to its logic and interface. The workshop was held with a limited number of invited "external" to the project participants as well as "internal" members of staff of the Acropolis Museum.

This workshop has been detailed in *D03.53 End User Workshop #3* and summarized below.

1.3.1.1 Method

Two groups were formed, each with 4 staff members from the Acropolis Museum and 3 "external" participants. Participants were pre-assigned by us to one of the two groups so that each group included individuals covering key areas of expertise. As a result, each group comprised two archaeologists, a museologist, a writer, an expert from the creative industries, an educator, and a host-archaeologist. Additionally, members of the CHESS project supported the two groups, providing help with the authoring and production of the stories within their various capacities and expertise (e.g., audio recording, technical help with authoring tool, production of images, etc.).

Each group had to come up with a story experience for a particular visitor persona (assigned beforehand), produce it using CHESS tools, and present the result at the end of the day (Figure 9). The whole process, both in the gallery and in the meeting room, was carefully observed by the CHESS members in charge of management and assistance and video-recording was undertaken with both groups in order to allow more in-depth analysis after the event had finished.

Figure 9: Two groups of museum authors brainstorming (left) and testing their story in the AM (right).

The story ideation phase took up most of the group's time. Consequently, the stories created by both groups were staged but there was not enough time to produce, test and bring the stories to their final version (including purposefully designed multimedia assets). However, since the groups were so engaged with the process and greatly enjoyed it, they decided to continue working on their stories in the weeks following this full day workshop. Both groups had meetings and exchanges via e-mail and file sharing means, and engaged in a kind of "competition".

A second workshop was organized two weeks after the first, on October 7th 2013, in which the two groups came together to present their stories and discuss the issues and shortcomings.

1.3.1.2 Results from the workshop

The workshops provided invaluable results about the CHESS authoring process. As noted also in *D03.53 End User Workshop #3*, the main conclusions of the event can be summarized as follows:

- The design of CHESS experiences needs interdisciplinary authoring groups. The main complementary skills would be: storytelling, archaeology, museology and graphic design. It is not necessary that each one of these skills is impersonated by one single person, but rather having authors with a multidisciplinary background facilitates the dialogue between specialties.
- The production of digital interactive personalized stories for museum settings needs several iterations. One of the most important is staging in the gallery, as the introduction of the environment breaks spatially the experiencing of traditional storytelling.
- The training for the design of CHESS experience needs systematic independent training not only about the CAT but also about the authoring process. This is due to the fact that cultural heritage professionals are less familiar with the new aspects introduced by interactive digital storytelling for mobile devices (interaction, staging, and especially personalization and non-linearity), and need more time to assimilate them.
- The CAT should be endowed with a range of specific features in order to better support user-centred story design.

1.3.2 CAT usability evaluation at the Acropolis Museum with authors

As noted in section 1.3.1, during the 3rd user workshop emphasis was given on the creative aspect of authoring with a minor part dedicated to evaluating the CAT tool. To record more feedback on the tool itself, it was decided to proceed with evaluation activities more focused on the usability aspects of CAT. These activities were more of a formative nature, leading to several improvements and updated versions of the tool. This section presents the methods deployed for this evaluation and outlines its results.

1.3.2.1 Method

The CHESS authoring tool, as opposed to the CHESS end user experiences, is not a tool addressed to first-time users but to authors who have been trained for its use and have a clear understanding of the authoring methodology that it is designed to support.

In order to "simulate" as closely as possible this trained group of users and obtain constant feedback on the new versions of the tool, a small team was formed with the purpose of evaluating CAT in the "real-world" context of the on-going story-authoring activities in AM (Figure 10).

The team was comprised of a cultural technologist and an archeologist specialized in digital heritage, as well as a computer science researcher from NKUA. The objective was to evaluate the tool both from an interface design expert's point of view and from the usability aspect as experienced by the foreseen future users of the tool, museum personnel of basic computer skills.

It was decided that the team would be kept small so as to be able to meet frequently and dedicate more work hours in training and using the tool, as would happen in a real world scenario.

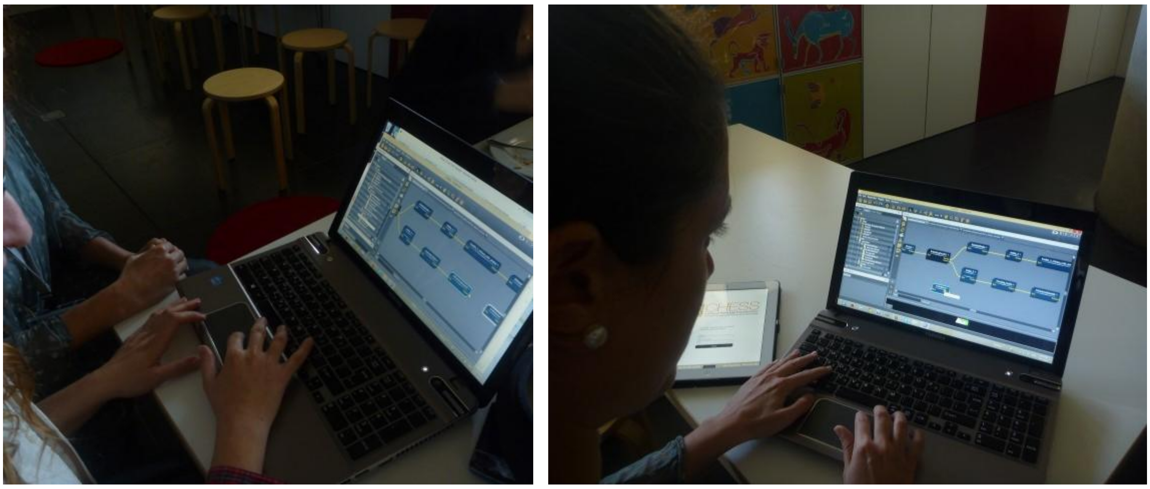


Figure 10: A small group of museum authors was trained to use the CAT on a continuous basis.

The computer science expert presented the tool to the AM personnel members, in a 1.5 hour training session after which they were asked to use the tool to author one of the stories produced during the 3rd CHESS User Workshop (held on September 23, 2013) and later updated at the follow-up Workshop (held two weeks later, on October 7, 2013). This session produced an initial list of issues that was presented to the technical team developing the CAT, namely DXT, and a new CAT version was produced.

This process was repeated in several sessions that took place weekly at the AM, during which the team jointly or individually authored parts of the story focusing on different aspects, including design of the story graph and authoring of the corresponding activities for each story node. New issues were discovered as the complexity of the authored story model increased and the users focused on different stages of the authoring process.

1.3.2.2 Results

The project wiki was used for recording the working list of issues. This list was constantly updated by the evaluation team and the CAT developers at DXT. A “snapshot” of this list is available in Appendix 7.1 and represents an important contribution of this process. This section summarizes the main findings from the CAT evaluation process.

On the whole the tool has been used successfully to author the stories designed by the users, including the story graph design and the implementation of each script unit through Narrator 1, Narrator 2 and other activities (games, AR, etc).

Complexity of the story model and personalization aspects

One of the main issues that the authors faced during their interaction with the tool was the complexity of the story model that the authoring tool supports, especially in relation with its personalization aspects.

The museum personnel were already familiar with the concept of personas and their use in CHESS to facilitate the authoring process (Roussou et al., 2013). During the authoring workshops, two personas were considered and integrated in story design as a conceptual starting point for the authors.

Also, the concept of dividing the story into script units and using mandatory[1] branching points to offer choices to the users was clear to the users.

However, the authors had more difficulty grasping the more complicated personalization aspects, for example:

- How does the personalization system take into account the personalization annotation attributes in each script unit?
- How does the system handle automatic[2] or no-menu[3] branching points and what do they mean in terms of the final experience?
- Which is the criterion for dividing the story into story units? Bigger, meaningful and complete story parts may result in the user missing an important part of the story when the user chooses to skip.

As these issues are crucial for the successful design of a fully personalized storytelling experience, there is possibly a need for detailed documentation and support to the author on how to handle these aspects with CAT.

Complexity of the user interface

The users did not have significant difficulties in using the main graph design functionalities, including script unit creation, branching points, etc. The toolbars used for the creation of these elements were not described as intuitive, however training and repeated use established familiarity.

Map manipulation was more challenging for the users, especially for 3D maps. Navigation in 3D environments is not a trivial task, however, for the authoring tool maybe a simpler approach should be adopted allowing the positioning of the user automatically on the hotspots s/he has defined, avoiding free navigation on the whole space.

The most challenging task for the less experienced users was to edit the properties of the created node elements. The AM authors needed significant training to familiarize themselves with the various properties of each element. For the initial versions of the tool there were several issues in the operation of the properties hierarchy which were gradually resolved.

However, the interface still remains complex for non-computer experts as there are several interface elements and interaction issues that are unclear to them or that create difficulties during the interaction with them. For example:

- Users did not understand what the right click menu choice "Edit attribute" on attributes was about.
- Users must have already selected the destination property if they want to add an image or audio file to it.
- When users drag & drop an asset in the asset editor to upload it, the status bar appears at the bottom of the asset editor window. As a result the user must have resized this window in order to get feedback that the asset is actually being uploaded.

Editing of narration activities (whether Narrator 1, Narrator 2 or Presentation type ones), would significantly benefit from a more visual interface where the user would be able to design the visual aspect of the activity, including the possibility to preview the activity, as described in the next paragraph.

[1] Story branching points that appear to the user as menus where she is asked to decide which branch of the story to view.

[2] Story branching points that either appear as menus or allow the system to automatically make the choice for the user and no menu is shown.

[3] Story branching points that are never presented as menus. In this case the system makes the choice for the user.

Lack of preview functionality for Narration activity design

One of the main issues when designing a narration activity is the need for immediate visual feedback when editing the activity. For example, as currently implemented, the author cannot have a direct overview of the visual and sound elements combined on a Narrator2 page; not even what the text corresponding to the sound elements is. To accomplish this, the authoring team kept a separate textual file (outside of the CAT) where this correspondence between visual and textual (sound) elements and consulted this file every time, going back and forth between the CAT and the list of content elements.To sum up, the CHESS authoring tool can be used to design and deploy CHESS stories. It supports the user in editing the story graph and creating the narrating activities of the experience, as well as importing crafted activities, like games. Once trained in its use, the author can author complete stories and deploy them as end user experiences with minimum support by technical experts.

However, for non-computer experts the tool requires extensive training and it is cumbersome in its use. To improve CAT as a tool for non-computer expert authors, it would require (a) improvements in its interface and interaction aspects, (b) making the software more stable through extensive testing and (c) a more visual design of Narrator 2 activities, including preview functionality to compliment the Simulation one.

1.4 Case study of a mobile experience authoring process at CITE

1.4.1 Overview

A significant strength of the CHESS project is that two consortium partners are important cultural heritage institutions in their own right, both of whom have committed to exploring and experimenting with the CAT. This section documents a case study of the usage of CAT by CITE, through a realistic design and deployment process focused on a collaboration with the "class tablette", an experimental school group whose lessons have been constructed around the iPad for an entire year. The case study reveals specific details of how staff at CITE approached the task of designing and producing a new experience. This then supports a greater understanding of how cultural heritage institutions might work with mobile experience authoring tools if their deployment becomes more widespread.

1.4.1.1 Structure of the CITE case study

The case study itself begins with a descriptive analysis of an interview with a senior member of exhibition design staff at CITE, which was conducted early in the project. This analysis considers existing working practices relating to exhibition design and the broader organisational context in which these are located. This knowledge supports an understanding of the broader environment in which this case study is located. The interview itself has a specific focus on how exhibitions are conceptualised and realised, and how the work of conceptualisation and realisation is divided between internal CITE staff and external contractors. This is an issue that is very relevant to the design of mobile experience authoring tools, as it determines who the users of a tool might be, and how the process of creating experiences will be structured.

Following on from this initial interview, the case study then presents detail from an eBook which was authored by CITE outside of the CHESS project. This eBook was authored specifically for the "classe tablette", and was intended for usage during a school visit to CITE which took place in March 2013. Effectively, this eBook defines an on-site mobile experience, albeit one that has no components that dynamically respond to the needs of different users. The interactive mobile experience authored using the CAT builds on the design of this earlier experience, and was inspired by it. Presenting key details then supports an understanding of the design process as a whole, and supports an understanding of how CITE went about the design of a mobile experience without the support of a specific authoring tool.

Working from this initial design represented by this eBook, CITE educators and exhibition designers then collaborated to design and implement a prototype interactive experience through the CAT, which was deployed in October 2013. This process was very much led and completed by CITE, but training and technical assistance were provided by consortium members. A detailed study of this process is included. The expression of this study draws on:

1. An archive of material collected during the design and implementation process
2. An interview with CITE staff conducted towards the close of the implementation process
3. Documentation of the effort put into this process by CITE staff and consortium members
4. A reflective interview after deployment in October 2013

Point 3 responds to a specific a request from the year 2 reviewers for estimates of the effort required to construct experiences using the CAT.

In the context of this broader case study, detailed work with the CAT took place in September and October 2013. This coincided with a period in which the main phase of CAT design and development had been completed, but in which bug-fixing and feature improvements were still ongoing. These processes are to be expected in a piece of software that is very new, and though bugs did cause some disruption to the processes described in this case study, the CAT itself was sufficiently operational to allow a working experience to be deployed. There is very little to be learned from documenting issues such as bugs in a deliverable, and analysis presented in this section mostly focuses more on how the tool was used rather than on difficulties that were encountered.

The case-study concludes with a discussion that highlights some interesting issues around the authoring process. Specifically, it presents a detailed discussion of:

- Who the users of a mobile experiencing tool might be
- The boundaries of functionality that might be offered by an authoring tool
- How a tool might interface with paper and other forms of prototyping

This discussion is grounded in data presented within the body of the case study.

1.4.1.2 Summary of data collected to support the assembly of this case study

A significant amount of data has been collected to allow for the authoring of this case study. Data consists of the following elements. Specific descriptions of these are provided in the body of the case study:

- An interview with a senior member of the CITE exhibition team, conducted early in the CHESS project
- An eBook, described above, which was used as the basis of a non-interactive experience at CITE
- A set of material collected during the process of designing and authoring the mobile experience deployed in October 2013. These include more than 100 sketches and mock-ups produced by CITE, many of which have been included as exemplars of working practices.
- Two CAT project files, which illustrate the practices that CITE staff adopted in working with the CAT.
- A one-hour interview with members of staff at CITE who were directly involved in the design process described above. Questions asked in this interview focussed on understanding the working practices that had been adopted in working with the CHESS authoring methodology, and on understanding the reasons that these working practices had been adopted.
- A post-deployment interview with the same members of staff, which provided some reflection on the process of deploying an experience using CHESS, and some specific detail on the experience of using the CAT using a realistic deployment.
- An estimate of the effort required on the part of CITE staff to design and deploy the experience itself. An estimate of the cost of designing and deploying experiences was requested by the reviewers through the CHESS second year review. The estimate has been compiled by project staff working at CITE

1.4.2 An interview with a senior member of the CITE design team

On 27th April 2011, the CHESS project conducted an interview with a member of the exhibition design team at CITE. The purpose of this interview was to understand the processes involved in constructing exhibitions at CITE, with a particular focus on the structure of the interactions between individuals involved in this. This was a detailed interview, which produced 100 pages of collected transcript and illustrative photographs of materials, and this analysis only considers a portion of its contents. A brief descriptive analysis of its contents is provided here, where it sheds light on the working practices at play in CITE at the time of the interview. A more detailed consideration of important questions raised by this interview is then provided at the end of this section.

1.4.2.1 What kind of exhibitions are designed?

The following descriptions have emerged directly from a consideration of the interview described above, and therefore represent the perspective and understanding of the senior exhibition designer who was interviewed.

CITE as a physical venue hosts exhibitions that are described in the interview as either "temporary" or "permanent". Some of the internal processes involved in these are different, and temporary exhibitions have a much shorter life-span than permanent exhibitions. Exhibitions at CITE can span the entire site, and hence temporary and permanent exhibitions can be interleaved together in physical space. Exhibitions often consist of multiple fragments that are tied together to form a narrative that is comprehensible to visitors.

CITE also produce touring exhibitions. The design of these is not disjoint to the permanent and temporary exhibitions; touring exhibitions are modified versions of exhibitions that already exist in CITE.

Temporary exhibitions

Temporary exhibitions generally open in February (because CITE is closed to the public in January). Each temporary exhibition is focussed on a single theme. Generally, they are intended to stay in place for one year, but there are variations in this depending upon a number of factors. One annual exhibit was kept in place for two years, because it had been expensive to produce, and because CITE staff were starting to engage in the redesign of the permanent exhibition space, so had less time to focus on designing temporary exhibitions.

Some temporary exhibitions are very small in scale. One annual exhibition, presented in 2008, consisted of just a few small exhibits which were distributed throughout the main exhibition space and which provided a new visitor trajectory through it.

In general, the construction of temporary exhibitions might include activities such as authoring new videos or new live shows (e.g. in the Planetarium). An example of a temporary exhibition was "Cosmomania", a space in which corridors linked five rooms (referred to as "bubbles"). Each room presented material about a different country involved in the space race, and organised temporally so that the last room considered China as a very new participants.

One temporary exhibition, focused on the "search for extra-terrestrial life" featured three different exhibits, split across the outdoor space of the site. The preference of the designers was that visitors would visit these in a particular order. To encourage this, and to create a narrative that spanned across the exhibits, a physical document was provided in the entrance hall. This exhibition was left in place for a second year – for the second year, the design of the exhibition did not change, but the design of the document was updated, based upon studies of how visitors had understood it in its first year.

Permanent exhibitions

Permanent exhibitions remain in place for a much longer period of time, and replacing them is a major exercise. A "refreshment" (French term, but roughly the same meaning in English) was underway at the time of the interview, and was described in detail.

This refreshment involved:

- the complete redesign of the contents and routes through the main exhibition space
- changes to the "scenographie" (French term – referring to the general approach to engaging with the audience. Might be compared to the general set of competencies and activities involved in theatre design)
- changes to the emphasis of what CITE chose to present

Through the renewal, CITE wanted to create four routes through the main exhibition space, using different colour schemes to mark them out. The result of this refreshment would be a permanent exhibition presenting four key topics:

- General applications of space technology, such as exploring the solar system
- A specific consideration of communication as an application of space technology

- A specific consideration of geo-location as an application of space technology
- observation (observing the universe at great distance)

These required changes across all four floors in the main CITE exhibition space.

One specific consideration in the *refreshment* was how to explain applications of space, such as support that could be provided for disaster response. CITE wanted to construct an interactive game around the topic of disaster response, but they needed to be careful how they present work around disasters.

Touring exhibitions

CITE also produces touring exhibitions, which are related exhibitions that can be found in CITE. There a tension between creating exhibitions that are large and immersive, but which then require further effort and expense to tour, and creating exhibitions which can be toured immediately. One temporary exhibition cost 700,000 Euros to produce, but an additional 300,000 Euros was spent on producing a touring version. CITE are increasingly aiming for exhibitions that are "itinerable" (French term. Candidate translation: tourable) i.e. those that can be used both at CITE and also taken on tour with little change.

1.4.2.2 Who leads the design of exhibitions at CITE?

At the time of the interview, the direct process of exhibition design was managed by a team of around five people employed by CITE. The structure of management has changed over time, and the exhibition design process has changed to reflect this. Up until 2004, there was a role of "direction exhibition" [French term. Candidate translation – director of exhibits], who made all of the important choices, incorporating scientific advice. Through a major reorganisation, all major functions placed under the integrated control of a "direction de programme" [French term. Candidate translation – programme director]. Functions currently under the direct control of this person include:

- exhibition design and content production
- event organisation – to include lectures and specialised visits for schools
- live shows
- programming of IMAX shows
- production and programming of planetarium shows
- educational activities

CITE has a marketing department, and members of this department have a significant influence on the selection of themes and topics for exhibits. CITE have tried to maintain a good balance between education and fun – to still try and present serious things, but want to be more fun in the way they present them.

There can be a tension present in this influence. One temporary exhibition featured a model of a flying saucer as an exhibit. This was criticised by some staff for not being scientific, but the interviewee argued that the exhibition itself was still intended to be scientifically informed. In general, there has been a movement away from an initial conceptualisation of CITE as being all about space technology. Originally, the park was full of scientific detail and technologies. However, CITE staff started to realise that these were not sufficiently interesting for visitors. There has been a movement towards exhibitions that are more focused on telling people how and why particular technologies existed.

The process of exhibition design is generally described as having two top-level phases - "conceptualisation" and "realisation". Some interesting detail about these phases was provided through the interview. Conceptualisation is generally done by CITE staff, realisation is generally done by external contractors, although the exact split depends upon the nature of the task.

1.4.2.3 Structure of the conceptualisation process

The conceptualisation process for a temporary exhibition begins with the consideration of a single theme. There are generally two sources of themes – the marketing department and the exhibition design department. Where there are disagreements about the theme to choose for a particular year, final decisions are made by a "Comité de direction" (French term. Candidate translation: management committee). This committee considers the various possibilities they have been presented with and make a choice.

Key anniversaries have sometimes provided inspiration, and have included the 50th anniversary of the first satellite. If this topic had not been chosen for a temporary exhibition, then it could still have been the subject of a small show or event, scheduled for the day of the anniversary. Another example of a theme was the 40th anniversary of the first manned moon landing. This was considered to be such an important topic that both the exhibition department and the marketing department agreed on it very easily.

Once a topic has been agreed, then content will be identified. This is then organised into sub-topics which express the ideas that visitors will have to understand. Exhibitions might be spread across the park. In the example of a temporary exhibition organised around the topic of the search for extraterrestrial life, there were three key locations, spread around the park, with a natural starting point at a building called the Terradome. This particular process was led by one person, working as a project manager, who really "drove the project". This person was very knowledgeable about the history of space exploration, and worked with a small team of exhibition staff. Early discussions around this project were held in meetings during the course of design, using whiteboards and paper.

Contrast with the conceptualisation process for permanent exhibitions

There are differences in scale between temporary and permanent exhibitions, and hence differences in the structure of the process. Design of a temporary exhibition happens on a regular basis, so has some consistency of structure. Where updates to permanent exhibitions are made, this is then on a much longer (i.e. multi-year) timescale, and changes are much more expensive and required a very significant investment in the process. This is then a much more bespoke process, encompassing multiple themes and multiple narratives, and requiring collaboration between many staff across CITE.

1.4.2.4 Structure of the realisation process

Conceptualisation work, however structured, is done by CITE staff. Realisation work is generally done by external contractors. The interview provided some information about the structure of this work, some of which is mediated by key documents.

- Conceptualisation work leads to the production of a short document that presents the concept(s) that have been developed by CITE. This is called an "avant project summaire" (APS) (French term. Candidate translation: Pre-project summary).
- An external "scenographer" is recruited. They are given the APS, and asked to produce an "avant project definitive" (APD). This is a much larger document that provides a very detailed treatment of an exhibition design, incorporating elements that consider in detail such as:
    - How space might be used
    - How graphical elements can be used in communication with visitors
    - How interface to interactive elements might be designed

- A cohort of potential production companies are recruited through an external call structured around a document called an “Accord Cardon” that provides a broad summary of the requirements for an exhibition (French term. Candidate translation: framework agreement)
- Selected companies are then given a “Cahier de Charge” (French term. Candidate translation: specification document), a very detailed document that provides a precise specification of issues such as the context and purpose of the exhibit
- Companies are asked to present different implementation options, which describe precisely what they can offer and at what price – if accepted, these will become contractual obligations.
- Companies who are awarded a contract are asked to offer a one-year warranty, so offer technical support during this period.

In general, contracting out work avoids the overhead of maintaining the relevant capability at CITE. Some interactive technologies can be managed from a distance – e.g. a current interactive exhibit is managed by a company from Paris, who can log into the system and solve some technical problems without having to travel to the site. For physical exhibits, CITE prefer relatively local companies to reduce the time taken for repairs.

1.4.2.5 Key issues to understand

A detailed discussion that considers information provided in this interview is provided at the end of this section. At this point in the case-study, the following issues are important to highlight, and provide a foundational understanding of how work is structured at CITE.

Differences between the “Conceptualisation” and “Realisation” and realisation of exhibitions

Exhibition design and implementation is split into phases, labelled “conceptualisation” and “realisation” (both French terms, but with roughly the same meaning in English). The initial conceptualisation phase is led by CITE, and produces an “avant projet summaire”. Detailed conceptualisation work is done by a scenographer, who is externally-appointed, and who produces an “avant projet definitive”. “Realisation” is generally done by external contractors appointed by CITE. This avoids the overhead of having to maintain realisation capabilities within CITE.

Transfer of responsibility

Contractors are generally asked to offer a one-year warranty. Some temporary exhibitions are used for more than one year, and permanent exhibitions have a lifespan of multiple years. Exhibitions may be updated during their lifespan, potentially in response to an analysis of their effectiveness. CITE lead the process of making updates, and have some internal capability to support this. We might presume that some of this work could be contracted out, but this was not discussed in the interview.

Documents involved in the process

The entire process is mediated through a number of established documents. These include:

- An “avant projet summaire” (preparatory summary)
- An “avant projet definitive” (preparatory detail)
- An “accord cardon” (framework agreement)
- A “cahier du charge” (specifications document)

Documents help to structure the process. Each has an established purpose.

1.4.2.6 Key questions to consider

These processes are bespoke to CITE, but similar considerations might be present in other cultural heritage institution. Working from an understanding developed through the presented analysis of this interview, the following specific questions are interesting to consider, especially in the context of understanding how the authoring of mobile experiences might be integrated into cultural heritage institutions:

- How should an authoring tool support the process of conceptualisation?
- How is work split between internal and contracted staff, and who will the users of an authoring tool actually be?
- How can an authoring tool support collaborations between internal and contracted staff?
- How are updates to mobile experiences supported and made, especially if they are in place for several years?
- What documents are useful to support the process? How will these documents be authored and expressed?

We might also ask whether exhibition design is an appropriate model to consider in relation to mobile experiences. Are mobile experiences sufficiently like exhibitions that an existing understanding of how to design and implement exhibitions is relevant, or are they more like other activities at CITE? This is an open question, and one that is relevant to the cultural heritage sector more broadly. This question is considered in detail in the discussion at the end of this section, and is an interesting question for research work to consider.

1.4.3 An eBook for the "Classe Tablette"

Outside of the CHESS project, CITE have been working with an experimental school group known as "la of classe tablette", based at Lycee Paidalhan (a school). For a year, this group of students are working entirely with the iPad as an interface to teaching material. To support this experiment, CITE have produced an eBook, titled La "classe tablettes" à la cité de l'espace : Mission pierre de Lune et roche martienne". This can be translated as "The 'Class Tablette' at cité de l'espace : Moon stones and martian rocks". The model of usage for this eBook is that members of the CT would install this book onto their iPads, and work through its contents whilst at CITE, under the guidance of their teachers. This book then essentially defines a statically-designed mobile experience, in that it does not dynamically adapt to the interests of its users. As an eBook, it does include elements that support a broader model of interaction than a traditional book. These include videos and quizzes.

Design and deployment of this experience then took place outside of the CHESS project, so the working practices implicated in it have not been documented, and cannot be discussed in this deliverable. However, this book served as a starting point for the interactive experience that was constructed by members of CITE using the CAT in the summer of 2013, and hence an understanding of the structure of the book and the experience that it provides to students is important in the context of this later design work. As such, illustrative screenshots of this book are provided in this section, along with a textual description focussing on this experience.

The book itself then draws on a longer tradition of the production of educational material at CITE. School groups form an important sector of the CITE visitor base, and CITE produce teaching material to support the work of teachers, which is generally provided on paper, and integratable into lesson plans. This book, and the experience around it, can then be seen as an extension of an existing strand of CITE work that supports teachers, and which is well understood at CITE.

1.4.3.1 Summary of the eBook

The eBook produced by CITE has 28 pages, incorporating:

- A front page

- An introduction
- Five chapters, each consisting of either one or two sections

Each chapter presents a separate theme (titles are in French - the following are translations):

- Chapter one: Rockets and travel into space
- Chapter two: Soyuz: a vehicle that travels in space
- Chapter three: A story of scale (which considers the solar system)
- Chapter four: The moon
- Chapter five: Objective: Mars

Content presented in these chapters relates directly to exhibits at CITE. For example, page 5 (figure 1) provides a description of how cargo is carried into space, and explains features of the Ariane 5 model which is present at CITE. This then adds a layer of interpretation to exhibits, and helps readers to understand their purpose. Although the book can be read by itself, it makes more sense for its content to be consumed in tandem with the exploration of an exhibit.

Interactive Content

Because this is an eBook, then design and production work has more freedom than traditional book authoring. This then allows the book to embed the following material, which can only be provided through an interactive system: Videos, Photo-reels and Quizzes (see images below). The whole book then essentially represents a single narrative that ties together exhibits at CITE, and helps readers to understand them as a whole. Being able to create this style of narrative has been a design challenge for CITE from the start of the CHESS project, and this eBook then represents a tangible method for doing so.

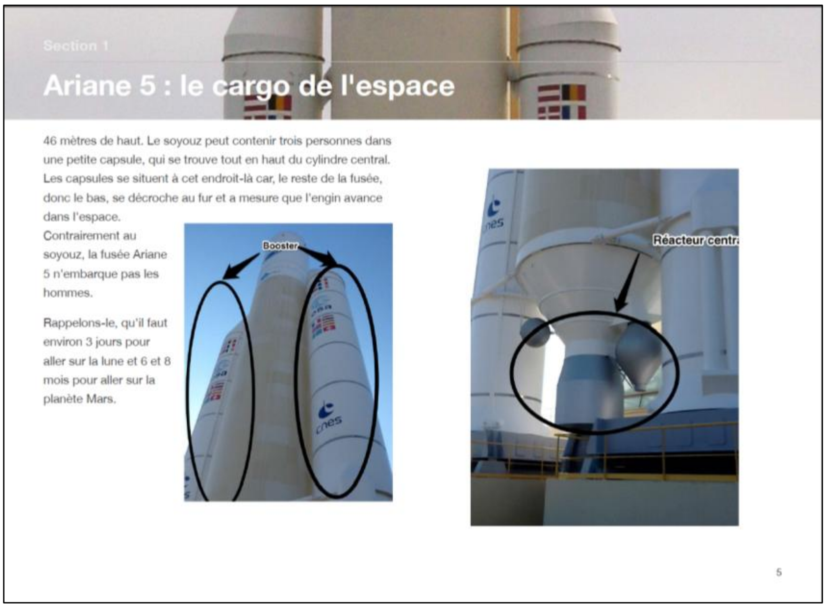


Figure 11 Images and text explaining the purpose of the Ariane rocket

Figure 12 Video integrated into eBook - video appears on left of page

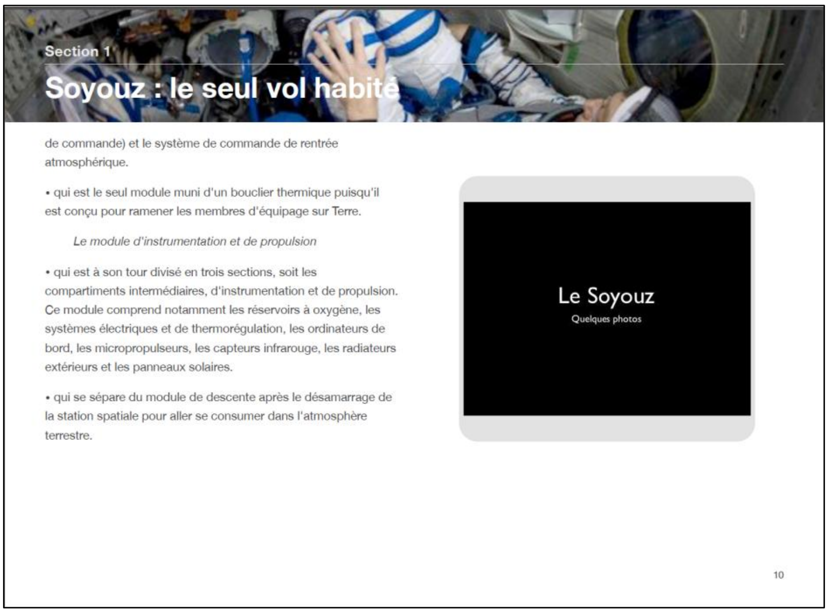


Figure 13 Page with photoreel – on the right

Figure 14 A quiz about the moon – bottom right

Missions

As well as content that can be consumed by readers, the eBook also embeds “missions” that require active effort. Each chapter presents a single mission, which is structured around topics and exhibitions present at CITE. Each student in the “class tablette” was assigned a mission, which required them to do work outside of the visit, and which then directly connected with lessons at school. Because this was an experimental deployment, targeted at a specific group, then the names of students who were assigned to a specific mission were incorporated directly into the book. Figure x shows an example mission relating to the Ariane 5 model (intended for consumption by “Hugo, Louise, Chloe and Shirley”. A translation of the mission is as follows:

> *Your mission*
>
> The first stage of your journey to retrieve a moon rock or travel to Mars will be to leave Earth on a rocket. This is what you’ve been waiting for …
>
> You need to explain the different stages of the launch of a rocket like Ariane 5. Take a photo of the replica at Cite de l’Espace, and use Skitch [4] to annotate it with the precise names of the different parts of the rocket. Explain their role in a “Pages” [5] document.

[4] http://evernote.com/skitch/ Skitch: a tool for annotating photographs

[5] https://itunes.apple.com/gb/app/pages/id361309726?mt=8 Pages: a word-processor for the iPad


Section 1

Ariane 5 : le cargo de l'espace

VOTRE MISSION

La première étape de votre voyage pour ramener une pierre de Lune ou aller sur Mars sera de quitter la Terre à bord d'une fusée. Voyons ce qui vous attend...

Vous devrez expliquer les différentes étapes du décollage d'une fusée comme Ariane 5.

Vous prendrez en photo la réplique de la cité de l'espace et vous annoterez avec Skitch la photo en précisant les noms des différents composants de la fusée. Vous expliquerez leurs rôles dans un document Pages.

LES EXPLORATEURS

Hugo, Louise, Chloé et Shirley

La fusée Ariane 5 est un lanceur a été conçu en 1995 dans le but de placer des satellites sur orbite géostationnaire, elle fait environ 50 mètres de haut.

Pour démarrer, la fusée utilise son moteur central, qui contient du kérosène. Mais pour aider au décollage, on y rajoute deux cylindres qui contiennent de l'oxyde métallique. Les cylindres, qui sont aussi appelés boosters se décrochent après que la fusée ai décollé, qui d'ailleurs ne m'est que quelques secondes avant de partir dans les airs. Après le décollage, il n'y a aucun rejet radio actifs, à part si le vol se passe mal. D'après un scientifique de la cite de l'espace de Toulouse, durant le décollage d'une fusée, celle-ci émet tellement de lumière qu'en pleine nuit, on pourrait se croire en plein jour. Cette fusée, Ariane 5 pèse en tout 760 tonnes, dont 700 tonnes de carburant et 60 tonnes pour le reste.

Pour les fusées comme le soyouz (lanceur russe), qui date de 1960 est lancé depuis la Guyane ou depuis le sud de la Russie, plus précisément depuis le Kazakhstan. Ces points de départ ne sont pas donnés au hasard, on les a choisi car ils se trouvent près de l'Équateur. Cette fusée pèse environ 310 tonnes et fait

Vidéo 1.1

Décollage d'une fusée Ariane 5

4

Figure 15 Page presenting mission ("votre mission", on left)

1.4.3.2 *Discussion of eBook*

This eBook is considered in detail in the discussion at the end of this chapter. However, the following points are interesting to consider in relation to this eBook.

Conceptualisation and realisation were done internally

The eBook described in this section is an example of an artefact that has been produced internally at CITE, and which presents a narrative that encompasses a number of exhibitions that are distributed around CITE. The design and realisation of this eBook was done internally by CITE, using available authoring tools. This contrasts with the realisation of exhibitions, which is done by external contractors. This then raises a question of why there is a different in working practices in comparison to the standard exhibition realisation process described earlier.

The production of educational materials provides an interesting model for mobile experience design

Many cultural heritage institutions will have a competence in the production of educational materials, alongside a competence in the production of exhibitions. This then raises an interesting question of whether the process of producing interactive mobile experiences is more similar to the process of producing educational materials than that of producing exhibitions. This has important implications for the design of authoring tools. It also has implications for the internal structure of cultural heritage institutions as they adapt to the process of producing mobile experiences.

Why is an authoring tool for mobile experiences necessary?

The eBook presented above effectively defines a mobile experience, and yet was presumably produced with tools whose purpose is the production of eBooks, not the production of mobile experiences. This then raises an important question as to why specific authoring tools for mobile experiences need to exist. Understanding this question can then support a careful targeting of the design of authoring tools at relevant and realistic needs or problems.

1.4.4 Working with the CAT to conceptualise and realise an interactive experience

Having considered the broader organisational context present at CITE, and presented the design of an eBook authored outside of the CHESS project, a detailed case-study of an authoring process conducted within the CHESS project is now presented. This was led by Christophe Chaffardon (CITE director of education) and Elodie Herrero (working as a CITE educator) and also involved other CITE representatives. The process of authoring involved interactions with the CAT, and also with an experimental sketching tool described in section x of this deliverable. Work with the CAT corresponds roughly to the realisation phase defined through the interview presented above. The sketching tool was intended to support the process of conceptualisation. Work with these tools was supported by DXT (for the CAT) and UNOTT (for the sketching tool). Producing the experience required the addition of activities required by CITE, and implementation of these activities was done by RF, working in the role of an external contractor.

This activity as a whole then represents a reasonably realistic model of how the production of a mobile experience might work, and hence documentation of the process should be valuable to the cultural heritage sector. Documentation has been used to produce an estimate of the resources required for production, which focuses on the time contributed by individuals working in specific roles. These estimates are provided in a table later in this section, and are intended to respond to a request from the year two reviewers for an estimate of these resources.

In interpreting this work, it is important to understand that the production process took place as part of a research project, using a tool that was still being debugged. It was also lead by an individual (Chaffardon) who had been involved in the project since its beginning, and who therefore had a substantial understanding of the research issues involved in CHESS. As such, this is not a fully realistic setting, and care needs to be taken when inferring meaning from the detail that has been provided. However, the task and setting are realistic, and did lead to deployments of a workable experience, and hence presented data is valuable as part of an ongoing exploration of the implications of producing mobile experiences.

Below we provide a set of tables that summarise key features of the process.

- Table 2 presents an overview of the structure of the production process. Each stage is given a number, and detailed descriptions of these stages are provided later in this document. Stage 1 is listed as the production of the eBook previously discussed in this section. The table summarises the roles of individuals who were involved in this work. Further detail of the tasks that were carried out later in this section are provided later in this case-study.
- Table 3 provides further detail about the individual involved in each of the roles defined in the first table.
- Table 4 provides an estimate of the time committed to the elements of this process that took place at CITE (114 days). This does not include time spent by RF working as external contractors, which amounted to 50 days. A summary of this information is presented in Table 5.

Further details of activities are then presented later in this section.

Table 2 An overview of the structure of the conceptualisation and realisation process at CITE

	Title	*Description*	*Roles involved*
1	Design of eBook	An eBook was produced by CITE, and trialled by the "classe tablette"	Teachers CITE educator CITE exhibit designers CITE direction board
2	Initial paper sketch of interactive experience	Two personas were identified – Solal and Marion. An initial paper sketch of an experience was produced.	CITE educators Teachers
3	Training session – CAT and sketching tool	A training session was held at CITE, in which the CAT, sketching tool and initial paper sketch were considered.	Trainers, CITE direction board CITE educators CITE exhibit designers
4	Refined sketch in sketching tool	A digital sketch of the experience was generated using the sketching tool .	CITE educators
5	Paper sketch of screens	An initial paper sketch outlining specific slides was produced, on paper.	CITE educators
6	Lo-fidelity prototypes	A low fidelity prototype illustrating the appearance of selected screens was produced in Balsamiq and shared with RF.	CITE educator CITE exhibit designers RF production team
7	Medium-fidelity prototypes	A set of slides with a more refined appearance were produced in Balsamiq and shared with RF.	CITE educator CITE exhibit designers RF production team
8	Outline produced in CAT	An initial structure was set up in the CAT.	CITE educator
9	Content production	Producing all the contents : texts, activities, medias, according to the teachers and students needs	CITE educator CITE exhibition designers Teachers

10	Detail added to CAT	Text, images and navigation activities were added and refined to the initial outline.	CITE educator CITE exhibit designers RF production team

Table 3 Individuals and tasks relating to roles

Role	Role in project	Who was involved in this role?
Teachers	Defining the requirements and content of the eBook. Organising the visit at which the eBook was deployed.	Didier Blanqui (teacher in Lycée Auch) Jean-Paul Castro (teacher in CITE) Marie-Hélène Chaput (teacher in CITE)
CITE educators	Scenario design [stage 1] Graphic design [stage 7] Writing of final text [stage 9]	Christophe Chaffardon Elodie Herrero Anne-Katherine Roy
CITE exhibition designers	Contents selection [stage 1] Iconography research [stage 1] Contribution of knowledge in relation to the field [stage 7] Media research [stage 9]	Inès Priéto Serge Gracieux
CITE direction board	Validation of eBook	Christophe Chaffardon Philippe Droneau Marc Moutin Isabelle Régnier Valérie Clavé Jean Baptiste Desbois
Trainers	Training CITE staff in use of the CAT and sketching tool.	Tony Glover Pat Brundell Stefan Rennick-Egglestone Thibaut Prados
RF production team	Digital production work	CHESS employees at RF

Table 4 Time committed to project at CITE. Each entry reflects the total time cost for a particular stage and role, and could have involved multiple people who shared this cost.

	Stage 1 eBook	**Stage 2** Initial sketch - paper	**Stage 3** Training session	**Stage 4** Digital sketch – sketching tool	**Stage 5** Initial screens sketch - paper	**Stage 6** Low-fidelity prototype - PowerPoint	**Stage 7** Medium-fidelity prototype - PowerPoint	**Stage 8** Outline structure in CAT	**Stage 9** Content final production	**Stage 10** Detail added to the CAT
Teachers	3 days	1 day				1 day			2 days	1 day
CITE educators	12 days	2 days	2 days	4.5 days	2 days	7 days	3 days	5 days	15 days	30 days
CITE exhibition designers	2 days		1 day			2 days	2 days		5 days	2 days
CITE direction board	1 day									1 day
Trainers			4 days							2 days
RF production team					0,5 days					1 day
Totals	*18 days*	*3 days*	*7 days*	*4.5 days*	*2.5 days*	*10 days*	*5 days*	*5 days*	*22 days*	*37 days*

Table 5 Total time estimates by role

Role	Estimated total
Teachers	8 days
CITE educators	82.5 days
CITE exhibition designers	14 days
CITE direction board	2 days
Trainers	6 days
RF production team (meetings at CITE)	1.5 days
RF production team (implementation work)	50 days

1.4.4.1 Specific details of each stage

This part of the case study provides specific details of stages 2 to 10, as defined in previous table, which incorporates a substantial amount of media that was collected during these stages. A reflection on this process is provided later in this section, consisting of a descriptive analysis of an interview with the authors of the mobile experience.. Stage one (production of the eBook) is not considered here, as the eBook has been described earlier in this case study, and because it's design and deployment was conducted outside of the CHESS project.

Stage two: Initial sketch on paper

In producing a mobile experience using the CAT, the intention was to produce an experience that could adapt to the needs of its users, in contrast to the more static experience defined through the eBook. A core concept for CHESS is that *personas* are integrated directly into the experience, and therefore serve as a basis for adaptation. In working through the CHESS process, and in light of their prior experiences with the eBook, CITE defined two personas to represent the perceived need of two group of students:

- Solal (analytic skills teenager)
- Marion (descriptive skills teenager).

The intention was that the CHESS system would match individuals to these personas, and personalise the experiences accordingly.

Having defined these personas, a paper sketch was produced to outline a relevant experience. This has branching points at various places in the experience, which can be clearly seen in the figure. What this means is that some parts of the experience would be shared between the two groups defined by these personas, and some parts of the experience would be disjoint. By including branching points and elements of shared experience, CITE hoped that the experience would be better tuned to the interests and needs of those interacting with it.

To produce paper sketch, four or five designers worked together in a group, with large sheets of paper. As a group, they drew ideas directly onto the document with a pencil or pen – making annotations, adding arrows, drawing squares. Through the process of these meetings, three draft versions were produced. Following on from these meetings, two CITE educators worked together to produce a more refined and therefore more legible version, still working on paper. This was then scanned and distributed to the group as a whole.

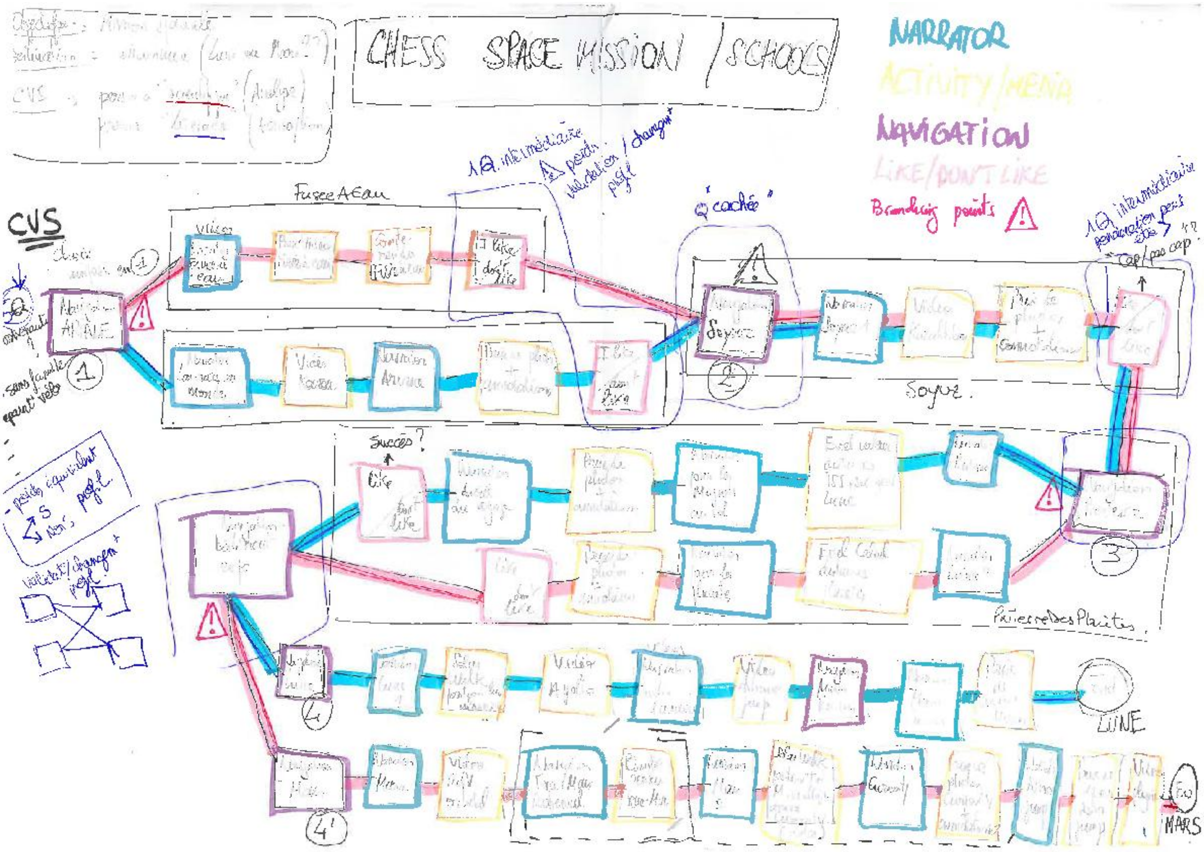


Figure 16 A scan of a paper diagram providing an initial overview of the experience. Blue tracks highlight paths for the Solal persona, red for Marion.

Stage three: Training session in CAT and sketching tool

Having produced an initial sketch of an experience, CITE were then provided with a one-day training session. The topics of this training session were:

- How to use the CAT
- How to use the prototype sketching tool developed by UNOTT
- How to use concepts presented within the trajectories framework (Benford et al, 2009)

Training for the CAT was lead by DXT, and involved participants working through the construction of an example experience, using media provided by DXT. This took roughly three hours.

Training for the sketching tool and trajectories framework was lead by UNOTT. There was a presentation and discussion of key concepts from the trajectories framework, and a demonstration and discussion of the sketching tool. This took roughly three hours.

Stage four: Production of a digital sketch in the sketching tool

A detailed sketch was then produced using the sketching tool. This allowed for feedback on the design of the tool to be provided to UNOTT – this feedback is discussed in detail in section 1.2. The sketching tool allows for a canvas of unlimited size, allowing for the production of a very large diagram. At this point in the process, the sketching tool did not incorporate the ability to print this canvas. Much of the design process at CITE is focussed on working with paper, and hence this was a major constraint. The sketching tool was not used in the remainder of the process.

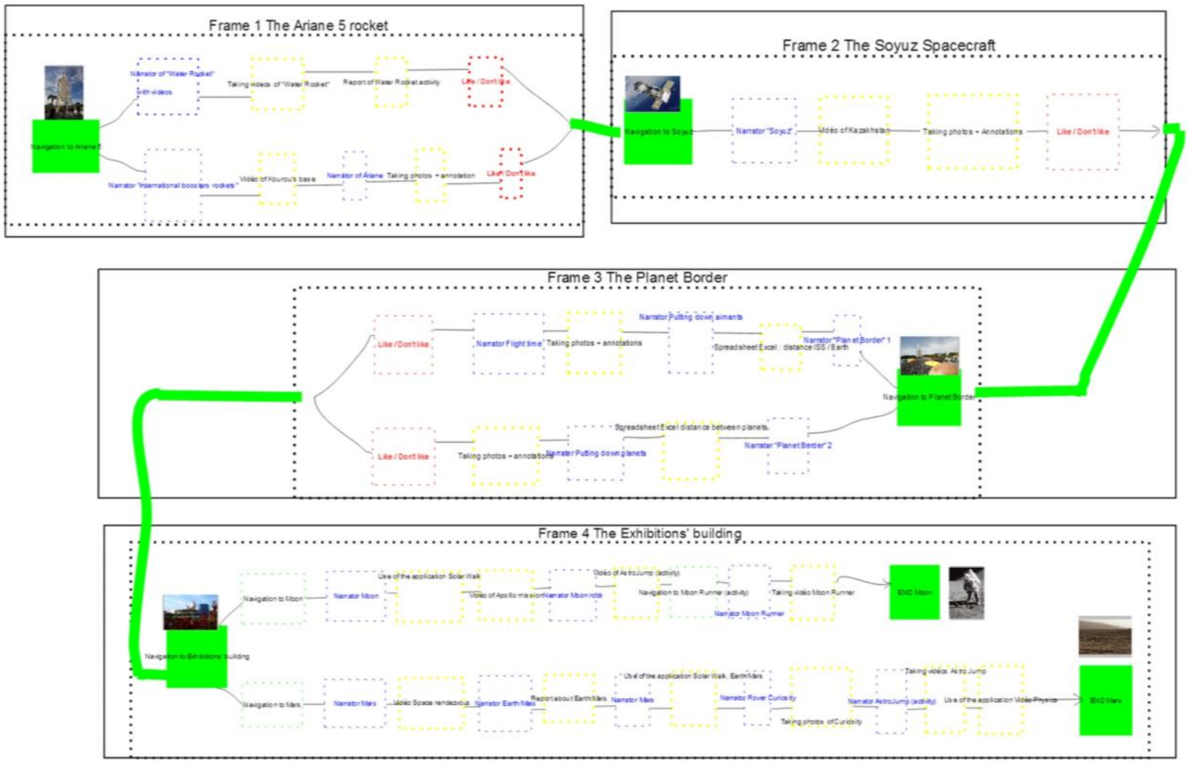


Figure 17 Digital sketch produced in sketching tool

Stage five: Initial paper sketch of screens

To refine the design, a second sketch was produced, which started to explore details of the individual screens that would be shown on the iPad at teach activity, and for each of the two chosen personas. This diagram is shown in figure x. As in stage two, this was a group activity, which used paper to support collaborative working.

Figure 18 Structure of stories to be told at each location, and for each persona. Blue shading highlights design work for the Solal persona, red for Marion.

Stage six: Digital design of lo-fidelity prototypes

In the CHESS authoring methodology, experiences are assembled from activities, and the CAT offers an extensible selection of template activities that can be used. When the work described in this case study was being conducted, then the available range of activities was relatively small, and it was expected that extensions would be needed. Developing a new activity template requires coding in JavaScript, and this was not a competence that was available at CITE. As such, RF took on a role similar to that of an external contractor in order to provide these activity templates. Given that CITE typically use external contractors for production work anyway, then this is a realistic scenario for how experience production might work outside of a research project.

To support the planning process at RF, CITE produced a detailed set of lo-fidelity prototypes. These consisted of a series of slides, produced using Balsamiq [6], illustrating an outline design of individual screens as they would appear in the application (one slide per screen). These slides helped RF to understand the needs of CITE, and also supported an initial set of media gathering activities on the part of CITE. In total, 9 documents were produced, each containing multiple slides, as summarised in the table below (79 slides authored in total).

Each document relates to either:

- the initial CVS activity
- a specific exhibition and the content for a specific persona at that exhibition.

Table 6 Summary of documents containing lo-fidelity prototypes

Document name	Number of slides
01 Réunion des CVS	5
02 Réunion Parcours Fusée Marion	13
02 Réunion Parcours Fusée Solal	11
03 Réunion Parcours Soyouz Marion et Solal	10
04 Réunion Parcours Parterre des planètes Marion	8
04 Réunion Parcours Parterre des planètes Solal	8
05 Réunion Parcours Intérieur Marion	12
05 Réunion Parcours Intérieur Solal	12

Examples of slides are provided in Figure 20. A document was also authored to illustrate the top-level structure of the experience in relation to material presented at each exhibit (Figure 19).

[6] http://www.balsamiq.com

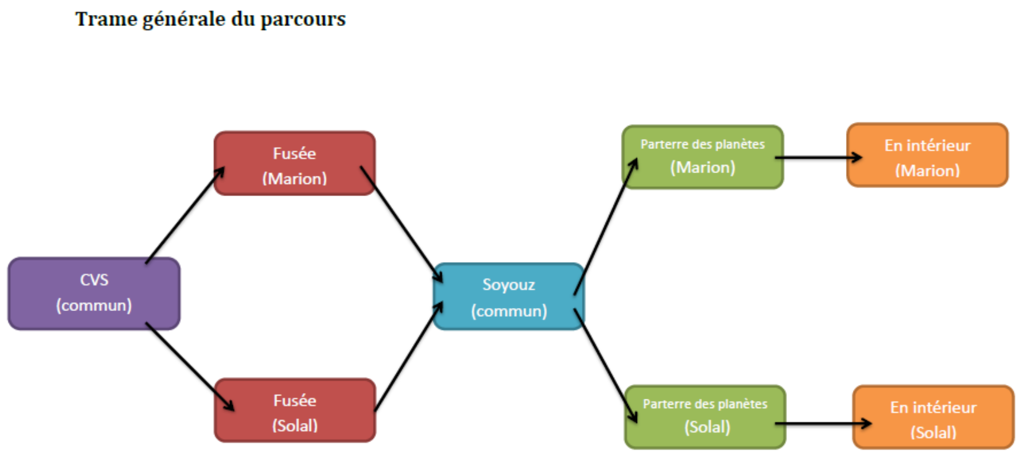


Figure 19 Structure of the experience

Figure 20 Lo-fidelity prototypes of mobile experience screen.
Left to right: Screen incorporating a video. Screen showing a map. Screen showing content about space.

Stage seven: Digital design of medium-fidelity prototypes

The lo-fidelity prototypes produced to support communication with RF were relatively simplistic, and further graphic and interaction design effort would be required during the process of assembling a final version of the mobile experience. To co-ordinate this graphic design effort, a medium-fidelity prototype was produced, again using Balsamiq, and consisting of a series of slides whose design was much closer to the final appearance of screens, and which also illustrated control features such as buttons.

To produce this prototype:

- five “background images” were produced – each related to a particular category of screen. Categories were as follows: CVS, navigation, information, narration and “interactive activity”
- a medium-fidelity prototype was produced, through a process of refinement from slides in the lo-fidelity prototype, with relevant background images being incorporated directly into the medium-fidelity prototype

In total, this process produced a set of 48 new slides. An example of a background image is supplied in Figure 21, and a slide in Figure 22.

Figure 21 Background image for navigation slides

Figure 22 Medium-fidelity prototype incorporating background image and a button

Stage eight: An outline experience produced in the CAT

Having produced a medium-fidelity prototype, the next stage for work at CITE was the production of an outline of the experience using the CAT. This work was led by one educator at CITE, who worked with the CAT to produce a project file that defined the experience. It is important to note that this work was done in parallel with production work at RF, and hence required co-ordination with RF for assembly. At the outline stage, the experience was not usable, but translating it into the CAT helped CITE to learn about the capabilities of the CAT, which then supported them in the process of working towards their final design.

The approach in assembling the outline was to translate the top-level structure of the experience, defined by the medium fidelity prototypes and the various diagrams that had been produced, into the CAT. Structural elements included branching points, given that this design catered for two personas. Some activity types were not available, since they were in production at RF. To allow work to continue without these activity types, DXT added a placeholder activity known as a “coming soon” activity Figure 24, which could be replaced as and when a workable implementation of the activity was available. The full outline project file is shown in Figure 23.

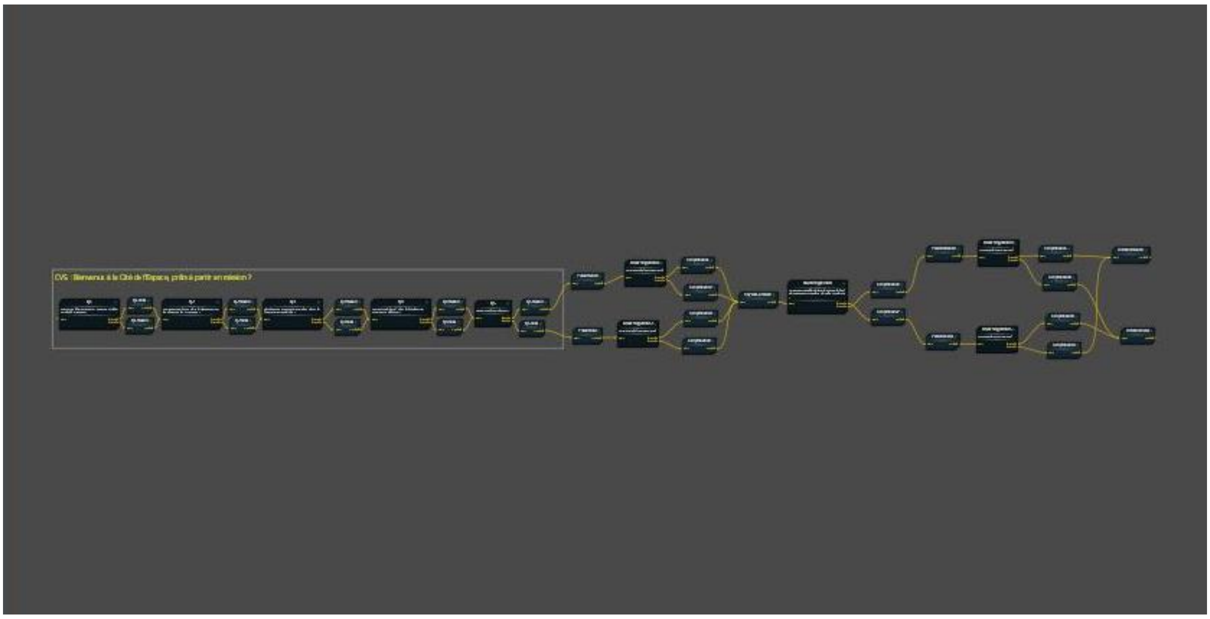


Figure 23 Outline produced in CAT

Figure 24 Detailed view of activities taking place at the Ariane, illustrating two "Coming Soon" activities

Stage nine: Final media collection and navigation design

A better understanding of the operation of the CAT then allowed CITE to finalise their experience design. This involved two activities:

- final decisions over media to use in activities
- design of navigation screens for the experience

In this experience, navigation around the site was intended to be supported through real photographs annotated by arrows. Stage nine then involved the design of these navigation screens, using an external graphics package - example below. A translation of the caption is: “At the end of the corridor, take a right and use the stairway that drops down a level”.

Figure 25 Annotated image used for navigation

Stage ten: Final experience produced in the CAT

This stage essentially involved uploading final choices of media into the CAT, and finalising navigation activities, producing an experience that could be deployed. A detailed study of the deployment of this experience is describe elsewhere in this deliverable, so is not considered in this section.

Activity implementation work at RealFusio

In parallel with these stages, and drawing on diagrams produced in stages six and seven, RealFusio were developing new activity templates to meet the requirements of CITE for the experiences that was being produced. This work consisted of the implementation of 5 activities, and took 50 days in total. RealFusio have indicated that this would take considerably less time with a more mature CAT, and hence this estimate reflects typical technical and integration issues that are present in an R&D context.

The process of creating a new activity is split into three sequential phases. Approximate timescales have been indicated for these.

- *Phase 1: Creation of the activity template.* Average 1.5 weeks. From 1 to 3 week depending on the complexity of the activity template.
- *Phase 2: Integration in CAT*. Integration in the CAT - 1 day. From 0.5 days to 1 week depending on scenario.
- *Phase 3: Publishing in Mobile Experiencing System*. This should take no effort, but publishing these five activities took one weekend, due to technical issues revealed by it.

RealFusio estimate that the entire process should take on average 1.5 weeks per activity template once the CAT becomes a more mature system.

1.4.5 Discussion of the case study

This case study has presented a very detailed account of the process of producing a mobile experience. This has encompassed:

- A descriptive analysis of an interview with a CITE exhibition design, which revealed the broader context in which exhibition design is done at CITE
- A presentation of an eBook which was used to define a static mobile experience, and which was deployed for usage by the "classe tablette", an experimental school group whose lessons are constructed around the iPad
- A detailed description of the process of producing a mobile experience at CITE using the CAT, and an analysis of an interview that clarified some key elements around this process

Case studies of this kind are important to present:

- They document the emerging practice of designing mobile experiences, which is currently poorly understood by the cultural heritage sector. This kind of documentation can support the sector in understanding how to adapt to unique opportunities offered by the possibility of deploying mobile experiences into museums.
- They can help authoring tool designers understand the context in which their tools will be used, and therefore to improve the design of their tools so that they are appropriate for the needs of cultural heritage institutions

This case study now concludes with a discussion that considers three key issues that have emerged through the documentation included above, and which are intended to be of interest for cultural heritage institutions and mobile experience authoring tool designers.

Who will use an authoring tool?

The design of any user interface needs to be sensitive to the needs of those who use it. Data presented in this case study provides an insight into who these users might be. These insights are specifically linked to the question of whether production work will be done by museum staff or external contractors. This issue is addressed in multiple places in this case study.

The initial interview with a museum exhibition designer, presented in section x, indicates that exhibition work is typically divided into two phases – "conceptualisation" and "realisation". Both are French terms, but have cognates in English with a similar meaning, and are hence used directly in this discussion. Broadly:

- Initial conceptualisation is done by museum staff
- More detailed conceptualisation is done by an externally-contracted scenographer
- Realisation is done by external contractors, who offer a one-year guarantee
- CITE take responsibility for an exhibit after one year – updates might be done by CITE staff where they are small (e.g. updating a document that describes an exhibit), or could be contracted externally if larger

The CAT does attempt to make production work simple for museum authors, but even in this case-study, some work was carried out by RF, a project partner, but playing a role of an external contractor. This work essentially consisted of coding in JavaScript for the purposes of adding new activity types to the CAT. This was then essentially a technically-focussed activity for which a competence was not available at CITE.

These observations then raise a general question of who the user of a mobile experience authoring tool will be. At CITE at least, museum educators argued that, even though doing production work in-house might be better in terms of quality, pressures of work meant that sub-contracting production work was a more likely scenario. If updates of content were required on a regular enough basis, then a member of staff at CITE might make them, but if updates were only required infrequently, then these might be contracted. Highly technical work such as the addition of bespoke activities to a tool seems extremely likely to be contracted, as the competencies involved in this work are narrow and expensive to maintain in-house.

The boundary between conceptualisation and production work will be negotiated differently by every museum, depending upon their own history and strategic choices around capability. This situation then raises a number of implications for the design of authoring tools and the work of using them:

- Production work may be done by external contractors in some museums, in which case the primary users of an authoring tool could be contractors rather than museum authors.
- This raises an issue of how to support communication between museums and contractors, especially at the boundary between conceptualisation and realisation.
- It also suggests the need to understand the current work of contractors, and to ensure that the design of an authoring tool is appropriate for their needs, particularly in relation to existing patterns of tool use
- Updates may be required to mobile experiences, and those updates could either be done by museum staff, by the original contractors, or by new contractors.
- This raises an organisational need to ensure access to important source files (such as project files), and sufficient control over the ownership of these files to allow them to be passed onto others for future modification.
- This may require the design of contracts that are appropriate to ensuring this. It could also require interfaces that support collaborative working between contractors and museum staff, potentially specialised to allow easy updating of experience that have been produced several years in the past.

The eBook, authored by CITE, and described in section x, presents an interesting counterpoint to these discussions. This eBook can be seen as an extension of existing CITE activities around support for school groups. The eBook was produced internally, utilising existing competencies of CITE staff. This is in keeping with general CITE activities around support for school groups, which are generally satisfied internally. If the production of mobile experiences is more like educational support processes than exhibition design processes then there is at least the possibility that it will be done internally rather than being externally contracted.

When is a mobile experience authoring tool appropriate?

The eBook described in above is an interesting piece of work, in that it was used to create a mobile experience for use in the museum, and yet did not require an authoring tool that was specifically designed to produce mobile experiences. It even embedded interactive elements such as quizzes and videos. This then raises a question of when a specific mobile experiencing authoring tool is necessary and appropriate, given that the eBook itself was effective for the purposes for which it was designed. Understanding this question is important; where experiences can be authored by existing tools, there is little use in designing new tools where existing ones are competent.

The experience presented in above then provides an example of a scenario in which a specific mobile experience authoring tool might be beneficial. Specifically, this scenario involves an experience that branches and rejoins at multiple places, allowing different individuals to have experiences that are the same in some places, but different in others. This branching and rejoining is then an example of a model that is outside of the model of a traditional eBook, and which might then be appropriate for production in a more specialised authoring tool.

This then raises a general question of the competencies that are required of a mobile experience authoring tool. What do they need to do that is not available in existing tools? Understanding this question can help frame the work of refining authoring tools in the future, to ensure that they are focussed on specific needs, and avoid overlaps with existing tools. Given that any specific authoring tool will be used as part of a broader tool chain involving other tools (such as graphic design software) then the boundaries around the competencies of particular tools need to be carefully explored and understood. As an example, navigation screens included in the mobile experience described above were not drawn within the CAT, but were in fact produced by an external tool. Should the CAT have a competency to produce these kinds of screen, or is it more appropriate for these to be produced in an external tool? This is then interesting future research to consider.

Interfacing with paper and other forms of prototyping

A notable feature of the authoring process at CITE was that of the extensive amount of collaborative work done on paper. Paper was used to plan and develop the overall structure of the experience, and to plan initial details of the screens that would be seen at each stage. More formal prototypes were produced, working from paper plans, including a “digital sketch” of the experience structure produced using the UNOTT sketching tool and a set of lo-fidelity and medium-fidelity prototypes produced using Balsamiq. A later phase of the process involved translating work done in these prototypes into an initial assembly of activities in the CAT. This initial layout was then evolved into a final experience through the integration of a final selection of media.

An interesting issue to highlight is then the disconnect between the prototyping and assembly phases. Prototyping involved the production of multiple iterations of paper diagrams and 127 separate slides produced in Balsamiq. The assembly phase then involved a very substantial amount of work, in which ideas from prototype were “translated” into the CAT. This kind of translation is not necessarily inefficient – it can often make sense to develop ideas in tools and formats that support the process of ideation, and then to translate ideas into a tool that supports production. However, this kind of disconnect does offer opportunities for technological innovation that can support the authoring process. In the case study presented above, CITE devised their own representations for the overall structure of the experience and of individual representations of screens. More standardised representations, potentially provided by the authoring tool, could have supported this process.

Given this argument, an interesting possibility here is the augmentation of paper with mechanisms that support a more effective conceptualisation process. At its simplest, this could be a set of standardise paper forms, intended for printing on very large sheets of paper, that provided some guidance to the process of design in light of the capabilities of the authoring tool. In a more integrated workflow, sketches constructed around these forms could be scanned and processed by the authoring tool, or a plug-in, and could be used to bridge the gap to an initial layout of authoring tool activities, which could then be extended through direct interaction with the tool itself.

Resources required to author experiences

Work on this case study has allowed for estimates to be made about the resources required to produce the featured mobile experience. The headline figure, encompassing work at CITE and at RF, but not incorporating R&D work on the authoring tool at DXT, is 164 days, comprised of 114 days at CITE to conceptualise and realise the experience, and 50 days at RF to create activity templates required for the CITE experience. Media costs (i.e. purchasing or licensing of media) were essentially nothing, as CITE were already in possession of suitable media, or authored media themselves (such as background images). Given that a core part of the competence of a cultural heritage institution is media collection, then this might be a relatively common situation.

This estimate does include the time taken to produce the eBook, as for the purposes of this case study this was considered to be a preparatory activity that sped up the design process. If time taken to produce the eBook is removed, then the headline figure is 146 days.

Producing this experience should be seen as a piece of R&D, and is therefore inherently slower than an equivalent process with a mature system would be. RealFusio have estimated that 15 days were consumed through typical technical difficulties that can be associated with R&D. The estimate also includes 7 days for training (stage 3), and 9 days for exploration of the UNOTT sketching tool (stage 4). Training might only happen once, and the UNOTT sketching tool was not a core part of the process. If these three activities are removed, then the headline figure is 135 days.

Much of this work is then accounted for by the final integration efforts (stage 10) – 37 days, of which 30 were spent by one CITE educator working with the CAT. This case study was before the final release of the CAT – CITE therefore reported that bugs in the system caused this phase to be very slow, and substantially slower than would be expected with a production system. Quantifying the difference is impossible, but it seems reasonable to assume that a headline figure of 100 days is achievable for a more mature authoring process, with experienced authors, even in the situation where bespoke activity templates are required from an external contractor. As the CAT matures, more templates will be added, and hence the need to implement bespoke ones may reduce, so this figure could be reduced further. A better integration between the conceptualisation and realisation phases, as considered above, could support ever more efficient working.

Even taking the headline figure of 100 days, it is then instructive to compare the cost of a mobile experience produced by CITE to that of a temporary exhibition at the same institutions, so as to get an idea of the scale of the task. Some evidence in relation to this is provided in section 1.4.2, which presents an interview with a senior member of exhibition design staff, who indicates that one temporary exhibition cost 700,000 euro in total to produce. Temporary exhibitions are intended to be in place for just a single year.

An approximate figure for a mobile experience of roughly the same scale as the CITE experience is then estimated as 24,000 euro, on the following basis:

- 0.4 of a working year for conceptualisation and realisation (roughly 100 working days)
- average cost of 60,000 euro per working year as the total cost of an employee

In comparison, a mobile experience of the scale of the one featured in this case study is then a comparatively small cost in comparison to a temporary exhibition, and even smaller relative to a permanent exhibition.

The cost as estimated above is only for the initial conceptualisation and realisation phases, as these were the only ones that were implicated in this work. Updates to mobile experiences could take place, as could updates to exhibitions (see section 1.4.2 for a discussion of how updates are made). It would be instructive to understand the relative cost of exhibition updates to that of mobile experience updates.

1.5 Summary and conclusions with respect to authoring evaluation

This section of the deliverable has presented evaluation material relating to CHESS authoring technologies, which has been conducted under a principle of involving museum professionals directly in the evaluation process. This was structured around three principle topics:

- A formative evaluation of an Experience Sketching Tool, whose design is grounded in earlier analytical work presented in CHESS, and whose design progressed through multiple iterations guided by museum experts.
- Evaluation work conducted with professional museum authors associated with the Acropolis Museum. This consisted of
    - A creativity workshop, in which museum authors explored the usage of the CAT to create innovative experience, thereby revealing their own orientations to its usage.
    - A usability analysis of the CAT, which integrates feedback from two museum authors.
- A detailed case study of CAT usage at CITE. This focuses on the working practices that were adopted around the CAT, and provides a detailed estimate of the resources required to implement an experience.

Collectively, this evaluation work provides evidence for the efficacy of CHESS authoring technology in supporting the design and deployment of visitor experiences for the cultural heritage sector. It also provides evidence to support the ongoing development of CHESS technology beyond the end of the project.

Research work presented throughout this evaluation has raised issues of interest to the question of how to produce technology that supports the process of authoring experiences for the cultural heritage sector. A detailed consideration of these issues is presented within the sections above, Four of the most relevant issues for future research are summarised below:

1. Although museum authors at CITE and AM successfully created branching experiences that were appropriate for experiences that were personalised for multiple personas, user interface elements relating to branching were difficult to use, and how to improve them is an open question. In general, the CAT is a complex tool, and ongoing improvements to the user interface could support usability (issues to consider are presented in Appendix 7.1).
2. Training was provided for museum authors at CITE and AM, and was considered necessary to structure initial engagement with a tool that is necessarily complex, given the complexity of experiences that are being constructed. As such, the uptake of CHESS by the cultural heritage sector is likely to require training. Models for delivering effective training are then interesting topic to consider.
3. The question of who the users of CHESS authoring technology will be is an interesting one to consider, given that a variety of models for external contracting of working are present in the cultural heritage sector. Users may sometimes be employed by museums, may sometimes be external contractors, and there may be a variety of models for sharing authorship between employees and contractors, and for handling updates to experiences where they are needed. How to embed CHESS authoring technology into these kinds of commercial relationships is an interesting topic to explore, and the technology itself will need to be flexible and accountable in light of these relationships.
4. The question of whether mobile experience authoring is more like exhibition design or more like the production of educational material is interesting, in that it sets expectations for the uses and design of a tool. Given that mobile experiences can be authored through non-specific authoring

tools (e.g. see the CITE case study), clarity over the style of experience that are amenable to implementation through the CAT could guide its future development.

2 Evaluation of CHESS user experience deployments

2.1 *Summary of deployments of user experiences in year 3*

Evaluation of user experience deployments have continued in Y3. Evaluation work has focussed on three user experiences which were carefully selected for the contribution to research that could be made through these evaluations. User experience evaluation work builds on prior research conducted in Y1 and Y2 of the project. A summary of the user experiences that were evaluated, and the methods that were selected, is presented in Table 7 below. Further details are then provided in section 2.1.2. Methods used in these evaluations are presented in section 2.1.1.

Table 7 Summary of evaluation work conducted in year 3 of the project that relates to new users experiences for cultural heritage institutions

Location	Description of experience	Participants	Method
CITE	A mobile phone app that monitors the location of the visitor through GPS and indoor positioning. It supports users in planning their visit, and provides media relating to specific exhibits. (Section 2.2)	Four groups of visitors recruited on site.	Ethnography
CITE	A tablet app intended for use by members of school group. There are two routes through this experience. (Section 2.3)	The “Classes tablette”, an experimental school group who are spending a year doing lessons constructed around an iPad.	Ethnography
AM	Final individual experience intended for use in the Acropolis Museum. (Section 2.4)	28 participants recruited specifically for the evaluation.	Semi-structured interviews Ethnography

2.1.1 *Methods used in these evaluations*

One of the primary vehicles drawn upon for collecting insights for evaluation in CHESS has been ethnographic studies. These involve detailed in situ observations of people’s practices together with the recording of these practices across a range of handwritten notes, and audio and video recordings. The objective of such studies is to get at an in-depth understanding of how people’s activities are being reasoned about and constituted as methodical features of the world.

Analysis of the data is then conducted under the auspices of an ethnomethodological approach. A prime feature of this approach is that no feature of the participants’ actions and interactions is taken to be irrelevant on an *a priori* basis, none of the data is coded according to a preconceived ‘theory’ of how the course of action might proceed, and all of the elements are inspected for what they reveal about how local members of groups are reasoning about their activities as their activities unfold. This is a well-established approach to evaluation in the fields of HCI and CSCW. For more detailed expositions of the approach in general see Garfinkel (1967), and for it's specific application in the context of studies to inform system design see Crabtree et al (2012). Its principal concern can be summarised as an inspection of how implemented systems can be seen to fit with people's situated practices and patterns of interaction. In this sense it can be said to be moving beyond looking at the technical articulation of systems and exploring how they are being constituted as features of the social world, a world within which all technologies must ultimately find a home.

A similar approach was adopted to analysis of the evaluation of the bodystorming at CITE in October 2011 and the subsequent formative evaluation of the CHESS beta at CITE in May 2012 (reported in Deliverable D09.21). It was also at the core of the analysis of the preliminary ethnographic studies conducted at the site in 2011 (reported in Deliverable D03.21) that formed the original inspiration for the development of the application.

The ethnographic evaluations in CHESS are specifically designed to complement more introspective studies, based on techniques such as interviews and questionnaires, which are also a strong feature of the evaluation work. Introspective studies can serve to capture a wide variety of descriptions and expressions of people's rationales for their actions, their likes and dislikes, and their associated sentiments. However, such articulations inevitably happen at some remove from the actual lived courses of action they seek to index. Ethnographic studies, by contrast, serve as a vehicle for understanding how such rationales and preferences are actually made manifest in the situated realization of people's activities. Introspective studies often help to highlight interesting phenomena that are not easy to capture in any other way. Ethnographic studies provide a means of uncovering what such phenomena actually look like. In the specific case of evaluation introspective studies capture what people thought of an implemented system, what bits they felt worked or didn't and why, and things they specifically liked or didn't like. Ethnographic studies capture what people actually did, how they did it, and the things that were seen to cause trouble in various ways. Together these views are able to assemble a comprehensive picture of people's engagement with a system that is simultaneously descriptive in terms of what people actually did, analytic in terms of what can be said about the principals their actions can be said to adhere to, and expressive in terms of the meaning they assigned to their engagement with the system.

2.1.2 Further details of evaluation studies and their research contributions

Deployments of user experiences, and associated evaluations of these experiences, have been carefully selected for their value for research. The following is then a brief summary of the rationale for their selection.

2.1.2.1 Evaluation of a location-based mobile phone app deployed at CITE (section 2.2)

The mobile phone app deployed at CITE was designed and implemented outside of the CHESS project, but its design drew upon an initial set of ethnographic studies conducted in Y1 of the project, and presented in D03.21 Initial Scenarios and Storyboards. The evaluation of this app then provided an ideal opportunity to conduct a second ethnographic study which documents patterns of usage of this app, and which then allowed linkages with research issues raised in the earlier study to be assessed and extended. The opportunity to conduct ethnographic studies which are linked in this manner is rare; integrated findings across the two studies therefore make a very strong academic contribution, and will lead directly to a high-quality publication beyond the end of the project. The studies themselves consider specific issues around group usage of mobile technology and interactions between location and mobile technologies. These are both current topics of interest in the cultural heritage sector, and also for the HCI and CSCW communities more broadly.

2.1.2.2 Evaluation of a tablet-based app deployed at CITE (section 2.3)

The tablet-based app deployed at CITE was conceptualised by CHESS project members at CITE, and was implemented using the CAT. A detailed case study of the conceptualisation and implementation process for this app is provided in section 1.4, and hence the combination of sections 1.4 and 2.3 can be seen as a very large and detailed case study of the conceptualisation, implementation and deployment of a single experience. The level of detail presented in this compound case study is rare, and a collective analysis that considers these three phases in relation to a visitor experience has a substantial amount of academic value, and will as such lead directly to high-quality publications.

In addition, much of the research work around museum visitor experiences has focussed on individuals, or individuals within families, and research into user experiences targeted at school groups are rare. School groups are, however, an important segment of the visitor base of many museums, and are therefore important to consider in research. By presenting a detailed evaluation of the interaction of a school group with an app, then we contribute knowledge about the needs, orientations and interactions of school groups which will be of interest to the cultural heritage sector, and which will inform future visitor experience design work.

2.1.2.3 Final individual experience deployed at the Acropolis Museum (section 2.4)

A beta version of an individual experience for the Acropolis Museum was deployed in Y2 of the project. The final version of this experience extends and matures the earlier experience, and integrates a number of innovations in relation to digital storytelling, such as features that allow visitors to zoom-in on specific sections of the digital presentation of a physical exhibit. An evaluation of this final experience has then allowed for an understanding of the implications of these innovations to be explored and understood. Whereas other evaluations presented in this section have focused on group interactions, a portion of this evaluation focuses on individual interactions, in keeping with the nature of the Acropolis Museum, whose visitor base includes a substantial number of individuals. Evaluation work presented in section 2 then considers a broad spread of visitor types.

Whereas evaluation work in sections 2.2 and 2.3 has principally been structured around ethnomethodologically-informed ethnographic studies, evaluation work presented in section 2.4 integrates visitor reflections on their experience. This is then an important source of data that cannot be inferred from ethnographic studies, and which supports a more detailed understanding of the impact of experiences on visitors. The experience evaluated in this section was constructed using the CAT, and illustrates the efficacy of the CAT in constructing visitor experiences.

2.2 Evaluation of a location-based app deployed at CITE

2.2.1 Introduction

This report presents the principal findings from an evaluation of a mobile-based application developed to support visits to the Cité de l'Espace in Toulouse, France. The application was developed by the museum itself in collaboration with local technical partners and was evaluated by ethnographers from the University of Nottingham in the UK. The concern here is to explore the ways in which the application evidently worked in the context of group visits and the ways in which problems or potential issues were seen to arise. In order to do this we will first of all be looking at a range of topics to do with the nature of the technology itself and its use. After this we will look more broadly at how the technology was accommodated in the social milieu of group interactions and how it contributed or otherwise to the ways in which these interactions unfolded.

In tandem with the findings some outline suggestions for refinements are also provided. These suggestions are primarily located along with the observed detail, but are also re-iterated in the conclusion of the report, together with a table designed to indicate their relative tractability. The purpose of these suggestions is to inform both future development of these kinds of mobile applications and certain aspects of the broader future development of CHESS-like experiences in cultural spaces.

The findings presented in the report are built upon ethnographic observations of four different family groups over the course of their visits to the Cité de l'Espace on 9th August 2013. Each of the groups were followed around the site for several hours as they pursued their ordinary planned visit with the sole addition of having been given access to the mobile application so that they could use it (or not) as a feature of how the visit then unfolded across the group. The observations were subjected to an ethnomethodological analysis that sought to bring into view the part played by the mobile application with regard to the orderly production of a group visit, in terms of both local reasoning and practice and of orientation to the site and its contents.

The development of the mobile application in question was originally informed by the findings that came out of two weeks of ethnographic observations of visiting practices at the Cite de l'Espace at the start of the CHESS project in 2011. A number of the highlighted features regarding how visitors navigated around the site and attempted to plan and manage their visits over the course of their time there were drawn upon in order to inspire the organization of the resources offered within the application. At the same time the application sought to take things step further by exploring how the presentation of these resources might be further facilitated through the use of geospatial localization technology.

Although the development of the application was driven principally by a desire to make good use of the findings coming out of CHESS at a local level, it stands as a good test bed for several of the broader issues CHESS is necessarily addressed to: ways of practically situating the visitor in a physical space that are commensurate with their experience of an unfolding series of interrelated events; ways of providing visitor support through the context of a compelling application on a mobile device that has to be used in the course of actual visiting practices, in environments that may or may not be conducive to the use of such a device. These are reflection we shall return to in the conclusion to this report.

Despite some routine technical problems and some minor interface issues, overall the application was found to be both effective in its goals and compelling in the context of use. The latter observation itself threw up some additional issues regarding how such a technology might be embedded in the broader social dynamics of group visits, but, if anything, this has contributed further to our understanding of the requirements to be met by such technologies, and it was not seen to significantly disrupt visitor engagement with the application itself. Most importantly of all, the geospatial localization feature of the application was found to be ‘adequate for all practical purposes’ at least to the extent of what these particular visitors were seeking to accomplish with its use. This has to be gauged against the fact that this is a general-purpose application where the granularity of positioning does not often need to distinguish between closely proximate objects and orientations. However, the evaluation did also reveal the extent to which visitors are able to ‘reason around’ the limitations of the technology in a complete routine and unproblematic way, suggesting that even fairly crude geospatial localization techniques may be good enough across a wide range of ordinary circumstances of use.

2.2.2 The Evaluation

As mentioned above, the findings are presented here in two principal blocks. The first of these concentrates on the specific use of the application by the individuals who were handling the mobile phones on which it had been installed. Here the goal is to look at how individuals coped with the organisation of the application, the features it offered, its technical characteristics, and the nature of the interface. The second block focuses on how use of the application impacted upon the interactions amongst members of the group within which it was situated. This covers how the application was integrated into the visit as a whole, not just as an experience being engaged with by a sole user. Prior to this we briefly sketch out the application itself, how it was evaluated, and who it was evaluated with.

2.2.2.1 The Technology to be Evaluated

The Cité de l’Espace mobile application is intended to function as a visitor aid across three principal dimensions: 1) navigation around the site itself; 2) planning and scheduling the visit; and 3) uncovering further layers of information about specific tagged exhibits. Its principal novelty lies in the use of geospatial localization technology to identify the whereabouts of the device within the site, and its proximity to various objects. The user location and the location of objects is displayed on a manipulable and zoomable map of the site (see Figure 26) and tapping on flagged objects takes the user to webpages providing further information (see Figure 27). By passing through a higher level menu the user is also able to display a list of animations for the day (regularly updated via the local wifi) and the times they are scheduled to take place (see Figure 28). In this mode the user can also set alarms to be reminded when certain animations are about to begin.

At the time of the evaluation the application was designed to be downloaded to (theoretically) any android phone via Google Play (see Figure 29).

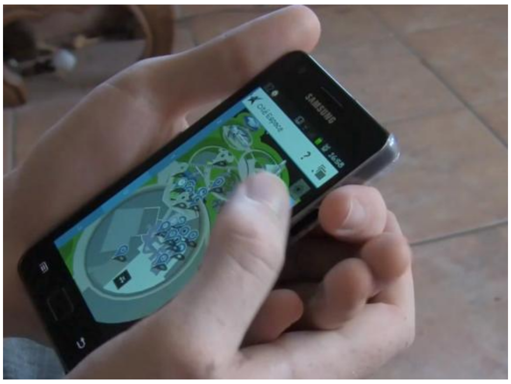


Figure 26 Map of the site

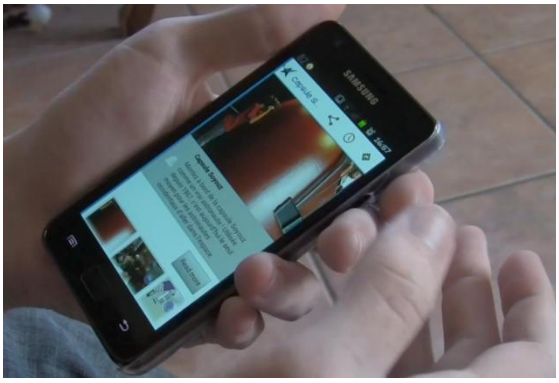


Figure 27 Pages providing further information

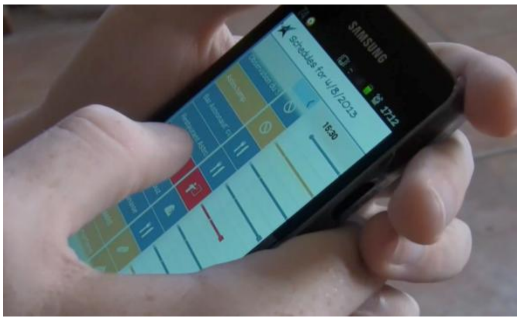


Figure 28 Schedule of animations

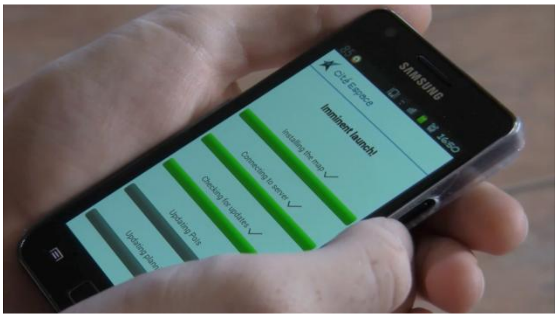


Figure 29 Google play integration

The mobile app evolved out of several different complementary strands of work at the Cite de l'Espace. First of all, in 2007, a mobile application had been developed for the PDA that enabled visitors to undertake a treasure hunt within the site, that included features for navigation and gameplay, as well as a stored record of their performance. This had proved a great success with visitors at the time and had been ultimately stopped after 18 months in service because of issues of internal support and technical performance of the devices. Secondly, the CHESS project had provided a vehicle for experimenting with a number of technological possibilities relating to visitor support and the evolution of mobile tools to facilitate that. Finally, and most specifically, the requirements for the mobile app were articulated around the findings of the early CHESS ethnographic sensitizing studies at the site which had highlighted a number of issues and opportunities relating to visitor activity over the course of their visits. Here the 'Responsable d'Education' for the site recounts the influence these studies had upon their thinking:

> "… my introduction to this mobile app is ethnographic study of the visitors in the frame of CHESS. And when I said on this is, okay, thanks to CHESS, thanks to all the knowledge we developed with that and the persons involved in the partners we have the chance to have an ethnographic study of visitors where we studied their behaviour and just the behaviour, of what happened and how could we face problems with an app more or less. So the problem of

questions asked to this person here [at the ticket counter], at this moment; then the problem there is just after the turnstiles when you have to decide where you are going, and you consult the map at this stage, even if you have plenty of time before to do that, but you do not do. So for the last moment. And then you get pull and resistance that means, for instance, that we've got different targets and different objectives, so perhaps we have to think about her and about her differently. So perhaps that's why on the app we've got a filter with young children. So on the map you have just all the exhibit adapted for young children. So in a way this is a way to answer that. We have to help them in helping their children to manage and understand what they are supposed to do. There is the classic wrong way to use an exhibit. Then we know that people are taking a lot of photographs, and we know perfectly where they take their photograph because sometimes we are engaging them to do that. So perhaps we can use those photos to make something. We know they are queuing a lot. We know they are co-educating as well. And we know that, well, problem is do we really replace the guide with this kind of app? So what happens during a guided visit?. What kind of human interaction there is? So the result is we could not replace the guide with an app. Two different types of public, and of expectations, needs. So that's why we developed the app … "

Thus we can see that all of the features geared towards supporting navigation, exhibit identification, exhibit explication, and planning were identified as targets for further reflection and development relatively early in the CHESS project as a result of direct observations of how visitors to the site behaved over the course of their visits.

2.2.2.2 The Evaluation Process

Two ethnographers from the University of Nottingham evaluated the application over the course of a full day at the site in August 2013. Between them the ethnographers observed all of the in situ interactions of four different family groups during their visits by joining the respective groups and 'hanging out' with them so that they could be fully party to the reasoning in play. Each of the groups were already prospective visitors and were approached as they entered the site and asked if they would be willing to participate. Between two and three hours was spent with each group and everything was recorded on video for subsequent revision and analysis.

The Cite had already gathered some basic feedback on the application via questionnaire. This encountered strongly positive results regarding ease of downloading the application and ease of use, with somewhat more mixed results regarding the range of features provided. Reflecting later findings, the principal feature used by participants on this occasion was the map with its associated elements for geolocation and navigation. Some specific plus points expressed by respondents were: 'good design'; 'very powerful geolocation'; and 'better than the paper plan'. Noted limitations were: that it was 'only available in French'; that the 'given information could be more concrete'; and that 'all of the exhibition elements aren't described'. Figure 30 provides a summary of the principal results:

	SATISFACTION	DISSATISFACTION
Time of download	100 %	0 %
Understanding of the application	75 %	25 %
Fluidity in the use	100 %	0 %
Design	87,5 %	12,5 %
Quality of contents	75 %	25 %
Features	50 %	50 %

Which application features did you use?
50% used only "the free access" (map, Point Of Interest, geolocation)
25% used only the free access, the schedule and the help
25% explored the whole application (alarm, itinerary)

Did you encounter difficulties by using the application?
No 75%
Yes 25%
Which one? Blocking of the map, incomprehension about the schedule, incomprehension of the geolocation system

Figure 30 Principle questionnaire results

The evaluation exercise reported here was intended to provide a richer body of understanding by seeing just how use of the application was managed in situ and in the context of broader interactions amongst a group of visitors. By doing this a range of otherwise unreported issues were uncovered and a much more detailed set of potential future requirements were revealed – for both this and for other mobile-based applications operating in this way.

2.2.2.3 The Participants

All of the families followed were French speaking French residents and were, variously:

- Family A: Mother and Father there with 3 children, 2 boys (one of 16, one of 14) and 1 girl (10).
- Family B: Mother and Father with 1 teenage boy.
- Family C: Mother and Father with 2 older boys (18 and 16)
- Family D: Mother and Father with 2 pre-teen children.

Each group was accompanied throughout their visit for half a day, covering activities in both the main exhibition space and in the park. All groups had varying levels of interest and competence with mobile technology such that it fell more to some members than others to drive the application. No group ran the application on more than one device. Family A tried to run the application on their own device but could not complete the download so used a pre-prepared Samsung S3 provided by the Cite instead. Family B was similarly obliged to borrow a device. Families C & D both used their own devices. Each of the families were also provided with a standard paper map of the site with a list of planned events for the day and their times, such as would be given to any visiting group. These were used in tandem with the mobile phone-based application.

Additionally one teenage boy of 16 toured the site on his own using just the application for half of his visit and only paper resources for the other half of the visit. This participant kept notes during his visit and was debriefed afterwards in order to gain insight as to which resources were most effective for which kind of activity.

2.2.3 The Findings

The following materials highlight the main findings from the evaluation in brief. The technological issues and the social issues are deliberately set out apart from one another, although aspects of both permeate each. Straightforward issues with the current deployment can, to varying degrees, be tackled through further technical refinements and changes. Matters arising to do with the social aspects of its use can be more tricky to deal with and sometimes it is better to do nothing and accept that certain kinds of limitations may exist. It is also the case that social aspects may be tackled through other than technical means.

A caveat needs providing here regarding the apparent character of the findings. Necessarily one's attention is drawn to the elements of the technology that somehow breached people's interactions with the device or with each other. This focus on troubles can give the impression that the technology is flawed but it is important to stress that there were many features of the application that worked smoothly and without incident throughout the evaluation.

2.2.3.1 The Technology

In this section we focus upon the technology itself and its use by those who were operating the device during the evaluation. Elements to be addressed are the geospatial positioning technology; the ways in which people first obtained the application,; the range of devices able to handle the application; the impact of needing access to local wifi updates on a regular basis; the ways in which the application is presented to its users; the functioning of the three principal aspects of navigation, scheduling and information about exhibits; and finally the effectiveness of the interface.

Geospatial Positioning

An important positive message from this evaluation, especially in view of some expressed degree of scepticism about its potential, is the adequacy of the geospatial positioning technology for this kind of application. Mostly users were able to rapidly identify what was representing their own position on maps of the site and what the flagged items were intended to represent. Movement of themselves with the device in relation to other facets of the surroundings rapidly disambiguated any possible sources of confusion. Users also proved highly tolerant of certain artefacts of the varying levels of precision available, rapidly understanding where lags occurred in update of position and the slight fuzziness regarding which specific objects were being represented by flags. Indeed, users paused on a number of occasions and specifically commented that they were just waiting for the device to catch up on itself, especially when they changed orientation. The only problems witnessed in this regard related to the consequences of network dropout which we shall be discussing shortly.

Improvements could be made here with regard to the degree of accuracy and the speed of recognizing changes in people's orientation as they move off on a different trajectory, but these are not critical refinements because we found most participants were more than equal to handling slight imprecisions through ordinary commonsense reasoning.

Application Acquisition

A more problematic element of the evaluation proved to be the initial acquisition of the application from the Google Store. In all cases where effort was made to get people to download the application for themselves, they required significant assistance to locate the application in the first place and also required help in managing the installation process (even amongst those who were used to downloading mobile applications). This at present appears to be a potential barrier to use. The application needs to be unproblematic to locate and relatively seamless to install if people are not to be turned away at the first hurdle.

Figure 31 Helping to find the application

Device Dependency

Another current but hopefully short-term issue relates to the extent to which the application proved to be dependent upon the use of certain kinds of devices. Locally provided Samsung handsets were able to acquire and run the application without difficulty, but other, older android phones, appeared to only be able to partially download the application such that it did not function properly once installed. A further limitation (apparently in-hand) is the restriction to android devices. An important component of being able to get users to download the application more readily for themselves is to make it compatible also with iOS so that it can be run on iPhones and (prospectively) iPads. For guaranteed free downloading and effective functioning of the app, visitors are required to turn on wireless networking and GPS on their handsets. It is unclear how visitors may be informed of this.

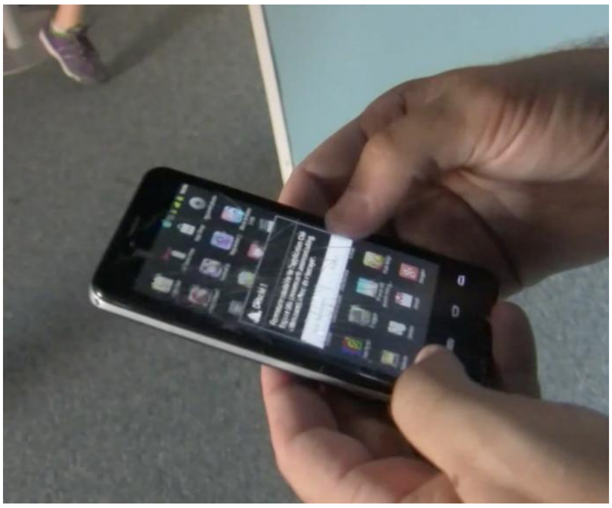


Figure 32 Struggling to Get the App on an Old Android Device

Network Dependency & Coverage

Certain aspects of the Cite application require the regular updating of information which is then cached on the device. During the evaluation it became apparent that this can lead to certain difficulties. There was a notable hole in coverage in the park, at the beginning of l'Allee d'Infini coming from the main exposition building, where devices temporarily lost this capacity to update. A result of this was that the device would get locked into displaying the last location that it updated, usually in the exposition building, and would take time to recover. This led to some confusion on the part of the participants, though they quickly recovered once they had moved on and the device had re-established a connection. Obviously this gap in coverage requires fixing if the application is to be rendered fully robust. Additionally, for local administrative reasons, the Astralia building is not currently covered for public wifi access either. This again renders the application temporarily unusable when visitors go to the iMax cinema or the Planetarium. More critically it also means it cannot be used whilst they are queuing for these two events or whilst they are inside the sandwich bar – all places where planning and scheduling activities have previously been observed to take place. A longer term goal should be to find a way of extending network coverage to this building as well. Alternatively, means should be explored to reduce the dependency of the application upon the local network.

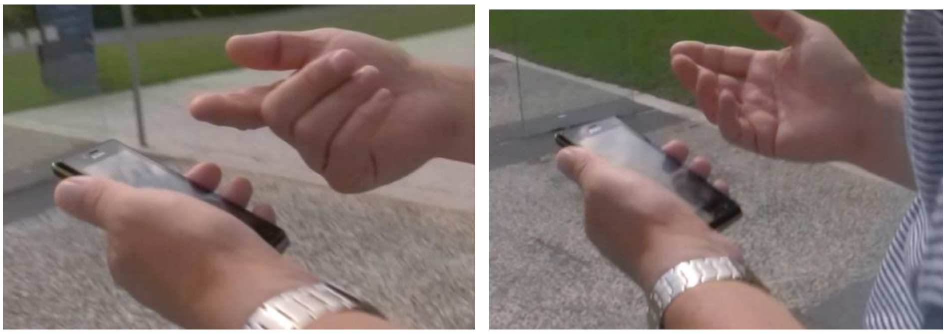


Figure 33 Losing the network

Application Presentation & Intelligibility

Whilst the graphics and content of the application were generally well-received and evidently easy to understand it was noticeable that, upon first encounter, visitors had some difficulty grasping just what the application might be best used for. Most quickly discovered the map and geolocalisation tools and presumed from this that the tool was primarily geared towards navigation. They confirmed this by moving around without it to see what happened and, once they had seen it functioned in this way, they largely stuck to keeping it in that mode. Eventually, by clicking on flagged objects, they also uncovered this functionality, though mostly only explored it at the outset. Most participants had to have the scheduling tool demonstrated to them to realise it could also do this. It may therefore be worth considering whether there are ways of providing an opening page for the application that more clearly articulates the things it can be used for so as to provide a more immediate frame for how to engage with the device. The help function does offer this assistance.

Figure 34 Trying to Understand What the Application Can Do

Navigation

By and large the navigation aspects of the application worked extremely well and most users kept the device primarily in this mode, regularly referring to it to reassure themselves that it was still tracking them. The few difficulties that occurred here largely related to the updating problem already discussed and the occasional lag in capturing a shift in direction such that what was being displayed was no longer fully relevant to the path they were pursuing. Improved coverage and a more rapid refresh would handle such issues. For the purposes of navigation the level of granularity of display seemed more than adequate. It should be noted that, for the purposes of disambiguation and figuring out 'where I am', the navigation function is of greater utility in fairly densely packed areas such as the exposition building. In more open spaces such as in the park, the information being relayed could often be more quickly gathered by simply raising one's eyes and looking around.

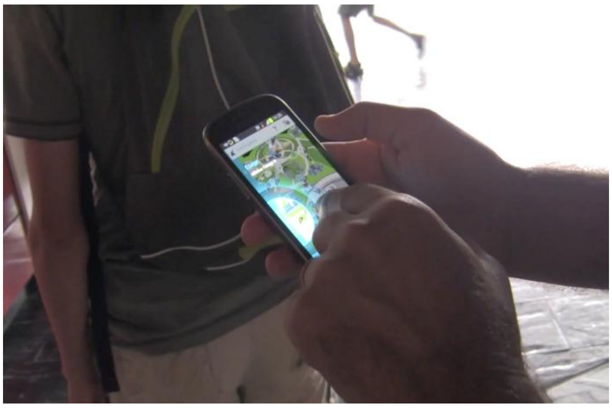


Figure 35 Using the Application for Navigation

Scheduling

As already mentioned, the participants did not readily uncover the scheduling component of the application but rather had to be pointed to it. Once they had seen it was there they did return to use it from time to time in order to check the running times of certain animations they had already decided they wanted to see. They found navigation to the scheduling through the higher-level menu difficult, however. It was also problematic that the default display for animations was an icon rather than a textual description. Text could be revealed, but quickly disappeared again and users found it hard to recall what the different icons stood for. This was aggravated by the length of the list meaning that they had to scroll down, which immediately led to the display returning to icon view. Obvious improvements here would be revising the display so as to retain the text by default, even if this means re-working other elements of the display. No-one was observed to make use of the alarm/notification of event functionality, even though this would seem one of the more useful functions for a comprehensive visiting aid. However, once the existence of this had been mentioned participants did appreciate its potential utility. Again the issue here may be one of providing a clearer articulation of the application at the outset so that it is oriented to as more than a navigation tool.

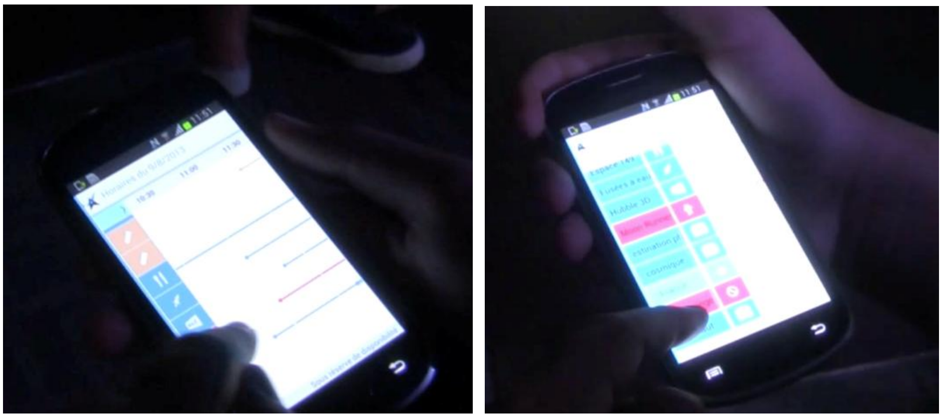


Figure 36 Looking at the Schedule, Without and With Text

Exhibit Information

All participants using the device were observed to click on the flags relating to specific exhibits from time to time. Some specific things to note about this are: a) this was more frequently observed with some visitors when first using the application, of the order of exploring how the application itself worked as much as because of specific interest in the exhibit itself; b) a number of occasions of use happened some distance from the object rather than stood in front of it or as walking away from it, again seeming to be as much about disambiguation (checking the object of reference to get one's bearings for instance); c) on occasions where it was clearly for the purposes of finding out more, the information itself was skimmed through fairly rapidly rather than read in detail (some participants later reported that they found the information a bit too dense to read on the spot on a mobile phone); d) For some visitors, use of this aspect of the application was much more frequent within the exposition building than elsewhere in the site. e) Some visitors were observed working through the icons located in the building or area of the park they were currently located. This tended to take place when the family group was static. Such instances was observed when some members of family group were engaged in an extended demonstration or educational activity and other members were able to take the opportunity to explore the information provided by the app. Use of the information flags to explore the application and to assist in confirming one's location seem entirely reasonable uses of this functionality even though they were not necessarily deliberately 'designed in' for that purpose. Density of information may be more problematic so some testing of what can comfortably be consumed on a mobile phone in situ may be required. It was not clear during the evaluation how much exploring of the flags might be handled remotely and when not proximate to the location of the object itself. This has at least two associated considerations. 1) Being able to browse through select information later on in queues or sat in cafes, etc. would fit well with previously identified requirements where people may wish to 're-visit' aspects of the visit to learn more, as a feature of conversations, to pass recommendations to others, etc. 2) During the observations one participant attempted to locate where something else in the site was located because they wanted to see where other members of their party had gone, but found themselves unable to move the map far from their own location, the default assumption clearly being that you want to see where you are, not where others might be. This second requirement has also been identified in observations of the CHESS beta UX system as a desired feature for group visitations.

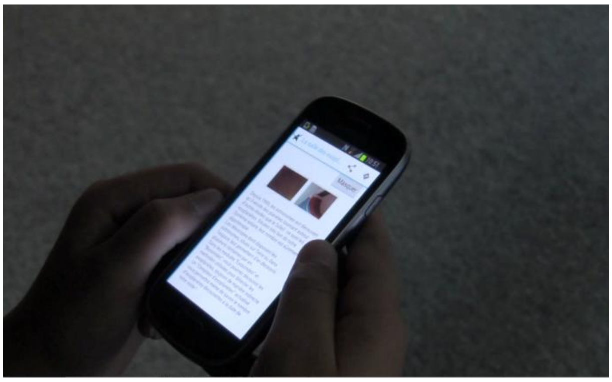


Figure 37 Looking at Exhibit Information

Interface

Largely the interface for the application worked very well and people were not observed to struggle with it unduly. Some exceptions have already been noted, such as the logic of the higher-level menus and the problem of showing icons by default in the scheduling mode. A further noted difficulty related to the very small size of the tags referring to different levels in the exposition building, which most participants found too small to handle with ease. Dragging across the timelines on the schedule seemed difficult for a similar reason.

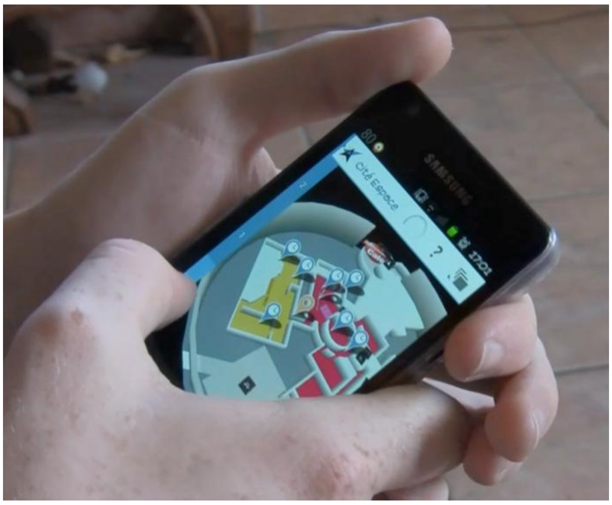


Figure 38 Struggling With Under-Sized Tabs

2.2.3.2 Use in Group Interactions

In this section we move on to looking at how the application was used in the context of broader group interactions and the kinds of issues that arose and further considerations that may be necessary. As mentioned previously the findings here are directed less to clear cut technical issues and requirements and more to considerations of how to appropriately position use of the application as part of a constellation of resources available during group visits.

Ownership

In the majority of groups use of the application fell pretty quickly to just one member of the party and, rather than sharing the device around, they became oriented to as an owner of the device, with rights of management in relation to the rest of the group. In our observations it became expedient to use the CITE's own Samsung devices to get around the difficulties involved in installing the application on other phones, but clearly, when the phone actually belongs to some specific member of the group this matter of ownership will feature even more strongly. In one group a father and son shared the device between them to some degree, but with others in the party still being largely excluded from its use. Instead, such as the application was required, these individuals became the ones who were oriented to as ‘spokespeople’ for the device. In the same way as when one particular member of a party keeps hold of the map/guidebook, this clearly has implications for how group interactions unfold and for the management of planning, decision-making, navigation, and instruction or elaboration around exhibits. Multiple users of the same application in a group were not observed but this would probably have some impact upon how these matters get handled, defaulting instead to usual patterns of rights and responsibilities within the group for such things. It is an open question as to whether democratizing ownership of the application will provide for more effective group support.

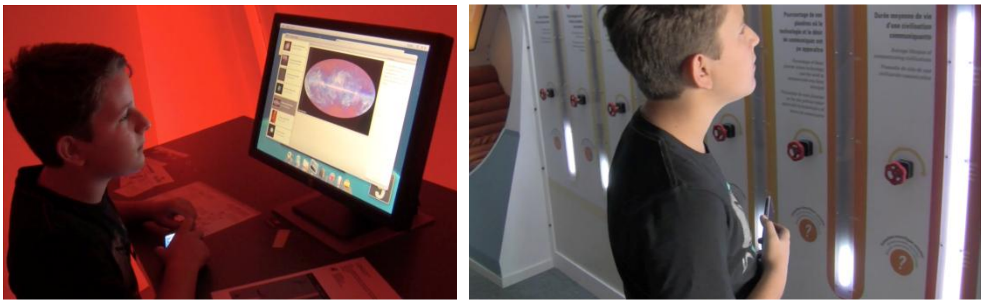


Figure 39 Keeping Hold of the Phone

Accessibility

Strongly related to the preceding point is the matter of accessibility. When the application is based upon a mobile phone and everyone is oriented to certain particular individuals having ownership of those devices, access to the information contained in the application, sight of the application itself, and actual use of the application become gradated matters of account between group members. In other words access to the application is differentially organised across the group. Others not holding the device have differing rights regarding access to the application. Asking for information coming from the application is relatively unproblematic in group interaction and most members of the group are able to do this, but not necessarily, note, ask more generally what someone is up to with their mobile phone. This poses a potentially interesting problem, especially where people are using their own phones to run the application. To ask what the application is telling them means they already have to be able to recognise that the application is what is currently being used on the phone, and this may not always be evident. Asking to actually see what the application is showing is a potentially more sensitive matter and is managed according to a whole set of group concerns and accountabilities. Some parents were clearly seen to find showing younger children what was being displayed unproblematic. Sharing sight across peers was not so necessarily freely given. The brothers in one of the groups were noticeable reluctant to share the device in this way. In one group, the adult who was not using the device only accessed information at one occasion, when explicitly drawn to it by the person who had control of the device. Of course, this may be an example of general disinterest rather than being exclusion from access. In this group the adult not using the device was not observed making attempts to see the app and being rebuffed. As far as handing the device over for others to use the application is concerned, this is the most potentially problematic negotiation, though once again parents seemed willing to do this on the whole, but with a clear orientation to overview and instruction having done so. In one family, children were rebuffed on a number of occasions when they attempted to physically take the device from the parent in control. The parent did show the app to the children at times to impart information, but did not relinquish physical control of the device. The upshot of all this is that it further serves to reinforce the situation where one specific member of the group may be acting as a filter between the application itself and the other members of the group. This is completely bound up with broader sets of family dynamics and relations. Again, it must be noted that the device was provided by Cite, so there may have been some protective aspects to this behaviour. When visitors' owned devices are used, this physical sharing may be seen to be less problematic. However, elements of this are visible in the use of paper maps as well so it is likely that any resource will be handled in group interactions in this way. Once again it is not clear that resisting differential access is a productive form of support and the only easy way of accomplishing it would be to have multiple users using different devices.

Figure 40 Turning to Other Resources

Planning

The Cite de l'Espace is spread across a fairly large geographical area with a range of different kinds of exhibits and exhibitions and with a variety of different kinds of animations and the buildings are arranged around a central park area that itself contains a variety of exhibits. Families typically come to the site for visits of about 6 hours and to conduct such a visit takes a measure of planning. As has been reported elsewhere this planning occurs at a number of nodal points around the site, with the family congregating together and discussing what things to do next or later, and in what order. This is something that happens throughout the visit and the plan is modified as they go along. Visits incorporating the mobile application were no exception here and the mobile application was one of a range of resources that was turned to on occasion to inform the decision-making process. For the larger part this involved the holder of the device using the application to add information about their current location and the location of other things on the map and potential routes to follow. After having been shown how to use it participants also attempted to make use of the scheduling display by looking at the list of animations in order to confirm the times certain events were going to take place or film showings happen that were already known about by other means. As such, and despite its clear potential to assist with this activity, the application was largely drawn upon as a confirmatory resource, with users of the device tending to trail along with other members of the group affirming that they were indeed going the right way (if anything was said at all) in order to pursue a plan that had already been arrived at independently of the application. We will discuss an exception to this pattern below, but for the larger part it appeared to be the case that the application was under-utilised with regard to this important group activity. Of course, a part of this is to do with the fact that the application was effectively delivered to the group after a decision had already been made to come to the site, and was worked through with one member of the group only whilst the others had already passed through the purchase of tickets, been given site maps, and begun to work through collectively the things they might be doing. In other words, one important element is that, for effective use of the scheduling, the application has to be acquired and drawn upon at the right moment, which is typically prior to entering the site and at the first moment where families group together in order to discuss how they might pursue their visit (often just past the turnstiles). If the user of the application is still trying to master how to use it at this point this would appear to be fateful for how it is oriented to as a planning resource over the rest of the visit.

Additionally, we have observed above how the application being sat upon a single, owned device tends to mitigate against its availability to others, whilst a folded out sheet of paper, with the map in clear view to any who choose to gather round, serves as a resource around which group discussions can proceed and multiple parties point to and discuss specific features. This collaborative planning activity centred upon the paper map was observed between family members who were not using the mobile application in the same context as the person with the device was close by, but crucially not joining in. In this respect, the placing of the application upon a mobile phone handset limits its scope as a planning resource, with other devices such as iPads perhaps offering a more effective resource for this kind of activity.

The form factor of the device when compared to the map, offered advantages in some circumstances. It was observed to be consulted and some interaction took place between adults and children in the context of an educational demonstration lecture in the subfloor of the expo building. The small form factor of the device allowed some sharing of information without engaging in the potentially noisy and disruptive act of attempting to use the paper map in a crowded environment where other audience members were paying attention to the demonstration. At least one visitor expressed the view that the paper map offered an unique large overview of the whole park in comparison to the necessarily, but also useful, but focused views of the application

Collaboration

As we have commented in the preceding sections the way in which the mobile device encouraged certain kinds of orientations towards ownership, accessibility and its use in the context of group discussions also had a strong impact upon the extent to which it was drawn upon in the accomplishment of collaborative tasks. This is not to say that there was no collaborative activity around the device and the application. This certainly occurred early on in its use as a potential navigation resource as others in the party looked to the user of the device for input in decision-making work. It was similarly looked to as a potential resource for collaboration when certain scheduling options were being pursued. However, there was a strong tendency for members of the group to leave those who were using the application alone to get on with ‘figuring out how it works’ which resulted in the majority of collaborative activity taking place amongst other members of the group who were not using the device. Indeed, when more collaborative activities were engaged in and others in the group looked to those using the device for input the device was frequently dropped down to one side and even put in a pocket or adjacent surface whilst collaborative activity took place. This was most particularly the case where collaboration was occurring around interactive exhibits. There were notable exceptions here with regard to parents working actively with children to figure out ways in which the device might be used for guidance or to provide additional information, where the parent and child would work collaboratively together through menus and manipulations. Frequently this was of the order of parents instructing and children doing. Here too, in that case, it would seem that the placement of the application on a mobile handset has strong implications for how it might be used in the context of collaborative work, frequently constraining the amount of such work that can be undertaken and leading to abandonment of the device. This was also clearly impacted upon by the fact that users of the application were uniformly ‘novice’ users. It would be interesting to see how experienced users of the application would make use of it in the context of a return visit, to see if this expands the ways in which it might be drawn upon as a resource for collaboration across the whole of the group.

Figure 41 Collaborating Around the Phone

Spatial Relevance

One of the strong topics of interest with regard to evaluation of the usability of the application has been the extent to which it might or might not be used according to the specific location of the user. Significant variability did become visible here, some of which is implicated by the preceding observations. The strongest situations of use appeared to be those where navigation was to the fore and where specific scheduling decisions needed to take place. So consultation of the device as a navigation resource happened at many of the nodal points previously identified in the park, such as when first entering the exposition building and at the beginning of l'allee d'infini. Unfortunately the latter exposed the problem of network dropout and refreshing of the cache as the hole was exactly at the point where people entered the park coming from the exposition building. Its use was quite heavy throughout the park. Use was more patchy in the exposition building, largely centering around changes in level or moving across exhibition boundaries. Use of it as an additional information resource quickly tailed off and we have already noted that it tended to be put to one side when people were engaging with interactive exhibits. It was also put to one side when people settled down to watch films and, for obvious reasons, when people entered the terradome. It was immediately turned to, however, upon leaving the terradome. The principal place use of the scheduling tool was observed was at the top of the stairs down to level minus one in the exposition building. This was coherent with exploration of the timing of animations such as the moonwalker, though this also seemed to then lead to explorations of iMax cinema timings as well. A strong implication here is that, in its current form at least, the application is most strongly oriented to as a potentially useful resource at transition points between blocks of exhibits and buildings, reinforcing the larger observation already made that the application is currently primarily understood to be a resource for navigation. A decision to be made here is whether to seek to further exploit this transition-point focus by using such moments to provide targeted information, or whether to try and extend the relevance of the device to other spatial locations by boosting what can be accomplished with the exhibit information functionality in some way. Whatever, there are clear constraints with regard to where the application can be made relevant to group activity, most especially when physically engaging with exhibits or watching others in the group engaging in this way, and when environmental conditions mitigate against its use such as in the terradome. An interesting further observation to be made is that use was limited in the Mir space station, even though the application could be exploited very effectively here to provide further information and media layers. Two things are worth bearing in mind about this: a) people were reaching Mir after their exploration of the information functionality had already tailed off; and b) Mir is often a quite high pressure environment with people evidently queuing up behind you if you stop to look at any one feature for too long. This makes it highly accountable and potentially interactionally difficult to pause and engage with your handset, especially as, to others you appear to just be using a mobile phone, which could be just holding up others while you look at your text messages or chat on Facebook, etc. The lack of availability of the use of the device as an accountably appropriate and interesting use of the device mitigates strongly against how one might make the best use of it in this kind of environment.

Figure 42 Setting the Device Aside

We have already made a number of observations about the use of the application as a resource for navigation. In the context of its use as a resource for navigation across the whole of the group, whilst it did get drawn upon in the context of larger discussions and moments of decision-making occasionally, it was primarily adopted, almost on occasion as a matter of obsession, as a resource for navigation for the person handling the device. This could have two outcomes: A) The user could be the principal decision-maker regarding the direction in which the visit should unfold, in which case the use parleyed into the issuing of guidance instructions being produced by this individual. B) The user could be involved in following around others in the group, in which case the navigation functionality became a default display not for the purposes of issuing guidance but rather as a form of confirmation of position within the site. Indeed, when nothing else was happening, the application and its localization element such that it moved with you through the site and provided an alternative view on your surroundings, seemed to be an object of serious fascination for users, with them spending time doing this to the exclusion of all other kinds of engagement with the site or the rest of the group around them. Clearly the navigation function built into the application, and the geospatial localization technology it draws upon, is a powerful and compelling feature. However, it does tend to lead to two important outcomes: a) it isolates the user from the rest of the party and what is going on around them; and b) it displaces engagement with exhibits for engagement with the device. It is not clear whether this should be viewed as necessarily problematic, though it does seem to undermine certain kinds of educational goals that might be present in how exhibits are organized and presented. However, in that this feature becomes compelling, it may also present an opportunity to consider how further functionality might be built upon this element to enrich the fact that the user is already engaging with what amounts to an alternative view of the museum's content.

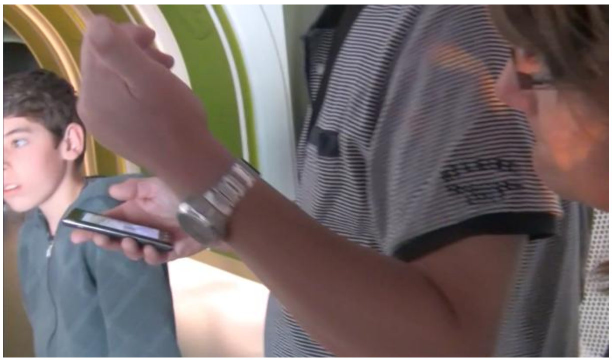


Figure 43 Leading the Way

Mutual Elaboration

We have stressed thus far a number of ways in which the placement of the application upon a mobile handset can serve to reduce certain aspects of group interaction. However, it is important to note that we did also see several occasions where its use became a central feature of how group interaction could unfold. This was most evidently the case where it became part of a constellation of resources being drawn upon in order to disambiguate certain aspects of the environment and the positioning of events within it. In situations where both placement and scheduling became interrelated concerns it was seen to be used in conjunction with things such as the paper plan of the site and list of animations such that each could elaborate the intelligibility of the other in order to move towards a decision. Here the device, unlike so much of its use, was placed in a central position of visibility directly adjacent to or on top of the paper map so that comparisons could be made between them and connections made.

Figure 44 Mutual Elaboration of Resources

Comparison to Paper

A paper map of the site and listing of the events and iMax showings for the day is always provided to visitors at the ticket desk when they first arrive. In all cases participants used both the application on the phone and the paper map to some degree. In the family groups this was mostly a matter of one member of the group handling the paper map and another handling the application, with them occasionally being used in tandem. The 16-year old boy visiting the site alone used the application for half a day and the paper map for the other half.

Although the application clearly offered more in terms of embedded information about the exhibits, a means of locating your own position on the map, and dynamically updated information about events, for the larger part participants did not orient to the two resources in radically different ways. One needs to be careful regarding what is understood by this. In terms of how the two resources were handled in terms of *practical interaction*, both with the resource itself and with other people around them, there were very significant differences. Paper maps and event listings were drawn upon very much on an 'as needs' basis, often in tandem with specific issues of wayfinding or specific concerns with planning. The application, by contrast, became a frequent focus of attention for the participants handling it, to the point of distracting them from the exhibits around them and limiting their interactions with the rest of the group. The 16-year old boy going round on his own found this to be a serious issue and very quickly stopped using the application completely for the majority of the time, holding the phone down by his side and only consulting it at the same kinds of moments of indecision that people were seen to draw upon the paper resources. This participant had the most negative view upon the application and felt it was offering him nothing he couldn't obtain from the paper map, with less interruption.

In all of the other observed cases the participants using the application allowed themselves to be seduced into concentrating upon it. However, it was also the case that the resource was ultimately still seen by them as something to support them in finding their way around the site and finding out what was going on. Only in highly specific circumstances did the information about exhibits become a focused upon feature in any way. A much more frequent use of this facility, as detailed above, was as a means of verifying the names of objects around you in order to confirm the location and the kinds of things to be found there. We also indicated above the fact that the quantity of text provided tended to further limit people's willingness to stand and look at it in any detail. Indeed, participants using the application often displayed a clear orientation towards *not* standing directly in front of exhibits when consulting the application, but rather standing back and out of the way, limiting its direct relevance to the act of actual engagement with the specific exhibit.

Figure 45 Working With Paper

Technology Failure Management

As was pointed out earlier, one of the features of this particular evaluation exercise was a set of technical issues that led to the use predominantly of locally provided handsets rather than people's own mobile phones. It is, of course, to be hoped that the technical issues that arose will be resolved and that most visitors will be able to download the application without difficulty and use it without incident across the course of their visit. However, when technical issues do arise it is important to note that the consequences of this can extend beyond just the interactions of a single user with their own, specific device. Instead, what often happens is that the failures of technology can come to impact upon the interactions of the rest of the user's group as well. So, in one group that was observed there were difficulties involved in trying to locate the right application and then to download the application to one member of the group's mobile phone. The individual concerned engaged in multiple efforts to try and accomplish this. Initially the rest of the group waited with him as he tried to deal with the problem. After a while, however, they progressed through the business of buying tickets, before coming to join him once again as he continued to re-try various possibilities. Impatience amongst other members of the group was manifest during this phase and the prospective user's spouse asked him if they could started with the visit now on several occasions before the matter was finally resolved by changing handset. In another group where the user of the application was also oriented to as the principal guide for the group, when the hole on coverage was encountered, he simply stopped in his tracks and evidently expected the rest of the group to wait around until he had resolved the problem. And, indeed, this is exactly what they did. So an important aspect of the management of the technology and its potential failings in the context of the evaluation was that, even though the application was primarily being exploited by a single user, breakdowns in the technology were handled as matters that could disrupt the whole of the group, regardless of their own orientations to the technology. This is clearly a part of how being situated as a group hosting a trial of a technology deployment is handled. Accountability for effort to make the technology work is attributable to all of the group even if the actual use is not equally spread. However, insomuch as technology failure is likely to happen in this setting in a group context, a question to be considered is how failure of the technology will be managed on other post-deployment occasions (and it would be foolish to imagine that technology failure will never occur). A significant concern in this regard is the extent to which the failings of technology will be readily accountable. Previous research has demonstrated that it is occasions where accounts for troubles are difficult to uncover that prove the most disruptive. So, for instance, if failures in the cache updating occur as a result of patchy network cover, messages indicating that network cover has temporarily been lost will help users to disambiguate the trouble and potentially try to rectify it by moving on to other locations rather than simply standing around and trying to understand why the display still registers their position as being in the exposition building.

2.2.3.3 Broader Issues

As a final set of considerations it is worth also situating the use of the application as witnessed in some broader issues of social interaction in museums. These will cover matters such as conversation, engagement with exhibits and the handling of group dynamics.

Talk

As members of groups progress through visits to museums they engage in a variety of spoken interactions geared towards different ends: discussions of where to go; commenting on exhibits; asking about the whereabouts of various members of the group; commenting on the behaviour of different members of the group; discussing matters unconnected with the visit itself that have been occasioned by features of the surrounding environment; instructing other members of the group in how to proceed in accomplishing something; requesting refreshments; and so on. In that users of the application are also implicated in these spoken interactions, management of the technology can simply be set aside from these things. For the larger number of these interactions the technology itself was not able to offer any direct contribution. Engagement with other interlocutors therefore largely involved setting the technology aside for their duration. However, engagement with the technology itself, with gaze clearly directed to the screen and manipulations being undertaken with the device, were strongly oriented to as circumstances where utterances directed to the users might be construed as interruptions. It was therefore the case that a lot of the time users of the application were not drawn into more routine conversations and comments as these were handled as not accountably appropriate reasons for distracting users from their interactions with the device. This itself carries further implications for how the use of such applications on mobile handsets may serve to isolate users from other members of the group and undermine some of the ways in which ordinary interactions around exhibits might take place. Exceptions to this were largely centred upon where the application had relevant information to offer with regard to the unfolding talk, for instance with regard to directions, or additional information about exhibits, or scheduling. What was not observed was use of the application to generate further discussion of quests for information in periods of repose, such as at cafes. This is clearly one place where further opportunities for application development might be seen.

Engagement With Exhibits

Overall, our observations of use of the application demonstrated a fairly consistent pattern of engagement with the application, which has implications for a number of the broader matters of sociality in museum environments. A typical engagement is one user holding onto the device, with only limited sharing of the device with others, and a strong orientation from others in the group to just let that person get on with it. The user themselves then predominantly went around the site watching their progress through the site on the navigation screen of the application. There were periods of disengagement with the device to do things with others in the group, and to use the device to help answer arising questions, but the heads down, watch the screen mode was by far the main presentation of that person throughout their use of the application. This, it would seem, has some profound implications with regard to how people engage with exhibits. The users of the device were engaging with the exhibits around them to a significantly lesser degree than others in their group and much of their engagement with the exhibits was being mediated through the application. There are two possible responses to this: 1) as museums are centrally about encouraging visitors to engage with their exhibits one can view this impact on engagement as being wholly negative, with a concomitant need in that case to find ways of using the application to support the visit that limit the users opportunity to focus most of their attention just on the application and nothing else; or 2) one can see that users actively accepting this as an appropriate way of engaging with a museum and its contents is a potential opportunity to further enrich that kind of engagement for users who wish to visit museums in this fashion. It should also be borne in mind, of course, that the users of the application here were novice users. It might be that after sufficient exposure to the application their focus upon it would reduce. Additionally, users have been asked to 'trial' the application in a sense, so to not focus their attention on it (especially when being followed by people who have an interest in what happens with it) is to some degree accountable. However, it is important to weigh against these considerations the fact that many visitors are first-time visitors who will be using the application for the first-time when they get there, with only a small sub-set having the opportunity to learn other forms of engagement through repeat visits and repeated use.

Figure 46 Ignoring the Exhibits

Situated in Group Dynamics

The observations we have just made about engagement carry obvious implications for group dynamics as well. For much of the time, use of the application effectively removed that user from the group as an active member of the group and its visit as an ensemble. There were occasions where use of the application was situated within broader group interests, at moments of disambiguation and scheduling for instance, discussion of which has been presented above. However, it is the tendency of the application to focus interest away from the group visit as a whole that may be more problematic. Solutions here could include finding ways of making the application more evidently there to support these kinds of matters in its framing. This dislocation from group dynamics was not seen with one family where the device was used by the adult who appeared to have the role of chief planner. In this instance, the device was put away at moments where a group discussion was appropriate. This tended as previously noted, to be at transitional points, that is when engaging or disengaging with an exhibit or demonstration, or sometimes when physically moving from one location to another. However, even in this family instance, when the device was used by the leader whilst walking from one exhibit to another, interaction was curtailed with one of the children which appeared to be regarded as problematic by the child. The child attempted to take the device from the mother. This could be regarded as showing interest in the app, or it may have been a case of attempting to stop the mother using the device as it was annoying the child.

Figure 47 Disengaging from the Family

Figure 48 Everyone Doing their Own Thing

Impact on Management of Group Coherence

Evidently, what has been said so far also carries implications for the management of group coherence. Where users of the application are not being as attentive to the group as they might otherwise be, the scope for breaching group coherence is increased. Those using the application but following others in the group are more likely to not notice when the group moves on and need regular reminding to stay with the group. Those using the application in a leadership role are more likely to overlook that some of the party are being left behind and need reminding by others that they are not all together. Indeed, in one group after half an hour of the older man in the group using the application in this way, two members of the group decided to head off and do their own thing instead. Once again, the indication here is that the best solution is to try to locate ways of keeping the use of the application constrained to points of evident relevance by foregrounding it at certain moments and backgrounding it at others. Augmentations to the current application could be of use here by facilitating an understanding of where others in the group are right now. When the group mentioned just now had reached a point where the man using the application wanted to bring the group back together, he wanted to be able to display the location the others had said they were going to so as to find out where it was in relation to the point he had just reached and how far away it might be. However, as already mentioned above, the application tends to resist these kinds of use currently by being centred upon the user's own location. In the case of multiple users using such an application one can imagine functionality that would support identifying where the other users were upon request.

Figure 49 Lagging Behind

Figure 50 Making People Wait for You

Accountable Use

One of the clear issues associated with use of this application and, by implication, of mobile phone-based applications in similar circumstances, was the impact it had upon broader patterns of accountability in group interaction. Several pronounced matters are of relevance here: a) ordinary routine accountability to the rest of one's group when using mobile phones in such settings; b) understood accountabilities as a participant in a technology trial; c) management of transformed accountabilities across the rest of the group.

Taking each of these in turn, people visiting cultural sites such as the Cite de l'Espace in groups have certain accountable understandings in play regarding what they can or cannot do presumptively without needing to provide special account to the rest of the group. As already pointed out, one of these is the preservation of group coherence whereby it is understood that everyone will make all reasonable effort to remain available to the rest of the group or will provide an account if they decide to leave the group for a while. Hence people announce they are going to the toilet or going to sit down or going to watch a film somewhere, thus displaying an orientation to their find-ability should the rest of the group need to locate them. Another is that they show due attention to the activity in hand. In other words they don't typically drag along behind everyone else disregarding everything around them and concentrating on listening to music or fiddling with their phone or reading a book without attracting negative attention from others in their group. This can be manifest in various ways: through instructions to put the phone away; exchanged glances between parents of adolescents who are 'doing it again'; questions posed such as 'are finding this place boring?', and so on. Another gross element of ordinary accountability is that you be seen to join in group interactions and show due attention to other things people draw to your attention or try to talk to you about. Failures to do this and displayed 'detachment' can provoke similar kinds of calling to account to those that occur when you are failing to participate in the group activity, except that actively ignoring others in the group when they are addressing you is more likely to result in direct complaint on the part of others. Yet another feature of one's ordinary accountability is that all members of groups have differential rights amongst them regarding who might or might not give advice, direct, lead the way, expound points of view, and so on. Thus trying to lead or direct when that is not one of one's ordinary responsibilities may result in resistance on the part of others. In various ways the application was seen to breach all of these ordinary accountabilities such that it did undermine group coherence, did distract users from the ongoing activity of others, did provoke moments of clear detachment and did cause troubles regarding ordinary patterns of guidance and pursuit. This indicates a need to reflect upon how all of such matters might be managed within groups in the very articulation of such technologies, such that it may reside within ordinary everyday accountable use of such technologies, rather than outside of it.

An important difference in play during the evaluation was that each of the participants was actively invited by the museum and the research team to use the application as a part of their visit. This complicates matters in several ways. For a start there is an understood accountability to the third parties who have asked them to use the technology such that to *not* use it would be potentially open to account. And following people around to see what they do with a technology is open encouragement to keep that accountability in mind. Thus some of the ways in which the technology was being used in breach of more routine accountabilities was clearly a consequence of trying to show due attention to the technology to those who were wanting to see it used. Clearly turning up on an ordinary day without any preamble or special invitation to do more than visit in an ordinary way would quickly result in those who might have been seen to be using their mobile phones 'obsessively' being called to account for just that. And this is indicative of the another aspect of all this: that ways of calling to account made manifest on this occasion were not wholly routine and in the course of such visits callings to account but rather complaints about the conflict the agreement to be a trialist were being seen to provoke. Others in the group also understood that a trial was going on and were giving licence for that. Thus disruption was not necessarily being seen as the user being just annoying as the user might be on any other day, but rather being annoying because they were participating in the trial. What this underscores is the extent to which the act of evaluation is itself a breach of ordinary group accountabilities. Thus an important part of investigating how such applications might be made more at home in the context of group visiting is to see how they become accommodated in group interactions where there is not understood to be a special circumstance or trial going on. This is not something that conventional approaches to evaluation are currently well-scoped to accommodate.

The preceding discussion elides, in fact, into the final matter of how the rest of the group might manage transformed accountabilities resulting from the presence of such an application. Clearly on this occasion a part of the management was the continual recourse to the over-arching account of the whole of the visit being transformed because they were, in part at least, also doing something else. However, there is a more subtle point in play here as well because the technology was not only understood to be disruptive, it was also seen to be potentially instructive in various ways. Thus members of the group looked to the user sometimes for guidance about specific locations of things or timings of events because they were seen to be potential owners of such information, even if they might on other occasions have not had the rights to adopt such a role. This is something that has obvious scope to extend beyond trail circumstances to just any occasion when any particular user within a group may have the use of such an application available to them. And this, of course, means that just how they proceed to use the device housing such an application is not necessarily going to be called to account by others in exactly the same way as if they were using 'just any old application' or testing or tweeting or whatever, because it is also open to being understood to be of potential utility to the whole of the group.

Mutual Intelligibility

As already reported above, a great deal of what participants were doing with the application on their mobile devices was invisible to other members of the group for the majority of the time. What could be seen was that the mobile device was being used, and where reference was made to surrounding objects, the environment, or scheduled events, either verbally or by orientation and gaze, use of the specific Cite application could be deduced. Other than this the users of the phone could have been doing a range of things with the phone without it being evident which. Close focus upon the screen was likely to be accounted for as use of this particular application as well because, as outlined above, a general concentration upon one's mobile device when visiting such a site with one's family would otherwise be rapidly called to account. Thus one might say that a broad understanding on the part of the rest of the group that one was using the Cite application, and with focus on that application being a recognizably appropriate way to proceed when involved in testing such an application, provided licence for the users to proceed in that fashion. Other than this, however, just exactly what was being done with the application was not mutually available and therefore not mutually intelligible across the group, but rather covered by the general gloss of 'trying things out on the phone'. The licence to use the application in this way, however, also provided greater licence to others to seek to render what was being done more intelligible by directly approaching the user and looking at what was on the screen. Ordinarily there is a gross etiquette in play that makes it accountable for others to pay close attention to what you are doing with your mobile phone. In the context of using the application and, most especially, using the application as a test, however, such ordinary etiquette was temporarily suspended and the interest of others in what was being done with the phone was not treated as something in need of account. The link between availability and intelligibility here and the further matter of open inspectability of action are all interrelated aspects of using a relatively small and discreet device for the purposes of supporting group activity *where that group activity is in the course of actually unfolding*. It testifies to recurrent efforts on the part of the group to make what is happening on the application available and intelligible to everyone in the group so that they too can draw upon it as a resource. However, it was also evident that these efforts were not sustained and, notably, declined over the course of the visit as it became clear that there were practical limitations upon making such a thing truly a group resource. Thus we encountered the phenomenon where intermittently, at points where decisions had to be made or where disambiguation was required, the user of the application became a *mediator* of the application for the others. This stepped around any possible mystification of what was going on as everyone had the taken-for-granted right to demand of the user information derived from their use of the device.

Distributed Coordination

One of the routine things that happens when groups of people visit sites such as museums together is that they devote significant effort to retaining group coherence. Indeed, this is one of the primary organising characteristics of such visits and overrides many point of individual interest (see Tolmie et al (2014) for further elaboration of this point). Thus managing the group as a distributed entity is not something that features strongly in their various interactions. However, from time to time, specific licence *was* granted to certain members of a group to separate off from the others. Often this was about practical considerations such as going to the toilet, but it was also sometimes about allowing members of the group to pursue individual trajectories, with the caveat that ways of regrouping were established in advance of the separation taking place. Use of the application was largely divorced from these discussions. However, one can see how it could have potential for identifying the parameters of regrouping in a range of different ways. Thus it might be used to explore mutually interesting events and their times and locations such that regrouping could happen there. Alarms could even be set to further facilitate this. It could also be used to explore other locations and suitable places where regrouping could occur.

In view of the above comments it is worth noting that on one occasion a group that had split up in such a way did try to use the application as a resource for regrouping. Here, as some of them concluded their own activities and wanted to regroup, the father was concerned to try and see on the navigation map the place where his son had said he was going. However, on this occasion that application served to *resist* this interest because it was primarily set in geolocalisation mode and it insisted on pulling the map back to where the father was located, rather than allowing him to explore other locations in equal depth. Two primary lessons to be drawn from this are: a) that, to support distributed coordination, these kinds of applications need to provide ways of identifying not just where you are, but where others in your party are as well, and b) as a resource for regrouping the application would work best, as it stands, if it was incorporated into the ordinary ways in which regrouping is pre-discussed at the point *prior* to where parties separate, rather than as a way of resolving regrouping issues at the moment where regrouping is supposed to occur. However, it should also be noted that in solving a) such that one can readily identify the current location of others in your party, b) becomes less imperative. Indeed, if an application could actually display genuine current location of others in the party rather than just some projected location it would, if anything, be most effective as a resource at the moment when regrouping actually occurs.

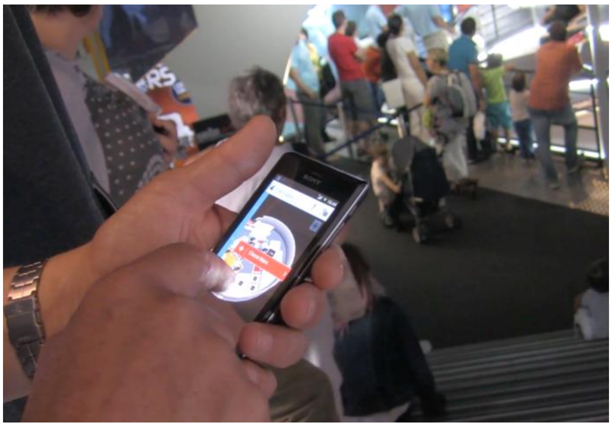


Figure 51 Trying to Find Where Your Son Might Be

Availability & Awareness

One final classic aspect of group interaction and coordination relevant to some of the more problematic features of how the application was used is the extent to which users' current actions and prospective future actions are available to others around them. We have already seen above how lack of visibility of the specific features of use of the application, and a lack of accessibility to others of the application can ramify for how the user is engaged with within the group and how their actions are rendered intelligible to other members of the group. Fundamental to routine coordination across members of the same cohort is a mutual awareness of one another's doings.

This is not necessarily down to the fine-grained level of having mutual available the detailed specifics of each other's current undertakings but rather enough to be able to reason ordinarily about what kind of activity each of you are currently engaged in doing. This enables people to articulate their actions with one another, taking into account what one might ordinarily expect the other person to do next, what their degree of interruptibility might be just now, what kinds of things might be asked of the other person and so on Where current activity is obscure and difficult to reason about appropriately it is easier for disarticulation to occur. Thus it was found that others in the group were not always able to adequately anticipate what the user of the application might be doing or about to do. This led to a number of instances where people tried to engage the user at inappropriate moments, had difficulty judging where the user would be going next, and found themselves temporarily unable to mesh with the users actions and therefore stood around waiting for the user's current course of action to become more apparent.

2.2.4 Conclusion

Evaluation of the Cite de l'Espace's mobile application uncovered a range of positive results. Chief amongst these was the sufficiency of the geospatial localization technology, in a domain where it had been expected that significant issues might arise.

Here, in summary, are the principal positive findings:

- The *geospatial localization* proved to be more than adequate for the purposes of this kind of application. It provided for rapid identification of one's own position; people were able to understand the maps and the intent of the flagged items on the maps easily; moving around was sufficient to disambiguate any possible confusion that might otherwise arise; and people were highly tolerant of imprecision, were able to use commonsense reasoning to deal with its effects, and were generally willing to wait for the device to catch up. This feature also proved to be an object of serious fascination for users, powerful and compelling to a point where it became potentially problematic in other ways.
- For the *application's presentation and intelligibility* the graphics and content were generally very well received.
- For purposes of *navigation* the application is highly effective and the granularity of the display provided more than adequate.
- All participants used the *exhibit information* to some degree and it had clear utility in certain kinds of circumstances. It was particularly useful as a resource for disambiguation, to provide confirmation of location, and for general exploration of one's environs when deciding what features might be of interest.
- The *interface* for the application was also largely well received.
- The application proved to have good utility for certain kinds of *instruction and elaboration* with children. It also had occasional utility for providing added information for the whole group. Generally the application exhibited potential for being used by members of groups who are already oriented to acting as guides for the other people who are with them.
- The location of the application on a mobile device provided for certain kinds of advantages in crowded and noisy environments, most notably for *exposition and instruction*.
- The application was also effective as a resource for *planning* in group interaction, working well in tandem with other resources.
- Equally, it provided effective support in some *collaborative* tasks such as wayfinding and decision-making and the elaboration of exhibits for children.
- The map, geospatial localization and scheduling resources were all treated as being of strong utility at key *transition points*, where groups were moving across exhibition and site boundaries of various kinds. This was also the case when groups were temporarily uncertain about matters of location and scheduling.

At the same time a number of ways in which the application might be revised, developed or enhanced were identified. Principal amongst these were the following:

- The *geospatial localization*, whilst already effective, could be enhanced through improved accuracy of positioning and through more rapid recognition of changes in direction of movement.
- The application needs to be more *easily located* on Google Store and more *seamless* to install.
- The application needs to work across the *whole range* of Android handsets and needs to be developed so it is also compatible with iOS for both the iPhone and the iPad. it also needs to be made evident up-front to users that functionality will depend upon wireless networking and GPS being switched on.
- Current dropouts in *network coverage* need to be dealt with and the coverage needs to extend across the whole of the site.
- The initial *presentation and intelligibility of the application* needs to be improved such that the range of functionality is made immediately apparent upon opening the application.
- For the purposes of *navigation* the network coverage needs to be more reliable and the refresh of the data cache needs to be more rapid upon changes of position.
- For the *scheduling* component listings of events need to be text-based rather than icon-based by default so that they are more immediately intelligible, the scheduling tool needs to be better articulated at the outset, and it needs to be easier to move between the different modes rather than having to return to a high level menu on the opening page.
- The presentation of *exhibit information* needs to be refined in several ways. First of all testing is required to establish how much information is enough as it would appear that current text density is too great. Secondly, the default presumption that the application is about locating where *you* are needs to be revised so that it can also provide for ascertaining where others might be according to exhibits they have proposed visiting. A further refinement of this would be active identification of the location of other people in one's group. Exhibit information should also be designed so as to support browsing in other locations and recommendations to other people.
- The principal menus in the application *interface* should make it easier to locate the different primary functions and the sizing of certain elements such as tags for levels in the exposition building needs to be larger. Scheduling timelines also proved tricky to handle.
- There may be a requirement to more effectively democratize *ownership* of the application such that it can be easily shared across all members of the group. This may also imply a need for users to be encouraged to download the application to more than one device within their group. These refinements would also serve to facilitate *accessibility* and *planning*.
- So far as only certain individuals are running the application at any time it is worth investigating how to best support the *filtering* work they engage in such that they can *mediate* between the application and the rest of the group to best effect.
- *Planning* activities are currently restricted by the size of the device. Supporting the application on larger devices such as tablets and iPads would facilitate better group sharing. The delivery of the right kind of information at the right time to support decision-making would also further facilitate planning work. This observation also applies to where tips and training hints about the use of the application are provided, rather than simply relying upon information provided at the outset.

The table situated below summarises the various recommendations and implications outlined in this report in terms of what kind of future effort and investment they might require. As can be seen, some of these implications require little investment to move forward. Other implications, however, speak to the possible need for further research in this domain, something that is itself an important outcome of the CHESS project, indicating as it does ways in which CHESS research may itself provide the foundation of other research endeavours in the future.

Table 8 Recommendations and implications

Requirements and Future Considerations			
Simple Technical Revisions	**More Involved Re-Design**	**Potential Re-Design and Re-Conceptualization of the Technology**	**Implicating Further Research**
Faster recognition of changes of direction for geospatial positioning	Improved accuracy in geospatial positioning	Provide for a wider ranging view that steps away from the assumption that localization is always about finding out where you are, not other people and things	Explore the scope for, and implications of, democratizing and sharing personalized access to visit-related resources across devices within a group
Increase speed of refresh for localisation	Explore question of how much information is enough information for this kind of application	Provide for the location of other people within the same group	Explore how to move the control of differential access to visit-related resources away from an accident of design and device availability and into the realm of ordinary group dynamics
Easier location of application for download	Provide targeted information at transition points	Recognising and supporting the situated filtering work undertaken by owners of devices	Exploring how applications like this become embedded into practice over the course of multiple visits, not just exploring first encounters
More seamless installation of the application	Expanding on how information about exhibits is conveyed	Supporting delivery at the right moment for induction into use, not simply at the moment of identified need	Exploring how applications like this can modulate their demands for engagement so that users do not become ‘locked into’ their use to the exclusion of everything else

Enable genuine compatibility with all Android devices	Adding functionality for people to adopt the role of 'guide'	Making the application more relevant to the conduct of collaborative work	Exploring, as an alternative to the above, ways in which these kinds of resources might provide completely alternative ways of visiting cultural sites and providing enriched and distinctive views upon a site's content (one of the significant drivers underlying projects like CHESS)
Ensure iOS compatibility (including iPads)	Supporting alternative versions of the application on other kinds of devices such as tablet computers	Finding ways of making users of the application more readily 'interruptible' according to need	Exploring how to support the use of these kinds of resources in densely populated and highly contested zones in cultural sites
Ensure users are notified of need to turn on wireless networking and GPS	Providing support for paper-digital interaction so that the application can directly elaborate existing paper-based resources	Looking into ways that the application might extend its remit to support 'outside of visit' use (at home, in cafes, during journeys, etc.)	
Ensure comprehensive site coverage with no drop-out zones			
Provide a clearer frame for people to know how the application can be used without resorting to help menus			
Provide clearer text labeling of events			
Make chief functions more evident in principal menus			
Increase size of tabs for switching between levels			

Refine the presentation of timelines			

For the application itself, after this evaluation some initial changes were made, principally to the graphic content and the way in which it presents itself to visitors. Largely this covered matters such as simplifying the planning tool so that the columns were clearer and the representations of events and animations less abstract. Some of the textual descriptions of exhibits were also modified and some new elements were built in, such as indicators of when the site was open or closed. More radical changes were not pursued at this point because of their cost implications. However, the Cite is now in the process of developing a new version of the application that is dedicated to supporting visits by blind visitors. Here the idea is to give use the 'Voiceover' system on iPhones to provide them with audio information about exhibits, triggered by the geo-localization system driving the existing application. In this case the navigation elements are played down and, for obvious reasons, there is no map. Navigation in this case is left to the assistants and family members who always accompany blind visitors around the site. Other graphic elements are also simplified for similar reasons. This application is moving towards completion at the time of writing this report.

2.3 Evaluation of a school group experience deployed at CITE

2.3.1 Introduction

In this evaluation report we examine an implementation of the CHESS experience, that was authored in the CAT, with groups of schoolchildren visiting the Cite de l'Espace in October 2013.

The Cite de l'Espace has a heavy commitment to its education programme and has large numbers of school visits over the course of a year, many of them framed around the French curriculum. There was significant interest in the Cite in trying to find ways of marrying this interest up with the work coming out of the CHESS project. It was therefore decided that some basic profiles would be developed that reflected profiles to be found in the classroom, around which some adaptability in the assignment of story and task components could be constructed as part of an ongoing experience for users using iPads. The aim was to have two basic personas, Solal and Marion, with a scientific-analytic and artistic-descriptive leaning respectively. Further information about these profiles can be found elsewhere in this deliverable. On top of these basic tendencies there was a sense of providing users with tasks directed towards two distinct space-related missions, a manned trip to the Moon and a robotic mission to Mars. Initial questions and answers to supplementary questions as users actually undertook the experience would be used to assign them to one or other profile and one or other of the missions. This would then shape the tasks they were given. The plan was to divide the visiting schoolchildren up into groups who would collectively engage in the experience, with set groups being given profiles and missions related to the profile of the group itself indicated by their responses to the provided questions. Notionally at least it was thought that children with a more scientific leaning might thus end up going around together, and likewise for children with more artistic leanings.

This is evidently a rather simplified application of the notion of personas and personalization being used in CHESS, but the intent was to find something simple that would enable staff locally to assess the feasibility of applying the CHESS framework in a way that could suit the Cite's particular needs as an organisation with a strong educational mission.

This report examines what happened in this implementation, analyses what this has to say regarding the adaptability of the CHESS framework to the construction of these kinds of experiences, and evaluates the strengths and weaknesses of this particular implementation as an experience in its own right. As with the preceding report regarding the implementation of a mobile application at the Cite, much of the discussion is organised around a careful attention to the nature of the experience as a *social* experience and how this was impactful for the kinds of action and interaction that took place.

2.3.2 The Evaluation

In this section we take a closer look at just what kind of experience was being evaluated on this occasion, the nature of the participants involved (who came with some quite specific characteristics that need to be borne in mind), how the experience was constructed to take place and how the evaluation activity was situated against this.

2.3.2.1 What was evaluated

Through the CHESS authoring tool staff at the Cite, together with assistance from technical staff at RealFusio, constructed an iPad-based experience that was framed around two alternative missions: a robotic mission to Mars; or a manned mission to the Moon. Each mission contained 4 principal steps. These steps were additionally informed by whether participants were assigned the profile of Solal with scientific-analytic tendencies, or Marion with artistic-descriptive tendencies. As discussed above, responses to tasks during the course of the experience could result in participants being moved to a different profile or switching mission. The basic framework of the experience was as follows:

- An initial questionnaire upon starting up the application consisting of 5 questions designed to assign the user to either the Solal or the Marion profile.
- Then each of the 4 tasks consisting of:
    - A set of photos that provided navigation cues for users to find their way to a particular location within the site.
    - An introductory page that provided an overview tied to the exhibit currently in front of them once they had reached the specified location.
    - Some video material that further set the scene, with some further textual content.
    - A set of activities such as taking photos, labelling objects, making videos, uncovering information from other resources, and so on.
    - A feedback page that provided the chance to articulate whether the previous activities had been appreciated or not.

Each of the tasks was conceived to build iteratively upon the preceding task, framed around the progressive acquisition of skills and knowledge and culminating with the completion of the set mission.

Content was cached on a server and dynamically uploaded to the device over the local wireless network according to a set of decision rules and calculations associated with the assigned profile, latest responses to questions, and the location of the user within the overall trajectory of the mission. All of the users (except 1) had already downloaded the CHESS application on their iPads together with some additional software, such as Instant AR and Solar Walk, designed to support some of the surrounding activities. Content generated by the users themselves over the course of the experience, such as photos and videos, was itself uploaded to the server so that it remained associated with the specific user and the CHESS application.

As the evaluation reveals, some of the decision made here proved fateful for the capacity of the system to operate robustly within the timeframe that had been provided for its construction.

2.3.2.2 The participants

The participants in the evaluation were 24 students of 14 to 15 years of age from a Lycee about 100km north of Toulouse in France. They had not yet settled on specific course options so were of mixed disciplinary interests and there was a more or less equal mix of boys and girls. The students were accompanied by 3 of their teachers and had travelled direct to the site that morning.

A critical characteristic of this particular group of participants was that their class was part of an experimental scheme being run by the French Ministry of Education whereby all of them had been given iPads and all of their course materials were stored upon or had been designed to be accessed from these devices. This meant that they were already familiar with the devices they were using and, as mentioned above, were able to arrive with the relevant software already installed. Being able to assume the presence of certain resources and a certain level of user competence made a significant difference to how the experience might be run.

The group of users finally followed and observed in detail ethnographically during the experience was, initially, a sub-group of 6 made up of 3 girls and 3 boys, that then divided up into further sub-groups of 4 (3 girls, 1 boy) and 2 (2 boys). The sub-group of 4 itself worked largely as a set of 2 pairs over the course of the experience, though these 2 pairs interacted fluidly and assisted one another across a range of tasks.

2.3.2.3 The evaluation process

The actual experience ran over the course of a morning in October 2013. It was anticipated that each of the pursued scenarios would run for about 1 hour and 30 minutes. In order to avoid congestion at any one point, the 24 students were divided up into 4 groups of 6 and were sent out from the main site reception at 20 minute intervals. The principal locations to be visited were the Ariane 5 rocket, the Soyuz Vessel, the Parterre des Planetes (a large replica of the solar system built on a slope in the park), and either the Moon or Mars exhibitions in the main exposition building. Each group was also, where possible, accompanied by a member of staff from the Cite and someone who could provide technical support.

The process began with a short introduction to the purpose of the test by the Responsible d'Education for the site. All of the students were then given personalized cards giving some outline information about the application, the network they needed to log onto, and a unique username and password for logging on to the CHESS server. The latter was designed to ensure that specific users and logged data could then be identified at a later stage if required. It also ensured that their own content was specifically associated with them when generated and stored. At this point the students went about logging onto the network whilst being simultaneously divided up into their respective 4 groups of 6, largely by means of self-selection. Once logged onto the network the idea was that they would then fire up the application and connect to the CHESS server. Once connected hey were fed their 5 principal questions so that they could be assigned a profile. After this they were supposed to begin navigating round the site, fulfilling each of the tasks in the 4 main locations. As the phrasing here indicates, the actual realization of this proved to be a little different and many students found themselves at the first location before they had even managed to log onto the network.

Further contingencies that occurred on the day were that it was decided that where possible the students should share one iPad between two of them because it was raining intermittently and it was considered best that one student should hold the iPad and another an umbrella to protect it. In fact, divisions were even more contingent in practice, with some groups going around together as a set of 4, and others going around individually. Specific groupings were bound up with the specific scenarios the groups of students were following (the mission to Mars or the mission to the Moon).

The exercise was evaluated by an ethnographer following around throughout the experience the largest single group identified (4 students in total). Careful observations were made of all of the students' practices, interactions, and difficulties over the whole of the test, from the moment they arrived in the reception hall until the last task had been terminated (it was never completed because of a technical issue). All of the experience was recorded on video and was subsequently analysed from an ethnomethodological perspective, as outlined in section 2.1 of this deliverable. Additionally, a 20 minute debrief was conducted with all of the students before they left to go home in the afternoon. Here they were invited to give direct feedback about the experience.

2.3.3 Findings

In the bulk of the remaining material a series of observations are made about how the experience worked across a variety of practical perspectives. We begin with some reflections regarding the framing of the experience, how the application was engaged with, and some of the technical problems that arose. After this we look more at how the experience worked in the context of the students' social interactions and how it was made meaningful as a social rather than a technical phenomenon. We conclude by directly reporting the main outcomes of the debrief with the students and the feedback that was given regarding the features of the experience they either struggled with or appreciated.

2.3.3.1 Getting ready for the experience

One of the things that needs to be understood in this particular implementation is the way in which the participants were prepared for the experience and the import of that for everything that followed.

We outlined several things that happened in the reception hall before they ventured out into the parc above. These included being given an introduction to the test, being split up into groups, being given individual cards with unique usernames, logging on to the wireless network, opening the application, logging on to the CHESS system, and completing a questionnaire for the purposes of profiling. All of these were fateful in various ways and worth looking at individually.

The introduction to the test

The first thing to comment upon here is the way the introduction received by the students emphasised that they were about to be involved in a 'test'. When one says of something that it is going to be a test, this provides for a particular understanding of what will unfold. It implies from a commonsense perspective, especially once one is told it is software under development, features of varying reliability that may not function perfectly, It implies subjecting a system to certain kinds of strains and pressures or to exhaustively exploring its features. It may simply imply running through what a system can do and assessing how useful those various things might be. What it does not put to the foreground is the sense of being involved in an experience. Nor does it convey in its own right anything about the organisation of such an experience, for instance in terms of profiles or missions or scenarios. Indeed, the sense of their being profiles that the students were being assigned to only arose a little later as an outcome of login troubles when there was a need to account for why everyone had a unique username. The fact that the undertaking was not strongly promoted as being an experience at this stage had certain consequences for how the students understood the rationale for the tasks they were engaged in, as we shall discuss further in section 2.3.3.6.

Instead of the character of the experience as an experience, equally important matters were articulated regard the pragmatics of how the test would be organised. Explaining they will use their iPads the students were told that they would be using the devices 1 between 2 because of the weather so that one could operate the iPad and the other protect it from the rain. They were told that they would be going out in 4 groups of 6, one after the other, at 20 minute intervals. He then showed them cards he would shortly be handing out which were designed to explain the application they had downloaded. He then checked they had, indeed, all downloaded the application. Most had, though 1 hadn't. He also explained that the card would give details for the wifi and everything they needed to get them started. Saying that the scenario would start in the park he reminded them again to protect their iPads whilst outside and said they would encounter guides at various points outside who would be able to help them where needed. After this he checked whether they already had any idea of the groups they might want to be in and, when he found they hadn't, he began to go about gathering together volunteers for the first group whilst introducing them to the other people who would be involved in the test and assisting them as they went round.

Another detail to focus upon regarding the initial introduction is the decision to get the students to share their iPads 1 between 2 because of the weather. There is an implication underlying this that, although all of them had unique usernames, only 1 person in each pair would be logged in to the system. This poses certain questions in that case regarding the initial profiling questionnaire. Which of the pair would it represent? Or would the students be encouraged to think about it as a composite? As matters unfolded, in fact, it was not clear that the students had any opportunity to reason about the nature of the questionnaire at all.

Splitting into groups

After the introduction the students were split up into 4 groups of 6 as promised. Here further questions could arise. Once he had finished handing out cards the Responsible asked the group 1 people to come with him but found that, at present, there were just three of them lined up against the window. He therefore asked for 3 more people to join them, at which point the 3 there already began beckoning to other people in the hall and a teacher showed 2 girls over who said they were ok with it. Clearly this process was organised around self-selection and the grounds of selection were largely bound up with people knowing one another and being friends. This, too, had implications for how people might go about responding to questions where it was understood that these might be fateful for whether they got to go round together or not. Indeed, a later discussion made it clear that friends had been making an effort to stay together wherever possible.

Handing out cards

When it came to handing out the cards this involved a significant amount of work. The Responsible split the pile in half and, together with one of the teachers, he went around the hall systematically calling out the name on each card, getting people to put their hands up so he could pass the card over to them. This attention to getting the right cards to the right people indicated its importance, but the fact that the cards had a unique identifier that would assist with marrying specific bits of data up with specific people was something that only became visible to the students down the line.

Logging on to the wireless network

Offering up logging on to the wireless network as just one more component part of the process rather belies in this case the complexity and duration of this task. In fact this proved especially problematic and insinuated itself as a feature into the subsequent parts such that one might say that it became *the* framing feature of the experience. We shall look at this in a little more detail in section 2.3.3.2.

Opening the application

Opening the application was not so much something that happened at a certain moment within the process as something that the students were trying to do at various moment from just after their arrival through until the experience had concluded. From the moment the students were told to get their iPads out people were starting to try and get the application running in anticipation of the coming need. This is not problematic in its own right, but firing up the application was intimately connected with the following step and it was at the following step that it became clear there were some serious issues.

Logging on to the CHESS system

Going into the CHESS application immediately began a process of trying to get the user logged into the CHESS system supported by the local servers constructed for this purpose. However, this login process had to be handled over the wireless network and the fact that the wireless network was currently oscillating between patchy to being total non-functional meant that logging in was for most of them far from trivial.

Figure 52 Using a card to try and get logged on to the CHESS system

A compounding feature here was that it was more or less opaque to most of the users just what might be causing the trouble. All they could see for the majority of the time was the fact that the device was attempting to process their request and cycling. It was actually more meaningful when users managed to get onto the system but then lost connectivity because at this stage they were at least told the network had become unavailable, but many of them never managed to get to this point of initial connection in the first place. Those who did get a connection were in most instances driven to doing it recurrently, with the connection failing prior to completion of the questionnaire and therefore before their profile had been established. This was a problem that largely persisted until groups were out in the parc, though some machines found a stable connection before others. The fact that some did get connected did at least make clearer to others around them what connection should look like and the fact that there were network problems that were underlying the behaviour of their devices. Even once connected in the parc this problem of getting logged on to the system was not finished with but rather became a feature for them again at the close of the experience when the server crashed, leading to a new round of connection difficulties.

Completing the questionnaire

The next stage in the process once users were logged on to the CHESS system was the completion of the profiling questionnaire. Unfortunately this, too, had an enchained dependency upon the preceding matters of having a network connection and being logged on to the system in the first place. Thus, many of the users never quite got to the point of completing the questionnaire. However, even once they had got to this stage it was not equally evident to all of them that they were, indeed, engaged in completing a questionnaire. And even once they did realise this was what they were being asked to do, the purpose of the questionnaire was not especially apparent to them. The enactment of this part of the process was further compounded by it not being quite clear when it was appropriate to begin answering the questions. Some began to do so immediately but others waited or sought permission from the support staff first of all. In most cases it took until the students were in the park and in place for the first task for the questionnaire to be completed. But it was at just this point where people were beginning to start the experience that the issue of how to ensure people seeking to go round together were assigned to the same profile began to raise its head. In the end, the only practical solution to this was for the completion of the questionnaire to be 'massaged' in situ, with users who wished to go round together being instructed in how to respond to fateful questions within the questionnaire such that they could be sure of having the same profile and therefore be able to share the same trajectory around the site with one another. There was nothing especially surprising about the pragmatics of ensuring people had a satisfying and coherent experience winning out over abstract notions of personalization in fact. Several bodies of our prior research had already made clear that decision-making about group experiences is bound up with a multitude of situated considerations that rarely have much to do with expressions of personal preference (Crabtree et al, 2013; Tolmie et al, 2014). Here is an example of how the questionnaire completion proceeded for one of the members of the group that was ultimately followed:

> Charlotte[7] logging back in to the system again. Had already been in but was instructed to logout and back in again to ensure the questionnaire had the responses necessary. The technical support person talks her through, saying restart app. Entering her details. Entering her username. The member of staff assisting saying 'that works'. Gets to the questionnaire. Waiting for it to load. The assistant instructs her on responses to fill in that matter to ensure the right profile for the group.

The same participant was later obliged to try and re-create this construction of the questionnaire in English when she tried to get back into the system after the server had crashed, which compounded the difficulties of providing adequate responses from her point of view. The compliance of the students with this adaptability of response made visible an understanding of what these questions were about that is at some remove from them having any connection to their own personality. Rather the students came to orient to them as a pragmatic vehicle for ensuring they were directed through a particular set of tasks within a sequence.

Something needs to be made clear from the outset, lest more be read into the above observations than should be. First of all, as an organisation the Cite de l'Espace has no particular investment in personalization per se. Rather it has a strong interest in finding ways in which to make the crafting of experiences promoted by CHESS a feature of its own offering. It was the presentation of several alternative 'crafted' experiences that mattered most here. Not a tight correlation between a user's personality and the exact content of those experiences. Notions of preferences within certain kinds of profiles informed the construction of the initial materials, but this was not reasoned about as something that should constrict user choices on the ground. Rather the idea was to present users with several ways of going about two simple underlying missions so that a unifying link could be made between the presentation of what might otherwise appear to be divergent bits of information and activities[8]. As such, what really mattered here was that groups of users got assigned to missions and then followed through the logic of those missions. The questionnaire was simply a vehicle for accomplishing the assignment of people to missions, so re-crafting it on the ground to ensure particular assignations was not at odds with this fundamental strategy. Secondly, the fact that users were going around the site in groups rather than as individuals meant that compromises had to be made. The constitution of group profiles is not something that has been addressed in CHESS. Personalization for individual users is already understood to be a challenging domain of research and expanding the remit for that research would amount to a whole new project. What confronted the staff at the Cite on the ground was a very real practical problem. The system required the construction of a profile for it to run. Therefore not constructing a profile was not an option.

Being ready

[7] The names of the students involved have been anonymised throughout.

[8] Though the extent to which this itself was accomplished is a question we shall return to.

As a short addendum to the above observations it is worth noting that, whilst it might seem that, for those who had managed to get a connection, the situation was better, in fact, the construction of the experience around groups meant that they were equally obliged to wait. Now, however, it was a matter of waiting for others to be ready as well.

Getting to the right place

As we have intimated, because of widespread network issues, what was conceived to be the first preliminary to the experience, network connection, elided into what was notionally the final preliminary of questionnaire completion, before tasks were able to get underway. What actually happened was that people were obliged to move on in incremental steps towards the park whilst still not being logged in. Thus it happened that people found themselves pursuing the necessary spatial trajectory whilst still not following the sequence of the experience itself. The need to engage in this kind of incremental movements was about being ready and keeping the planned flow of groups underway. Again what this demonstrates is the need to handle things pragmatically taking precedence over any idealized notion of the process. Getting to the right place whilst still not ready was about the management of contingency so that it would take as little time as possible for the experience to begin once readiness had been achieved. At the same time, of course, the pragmatic push to move along and go with what was available did have consequences in the end for who got to do the driving, whose iPad got to be one of the iPads being used, and whose profile got to shape the profiles adopted by the rest of the group.

Much of the experience in the end, then, became about getting ready for the experience. It is important to stress, however, that despite these difficulties, the first 2 groups out did manage to experience more or less complete 'missions' and the current evaluation is based upon what happened with them. Sadly, however, the later groups never got much beyond this preparation phase and the feedback from the students provided towards the end of this report needs to be understood against this. These observations should, additionally, provide a salutary lesson about the construction of systems with too heavy a dependency on wireless networks, and mechanisms involving ongoing data exchange across such networks. This is not a fault in CHESS as such, but underscores the vulnerability of systems such as CHESS, which often have little choice but to make use of wireless networking technology, to recurrent issues within such infrastructures.

2.3.3.2 Dealing with technical troubles

In this section we look in a little more detail at the various technical issues that became manifest over the course of the deployment. Unlike the preceding section, here we take as our interest the whole of the experience, though once the students were underway there were relatively dew technical issues that they had to contend with until the final catastrophic collapse of the system. Our focus here is also upon some of the methods drawn upon to try and manage the technical troubles that arose.

Getting onto Network

We emphasized in the preceding section the extent to which getting on the network impacted upon everything else that was required for the smooth running of the system. Something to note here is the sheer scale of the problem that unfolded. In the first instance only a couple of the students were able to get any connection at all which meant that all of the remaining participants were in potential need of technical assistance, and all at the same time. Confronted with this, first efforts were devoted to dealing with relatively basic issues, such as people connecting to the wrong network. There were several networks available in the reception hall and there was scope for confusing them because they had rather similar names, so museum staff and technical support personnel initially went around stressing to all parties the exact name of the network they should be connecting to:

CHESS CITE. In addition the personnel made a point of inspecting people's iPads to make sure that they were indeed trying to connect to the right network.

At the same time the students themselves were making efforts to cross-verify amongst one another that there was, indeed, first of all a problem with getting a connection and, secondly, whether there was anything they could do about it. This work amongst themselves was independent of the work of the staff and often involved recurrent attempts to disconnect and then reconnect in the hope that they would get through.

A part of the competence here that was evident across all parties, technical and otherwise, was being able to understand the implications of certain kinds of interface behaviour such that they might be seen to be signalling simply a problem or a change in state. For technical support staff an additional strategy they adopted was to co-opt one of the students' iPads so that they could directly attempt various configurations and undertake the work of troubleshooting. This they were seen to do in tandem with assisting people who were confused about how to use the information on the cards for the CHESS system login.

Characteristic of all of this phase of the deployment was an immense amount of simply standing around, looking at screens, waiting for connection to happen, or talking with other people. A further feature of this waiting period was recurrent verification across the different groups of students that they still had no connection by literally calling across to one another. There was a sense in which it was understood that everyone was doing the monitoring, not just you.

Ultimately the capacity of different devices to get a connection became the grounds upon which iPads were selected for use in the actual experience, giving up on the ones with no connection and redistributing the others so that they could still work in pairs. In this way half of the iPads could be set aside at a pinch, further reinforcing the 1 between 2 strategy.

Variability of network connection

A compounding problem to the above was the fact that, even where network connection was achieved, this was no kind of guarantee that the connection would be retained. Many of the students found they were getting initial connection only to lose it again. So they were having to login again recurrently. This was still happening almost up to the point where they began the scenario in earnest. Recognition of this prompted support staff to share their numbers within one another so that they could be called upon if further issues were uncovered.

Display glitches

Network issues were not the only troubles encountered by the students during the deployment, though the rest were very minor by comparison. So one noted fault was a recurrent issue with the character display in the questionnaire such that some characters were replaced with boxes, though this was not found to seriously impact upon readability.

Another display glitch encountered later on in the experiences was a failure of the photo captured by the user of the Soyuz rocket to display on the page where they were doing annotation. This made it harder to make direct reference to the photo. It was also hard in this activity to know initially whether a submitted annotation had been accepted. Users were only reassured once a progress bar had appeared at the top of the page.

Known troubles

It also became apparent as the students went round that it was already known to the staff that some buttons on the screens were non-responsive. In this case participants were advised to click on another button instead:

Message: Do you want to take a photo with the rocket?
Charlotte clicks yes but nothing happens
Helper saying if it doesn't work press on another button
Charlotte does

This, of course, carried further implications for ongoing profiling because users were being obliged to make certain choices rather than exercising any preference.

Server crash

Towards the end of the final task in the experience a server issue gradually began to become manifest, though it was not recognised as a server issue immediately. Instead all parties, including the technical support staff, made an immediate assumption that it was the network again, Uncovering the actual nature of the problem took some work of disambiguation. In the end one of the support staff got one of the participants to try and access their email on their iPad to establish that the network was still working and that it must therefore be an issue with the server.

An associated problem that arose as a consequence of losing server functionality was that all of the media the students had accumulated over the course of the scenario was no longer accessible to them because it was not stored separately on their own device. The hiatus caused by the failure of the server provided a natural opportunity for them to review this media, but they were unable to do so and this forms part of the backdrop to complaints about media availability that surfaced during the feedback session.

Another aspect of it being the server rather than the wireless network that had failed was that this kind of failure proved to be less tractable for ordinary reasoning, such that the distinction between the two issues was not clear:

Mathilde goes to check the iPad
Elise joins
Mathilde saying three bars there (pointing to screen) so why's it not working?

In the end the failure of the server proved to be a Proving to be a terminal problem and the test had to be concluded in advance of its proper completion.

2.3.3.3 Navigation

In this section we shall reflect briefly upon how the experience worked in terms of providing the necessary resources for users to navigate between locations in order to accomplish the various activities.

Instructing in the method

In fact navigation proved to be a non-issue for the users. The principal navigation resource was a series of photos on a separate page that progressively provided for recognition of relevant landmarks for navigation. When the very first navigation pane with photos appeared the support staff made a point of getting the students to recognize one of them as being where they were now. This made it evident that how photos were to be used as a resource for orientation and an absence of subsequent difficulties showed this to be a strategy that worked well. The navigation resource was one of the features highlighted as being effective in the final debriefing session with the student.

Managed navigation

In addition to the above instruction some additional assistance was provided by the helpers to steer participants to relevant locations at appropriate moments:

Helper saying 'now imagine you have been launched on a rocket' (pointing to image on navigation pane)

Charlotte scrolls to bottom and clicks on next button

Next page comes up (with flags etc. – re Ariane)

Helper saying 'Alor vous vous approche l'Arianne' [move towards the Ariane]

Start to walk towards the Arianne rocket together

This particular instance is interesting in that it also served as practical instruction in the framing idea of the mission which was manned flight to the moon and therefore how they might engage with the experience.

Later they also received some gentle encouragement from the helper that they were heading in rthe ight direction when they first used the navigation pane on their own, for heading towards the Soyuz rocket.

Guides

Another noticeable phenomenon was that certain individuals tended to take command of the navigation and direct the others or lead the way at moments of indecision. Sometimes this was active as in pointing or saying 'this way'. Sometimes it was simply a matter of walking a certain way confidently and the others then having to follow.

Get to top of stairs and pause and look around

Charlotte heads off to their left, Mathilde follows

Alain looks at navigation pane on Elise's iPad, then they both follow as well

Verification

Although the navigation pane was clearly adequate for the purpose it was notable that the use of it did involve occasional reference to verify the right way to go when the navigation became more complex, e.g. for the final task and heading back into the exposition building.

Being instructed by others

A further navigation resource was that subsequent groups were able to use where they saw previous groups clustering as a means for knowing where they had to go themselves – e.g. seeing a group at the Parterre des Planetes as passing and then being confident of finding this location when it came to their own turn.

2.3.3.4 Working with the interface

In this section we look briefly at how well the provided interface for the application supported the accomplishment of the various tasks. As will be seen, this was mostly unproblematic.

Familiarity

It was evident that all of the students had tremendous familiarity with using the iPad. This doubtless arose from their daily use of it as a tool. How to move between pages, access media, shrink and expand items, etc, was all quite natural from their point of view. So mostly they found the interface for the application very easy to deal with. In fact they sometimes used it with tremendous dexterity to meet situated need:

Elise goes on to activity screen as video finishes

Same for Charlotte

Reading about activity

Elise sideswipes page to the right
And pinches in with her fingers to display the desktop icons
Taps on solar walk icon with right forefinger
Alain watching to her right
Elise swipes solar walk main page to left
Brings activity page back to the fore (from right)
Alain swipes back a page
Elise articulating what she understands they need to do
Shrinks page in front of her and scrolls the pages to the right

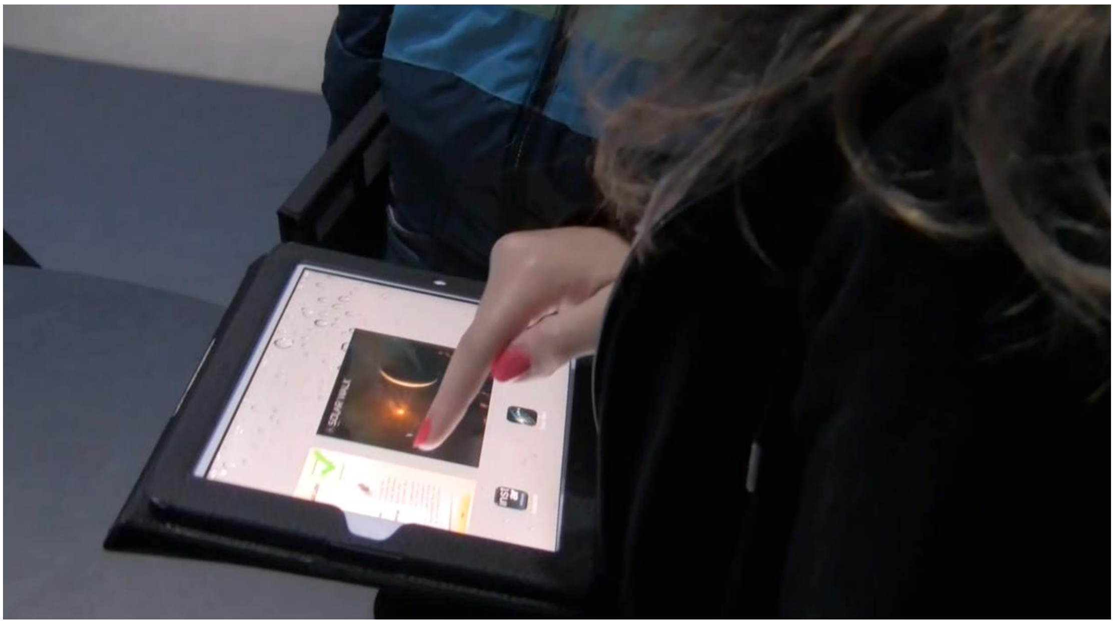


Figure 53 Showing expert understanding of how to use the interface

Pushes a couple of pages upwards and out of view
Taps on activity page again and reads out
Back to solar walk page
Taps on page and moves back slightly as waiting for app to open

Some of the participants did display less competence, however. For instance one pair of students was observed capturing photos when they should have been capturing video and it was only at the conclusion of the movement of the iPad that they discovered they had captured just a single image.

Problems with orientation

Display of some parts of the content had to happen in landscape mode or the content disappeared off the side of the screen. What was not immediately evident to the students was that this had a right way and a wrong way to it. Generally with iPads the screen re-orients to whatever position you happen to hold it in so this requirement initially puzzled several of them. One of the difficulties was that it was not immediately evident what they issue actually might be so they had to work to discover the right orientation in the first instance:

One of the boys gets a proper connection – answering the questions
Gets to next page
Reading
Notices going off side of screen
Turns to landscape

Doesn't move
Shakes from side to side
A helper comes to look as he turns it the other way and it works

It can be noted here that support staff were usually on hand to help with these kinds of issues.

Visibility

The day of the deployment was not a bright day so they had few problems with glare on the screen making it difficult to see. Nonetheless, it should be acknowledged that this did constitute a *potential* problem because of the obligation to share between two. There was a risk of the person not holding it being unable to see it properly. In fact, this did happen occasionally as in the following where other party resorted to shading the screen with his own, redundant iPad:

Arrive in front of the Ariane and stop in a line

Figure 54 Stopping to read in front of the Ariane rocket

Read info
Alain holds up his iPad against the one Elise is holding to shield it from the reflection

Figure 55 Shielding the iPad you are sharing so you can see

Rain, which they'd been warned about, was another potential issue. In this respect we did see them occasionally having to wipe the screen with their sleeves when raindrops accumulated but it didn't lead to any other evident issues, though it did mean that at times the participants had to move around together in huddles under umbrellas.

__Handling new interfaces__

Tellingly it was when they had to use unfamiliar interfaces that they encountered the greatest difficulty. This was particularly the case with the Solar Walk application that they had to use in the final task. Here they had significant trouble working out how to get the date display to change:

Looking at image of globe
Elise brings up side menu, Alain watching

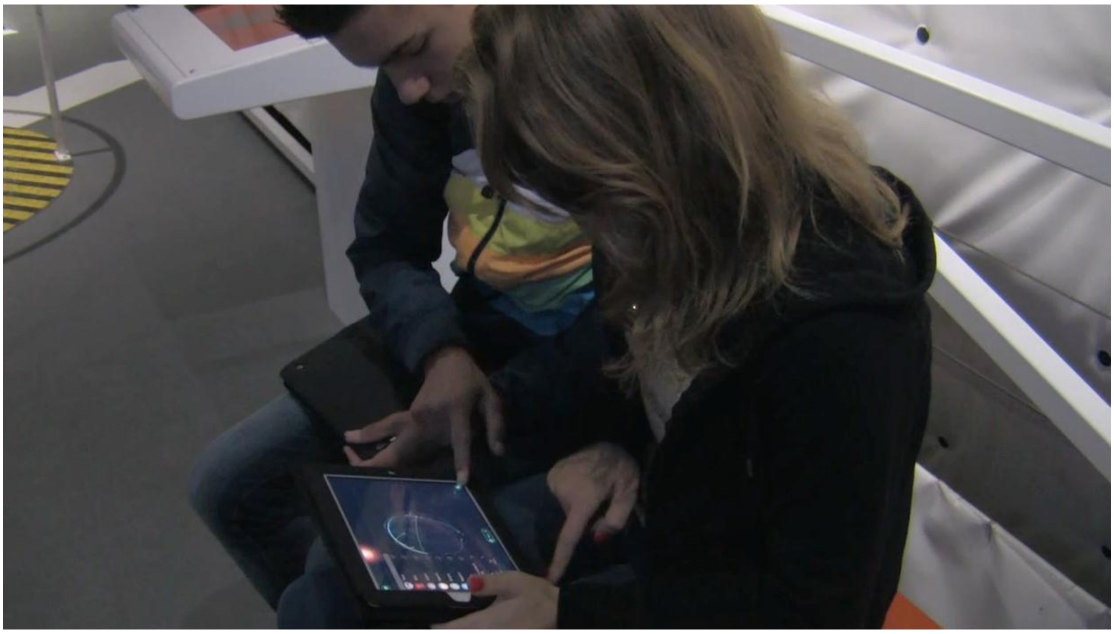


Figure 56 Working together at the Solar Walk display

Moves globe with finger
Alain moves it other way
Alain tries tapping on various icons at right of screen
Elise turns globe again
Brings up menu and opens keyboard and enters search
Charlotte carries on look at app, sat on chair,
Elise makes globe larger but can't figure out what to do [need to display at a particular date: 31 July 1971]
Gets up and goes over to Charlotte to look at what she's doing
Charlotte looks up and looks at screen of Elise's iPad when she arrives
Elise points to set of dates Charlotte has managed to get at top of page
Asks where they came from, pointing to them
Charlotte says she doesn't know
Elise studies her own screen for a moment then goes back to sit on bench with Alain
Charlotte tries tapping on the various icons to see what happens
Mathilde leans over and tries tapping on them as well
Alain points to screen as Elise continues to try and work out how to use it
Manages to bring up same set of dates as Charlotte with a gradated wheel at the right hand side of the screen
Elise side swipes the screen and looks at the activity page again
Reading out loud
Pauses, sighs, and says 'non'
Swipes back to app
Alain tries using dates at top right again
Tries dragging them around (can't seem to change it but need to because looking to find something that happened on an historical date)
There's a small arrow at the right and Elise tries touching it repeatedly but nothing happens
Alain tries dragging down across the numbers, but that has no effect either
Elise uses outward motion with fingers to expand the image of the globe

Tries moving it round then makes it even bigger

Taps on date again to see if it makes any difference, but it doesn't

Mathilde goes and sits with Elise and Alain

Charlotte takes iPad over to them and gives it to Mathilde to have a go

Mathilde takes and discovers that if she drags her thumb up and down the gradated wheel at the right it changes the date in the display

Scrolls down and down

Checks date looking for – Charlotte says 31st

Elise starts doing the same

Charlotte leans right forward over screen as Elise starts to slow down and make smaller movements on the wheel – approaching date – goes too far and moves wheel in opposite direction

Charlotte moves to look at Mathilde's screen

Also scrolling date using wheel

As gets close holds finger on wheel and moves it slowly by small increments

Elise uses the wheel as well.

This example exposes what can happen when people are confronted with a non-intuitive interface – but it also shows here how quickly they acquire and make use of the relevant skill once it has been established.

2.3.3.5 Engagement with the content

We now move on to an area where the effectiveness of the resources provided was more variable: the content.

Reading Text

Figure 57 Reading together through the content

There was a lot of content to be read in the application and their handling of it was relatively evident. This was especially the case where they were presented with pages of text. They understood that the job in hand was to read it and did so without fuss or evident distraction. They did exhibit variable speeds of reading and, in relation to this, there were clear ways of evidencing completion, e.g. by looking up, saying 'ok', etc. This did lead to some people waiting for their partner to finish – clearly one cannot just hit next when someone else is still reading. There was a risk also that those managing the device would simply progress without waiting when others were still reading the text and this did seem to happen from time to time.

Playing media

There were a number of instances where were they expected to play videos. Mostly they did this without trouble and were diligent about letting it finish and staying attentive.

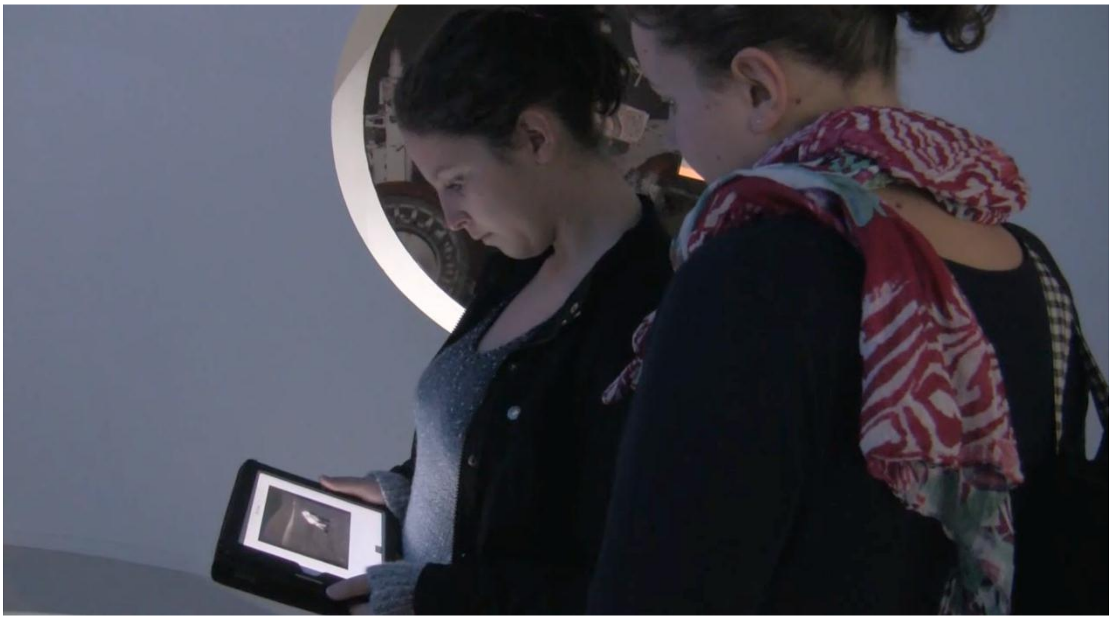


Figure 58 Watching video material together

Taking Photos

When it came to taking photos, which featured in several of the tasks, they engaged with this quite willingly. However, it was noticeable that taking photos with an iPad involved certain kinds of work. They had to reposition themselves to do it. In fact, the work of taking a photo could become an entertainment in its own right:

Charlotte's video finishes
On screen gets instruction to take photo of Ariane
Taps on camera
Window comes up
Holds iPad cover and turns to left so portrait
Swivels window within with thumb
Expands camera window
Holds up
Top of rocket cut off
Looks behind her then walks backwards
Alain also walking backwards
Elise instructing Alain to go further back as well
Charlotte holds iPad up again
Alain gives Elise the iPad
She holds it up then looks behind and moves back still further
Charlotte takes photo
Elise still holding up iPad

Takes photo

Deference to expertise

An understanding they did have was that their progress through the experience was about following instructions and completing tasks, and they were largely compliant with that (see Tolmie et al, 2012, for a further discussion of this matter of instructions and compliance in the context of enacted experiences).

A thing with groups is that they contain people of mixed capabilities. This being the case the most efficacious way of handling a task is often to get the most expert member of the group with that kind of expertise to help out. Those with less expertise, it was noted, will seek out verification from others or, at least, consensus.

Sometimes experts are clearly to hand. Alain made it evident through his recognition of the objects and his ability to talk through the process of stage detachment in the Ariane video that he knew something about all of this. When it came to playing a game about the Ariane rocket both quests for affirmation/consensus and deference to expertise were therefore visible:

Game now of attaching labels to parts of the rocket
Drags one over with thumb
To Mathilde: C'est ca?
Mathilde: D'accord
Helper instructing that they have to do it all
Alain comes up and stands in front to help
Now rebuild the rocket
Alain comes round to side of Charlotte and points out which bits he thinks are which
Charlotte labels accordingly
Charlotte checking he's sure
Laughing
Charlotte says it's his fault if it's wrong
Alain points out next label
Charlotte moves into place, tapping on with thumb then tapping on right place on rocket picture
Decides next for herself- discussing with Mathilde
Mathilde does next one
Charlotte asking about the Vulcan – c'est ca?
Mathilde: oui
Charlotte taps on label and on the rocket
All done

Making videos

Willingness to engage in tasks was differential. They found some tasks easier than others. One of the most variable tasks was the making of a video about the solar system at the Parterre des Planetes. Here one can see how, in the group followed, the two pairs handled this task in extremely different ways. One couple embraced the spirit of it wholeheartedly and worked at doing it diligently across the whole of the exhibit (which is large). An interesting feature here was how they acquired competence in doing it as they went along (though they clearly already had some idea of what it might take to make a video, including the scope for subsequent editing of material):

Elise and Alain discussing how to do the video
Elise pressing start on video on iPad
Goes to point at Alain but he tells her to point it at the planet instead

She does
Drops it down
Alain saying not ready
She goes to lift it then drops it again, laughing
Passes Alain her iPad so she can focus on holding this one
Holding back up
Alain giving count in
Elise turns and faces it towards Alain
He starts to say first of all
Stops
She starts again filming planet whilst he says first of all..
Alain reading verbatim off panel, looking at panel as she films
Elise turns and faces iPad towards him as he continues to read
Turns it back towards the planet
Stumbles over what he is saying and laughs
Elise turns towards him and laughs as well
Gestures with her hand towards the parterre saying come on its easy, it’s the solar system
Elise asking Alain if should do in different order, working outer to inner instead of left to right, but he doesn’t agree
Elise and Alain continue to dispute
Interruption by two girls
Elise and Alain discussing again how to approach their video
Alain says what he’s done already
Elise says ok
Elise filming again as Alain reads out from panel
Planet first, then turns towards him
Move on, Elise still holding up iPad to film, to next panel
Points at Jupiter
Alain reads out from panel
Turns towards him again as he reaches end of passage
To next panel - Same method
Straight to next panel (adjacent) without her turning iPad towards him
To next - Dodging round some other people - Same approach - Elise following text on panel as he reads

Figure 59 Making a video together

To next (ensuite…) [Alain doing connectives to preserve a flow]- adjacent panel
To next – Elise films Alain as they move using same approach
Alain saying forgot Pluto but it doesn't matter
Laugh
Elise stops filming

The other pair, however, were visibly uncomfortable about the exercise. They vacillated enormously about it when others were around, waiting for them to go, tried to get others to be quiet, and in the end resorted to just one of them doing it sotto voce and in a very truncated fashion

Reading instructions re making video
Charlotte sighs
Charlotte discussing with Mathilde what to do
Charlotte and Mathilde discussing layout of the planets
Charlotte counting the planets, pointing at them as doing so
Ethnographer asking if they understand
Charlotte saying have to make video about solar system
Guide to the planets and differences between them
Hesitate then move to their right towards some panels to read
Charlotte makes suggestion, pointing to the planets as she does so
Mathilde enumerating what planets there are, counting off on her fingers
Look at panel in front of them
Charlotte pointing out another planet
2 girls come up, shouting to one another, one several metres away
Another girl and boy come up
Charlotte and Mathilde move further over to the right, still hesitating
Charlotte gets ready to do video, iPad in landscape
Holding iPad up
Drops it back down again
Waiting, watching what the others are doing
Goes up to Mathilde and asks if she'll do the commentary

Mathilde saying doesn't know how to explain the solar system
Others from other groups stood at various panels, doing the videos as well
Charlotte waiting as Mathilde moves off
Charlotte goes to join Elise and Alain and Mathilde at extreme left end of parterre
Charlotte doing video without commentary, stood to right of Elise and Alain
Mathilde looking at panel
Charlotte talks to her and she turns round
Charlotte carries on filming
Girl from another group comes up and interrupts them asking what it is
They tell her
Another girl comes and joins her and they discuss the task with Alain and Elise
Charlotte stops filming
Discusses briefly with Mathilde again (clear they don't want to do this – too self-conscious)
Two girls reading the panel in front of Alain and Elise, discussing
Mathilde says 'shh' but they carry on talking
Charlotte films again, quietly commentating on what she is filming anyway as she does so
Stops and turns towards Mathilde
Mathilde saying it was good

A comment from one of the girls after this summed up her concern completely:

Charlotte commenting as turns to head to right 'I don't know how to make a video'

Engagement here, in that case, is bound up with competence and a sense of being able to proceed in accountably appropriate ways. In the same group experience this brought about significant engagement for one pair and notable *dis*engagement on the part of the other.

Being defeated by the content

As already mentioned, there was a strong orientation to task completion amongst the students. As a consequence they became manifestly frustrated when a task could not be completed. In relation to this, the observations uncovered one instance where it seemed the necessary content for task completion was actually missing:

Displaying moon globe
Charlotte brings up side menu and points out to Elise an option on it
Elise uses forefinger to scroll up through the options on the menu
Looking for date and landing site of Apollo 15 mission, but can't find it on the globe at this date
Mathilde tries changing the date
Tries turning moon globe round and round but still can't see it
Swipes to right and looks at activity page to verify the instructions once again
Swipes back to moon and starts turning it again
Saying that's definitely what they're looking for but she can't find anything
Continues turning it round
Charlotte points out 'L'Apollo 17 est la' [marked landing site]
Imagine it was before 17
Charlotte turning globe round and round using forefinger and middle finger, knelt on floor in front of Mathilde

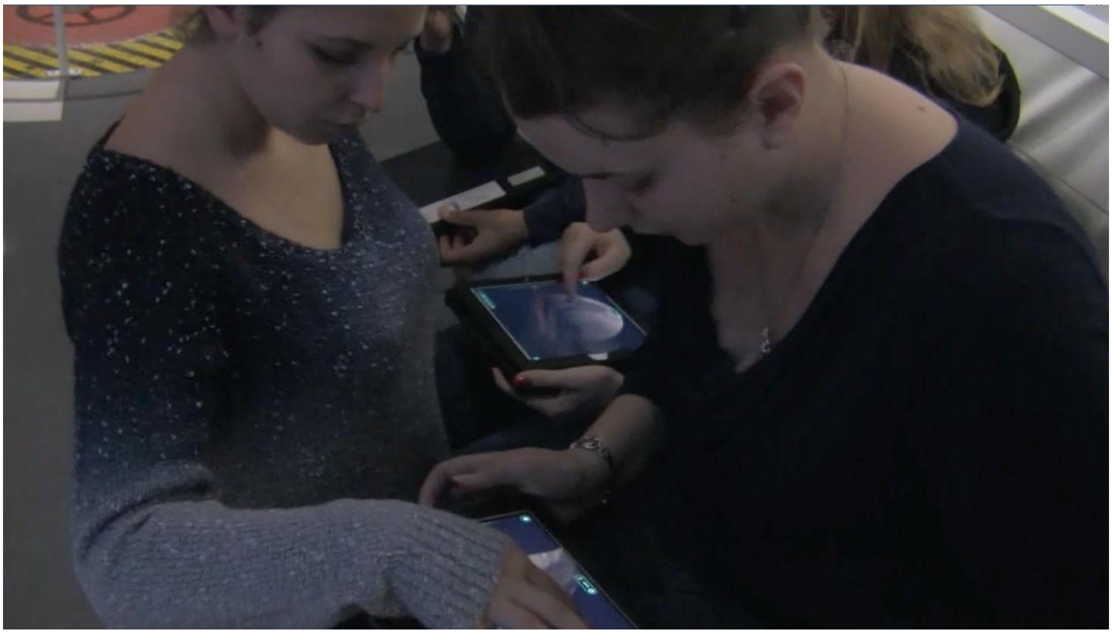


Figure 60 Struggling to find the landing site

So where is it? If it's before Apollo 17?

Spins the globe a few more times, then shrinks it a little by pinching and carries on spinning it

Elise and Alain are engaged in the same hunt, with same problem of it not being marked on the moon

Charlotte shifts to watching Elise turning the globe

Mathilde brings up keyboard and tries a search

Elise and Charlotte expressing puzzlement

Elise goes to turn moon but Network message comes up on her iPad and a spinning processing icon appears in centre of the screen

Moon turns again – Elise continues to spin it

Mathilde goes back to spinning the moon, the search gave no results

Elise swipes back to activity page again

Checking the instruction once more

Mathilde tries zooming in with outward finger motion around Apollo 17 landing site to see if more detail when you zoom

No additional details

Shrinks back again

Alain saying 'C'est 15, mais ce n'est pas 15, c'est 17'. Ca n'existe pas le 15'

Charlotte: Mm

Mathilde trying tapping on the visible landing sites to see if that gives anything, but it doesn't

Charlotte checking with Alain whether he remembers anything about it

Alain saying knows about 11 and that there was 17, but nothing about 15

Mathilde displaying menu at side

Elise swipes to activity page once more

Elise's iPad flashes to white screen

Says 'ah?'

Activity page displays

Reading again

Mathilde still turning globe, looking

Alain starts to say something but pauses as iPad screen flashes

Goes to blank screen, then back to activity page

Elise: 'Ah, I've still got the same problem with the 'next''

Charlotte taps on the next button

Nothing happens

Then shifts to black screen saying Lost connection and asking if they want to retry or go offline

Elise: 'Ah, it's the connection'

Frustration here was increased by the server crashing before the problem was ever resolved.

2.3.3.6 Presentation of the experience and its intelligibility

In this section we look at how students were orienting to the overall experience they were engaged in and trying to make sense of it. This was one of the core areas of improvement noted for this deployment and the observations made here were reflected in feedback from the students.

Seeing the experience as a set of tasks

As pointed out above the primary orientation adopted towards the experience by the students was as a series of tasks to be accomplished.

Finding tasks opaque

However, some of the realization of the tasks undertaken made it manifest that the students had little idea why they were being asked to undertake them. The annotation of the photo of the Soyuz rocket is a case in point. They did this diligently but had no idea what text to append when it came to it because they couldn't see how Soyuz related to an overall objective they were moving towards. They had no sense of the mission. It was the same with the video task at the Parterre des Planetes. This was seen as an activity to enjoy (or not) but they expressed no recognition of how it made sense as an activity with regard to a mission they were undertaking. They were being asked to buy into an imagined scenario or perspective, but it clearly takes more than a set of texts and resources to accomplish that kind of investment. This kind of concern requires orchestration and highly nuanced instruction (see again Tolmie et al, 2012).

Profiling as an abstract idea versus situated reasoning about profiles

As a mechanism for building in CHESS-relevant personalization the profiling system and its association with the missions was an abstract idea that was realised in its conception on the grounds of 'what anybody knows' about particular 'kinds' of people. In discussion the profiles were accountable because accounts *could* be duly delivered:

For the CVS and the choice of 2 personas it was linked with the profile of the students the teachers have this year

One more maths, one more humanities

As CHESS asked them to define personas, had to decide a reasonable choice

Decided these two orientations were best but could be others

Tried to define the 5 questions with these profiles, Solal and Marion, in mind

Solal science, Marion humanities

Different objectives: Solal involved in robotic mission to Mars; Marion involved in human flight to the moon

Questions linked to this aim

Question about astronaut and if stressful or a dream linked to this

Questions ordered around profiles and the objective

First question about astronaut relating to deciding profile

Second writing text or preferring equations – clearly linked to persona

Assumption more analytic if maths questions and more humanities if written texts

Third if you travel do you plan everything or do you take your backpack and go – Planning more for Solal, adventure more for Marion – Reasoning planning associated with analytic mentality, free-winging more artistic

Fourth was proud of DIY skills or team spirit – Proud of creating stuff for yourself or as a part of a team – Not so obvious – Handmade was Solal – Other Marion –More artistic people more likely to be team players, more analytic more likely to make things, etc.

Fifth if you like sport a lot or a little – This time linked to aim of mission – if want to be astronaut have to be fit – if not robotic mission is ok

All worked out via points – 3 of 5 to be Marion or Solal – majority weighting

No one single response overthrows the others

During scenario have other questions – e.g. activity re rocket – Add a question re if liked – Response adds point one way or the other – This then informs what activities are assigned next – Could switch persona

Wanted to make as simple as possible to make it easy to run

Know that some will choose one persona or another just to be with a friend

Notions of scientific/analytic or artistic/descriptive – relating to first of all, have to perform a mission, and then what does it take to be an astronaut

First of all decided the two profiles with the two different goals – Critical thing is they wanted to stay in the mission

Inevitably this doesn't reflect what happens on the ground for a whole bunch of different reasons. They point out themselves, for instance, that profiles may be sought out for reasons other than whether they reflect anything about your own likes and interests (e.g. to be with friends). Another such reason is that for any kind of articulation of a choice there will always be other choices that sit outside of it, e.g. :

Helper instructing her on responses to fill in that matter to ensure right profile for group

Loads first page (Charlotte commenting she doesn't like sport – said in question she did – phrased do you like it a lot or a little)

*Understanding there **is** a mission and you **have** a profile*

The experience was articulated at the outset as a software test. The students were invited to understand the application as a piece of software to evaluate, but evaluating this and evaluating an experience are two different things. The staff did mention the existence of profiles to the students on a number of occasions (and in occasioned ways), but they did not make the profiles and the mission explicit as a frame to organise what the students were being asked to do. Its main use in context was to enable the structuring of groups so that some were following one set of tasks or another.

The need for a frame

One of the things that was more problematic was the difficulty the participants had in uncovering what the frame was for this experience. This was something that was evident also in the feedback. Many did not, despite hints to that effect, understand that they were being assigned a profile and pursuing the scenario of a 'mission'. Indeed, many understood it to be primarily just a treasure hunt (not that this is problematic in its own right because they enjoyed it as that at least).

Being given the frame

There were some instances where something closer to the kind of framing required was provided:

Helper saying 'now imagine you are launched on the rocket' (pointing to image on navigation pane)

Charlotte scrolls to bottom and clicks on next button

Next page comes up (with flags etc. – re Ariane)

Helper saying 'Alors, vous vous approche l'Arianne

Start to walk towards the Arianne rocket together

This was not preserved systematically, however and, importantly, required reading outside of the materials, i.e. it took understanding what the materials were trying to accomplish rather than the materials making it explicit for themselves.

2.3.3.7 Managing the unfolding experience

Elaborating the sequence of tasks and instructions

For the larger part, once they'd got going, the students had little trouble with the actual sequence of tasks and understanding their specific implications for activities to be undertaken beyond the screen. They understood easily the dynamics of the interaction on the iPads themselves and how to progress from one step to another. Action beyond the screen then became an elaboration of these things, though some tasks were not greeted enthusiastically (e.g. making a video) and some were challenging in their specifics (e.g. the location of the lunar landing). They were not seen at any stage to be confused about what they had to do. The only point they were given pause was when the buttons themselves were not working. The only source of uncertainty was with regard to what was going to happen with their photos and videos.

2.3.3.8 Engagement with exhibits

Locating the exhibit within the frame

One of the principal things accomplished by a framing articulation of objectives or desired outcomes etc., is a sense of how specific exhibits should be engaged with in relation to that frame, so for instance, we see a helper telling the students at one point to imagine they are being launched on a rocket, a clear invitation to engage as people who are set to be involved in manned space flight. The absence of a sense of such a frame therefore rather hampered the students in accomplishing this nuanced kind of orientation to the exhibits they were being directed to.

Finding an orientation anyway

This is not to say, however, that they were largely disinterested. Instead, and once again, the orientation was informed by them understanding that engagement was related to the accomplishment of a specific task. Thus, at the very least, the Ariane and the Soyuz became impressive large objects that had to somehow be photographed. The Parterre des Planetes became a constructing backdrop and means of articulating the making of a video. The distinction here was the moon rock. No task had to be performed upon the moon rock itself. However, all four of the members of the group observed took time to examine it through the provided magnifying glass. So here the orientation was instead principally towards it being an object to be looked at:

Figure 61 Studying the moon rock

Noticing other exhibits

One of the features of an experience such as CHESS is that it quite tightly specifies particular objects of interest, usually in terms of how they are indexical of larger themes. This makes it relatively hard for participants to take much notice of other exhibits around them. One of the difficulties, of course, is that it is hard for participants to reasonably account for suddenly diverging from the intended path to look at other things in terms of the ongoing accomplishment of the experience, be that a full-blown experience or simply a set of tasks. This is still harder if you are accompanied by others engaging in the same exercise and are accompanied by overseers who are notionally there to assist but who can implicitly also call you to account for being distracted in any way. And participating in a research exercise where your understood 'job' is to test a piece of software, the sense of allowable divergence is even more constrained. However, having said all this it was noticeable that the participants did occasionally take note of other feature of their surroundings. So, when the group being followed was making its way towards the Ariane rocket, it passed the preceding group who were stood in a cluster at the Parterre des Planetes. This attention of the other group was seen to direct glances on their own part towards this exhibit. At another point the group passed someone taking a photo of a cluster of balloons, squatting down on the ground to do so, which was unusual enough a sight for anyone to pause to take notice. When mounting the stairs in the exposition building to get to the Moon exhibition, the noise coming from the area of the Moonwalk exhibit below drew glances downstairs from all of them. What is important about this is the fact that, on none of these occasions, was evident interest enough to allow for actually seeking out further engagement. This underscores the extent to which an experience of this order can become a constraint upon engagement in other kinds of ways.

Figure 62 Going up, but looking down

Getting licence to play

Something that serves to further reinforce the preceding observation is the way participants began to comport themselves when the server crashed before they had completed their final task. When the technical expert who was shadowing the group went away to try and discover exactly what had happened he instructed the group to stay where they were for the time being. However, engagement with the tasks on the iPad was at this point clearly no longer a feasible course of action. So fairly shortly after he had left members of the group began to drift off to look at the surrounding exhibits. Several of them were interactive exhibits that involved jumping or turning handles and the interactions of the group around these quite quickly became noisy and lively. Some things worth noting about this are that it was not wholly unconstrained. For a start, each of them returned periodically to the iPads to see whether functionality had been restored. Additionally, the moon rock was situated in a partitioned off area with only a few other exhibits within it but at no point did anyone in the group attempt to explore the other spaces around them.

Figure 63 Getting a chance to play

So what we see here is circumstance providing licence to the participants to engage in activities that were no longer bound to the accomplishment of the experience because in this situation it would have been more accountable to persist in trying to work a clearly non-functioning piece of technology. However, at the same time, there was a background orientation to this licence being temporary and open at any moment to being revoked, such that there were limits on how removed from the experience one might become. This was made neatly evident by the arrival at a certain point of the Responsible d'Education for the site who had first welcomed them to the site that morning. The moment he entered the room all members of the group came immediately to stand in front of him, and in close order, rather than spread out, just as they had been across the rest of the tasks.

2.3.3.9 Ownership and Sharing

The rights of ownership

Something implicit to the ownership of a device that one can see in almost any setting is the right to use that device on all occasions that might be deemed accountable for its use (obviously there are limits on this such as using it when we've all sat down for dinner, using it at 3 o'clock in the morning when you should be asleep, and so on). So there is a sense in which, for the participants in the experience, the person holding the device had certain rights regarding its use that would only transition to the other person if the device was physically handed over to them. In the case of Elise and Alain, this use, and the rights of one or the other to engage in its use, was something that was managed without difficulty between them:

Walk together back towards the parterre des planets
Navigation pane up
2 others from their party already there
Stand to their left
Alain passes iPad to Elise
Charlotte reading first page, Mathilde looking over her shoulder
Elise opening first page and reading as well

Alain comes and stands to her right

By contrast, it was noticeable that the device use between Charlotte and Mathilde was very unequal. For instance, during the exercise where they were instructed to take a photo of the Ariane rocket Charlotte proceeded to undertake this activity without any consultation with Mathilde, simply readying the iPad for taking the photo as soon as Mathilde had finished reading. She similarly took charge of the rocket launcher game and the photo of the Soyouz rocket and only handed the iPad over to Mathilde during the Solar Walk activity once she had failed to get anywhere with it herself. This led on occasion to quite noticeable disengagement on the part of Mathilde, the video making exercise being one such case in point where Mathilde showed little inclination to involve herself in it.

Figure 64 Exercising ownership in the taking of photos

The responsibilities of sharing

A concomitant part of the above observations, and something that was seen to happen on numerous occasions over the course of the experience, was that there was an understood responsibility to share in the device's use. Thus one member of each of the pairs in the group would pass the iPad they were currently using over to the other member of the party for them to use instead. This typically, though not exclusively, happened at the transition points between different activities, as it does in the example regarding Alain and Elise above. Other occasions it happened were where one or other person had a manifest understanding of how to proceed, or when one party had struggled to accomplish something and had therefore given it to the other person to 'have a go' (notably in the final task using the Solar Walk application). It was clear that there was also an understood responsibility in play here for the device to be shared with the other member of your pair. As with the preceding discussion of the licence to proceed, however, it was notable that the passing of the iPad to and fro happened significantly more often in the case of Elise and Alain than it did between Charlotte and Mathilde,

Figure 65 Re-distributing the iPads in the group

A curiosity here is that right at the beginning of the experience when the group was established, the principal helper for the group had suggested that Mathilde pass over her own iPad (which had managed to log on to the network) to Elise and Alain (whose iPads had not) and that she share herself with Charlotte (whose iPad was also working). This solved a difficulty of distribution of devices and Mathilde showed no concern about it. However, it was noticeable that for the duration of the experience she evinced no inclination to claim ownership over her own iPad whilst Elise and Alain were using it, even though her own partner frequently pursued courses of action without consulting her. Two observations are worth making here. One is that, having agreed to the re-distribution, it would be accountable not just to the others in the group but to the helper who first suggested it, if she were to suddenly decide to reclaim her own device. The other thing to note is that 'ownership' here is somewhat distinct from many other situations. These devices had been provided to the students by the school, for the duration of a school year, to facilitate an educational experiment. Thus there is a sense in which, even for the notional owners of the devices, the device is already borrowed rather than it being in all respects their own. Indeed, exchanging at need might be said to be not largely different from sharing provided school textbooks with another student when for some reason they do not have their own. What this serves to foreground is the difference, not of Mathilde's, but Charlotte's orientation. During the course of the day the teachers happened to mention that a few of the students had opted to use their own iPads for the experiment rather than to take one that was provided by the Ministry of Education. Whilst clearly a matter of supposition, Charlotte's actions here would seem to strongly indicate that she was one of the students who had chosen to use what was genuinely her own device.

2.3.3.10 Collaboration, coordination and divisions of labour

One of the characteristic features of group activities of this order is that they are typically generative of various kinds of collaboration and coordination. Here we briefly outline some these kinds of features that were a contribution to the character of the experience that unfolded.

Helping out with troubles

Right at the start collaboration was evident in hw people were helping others to see what they should be seeing when they were connected. Collaboration was also widely visible when it came to entering details from the cards, with one holding the card or reading out from it, whilst the other made the entry. Collaboration was visible even to the point of helping one another find the right network.

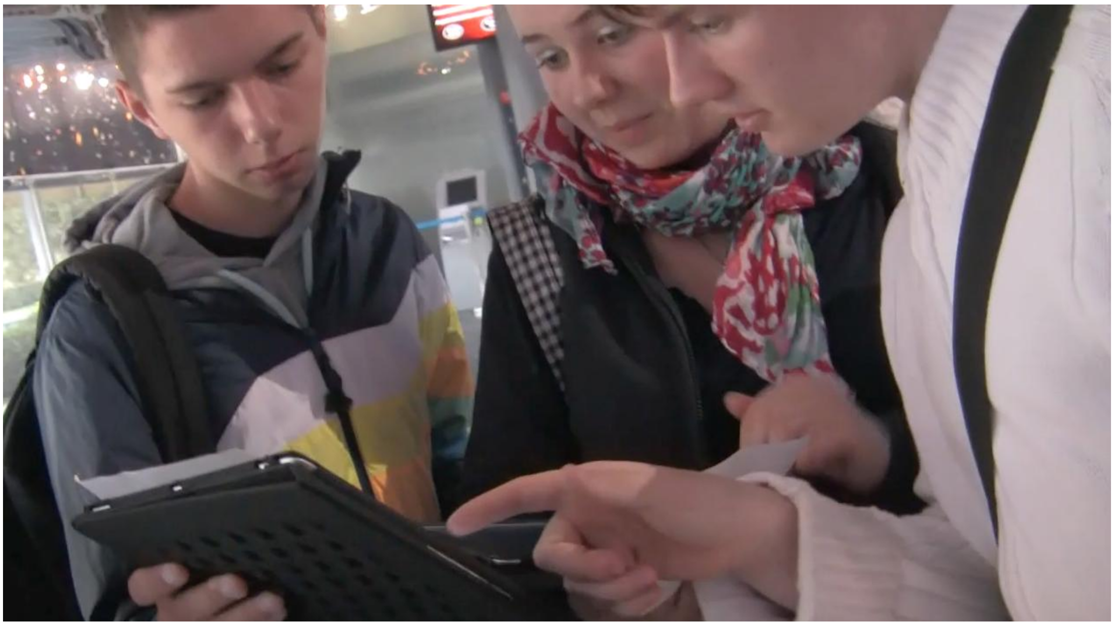


Figure 66 Helping with network selection

It was also manifest in how there was ongoing verification across each group regarding people's situation and status, with people continually asking one another how they were doing.

Collaborating on tasks

Several of the tasks we have already described above also make visible the degree to which collaboration between participants provided the oil whereby such tasks might be accomplished. Apposite examples here are the rocket launcher game and the making of a video.

Working together to try and solve troubles

Collaboration of the kind visible in accomplishing tasks was equally present in how the students went about trying to solve actual troubles that arose over the course of the experience. Of particular note here is the rich pattern of interaction and shared work that evolved around trying to use the Solar Walk application.

Collaboration between helpers and participants

Collaboration didn't just stop at the level of participants. There was also a great deal of collaborative work visible in the interactions between the staff and the students, for instance with regard to the efforts made to get people logged on:

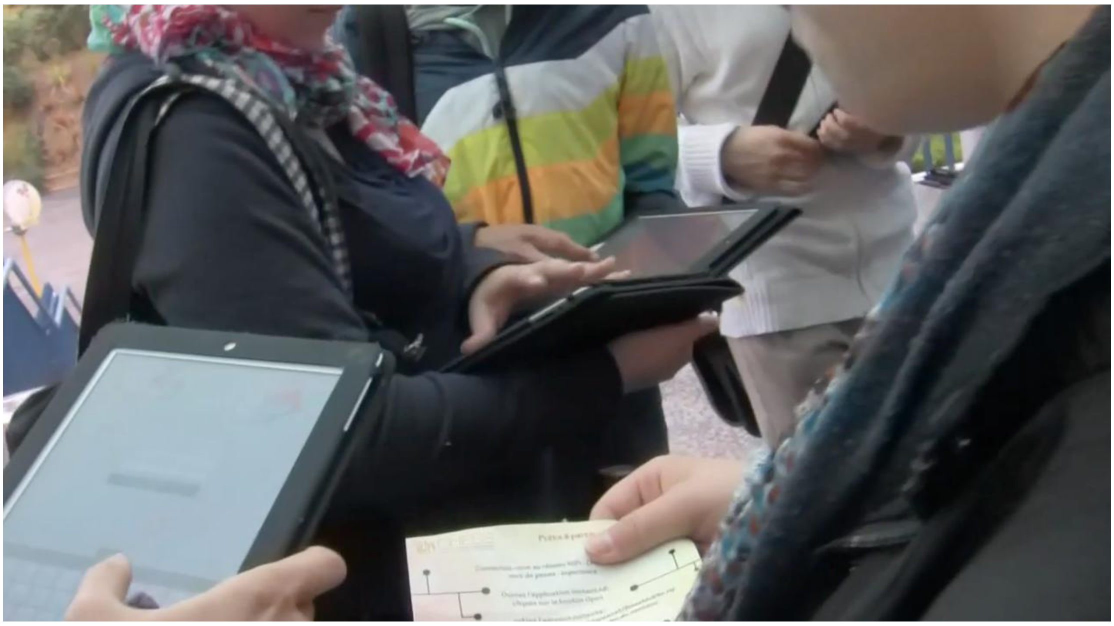


Figure 67 Staff assisting a participant to get logged on

Scale of collaboration implied for those doing the orchestration

A further backdrop of note here is the fact that software like this does not self-orchestrate. It takes a whole apparatus of people to make an experience like this work and their investment was palpable in how the whole of the deployment had been scaffolded around the Cite's own infrastructure.

Overall, collaboration in relation to the experience mostly worked pretty effectively and stands in contrast to other some other shared experiences we have observed, such as those articulated around mobile phones. In view of how it made resources mutually visible and available the nature of the iPad itself was clearly an important element of how collaboration was accomplished here.

2.3.3.11 Group coherence and coordination

An important backdrop to how the activities the group undertook were able to be realised is how the group itself managed its constitution *as a group*.

Comportment as a group

So one of the things here is how the group actually comported itself as a group. Various features can be pointed to here. One such features is how they occupy space in proximity to each other, for instance by lining up together at a window or clustering together under an umbrella. These kinds of features serve to make their coherence as a group visible in relation to others around them.

Figure 68 Grouping together under an umbrella

Another element here is how the group can be seen to move together as a group, for instance in the proximity of its passage through a turnstile. Waiting as a group is also visible as waiting together, often primarily as a result of how people's orientation is positioned to each other, how people face 'into' the group, and how this itself creates a tendency to cluster in circles and with different bodily proximity.

The generation of talk within a group also provides for it being seen in that way. So, one thing one encounters is different rights of address, with 'has anyone got a connection' then being hearable as being addressed to anyone within the group. And by the same token instructions are hearable as instructions to the group.

Group orientations also extend to how people may witness one another's actions with or without account. So, and for instance, other group members may be seen as 'watchable' when at a remove e.g. when taking photo of Soyuz.

Management of the group

Another aspect of relevance here is how people take active responsibility for the management of the group as a group. Phenomena here include waiting for one another (e.g. Charlotte and Mathilde waiting for Alain and Elise whilst they made their video), glances over the shoulder to make sure people are following, and, conversely, being seen to follow, and regrouping after separation e.g. after Charlotte had taken the Soyuz photo. A more detailed elaboration of these matters can be found in (Tolmie et al ,2014).

Overall these kinds of features were found to be largely unproblematic. The observed group managed to preserve its coherence as a group throughout the whole of the experience without any serious difficulty. It does need to be remember, though, that this is not a given but rather an accomplishment and it is open to being disrupted by technology and the design of experiences. The fact the group was not disrupted here is therefore a testament to the capacity of the application to support group experiences.

2.3.3.12 Interactions within the groups

As an elaboration of the preceding section, it should be noted that one of the principal ways in which groups manage and make visible their coherence as a group is through the character of their interactions with one another. Interactions over the course of the experience were no different in this regard. The following captures just a few of the many examples of this.

Sharing outcomes (delivering news)

Examples of how certain features of the experience could be shared and handled as newsworthy are the announcements we saw of successful connection. This was important for how it was then implicative for the efforts of others to get connected as well.

Expressing confusion. puzzlement etc

Articulations of confusion and puzzlement mainly revolved around their efforts to try and understand the technical issues. Often this served to make the reasoning manifest as well as the need for there to be an account, e.g.:

Stand just outside the door for a moment then go closer to top of steps
Checking network connection amongst each other
One saying got just 1 bar

Discussing ways to proceed

Another important job undertaken through verbal interaction was the negotiation of strategies for handling difficulties. This was especially visible during the Solar Walk activity where there were significant troubles.

Another common way in which talk was generated was in situations where one or other party was uncertain about what to do or how to understand something, at which point they would seek help or clarification from their peers. We have already seen a nice example of this in the case of Alain helping Charlotte with the rocket launcher game. Another nice example for its simple intimacy is the following, which unfolded quietly whilst they were being instructed by the helper for the group:

Elise nudging Alain to get him to look at screen
Pointing out image and asking if they are there
Don’t know
Ok

Figure 69 Are we here?

Many group interactions are arrived at through these kinds of routine assumptions of rights to address and touch other people and this is another way in which the constitution of a group of people as a group of people who are together is made manifest.

Presumptive rights to tease and criticize

Tightly bound up with the preceding point regarding routine intimacy amongst members of groups is the presumption group members exhibit to criticize one another in various ways. In the context of the group this kind of interaction is understood to be teasing and/or humorous and is oriented to accordingly. This short interaction followed straight on from Alain and Elise's efforts to make their video:

Elise stops filming

Mathilde points to panel and bit of wording he got wrong (million rather than billion)

Figure 70 You got that number wrong!

Elise says 'ohhh!'

…

(Moving on to next task)

Elise Eh, voila, c'est par la. Indicating main expo building

All turn and walk in that direction

Charlotte and Mathilde looking at iPad Charlotte is holding as they walk

Alain and Elise chatting

Charlotte looking at pictures in navigation pane

They pause at panel and Elise comments on figure Alain got wrong again

Laughs

Clearly, if people of slight acquaintance or wholly unknown to you were to make the same kinds of observation it would be taken to be a genuine form of criticism.

2.3.3.13 Working up the content together

An elaboration of the previous section is the way in which groups going round cultural sites together actively find matters of personal interest, significance, or relevance in what they encounter. Here are a few examples to the point:

[Doing the series of tasks in front of the Ariane rocket]

Alain commenting to Elise on what they've just read

Saying multiple countries – US as well

E Mm
Charlotte tapping bottom of screen again with thumb
[Waiting in part for other in pair to catch up]
Charlotte tapping screen again
Peering up at rocket
Mathilde continuing to read
Elise looks up at rocket
Alain points up and comments
Elise gets to end of what she was reading and says Mm
Alain commenting again on what they are reading
…
Both watching video – Charlotte holding device, Elise holding device
Elise asking if Ariane 6
Alain commenting on video and order in which parts detach

Sometimes this extends to active commentary or elaboration upon the things they see:

Video window comes up on Charlotte's ipad
Starts to play
Alain now playing same video as well
Sound starts up on video
Commenting on it and laughing
Saying 'Couldn't they buy the rights to use an official video?'
Alain commenting on music
Charlotte agreeing

The important aspect of this to take note of here is that these are the kinds of vehicles whereby members of groups demonstrate active engagement with the exhibits and information they are encountering, either in positive or negative terms. Thus these little moments serve to illuminate the features of the experience they themselves are choosing to foreground and render reportable in some way.

2.3.3.14 Accountability

Accountability, as being used here, refers to a powerful and utterly pervasive feature of human action. All human action is variously seeable as appropriate or inappropriate for the accomplishment of various ends and according to who is doing the 'seeing'. Members of the same group or cohort of people routinely recognize most of one another's actions as completely ordinary and in no way worthy of comment. Another way of describing this is to call these things 'naturally accountable' (Garfinkel, 1967). Naturally accountable phenomena are things that are taken by members of the same cohort to be open to being accounted for as completely 'natural' and ordinary ways of doing things. Furthermore, there is a strong orientation amongst people to see things as being ordinary in exactly this kind of way (Sacks, 1984). Only when people cannot just find this ordinariness in one another's actions do they directly call one another to account and ask an explanation of why something was done in a certain way. Often people who are engaged in action that might be seen as somehow out of the ordinary will pre-empt this by expressly offering up an account for their actions before anybody can ask.

Now engaging in the exercise of going around the Cite de l'Espace for the purposes of testing some software and engaging in an iPad based experience, whilst seemingly exotic in some kinds of ways, is no less open to being subject to expectations of ordinary ways of doing things than any other kind of sequence of human action. So, as a conclusion to the observational findings gathered during the experience, we shall briefly look at a few matters of how accountability was particularly important for the unfolding character of the experience in this particular case.

Seeing responsibility as residing elsewhere:

So one thing of note in an instructed 'mission' or experience is the way in which people can understand it to be the job of other people or the content itself to take responsibility for the decisions that are made regarding moving on or staying put at any point, e.g.:

Responsable comes up and says come with me
Leading them up to turnstiles to go through
…
Support person saying perhaps they should go outside
They head out of door
…
Start to head towards the steps – prompted by the helper

Being accountable to others

A different side of this is how people may understand themselves to accountable to others for the things they do. We saw, for instance, how assisting one another in their efforts to log on and making visible to other people that the state of the connection has changed somehow, are themselves tightly bound up with the requests people make for whether anyone has anything. The delivery of requests and manifest expectation of monitoring is accountable as monitoring for all, not just yourself and to get a connection and not telling anyone would be understandable as being contrary to the spirit of this:

Checking network connection amongst each other
One saying got just 1 bar
Re-confirming the name of the network to connect
One boy helping another to find the right network by tapping on his screen
Girl checking if anyone has anything
No
Support person using Charlotte's iPad to try and connect again - saying it's the network
…
Mathilde starts to get connection – saying 'ca charge'

Providing accounts

Sometimes, of course, it is necessary to provide accounts for things. One such account can be seen above in terms of an account for failure: 'it's the network'. We also saw Charlotte accounting earlier for the difficulties she had with making a video in terms of not knowing how to make videos.

Rendering accountable

Sometimes 'proper' ways to proceed are not immediately evident. In these kinds of cases people may issue explicit instructions that serve to make other people accountable for any 'inappropriate' decisions:

Another boy gets a proper connection and gets to the first page with images of locations
Helper saying You are there (pointing to photo) and you touch to continue the navigation
Saying he should stop there for now

Callings to account

It was also the case that people did sometimes get directly called to account. Here, for instance, troubles with the network prompted one girl to issue a complaint about another who was getting access without the same amount of trouble that clearly implicated some kind of account, even if it was tantamount to a recourse to magic:

Elise saying she started after me and she's already in
Charlotte saying about no network anymore – ah, no, it's ok
Moving over by the turnstiles
Elise keying in
Charlotte already in Destination Espace screen
Holding up side by side to Elise
Elise still waiting for login
Charlotte asking if working
No, still not
Charlotte gets through to start of questionnaire
Saying 'It's worked!'
Bizare
C'est mon zone positive

Technology as accountable

There is a long history in HCI of discussion about ways in which to make sure that technology is more accountable in situations of use (see Dourish & Button, 1998, for its inception). What is meant by this is the ability of technology to deliver indications to people such that they can locate a reasonable and meaningful account of 'what the technology is doing'. Many of the most frustrating encounters people have with technology are exactly those where this kind if accountability is absent and people have simply no idea how to understand what might be going on. Some positive and negative aspects of this were encountered over the course of the experience. Thus, and for instance, we have seen how people used the connection strength in terms of bars on their iPad to reason about what was going on with the network, both as an explanation of there being no network connectivity and as a source of puzzlement as to why things were crashing even though the network was apparently good.

In the following example a participant is momentarily confounded by the absence of any feedback regarding the annotation she has made for a photo, but then she sees a progress bar and find she can make sense of what is happening, though she remains at a loss as to what has happened to the actual photo:

Charlotte saying can't see her photo (annotation task)

Figure 71 Trying to understand the technology

Charlotte reading out text at top but doesn't help her locate photo
Starts to key in
Trying to send message with photo
Nothing happening
Says 'ah' when progress bar comes up

Incumbency

Something importantly related to matters of both engagement and having a sense of 'the mission' is the question of, when tasks are set, who is it incumbent upon within the group to accomplish those tasks?. Reflection here shows that this is non-obvious. Do all of them have to do it? (i.e., in the case of the observed group, all 4 of them) Does it just have to be done by one member of each pair so that it is done on each iPad and registered accordingly? Or does only one member of the group need to do it? Interestingly in the group observed all three of these potential perspectives upon incumbency were encountered. For the reading tasks and watching of videos, they understood that they were all required to participate. For some tasks, such as the video task or the solar walk activity, this could not be reasonably accomplished on more than one device but all members of the group and both devices were implicated in their accomplishment. For the photo of the Ariane it seemed to be enough that this was recorded on each machine. For some tasks, such as the rocket launcher game, only one person actually did it (though the others got drawn into the discussion), and for the annotated photo at Soyuz only one member of the group undertook it. In each of these cases incumbency appears to be a wholly practical matter. What counts overall is that every task is done by *someone somehow* within the group. For some tasks doing them on your own is not practical, e.g. making a video where one may have to film, the other enact. For some tasks individual pursuit would not be economical in terms of effort (e.g. the rocket launcher game). For some tasks it would be accountable in terms of being, say, detached from the group or not properly engaged in the exercise if they did not undertake them, e.g. reading the texts or watching the videos. It therefore needs to be understood that accountable engagement is not something that can simply be generated through the right provision of tools, it is also about what it takes to accomplish specific things in specific circumstances.

The important thing to grasp from the above observations is that accountability, in terms of both what is happening with the technology and in terms of what an experience itself might be expecting people to do, is not something incidental or occasional in situated action. It is continually present in the very taken-for-granted nature of the world and it is when this is breached that it can lead to the greatest difficulties.

2.3.3.15 Feedback

As a final short set of observations, it will be remembered that a separate activity was undertaken after the activities with the iPads, where the students were invited to feed back directly anything they might have to say about the application and the experience. Here we briefly summarise the main points that came out of this discussion.

On the more negative side:

- The main problem was the technical issues. The program didn't work and sometimes images didn't load. It made the experience less enjoyable.
- The fact that there were multiple scenarios was seen to be a problem. The students felt that they were not getting the full range of information needed to be able to make a judgment about what scenarios to follow because they had no access to what was happening in the other scenario. They felt it would be better to be able to able to choose the scenario. They felt like they were missing out.
- There was no going back in the questionnaires and they wanted to be able to have the option to rectify mistakes or deal with things they had missed.
- They were unable to export media into other programs (though they were advised at this point that the media would be available for download/export later on).

On the more positive side:

- The texts and written stuff was interesting. They were expecting more experiments, activities, quizzes, etc., not really texts, but this wasn't a particular problem.
- The navigation page worked very well. The directions were clear and it felt quite like a treasure hunt.
- The Mir, Soyuz and Water Rockets were all especially memorable (and they took their own photos here as well).
- It was better than a guide. It offered freedom and shared experience within the groups. It allowed people to take their own time, and it is more fun and entertaining when you can talk to each other, without having to listen to the guide talking. It was more attention grabbing.

Overall they felt the most important improvements to be made related to a need for a better overview of the missions and a much clearer idea of the objective.

2.3.4 Conclusion and Implications for Design

Issues arising from the above observations are numerous but the principal matters are as follows:

- The navigation method provided was highly effective and should be preserved for future use.
- The sequencing of tasks and delivery of instructions was mostly very effective for this kind of experience.
- The iPad appeared to be an effective resource on the whole for supporting group experiences being worked through in pairs. Larger numbers sharing one device may be more problematic and it should be remember that at the Cite there are few constraints on allowing the broadcast of audio.
- Some small parts of the interaction mechanism and interface were non-obvious, even to experienced iPad handlers such as these, so care needs to be taken to embed these kinds of mechanisms in established practice for iPad use.
- A heavy dependency upon a wireless network infrastructure is a risk, and the effects of this need to be offset in whatever way they can.
- At this point the underlying application was still not as stable as it could be. This is a feature that is likely to have improved by the time of the Acropolis deployment in January 2014.
- A reliance upon other applications creates a dependency upon the ready intelligibility of those applications. This, too, is a risk.
- Just who owns a device is fateful for how the device is engaged with in group interaction. This is a point that was also made in the previous study of the mobile application at the Cite.
- Some activities have the scope to make people uncomfortable (e.g. making video recordings). At these kinds of points choices of activity might be a better strategy.
- Further reflection is required regarding how these kinds of experiences can constrain engagement with particular exhibits as well as opening up new ways of finding coherence across collections. It may be that the constraint is acceptable but this would seem to require additional research.
- At the point of set-up there needs to be the provision of an adequate frame for the experience, such that ideas such as different missions and their implications are made visible.
- Related to the preceding point, mechanisms relating to how people are assigned to different experiences need further reflection such that they can honour practical decision-making on the ground.
- Existing approaches to personalization do not necessarily take us closer to the things that people themselves find interesting and pertinent about exhibits. There remains space here for future research.
- There is an ongoing need to ensure that all facets of these kinds of experiences are readily accountable in the actual situations in which they unfold. Often potential breaches are only discoverable and remedial through iterative processes of deployment and refinement over time.
- These kinds of experiences implicate a heavy investment in terms of orchestration. Consideration needs to be given to how they might be scaled for more regular or modest use.

2.4 Evaluation of final AM visitor experience

A two day summative usability and user experience evaluation study of CHESS was carried out on January 27th and 28th 2014 at the Acropolis Museum (AM). The study consisted of observation of visitors' interaction with the system and other social actors, both co- and other visitors. The observational studies were supported by extensive data collection consisting of audio-video recordings, photographs and field notes. At the conclusion of the visitors' experience, semi-structured interviews were conducted to gather visitors' perceptions of system usability, specific functionality of personalisation, story structures and their impressions of the overall experience. Due to the large amount of collected data, the analysis of the data is still underway; nevertheless, many insights have already been gathered and are presented in the results section below.

2.4.1 Overview of the experiences

Two stories were authored and completed for this evaluation. These stories were composed by the museum authors for two different personas: Nikos, the 10 year old boy, and Natalie, the young executive. A brief description of the stories is included below:

Theseus *(created with the "Nikos" persona in mind)*

> *Theseus, the famous hero of Athens needs your help to build an army after exiting the Cretan labyrinth! Join him in an exciting adventure to get all sorts of human, animal and divine aides!*

Figure 72: The character of Theseus.

The Theseus story starts with the squeaking sound of electronic "static". The voice of Theseus (Figure 72) is then heard:

> *Hello? Is anybody there? Can you hear me? Oh finally! Someone's found me! Please stay with me, this is serious! My name is Theseus, Prince of Athens. I have come to the far island of Crete to save my fellow Athenians from a terrible monster, the Minotaur. This monster was part bull part man and lived in a labyrinth. After a fierce fight I managed to kill him.*
>
> *And now, we are on our way out of the labyrinth, with the cunning help of Ariadne, the island's princess. Ariadne gave me a ball of yarn before entering the maze and I used it to leave a trail and find the exit.*
>
> *Yet, the problem is that the king's army is probably waiting for us outside. If so, how are we going to make it to the ship to go back to Athens?*

Here's where you come in. I need you to gather the mightiest warriors you can find there and send them to me with the help of your device. Let's begin searching, shall we?

The story continues on with Theseus guiding the visitor to the various exhibits – "powers", such as Hercules, the three-bodied daemon, Megakles, the archers, etc., which must be "collected" by the visitor and "sent" to Theseus in order to help him fight the soldiers of King Minos upon his exit from the labyrinth (Figure 73).

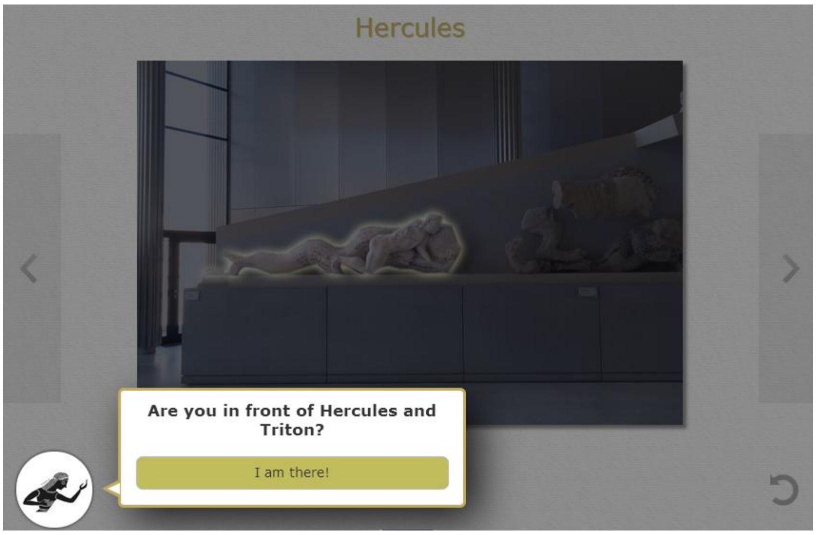


Figure 73: Theseus "guiding" the visitor to the Hercules exhibit.

In the end of the story has Theseus exclaiming:

We've made it! Now I'm out of the Labyrinth, and you have provided all the help I and my fellow Athenians will need outside to reach the ship safely. Your job here's done. Ariadne is coming to Athens too! And hey, thanks!.

Melesso *(created with the "Natalie" persona in mind)*

Melesso, an ordinary woman weaver talks about her life in the city of Athens. She has many things to say! Join her journey of memories, choose the ones you want her to share with you, and learn about the historical events that affected her life.

Melesso's story is different from the story of Theseus on many levels. The story is more descriptive than explorative, including information about life in ancient Athens; in many cases the information reveals aspects of life that are little known. The experience is much longer with many branches and opportunities for personalization. Melesso (Figure 74) is the sole character of the story:

Hello. My name is Melesso. I lived on this very land thousands of years ago. I was born here in Athens in the fourth year of the 61st Olympiad, or, as you would say now, the year 533 Before Christ. But my Athens was so different from what you see now!

Around you and below your feet is much of what remains of that Athens, now housed in this odd building that looks like nothing I knew in my times! If you so wish we can look at these together while I tell you my story.

Now, where shall I begin... maybe from that summer evening of 474 BC, when, already 59 years old, I made my way to the Acropolis to make my offering to Athena, the great goddess of our city. But, I'll tell you all about that offering when the time is right.

Until then however, I have much more to tell you... Around me all these things awaken so many memories.

Let's stand to the left, near glass case 5, in front of those big vessels.

Figure 74: The character of Melesso, created by the Acropolis Museum

In the story, Melesso covers many topics including love and marriage, the life of women, the temples of the Acropolis (Figure 75), the offerings to the gods, the Persian destruction, etc., concluding with the offering that she made to goddess Athena.

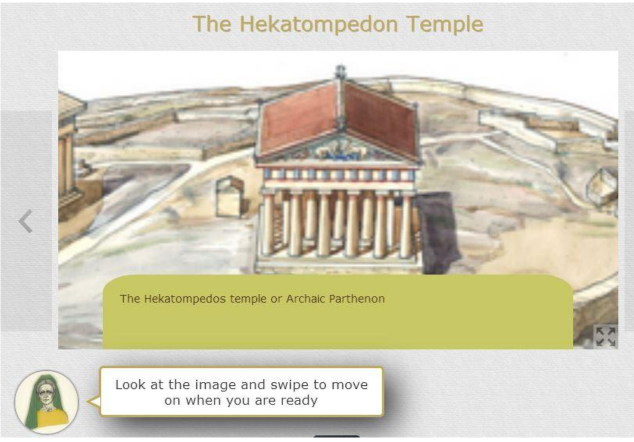


Figure 75: In one of the interactive features of the Melesso story, the visitor can click on parts of an image to learn more about the temples on the Acropolis hill.

Her offering was a small bronze statue of the goddess in battle, which the visitor can actually see in the Archaic Gallery (Figure 76), a fact that grounds the story to the place and is appeals to visitors (Figure 82).

Figure 76: The inscription *Dedicated by Melesso as dekate*, visible on the little bronze statue offering that features in the Melesso story.

Come with me to see my offering.

Today she is not preserved in her original form. When I brought her to the temple she carried a spear in her raised hand and a shield in her other hand. The craftsman engraved my name at her base at my bequest. I will read it to you: Dedicated by Melesso as dekate, that is, as one tenth of my annual income of that year. And indeed it cost me that much!

The day that I chose to make my dedication to Athena was not an ordinary day. A few days earlier, the celebration of the Great Panathenaea had started and that night was the eve of the birthday of the Goddess. I recall it was very hot, around the middle of your August. We women were to pass the night at the Acropolis and the girls were to dance and sing with ritualistic cries and acrobatics. On the following day the procession would commence.

If you go up to the third floor you will see the Procession presented on the frieze of the Parthenon. It's the temple that I did not live to see being built…

Both stories include at least one augmented reality (AR) activity, with slightly different text depending on the story. For example, in the AR activity for Peplos Kore, the Melesso story has a third-person description of the statue's various parts by a narrator who is supposedly a museum expert:

"*Nowadays this statue is called the Peplos Kore. This means the maiden who wears a peplos, which is a kind of dress.*"

For the same activity in the Theseus story, the Peplos Kore herself is heard:

"*Hello, people call me the Peplos Kore. This means the maiden who wears a peplos, which is a kind of dress. And what most people aren't aware of: I was once fully coloured.*"

In addition to AR, both stories included an "exhibit browser" (i.e., the ability to zoom into hotspots on an image and obtain information), a game to paint in the daemon (in the Theseus story, Figure 77) and a quiz about the Panathenaic games (Melesso story).

Both stories take place in the Archaic Gallery of the Acropolis Museum. However, the story of Melesso begins at the foyer of the Museum, eventually guiding the visitor up the ramp and the staircase to the Hecatompedon and then to the Archaic Gallery, whereas the story of Theseus starts at the top of the stairs at the Hecatompedon. Thus, the story of Melesso makes for a longer experience, tailored also to the persona it is created for.

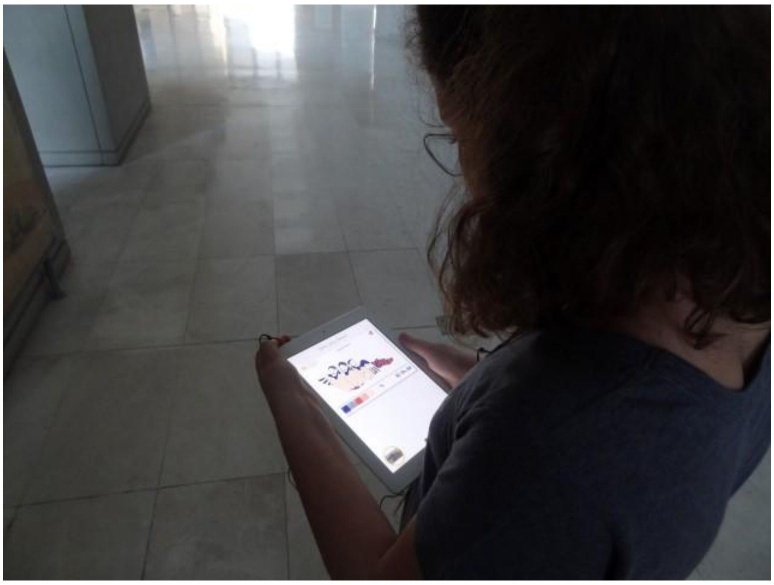


Figure 77: A girl playing the Paint the Daemon game.

As this evaluation study can be considered as a follow-up to the evaluation study carried out in December 2012 (reported in *D09.31 – Beta Summative Evaluation*), an effort was made to design and produce the stories of Theseus and Melesso following, as much as possible, the guidelines that resulted from that evaluation. In other words, care was taken to improve on the problematic aspects that were observed during the December 2012 evaluation and to enhance the new stories with the positive elements and suggestions made by the visitors.

Additionally, production costs for the stories were kept to a minimum with images and sounds created, for the most part, "in-house". For example, some of the voices recorded for the different characters in the stories belonged to archaeologists of the Acropolis Museum and even computer programmers (Figure 78).

Figure 78: Recording voices for the story productions (left). Researchers from NKUA, AM, and IGD preparing for the evaluation studies at the Acropolis Museum (right).

2.4.2 Method

Visitors were invited to test the CHESS prototype experience at the Acropolis Museum on Monday, January 27 and Tuesday January 28, 2014. The choice of dates was deliberate so that evaluation can take place both on a day that the Museum is closed to the general public (on Monday) and in the more realistic situation of when it is open (on Tuesday).

Each visitor was “shadowed” by two members of the CHESS team, the observer and the recorder, while moving about the museum (Figure 79), and then interviewed. In particular, the two CHESS researchers observed each visitor’s behaviour in the natural context of the activity, one taking notes and the other video recording the experience. After the end of the experience, two semi-structured interviews, one addressing general experience issues and the other focused on personalization issues, took place at the Museum’s temporary exhibitions room. Each individual session lasted approximately two hours.

Figure 79: Each visitor/pair was “shadowed” by an observer and a recorder.

Specifically, for the main body of the observations, the general principle was to observe each of these visitors’ experience from start to finish and record the issues on multiple levels. To ensure that the visitors’ behaviour would be affected as little as possible by the presence of the researchers, the latter followed each visitor around the Museum from a reasonable distance and without intervening, except when necessary for the process. With agreement from all concerned, the observation process was video/photo captured to assist further data analysis and to be kept as record.

2.4.3 Participants and selection criteria

Twenty eight (28) visitors participated in and completed the evaluation. Sixteen (16) were male and twelve (12) were female. The ages ranged from 11 to over 45 (four 11 year olds, two teenagers, and the rest over 20 years of age), shown in Table 9.

The recruitment was mainly based on demographic information (such as gender, age or profession). We chose to recruit people that we know, e.g., friends, friends of friends, family members or people we work with. In most cases, participants had not experienced the CHESS interfaces or stories before. All individuals contacted responded positively to our invitation, however one was not able to come in the end.

Table 9: Final participants & schedule

no.	Time slot	Story selected	Male/Female	Age
Day 1				
U1	12:00	Melesso	Male	40+
U2	12:00	Melesso	Male	30+
U3	13:30	Melesso	Female	40+
U4	13:30	Melesso	Male	40+
U5	14:00	Melesso	Male	30+
U6	15:00	Theseus	Male	30+
U7	15:00	Theseus	Male	30+
U8	16:30	Theseus	Female	11
U9	16:30	Theseus	Female	11
U10	17:30	Theseus	Male	11
U11	17:30	Theseus	Male	11
~~U12~~	Could not come			
U13	18:30	Theseus	Female	12
U14	18:30	Theseus	Male	40+
Day 2				
U15	10:00	Theseus	Female	40+
U16	10:30	Melesso	Female	30+
U17	10:30	Melesso	Female	30+
U18	11:30	Melesso	Female	40+
U19	11:30	Melesso	Male	30+
U20	12:30	Melesso	Male	20+
U21	12:30	Melesso	Male	20+
U22	14:00	Theseus	Female	20+
U23	14:00	Theseus	Male	20+
U24	15:00	Melesso	Female	50+

U25	15:00	Melesso	Female	40+
U26	16:00	Theseus	Female	20+
U27	16:00	Theseus	Male	20+
U28	16:30	Theseus	Male	18
U29	16:30	Theseus	Male	17

Fourteen (14) users experienced only the Melesso story and the other fourteen (14) only the Theseus story. Furthermore, although both stories included an integrated Augmented Reality activity, a separate evaluation of the AR activities was also held with eight (8) *unique* users (i.e., not the same ones evaluating the overall experience).

Of the twenty eight visitors, some chose to share their experience with their friend, sibling or child (e.g., U3 & U5, U10 & U11, U16 & U17, U24 & U25).

2.4.4 Procedure

Our participants' visits to the Acropolis Museum were scheduled throughout the two days, starting in the morning and ending in the evening. We arranged for each participant to arrive at different times, in approximately two-hour slots, in order to facilitate the observation process and give ample time to conduct the informal interviews afterwards. Where visitors were children, the participants were expected to visit with a parent.

Upon entering the museum, participants were sent to the temporary exhibitions room, reserved for the study, where CHESS researchers would greet them. Coffee, juice, and snacks were always available. Each visitor was introduced to the study (using the same introduction and interview guide as the ones developed for the Beta evaluation) and asked to complete the consent form. In this respect, the researchers were careful to inform the participants that they would be following them throughout their visit to the Museum with a video recorder; that recorded video data would be used only for research purposes and destroyed after the end of the research; and that they could stop their experience at any time. Then researchers asked participants for their written consent. Likewise, consent was acquired from each participant for the use of any photographs (e.g., in this report) taken. On the other hand, it was important for the visitors to behave as naturally as possible, forgetting the presence of the CHESS researchers, and this was explained to them with emphasis.

A small tutorial of the application's interface on the tablet was then provided and the visitor was handed the tablet to try it out. The visitor was then asked to take the CHESS Visitor Survey (CVS), the short quiz designed to bootstrap personalization and provide the initial story selection (see D09.31 - Beta Summative Evaluation for the CVS questions). To ensure a balanced set of experiences for the two stories, we opted for suggesting the Theseus or the Melesso story if we noticed that one of the two was underrepresented (i.e. did not tend to get chosen by the visitors as much as the other). Nevertheless, in the end, no visitor experienced a story that s/he did not want to.

When the introductory process was complete, each user was accompanied by his/her observer and the recorder (who was holding a video camera) to the beginning of the museum's visiting path. The beginning of the visit depended on the story that the visitor had selected: for the Theseus story, the group had to walk past the turnstiles, ascend the ramp and staircase to the Archaic Gallery and then the visitor would take the tablet to begin; for the Melesso story, the visitor was handed the tablet right before the turnstiles.

All visitors were given headphones to wear. In the case of visitors who wished to share the experience (i.e., use the same tablet), splitters were used to split the sound output (Figure 80).

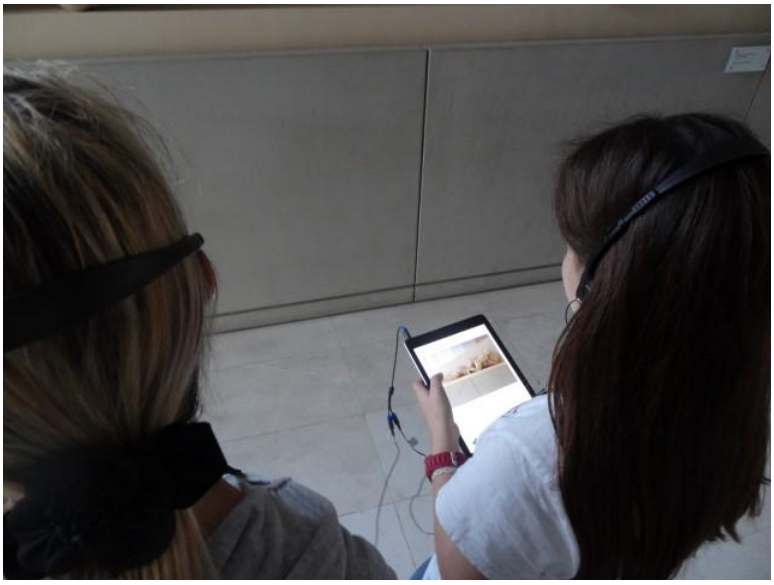


Figure 80: A splitter was used for the headphones of users who shared the tablet.

2.4.5 Results

In this section, we present key results from the evaluation with visitors at the Acropolis Museum. In the weeks following the evaluation, all notes, video data, and interviews were transcribed and collated. Key concepts, comments, and responses, initially organised by user (using the numbering scheme U1, U2, etc., listed in the first column of Table 9), were then grouped into themes, which corresponded to the question categories created before the evaluation to guide the semi-structured interviews. We used the same themes that we had used for the evaluation of the CHESS Beta in December 2012 (Figure 81).

The results are thus categorised under the following themes:

A. Story plot (was it clear, interesting, exciting, immersive. etc.).

B. Navigation / information (did visitors have difficulty locating exhibits or finding where to go).

C. Screen vs. Physical space (where was the visitor focussed on, the screen or the exhibit).

D. User Interface and Usability (was the device easy to use, were there external issues hindering the experience).

E. Pre- and Post-visit activities (did visitors prefer to experience content at a later time).

F. Social aspects (would visitors prefer sharing the experience with someone else).

G. Personalisation and Adaptivity (aspects of the experience related to the user model, the menus and preferences, etc.).

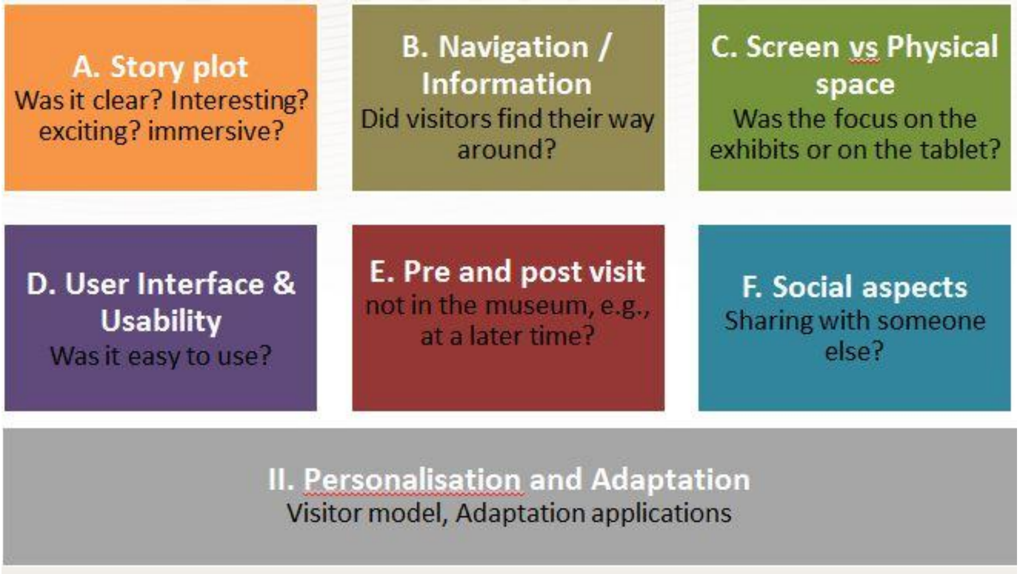


Figure 81: Evaluation results have been grouped under 7 themes

2.4.5.1 Story plot

The questions related to Story plot that were asked during the interviews and/or kept in mind by the researchers during visitor observation include:

1. Can you tell me what the story you experienced was all about?
2. Was the plot clear to you at the beginning?
3. Is the plot clear to you now?
4. Did you find the story, interesting, exciting, immersive?
5. Was the story easy to follow?
6. Did you like the fact that more than one characters appeared?
7. Did the alternation of characters help or hinder the story?
8. Did the story flow or did it feel broken or disjointed at times?
9. Did you find your experience different from museum guides (e.g., audio guides)? In what way?

The two stories selected for this evaluation were designed taking into account the results and guidelines from the beta summative evaluation and formative ones that followed. The Melesso story was created by the AM authors with the persona of Natalie Schmidt (see D03.11 – Initial User Requirements Analysis and Roussou et al., 2013) in mind, a woman who would like an overview of the Gallery with more emphasis on social aspects of Ancient Athens.

The Theseus story is addressed to visitors closer to the personas of Jack, the visiting athlete, and Dimitris, the teenager, both personas with limited interest in the museum itself and familiar with interactive applications, including gaming.

The Melesso story was about 10 minutes longer than the Theseus one and followed a more guided approach whereas the Theseus one was more interactive in the sense that the user was asked to recruit fighters to help Theseus to fight King Minos' army. Furthermore, the Theseus story was designed based on the trajectories framework developed by UNOTT (Benford et al., 2009). A representation of the Theseus story in light of the trajectories framework is presented in Appendix 7.2.

The two stories were presented both to visitors that were closely related (according to our estimates and knowledge of each invitee) to the persona(s) they were created for as well as visitors more close to other personas for which these stories were not considered particularly suitable. This approach was adopted to test the stories with a variety of users.

All visitors found the stories more interesting and exciting in comparison to audio guide applications they had been familiar with. The first person narrative, especially in the Theseus story, was found particularly engaging. As was also noted in the summative evaluation of the beta, humorous references and rhetorical questions triggered the users' interest and personal connection with the story, this being expressed through body language, facial expressions and comments.

Theseus story

The Theseus story worked really well for the visitors who favour interactive over guided experiences and are not interested in "heavy" informational content. Indicative was the positive reaction recorded with the pair of two 11 year old boys, who seemed to actually enjoy the visit through the Theseus story. As another user explained, a 37-year old male close to the persona of Jack Harris, "*The narration was great! I generally have no interest in small half broken statues. It was the first time I really looked at them with interest because of the story. Otherwise, to extract information from the labels it is true hell for me.*"

The story was successful in attracting the visitor's attention to exhibit details, like the description of Theseus' plate, an otherwise overlooked exhibit, or the hand of the criminal Procrustes on the Theseus statue.

However, as was also the case in the beta summative evaluation, the need for rich multimedia content for story parts with no connection to an exhibit was noted. As an 11-year old girl commented for the story plot parts where Theseus referred to the reasons he went to Crete to fight the Minotaur: "*The story was nice and what you had to do there was nice but at some point you are sitting there as it goes on and on and you do not know what to look at, on the screen there was only a picture of Theseus.*"

Another issue commented by most of the users was the lack of a "stronger" conclusion to the story in combination with an appropriate souvenir, showing what has been accomplished with the help of the visitor to collect fighters.

Melesso story

The Melesso story combined the narrating character's life story with information from Ancient Athens of her time. Although all users found the story interesting, most felt that the plot should be made more pronounced throughout the story, to provide the necessary climax for reaching the story objective, Melesso's dedication (Figure 82). As one user commented: "*Something was missing… The attractor that would make me follow the story. It was interesting to find Melesso's dedication. When I reached the goal it was great!*".

Some users with no pronounced interest in the emotional and personal approach conveyed by the female narrator Melesso felt that the story should be a bit shorter, that it was "too wordy". There was also the suggestion that it could benefit from more anecdotal information in certain places. The recommendation for this is to improve the content as suggested and add more multimedia productions for the story parts that are not directly related to an exhibit. Furthermore, more branching points will be added so as to make parts of the story optional and shorten the experience.

One of the users, who had already visited the Gallery several times in the past and was closer to the Georgia persona (i.e., the elderly woman who likes to read all labels), really enjoyed the story but confirmed that it is not addressed to a visitor like her, who needs in-depth information, but to a visitor who needs an overview of the Gallery, like the persona of Natalie.

The Augmented Reality (AR) activities integrated in the stories were impressive and engaging for most of the users. However, in the case of the Theseus story, the Peplos Kore informational content felt a bit disjoint with the plot.

On the whole, both stories were enjoyed by the users, but there were also several comments recorded that may lead to their substantial improvement as end user experiences for a real-world museum visit.

Figure 82: A highlight of the Melesso story was an offering with Melesso's name inscribed on it.

2.4.5.2 Navigation/ information

The questions related to Navigation (way finding) that were asked during the interviews and/or kept in mind by the researchers during visitor observation include:

1. Did you like the provided hints for locating your next exhibit?
2. Did you like the transition between physical places?
3. Were there any places you would like to spend more time at?
4. Did you like being told what to do?
5. Would you mind moving back and forth in the gallery to locate particular exhibits?
6. Did you stop to observe additional exhibits between location transitions?

User observation and comments on navigation in the Gallery confirm the results recorded in the beta summative evaluation deliverable D9.31.

Regarding the number and size of physical transitions (movement within the gallery), evaluation results confirm that visitors like to move around in the gallery and they don't mind moving back and forth in a non-linear fashion. As shown in the beta summative evaluation, visitors do not like staying at the same place for a long time without being engaged in rich multimedia content or activities that urge them to interact with the story or the physical world. The Melesso and Theseus stories were designed with these guidelines taken into account, however again several users commented that in specific cases the experience felt too static for them. This issue is discussed in detail in section 2.4.5.3.

In both stories the hints-based approach was adopted, which in Theseus had a more explorative aspect, giving in some cases to the user verbal clues to locate the exhibit without immediately showing an image of what the user should be looking for. The directions provided by the narrating character were combined with annotated images.

For this evaluation a different approach was adopted for the design of the navigation images. The target exhibit was highlighted whereas the background was made darker, as shown in Figure 83. The objective was to create a more subtle and aesthetically pleasing highlight for the exhibits in comparison to the arrow used to annotate them in the beta.

Figure 83. An example of a navigation image

Although no significant navigation issues where recorded with the majority of the users, in specific cases, due to the light conditions in the Gallery around noon, the glare of the screen in combination with the dark background made the image impossible to see. The users could not discern clearly the background of the exhibit and as one explained: "*I used structural characteristics of the building to navigate and in this case they were not visible*".

On the whole, the results confirm the previous summative evaluation ones that the hint-based navigation approach is successful for most users: "*Navigation was ok, no problem. Sometimes I had found it [i.e., the exhibit] before it [i.e., the system] asked me*". Some users even enjoyed the exploration aspect: "*It was like treasure hunting!*".

However, in this summative evaluation as in the beta, there were users that would've liked a more guided approach so that they did not have to dedicate any effort for navigation in the Gallery. The main issue with the hints-based approach is that if the user moves away from the point of view shown in the image s/he may become completely lost, wandering around the Gallery. In such a case, it is nearly impossible to locate the exhibit without going around the whole gallery.

For a CHESS experience to be deployed in a Gallery where geo-localization infra-structure is not available, the hints-based approach should be combined with a way to support the user if lost. QR codes can be used to this end. QR codes placed throughout the Gallery can be used for the users to input their position so that the system can then guide them to the next hotspot. This approach was tested as proof of concept but it was not included in the summative evaluation as the work required would be out of the scope of this project.

2.4.5.3 Screen vs. Physical space

The questions related to Screen vs. Physical space that were asked during the interviews and/or kept in mind by the researchers during visitor observation include:

1. Did the visual material presented on your screen help you get into the story?
2. Did you like the accompanying visuals on the iPad?
3. Would you've liked more or fewer visuals?
4. Did you like switching your focus from exhibits to screen?
5. Did you find it easy to understand when visual material was displayed on your screen?

The design of the stories for the final summative evaluation had taken into account the previous summative evaluation results that suggested that users were too absorbed on the screen and spent significantly less time looking at the exhibits.

Content for the final evaluation was designed so that there would be significantly fewer story parts unrelated to an exhibit and that the user would be subtly guided to observe exhibit details.

Very few users seemed to be completely absorbed by the iPad, and in these cases even this was partly due to the fact that they were not sure what to expect of this new museum visit experience:

"*I was engaged on the tablet and not on the exhibit. The tablet should initially free me from the screen and then ask my attention when needed. It is a new experience and I do not know how it behaves, I need to hear explicitly what I have to do.*"

The Theseus story was more successful than the Melesso one in providing the user with such guidance and making sure that the pace of the story and the directions provided were the appropriate ones to ensure a smooth end user experience. The success of the Theseus story in this respect is partly due to the application of the trajectories framework on the story during the story design phase, making sure that there is appropriate and balanced support for the story plot parts and the parts that require user engagement to exhibits (see Appendix 7.2).

As in the previous evaluation, again there were in some cases parts of the story that were characterized as "static", keeping the user in the same spot for some time.

An interesting finding was the reaction of the users that visited the Gallery in pairs. The one holding the iPad had a greater tendency to focus on the screen than the other, who seemed more engaged with the surrounding physical space and focused on the iPad screen only when prompted to do so.

2.4.5.4 User Interface and Usability

The questions related to User Interface, interaction and usability that were asked during the interviews and/or kept in mind by the researchers during visitor observation include:

1. How was the user interface?
2. Did you notice any errors?
3. Could you hear the audio at all times?
4. Would you have preferred to use headphones?
5. Could you see the text and images well enough?
6. Did you feel that you were in control of the experience?
7. Did the technology do what you expected it to do?
8. Did you know how to use the iPad?
9. Would you've preferred to have experienced this on a smart phone instead?

After the summative evaluation of the Beta, the end user experience was redesigned to address the main identified issues. The story narration activities were implemented with the "Narrator2" interface (Figure 75), which combined an icon of the story's narrating character as an avatar with the main visual content. The control menu was available by tapping on the avatar.

No significant issues were recorded with the use of the interface; it was straightforward to the users after a very brief pre-visit introduction.

There was however some confusion between the "Skip" button which interrupts the current activity and moves to the next one, the "hurry-up" button which asks the personalization engine to provide the shortest possible version of the story, and the use of the swiping gesture on the touch screen to move to the next content screen.

As the users do not have an overview of the story structure and the graph layout, it was difficult for them to differentiate between these three actions and used them interchangeably when they felt they needed to skip part of the story that was not interesting to them.

The AR interface proved to be somewhat challenging for most users. Instructions were not evident enough at the beginning of the experience and most users had difficulties to realize how to control the experience.

Furthermore, holding the iPad high in front of them after a while felt tiring because of the weight of the iPad.

Figure 84: Tablets afford touching but sometimes that may be difficult.

2.4.5.5 Pre- and Post-visit

In general all users showed interest in having some kind of souvenir or post-visit activity to complement their visit.

For the Theseus story, the post-visit experience foreseen was the Paint the daemon game (Figure 77). A teaser for this game was inserted in the story after the Three-bodied daemon story part in the Gallery and the game was presented to the user after the experience at the room where the interviews took place. Most of the visitors, especially the younger ones, enjoyed the game.

For the Melesso story, a quiz was offered to the user as a suggestion for a post-experience related to the visit. By completing the quiz, the visitor would see who would be in the Panathenaic procession, ancient Athens' great feast celebrating the birthday of goddess Athena. Users were very interested in the quiz and several re-did it in order to see different conclusions if some of the questions change.

A post-experience related to the story is an effective way to enhance the memory of the visit and prolong user interest in the information content offered.

2.4.5.6 Social Aspects

During the final summative evaluation users that came together were given the option to visit the Gallery in pairs sharing the same iPad (Figure 85).

Interesting observations were made as to how users share the device and interact with one another to make decisions, control the flow of the story or interact with another.

The group visit worked in cases where users had similar interests and agreed on the trajectory to follow with significant compromises. Especially younger visitors who experienced the Theseus story seemed to enjoy this shared "adventure". Although CHESS has been designed as a single user tool, the evaluation showed that it can work as a group experience as well.

As one of the users suggested, different levels of interaction between users could be envisioned:

- One iPad and listening to the same story at the same time
- Different iPads but one shared experience. Possibility to synchronize with the other use when close to one another, so when they are together they can listen to the same audio content.
- Different iPads and different but complementary experiences. For example, in the case of Theseus, the users could split the types of fighters they need to retrieve, as they would be given different instructions by Theseus. They could also at specific points exchange their accomplishments in the story so far.

Another positive result is that the CHESS system in the presence of other visitors was not problematic even in times when the Gallery was crowded.

The social aspect of CHESS needs further investigation to explore all its implications.

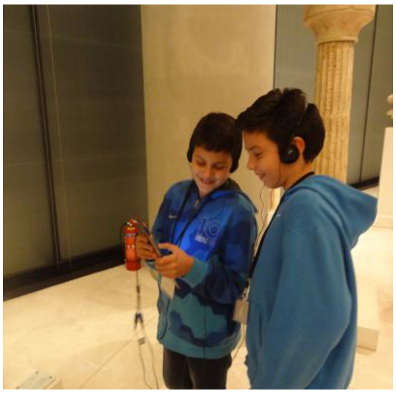



Figure 85: Some visitors chose to share the experience with their friends.

2.4.5.7 Personalisation and Adaptation

The Melesso story was the primary test-bed for the personalization aspects of CHESS. Detailed interviews with the users after the visit produced rich feedback that is presented in the corresponding Section.

Figure 86: The Melesso story included many branching points.

2.4.5.8 General observations and comments

As a main conclusion of the final summative evaluation at the Acropolis Museum is that the CHESS storytelling experience is in fact an attractive and effective way to bring visitors closer to museum exhibits and their stories. As one user commented: "*I liked that it was a kind of guided tour with a story there to connect the exhibits, and not a mere presentation of the facts*."

Especially for users with limited interest for the museum content, CHESS has the added benefit that accomplishes engagement of the young visitors with the exhibits. As one user suggested: "*It is better that the visit is guided with the illusion of choosing the experience trajectory yourself. When you seek entertainment it is nice that you go back to your childhood where you had your parent playing the role of discreet guide and entertainer.*"

However, to make a successful CHESS story, several factors need to be carefully considered and the different aspects of the experience implemented taking into account all the issues identified in the formative and summative evaluation reports.

2.5 Summary and conclusions with respect to user experiences

This section has presented three detailed evaluations of user experiences conducted as part of Y3 of the CHESS project. The first two studies were ethnographic in nature, and the third integrated ethnography with participant reflection. Collectively, these studies present a substantial and coherent body of knowledge about interactions between museum visitors and visitor experiences, which encompasses a variety of models, including:

- Individuals
- Families
- School groups

Two of these experiences were constructed using the CAT, providing evidence for its efficacy. The design of the other user experience was directly informed by evaluation work conducted in Y1 of the project, providing evidence for the efficacy of this early work.

Section 2 as a whole presents a very substantial contribution to knowledge. This will lead directly to further academic publications submitted beyond the life of the project. Given that the design of authoring tools depends upon a knowledge of the experiences that can be produced using them, then this knowledge will also support and guide the development of CHESS authoring technology as a whole beyond the end of the project.

3 Evaluation of CHESS personalisation and adaptation features

The Chess personalization and adaptation facilities were evaluated during the two day summative usability and user experience evaluation study of CHESS that was carried out on January 27th and 28th 2014 at the Acropolis Museum (AM). The overview of the study is described in Section 0 where results are classified in seven themes (Figure 81). This chapter reports on the main results and conclusions reached so far, regarding the 7th theme, Personalization and Adaptation.

Aiming to follow the layered evaluation paradigm (Paraymythis, 2010), we have examined and assessed separately the main personalization and adaptation facilities:

1) ***Initial story selection, utilizing the CVS answers.*** We investigate the users' ability to make well informed story selections based on small teasers and we exploit the users' answers to evaluate the system's performance in the initial story selection. Focusing on the cases where the system's suggestions were not successful, we investigate the weaknesses of the adopted approach along with ways to address them.
2) ***Personalized decisions in authored branching points.*** We first describe the decision points included in the story of Melesso and then we examine the system's performance in the decision making process. We compare it to user' performance, showcasing that they are comparable. Then we discriminate between the two personalized facilities provided, namely the automatic decisions and the personalized suggestions and ranking, and we discuss their utility under the particular setting, while also considering additional ones. We follow a user-centric approach to evaluation (Pu, 2012) and we examine the users' perception regarding the usability, usefulness and quality of the system's personalization functionality, while at the same time considering for related interface issues.
3) ***Hurry up functionality.*** We report on the results reached regarding the user's perception of the Hurry up adaptation functionality.

Finally, we discuss the observed effects of the joint experiences in users' behaviour and we report on the different preferences expressed in the available options. We investigate their relation to user distance estimations, computed using simple metrics over the users' explicit topic-ratings. We conclude by suggesting the "group compatibility estimation" functionality for future work on that front.

3.1 Initial story selection process, utilizing the CVS answers

The evaluation study included a short pre-visit interview, which preceded the Chess Visitor Survey. All the users were provided with a short description of the Melesso and Theseus stories, and they were asked to rate them in a five point Likert scale as well as to explain the reasons for their rating. In case of equal ratings, they were asked to choose the story they would prefer. Then they were asked to rate a set of 5 topics, using the same scale. Having the pre-visit interview completed, the users were instructed to complete the Chess Visitor Survey, as described in Section 0, and a story was suggested to them based on their elicited profile. Independent of the system's suggestion, the users were explicitly instructed to choose a story that was pre-selected for them by our team, to ensure a balanced set of experiences for the two stories. In total of 28 users, 14 users experienced the story of Melesso and 14 users experienced the story of Theseus. Based on this dataset, the main research questions (RQ) addressed regarding the CVS story selection process were the following:

RQ: "Does a small story teaser enable users to make the optimal story selection?"

In general, users were able to identify the most prominent aspects in each story, based on the teaser description, and most of them were quite confident for their choice. However, we observed two cases (users 19,20), where the users selected Theseus story only because they were familiar with him, hence in essence neglecting all the other aspects of the teaser (such as subjects covered, narration style, plot theme). These users stated that they actually made an impulsive selection, having no real preference between the two stories. Familiarity with the narrating character has also affected one of the children participating in the user study (user 8), but in the opposite way: she gave a negative rating to the story of Theseus, due to her extreme knowledge about the specific hero, while in fact she believed that the story of Melesso would be quite boring.

RQ: "How did the CVS-process performed for the initial story selection step?"

User ratings are depicted in the following figure. Red bars denote ratings for the Theseus story and blue bars represent the ratings for the Melesso story. Bars extending above the user axes depict positive ratings while the ones beneath it denote negative ratings. Small, 1-level bars represent the "somewhat" preference, both on the positive and negative scales, while the big, 2-level bars illustrate the "a lot" preference. Finally, the neutral rating is depicted with the absence of for the related bar.

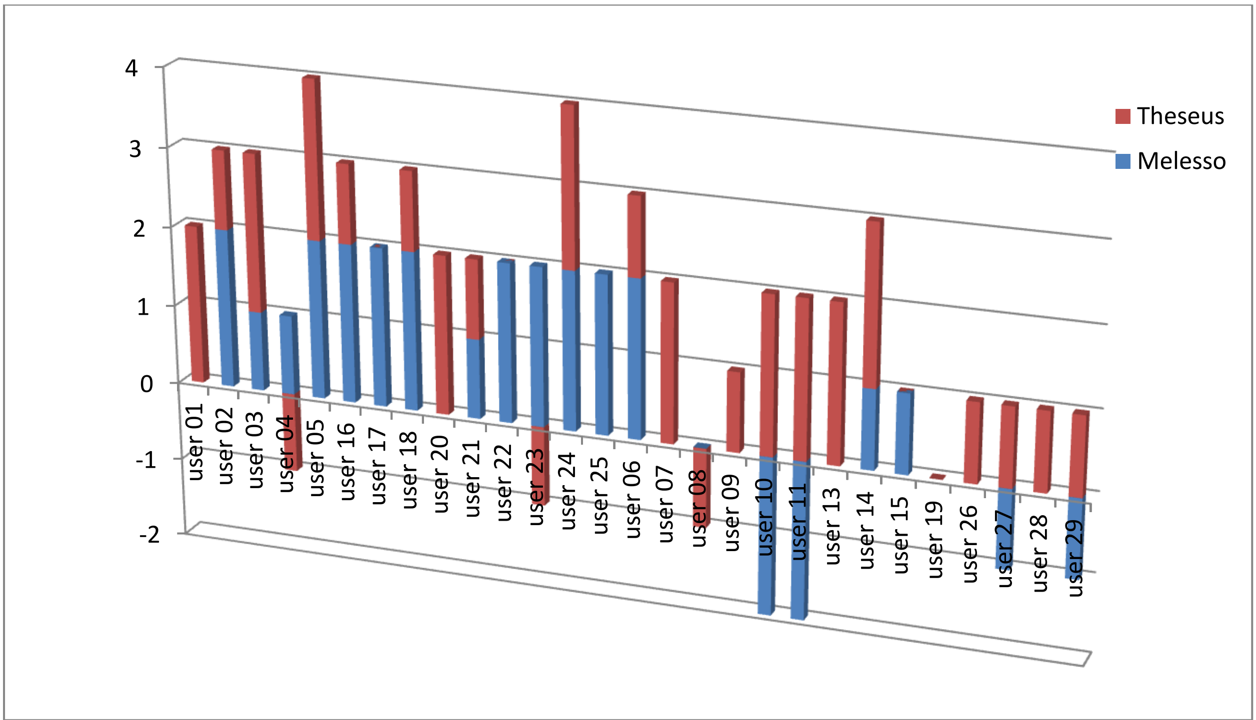


Figure 87: User ratings over the Melesso and Theseus stories

Figure 87 quickly shows that individual visitor preferences greatly vary between the two stories, verifying that the authored stories address different visitor interests and needs. The following table reports on the users' story selections, along with the corresponding recommendations from the Profiler, based on each user's answers in the CVS.

SN	USER IDS	Story Selected by the User (Theseus / Melesso)	Comments	System's Story Recommendation (Theseus / Melesso)	Right / Wrong Decision
1	user 01	T		T	R
2	user 02	M		M	R
3	user 03	T		M	W
4	user 04	M		M	R
5	user 05	M		M	R
6	user 16	M		M	R
7	user 17	M		M	R
8	user 18	M		M	R
9	user 20	T	Random selection	M	W
10	user 21	M		M	R
11	user 22	M		M	R
12	user 23	M		M	R
13	user 24	likes both stories equally		M	
14	user 25	M		M	R
15	user 06	M		M	R
16	user 07	T		not able to reach suggestion	
17	user 08	M	Child	not able to reach suggestion	
18	user 09	T	Child	T	R
19	user 10	T	Child	T	R
20	user 11	T	Child - no CVS		
21	user 13	T	Child	T	R
22	user 14	T		M	W
23	user 15	M		M	R
24	user 19	T	Random selection	M	W
25	user 26	T		M	W
26	user 27	T		M	W
27	user 28	T		T	R
28	user 29	T		T	R

Table 10: Comparison of users' story selections and system's story suggestions

In total of 28 users, we exclude the experience of 4 users to investigate the system's accuracy in story suggestions for the following reasons. In two cases (users 16, 17) the system could not reach to a decision on which of the two stories to recommend, while one user performed no CVS due to time constraints, so no recommendation was made for him (user 11). Finally, one user resisted on selecting one of the two stories, declaring that she liked both of them equally. So, by examining the remaining 24 sessions, where a clear user preference is expressed on one of the two stories, we can see that the recommendations reached were successful in 75% of cases, taking 28 right decisions and 6 wrong ones. The percentage gets higher if we consider that two of the wrong decisions concern the two cases where the users stated that they made a semi-random selection, based on their familiarity with the hero Theseus, thus reaching approximately 82%.

It should be noted that, due to the small size of the available dataset, the reported results should be interpreted as positive indications regarding the process's performance, rather than as quantitative measures. Making a qualitative analysis, the cases where wrong decisions were reached are further explored, so as to assess the weaknesses and provide insights for further improvement.

From the remaining four users, for whom the system made a false suggestion, two of them explained that they had a strong dislike on a particular narrow subject (e.g. the pantheon and religion) covered in the story of Melesso, and this dislike is what actually determined their choices. Their dislike to these subjects is also reflected in their topic ratings, provided afterwards.

Since all the users had rated the main five topics covered in the stories, we experimented with a simple topic based approach to initial story selection; each user was represented as a vector over the five topics, taking values in {-1, -0.5, 0, 0.5, 1} and the two stories were represented in a similar way, reflecting the extent to which they cover each one of the given topics. We employed a simple Euclidian distance metric between the users and the stories to compute the story best matching each visitor's topic tastes (i.e. the one with the smallest distance). We observed that the results were very vulnerable to modifications in the topic representations of the two stories, impeding to reach a general result. However, since preferences on narrow topics seem to be critical whenever dislikes are expressed to some of them, we also investigated another approach; stories are represented as a vector over the five topics, but they take values in {0, 1}, indicating the main topics covered by each story. Then we computed the Euclidian distance between the users having provided one or more negative ratings to the stories (7 users). The predictions reached were correct in for all of these users and the results were not so vulnerable to story representation. As a future work, we should further investigate the extension of the existing CVS with a topic-based approach, which should be emphasized for the users expressing dislikes, or for cases that the CVS approach wasn't able to reach a confident suggestion.

Finally, regarding the significance of the CVS-based initial story selection step, we conclude that even in this simple case, where the users had to read the teasers of just two stories, 3 users didn't read the descriptions carefully enough, making random, uninformed decisions. When more stories are provided, the effective personalized ranking and suggestion of the available stories will be critical; reading all the story teasers will be a huge burden for the visitors, probably damaging the quality of their selections.

3.2 Personalization decisions in authored branching points

The story of Melesso

The script of Melesso includes 13 decision points overall. The first 3 decision points have been annotated by the author as "REQ" (required) in Figure 88, so when they are reached, a menu is mandatorily displayed, depicting a short description of the candidate choices. The visitor can either choose to be provided with additional information on a particular subject (i.e. related to society and everyday life in the first decision point, an historical event related to the Hekatompedon in the second one, information about a mythological creature in the third one), or to go on with the rest of the story.

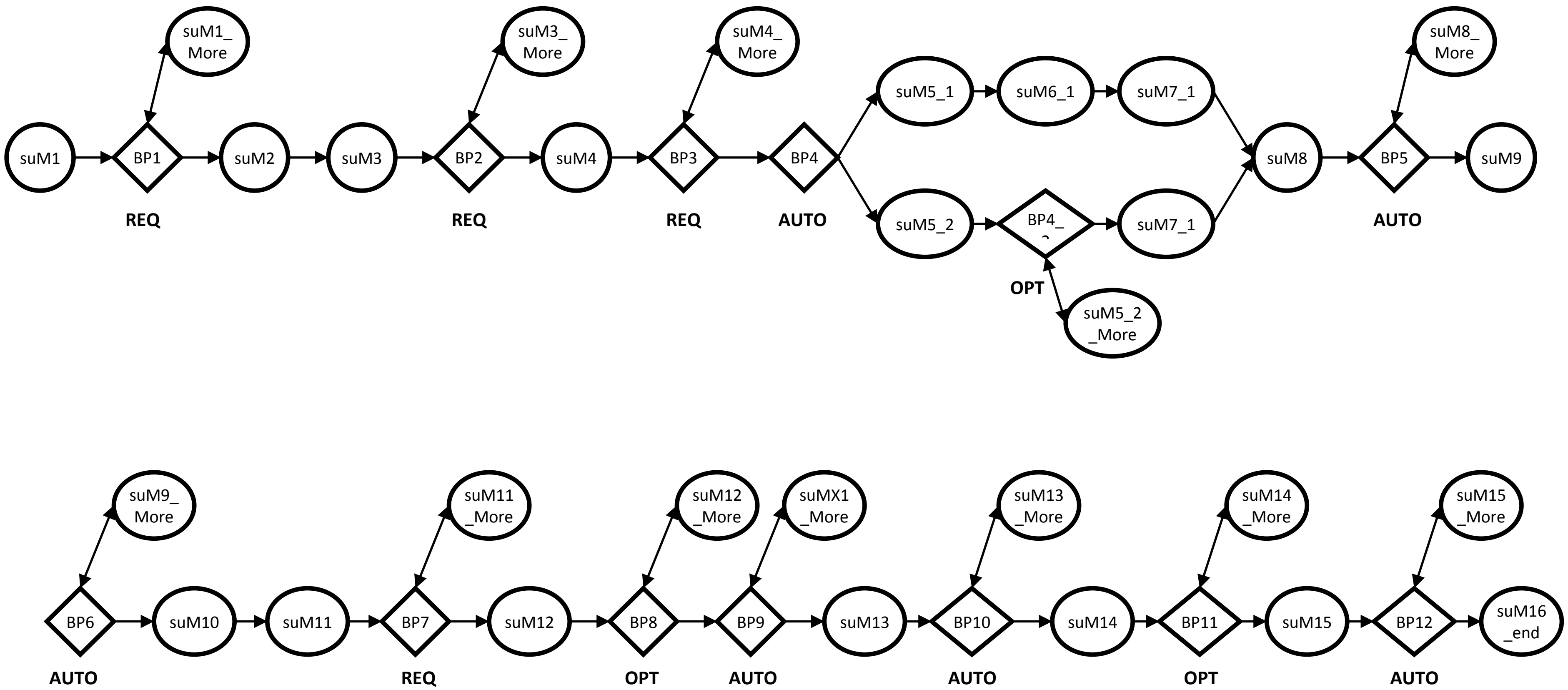


Figure 88: The Melesso script graph

The fourth decision point defines two alternative continuations of the story. At this point, the story can evolve around the monster Medusa, goddess Athena as a great warrior and the hero Hercules fighting with a creature. Alternatively, the story can continue with the powers and skills of goddess Athena, the ways she was worshipped and her influence to women's everyday life. Instead of providing a menu, the author has chosen to let this decision be taken automatically by the system (annotated as "AUTO" in Figure 88). From an authoring perspective, there are two reasons for setting this decision point as "AUTO". The first one is that each continuation covers several subjects, so it is difficult to provide a short teaser giving a good insight for each option, while at the same time not revealing the continuation of the story. The second reason has to do with the visitor's satisfaction. While it is not feasible to experience both of the story continuations, some visitors may be disappointed by this fact that they can select only one of them. So the main question is if, in such cases, the author can effectively exploit the Personalization system so as to take the best decision without involving the visitor in the decision process.

The fifth and sixth decision points are again annotated as "AUTO", requiring the system to make a choice automatically. No alternative continuations of the story are provided there however. The system has to decide whether to provide additional information on the subject that is at hand, or not, going on with the rest of the story. From an authoring perspective, there may be several reasons for deciding not to show a menu. For instance, when the optional side-stories are really small, and another branching point follows directly, the insertion of consecutive menus would result in a defragmented experience. On the other hand, if a side story covers several narrow topics, or quite a few exhibits, or even a number of alternative productions, the authoring of a short, well descriptive teaser becomes a very challenging task. Moreover, there are cases where the author doesn't wish to reveal in a teaser the upcoming topics or exhibits, so the display of a menu wouldn't really help the visitor to make an informed decision. So again, the research question here is if the Personalization system can automatically take such decisions, without hindering the visitor's experience.

Then at the seventh decision point a menu is displayed, asking the visitor to choose whether (s)he wants to learn more about the dress styles or go on with the jewellery of Athenians during the archaic period. The rest of the decision points provide the option to hear more about a subject or to go on with the story. Three of them are annotated as "AUTO", requiring system's initiative, and two of them are characterized as "OPT" (optional), in the sense that they should be automatic if the system is quite certain about its decision, but they can afford to have a menu displayed for them otherwise, so that the visitor makes an explicit choice.

One of the main objectives of the CHESS system is to find the right balance between the mental load created to the visitor when asked to reply to numerous questions during the visit and fully automated decision making. This goal is addressed by the optional menus; authors are encouraged to create automatic and required menus only when they believe it is absolutely necessary to do so, and set all the other menus to optional. In this way, it is the responsibility of the CHESS system to decide when an automatic decision should take place or a menu should be displayed instead. So the main question here is if the Personalization system can effectively help towards finding the right balance between menus and automatic decisions, tailored for each individual.

RQs: "How did the system perform in the decision points of Melesso? How did the users perform in these decision points? Is the system's and users' performance comparable?"

To answer this question, we conducted a detailed post-visit interview with the users; we went through all the decision points in the story graph, we presented to the users all the available options and the system's decision at each one, and we asked them to evaluate the system's decision in a 3 Likert scale (right decision, neutral, wrong decision) as well as to explain the reasons. Out of the 14 users who experienced the story of Melesso, the first two were used as pilot users, to identify and correct any main issues affecting the evaluation process. As it turned out, both of the pilot users performed a “Hurry up” request at the beginning of their experience. We were very surprised to see that, since the Hurry up requests, if any, are expected to take place at an advanced state of the experience. During the post-visit interview, it became clear that, while the Hurry up option was explained in the pre-visit tutorial, none of the two pilot users had understood its functionality and they used it by mistake; their actual intention was to skip a particular story part instead. We will examine the reasons and correcting actions that we took on that front later on.

Regarding the evaluation of the system’s performance, the implication of the Hurry up requests is that the system provided the shortest version of the remaining story for the two pilot users, thus neglecting the individual’s preferences stored in their profiles and biasing the profiling procedure overall. For this reason, the experience of the two pilot users is excluded from the upcoming analysis. From the remaining 12 users, two of them have undertaken the short version of the interview, departing before the examination of the story graph, due to time constraints. So the following analysis is conducted over the experiences and feedback of 10 users.

The following table depicts the system’s performance in all the experienced decision points, indicating right decisions with R, wrong ones with W and neutral ones with N. Whenever a menu was displayed for a branching point, user’s effectiveness in the decision making process is indicated similarly, having the user’s right calls indicated with UR, wrong ones with UW and neutral ones with UN. In such cases, the system performance is examined based on the ranking of the available choices; if the best choice is ranked at the first place, then the system’s decision was right. Since not all the decision points were experienced in all the sessions, some cells are empty.

In total of 127 decision judgments, 9 of them were judged as neutral; users expressed a clear preference for some of the choices in the remaining 118 decision points. Table 12 summarizes the system’s and users’ performance in the experienced decision points. It should be noted that system’s and users’ decisions are examined over the same set of decision points; system’s decisions are evaluated over all the branching points and user’s decisions are evaluated only in the cases where a menu was displayed to the user (i.e. in all the REQ branching points, as well as for some OPT ones). Again, due to the small number of evaluated sessions, and especially due to the strong, inherent dependencies with the particular story’s content, we believe that the reported results should not be interpreted as absolute metrics of accuracy. However, they provide valuable insights on system’s performance, indicating that the authors can effectively leverage the Adaptive Storytelling Engine so as to make suggestions or even take automatic decisions on the visitors’ behalf. Moreover, the evaluation results reveal several important aspects regarding the various levels of the Melesso story, such as the menu teasers, script, staging and productions. In the remaining of this section we highlight the main findings reached from the semi-structured interview, regarding all the aforementioned aspects.

BRANCHING POINT ID	BPRANCHING POINT TYPE	MELESSO USER IDS & IPAD IDS									
		ipad 03		ipad 04	ipad 16		ipad 18	ipad 20	ipad 22		ipad 24
		user 03	user 05	user 04	user 16	user 17	user 18	user 21	user 22	user 23	user 25
1	REQ	UR, W	UR, W	UR, R	UR, R	UR, R	UR, R	UW, R	UR, R	UR, R	UR, R
2	REQ	UW, W	UR, R	UR, R	UN	UN	UR, R	UR, R	UR, R	UW, W	UR, R
3	REQ	UR, R	UR, R	UR, R	UR, R	UR, R	UR, R	UR, R	UR, R	UR, R	UR, R
4	AUTO	R	R	R	W	R	R	R	W	W	N
4_2	OPT	-	-	R	R	W	R	-	W	W	R
5	AUTO	R	R	R	R	R	R	N	R	R	R
6	AUTO	R	R	N	R	R	R	N	R	R	R
7	REQ	UW, R	UW, R	UR, W	UW, R	UW, R	UR, R	UW, R	UR, W	UR, W	UR, R
8	OPT	UR, R	UR, R	R	R	R	R	UR, R	R	N	R
9	AUTO	R	R	R	R	R	R	R	R	R	R
10	AUTO	R	R	R	R	R	R	R	R	R	R
11	OPT	UR, R	UR, R	UR, R	UW, R	UW, R	UR, R	UR, R	R	R	R
12	AUTO	R	R	R	N	N	R	R	R	R	R

Table 11: User assessments over the experienced decision points in the story of Melesso

First of all, one can observe that the system's right decisions outperformed the users' right decisions. This showcases the effectiveness of our approach while also verifies our assumption that the definition of attractive, well descriptive teasers is a very demanding task.

	Total	Percentage
System's decisions	127	
System's decisions excluding Neutral	118	
System's right decisions	105	89%
System's wrong decisions	13	11%
Users' decisions	50	
Users' decisions excluding Neutral	48	
Users' right decisions	38	79%
Users' wrong decisions	10	21%

Table 12: Summary of Users' and System's performance at the decision points in the story of Melesso

The users have reported several reasons for taking a wrong decision. User 21 stated that "at the beginning of the experience, I didn't pay so much attention to menus; I expected the system to guide me and explicitly notify me if something interesting is available". User 16 explained that she hesitated to choose some of the optional story sub-parts, such as the historical event about the Hekatompedon at the second branching point, because she was afraid that the story would switch its main theme from "social life" to "historical events"; so she didn't select the corresponding part even though she would like to hear about it. These statements indicate that, despite the fact that a short tutorial was presented to the users prior to their CHESS experience, they didn't know what to expect from the system exactly and they needed some time to familiarize with the provided interaction, thus biasing their initial selections. This finding highlights the special care that needs to be paid to the specification of a short, descriptive tutorial, taking place before the visit, so as to help the users take better decisions from the beginning of their experience. Moreover, teasers should follow a standard "notation" so as to enable the users quickly grasp the effects of their choices, making well informed decisions and feeling more comfortable when they need to make a decision.

In general, it seems that unsuccessful teasers lead users to random selections. For instance, one can observe that half of the users made a wrong decision in the 7th branching point. This is a typical example showcasing the ineffectiveness of teasers' when the upcoming story part covers several narrow topics. Users 16 and 17 stated that they would prefer the system to decide for them at that point, since they didn't know what to expect there exactly. Users 03, 05 and 21 explained that, when in front of this menu, they decided to go on, rather than choosing the optional story subpart, because they believed it merely included an additional augmented reality activity; they didn't understand that they would be provided with more information. These statements show that this particular teaser was clearly not descriptive enough. We believe that this situation can be remedied in one of the following ways, by either i) refining the teaser accordingly, or ii) by dividing this story subpart into smaller optional ones with the appropriate teasers, if possible, or iii) by setting this branching point as automatic. A similar situation is observed in the 11th branching point; two of the users who were provided with a menu at this point (users 16 and 17) explained that they clearly misinterpreted it and they were very sad to discover they had missed the corresponding story sub-part, covering interesting topics and exhibits. It is worth noting that the system made a right suggestion to these users at the particular branching point, so an automatic system decision would benefit their experience.

The next research questions have to do with the utility of the system's decisions in the Melesso story. To investigate that we discriminate between the three different ways that the system's decisions are used, as implied by the type of the branching points in the story's graph

RQ: "How useful were the personalized automatic decisions in the story of Melesso?"

The evaluation results indicate that the authors can effectively leverage the Personalization system in the decision making process, without involving the visitor. This is particularly useful for cases where teasers are hard to define, such as when several narrow topics or exhibits are covered by each branch. Our findings show that, in such cases, the users would prefer to have the system decide for them, rather than taking semi-random decisions. In this sense, automatic system decisions can provide a valuable aid to the authors, so as to overcome the demanding teaser specification task.

Moreover, automatic system decisions seem to be very useful in cases where alternative story continuations are about to be undertaken. For instance, in the 4th branching point of Melesso, the users had to follow only one of the two branches in order to maintain story coherency. When we went through the story graph during the post-visit interview, the majority of users were disappointed to find this out; users 4, 5, 16, 17, 18, 21 and 25 commented that both of the available options seemed interesting and they would prefer to be able to experience both! So in some cases it may be a good policy not to let the user know about all the available options, and automatic system decisions provide the way to do that.

Finally, automatic decisions enable authors to define several "consecutive" branching points in the story. In this way, one can provide several optional subparts, without interrupting the story flow and defragmenting the storytelling experience. This approach has been fully exploited in the script graph of Melesso, from the 5th branching point and onwards. We have also employed a couple of optional branching points, allowing for menus to be displayed under situation of uncertainty regarding the users' preferences, while taking automatic decisions otherwise.

Evaluation results show that all users but one liked a lot the fact that menus were provided. They conceived them as a way to control their experience, enabling them to decide what to include and what to exclude. However, all the users commented that they would not like to have more menus in their experience; they would like to have more options at each menu instead. Users 4 and 25 commented that they might actually prefer to reduce the number of displayed menus, because at some points they felt like they interrupted the story. It should be noted that, for user 4, a menu was displayed for only one of the three optional branching points, while no menu was displayed for user 25, enabling her to experience the least possible number of menus. These findings verify our assumption that, while menus are generally very well accepted, users should not be overloaded with decision points. Automatic and optional branching points are crucial in this regard and the evaluation results indicate that CHESS authors can effectively exploit them so as to reach the right balance between the mental load created to the user when asked to reply to numerous questions and fully automated decision making.

RQ: "How useful were the personalized suggestions in the menus displayed in the story of Melesso?"

When a menu is displayed, presenting the available options and asking the user to make a decision, the options are ranked according to the user profile obtained so far (personalized ranking) and the top-choice is highlighted in yellow, indicating that this is the system's suggestion.

While the pre-visit tutorial of the evaluation included a small reference on this aspect, the post-visit interview revealed that the great majority of users (11 out of 14 users) didn't notice at all the fact that one option was highlighted during their experience; they were also not aware of the fact that the options were ranked according to their preferences. This result clearly shows that a different visualization approach needs to be adopted for the display of the system's suggestions. In fact, all the users commented that they would prefer a different visualization approach, making more obvious that some options are actually suggested.

Users 04, 16 and 25 who did observe the highlighting and they were thus aware of the system's suggestions were asked if the suggestions were helpful for them and they all replied positively. User 25 also commented that the suggestions were very important for her and she always took them under consideration to make a decision. However, users 4 and 16 commented that when only two options are available in a decision point, it doesn't take much effort for them to examine all the choices so as to take a decision, so they wouldn't feel the need to trust the system in similar settings; they would do so only if many more options were provided in a menu. A similar statement was made by user 21, who at some point during his experience noticed that the "Go on" option was displayed in the first place, rather than the last one where it used to be (while totally missing the highlighting feature): "It is not hard for me to choose between two options. I would definitely need some help though if several options were provided!". These findings verify our assumptions that, in general, users enjoy to be provided with suggestions by the system but the utility of the personalized suggestions in menus increases along with the number of available options.

The next research questions has to do with the effectiveness of the storytelling engine to adapt the Melesso story to each visitor's preferences and behaviour, both from the system's and the users' perspective. To answer this we take under consideration the content dependencies inherently residing in this process.

RQ: "From the system's perspective, was the Melesso story effectively adapted for each user / group of users based on their preferences and actions?"

The following figures illustrate the user trajectories in the script level. Since some users had a joint experience, using a single iPad, their shared trajectory is depicted within a single figure. One can observe that for the 7 visits that took place, 6 different versions were provided. The script-level trajectories of iPad 03 and iPad 20 are the only identical ones; this is explained by the fact that the users made the exact same choices and they performed no skip or other diverging actions, following closely the prescribed story's flow. A different set of script units and menus is included in the rest of the user sessions however. Even for iPads 18 and 24, where the same set of script units is experienced, a skipping action performed in the ipad24 led to the dynamic display of a feedback menu to investigate the reasons for skipping. The choice entered enabled the system to increase its certainty about the users' interests, which in its turn lead to an automatic decision in the 11th branching point, rather than to a menu display which was selected for the user of ipad18.

From the system's perspective, the rational generation of different outcomes based on the visitor's preferences and actions, along with the high scores reached in the decision making process (provided by the users who participated in the detailed semi-structured interview), indicate that overall, the storytelling engine was able to effectively dynamically adapt the provided story of Melesso based on the users' actions, so as to bring it closer to their tastes and needs.

However, the collective analysis of all the users feedback, revealed a couple of issues arising in terms of the content, such as in the script units talking about the Hekatompedon replacement (su_M3_More), and the faces of Athena (suM5_2_More). Regarding the replacement of Hekatompedon, user 3 commented that, while it talks about an interesting topic, the textbook-like presentation of the subject repels her; even after re-listening the particular script unit she could not remember it! User 5 noted that he would like some more info to be included in this part, in order to give some context to the presented information. Similar comments were made by most of the users about this script unit.

A similar phenomenon is observed in the faces of Athena. User 17 commented that while she didn't skip, she started considering it at this point, but she didn't do so because she was making a joint visit. User 4 also made the same comment, but he explained that he didn't skip because he was afraid that he would lose something interesting that may be following. User 23 was actually annoyed by the way the information was presented that he skipped this part; his companion, user 22, commented that while in general not in favour of skipping, she agreed with his choice at this point: "I expect to learn some anecdotal information, I am not interested in Wikipedia-like information that I can easily find online".

While the users reacted in different ways when experiencing these particular script units, most of them commented negatively the textbook-like flavor of these sections. These findings indicate the some modifications are required in the related script parts, while also showcasing the users' desire to move away from traditional guides to casual, personal storytelling approaches!

Another observation has to do with the interpretation of the skipping actions as negative feedback. The evaluation results verify that skipping typically denotes a dislike for the subject being presented at the time of skipping. However, we have also observed several cases where the negative feedback actually concerned the previous script unit and its subject, rather the current one (where the skip would have occurred). This is the case with Athena Ergane, following the faces of Athena; users 4 and 17 commented that, while this section turned out to be quite interested, they did consider to skip it at first, due to their dislike in the previous script unit. While the script unit talking about Athena Ergane has a different subject than the faces of Athena (i.e. it focuses on the Athenian society along with the pantheon, rather than on the pantheon itself), the users assumed that, since the two topics are very closely related, the same subject and information style would be provided. A similar situation seems to have occurred in the Gigantomachy, which covered two very different subjects: the mythological battle itself first, and then its significance to social life and art. Users 23 and 24 skipped the second part, but when they experienced the related section during the semi-structured interview, it turned out they liked it a lot! When discussing the potential reasons of skipping, user 23 said:"It was just an impulse! I was disappointed from the previous part and I suppose I didn't give this a chance!".

A similar situation is also observed in the 7th branching point, which follows the AR activity of a Kore and leads to an additional AR activity over another Kore statue. While the users generally liked the original AR, most of them didn't want to immediately enter a second AR activity, because they felt they would just see the same things. Some users also commented that they had absolutely no reason to enter the second AR activity since a coloured representation of the statue was standing right next to the exhibit.

These findings show that, in some cases, skipping needs to be interpreted in the context of the experience, rather than as an isolated action. This is a very interesting result and it needs to be further investigated.

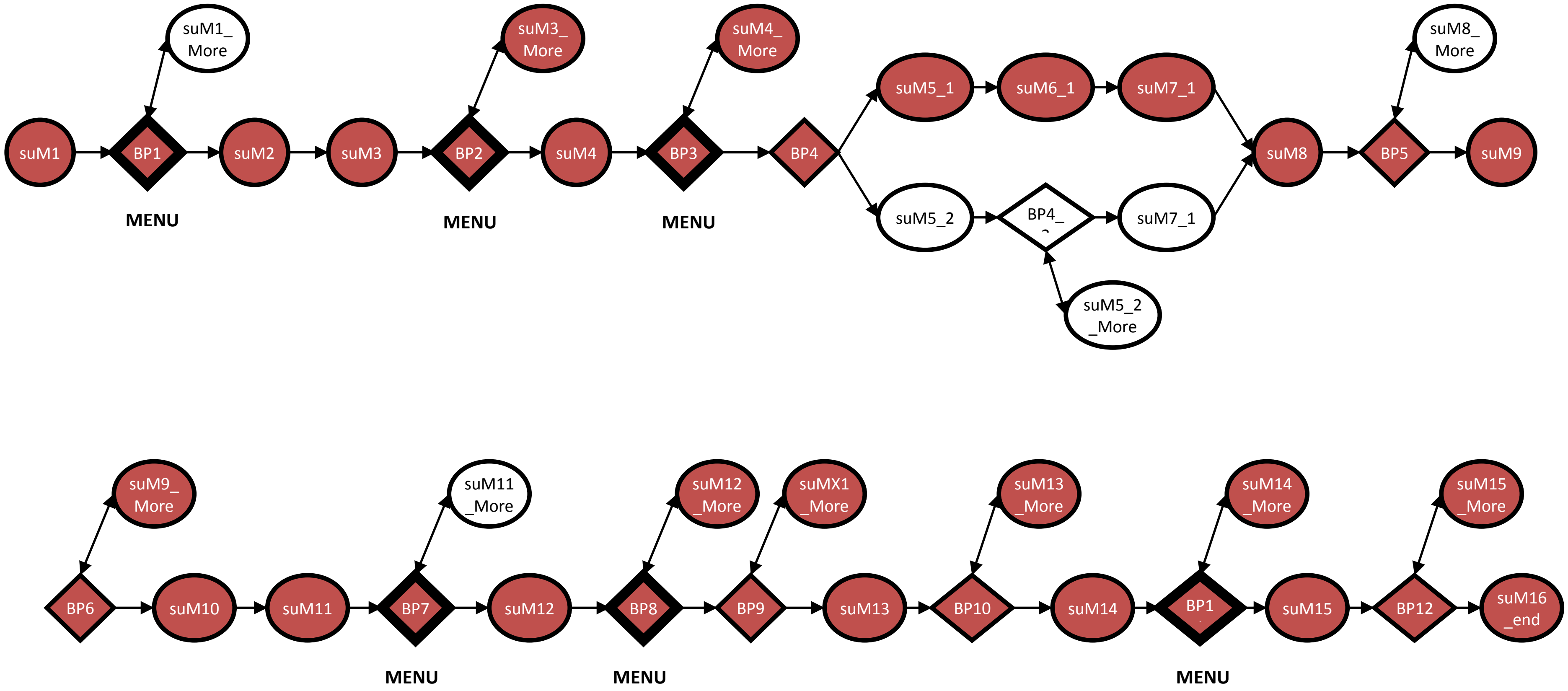


Figure 89: Users 03 and 05

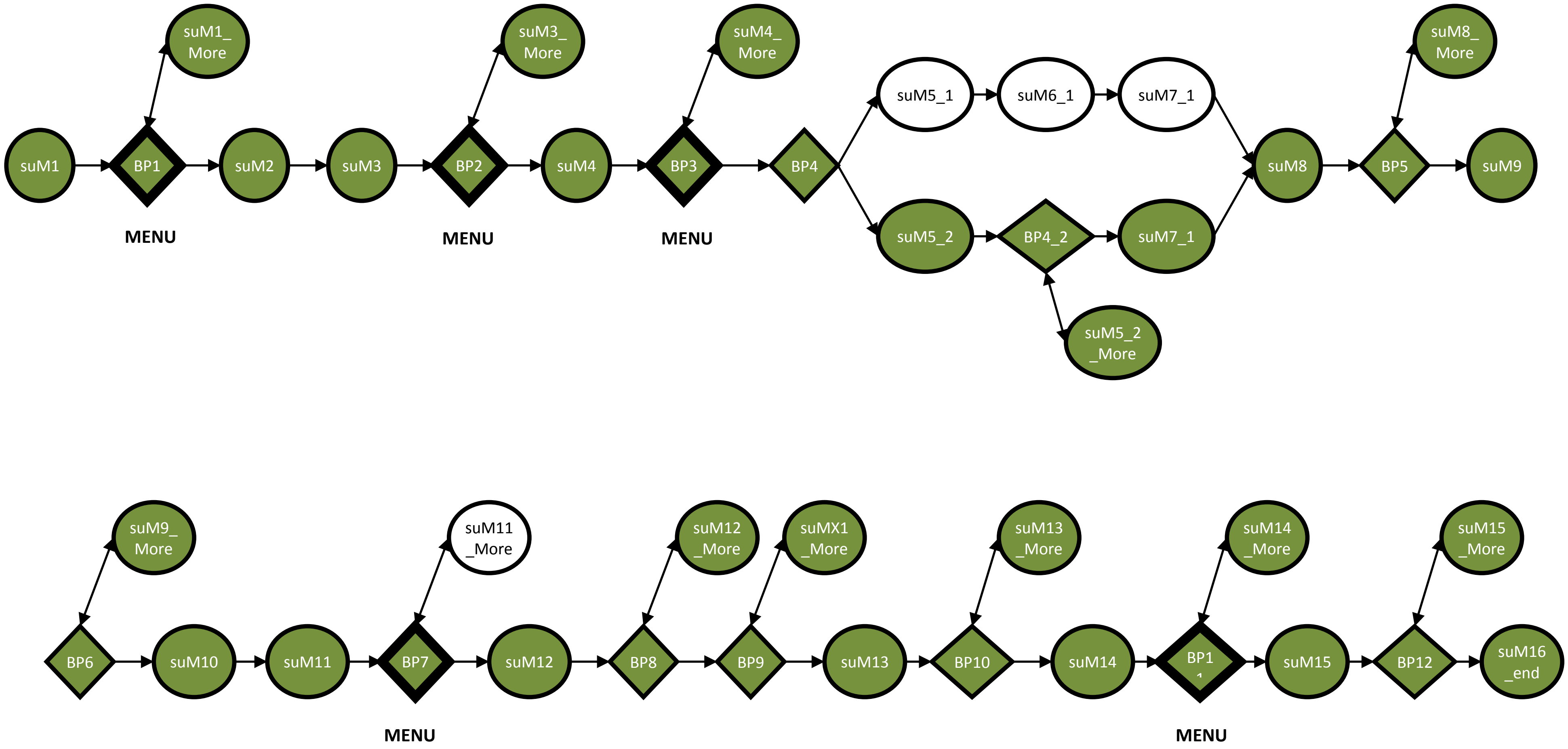


Figure 90: User 04

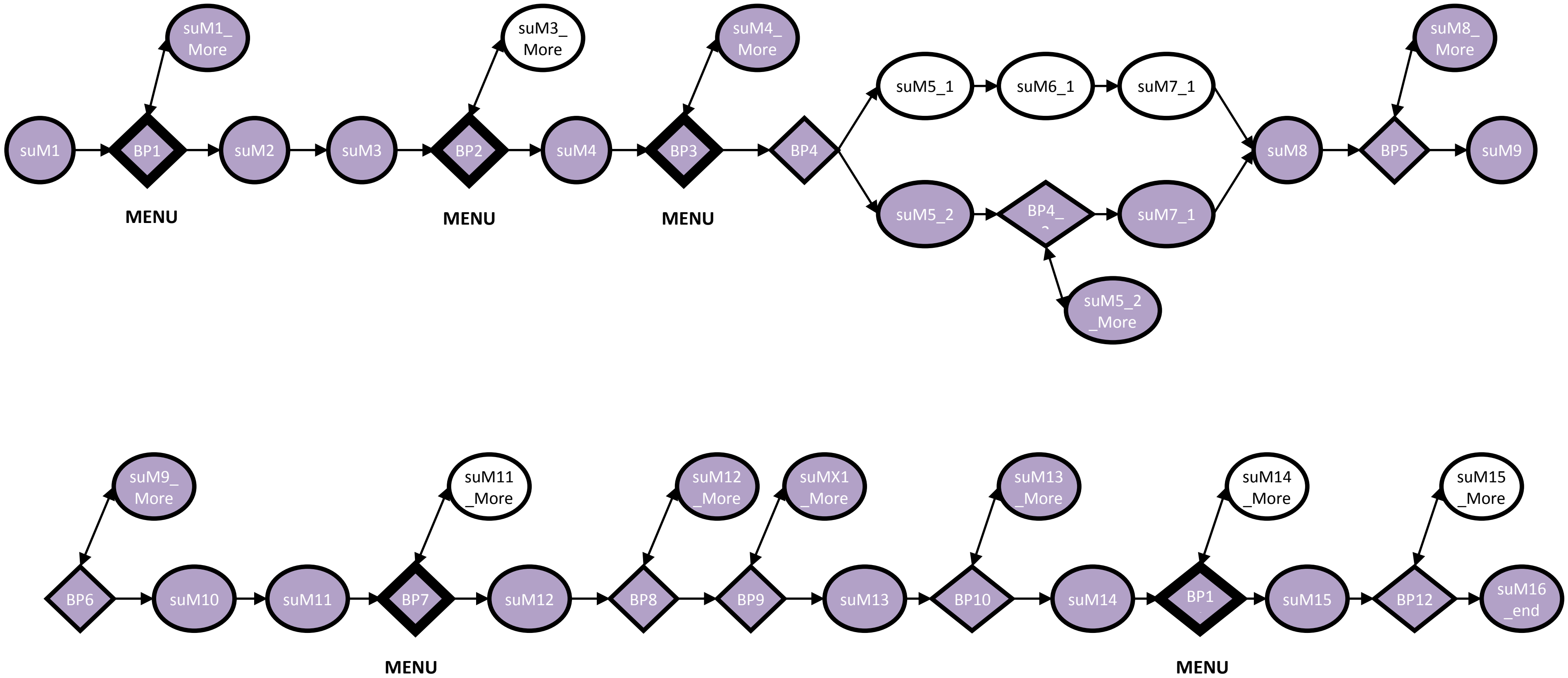


Figure 91: Users 16 and 17

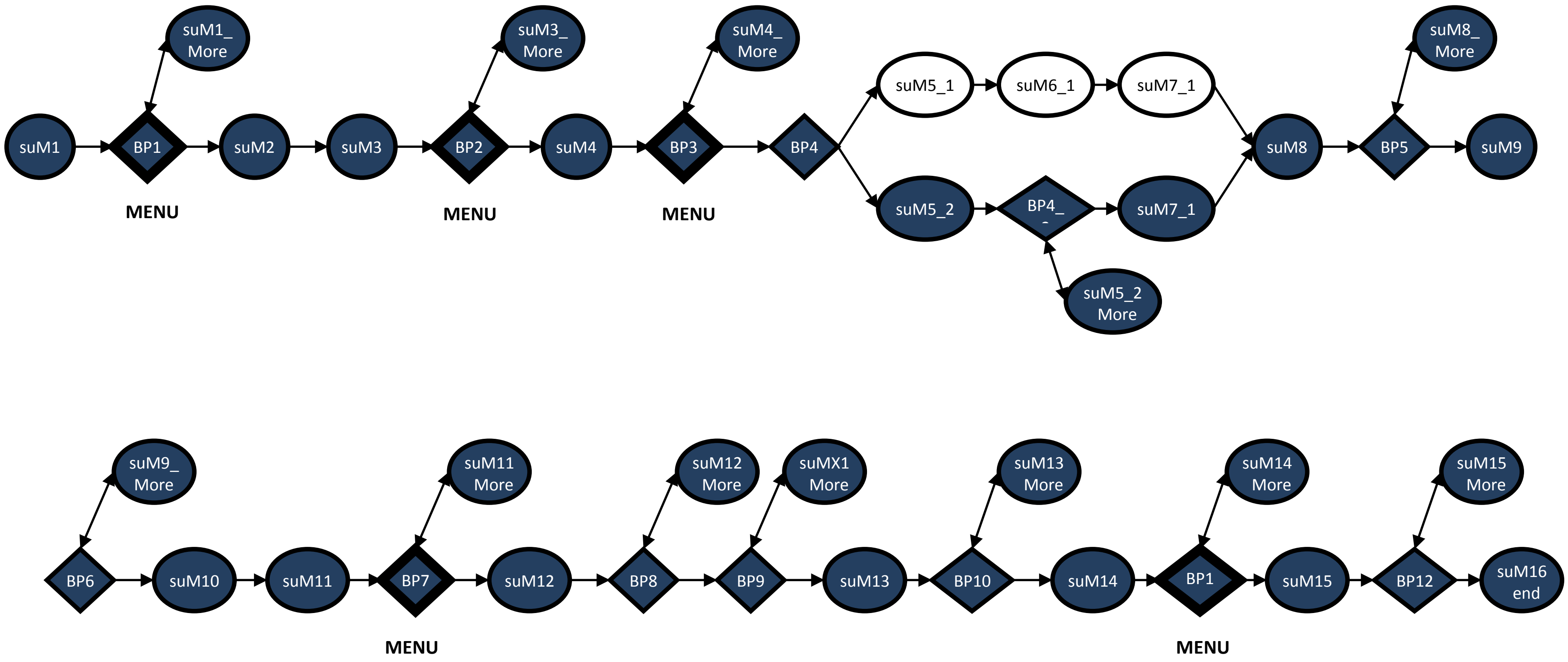


Figure 92: User 18

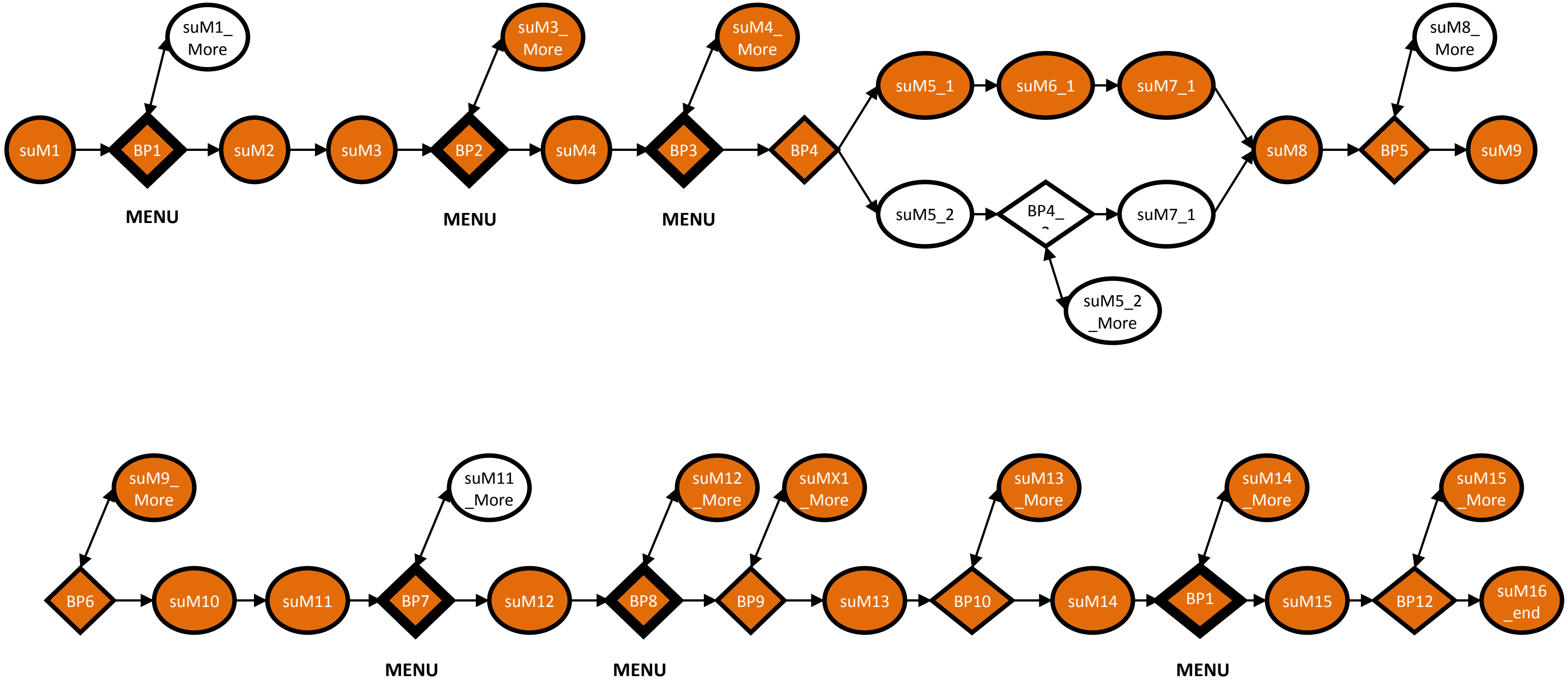


Figure 93: Users 20 and 21

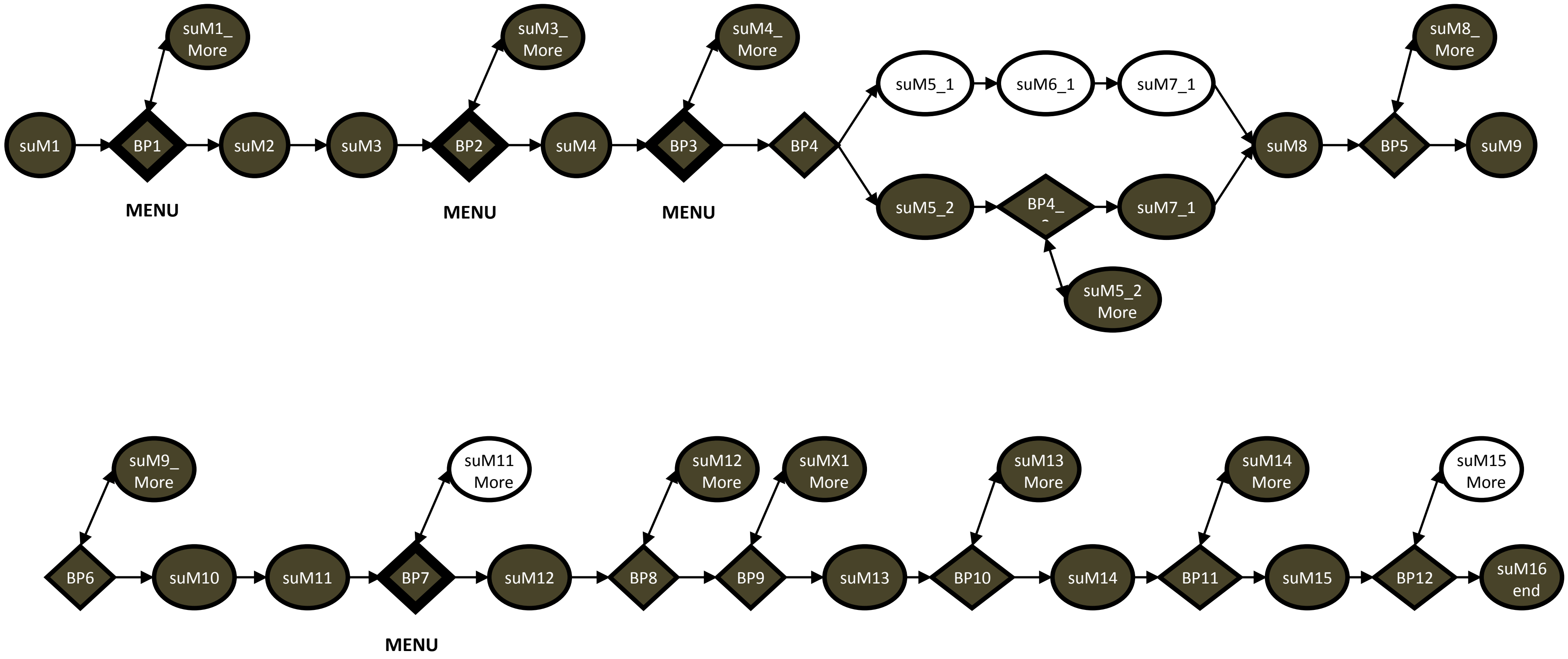


Figure 94: Users 22 and 23

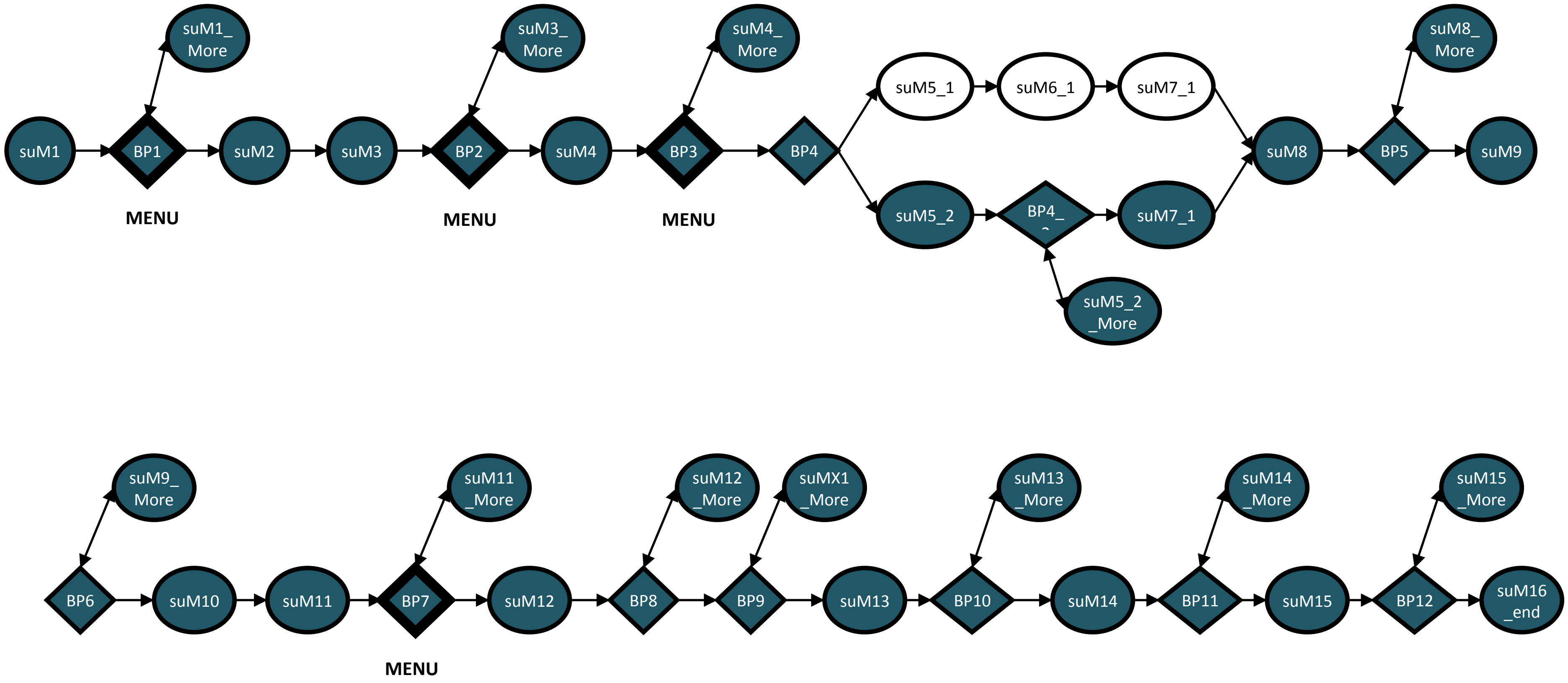


Figure 95: Users 24 and 25

RQ: "From the users' perspective, was the Melesso story effectively adapted for each user / users based on their preferences and actions?"

Moving to the users' perspective, we asked all the users, both the ones experiencing the Melesso and Theseus stories, if they felt that the story was adapted to meet their preferences and needs. We made this question at the beginning of the post-visit interview, priori to revealing the story's structure and the decision points it included. We also asked them to shortly explain their responses, so as to account for the strong dependencies between the story content and the users' satisfaction. For instance, if a user is interested in a topic that is covered by none of the available script units, then even if the system made all the optimal decisions, the user may perceive this as the system's failure to adapt to his/her interests.

Focusing on the Melesso users, their responses were divided; almost half of them replied positively and the rest negatively. In most of the cases however, the reasons driving the answer concerned the story content itself, rather than the adaptation functionality. User 3 explained that she generally didn't like the script style, she would definitely prefer a more casual, light tone overall. User 5 commented that the story was at some points very verbose, getting around the information rather than enabling him to deep into the details. A similar statement was made by user 21, while user 18 explained that she had different expectations regarding the size of the story: "The length may be appropriate for a person visiting the museum for the first time, but I have been several times here and I want to learn many new things; even though I selected all the optional parts, I would like to have more information to be included in the story". User 25 commented that it seemed to adapt to her tastes and this is why she expecting from the system to guide her to a particular exhibit she knew she would like, but it finally didn't. User 23 explained that she was generally expecting to hear more anecdotal information about their everyday life and the importance and effects of religion on ancient Greek lives, which was partially provided in the story. Based on the script units that are currently available for the story of Melesso, all the aforementioned issues provide nice suggestions for extending and/or refining the story's content and structure, rather for assessing the effectiveness of the adopted adaptation approach.

Finally, it should be noted that most of the users who participated in the detailed interview were very surprised to find out about all the automatic decisions that were taken during their experience; "I didn't imagine there were so many options in this story!" remarked user 17. So it seems that, thanks to the automatic decision points, the adaptation procedure went mostly unnoticed, avoiding the defragmentation of the story's flow while at the same time tailoring the story parts to the visitors profiles.

3.3 Hurry Up Functionality

The formative evaluation that took place at the Acropolis Museum in year 2, showed that users seem to greatly appreciate the provision of "Hurry up" functionality, enabling them to request from the CHESS system to present them the shortest possible version of the remaining story. This functionality has been implemented by the STE and MES's GUI has been extended so as to enable users to perform "Hurry up" requests.

As previously reported, during the evaluation we were surprised to find out that both of the pilot users performed a "Hurry up" request at the beginning of their experience, due to their misconception of its functionality. Such accidental requests have a crucial effect in the users' experience while also biasing the profiling procedure from that place and on, thus impeding the useful exploitation of these users' experiences for the evaluation purposes. To address this we extended the "Hurry up" description in the pre-visit tutorial, emphasizing its difference to the skip requests. The result was that no more "Hurry up" requests were observed, but the post-visit semi-structured interview revealed that many users hadn't yet understood exactly its functionality is exactly. One user humorously stated: “I don’t really know what it does, but I got the feeling that this is something I must NOT do”.

Most of the users who seemed to have a clear understanding about the Hurry up option stated that they very much appreciated its existence, even if they don’t use it. User 25 explained that she would find this very useful in case she had limited time while user 21 pointed out a interesting usage that we hadn’t anticipated for: “I would use it as a way to wrap up the current story and switch to another story”.

These findings clearly show that the Hurry up functionality is a bit complicated and it requires special care to successfully communicate it to the users. However, it seems that it is very well accepted so it is worth to spend the effort doing so.

3.4 Effects of Joint Experiences

Moving on to a different aspect, we investigated the effects of the joint experiences to users’ decisions and actions. As already reported, the Melesso story was experienced by five groups, illustrated in the following table. Each group consisted of two users who had a joint experience by sharing the same device.

GROUPS	USERS		TOPIC-BASED DISTANCE
Group A	User 03	User 05	1.5
Group B	User 16	User 17	2.5
Group C	User 20	User 21	2.5
Group D	User 22	User 23	2.5
Group E	User 24	User 25	0.5

Table 13: User groups and intra group topic-based distance

Groups A, B, C and E seemed to have been quite successful; the sharing of a single device caused no problems to each individual’s experience. From the detailed interview we have observed that a few different preferences are expressed for some of the available options in groups A and B. Following however a condescending behaviour, no significant issues were raised in their joint experiences of Melesso’s story. The joint visit turns out to have affected these users’ behaviour in the following ways: i) they hesitated to skip parts of the story that their companion seemed to be interested in, ii) they entered some optional story parts that they would probably have omitted, iii) they didn’t enter some optional parts that they would have probably entered if they were alone.

A very different situation is observed Group D however. The two users had quite dissimilar interests and expectations, which is also indicated in their topic-ratings prior to the experience. But the key difference seems to be located in their “behavioural code”, causing one to suppress the other in various occasions. User 23 performed several skips, while not a mutual decision or desire, and similarly, user 22 selected to enter some optional choices that user 23 would like to have discarded in the first place. When they were asked if they would prefer to make separate visits, based on their acknowledged disagreements, again, different answers were given! User 22 replied very positively but user 23, who soon dominated the visit, insisted that he prefers the joint visit.

As a future work, an interesting extension of our work is to account for a “group compatibility estimation” based the individual’s profiles, so as to recommend whether a joint or an individual visit seems to work better for a group of people. We plan to investigate metrics of “groups compatibility” as well as to explore their potential correlations to user ratings over topics. For instance, for the small set of five groups, the comparison of the users’ topic ratings (using a simple metric of absolute differences) shows that their distance seems to be aligned with the observed amount of different preferences in the available options.

4 Technical validation work

For the purposes of the third year review, the CHESS project has been asked to present a full assessment of the most crucial individual components. This assessment have been assembled by the technical partners, and integrated into this deliverable as part of work-package 9. The table below summarises the chosen components, and the technical partners who have done the assessment work.

Table 14 Technical validation work provided by partners

Component	Description	Partner
Hub	The Hub is the central server of the CHESS system. It aims to store all the assets of the story, the content of the story, and keep a track of the visitor position and actions during the experience.	DXT
Asset Adapter and Asset Editor	The Asset Editor lets the activity author uploading an asset or editing its metadata. The Asset Adapter is in charge of transforming the assets in several formats to fit CHESS target hardware (desktop, smartphone or tablet).	RF
Storytelling engine	The storytelling engine is composed of the CAT Adapter, the CHESS Mobile Terminal Adapter, the CVS adapter, the CPAD and Personalization Engine, and the Administration Adapter.	NKUA
CHESS authoring tool	The CHESS Authoring Tool targets non-technical museum authors or curators who want to create stories adapted to the visitor (interests, age, and more widely the visitor profile) and dynamically adapted to the visitors mood and interactions.	DXT
Mobile experiencing system	The mobile experiencing system is hosted by a visitor's mobile device, and presents the CHESS experience to the user. It encompasses the augmented reality features of CHESS.	IGD, NKUA, DXT, RF

4.1 The Hub (DXT)

4.1.1 The CHESS Hub

4.1.1.1 Introduction

This section provides a technical validation of the CHESS Hub which is the central sharing point of the CHESS system. This validation is done by enumerating the results of many technical assessments. The objective of this technical validation is to devise if the components of the CHESS framework are mature enough for industrialization. If the components are not stable enough, in order to strengthen the CHESS framework, these results could pinpoint what are the limitations of the current implementation and what could be improved.

The results present some standard non-functional requirements (e.g. robustness, efficiency, latency, number of failures or application errors, etc.). When possible, the technical validation includes a number of tests & benchmarks done against a set of samples. These tests have been conducted by the developers of the Hub (here DXT). The main strengths and limitations are synthesized in SWOT matrices. Then, a detailed presentation of quantitative measures is provided. These results imply some limitations and consequences on the deployment of the CHESS Hub.

4.1.1.2 An overview of the CHESS Hub

The CHESS Hub is the central server of the CHESS system. It aims to store all the assets of the story, the content of the story, and keep a track of the visitor position and actions during the experience. All the requests with the CAT, the MES, the WES and the STE are done thanks to its RESTful interface. The main goal is to have a database interface easily usable by any client with a simple request set working on every platform especially mobile device which could have performance issues due to network access and battery lifetime.

Here are the services offered by the Hub:

- Store and retrieve assets and their different variations (for each platform)
- Store and retrieve the visitor history (position, activities, souvenirs, ...)
- Update the visitor state during the experience
- Store the different story releases for publication or debugging
- Retrieve visitor statistics from the past experiences for the use of the authors
- Forward requests from the MES to the STE.

The Hub architecture is based on highly used systems and well-known web services such as Facebook, Google ... The main interface is Tornado, which is a light web server based on python language allowing to implements customizable behaviour. Tornado is interfaced with MongoDB which is a NoSQL Database services based on BSON documents[9].

[9] BSON stands for Binary JSON, a JSON derivate to improve storage and encoding/decoding performances.

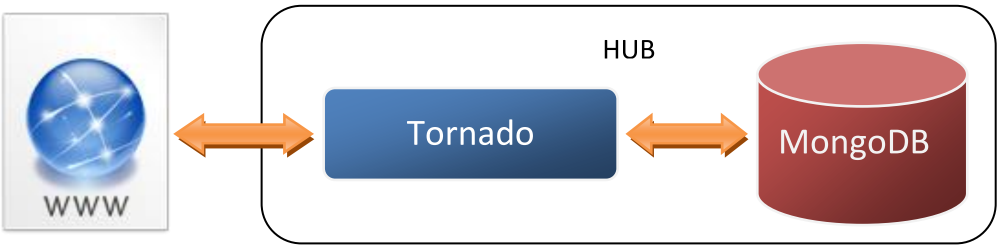


Figure 96 The Architecture of the CHESS Hub

4.1.1.3 Logical structure

The HUB has a partitioning system called space. All spaces are independents and could be managed separately.

Elements stored on the Hub are called entities. These elements are generic as they are based on the JSON format. In CHESS, we used mainly 2 kind of entities: Assets and Visitor.

Assets entities store any images/sounds/... and their variations for the different mobile devices.

Visitors entities store any information related to visitor, his position, current activity, past activities, battery state, ...

All these entities are versioned, so the CHESS platform is able to log information on a visitor and for instance returns him a trace on a map with activities locations, souvenirs.

4.1.2 SWOT analysis

This section provides a summary of Strengths, Weaknesses, Opportunities, and Threats for the CHESS Hub.

	Strengths	**Weaknesses**
INTERNAL FACTORS	• Open sources under Apache V2. • Robustness. • RESTful interface to add/change/remove assets or entities. • RESTful interface for database requests service. • Supports media streaming for iOS • Multi-platform Linux/Windows (limit scalability costs). • Proxy service.	• Database memory footprint may be important. • No automatic load balancing implemented.
	Opportunities	**Threats**
EXTERNAL FACTORS	• Scalability improvement due to the use of a MongoDB (NoSQL) database. • Benefits of the Tornado server improvements. • The Hub source code can be improved by all the community (right now limited to the consortium) thanks to its license.	• A similar open source product with a wider community and extra features may appear in the future.

4.1.3 Quantitative results

This section tries to illustrate the SWOT analysis thanks to quantitative results.

Number of supported platforms

The Hub can run either on Linux or Windows as all its components can run on both platforms:

- Tornado server (http://www.tornadoweb.org/en/stable/)
- MongoDB database (http://www.mongodb.org/)

Number of failures

The current Hub uptime is 128 days with no crash which was the date of the last update of the Hub.

Responsiveness

In order to evaluate the CHESS Hub performances, we created some spaces containing various entities.

We simulated a growing number of connections and entities to check the Hub robustness. These connections are separated in two request types:

- Entity listing : lists all the entities of the requested space
- Entity retrieving : retrieve the content of one given entity

We measured in both cases, the number of requests that the HUB can handle per second and the error rate.

All these measures have been done in two different modes with or without zip compression. Compression allows to preserve the bandwidth which is one of the most restrictive criteria with mobile device.

Number of entities	100 entities	1000 entities	5000 entities
Original size	15.4 Ko	154 Ko	770 Ko
Compressed size	574 o	11 Ko	51.7 Ko
Ratio	27 %	14 %	14.9 %

Figure 97: List entities request compression ratio

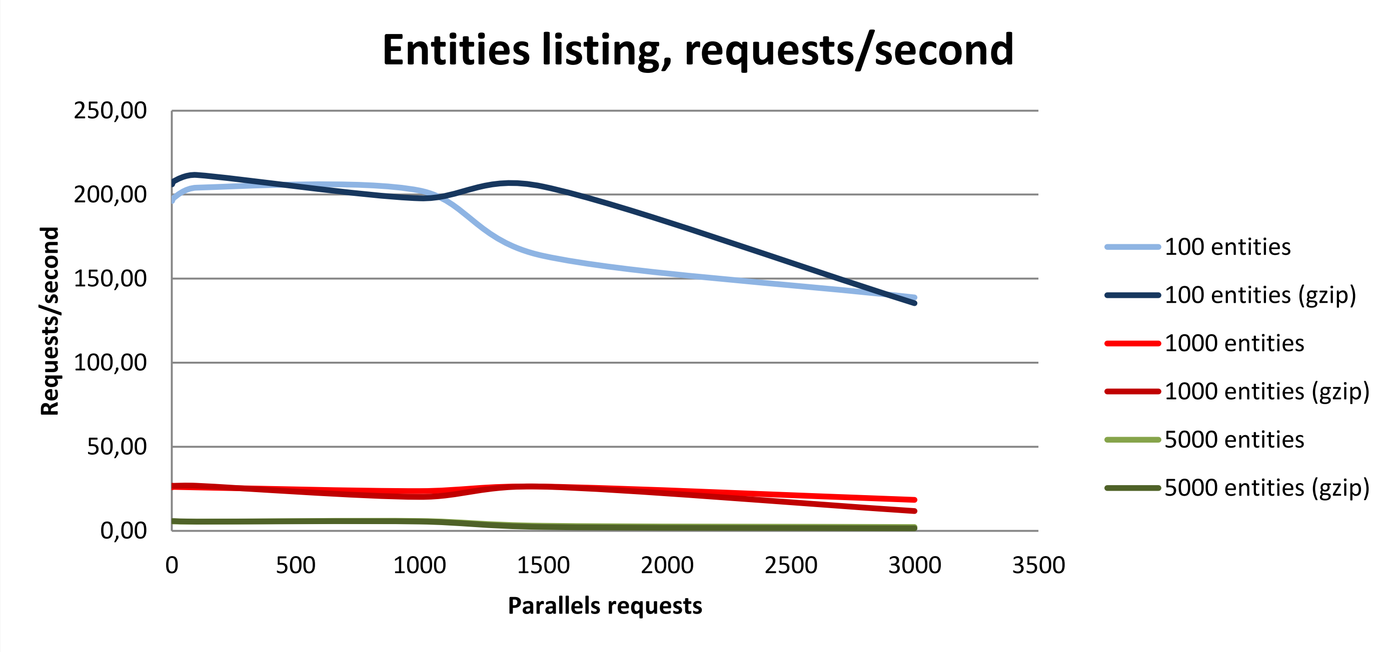
The benchmark conditions are the following:

- The application used to perform requests is Apache Benchmark[10], allowing us to send as many requests as we need on a given address for a limited time range.
- HUB and Apache Benchmark worked on the same Virtual Machine based on Ubuntu and was configured to manage thousands of connections.

Entities listing

First, we tested the entity listing requests.

[10] http://httpd.apache.org/docs/2.2/programs/ab.html

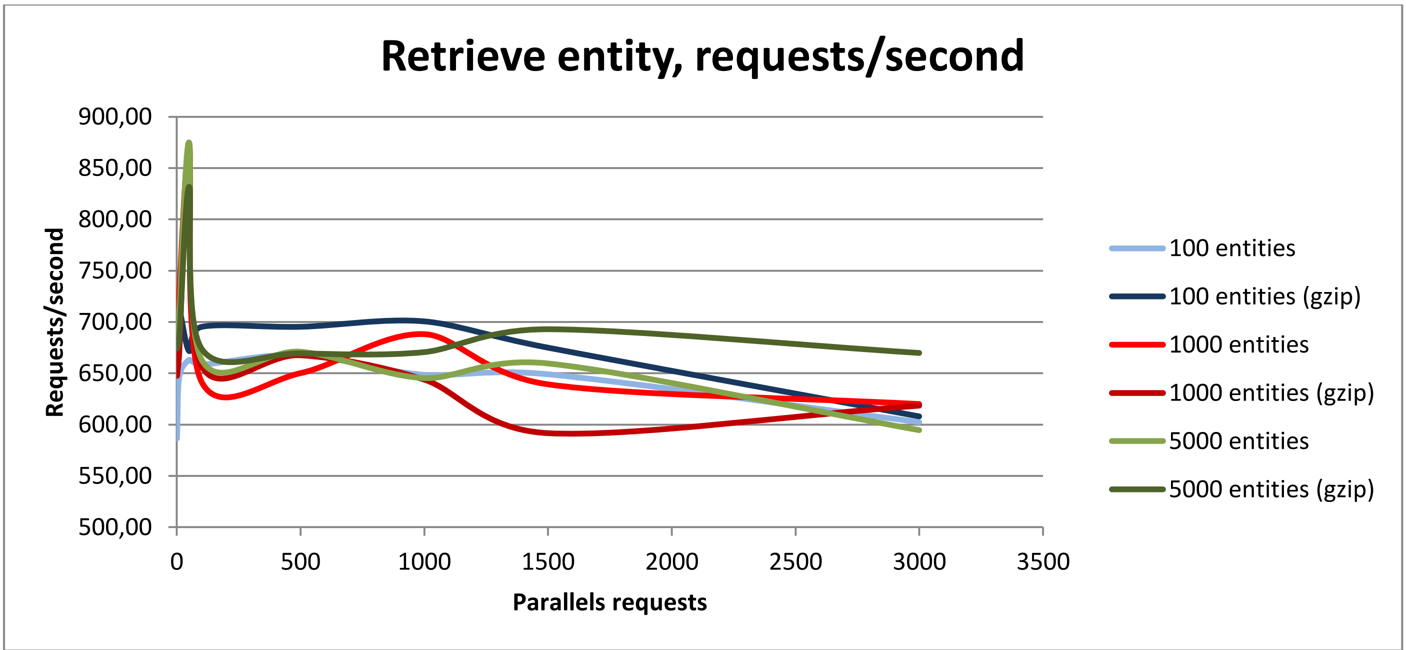


As we can see on the graph, the most limiting factor is the number of entities. This is due to the database request time and the small amount of data processing to transform the BSON documents (database format) to JSON documents (used in the HTTP requests).

The second point we can note on the graph is the impact of the number of connections: The more the hub receives connections, the more it becomes difficult to manage them.

Entity retrieving

The second test is based on entity retrieving. It shows that the HUB is more powerful on this task.



We can see that the only limiting factor is the number of connection which introduces latency. Another point we can notice is the huge difference between the two kinds of request. This is due to the time needed for entity processing and formatting, not to the database.

Component maturation according to sensible limits

In the CHESS context, the communication is mostly based in retrieving given entities during an activity (asset) and updating visitor status (position, activities results). The listing functionality is only used for debugging purpose and in the CAT to shows to the author the available list of assets. As we can see on the graphs, the compression has no relevant impact on performances unless to reduce the bandwidth. This last point is more interesting from the network infrastructure point of view.

We didn't focus our efforts on HUB performances because they were not relevant in our context. Indeed, in a museum we have at most 50 000 visitors per day[11]. All these visitors are not inside the museum at the same time which would even reduce the HUB use.

On the other hand, we have some ways to improve its performances. The first one is to use the nginx[12] system which distribute requests over other servers (physical and/or logical servers). Another one, a bit more complex is to switch on a new system as elasticsearch which is designed for cloud systems and allows to increase the number of connections and the database capabilities.

The Hub can be usable for a commercial exploitation regarding its robustness and performances. It has been used for all the events without any other issue than the missing disk space available.

Moreover, it has been released under an Apache V2 license allowing each partner to reuse it for their own usage either after the project.

[11] based on Wikipedia figures between Acropolis museum, Cité de l'Espace and Le Louvre attendance levels.

[12] http://nginx.org/

4.2 *The Asset Adapter (RF)*

4.2.1 Overview

This document provides a technical validation of the Asset Editor, the Asset Adapter and two Asset Editor add-ons, the ontology editor and the photo pairing tool components. This validation is done by enumerating the results of many technical assessments. The objective of this technical validation is to devise if the components of the CHESS framework are mature enough for industrialization. If the components are not stable enough, in order to strengthen the CHESS framework, these results could pinpoint what are the limitations of the current implementation and what could be improved.

The results present some standard non-functional requirements (e.g. robustness, efficiency, latency, number of failures or application errors, etc.). When possible, the technical validation includes a number of tests & benchmarks done against a set of samples. These tests have been conducted by the developers of the Asset Editor and Asset Adapter (here RealFusio). After a recall of the Asset Editor and Asset Adapter, the main strengths and limitations are synthesized in SWOT matrices. Then, a detailed presentation of quantitative measures is provided. These results imply some limitations and consequences on the deployment of the Asset Adapter. The Asset Editor add-ons are still in early preview version; that is why we enumerated key points deserving to be studied extensively.

4.2.1.1 Asset definition

In CHESS, an asset is a multimedia resource (image, sound, video, 3D mesh) used to illustrate the CHESS activities. An asset also covers the activity itself, the profile of activity user and the results of activities called "souvenirs". The assets are stored in the HUB, a NoSQL DB server (MongoDB).

The assets are managed by the Asset Editor for the front end part and the Asset Adapter for the back end. The Asset Editor lets the activity author uploading an asset or editing its metadata. The Asset Adapter is in charge of transforming the assets in several formats to fit CHESS target hardware (desktop, smartphone or tablet).

See also CHESS Beta Framework Design document / D04.1 - CHESS Beta Framework Design - V1.1/ 4. Presentation Service.

4.2.1.2 Asset editor

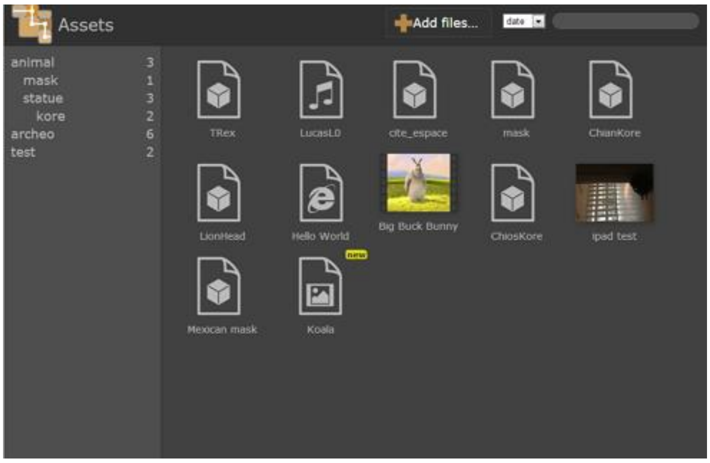


Figure 98 - Asset Editor user interface, showing a hierarchy of tags

The Asset Editor is a software component that allows authors to publish assets on the HUB. It consists in a web application that can be deployed on a web server. The Asset Editor lets the activity authors to create, read, update or delete an asset.

The Asset Editor supports these input formats:

- Image (PNG, JPG, GIF, BMP, TIFF);
- Video (MP4, OGV);
- Audio (MP3, OGG, WAV);
- 3D models (OBJ, VRML);
- Text (HTML, TXT)

See also CHESS Beta Release Manual / D08.1 - CHESS Beta Release Manual/ 8. Asset editor

4.2.1.3 Asset adapter

Once the asset is posted, the Asset Adapter reacts to the new asset to create a variation (file formats and quality levels) of each asset dedicated to CHESS hardware platforms.

The Asset Adapter provides these features:

- Hub access and hub spaces to process;
- Performance of assets downloading;
- Performance of assets uploading;
- Performance of variations generation;
- Quality and formats of variations;
- Message logging.

Note: During the early stages of the CHESS project, the "Asset Adapter" was known as "Presentation Service".

See also CHESS Beta Release Manual/ D08.1 - CHESS Beta Release Manual/ 5. Presentation Service

4.2.1.4 Ontology editor

Figure 99 - Ontology editor

The Asset Editor has been granted with two add-ons. The first, called the ontology editor provides a visual exploration and edition of the asset tags through an ontology graph. Ontology represents knowledge as a set of concepts within a domain, using a shared vocabulary to denote the types, properties and interrelationships of those concepts[13]. In our case, the ontology is applied to assets through the tags. Each node of the graph is a tag and the edges are links are between tags. The asset bound to tags can also be displayed in the side columns.

See also D01.13-PeriodicActivityReport.Year3

4.2.1.5 Photography pairing

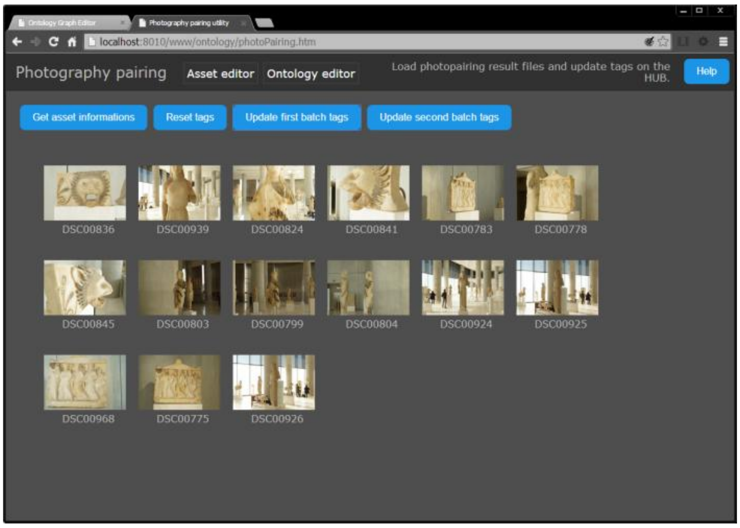


Figure 100 - Photography pairing

The second Asset Editor add-on is the photography pairing tool. This tool regroups the assets upon on image matching features. The matching is tolerant to variation of scale, orientation, luminance and chrominance of picture. No semantic match is done.

The photos are supposed to be already uploaded on the HUB. Identically, the photo pairing results have been pre-processed and uploaded on the HUB. The add-on web page reads the results and creates groups of photos upon the matches. Since these assets groups are built with tags, they are visible under the Asset Editor and the ontology graph.

See also D01.13-PeriodicActivityReport.Year3

4.2.2 SWOT analysis

This section provides a summary of Strengths, Weaknesses, Opportunities, and Threats for each technical modules enumerated above (Asset Editor, Asset Adapter, ontology editor and photography pairing).

SWOT analysis for the Asset Editor

Strengths	Weaknesses
• Web implementation : easy deployment and access • Recovery mechanism after network error • Can run on a mobile platform (responsive design) • Upload assets by batch • Asset DB consistency by incoming asset deletion : removes source file from the HDD if the asset has been removed by user	• No control of remaining HDD size
Opportunities	**Threats**
• Slight reduction of network throughput : replace HUB polling by websockets	• Network throughput limitation (assets can be huge) • DB integrity only relies on application clients (neither by the HUB SGBD, nor the HUB, nor the Asset Editor) • Limitation of input formats • HUB DB response time

SWOT analysis for the Asset Adaptor

Strengths	Weaknesses
• Web server implementation : easy deployment and access • Assets provided for many platforms (iOS;Android;Safari;Firefox;Chrome;IE and StoryEditor) • Scalable multicore architecture (pipelined processing) • Asset editor can run on mobile platform (responsive design)	• No control of remaining HDD size

• Batch run: can be deployed on a secondary server to limit the load of main HUB and MES servers) • Recovery mechanism after network error • Retry after a conversion error • Asset DB consistency by incoming asset deletion : if the source asset has been removed by user during transformation, the transformed assets will not be uploaded to the HUB • Uses a set of reliable Open Source converters (ImageMagick, MEncoder and FFMpeg) for resp. Image, sound and video assets • Uses the rfMeshConverter Real Fusio proprietary tool to convert 3D asset • External libraries and program error managing • Log mechanism	
Opportunities	Threats
• Could be instanced on several servers for load sharing amongst a cluster • Slight reduction of network throughput : replace HUB polling by websockets • Linux implementation (not yet planned for rfMeshConverter)	• Network throughput limitation (assets can be huge) • DB integrity only relies on application clients (neither by the HUB SGBD, nor the HUB, nor the Asset Adapter) • Cannot be sold as is (Mencoder and ffmpeg are under GPL licence, ImageMagick converter is covered by the Apache 2.0 licence and rfMeshConverter requires a commercial license) • Limitation of input formats • Requires Python 2.7 (not working on Python 3.0)

SWOT analysis for the Ontology Editor

Strengths	Weaknesses
• Compatible with Asset Editor tagging system • Web implementation : easy deployment and access	• Graph legibility scalability • Graph performance scalability
Opportunities	Threats
• Could be instanced on several servers for load sharing amongst a cluster • Only relies on HUB, no dependence on Asset Editor	• HUB ajax response time • Network throughput limitation

SWOT analysis for the Photography Pairing

Strengths	Weaknesses
• Tolerant to slight changes of point of view, luminosity and resolution • Almost no false positive results • Scalable (providing the hardware multi processing capabilities) • Web implementation : easy deployment and access	• Time / machine consuming for high definition picture • Detection rate decreases drastically for photography containing textures (like columns or grid) • Scale too high tolerance : A small sub region could be matched with region covering the whole image, it could result in only one group with all the photography • Non commutative groups: The order of photos processing matters, the groups will be different • Not real time processing • Not integrated to Asset Adapter (no calculation triggering and result upload on incoming photos) • No incremental processing (on a new photo, the process must be run on all photos plus one)
Opportunities	**Threats**
• Only relies on HUB, no dependence on Asset Editor • Could be instanced on several servers for load sharing amongst a cluster	• Requires an Nvidia GPU for optimal performances ; Relies on Nvidia proprietary CUDA library • HUB response time • Network throughput limitation • HUB limited storage capacity (the photo pairing requires high definition photos)

4.2.3 Quantitative results

4.2.3.1 Asset editor

The Asset Editor is a software component that allows authors to publish assets on the HUB. Supported platforms are as follows.

Hardware	Software
▪ Low-end desktop computer ▪ HTML5 compliant mobile	▪ HTML5 web client ▪ Desktop : Mozilla Firefox/ Google Chrome (Microsoft Internet Explorer not tested) ▪ Mobile platform (Apple iOS/ Google Android) (responsive design)

Conversion failure

The conversion failures can occur if:

- The asset is too big
- The HUB cannot be contacted
- The asset adapter fails (see the next chapter)

Responsiveness

The Asset Editor relies on HUB as database to process the assets. The whole trip time of data between the Asset Editor and the HUB via the Internet is the main source of performance hiccups we experimented during our tests.

- Slow start time

For a relative high number of assets, we noticed a slow start time (more than 1 minute). This is due to a suboptimal start-up sequence. The Asset Editor starting sequence fetches a considerable amount of data to finally get the last item. The Asset Editor and HUB should be modified to optimize such request.

- Irresponsive actions

We experimented slow response time during asset upload or modification. This can be due to Internet failure or HUB being heavily requested. The Asset Editor is built to be robust against Internet failure but some notification should be implemented to notify the user of such failure. Concerning the HUB, The Asset Editor and the later should be modified to optimize the database requests.

Component maturation according to acceptable limits

The Asset Editor appeared to be functional during the experimentations we have rolled during the authoring of activities. The major problems have been corrected thorough the multiple versions released. However, facing to a high amount of assets, we have detected responsiveness problems. The scalability of the Asset Editor becomes questionable. Improving the responsiveness of the Asset Editor is a technical difficulty to resolve before any industrialization.

4.2.3.2 Asset adapter

The Asset Adapter is in charge of converting the assets for the CHESS targeted hardware. Supported platforms are as follows.

Hardware	Software
▪ Multicore processor ▪ More than 4GB RAM	▪ Microsoft Windows only from Microsoft Windows XP to Windows 7 64bits ▪ Python 2.x

Number of failures

The conversion failures can occur if:

- Input formats are not supported
- The asset is too big
- The converter can fail on some formats
    - Audio (MP3 VBR) with ffmpeg
    - Video (OGV) ffmpeg

- see below for details

- The HUB cannot be contacted

Asset adapter conversion durations

We provide some quantitative results for the Asset Adapter. These timing are mainly tied to underlying Asset Adapter third-party tools. Since the process is pipelined, we provide a duration corresponding to the total duration T required to convert a given batch. Therefore, thanks to the multithreaded conversion, the overall total time T is better that the sum of single conversion timing (t_i) $(T \leq \sum_{i=0}^{n} t_i)$.

The conversion T duration mainly depends on asset type and size. For instance, the longest type to convert is the video (almost a factor of 1.66 regarding the video duration). During this conversion, the usage of CPU is intense and requires at least 1.2GB of RAM for 3D mesh conversion.

The t_i timing is given for information. For one single file, the conversion time t_a is better than the conversion time t_b of an individual file of a batch. This overhead is explained by the resource starvation due to multiple threads writing on a single HDD.

In conformity with the CHESS recommendations, these modules have been benchmarked without taking into account the network throughput or other interacting CHESS modules. Therefore, we choose to ignore the asset uploading /downloading durations. Since the assets are hosted by a remote HUB server, these timing are not directly bound to the asset manager but to the network throughput. However, since the Asset Adapter process is pipelined, the uploading/downloading stages have slightly influenced the timing since these stages stall the OS, due to HDD important inputs (reading asset for upload) and outputs (writing for download).

The results are given for an Intel Core i7 CPU 920 @ 2.67 GHz with 6.00 GB of RAM under Microsoft Windows Vista SP2 x64 with a WDC WD1002FAEX HDD.

Image conversion results

Input	Definition (pixels)	Input size (MB)	Conversion time (s)
Lenna.jpg	512x512	0.4	2
Kodak photo sample tiff (24 files)	768x512	27.0	3

Notes:

- Ran on 8 threads
- Image depth : 24 bits per pixel
- Average time, for the Kodak photo sample, it took less than 0,1s per file

Sound conversion results

Input	Total duration (mn)	Input size (MB)	Conversion time (s)
OckeFilms Soundtrack 2012 by CloZee MP3 VBR 192k (17 tracks)	45mn 47s	66.0	238

Notes:

- Minimum time, mp3 to mp3, 5s
- Maximum time, mp3 to ogg, 21s
- Average time: 14s per file

Some warnings occurred during conversion of VBR mp3 - this format is not fully supported by our version of ffmpeg

Video conversion results

Input	Definition	Total duration (mn)	Input size (MB)	Conversion time (s)
Big Buck Bunny mp4	640x360	1mn	5.2	93
Big Buck Bunny ogv	640x360	1mn	4.4	101
Big Buck Bunny mp4	320x180	9mn 56s	61.6	931

Notes:

- Ran 8 threads (due to CPU intensive operation, limited to max 3 threads for encoding)
- Timing in seconds resp. for h264-low;ogg-medium and h264-medium

  Big Buck Bunny 1 mn - mp4: 34;59;93; 1mn - ogv: 32;64;101; 9mn - mp4: 284;614;931
- Some warnings occurred during conversion of OGV - this format is not fully supported by our version of ffmpeg
- Bug : Ogg-medium has no sound

Video conversion results

Input	Input nb triangles (million)	Input size (MB)	Conversion time (s)
Chian Kore	0.75	29.1	31
Persian Horse Rider	0.75	29.8	30
Lion head	0.75	57.5	32
Peplos Kore	0.75	29.5	30
Reliefs of Graces	0.75	29.1	31

Notes:

- Ran 8 threads
- Bug : cannot upload zae-high
- At most 1.2 GB peak used RAM (Private working set)

See also CHESS Year 2 presentation, CHESS Year 2 review, WP4 – Presentation Service, 3D model simplification tool, March, the 22th, 2013 Athens, Acropolis Museum

Component maturation according to acceptable limits

During our benchmarks, we have found no major problems for the Asset Adapter. However, we should run extensive test on more several data to make sure no there are no remaining defects on the processing pipeline of the Asset Adapter.

4.2.3.3 Ontology editor

The ontology editor provides a visual edition and exploration of tags bound to the assets presented in the Asset Editor.

The ontology editor is an alternative to the tag arborescence of the Asset Editor (Figure 98). The tags are displayed as a graph. The nodes are the tags themselves and the edges are links between the tags. Two types of edge have been devised.

- The simple edge is a couple of tags owned by a same asset. For instance, if an asset is tagged with the tags [flower, tulip], the ontology graph will be granted with two nodes: flower, tulip and an edge between these nodes.
- The hierarchical edge represents a hierarchy tag as defined in the Asset Editor. For instance, the asset with the tag [status/animal/lion] will create two hierarchical edges.

The ontology graph can also be edited. The tags bound to assets can be added, removed and deleted. Inversely, the asset can be granted with new tags. Identically, the simple and hierarchical link can be created and removed.

Number of supported platforms

- Web client;
  - Desktop : Google Chrome (Mozilla Firefox/Microsoft Internet Explorer not tested)
  - Mobile platform : not tested

Number of failures

The graph rendering and editor failures could occur if:

- The number of assets is too high
- The HUB cannot be contacted

Component maturation according to acceptable limits

Due to development constraints, the ontology editor is an early version dedicated to experimentations. To reach a state of maturation enough for industrialization, extensive studies should be done on the user interface, the graph legibility and the performance. The purpose of the following sections is to enumerate the key points worth to study.

- User interface

Most of the graph edition actions are done, at its best, intuitively by a combination of the mouse and keyboard (drag a link to create an edge, click to select and press [delete] key to remove a node or a link). These actions should be refined after user remarks.
Moreover, batch actions are not addressed. For instance, in a single keyboard/mouse action, it is not possible either to assign multiple tags to one asset or to clear all tags of an asset. For such action, a direct interaction with a graph interface could not be the most suitable. A toolbar could help to trigger such batch actions.

- Legibility

We do not study the scalability of the graph in term of legibility. We added a zoom/pan feature but it could be insufficient if too many nodes are displayed. A hierarchical level of detail system could remove the view clutter. Likely, the remarks of the users could trigger changes on the graph representation if required.

- Performance

The performance on the ontology editor mainly depends on the Internet browser performance, the HUB and the network throughput.

The ontology editor main component is an interactive scalable vector graphic (SVG) graph entirely generated on the client side above the Data-Driven Documents (D3) library[14]. We do not study the performance scalability. The level of detail solution evoked in the previous legibility paragraph would kill two birds with one stone.

The CHESS program recommends benchmarking the CHESS modules without taking into account the network throughput or other interacting modules. However, the ontology editor can only run with the HUB on a network. That is why we must discuss about these items. Like the Asset Editor, the ontology editor fetches dynamically the assets and the tags from the HUB. These fetches are done through Ajax requests. We tried to reduce the number of these requests but the result was not significant. The time spent to process n requests is roughly equivalent to the time spent to wait the aggregate result. Moreover, the Hub being hosted remotely, the Internet network throughput must be taken into account. Therefore, the duration of Ajax requests become negligible when the Internet throughput is low.

More experimentation should be rolled to reduce this duration, for both JavaScript client side and HUB configuration.

Lessons learned

The Asset Editor and therefore its add-on, the ontology editor relies heavily on the HUB. Before industrialization, more investigations should be done to limit the risk of failure and latency due to the combination of the ontology editor, the HUB and the Internet data transport.

4.2.3.4 Photography pairing

The photography pairing tool is an add-on to the Asset Editor to build groups of photography on image matching feature.
This tool is split between a backend and a frontend part. The backend part consists in a pairing tool getting a list of photos and output a file describing the photo groups appearing after the pairing process. The frontend part is an Asset Editor web page which reads the former output file and creating the photo tags accordingly their groups.

Number of platforms supported by the back end

Hardware	Software
▪ Heavy computation and database server computer ▪ Multicore CPU ▪ For best performances, CUDA ready	▪ Microsoft Windows 64bits ▪ Python

[14] Data-Driven Documents (D3) D3.js is a JavaScript library for manipulating documents based on data, http://d3js.org/

Nvidia GPU	

Number of platforms supported by the front end

Hardware	Software
▪ Low-end desktop computer	▪ HTML5 web client ▪ Desktop : Google Chrome (Mozilla Firefox/Microsoft Internet Explorer not tested) ▪ Mobile platform : not tested

Number of failures

The photography pairing could fail if:

- The number of assets is too high
- The definition of pictures is too high
- The pairing algorithm fails
  - Photography containing textures
  - Photography of the same items with high scale factors
  - Order of photos processing changes (non commutative groups)
- The HUB cannot be contacted

Photography pairing backend

The backend is a command line interface pairing tool. The pairing tool implements an algorithm in two parts. The first part consists in the extraction of key points from the image, which can easily be run on CPU. The second part is the photo pairing itself. With a complexity of $O(n^2)$, this part could be really time consuming depending on the image count.

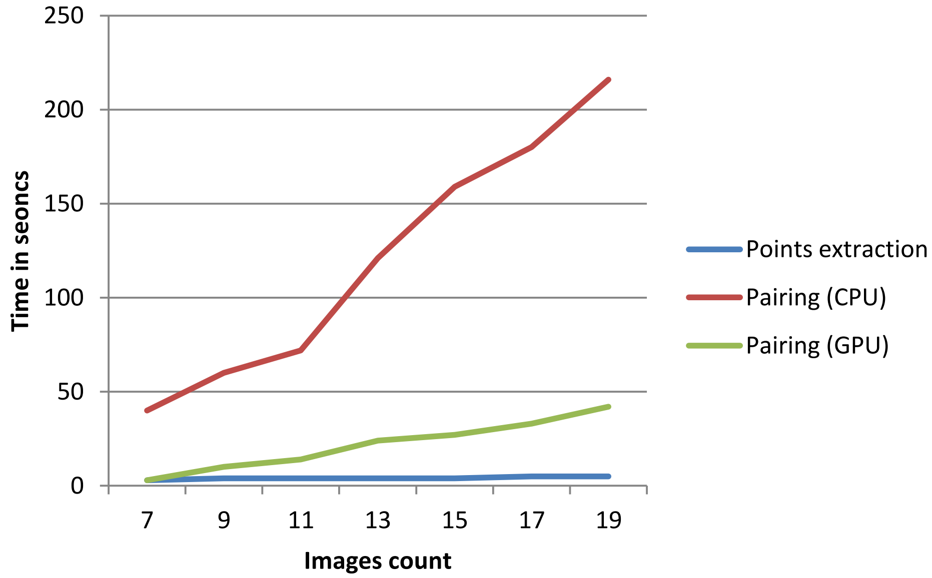
See also CHESS D02.21 report_CHESS-V1.1, the photography pairing technical report for details.

The pairing tool relies on the Open Source Computer Vision (OpenCV) library[15]. The pairing tool processing is accelerated through methods OpenCV written to benefit from heterogeneous multi processor hardware (multi core CPU and nVidia CUDA). The tool can work without a CUDA graphic card (GPU) but exhibits degraded performances. That is why these tests are also performed with a machine configured the best hardware combination which allows us to run the algorithm multicore CPU and accelerated with the GPU (CPU: Intel Core i7 930 2.8GHz, RAM: 12 Go DDR3 PC-10700, GPU: Nvidia GeForce GTX 480, Microsoft Windows 7 64bits). On such configuration, 208 photos require to spend more than 2 hours.

Unsurprisingly, the OpenCV CUDA implementation provides a tremendous acceleration of the pairing part of the algorithm, compared to a GPU less platform. However, the cost of this algorithm is still important: the duration per image pairing let us expect a linear cost in term of image count.

[15] OpenCV (Open Source Computer Vision Library), an open source computer vision and machine learning software library. http://opencv.org

Images count		7	9	11	13	15	17	19
Total duration (seconds)	Points extraction	3	4	4	4	4	5	5
	Pairing (CPU)	40	60	72	121	159	180	216
	Pairing (CPU+GPU)	3	10	14	24	27	33	42
Duration per image couple (ms)	Pairing (CPU)	0.816	0.740	0.595	0.715	0.706	0.622	0.598
	Pairing (CPU+GPU)	0.61	0.123	0.115	0.142	0.12	0.114	0.116



Photography pairing frontend

The frontend is an add-on of the Asset Editor. This web page resets pairing and translates the results of the backend pairing tools into asset tags compatible with the Asset Editor and the ontology editor. This web page is only for demonstration purpose. First, the photos are supposed to be already uploaded on the HUB via the Asset Editor. Second, the pairing results are assumed to be previously calculated by the back end. The front end reads these results and creates photo groups by assign a common tag to photo of a given group.
For the reasons mentioned above, the performance of the front end is only tied to external components, the underlying database supported by the HUB and the network throughput. Like the ontology editor, the photo tags and preview are dynamically fetched from the HUB via Ajax requests. We have tried to reduce the number of Ajax requests without any proving results (see ontology editor performance section). Like the ontology editor, more experimentation should be rolled to reduce this HUB communication time.

Component maturation according to acceptable limits

The photo pairing tool has been developed for R&D purposes. To be released in an industrial context, this tool should be improved mostly on the backend side.
The underlying algorithm should be refined to improve the photo pairing, to be less tolerant to image scaling and to be robust to image textures. Moreover, the built group should be consistent and commutative. For now, the group configuration changes upon the order of the incoming photos. Eventually, an incremental processing should be implemented to reduce the processing time. In the current version, on an incoming photo, all the photo pairing must be processed from the start.

To be fully integrated to the Asset Editor, the photo pairing tool should be called automatically by the Asset Adapter to trigger photo pairing updates on photo upload.

4.2.4 Conclusion

Regarding the tests we ran; the Asset Editor and Asset Adapter components seem to be stable. No major abrupt termination has been observed during the tests. More intensive tests should be done to confirm this.

For the Asset Adapter, the most consuming time was spent for video conversion and the most RAM consuming conversion was for the 3D mesh transformation. That implies constraints on Asset Adapter deployment. If the asset authoring and activity exploitation is done simultaneously, then the Asset Adapter should be deployed on a secondary server to prevent any interference with the main system (MES+STE+HUB). It also implies that the supporting OS should be 64bit. For now, concerning the Asset Adapter, the deployment is limited to a Microsoft Windows computer and some licensing clearance should be done before considering any commercialization.

The Asset Editor add-ons were published as early versions targeted to a R&D context. Their developments have been pushed as far the CHESS framework granted us to. Most of use cases have been addressed and no major failures have been detected. However, the following improvements should be brought before forecasting any industrialization of these add-ons. For the ontology editor, we should evaluate the usability of the graph editor and the scalability of the graph, in term of legibility and the display performance. The photo pairing tool backend is not yet integrated with the Asset Adapter and deserves algorithm improvements in term of matching result consistency and performance. The technological choices of the photo pairing tool backend limit the deployment platform of the tool: this backend requires a CUDA ready Nvidia GPU.

Eventually, since all these components rely on the HUB, we must discuss about it. First, the Asset Editor, we have spotted a lack of database integrity control from the HUB. For now, the responsibility of maintaining the integrity is mainly transferred to the client applications, here the Asset Editor and Adapter. It should be wiser to enforce the control on the underlying HUB SGBD. Second, we encountered some performance reductions due to the numerous HUB requests made by the Asset Editor and its add-ons. We have to investigate to determine if these problems are caused by the client-side implementation of the Asset Editor, the HUB configuration or the Internet inconsistent throughput.

4.3 The Storytelling Engine (NKUA)

4.3.1 Introduction

4.3.1.1 About this document

This document provides a technical validation of the components comprising the CHESS Server functionality, namely the CAT Adapter, the CHESS Mobile Terminal Adapter, the CVS adapter, the CPAD and Personalization Engine, and the Administration Adapter. The validation is performed by including the results of several technical assessments. This validation aims to assess whether the individual components are in a state of maturity that will allow their industrialization. Limitations of the existing implementations are reported so that they can be addressed.

The results include a number of standard non-functional requirements (e.g. number of failures, time to service requests etc.). Also included in this validation are test results for common usage scenarios for the components validated. The tests have been conducted by NKUA that implemented the aforementioned components. SWOT matrices are included for each of the components mentioned.

4.3.1.2 aCAT – CAT Adapter

The CHESS Authoring Tool Adapter is the component of the CHESS Server that facilitates the communication between the CHESS Server and the Mobile Terminal allowing the CAT to store models and basics (the files describing the story structure) to the server, make stories available to the visitors and changing the initial story among others. The CAT Adapter is accessed using a set of REST calls and the data exchanged between the Adapter and the CAT is formatted as CML (CHESS Modeling Language).

The CHESS Authoring Tool is a software application that is used to author, edit and publish stories. It has been developed by Diginext (DXT) and has been successfully used with the aCAT to author and publish stories to the CHESS Server in several occasions.

4.3.1.3 aCMT - Chess Mobile Terminal adapter

The CHESS Mobile Terminal Adapter is the software component of the CHESS Server that facilitates the traversal of the story model by the CHESS Mobile Terminal. This is accomplished by using a set of REST calls that that allow the Mobile Terminal to sign in the CHESS Server (login request), initiate a new storytelling session (start), request the next activity to be presented to the user (next request), notify the CHESS Server about a choice to a menu (selection request), transmit to the CHESS Server the fact that the user has completed an activity (completion request) or skipped it (skip request) as well terminate the current session (end request). The data sent by the CHESS Server using this protocol is formatted in text/XML.

4.3.1.4 aCVS - CVS adapter

In order to create a profile for the user that will later be used to personalize the stories for him/her the CHESS pre-visit experience includes a set of questions for the visitor called the CHESS Visitor Survey (CVS). This survey is tightly connected to the story experience, thus its content comes from the STE. The CVS adapter of the STE is responsible to communicate with the CVS front-end in order to provide the questions for the survey receive the answers from the user and provide the answers to other STE components, such as CPAD.

A CVS instance is described by an XML document, based on the CML (CHESS Model Language) specification. Additionally to the questions XML document, there are also the assets needed for the survey (e.g. images) and an XML document that provides needed meta-data for the profiling of the visitor by the personalization system.

The communication between the aCVS and the CVS front-end are based on simple REST API. Using this API the front-end may start a survey for a user and then post answers back, requesting the next question to show each time until the final question is reached. After the last question the aCVS stores the answers in the STE's database where they can be found later to be used by the CPAD (described in the current document).

Additionally to the communication with the front-end the aCVS provides the functionality for other internal components of the STE, like providing the answers to the CPAD, validating a questionnaire, and more.

See also D08.2 - Chess Final Release Document / chapters 18 and 19

4.3.1.5 CPAD / Personalization Engine

The Personalization Engine is responsible for (a) logging the user's actions that reveal his preferences towards the parts of the story, (b) recommending story parts during branching points that are predicted to be preferred by the user based on his previous actions. CPAD is a thin communication layer between the Personalization Engine and the STE. It is essentially a Java interface and relevant implementations that permit high-level communication between modules, allowing the STE to traverse the story graph in a personalized and adaptable way without needing to know the internals of the Personalization Engine.

4.3.1.6 aAdmin - Administration Adapter

The Administration Adapter is the software component of the CHESS Server that implements the administration functions needed by the CHESS Server. The functionality of the Administration Adapter is made available through a REST interface that uses text/XML as data type. The functions of the Administration Adapter include starting a new administrator session, which requires authentication using HTTP Authorization, listing the existing CHESS users, creating new user accounts, listing the CVS answers of a particular user or the answers of all users to a particular question.

4.3.2 SWOT analysis

This chapter provides a summary of Strengths, Weaknesses, Opportunities, and Threats for each technical modules enumerated above (CAT Adapter, the CHESS Mobile Terminal Adapter, the CVS adapter, the CPAD and Personalization Engine, and the Administration Adapter).

4.3.2.1 aCAT - CAT Adapter

Strengths	Weaknesses
• Industry standard cross-platform implementation: jBoss AS 7.0 • Communication using a simple REST protocol • Support for multiple simultaneous users • Support for both release and debug deployment • Support for user workspaces • Support for annotation suggestions	• No version control system • Accepts only text/xml

Opportunities	Threats
• Reduction of network load: support transmission of compressed models	• Deploying as a release an incorrect model can affect the experience of the end user • Lack of an authentication system that will allow only authorized authors to store data to the CHESS Server

4.3.2.2 aCMT - Chess Mobile Terminal adapter

Strengths	Weaknesses
• Industry standard cross-platform implementation: jBoss AS 7.0 • Communication using a simple REST protocol • Support for multiple simultaneous users • Support for both release and debug story models • Support for user workspaces •	• No support for jumping to arbitrary parts of the story
Opportunities	**Threats**
• Protocol refinement: The effectiveness of the communication protocol can be enhanced by using more specific status codes in the responses	• Dependent on HTTP session: in case the session information is lost by the mobile terminal, the state of the experience becomes unreachable • Uses HTTP Authorization: a more robust authorization method is likely to be needed.

4.3.2.3 aCVS - CVS adapter

Strengths	Weaknesses
• Simple, easy to follow REST protocol • Front-end agnostic: the front-end may utilize any technology and style • Easy to maintain survey and rules model: human readable and editable XML documents • Ability to direct the front-end look and feel: using CDATA the author may write HTML and CSS directly in a question • Support for multiple languages: ability to load strings from XML document with language code in filename	• Wrong survey model can break the CVS: XSD validation cannot cover all the cases • Missing authorization: username is given through a URL parameter
Opportunities	**Threats**
• Simple web GUI could used to create and maintain survey and rules models	• Dependent on HTTP session: in case the session information is lost by the front-end, the state of the survey becomes unreachable

4.3.2.4 CPAD / Personalization Engine

Strengths	Weaknesses
• Written entirely in Java and with minimal references to third-party libraries. Can be easily deployed on any platform. • System architecture makes extensive use of the Strategy Design Pattern. All algorithms can be easily extended and substituted with other implementations. • The core algorithmic techniques used for recommendations rely on well-known and tested formulas, adapted to the storytelling at a museum setting. This makes them inherently reliable. • All cases that might result in Exceptions are handled internally and gracefully. No exceptions are raised. STE and CPAD have established robust protocols for handling errors so that the visitor's experience is not interrupted. • All algorithms expose their internal parameters which can be trimmed to adapt their behaviour. • Correct use of multiple threads and intelligent pre-computations allows for very fast calculations during the visit. • Extensive logging of all internal processes using log4j. • A thin layer abstracts all internal mechanism so that STE can communicate easily with the Personalization Engine and get meaningful results without knowing how everything works. • The Personalization Engine is an autonomous system that handles its lifecycle transparently to the external systems that uses it. • Created with scalability in mind, so that multiple and concurrent visitors can be serviced with good performance. • Even in demanding situations with many multiple visitors the memory footprint of the Personalization Engine is minimal, and without sacrificing performance.	• Cannot handle two concurrent users with the same id. This will result in internal race conditions, which were not handled to avoid CPU-heavy locking mechanisms. In any case, concurrent users with the same id are not expected in any realistic setting, so this was a trade-off that does not impact correctness or performance. Of course, multiple concurrent users with different ids are handled without any problems. • The outside system that uses the Personalization Engine has very limited control over its lifecycle (start, stop, and getState). Of course, this makes using the Personalization Engine very easy and efficient, but one cannot easily optimize its internal processes. • The Personalization Engine keeps all its state in main memory to achieve fast performance during the visits. Nevertheless, persistence is not handled by the Engine, and it's the responsibility of the external system to frequently call getState and persist the state of the Personalization Engine in permanent storage.
Opportunities	**Threats**
• Can be easily extended with further algorithms to suit future needs, without the need to change the core functionality of the rest of the system. • Can be used as a stand-alone system,	• By design, the CHESS system needs to execute many concurrent modules to service the visitor and display assets on his terminal. This results in the Personalization Engine competing for system resources at the same time as other CHESS

without the STE. Its internal algorithms are meaningful in various personalization settings beyond storytelling. • Almost no dependence on external libraries, apart from log4j for logging and xstream for state serialization. This allows for great licensing flexibility.	modules, which may impact performance. Nevertheless, real-life tests have shown that the Personalization Engine needs minimal CPU resources to service the visitor, so it is unlikely that it will create a bottleneck. • The Personalization Engine keeps all its state in memory and relies on the external system (STE) to persist it in permanent storage. This makes it vulnerable to power outages and other external failures, although these can be handled with correct checkpoint persistence policies from the external system.

4.3.2.5 aAdmin - Administration adapter

Strengths	Weaknesses
• Industry standard cross-platform implementation: jBoss AS 7.0 • Communication using a simple REST protocol • Support for multiple simultaneous users	• Cannot be used to redeploy or restart the CHESS Server • Accepts only text/xml
Opportunities	**Threats**
• Protocol refinement: The effectiveness of the communication protocol can be enhanced by using more specific status codes in the responses	• Dependent on HTTP session: in case the session information is lost by the mobile terminal, the state of the experience becomes unreachable • Uses HTTP Authorization: a more robust authorization method is likely to be needed.

4.3.3 Quantitative results

4.3.3.1 aCAT - CAT Adapter

The CHESS Authoring Tool Adapter is a software component that provides a REST interface to the CAT allowing for the deployment of story models and basics files to the CHESS Server.

Number of supported platforms

Hardware	Software
▪ Java compatible server computer.	▪ jBoss AS 7.0

Number of failures

The communication between the CAT and the CHESS server can fail due to:

- Network failure
- The request towards the aCAT has an incompatible data format

Time required to transmit using aCAT

Measurements of the time needed to transmit models and basics files to the CHESS server using aCAT have been conducted and the results are included below. It should be noted that the measurements provided were conducted a very fast network and as a result reflect only the processing time of the CHESS server and not delays introduced by the network. It is also worth mentioning that the Melesso model and basics represent a rather long story and as such the result observed are satisfactory.

Model

Input	Input size (KB)	Transmission time (s)
Melesso.xml	20	0.5
Small.xml	4	0.3

Basics

Input	Input size (KB)	Transmission time (s)
MelessoBasics.xml	29	0.4
SmallBasics.xml	4	0.2

Component maturation according to acceptable limits

The CHESS Authoring Tool Adapter implementation was has been refined after its initial conception and has operated successfully as part of the story authoring process used by CHESS. The support for version control of the models and basics files produced by CAT is a functionality that should probably be implemented before industrialization.

4.3.3.2 aCMT - Chess Mobile Terminal Adapter

The Chess Mobile Terminal Adapter is a software component that offers a REST interface that the CHESS Mobile Terminal can use to communicate with the CHESS Server.

Number of supported platforms

Hardware	Software
▪ Java compatible server computer.	▪ jBoss AS 7.0

Number of failures

The communication:

- Network failure
- The request towards the aCMT has an incompatible data format
- The mobile terminal loses the session ID

aCMT request duration

The time required for the aCMT to service the various requests used during a visit has been measured and some representative values are included below. It should be noted that the measurements depend on the state of the network:

Request servicing time

Request	time (s)
Login	0.65
Start	0.2
Next	0.2
Selection	0.4
Completion	0.1
Skip	0.1
End	0.8

Component maturation according to acceptable limits

The Chess Mobile Terminal Adapter has been extensively tested and deployed as part of the CHESS system in multiple occasions. It has evolved as a result of the test results but no major issues have been identified and it has been found to work reliably.

4.3.3.3 aCVS - CVS adapter

The CVS adapter is the component of the STE that undertakes the task of managing (validating, serving, etc.) of the CHESS Visitor Survey and storing the answers of visitors to the STE's database.

Number of supported platforms

As part of the STE the aCVS supports the following platforms:

Hardware	Software
▪ Java compatible server computer	▪ JBoss AS 7.0 on any OS

On the front-end, the CVS application could be virtually any software-hardware combination that utilizes the REST API of the aCVS. During the development a web based REST client has been used for testing, while for the integrated CHESS system two different versions of CVS front-end have been developed by Real Fusio (RF): one GWT application and one HTML5 based application built to work within the MES (Mobile Experiencing System).

Number of failures

The aCVS could fail for the following reasons:

- Communication error
  - Front-end has lost the session
  - Network failure
  - Incompatible data format POST answer request
- Wrong data on survey model

Timing of aCVS requests

As described earlier in this document, the aCVS component utilizes the REST architecture of requests in order to communicate with the front-end. The CVS is based on a survey model that includes a series of questions of different types (single choice, multiple choice and ordering choices) that will be delivered to a client one by one.

With a "start" request the STE instantiates a session CVS session for this client and provides a response that includes the ID of the first question. The client then will have to ask for this question using the "question/{ID}" request. Afterwards, the aCVS waits for an "answer" request that should carry an answer in its body. The response to the answer request contains the ID of the next question in the list and the same procedure is followed until the end of the survey.

In order to test the system, a web based REST client was used to simulate the front-end behaviour. Each request was timed by the REST client, thus it includes the processing and the network transferring time.

The STE was deployed on a JBoss AS 7.0 running under Debian 6 on a virtual machine based on dual-core Xeon E5620 2.40GHz with 4GB of memory. The client and the server were both under the same private network (NKUA).

Request	Time (ms)
start	118

question/q0	41
answer (q0)	27
question/age	45
answer (age)	26
question/gender	52
answer (gender)	110
question/movie	52
answer (movie)	25
question/newspaper	20
answer (newspaper)	66
question/end	26

As shown at the table above, the requests are handled in less than 100ms at most times and in 50ms on average. This table is the simulation of a CVS instance for the Acropolis Museum. The same instance was used during the summative evaluation in January 2014.

Component maturation according to acceptable limits

The aCVS component has been developed and matured through testing, evaluating, and demoing either by itself or in the context of the CHESS system. Due to its simplicity the aCVS, which is actually the back-end of the CVS component of CHESS, was clearly defined during the first months of the project. After some refinements and additions that came as requirements from evaluation results, the tool was already in a very stable version and very close to its current state. On the other hand, it should be clear that there are still improvements to be done for this component to be released as product.

The CVS tool has been used widely during CHESS demonstrations and evaluation with users and has proven its stability and accuracy. Thought, the aCVS relies on XML data written by hand and validated using a simple XSD. The validation should become smarter, stricter and ideally incorporated in a survey submission workflow which will make the system more robust.

Finally, the aCVS, along with other STE components, should use a global authorization process that will improve privacy overall.

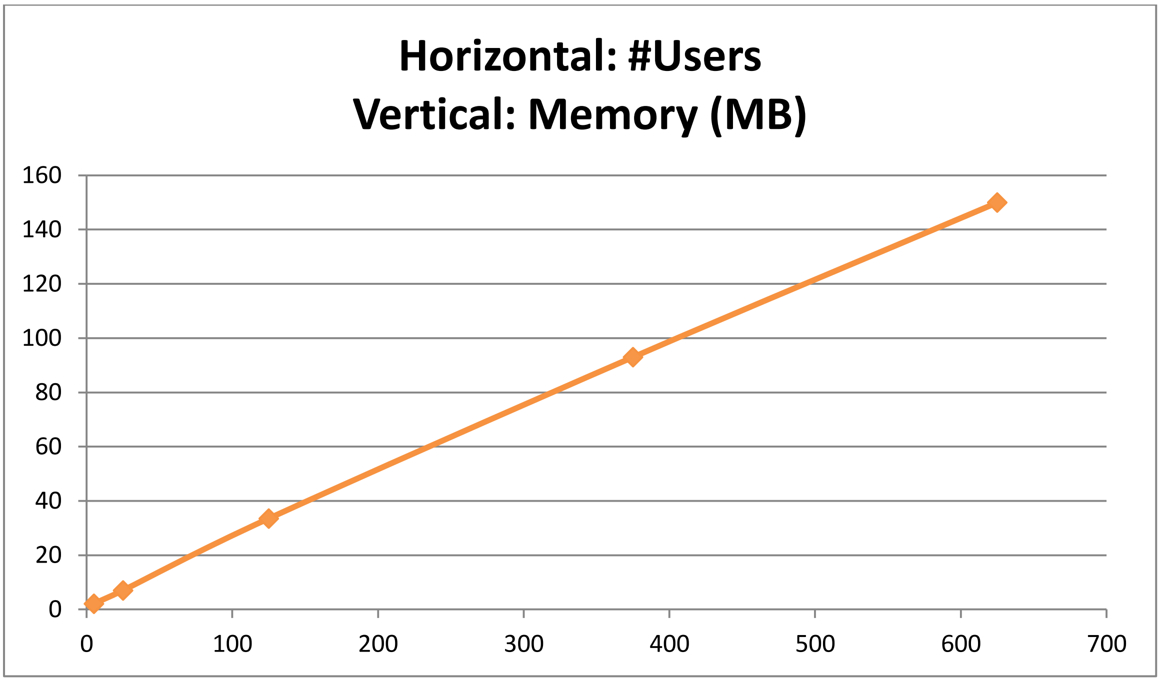
4.3.3.4 CPAD / Personalization Engine

In this section we will delve deeper into the internals of the Personalization Engine and evaluate the correct implementation and adequate performance of its more advanced functionalities. We will use several controlled test cases, along with general performance measures on memory footprint and execution time.

Memory Usage

In this section we measure the memory footprint of the Personalization Engine.

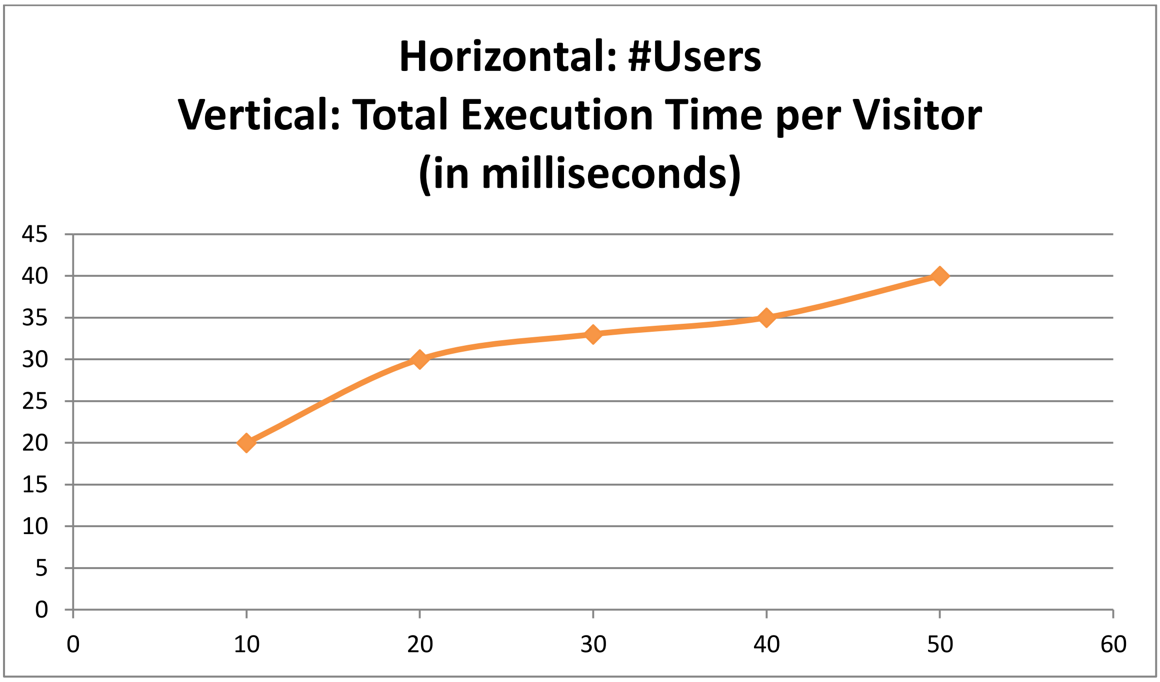
We initially create a Personalization Engine with 3 real-life story models (from the summative evaluation) and then add multiple users. The next figure shows how much memory is needed (in MB) for different numbers of users. As we can see, the memory footprint is minimal in all cases, even with 625 active users. Note that an explicit garbage collection was issued before the measurements were taken.



Execution Time

In this section we measure the total execution time per visitor of the Personalization Engine under various workloads. To this purpose, we created a simulation mechanism that takes a number of visitors as input and a story model and creates random (but meaningful and consistent with the story model) concurrent user actions. Notice that all user actions are created without the natural delays that would appear in a realistic setting (e.g., the user needs time to complete an activity before a request is made for the next one), so that what we measure is the pure execution time overhead of the Personalization Engine.

The execution time measured can be considered as the overhead added by the Personalization Engine to the total time that is needed for the CHESS system to process all the requests of a user during their visit from start to finish.



As we can see, the overhead of the Personalization Engine is minimal. This is due to the appropriate use of multithreading and intelligent pre-computations of various internal mathematical functions, so that time-consuming operations are avoided during a visit. The slight curve of the function is due to the fact that all visitors create simultaneous actions, and multithreading cannot handle all of them at the same time, so some requests are delayed until a thread becomes available. In a realistic setting only a few of the visitors will create simultaneous actions, and the thread pool will be able to cope without delays. Note that an additional one-time cost of about 500 ms was needed at the start of each simulation to handle the initialization of the system and make all necessary pre-computations.

Nevertheless, note that (a) The story model that was used was considerably smaller than the average CHESS story, (b) As a result, the simulated users' actions were fewer than what we expect from the average visit, (c) In a realistic setting, other CHESS modules compete for processing time during a visitor request, (d) On the other hand, the server machine that hosts the CHESS server is more powerful than the machine used for these measurements.

As a result, we list below some average measurements from the summative evaluation at the Acropolis Museum, where real visitors used the CHESS system with full-length stories:

- The initial one-time cost for initializing the system was 5 seconds.
- The most time-consuming request is the ranking of the branches of a branching point. Such a request needs to consider all the evidences we have stored thus far for the visitor and compare them to the content of each possible story part. Due to intelligent pre-computations, multithreading, and storing all active user profiles in memory, the average delay for answering a rank request was only 5 ms.
- Other requests to the Personalization Engine were completed essentially instantly.

Experimental Setup

In this section we will describe the system that is used for the evaluation, and the setup of the program that executes the various test cases.

The system used has 4GB of RAM and an Intel i5 2.27 GHz processor.

The program that executes the test cases communicates with the Personalization Engine through the CPAD java interface shown below.

```
public interface CPAD
    /**
     * Starts CPAD. Should be called before any other method may be called.
     */
    void start(String transactionId);

    /**
     * Stops CPAD and cleans up its resources.
     * @return An xml representation of the current state of CPAD and PAROS
     */
    String stop(String transactionId);

    /**
     *
     * @return An xml representation of the current state of CPAD and PAROS
     */
    String getState(String transactionId);

    /**
     * Notifies CPAD that a new user has logged-in.
     * @param userId
     */
    void newUser(String userId, String transactionId);

    /**
     * Notifies CPAD that a user has started traversing the specified script.
     * @param userId
     * @param scriptId
     */
    void userStartedScript(String userId, String scriptId, String transactionId);

    /**
     * Notifies CPAD that a user has logged-out.
     * @param userId
     * @return An xml representation of the user's profile
     */
    String userLeft(String userId, String transactionId);

    /**
     * Notifies CPAD that a returning user has logged in.
     * @param userId
     * @param profile An xml representation of the user's profile as created from previous visits
     */
    void returningUser(String userId, String profile, String transactionId);

    /**
     *
     * @param userId
     * @return An xml representation of the user's profile
     */
    String getUserProfile(String userId, String transactionId);

    /**
```

```
 *
 * @param userId
 * @param transactionId
 * @return The user profile as an object.
 */
UserProfile getUserProfileAsObject(String userId, String transactionId);
```

```
/**
 * Used for debugging purposes.
 * @param userId
 * @param xml An xml representation of the user's profile
 */
void setUserProfile(String userId, String xml, String transactionId);
```

```
/**
 * Sets a specific value to a user parameter.
 * @param userId
 * @param paramName
 * @param paramValue
 * @param ParameterType
 */
void setParameterForUser(String userId, String paramName, String paramValue, ParameterType paramType,
String transactionId);
```

```
/**
 * Notifies CPAD that a user has interacted with an object.
 * @param userId
 * @param eventType
 * @param targetObjId
 */
void eventOccured(String userId, String eventType, String targetObjId, String transactionId);
```

```
/**
 * Notifies CPAD that a certain answer has been chosen in the CVS by a user.
 * @param userId
 * @param amplifier
 * @param shortTerm true for short term, false for long term
 * @param answerObjId
 */
void userCVSAnswer(String userId, double amplifier, boolean shortTerm, String answerObjId, String
transactionId);
```

```
/**
 * Asks CPAD to rank the branches of the branching point based on degree of user interest.
 * @param branchingPointId
 * @return The branches of the branching point in descending order of user interest.
 */
Rankings rank(String userId, String branchingPointId, String transactionId);
```

```
/**
 * Asks CPAD to provide the id of a branching point to dynamically alter the story flow.
 * @param event "new_story_part" for dynamic user feedback, "qr_code" for qr code scanning
 * @param userId
```

```
 * @param transactionId
 * @return The id of a branching point or null if no dynamic jump is necessary
 */
String askForDynamicJump(String event, String objId, String userId, String transactionId);
```

The program that executes the test cases takes the following inputs: (a) the story model and basics file to be used (which contain the feature annotations needed for content-based recommendations), (b) a series of commands to execute.

As a reminder, we note that in the basics file Script Units and Activities are annotated with features (xml element: feature). Each feature has a unique name and a relevance score between 1 and 10. Respectively, in the model file the Branches (xml element: expression) of a Branching Point are annotated with features of the same type. This way, a similarity function can be employed, and is the basis of the recommendation algorithm we employ. For more details on the algorithms used, the reader should refer to D05 (Adaptive Storytelling Engine).

To provide a higher level language for defining these commands, we have created a small parser with the following logic (note that userId and transactionId are set to a default value at the start of the program):

Input	Interface Call
rnk bpId	rank(userId, bpId, transactionId)
dyn	askForDynamicJump("new_story_part", null, userId, transactionId);
ns scriptName	userStartedScript(userId, parts[1].trim(), transactionId);
ac actId	eventOccured(userId, "activity_completion", actId, transactionId);
ach cvsId	userCVSAnswer(userId, 1, cvsId, transactionId);
mac i1 i2	invokes multiple ac commands with ids aci1 to aci2 [e.g., mac 1 3 will invoke ac ac1, ac ac2, ac ac3]
as actId	eventOccured(userId, "activity_skip", actId, transactionId);
mas i1 i2	invokes multiple as commands with ids aci1 to aci2
cm branchId	eventOccured(userId, "choosen_branch_menu", branchId, transactionId);
ca branchId	eventOccured(userId, "choosen_branch_auto", branchId, transactionId);
ss suId	eventOccured(userId, "su_started", suId, transactionId);
sp name value	setParameterForUser(userId, name, value, ParameterType.session, transactionId);
cl	initializes the user's profile

In each test case we will provide the input to the test program (model & basics, commands) and the results that were produced. We will then briefly comment on their correctness.

Feedback from Script Units

A user may successfully complete a script unit, or he may decide to skip it. A script unit is completed successfully if the user completed most of the activities that comprise it, and he skipped it if he skipped a significant number of its activities. The success or skip of a script unit is then used as evidence for what the user likes or dislikes.

The model file that was used for testing is shown below:

```
<script id="tough_model">
        <scriptGraph>
                <scriptNode id="sn1" from="start" scriptUnit="su1" next="su2"/>
                <scriptNode id="sn2" scriptUnit="su2" next="bp1"/>
                <scriptNode id="bp1" type="scriptBranchingPoint" allowMenu="YES">
                        <expression next="sn3" branchGraphType="embedded">
                        <features>
                          <feature name="monsters" relevance="10" type="subject"/>
                          </features>
                        </expression>
                        <expression next="sn4" branchGraphType="continuation"/>
                        </scriptNode>
                        <scriptNode id="sn3" scriptUnit="su3" next="bp1"/>
                        <scriptNode id="sn4" scriptUnit="su4" next="end"/>
        </scriptGraph>
</script>

<stagedScript id="staged_Script01" scriptId="Script01" title="">
        <stageGraph scriptNode="sn1">
        <stageNode id="stn_su1"/>
        </stageGraph>
        <stageGraph scriptNode="sn2">
        <stageNode id="stn_su2"/>
        </stageGraph>
 </stagedScript>

 <story id="st_Script01" stagedScript="staged_Script01" title="">
        <edit stageNode="stn_su1">
                <storyNode activity="ac1" from="start" id="sn_ac1" next="end"/>
        </edit>
        <edit stageNode="stn_su2">
                <storyNode allowMenu="NO" from="start" id="acBp1" type="storyBranchingPoint">
                <expression branchGraphType="continuation" next="sn_ac2">
                <condition/>
                <features>
                        <feature name="expert" type="expertise" relevance="10"/>
                </features>
                </expression>
                <expression branchGraphType="continuation" next="sn_ac3"/>
                </storyNode>
                <storyNode activity="ac2" id="sn_ac2" next="sn_ac4"/>
                <storyNode activity="ac3" id="sn_ac3" next="sn_ac4"/>
                <storyNode activity="ac4" id="sn_ac4" next="end"/>
        </edit>
 </story>
```

And the basics file:

```
<scriptUnits>
        <scriptUnit id="su1"/>
        <scriptUnit id="su2">
        <features>
                <feature name="monsters" relevance="10" type="subject"/>
        </features>
        </scriptUnit>
        <scriptUnit id="su3"/>
        <scriptUnit id="su4"/>
 </scriptUnits>
 <!-- Activities -->
<activities>
        <activity id="ac1">
```

```
        <features>
                <feature name="expert" type="expertise" relevance="10"/>
        </features>
        </activity>
        <activity id="ac2"/>
        <activity id="ac3"/>
        <activity id="ac4"/>
 </activities>
```

The scenario that we are going to test is the following:

`ss su1, as ac1, ss su2, rnk acBp1, ca ac3, ac ac4, ss bp1, dyn, rnk bp1`

We expect the following points to be satisfied:

1. No evidence for su1, since it is not annotated
2. rnk acBp1 should recommend ac3 because of the skip of ac1
3. We should get positive evidence for su2
4. rnk bp1 should recommend su3

We list the relevant console messages during the execution:

ss su2
39548 [main] DEBUG gr.uoa.di.chess.cpad.LikeIntensityMapEventHandler - A new su started. Checking if previous su should get evidence: ***Previous su was not annotated.***
rnk acBp1
48831 [pool-1-thread-1] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [ac3#s:0#c:0#mc:0#a:default, ac2#s:-1#c:0.3#mc:1#a:default]. Branching point: acBp1. ***Recommended node: ac3.***
ss bp1
71345 [main] DEBUG gr.uoa.di.chess.cpad.LikeIntensityMapEventHandler - A new su started. Checking if previous su should get evidence: Previous su was completed successfully. ***Getting positive evidence.***
rnk bp1
79350 [pool-1-thread-2] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [su3#s:1#c:0.1114#mc:0.3714#a:default, su4#s:0#c:0#mc:0#a:default]. Branching point: bp1. ***Recommended node: su3.***

Predicting User Actions on BPs

The Personalization Engine needs to predict how a user will behave in a given story part (will complete it successfully or skip most of its script units). This is a prerequisite for Dynamic Feedback Menus, which are tackled at a later section.

The model file that was used for testing is shown below:

```
<script id="test_model">
        <scriptGraph>
        <scriptNode id="sn_init" from="start" scriptUnit="init" next="bp1"/>
        <scriptNode id="bp1" type="scriptBranchingPoint" allowMenu="NO">
                <expression next="sn_branchA1" branchGraphType="continuation">
                <features>
                        <feature relevance="10" type="subject" name="A"/>
                </features>
                </expression>
                <expression next="sn_branchB1" branchGraphType="continuation"
teaserTitle="...">
                <features>
                        <feature relevance="10" type="subject" name="B"/>
```

```
                </features>
                </expression>
        </scriptNode>
        <scriptNode id="sn_branchA1" scriptUnit="branchA1" next="bp2"/>
        <scriptNode id="sn_branchB1" scriptUnit="branchB1" next="bp2"/>
        <scriptNode id="bp2" type="scriptBranchingPoint" allowMenu="NO">
                <expression next="sn_branchA2" branchGraphType="continuation">
                <features>
                        <feature relevance="10" type="subject" name="A"/>
                </features>
                </expression>
                <expression next="sn_branchB2" branchGraphType="continuation">
                <features>
                        <feature relevance="10" type="subject" name="B"/>
                </features>
                </expression>
                </scriptNode>
                <scriptNode id="sn_branchA2" scriptUnit="branchA2" next="end"/>
                <scriptNode id="sn_branchB2" scriptUnit="branchB2" next="end"/>
        </scriptGraph>
</script>
```

And the basics file:

```
<scriptUnits>
</scriptUnits>

 <!-- Activities -->
<activities>
        <activity id="iac">
        <features>
                <feature relevance="10" type="subject" name="A"/>
        </features>
        </activity>
 </activities>
```

The scenario that we are going to test is the following:

```
as iac, ss bp1, dyn, rnk bp1, ss branchA1, ca branchA1
```

We expect the following points to be satisfied:

1. rnk bp1 recommends branchB1 because of the skip of iac
2. ca branchA1 predicts a dislike for the chosen story part branchA1

We list the relevant console messages during the execution:

rnk bp1
17225 [pool-1-thread-1] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [branchB1#s:0#c:0#mc:0#a:default, branchA1#s:-1#c:0.3#mc:1#a:default]. Branching point: bp1. ***Recommended node: branchB1.***
ca branchA1
34434 [main] DEBUG gr.uoa.di.chess.cpad.LikeIntensityMapEventHandler - Prediction renewed. Prediction: ***dislike***. Chosen branch: branchA1

Evident Choices

The Personalization Engine tries to be as silent as possible, i.e., if we are sufficiently certain for what a user will chose at a menu, we will indicate that choice as evident. The STE will then use this option to automatically continue on the story part suggested by the Personalization Engine, provided that the author allows such an automated decision (i.e., the bp is not Mandatory).

The model file that was used for testing is shown below:

```
<script id="test_model">
<scriptGraph>
```

```
        <scriptNode id="m1c1c2" type="scriptBranchingPoint" allowMenu="NO">
        <expression next="m1" branchGraphType="embedded">
        <features>
                <feature relevance="10" type="subject" name="A"/>
        </features>
        </expression>
        <expression next="c1" branchGraphType="continuation">
        <features>
                <feature relevance="10" type="subject" name="B"/>
        </features>
        </expression>
        <expression next="c2" branchGraphType="continuation">
        <features>
                <feature relevance="10" type="subject" name="C"/>
        </features>
        </expression>
        </scriptNode>
</scriptGraph>
</script>
```

And the basics file:

```
<cml version="2.0" id="test_basics">
<scriptUnits>
</scriptUnits>
<!-- Activities -->
<activities>
<activity id="aca1">
<features>
        <feature relevance="10" type="subject" name="A"/>
</features>
</activity>
<activity id="aca2">
<features>
        <feature relevance="10" type="subject" name="A"/>
</features>
</activity>
<activity id="aca3">
<features>
        <feature relevance="10" type="subject" name="A"/>
</features>
</activity>
<activity id="acc1">
<features>
        <feature relevance="10" type="subject" name="C"/>
</features>
</activity>
<activity id="acc2">
<features>
        <feature relevance="10" type="subject" name="C"/>
</features>
                </activity>
<activity id="acc3">
<features>
        <feature relevance="10" type="subject" name="C"/>
</features>
</activity>
</activities>
</cml>
```

The scenario that we are going to test is the following:

```
as aca1, as aca2, as aca3, as acc1, as acc2, as acc3, ss m1c1c2, dyn, rnk m1c1c2
```

We expect the following points to be satisfied:

1. rnk m1c1c2 will recommend branch c1 as evident because branches m1 and c2 are disliked by the user very much and we are confident of that (because of all the previous skips)

We list the relevant console messages during the execution:

rnk m1c1c2

```
6755 [pool-1-thread-1] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [c1#s:0#c:0#mc:0#a:evident, c2#s:-1#c:0.9#mc:1#a:default, m1#s:-1#c:0.9#mc:1#a:default]. Branching point: m1c1c2. Recommended node: c1.
```

Note the bold a:evident, which is the annotation used to indicate to the STE that the choice is evident.

Dynamic Feedback Menus

Dynamic feedback menus are an advanced feature of the Personalization Engine. As mentioned earlier, the system makes a prediction on how the user will behave at a given story part. If the prediction turns out to be wrong, and the system was sufficiently certain of its prediction, a menu will be shown to the user to provide feedback and clarify his actions.

The model file that was used for testing is shown below:

```xml
<script id="Meliso">
        <scriptGraph>
        <scriptNode id="bp1" type="scriptBranchingPoint" allowMenu="YES">
                <expression next="snbp1_more1" branchGraphType="embedded">
                <features>
                    <feature name="A" type="subject" relevance="10"/>
                 </features>
                 </expression>
                <expression next="snbp1_more2" branchGraphType="embedded">
                  <features>
                     <feature name="A" type="subject" relevance="5"/>
                     <feature name="B" type="subject" relevance="5"/>
                   </features>
                 </expression>
                <expression next="snbp1_cont" branchGraphType="continuation">
                </expression>
        </scriptNode>
        <scriptNode id="snbp1_more1" scriptUnit="more1" next="bp1"/>
        <scriptNode id="snbp1_more2" scriptUnit="more2" next="bp1"/>
        <scriptNode id="snbp1_cont" scriptUnit="cont" next="end"/>
        </scriptGraph>
</script>
```

And the basics file:

```xml
<cml version="2.0" id="Basics_25562">
 <!-- Activities -->
 <activities>
  <activity id="ac1">
    <features>
        <feature name="A" type="subject" relevance="10"/>
    </features>
  </activity>
  <activity id="ac2">
    <features>
        <feature name="A" type="subject" relevance="10"/>
    </features>
  </activity>
  <activity id="ac3">
    <features>
        <feature name="C" type="subject" relevance="10"/>
    </features>
  </activity>
  <activity id="ac4">
    <features>
        <feature name="C" type="subject" relevance="10"/>
    </features>
  </activity>
  <activity id="ac5">
    <features>
        <feature name="C" type="subject" relevance="10"/>
    </features>
  </activity>
 </activities>
</cml>
```

The scenario that we are going to test is the following:

```
as ac1, as ac2, rnk bp1, cm more1, ac ac3, ac ac4, ac ac5,
dyn, cm uf::pos_ev, rnk bp1
```

We expect the following points to be satisfied:

1. The first rnk bp1 will recommend the cont branch, since more1 and more2 branches are predicted to be disliked by the user based on his previous skips
2. Nevertheless, the user chooses more1 branch and completes all activities. That means that the Personalization Engine was in error, and the next dyn request will produce a jump to the system branching point uf::pred_neg. This branching point is part of the extra-story constructs that STE maintains. The declaration of the uf::pred_neg bp is shown below.
3. The user choses uf::pos_ev, which means that he liked the story we thought he wouldn't like. That initiates a re-profiling.
4. The next call to rnk bp1 will, as a result, recommend more2 branch instead of cont that was previously the case.

```
<scriptNode allowMenu="MANDATORY" id="uf::pred_neg" menuTitle="Please give us some feedback.
Do you like the story so far?" type="scriptBranchingPoint">

<expression branchGraphType="continuation" next="uf::norepr_neg_ev" teaserTitle="No! Please
give me something else."/>

<expression branchGraphType="continuation" next="uf::pos_ev" teaserTitle="Yes! It's a nice
story."/>

</scriptNode>
```

We list the relevant console messages during the execution:

rnk bp1
16461 [pool-1-thread-1] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [cont#s:0#c:0#mc:0#a:default, more2#s:-1#c:0.4243#mc:0.7071#a:default, more1#s:-1#c:0.6#mc:1#a:default]. Branching point: bp1. ***Recommended node: cont.***
cm more1
24418 [main] DEBUG gr.uoa.di.chess.cpad.LikeIntensityMapEventHandler - Prediction renewed. Prediction: ***dislike***. Chosen branch: more1
dyn
43766 [main] INFO gr.uoa.di.chess.cpad.CPAD - CPAD Message. Transaction Id: tr1. Datetime: Wed Feb 05 12:52:18 EET 2014. Message: ***PAROS decided a dynamic jump to :uf::pred_neg***. Event: new_story_part. User id: user1.
cm uf::pos_ev
53236 [main] DEBUG gr.uoa.di.chess.cpad.LikeIntensityMapEventHandler - ***Dynamic user feedback event detected.*** Event type: choosen_branch_menu. Target Object: uf::pos_ev. User: user1
rnk bp1
43051 [pool-1-thread-2] DEBUG gr.uoa.di.chess.cpad.BlockingThreadRankings - Rank finished. Rankings: [more2#s:0.3333#c:0.6364#mc:0.7071#a:default, cont#s:0#c:0#mc:0#a:default, more1#s:-1#c:1#mc:1#a:visited]. Branching point: bp1***. Recommended node: more2***.

4.3.3.5 aAdmin - Administration Adapter

The Administration Adapter is a software component that offers a REST interface that allows a set of administration functions to be performed on the CHESS Server.

Number of supported platforms

Hardware	Software
▪ Java compatible server computer.	▪ jBoss AS 7.0

Number of failures

The communication:

- Network failure
- The request towards the aAdmin has an incompatible data format
- The client (typically a browser) loses the session ID

aAdmin request duration

The time required for the aAdmin to service the various requests used during a visit has been measured and some representative values are included below. It should be noted that the measurements depend on the state of the network:

Request	time (s)
Start	1.5
list users	0.6
create new user	0.1
list user CVS answers	0.15
list answers to a CVS question	0.6

Component maturation according to acceptable limits

The Administration Adapter has performed reliably as part of the CHESS Server in several occasions including technical evaluations and demonstrations. Improving the method of authentication is an important goal that should probably be accomplished before industrialization.

4.3.4 Conclusion

The aforementioned components performed reliably in various test in multiple occasions as stated in their respective sections. The majority of the tests performed where successful; the issues that were observed have either been corrected or mentioned in this document as weaknesses or threats.

The aspect of the system that has the strongest influence on the performance has been observed to be the network capability and state. This is due to the fact that the operation of the components mentioned depends on the communication with other subsystems of CHESS. The exception to this is the CPAD/Personalization System which operates within the STE in the form of a Java library.

Another important factor affecting the integrity of the system and specifically the correctness of the data exchanged between the STE and the other CHESS subsystems is the validity of the input data (e.g. story model in case of CAT, CVS model, etc). Some validation using XSD is performed but for the system to be considered ready for industrialization more thorough checks including semantic validation should be implemented.

As part of the tests and demonstrations performed during the course of the project, the STE has been used with a relatively small number of concurrent users. The overall system architecture, which is based on JBoss AS, is suitable for relatively large number of concurrent users. Since the industrialization of the system depends on the scalability with respect to the number of users, further tests are needed in order to assess the requirements for a full scale deployment of CHESS.

4.4 The CAT (DXT)

4.4.1 Introduction

4.4.1.1 About this document

This document provides a technical validation of the CHESS Authoring Tool (CAT). This validation is done by enumerating the results of many technical assessments. The objective of this technical validation is to devise if the components of the CHESS framework are mature enough for industrialization. If the components are not stable enough, in order to strengthen the CHESS framework, these results could pinpoint what are the limitations of the current implementation and what could be improved.

The results present some standard non-functional requirements (e.g. robustness, efficiency, latency, number of failures or application errors, etc.). When possible, the technical validation includes a number of tests & benchmarks done against a set of samples. These tests have been conducted by the developers of the Authoring Tool (here Diginext). The main strengths and limitations are synthesized in SWOT matrices. Then, a detailed presentation of quantitative measures is provided. These results imply some limitations and consequences on the deployment of the CHESS Authoring Tool.

4.4.1.2 CHESS Authoring Tool

The CHESS Authoring Tool targets non-technical museum authors or curators who want to create stories adapted to the visitor (interests, age, and more widely the visitor profile) and dynamically adapted to the visitors mood and interactions. Its development followed an iterative process between the end-users and the development team to follow the changes in their needs.

It integrates different features:

- Resource browsers:
  - The asset browser (ontology search, image pair search)
  - Activity library browser
- The story editor features:
  - The story template
  - The story graph editor
  - The story node parameter editor
  - Museum 3D map visualisation and hotspot creation
- Debug and analysis tools:
  - Preview the story

  - Statistics extraction from the Hub
  - Preview the path of a visitor
- Story packaging and export to the Hub and the STE.

4.4.2 SWOT analysis

This section provides a summary of Strengths, Weaknesses, Opportunities, and Threats for the CHESS Authoring Tool.

	Strengths	**Weaknesses**
INTERNAL FACTORS	• Ease of use: ○ Usable by a non-technical staff ○ Easy deployment ○ Easy asset import by drag and drop with no codec issue. ○ Notion of template to initialize the project easily. • Allow story personalisation authoring • Use specific terms for museum (exhibits, museum map, visitor, ontology, ...) • Retrieve previous project on crash.	• Personalisation parameterisation is still a bit difficult to understand. • Activity authoring needs HTML5.0/JS. development skills. • Long deployment time for debug. • Network dependency for the assets.
	Opportunities	**Threats**
EXTERNAL FACTORS	• The CAT will benefit from the QT framework and the Inscape progresses as it is based these technologies. • Activity library can be enriched by external contributions from a community for example.	• Mono-platform (Windows) • New competitors (https://qreca.com/)

4.4.3 Quantitative results

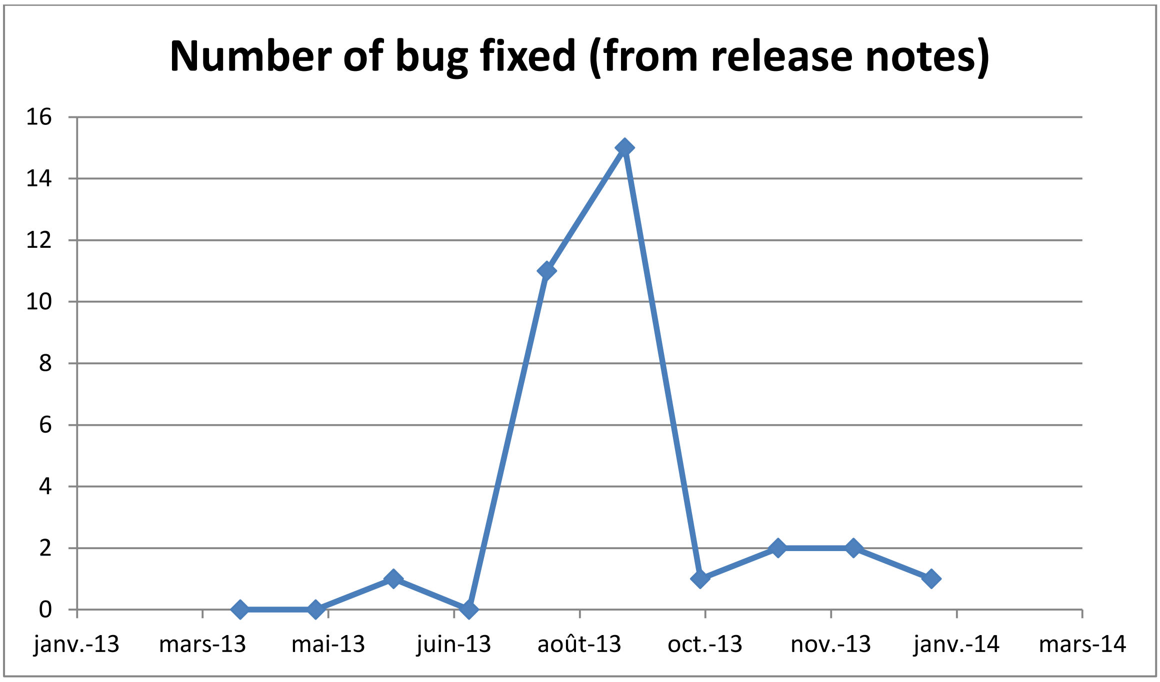
This section tries to illustrate the SWOT analysis thanks to quantitative results.

Number of supported platforms

This is one of the identified weakness of the CAT, as it only runs on Microsoft Windows OS, on PCs.

Number of failures

This metric gives measurements on the robustness of the tool before an industrialisation. The following graph shows the number of bugs solved on the CAT during the last year of the project.



We can noticed that after a testing period of the March release, a number of bugs have been raised and solved leading to a more stable version where few remaining bugs where fixed, mainly linked to the new added features.

Responsiveness

This section details the latency of the main features of the CAT, either offline or online. We based this statistics on the different stories we created during the last year of the project. These times have been measured on the main steps of the story creation:

- Application launching time: The time needed to launch the application, and load all the main libraries.
- Project loading time: The time to load the corresponding existing project and the extra dependant libraries.
- 1st Asset loading time: The time needed to retrieve and reload all the asset of the library from the Hub. Then, these assets are saved into the cache of the application.
- Deployment time: The time needed to build, package and export the whole story to the Hub (to be accessed by the visitors) and the Story Telling Engine.
- Saving project time: The time needed to save locally the project on the hard drive.

Most of the other GUI interactions are done in real-time.

	CITE experience 23 story nodes, 63 activities, 13 branching points, 99 assets	**Melesso** 34 story nodes, 37 activities, 13 branching points, 750 assets	**Theseus** 31 story nodes, 34 activities, 6 branching points, 262 assets
Application launching time	3s		
Project loading time	4s	5s	11s
1st Asset loading time	15s	25s	19s
Deployment time	123s	118s	48s
Saving project time	~1s	~1s	~1s

Component maturation according to acceptable limits

The CHESS Authoring Tool has been successfully used by the end-users during the project and benefited of the iterative refinement process. One of the major limitation was that the museum required a development team anyway to create specific games. However, they was able to create sophisticated personalised stories by themselves, without any development skills.

Some components developed during the CHESS project benefited directly to the Diginext's Inscape product. At the opposite, CHESS benefited of the fixes and the new features developed into Inscape (which is already a mature project available for selling in the Diginext offer).

4.5 The Mobile Experiencing System (IGD)

4.5.1 Introduction

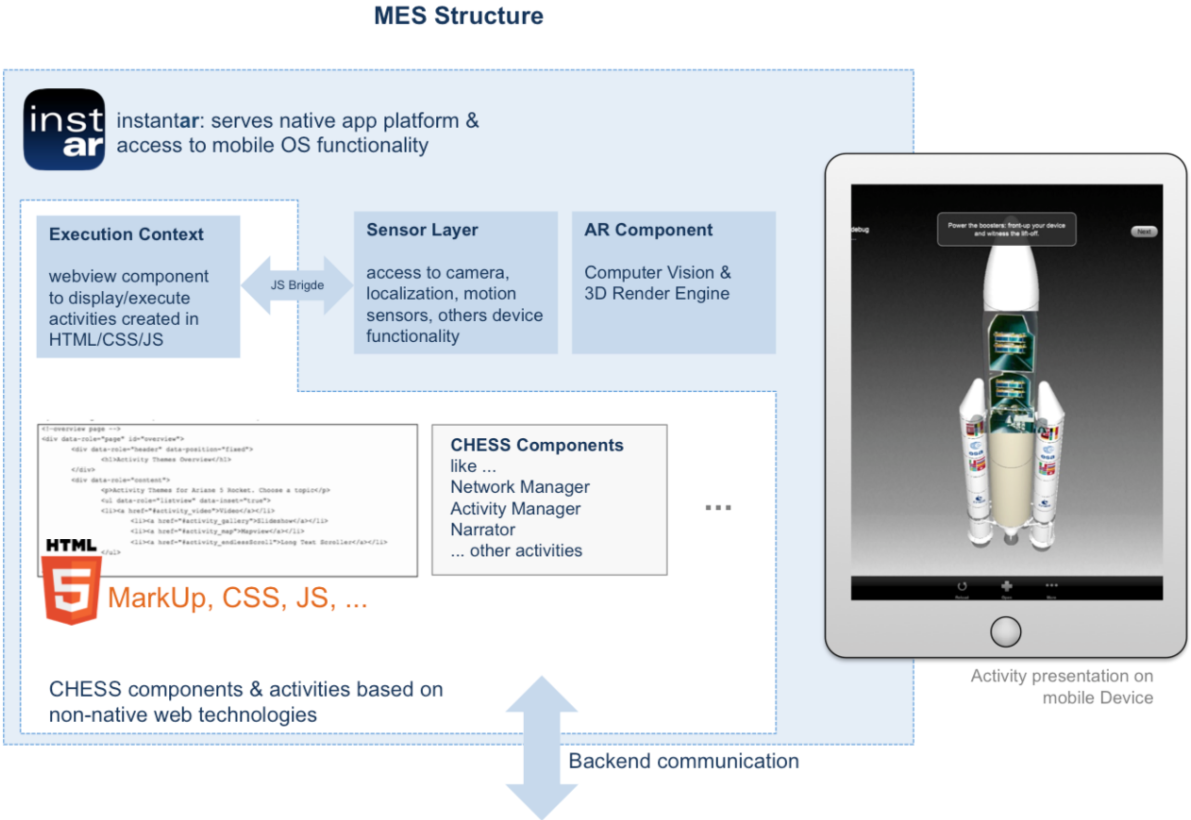


Figure 101: Structure of the MES

The MES enhances and augments the CHESS experience of a visitor during the visit to a cultural heritage physical space. As the mobile experiencing system, it delivers and presents the story/activities while visitors observe exhibits, and allows them to interact with them through the mobile device. The MES is in continuous dialogue with the CHESS backend structures, which select, structure and deliver activities specific to the visitor preferences, the location and the exhibit being the focal point at that moment, as well as the style of story telling selected by the author.

In order to do so, the MES serves the technological foundation for interaction and presentation and informs the backend of visitor's activities (where are visitors, what might visitors look at, what do they do on app level). On a technical basis the MES serves a multitude of features in order to be able to present a variety of different CHESS activities to visitors, such a narrated audio or text, interactive images, videos, games, 3D representations, and Augmented Reality features. A structural overview is given in Figure 6.

For visitors, the MES is a single application with a consistent UI and look-and-feel. Besides being the system that lets visitors/users "consume" the activities, it also serves general and all-time present features and functions (e.g., home/overview, map/orientation, login, settings, etc.) where needed.

4.5.2 SWOT analysis for the Mobile Experiencing System

In order to assess the developments, we took several considerations into account. One addresses the web-app approach, which per-se comes with some advantages (ease-of-development) and disadvantages (performance) over native implementations. Another is the tier-architecture of the entire CHESS system, which gives a lot of freedom to deploy only needed data fitting to the personalization and adaptivity of CHESS, while relying on a possibly weak network performance.

The following table sums the major structural and strategically decisions made for the MES system and assesses them in a SWOT analysis format:

STRENGH	**WEAKNESSES**
• HTML5 & web-apps powerful approach beyond the bounds of native implementations • In general platform independent (except AR and 3D features) • Technical abstraction of player (=MES/Browser, native app) and content (web-apps) • Scalability in terms of content, and system structure (easy to extend components) • Ready for network-based infrastructures • Notion of activity and activity instance to save memory footprint	• Non-native implementation and abstraction might lack performance • web-apps limit/hinder usage of special platform features without extending the standard • AR still lacks performance for 3D object tracking • AR/3D not (yet) reflected in HTML5 standard, needs custom native-apps (as is case for recent MES) • Needs network for personalisation and adaptivity • STE data delivery relies on network, when CHESS system used to full extend
OPPORTUNITIES	**THREATS**
• Server <> client / tier architecture allows to reuse core components of CHESS beyond the recent MES • Re-usage of content in other media systems (e.g. websites) • Architectural flexibility enables high portability • Architectural flexibility facilitates future extensions, and to change sub-components • Re-usage of the system, components beyond mobile devices, e.g. Wearables and other platforms • Permanent hardware progresses improves AR + 3D capabilities.	• Network architecture might break or not stable enough, therefore needs fall-back strategies • Network can cause latencies due to slow bandwidth • Loss of states: broken or corrupt message exchanges stop backend from working correctly • 3D tracking still too unstable for broad re-usage beyond scope of the project • AR or experimental components may break the entire story & user flow if not reliable enough • AR/3D won't become standardized in the near future

4.5.3 Qualitative and Quantitative Results

On the MES, often-addressed problems of web-apps compared to native implementations are performance issues and the mimic of native behaviour. While this has been true for performance and was often case at the beginning of the project, the problem decreased as vendors introduced better hardware with increased processing power. And, as CHESS evolved in receiving an own UI and behaviour, even the latter reduced and turned to be less relevant. Even more, the MES UI is based on actively maintained open-sources libraries (as jQquery mobile, underscore.js and backbone.js) and benefits from community developments, and can easily be modified or changed in the future.

Benchmarking Tracking Data Performance

Way more critical are Augmented Reality and 3D activities, as they rely per-se much more on powerful hardware. Not only the device's power increased, but also the demand of the technology, once we moved from 2D to 3D tracking; which becomes a crucial aspect for the user experience:

Heavy sets of tracking map features generated by the offline reconstruction result in large files, by storing 2D-3D point correspondences, low-level pixel and other unstructured data types. While it turned out to be a good choice to use XML to have a parameterize-able, and human readable file format during development, these XML descriptions tend to become very huge.

In order to improve loading time and performance (and hence the user experience) we developed an automatised optimization process and introduced a binary file format, representing the same content in an optimized, machine-readable manner.

For benchmarking, we created a tracking map that bases on round about 900 images (which is a quite typical amount for 3D tracking targets) and that stores round about 11MB of abstracted tracking data.

Especially its pixel data consumes a lot of loading time and CPU power, while being parsed (90%). Another 10% are consumed during the download via network (optimal circumstances). With no modifications, this file takes about 16 seconds loading time on an iPad4. After optimization, the parsing speed increased by factor 24 and reduced the file size by about 70% to 8 MB. Additionally we compress the binary file to get an even lighter file size (~2 MB), with a reduction by factor 5,7 in comparison to the original XML file. Using this method we increased the overall loading time by factor 16; which enables to load our test file in about 1 second.

With the binary format, the feature descriptor XML file (which is used especially for tracking initialization) is reduced by factor 65, which increases the loading speed up to factor 8 (from 1.3 MB to 0.02 MB). The following diagrams depict the benchmark results:

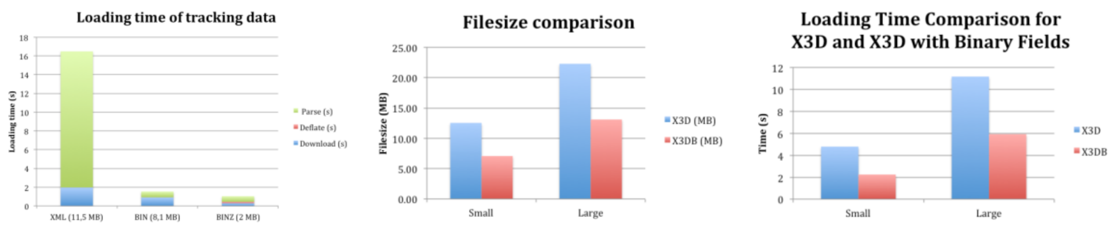


Figure 102 Benchmarks of loading and parsing performance of 3D and tracking assets

Benchmarking 3D Data Performance

Two factors influence the loading of 3D assets: a) the size of the model, and b) the processing of the model to create a runtime-ready scene.

Similar to the tracking data, the declarative X3D file format comes handy during development, but results in large file sizes without any optimization, where especially keeping the heavy unstructured data human-readable, is a performance killer in a technical sense.

Using the same techniques (binary files and compression) as stated above, we started to reduce file size, loading and parsing times. The advantage of this approach is, that loaded data can be directly read by the GPU.

But in order to keep a non-binary and human-readable file structure of the structured X3D parts, we only optimize nodes with unstructured geometry data (e.g. vertices) and compress and outsource them to binary container files that are linked inside the structured X3D file.

The optimization process uses a python-based tool to create the binary and compressed files for both, tracking data and X3D assets.

For benchmarking we have used a model of a landscape in two versions, with a) 100k polygon count and b) a larger count with > 200k polygons. The table illustrates the tremendous reduction of files sizes by up to 60% with increased loading times:

Format/Model	File Size (MB)		Loading Time (s)	
	small	large	small	large
X3D	12,53	22,27	4,7935	11,1796
X3DB	7,07	13,09	2,2464	5,9302
Reduct. factor	0,56	0,59	0,46	0,53

However, there is a limit to optimization. Although the mentioned process helps reducing file size, loading and parsing times, the semantic data information can be cropped or reduced only to some degree without losing quality (in tracking accuracy and visualization). Hence, AR on mobile devices will rely on performance improvements of mobile devices, too.

To give an example, let's use the case of the activity that superimposes a re-coloured 3D model of a Kore statue on top of the real one: when CHESS started in Y1, it was a 2D-poster-tracking running on an iPad 2 with an average frame rate of 20-25 fps. Once done with a more complex 3D tracking and although optimized, on iPad 2 the rate dropped to 8-10 fps. In Y2 with iPad 3 it increased again to match at least 10-15 fps. In Y3 with iPad4 it are 15-20 fps, and now 20-30 fps on iPad Air. Both latter mentioned could be considered to present a stable performance that is perceived usable.

Aside the core CV-tracking performance in general, the initialization (i.e. the phase before continuously tracking objects) takes some time before the system starts tracking and before the user "finds" the right position. It seems to impact the user experience. To cope with this aside well defined user instructions, we are about to add a key-framing functionality to the tracking pipeline. With this, it'll be possible for visitors to initialize AR activities more relaxed from several positions.

4.5.4 Conclusion

As of the time being we can say that the experiencing systems matured to a more than an acceptable level. Almost all initial requirements have been addressed and implemented within the scope of the project (compare requirement assessment list inside this document). It turned out that especially the web-app approach worked very well in terms of a) semi-isolated development and implementation of components amongst different partners, b) integration of all components to one CHESS system later in the project, and c) the content production, where many state-of-art tools could be employed that are used for media production today (and that are a de-facto standard for museums as well).

Data exchange and activity descriptions that are right now based on XML and JSON files turned out to ease the integration/evolution of prototyped CHESS activities to full-featured ones, and their (re-) usage in non-MES systems, such as the CAT authoring tool, or a pre-existing web environment (which is case for many cultural institutions). In general, the "web-development" behind a majority of CHESS activities and components approved to encourage prototyping, as it was fast to get early hands-on results, before looking into otherwise more time-consuming development strategies.

The mobile devices in general turned out to be tricky for several reasons:

On the one hand this refers to the form factor. While the MES and CHESS would work on smartphones from 4-6 inches in screen size without limitations, the experience and joy-of-use is far behind compared to the one running on tablets (which usually start at a screen size from 7-11 inches). This is one reason, why mainly tablets have been used throughout the project.

On the other hand this refers to heterogeneous hardware and software platforms. Both imply basically a lot of labour adapting natively implemented components every time operations systems get updated. This was one reason, why the “web-app approach” was chosen right from the start of the project, and it is also a reason why the consortium was working with mainly one, the iOS platform especially during technical demonstrations of CHESS. While the (mobile) CHESS app almost fully runs on the Android platform too, Google’s Android environment in general is far more heterogeneous than e.g. Apples iOS, implying way more labour to catch up and match with the pace of changes to the API of these operating systems; which is probably off the scope of such research projects.

This is not only a “lesson learned” during the CHESS project, but a general issue when developing for mobile platforms. One has to find the level of natively implementations and non-native ones. Especially where focus is on content delivery, hybrid approaches seem to become state of the art, where a natively implemented app acts as a wrapper/presenter for content deployed via web technologies.

But this has also implications on an economical level, when it comes to make a choice for a specific device or platform for any museum or cultural institution today. Institutions need to find or define a baseline of platforms and devices they want to support. Because its not that apps are only created for once, but due to rapid changes to the OS platforms, apps need to be kept up to date in order to stay relevant to customers and visitors. This creates strong implications on functionality and costs, which thereby influence the features for such apps. Eg. when it comes to AR, 3D, indoor localization based either on NFC, BLE or WiFi triangulation – so basically anything close to what can be considered “emerging technologies” today – could become a critical factor without thorough considerations.

5 Coverage of user requirements and functional specifications

Deliverable *D03.12 Final User Requirements Analysis* lists, classifies and prioritises the CHESS user requirements that have been generated as an amalgamation of the results of their elicitation and analysis. Deliverable *D03.41 Beta Release Functional Specifications* presents the functional specifications for each of the user requirements. For the purposes of the third year review, the CHESS project has been asked to review these user requirements and specifications, to identify which have been covered, and to provide comments where they have not been covered. This information has been collected and presented in the following sections.

5.1 User requirements coverage

In D03.12, user requirements were grouped into three categories. An assessment of the coverage of these user requirements has been conducted.

Table 15 Partners who have provided information about user requirements

Element	Description
User experience requirements	The final user experience deployment was lead by NKUA, and hence coverage of user experience requirements has been provided by them.
Off-site user requirements	RF were responsible for the off-site experience, and hence user requirements coverage has been provided by RF.
Museum author requirements	DXT were responsible for the design of the CHESS Authoring Tool, and hence museum author requirements coverage has been provided by DXT.

5.1.1 User experience requirements (NKUA)

EUR/VI/01		**Respectful interactions**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The system should co-exist with organisational customs and practices for visitors to the museum site.

Related User Personas: All personas

Source: End-user Workshop.

Rationale: The focus should be on the exhibit and not the mobile technology. The purpose is to minimise the risk of colliding with exhibits. Particular interaction will appear to be unacceptable at a particular site. Especially for the Acropolis museum, this is an important requirement.

Covered (Yes/No): Yes

Comments: During formative and summative evaluation sessions no issue of users in danger of colliding with exhibits or other visitors was noted. Users switch their focus between the screen and their surroundings effortlessly as the mobile application design never requires the user to look at the screen and move in space at the same time.

However in the case of AM, special budges would be needed for visitors using the CHESS mobile experience as using the mobile device in the room may be misunderstood as an effort to make photos, a practice not allowed in the AM galleries.

EUR/VI/02		Avoid interrupting others	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Interaction with the system should not interrupt the visiting experience of other visitors (using CHESS or not).

Related User Personas: All personas

Source: End-user Workshop.

Rationale: Not all visitors are using the CHESS system and those visitors should not be disrupted.

Covered (Yes/No): Yes

Comments: CHESS users use headphones during the visit

EUR/VI/03		Transparent recording of the user profile	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The user preferences should be recorded / conveyed to the system in the most transparent way possible.

Related User Personas: All personas

Source: End-user Workshop.

Rationale: Visitors are not willing to waste time in the museum completing long questionnaires without any immediate advantage evident for them. The system should support intelligent profile elicitation methods. (See also related author requirement EUR/AU/05).

Covered (Yes/No): Yes

Comments: The CHESS questionnaire (CVS) is designed to be brief and part of the experience. There are also transparent dynamic profiling methods used, taking advantage of the user actions (menu selections and skips)

EUR/VI/04		Protecting the user's personal data	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: It should be guaranteed that the user's personal data should not be exploited.

Related User Personas: All personas

Source: Sessions with Acropolis Museum staff.

Rationale: Visitors are reluctant to provide their personal information without the guarantee that they will not be used for any purpose other than enriching their experience in the museum. They prefer that information provided is anonymous.

Covered (Yes/No): Yes

Comments: The user in not asked to provide name/surname, only a username or nickname.

EUR/VI/05		Providing a guided experience	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Have a guided tour of the collections according to user requests and profile.

Related User Personas: All personas

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: All the visitors feel that they can benefit from guidance in organizing their tour and being provided additional content when they need it. The experience can include different presentation forms (multimedia, text, games, augmented reality etc., according the story and user's needs).

Covered (Yes/No): Yes

Comments: The guided tour is implemented through storytelling and includes different presentation forms as needed.

EUR/VI/06		Providing an audio guide experience	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Have a guided tour in the form of an audio guide in the museum.

Related User Personas: Jack Harris; Georgia Athanasiou.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Certain visitors would like to receive information on demand on particular exhibits in the style of a museum audio guide.

Covered (Yes/No): Yes

Comments: The CHESS engine can support stories that will be designed as audio guide content.

EUR/VI/07		Providing a linear story experience	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Have a guided tour in the form of a linear story in the museum.

Related User Personas: Takis Karathanassis; Georgia Athanasiou.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Certain visitors prefer to be fully guided through the collections through an experience that links the exhibits into a meaningful “story”. This experience could involve multimedia but does not require interaction on the part of the user.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/08		Providing an interactive story experience	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Have a guided tour in the form of an interactive / branching story.

Related User Personas: Natalie Schmidt; Nikos Athanasiou; Lucas Durand; Céline Moreau.

Source: End-user Workshop.

Rationale: Certain visitors would like their experience in the museum to link different exhibits into a meaningful story, with which they will be able to interact and guide the experience according to their preferences.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/09		Interactive activities	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Experience the museum or exhibition through interactive activities / games.

Related User Personas: Nikos Athanasiou; Lucas Durand.

Source: End-user Workshop.

Rationale: For younger visitors, especially, it is important to experience the collections through games or digital interactive activities in general.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/10		Playful Engagement	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should allow the playful engagement with exhibits.

Related User Personas: All personas but mostly: Nikos Athanasiou; Lucas Durand; Jack Harris.

Source: Sensitizing study.

Rationale: Sometimes visitors clearly wish to play with aspects of an exhibit and are prevented from doing so as this would be in conflict with the need to create respectful interactions in certain settings. CHESS might allow playful interaction still, for example away from the exhibits context. Even when they are physically close to the exhibit, they can play using the device (e.g., PDA). Depending on the kind of game, exhibits can become a game element (e.g. having to insert exhibit label number, in order to learn a secret...).

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/11		Providing additional information	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: Be able to access additional information on specific exhibits or parts of the experience upon request.

Related User Personas: All personas.

Source: Sessions with Acropolis Museum staff.

Rationale: Visitors sometimes would like additional content on a specific element of the experience to be available when they need it. This information should be available upon request.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/12		Changing visit trajectories	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the user to pass effortlessly to a different content/storyline if needed. The system should be also adaptable (changes controlled by the user) and not fully adaptive (changes controlled by the system).

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Visitors would like to be able to change the current visit trajectory/experience by explicitly choosing another. Some visitors would like to feel in control of the experience and being able to switch to a different option if the current one is not interesting enough.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/13		Overview of the collection	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should provide an overview/preview of the collection.

Related User Personas: All personas.

Source: Sessions with Acropolis Museum staff; End-user Workshop.

Rationale: Most visitors would like a general introduction to the museum content before initiating their visit, in order to get a general sense of the content of the collections and plan their visit (e.g., to choose particular parts of the collections, to organise their time spent, etc.). This overview is of high importance as it supports museum navigation and realisation of the museum's size. Also, visitors of certain learning styles prefer to approach information in a top-down fashion.

Covered (Yes/No): Yes

Comments: It could be implemented as an introduction to the story.

EUR/VI/14		Proposing trajectories	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should support visitors in the construction of visit trajectories.

Related User Personas: All personas.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Beyond knowing what immediate next step to take, visitors can find it difficult to construct an overall trajectory of the museum visit. The system could suggest the museum highlights, e.g. things that must be seen, even in a quick visit.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/15		Recommending parts of the collection	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should provide recommendations on which parts of the collection to see.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Related variables: #14.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/16		Optimisation of visit trajectories	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should help visitors optimise their visit trajectories around the 'must-see' exhibits and experiences.

Related User Personas: Georgia Athanasiou; Natalie Schmidt; Céline Moreau.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Some exhibits are more important to a particular individual or group than others. Especially when contingencies occur, the trajectory will be adapted so that those important elements can still be experienced.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/17		Access to headline information	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should allow visitors to make rapid decisions on whether something is interesting to them or not.

Related User Personas: Natalie Schmidt.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: It is common for museum visitors to inspect 'headline' information rapidly first before engaging with content fully.

Covered (Yes/No): Yes

Comments: Titles and title notes are available in both menus and Narrator2 activities

EUR/VI/18		Adapting the experience to the user's characteristics	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should be adapted according to different aspects of the visitor's personality and interests.

Related User Personas: All personas.

Source: End-user Workshop; Visitor Observation sessions in Acropolis Museum.

Rationale: All visitors would like an experience tailored to their personal interests and needs. Different aspects of the visitor's personality and current preferences that play an important role for the museum experience have been listed in Section **Erreur ! Source du renvoi introuvable.** in the orm of variables.

Covered (Yes/No): Yes

Comments:

EUR/VI/19		Adapting to user interests	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience in the museum should match the visitor's interests in general.

Related User Personas: All personas.

Source: End-user Workshop; Visitor Observation sessions in Acropolis Museum.

Rationale: Related persona variables: #5, #14, #17, #18.

Covered (Yes/No): Yes

Comments:

EUR/VI/20		Adapting to user equipment	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience in the museum should match the visitor's equipment.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Appropriate presentation for different devices.

Covered (Yes/No): Yes

Comments: The interface and visual content scales gracefully to the various screen sizes of the supported devices (iPad, iPad mini).

EUR/VI/21		**Adapting to computing literacy**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should be open to being used by people with very widely varying computing skills

Related User Personas: All personas.

Source: Sessions with museum staff; End-user Workshop.

Rationale: Visitors have very widely varying skills in the use of mobile computing technology and computing in general. The system should be made appealing even for people that do not feel confident with technology, because they will most likely avoid the application all together. Related variable: #29.

Covered (Yes/No): Yes

Comments: Brief introductory tutorial is available before the experience.

EUR/VI/22		**Adapting to the visitor's language**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The museum experience should be available in the appropriate language for the visitor.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Since the CHESS prototype will be in English, this is not considered a priority. However, there should be provision for multilingual material, especially for the two museums' local languages during evaluation activities and Workshops. It has thus been decided to implement aspects of the system and content into different languages, namely in French for the beta version of CHESS (since this will be presented in June 2012 at the CITE during the User Group Workshop #2) and in Greek for the final version (to be presented at User Group Workshop #3). Related variables: #8.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/23		**Adapting to narration style**	**High**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The system should support the creation of different versions of the same textual or audio asset / content element for different visitor types.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Different visitors have different needs in terms of narration style, depending on age, educational level and language skills. Narration style in this case includes tone and gender of the voices, soundtrack, etc.

Covered (Yes/No): Yes

Comments:

EUR/VI/24		Adapting to physical capacities	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience in the museum should match the visitor's physical capacities.

Related User Personas: All personas.

Source: Sessions with museum staff.

Rationale: Accessibility issues and taking into account visitors with special needs should be considered, as they can affect an experience. Related variables: #10.

Covered (Yes/No): Yes

Comments: Content can be used to adapt the stories for different physical capabilities, adjusting the duration and the trajectory of the user in space.

EUR/VI/25		Adapting to the visitor style	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience in the museum should accommodate the visitor's visiting style.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Related variables: #11, #15. It should be noted that in most cases visiting style changes completely when the visitor is in a group.

Covered (Yes/No): Yes

Comments: It is an issue of appropriate content design.

EUR/VI/26		Adapting to user preferences	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should adapt to visitor preferences.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: -

Covered (Yes/No): Yes

Comments:

EUR/VI/27		Taking into account previous visits	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should take into account which parts of the collection have been seen in a previous visit.

Related User Personas: All personas.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Many visitors return. When they do, the system should take into account what they have seen before and what has interested them before. Related variables: #15, #16.

Covered (Yes/No): Yes

Comments: The personalization profile of the user is saved at the end of their visit to be used by the personalization system when the visitor returns.

EUR/VI/28		Adapting to visit duration	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should take into account visit duration, including breaks and pauses in general.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: This is not only a matter of taking into account what is the real time spent with the exhibits but also how to return smoothly to the experience after each break. Related variables: #16.

Covered (Yes/No): Yes

Comments:

EUR/VI/29		Adapting to user level of fatigue	Low
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should be adaptive to the visitor's level of fatigue which may depend on what other visits have recently been made to other museums/exhibitions, on weather conditions, etc.

Related User Personas: All personas.

Source: Visitor Observation sessions in Acropolis Museum.

Rationale: Visitors, especially tourists, may visit a number of places on the same holiday, sometimes on the same day. The system should be able to take things such as visit fatigue and visit differentiation into account. The time of the day can be used: if the visit is early in the morning one can assume low fatigue; if it is in the afternoon, one can assume higher fatigue. Same goes with weather conditions: high fatigue for high temperatures.

Covered (Yes/No): Yes

Comments: It is a matter of appropriate content design and design of the personalization scheme.

EUR/VI/30		Encumbered use	Low
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should be open to being used where visitors are encumbered.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions in Acropolis Museum.

Rationale: Visitors carry bags and clothes. They carry souvenirs bought in the shop. They carry small children. CHESS should be useable when visitors are encumbered in such ways or aim to engage where encumbrances can be put to one side.

Covered (Yes/No): Yes

Comments: The ipad can be held with one hand if needed.

EUR/VI/31		Choosing parts of the collection	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The experience should provide the option which parts of the collection to see.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: The "parts" could even be specific exhibits. Related variables: #13, #14.

Covered (Yes/No): Yes

Comments: Story design can cover this requirement as the story may be created so as to allow the user to select early on story branches related to his/her preferred parts of the collection.

EUR/VI/32		Adapting to existing visitor flow	Low
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should be adaptive to the existing overall visitor flow and attraction schedules (in addition to contingencies) found at the participating sites.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: The flow of visitors and the availability of activities that can become part of a visitor's schedule change over time (daily, weekly and monthly).

Covered (Yes/No): Yes

Comments: Different stories may be offered by the museum at different periods.

EUR/VI/33		Adapting to on-the-ground contingencies	High
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should be adaptive to on-the-ground contingencies (such as congestion around exhibits that would normally be integral to a scenario or their schedule).

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: The CHESS system and its users will operate in an environment that is driven by its own independent schedule. This schedule will invariably impact the possible choices that users have.

Covered (Yes/No): Yes

Comments: As the project summative evaluation has shown, users had no problem adjusting slightly their trajectory to handle congested points in the Gallery.

EUR/VI/34		Location in the environment	High
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should inform visitors about where they are located in the museum.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: One of the main difficulties for visitors in large museum spaces is to know where they are located, before making the most appropriate choice to continue. A kind of "You Are Here" feature, such as the ones found on static map panels, could be considered.

Covered (Yes/No): Yes

Comments: CHESS has implemented appropriate map navigation activity with QR code scanning to verify the visitor position and show his/her position on a map.

EUR/VI/35		Legibility of environment	Medium
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should support visitors in understanding the museum layout (directions, suggestions).

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Museum spaces offer a large amount of content and it is often difficult for visitors to navigate or make the most appropriate choice of what to see next.

Covered (Yes/No): Yes

Comments: CHESS guides the visitor with appropriate navigation clues to the destination.

EUR/VI/36	**Orientation to exhibits**	**Medium**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should allow visitors to make rapid decisions on whether something is interesting to them or not.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Exhibits and individual features of exhibits are frequently best seen from a particular angle and location.

Covered (Yes/No): Yes

Comments: CHESS offers the possibility of teaser text and icons to be presented in menus so as to help the visitor make more informed decisions.

EUR/VI/37	**Engagement with exhibits**	**Medium**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should support visitors in maintaining the appropriate distance from objects (e.g. view, touch, move, etc.) and manage their engagement.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Different exhibits have a large range of appropriate interactions associated with them. Some are designed to be carried (rare), frequently touch is encouraged (interactive) and in most cases, only viewing is permitted.

Covered (Yes/No): Yes

Comments: This is an issue of appropriate content creation that will guide the user.

EUR/VI/38	**Surfacing exhibition design**	**High**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should respect and make visible the exhibition design and thematic coherence of the exhibits.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Museum exhibits can appear standalone and thematically unconnected to visitors. Some museums attempt to hide explicit interpretations; others wish to provide a clear view of their curators' decisions. The answer here is not straightforward and depends on what each museum's aim is, and on the educational model followed.

Covered (Yes/No): Yes

Comments: It is a matter of appropriate content design.

EUR/VI/39		Group variations	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should allow users to change their interests or profile depending on who they visit with and for what purpose / occasion.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Visitors come for different reasons and in different group configurations. Their interests vary depending on who they visit with. For example, a parent coming with their child is likely to take a different interest from when they come with their friend.

Covered (Yes/No): Yes

Comments: By re-taking the CHESS visitor quiz, the user can modify his/her profile.

EUR/VI/40		Supporting families	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should support families visiting together.

Related User Personas: All personas.

Source: Sensitizing study.

Rationale: A very large proportion of visitors to CITE and a sizeable proportion of visitors to AM are family groups. Even when those split up during the visit they remain in smaller groups (e.g. one parent with the children).

Covered (Yes/No): Yes

Comments: 2 members of the family could share the same ipad with headphones or all members of the family could listen to the same story.

EUR/VI/41		Supporting school visits	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should support school classes visiting.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Families and schools are among the most common museum visitors, with certain learning needs.

Covered (Yes/No): Yes

Comments: It is an issue of content design and splitting the groups into smaller ones.

EUR/VI/42		Flexible lead	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should be flexible about who takes the lead in a group.

Related User Personas: All personas.

Source: Sensitizing study.

Rationale: Especially for families, it is frequently the child who takes the lead

Covered (Yes/No): Yes

Comments: The users decide who has control of the device.

EUR/VI/43		Supporting different ages in groups	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should accommodate the interests of different age groups, from young children to the elderly, without breaching the capacity of a group to continue to go round a museum together.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: -

Covered (Yes/No): Yes

Comments: Group stories should be designed so as to maintain the same trajectory even though the content may be different.

EUR/VI/44		Reflect group trajectory	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: When multiple instances of CHESS are used in the same group, the system should take into account the group's overall trajectory and coherence.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: Groups, especially larger, guided and family groups, have overall trajectories through an exhibition. Where multiple individuals have a CHESS device in such a group, the content on their interface should reflect that fact, instead of suggesting content that moves individuals away from the group.

Covered (Yes/No): Yes

Comments: Group stories should be designed so as to maintain the same trajectory even though the content may be different.

EUR/VI/45		Group fragmentation	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: When groups become fragmented, CHESS should support people coming back together again.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: Group fragmentation is a frequent feature of museum visits. Visitors do not always find it easy to re-convene in a simple way.

Covered (Yes/No): Yes

Comments: Group stories should be designed with the same trajectory and check points in the plot to make sure the group can easily re-convene.

EUR/VI/46		Group awareness	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should allow members of a group to be aware of what other group members are currently engaged in.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: Especially, when groups are fragmented, visitors might benefit from being re-connected through the system, especially when many museum systems have failed due to the technology isolating powers.

Covered (Yes/No): Yes

Comments: Group stories should be designed with the same trajectory and check points in the plot to make sure the group can easily re-convene.

EUR/VI/47		**Respecting group dynamics**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should support different ways in which members of the same group may interact with one another.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: Within any one group, the interactions between the different members of the group are not all equal or structured in the same way. It is important that the system allows these dynamics to be preserved rather than forcing them to change. In all groups, you have at least one leader (sometimes you have a leader to organise the job and another leader to make sure everyone has a good time), someone that does all the work, someone that does no work and some followers... the roles are clear and well described in group psychology. Supporting the different group roles could also be considered.

Covered (Yes/No): Yes

Comments: It can be supported with appropriate content design for different story versions for the different group members.

EUR/VI/48		**Sharing information across the group**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should enable some of the same information to be broadcast to all members of a group rather than just one member acting as a relay.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: A common frustration amongst visitors in groups is that only one or two of them has the majority of the information about the site at any one time so the others are not fully able to engage in negotiations about what to do next.

Covered (Yes/No): Yes

Comments: It can be supported with appropriate content design.

EUR/VI/49		**Explaining to others**	**High**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: CHESS should allow visitors to use it for explaining information to others.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: When visitors are in groups there are frequently different levels of expertise (guide/guided groups, parent/child). The ‘guide’ might not always have the necessary resources to explain an exhibit to the ‘guided’.

Covered (Yes/No): Yes

Comments:

EUR/VI/50		Interaction continuing beyond the exhibit	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should allow visitors to interact with exhibits when they move away from them.

Related User Personas: All personas.

Source: Visitor Observation sessions.

Rationale: In very many group circumstances certain individuals are dragged away from exhibits by others in the group before they have finished reading about them. Information is currently attached to the object but the desire to 'finish' reading could be met by allowing the information to flow with the visitor.

Covered (Yes/No): Yes

Comments: This option could be available through the souvenir functionality or re-visiting the story on-line.

EUR/VI/51		Souvenirs	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: CHESS should support the generation or interaction with post-visit souvenirs.

Related User Personas: All personas.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Souvenirs are popular with visitors and museums (revenue). CHESS offers the opportunity to allow an extra layer of interaction when taking account virtual and physical souvenirs emerging from visits.

Covered (Yes/No): Yes

Comments:

EUR/VI/52		Adapting to visual aesthetics	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the creation of different versions of the of same visual asset / content element (image or photograph) for different visitor preferences.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Different visitors have different preferences in visual arts that could be taken into account when possible to make additional assets more appealing and interesting.

Covered (Yes/No): Yes

Comments: It can be supported with appropriate content design.

EUR/VI/53		Transforming profile recording into an experience	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the creation of appealing questionnaires for the initial user profile recording. Different types of questions should be supported, including both textual and visual elements.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: To approach the “cold-start” problem and record the initial user profile the brief questionnaire used should be possible to be turned into an appealing experience, possibly with story-telling elements as well.

Covered (Yes/No): Yes

Comments: The CVS can be edited according to the user and content needs.

EUR/VI/54		Transparent navigation	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should provide to the user navigation methods from one hotspot to the next without disrupting the user immersion in the visit experience.

Related User Personas: All personas.

Source: End-user Workshop.

Rationale: Navigation between the hotspots the user should be at each part of the experience should take into account that different museum spaces have different needs in terms of describing the space and guiding the user. A variety of navigation methods should be possible and provide per case.

Covered (Yes/No): Yes

Comments:

5.1.2 Off-site visitor requirements (RF)

The following are the end-user requirements (EUR) concerning museum visitors (VI) who are experiencing the museum “virtually”, via the Web. The on-line CHESS experience could be used to complement the actual visit (before and/or after an actual visit to the museum) or instead of an actual visit.

EUR/WE/01		**Preparing the visit**	**High**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The visitor can access all necessary content on museum exhibits, plan and layout, etc. in order to prepare for the visit.

Related User Personas: Georgia Athanasiou; Céline Moreau, Natalie Schmidt.

Source: Visitor Observation sessions.

Rationale: Many visitors express the wish to be able to use the website as a means to organise their visit and decide which content is more interesting for them.

Covered (Yes/No): Partial

Comments: The WES contains a demonstration web page containing the latest museum exhibits and a time schedule to help the user preparing his visit.

EUR/WE/02		**Taking into account previous visits**	**Medium**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The website visit should take into account previously accessed information as well as previous museum visits.

Related User Personas: Georgia Athanasiou; Céline Moreau, Natalie Schmidt.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Visitors who seek an in-depth experience in the museum would like to be able to have an overview of which parts of the collections they have visited and what information they have reviewed on the website.

Covered (Yes/No): Partial

Comments: See requirement EUR/VI/27

EUR/WE/03		**Extend the visit through the web**	**High**
Cf.	**Requirement ID**	**Requirement Name - Title**	**Requirement Priority**

Description: The web experience should be a means to experience additional content related to the visit.

Related User Personas: Céline Moreau, Natalie Schmidt, Jack Harris; Lucas Durand; Nikos Athanasiou.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: The user’s sense of presence in the “virtual” on-line museum space can be enhanced through a map and/or a panoramic walkthrough of the museum halls.

Covered (Yes/No): Partial

Comments: This feature was not implemented in the WES but is available through specific activities. In those activities, the player has an access to a 2D or a 3D map to help him to locate in the museum. In other activities, this map is a component of a game in which he has to guess its next destination.

EUR/WE/04	**Play on-line games**	**Medium**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: Younger visitors would like to play games related to the collections and exhibits.

Related User Personas: Lucas Durand; Nikos Athanasiou.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Educational games are very important as means to enhance the experience for younger visitors and to attract them to spend time on the website.

Covered (Yes/No): Yes

Comments: The WES includes a version of the MES to let the user play activities

EUR/WE/05	**Download material**	**Medium**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: Visitors should be able to download material with information and stories related to the museum's collections and exhibits.

Related User Personas: Jack Harris; Lucas Durand.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: -

Covered (Yes/No): No

Comments:

The museum collection and exhibits are available in the visit preparation section of the WES (see requirement EUR/WE/01). The section content is generated by extracting dynamically data from the museum website. For now, this parsing is based on heuristics built on an analysis of the web page layout.

In order to publish any downloadable content, the WES should be able to track down such data on the museum website. However, at the time of the writing, neither the Acropolis Museum nor the Cite de l'Espace website exposes an interface to fetch automatically such content. Once this interface is provided by the museums, it would be possible to implement the requirement in the WES.

EUR/WE/06	**Receive notifications**	**Low**
Cf. Requirement ID	**Requirement Name - Title**	**Requirement Priority**

Description: Visitors should be able to receive notifications when new material is available on the web.

Related User Personas: Natalie Schmidt; Céline Moreau; Georgia Athanasiou.

Source: Sensitizing study; Visitor Observation sessions.

Rationale: Notification is typically sent through e-mail, RSS, SMS, etc.

Covered (Yes/No): No

Comments: This requirement depends on the previous one (EUR/WE/05). Since this former requirement is not implemented, this later cannot be fulfilled.

5.1.3 Museum author requirements (DXT)

EUR/AU/01		Creating material for different user groups	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should be able to support authors to create different types of material for the needs of different visitor types, according to the goals of the museum (e.g., to promote education, entertainment, etc.).

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: Authors believe it is necessary to be able to tailor the material to the needs of the identified user groups (visitor types). Adaptation should include the content.

Covered (Yes/No): Yes

Comments: Different assets or script nodes can be use according to personalisation parameters : age, interests, visitor objectives (learning or playing), ... During the experience, the personalisation engine, will select automatically the suitable option.

EUR/AU/02		Creating material for different visit objectives	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should be able to support different types of material for different visit objectives (e.g., to promote education, entertainment, etc.).

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: Authors feel that the authoring tool(s) should support different content and presentation types, such as games, interactive activities, multimedia, etc.

Covered (Yes/No): Yes

Comments: The Authoring Tool activity library contains several activities for different visit objectives (learning or playing): games, AR activities, book-like narration, slideshow, video player, ...

EUR/AU/03		Digital reconstructions	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should be able to present reconstructions of objects, exhibits or content that the museum considers important.

Related User Personas: Ellie Petrou.

Source: Sessions with Acropolis museum staff.

Rationale: The AM curators would like to present the digital reconstructions of selected exhibits as they were in their original form, which includes, for example, the missing parts of statues or the bright colours of paint covering them. These reconstructions would be well presented via augmented reality.

Covered (Yes/No): Yes

Comments: The Authoring Tool displays a 3D view of the museum including the important exhibits. The scanned 3D models can then be simplified thanks to the RF patented algorithms that simplify the meshes keeping as much as possible their visual aspect. The author can then stage them on the map and define areas around the hotspot to define the interaction zone.

EUR/AU/04		Continuous use of the system	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The high density of exhibits or the low precision of the geolocalisation system should not impede the use of the experiencing system.

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: This is especially acute in the case of the AM's Archaic Gallery.

Covered (Yes/No): Yes

Comments: A workaround for this kind of issue is either to ask to the visitor if he is in front of the exhibit, or to scan a QR code placed in front of the exhibit. This mechanism has for example been successfully used in the MIR station at CITE during the 2nd year of the project. Currently the state of the art in indoor localisation systems only offers systems with a 4m precision without any external equipment, which is not sufficient for the MIR station example.

EUR/AU/05		Recording the user profile	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should be able to record all the information about the user needed for an adaptive experience.

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: Detailed information for each user of the CHESS system is needed to match the user to personas and, ultimately, to stories and experience scenarios. According to the authors, it is important to recognise early on the profile of the user in order to know how to provide the appropriate content in the most suitable way.

Covered (Yes/No): Yes

Comments: The MES regularly send information about the experience to the Hub. The Hub forward some information to the STE in order to update the visitor profile and retrieve the activities suggested by the STE.

EUR/AU/06		Quick authoring	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The authoring system should be an effective and intuitive tool, even for authors with limited computer expertise.

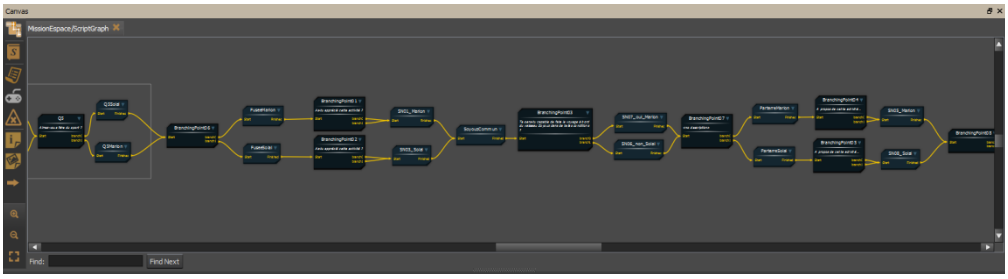
Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: The issue of CHESS story authoring impeding day to day author tasks has been mentioned as a concern. Hence, usability and learnability are paramount -the tool should minimise the effort needed to learn and use it.

Covered (Yes/No): Yes

Comments: The CAT has been successfully used during the last year of the project by museum curators and professionals with no development skills. Thanks to the CAT, they created custom personalised and adaptive stories by themselves that have been used for the different events. Number of elements have been designed in an iterative process to meet this requirement such as the visual authoring graph, the activity library, the story template, the parameter set, and many other widgets and layouts.



EUR/AU/07		Supporting creativity	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The authoring system should provide easy access to a variety of digital content that can be combined in different ways to be meaningful for different visitor types.

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: Authoring should be a creative process that supports the users in compiling appealing stories.

Covered (Yes/No): Yes

Comments: The CAT asset manager allows to browse a list of assets that can be used in different activities. The activity library offers different kind of activities to be put together and build a custom personalised story. In addition we integrated an ontology browser in the asset manager and in order to retrieve easily related assets by similarity matches.

EUR/AU/08		Supporting re-usability	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should make available previously created content (story elements and resources) for re-use in different stories.

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: Mixing and matching of previous story elements may be a good way to minimise the staff's effort of creating new stories.

Covered (Yes/No): Yes

Comments: All the assets created for a given workspace (or museum) are available for all the user working on the same workspace. Moreover, we added a notion of templates that initialize easily a project with common attributes and map. Activities can also be shared as they are contained in an external resource folder on the disk. Thus to add an external activity, an author just have to copy the activity folder to this location.

EUR/AU/09		Designing profile recording	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the authoring of questionnaires for the profile recording.

Related User Personas: All author personas.

Source: Sessions with museum staff.

Rationale: This should support different question types with flexibility in supporting different visitor personas (for example different questionnaires for children and adults)

Covered (Yes/No): Partially

Comments: An alternative questionnaire based on a succession of "feedback" branching points and story nodes simulates a CVS on the mobile. However, since the CVS should run on the WES, it has to be created by the web designer of the museum website.

EUR/AU/10		Designing the experience outline	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the authoring of experience outlines and overviews with the possibility to zoom-in and edit when needed.

Source: Sessions with museum staff.

Rationale: Visual overviews should be offered here to provide a better overview of the story and the overall experience

Covered (Yes/No): Yes

Comments: The story can be authored at different levels: The first level is the scripting level, where the author has to put together the "script nodes" that can be viewed as the chapters of the story. Then he can stage these nodes to hotspots on the map (staging phase). Finally he can enter into each of these script nodes to edit them (editing phase) as a sequence of activities. Each activity can be configured thanks to the parameter editor.

EUR/AU/11		Setting hotspots on the exhibition map	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

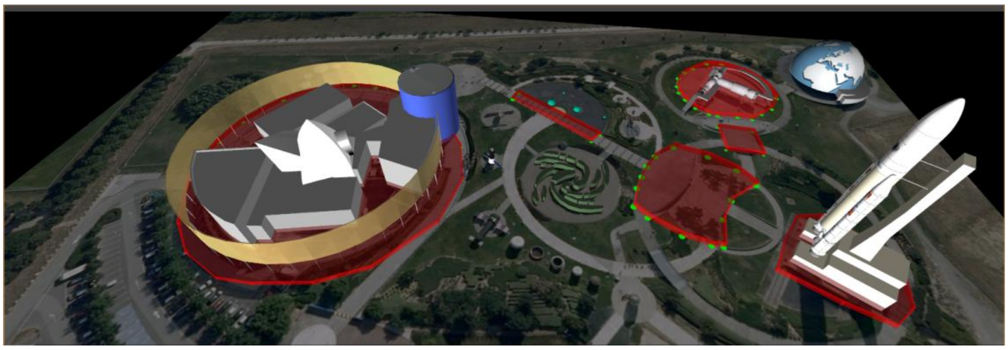
Description: The system should support the authoring of hotspots on a map of the exhibition spaces, to be used for the experience authoring in order to link the museum space and exhibits with particular story elements and activities

Source: Sessions with museum staff.

Rationale: Coupling the experience with the physical location and exhibits is very important.

Covered (Yes/No): Yes

Comments: The CAT offers the capability of defining hotspots on the museum map in a user friendly way: it consists only in drawing the bounds of the area directly on the map (in 2D). Then, the author can extrude this 2D shape to create a 3D area and move each of its control point to generate more complex shapes.



EUR/AU/12		Designing activities	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the authoring of activity requirements which will guide the production of particular story elements. The author should be able to provide textual descriptions as well visual assets that will guide the production processes.

Source: Sessions with museum staff.

Rationale:

Covered (Yes/No): Partially

Comments: CHESS activities are written in HTML5 and JS. They can be authored with any external text editor. As this phase requires technical and development skills, it has not been directly integrated into the tool, but as an external activity library. We defined an activity template and guidelines that have to be followed by an activity author in order to be automatically integrated into the authoring tool. Thus, the authoring tool automatically generates the parameter GUI of the activity thanks to the activity manifest files. This manifest also includes a description field of the activity that will be displayed in the activity library. Finally, each parameter of the activity can be associated to a tooltip description describing the purpose of the parameter to guide the author in the activity setup.

EUR/AU/13		Designing narration activities	Medium
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

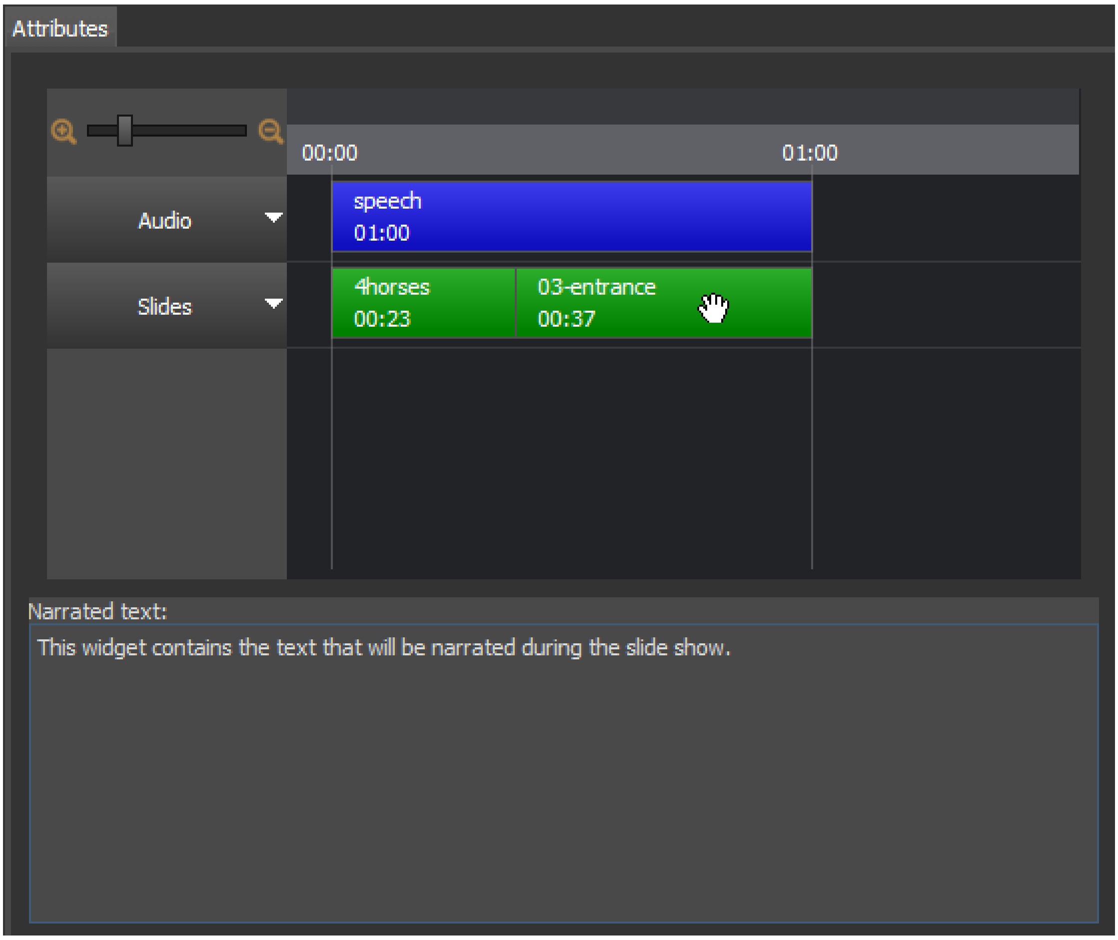
Description: The system should provide an appropriate narration editor to support the museum staff in creating narration activities. It should include the possibility to synchronize text, visual assets (images and video) as well as audio into a single presentation to be linked with a specific story element.

Source: Sessions with museum staff.

Rationale: Narration activities are the backbone of the CHESS experience.

Covered (Yes/No): Yes

Comments: A specific GUI has been designed for narrator activities. This widget is a double timeline to edit the audio track on the first track and the sequence of slides on the second track. Each slide can be scaled in order to be synchronized with the sound track. The audio track can be generated by the Text-To-Speech (TTS) feature integrated in the CAT. This feature was a strong requirement of the end-users who wanted to simulate the story before ordering the records to an external production studio.



EUR/AU/14		Managing assets	High
Cf.	Requirement ID	Requirement Name - Title	Requirement Priority

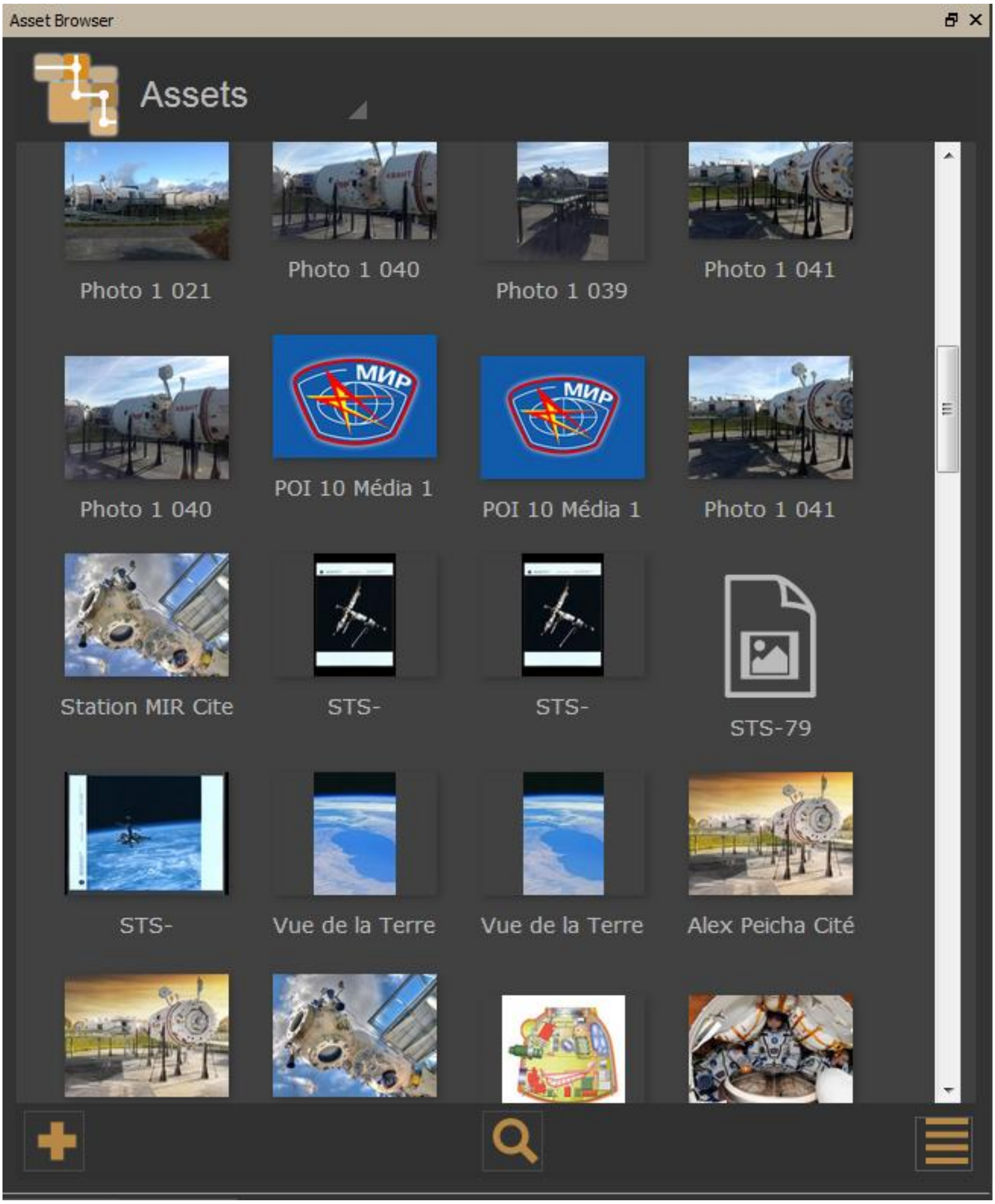
Description: The system should provide an appropriate tool to manage the audiovisual and textual assets gathered by the museum staff to be used in the creation of experiences. It should support saving, searching and browsing of the assets according user defined metadata.

Source: Sessions with museum staff.

Rationale: Re-usability of assets is very important.

Covered (Yes/No): Yes

Comments: The asset manager has been developed in the frame of CHESS. This asset manager is shared between all the authors working on the same space. This shared database of assets enables a tight collaboration between the museum curators who gather digital material on the collections and the author. Moreover, the assets are stored online, on the Hub and automatically and transparently translated to all the major codecs for the targeted platforms.



EUR/AU/15	Managing personas	Medium
Cf. Requirement ID	Requirement Name - Title	Requirement Priority

Description: The system should support the definition and management of visitor personas to be used for the story element tagging and the profiling, in order to enhance the personalization experience

Source: Sessions with museum staff.

Rationale: Personas are a useful design tool for story authors and the museum staff.

Covered (Yes/No): No

Comments: At the beginning of the project, we introduced the notion of persona into the Authoring Tool, however, an early feedback of the end-users mentioned that it was hard to design branching points conditions based on these personas as they represent a lot of concepts at the same time. To have a better control on the story parameterisation, they suggested to use instead a list of "topics" predefined for a museum. For example, at the Acropolis Museum these topics were: "Gods & Heros", "War fights and cunning ploys", "Animals", "Monsters", "Everyday life", "Athletics", "Social Structures", "Laws and politics".

Persona are still defined in the Authoring Tool in order to help the authors to communicate but their role was lowered for the story authoring. They are still widely used on the personalisation engine side to bind these topics to personas with an associated weight.

5.2 Functional specifications coverage

Functional specifications relate directly to specific CHESS components. As such, coverage of these functional specifications has been provided by partners responsible for those components.

5.2.1 The Hub (DXT)

FS/WS/01	Clients connect to the Hub over a RESTful interface.	Mandatory

Description: Interfacing with the Hub is done over a Representation State Transfer (REST) interface to simplify communications between components. Resources are uniquely using URLs, and common HTTP verbs such as GET, POST, PUT, and DELETE are supported as needed.

Constraints and assumptions: A growing number of web services use as REST as an architecture, replacing SOAP and RPC-style interfaces. Because it is client-server, stateless and cacheable, it is easy to support in any client, ranging from web browsers, mobile applications, and desktop applications. REST is a software architecture, and not a fixed protocol. As a result, specialized code will have to be written on the clients to interface with it, although this code can use the many widely available HTTP client libraries.

Covered (Yes/No): Yes

Comments: The Hub is only accessible with a REST interface that has been documented for the needs of each end-users. The requests allows to the clients to upload, update or remove entities or assets. Some other requests are used to retrieve statistics from the Hub database.

Example of the Hub users guide:

Get list of available spaces

GET http://chesshub.diginext.fr/space?<ARGUMENTS>

Argument	Description	Default value
tag	Tag filter	
type	Type filter	
Field	Field filter	Path, createdTime, tags, type

Exemples:
http://chesshub.diginext.fr/space
http://chesshub.diginext.fr/space?type=CppUtSpaceType&field=createdTime&field=type

Create an entity
POST http://chesshub.diginext.fr/space/<SPACE_ID>/entity
Exemple of body:

```
{
        "content": {
                "mimeType": "audio",
                "variations": {
                        "raw": {
                        "mimeType": "audio/mp3",
                        "path": "/space/AcropolisMuseum/asset/523039141d41c80753916fdd"
```

```
                    }
                },
                "properties": {"name": "Maid with the Flaxen Hair"},
                "formats": {"raw": "/space/AcropolisMuseum/asset/523039141d41c80753916fdd"}
        },
        "type": "asset",
        "tags": ["__new__"]
}
```


FS/WS/02	Clients exchange data with the Hub using JSON formatting.	Mandatory

Description: With the exception of assets, which is formatted using its native MIME-type, all data sent to and returned from the Hub is done in JavaScript Object Notation (JSON) format.

Constraints and assumptions: JSON is a lightweight format can be trivially parsed by web browsers, and libraries for reading and writing JSON are available in every programming language and platform. In addition, it is less verbose than XML, and a more direct translation of object structures.

Covered (Yes/No): Yes

Comments: All the entities and the asset description are transferred and stored in JSON format (see previous example). This JSON description is used from the MES to automatically generate JS objects.

FS/WS/03	Clients can organize their data into spaces on the Hub.	Mandatory

Description: In order to separate different uses of the Hub (for example, by museum or by release), all data (messages, objects, and assets) are grouped into *spaces*. Spaces can be listed, added and deleted, and may contain meta-data of their own.

Constraints and assumptions: Spaces may be identified by a unique name.

Covered (Yes/No): Yes

Comments: Spaces can be seen as workspaces into which all the assets and visitor history are stored. The spaces can be list with the request given as an example in section FS/WS/01. Each space suffice as a standalone set of assets and entities for a given museum. Though we can store multiple stories of different museums.

FS/WS/04	Clients can post, retrieve, and list messages on the Hub.	Mandatory

Description: A client posts a JSON formatted message to the Hub, including any fields desired. The message is immediately time stamped and available for other clients to list and download.

Constraints and assumptions: Once posted, the message is immutable. It is only erased when the containing space is deleted.

Covered (Yes/No): Yes

Comments: Each request on the entities is tracked by an event on the Hub automatically generated. This allows to retrieve the order of the operations done on the Hub. A request can list all the events.

FS/WS/05	Clients can add, modify, list, and remove versioned objects in the Hub.	Mandatory
Cf. EUR/VI/51	Souvenirs	Medium
Cf. EUR/AU/05	Recording of the user profile	High

Description: Unlike messages, which are immutable, objects can be modified; in which case a new version is created that replaces the old one, without deleting the old data. The set of objects available at a given time can be found by querying a message.

Constraints and assumptions: Object modification is done by posting a new message with *object updates* attached. The object updates are applied to the current set of objects. If the Hub detects that the object update does not apply to the current version of the object (i.e. the client tries to modify a deleted object, or an object that has already been modified) it may reject the message.

Covered (Yes/No): Yes

Comments: CRUD operations (creation, read, update and deletion) on objects can be done thanks to HTTP requests. We implemented a patch mechanism in order to update only a sub-part of the object and not the whole object each time an attribute (or a set of attributes) are changed.

FS/WS/06	**Clients can add, remove, list, and update assets on the Hub.**	**Mandatory**
Cf. EUR/AU/03	**Digital reconstructions**	**Medium**

Description: An asset represents data that can be downloaded directly from the Hub as if it was a static file. Assets can be added, removed, listed, and updated. Old versions of assets are not kept.

Constraints and assumptions: An asset is always returned by its MIME type, although meta-data can be queried separately.

Covered (Yes/No): Yes

Comments: Each asset is represented as a JSON entity. This entity lists the different variations of this asset data (i.e. the different encoding of the assets for the different platforms and at various definition). Then, all the assets can be retrieved thanks to HTTP requests:

Get list of asset

GET http://chesshub.diginext.fr/space/<SPACE_ID>/asset?<ARGUMENTS>

Create an asset POST http://chesshub.diginext.fr/space/<SPACE_ID>/asset?<ARGUMENTS>

Create an asset (with ID) PUT http://chesshub.diginext.fr/space/<SPACE_ID>/asset/<ASSET_ID>?<ARGUMENTS>

Get an asset or its information

GET http://chesshub.diginext.fr/space/<SPACE_ID>/asset/<ASSET_ID>?<ARGUMENTS>

Delete an asset

DELETE http://chesshub.diginext.fr/space/<SPACE_ID>/asset/<ASSET_ID>

FS/WS/07	**Many clients can connect simultaneously to the Hub.**	**Mandatory**

Description: The Hub should be able to efficiently handle a “worse-case” scenario of many simultaneous users while still providing a high quality of service.

Constraints and assumptions: The exact number of users to support will be determined during preparation for the beta and final releases. It is not the goal of the project to provide a million-user scalable system, but to produce a product that works well for an upper bound on the number of visitors a museum expects.

Covered (Yes/No): Yes

Comments: We didn't focus our efforts on HUB performances because it's not so relevant in this context, in fact in a museum we have at most 50 000 visitors per day[16] All these visitors will not be inside the museum in the same time which reduce HUB usage. In this context, the Hub performances are sufficient.

[16] based on Wikipedia figures between Acropolis museum, Cité de l'Espace and Le Louvre attendance levels.

FS/WS/08	An administrator can install the Hub on commodity systems.	Mandatory

Description: The Hub should support hardware and operating systems that are widely and cheaply available, including on cloud providers such as Amazon EC2.

Constraints and assumptions: Note that not *all* operating systems need to be supported as long as the supported one(s) are common enough.

Covered (Yes/No): Partially

Comments: The Hub is muli-platform and can run either on Linux or Windows servers as the technologies it is based on (Tornado, MongoDB) are multi-platform.

FS/WS/09	An administrator can quickly restart the Hub.	Mandatory

Description: In case of failure, an administrator must be able to shutdown and restart the Hub in a short period of time, such as 60 seconds.

Constraints and assumptions: In order to control the service, the administrator will probably need privileged remote access to the machine (e.g. SSH), which is not counted in the 60 second period.

Covered (Yes/No): Yes

Comments: The connection to the Hub can be done through a secured SSH connection thanks to a registered security key. Launching the Hub server and the database only consist in launching the Tornado server and MongoDB services. Both commands have been encapsulated into a single script to make it even easier.

FS/WS/10	An administrator can backup and restore the Hub.	Mandatory

Description: The administrator can make regular backups of the data on the Hub. In case of failure, the administrator can restore one of these backups.

Constraints and assumptions: Backing up and restoring may require a small amount of system downtime.

Covered (Yes/No):Yes

Comments: The Hub backup and restore operations only consists in saving and restoring the MongoDB database. These commands are part of the MongoDB terminal commands. We also created a tool allowing the authors to retrieve and save locally (on their HDD) their story. The same tool can be used to deploy the local archive on a different instance of the Hub on on the same instance in case of failure.

FS/WS/11	Clients can search for objects, messages, and assets in the Hub.	Important
Cf. EUR/VI/17	Access to headline information	Medium
Cf. EUR/VI/11	Providing additional information	High
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf. EUR/VI/19	Adapting to user interests	High

Description: A client can search for objects and messages based on their fields. Assets can be searched for using their meta-data.

Constraints and assumptions: For performance reasons, searching may be limited to a subset of fields that can be efficiently indexed. This may include tags or key-value pairs.

Covered (Yes/No): Yes

Comments: The following requests list the entities and the assets of the given space.
GET http://chesshub.diginext.fr/space/<SPACE_ID>/entity
GET http://chesshub.diginext.fr/space/<SPACE_ID>/assets
Adding some attributes to the request filters the objects. For example, in the following request, only

the objects which attribute "tag" equals "myTag" will be displayed: GET http://chesshub.diginext.fr/space/<SPACE_ID>/asset?tag=myTag

FS/WS/12	**Clients can filter objects and messages based on field in the Hub.**	**Important**
Cf. EUR/VI/18	**Adapting the experience to the user's characteristics**	**High**
Cf. EUR/VI/19	**Adapting to user interests**	**High**

Description: In the case of large objects, or lists of many objects, it may be that only a subset of the provided fields is interesting to the client. In this case the client can specify the fields that they wish returned.

Constraints and assumptions: If the client does not specify a field set, all available fields are returned.

Covered (Yes/No): Yes

Comments: In addition with the previous requests, the content of the result can also be filtered to only display relevant attributes for performance reasons. In the following example, only the field that are mentioned on the URL will be displayed. Thus, the user can retrieve quickly a specific attribute of complex objects : GET http://chesshub.diginext.fr/space/<SPACE_ID>/entity?field=path GET http://chesshub.diginext.fr/space/<SPACE_ID>/asset?field=contentPath In the first case, only the path of the activities will be displayed. In the second example, only the contentPath of the asset is displayed for all the matching objects.

FS/WS/13	**An administrator can test the performance of the Hub using provided tools.**	**Important**

Description: In order to help the administrator determine if the system can handle the expected load of visitors (see FS/WS/07), she can use stress-testing tools provided by CHESS.

Constraints and assumptions: The stress-testing tools should provide information on the performance provided by the system (min, max, and mean statistics on delay, transfer speeds, etc.) for a given number of users.

Covered (Yes/No): No

Comments: As network administrators have their own toolset for testing one server performances, this requirement priority was lowered. Standard network administration tools sufficed to find out the origin of the network latencies.

FS/WS/14	**A client can be notified of changes on the Hub without polling.**	**Important**
Cf. EUR/VI/20	**Adapting to user equipment**	**High**

Description: Using a *push* rather than *pull* model to receive notifications may be more efficient and/or bandwidth-saving for a large number of clients. This can be done using *Comet* (or *long-polling*) techniques that do not close an HTTP connection after the original request has been fulfilled.

Constraints and assumptions: The importance of this feature will have to be established once the performance of the system has been evaluated.

Covered (Yes/No): No

Comments: The way of using the CHESS system did not justified the implementation of the push mechanism. Indeed, most of the interactions do not require polling: requests which required performances (for example the requests to the STE) are done through the Hub, using its proxy service thanks to a GET method (the STE answer is straight forward).

FS/WS/15	An administrator can automatically deploy the Hub.	Important

Description: In line with restarting the Hub quickly (see FS/WS/09) it is useful if deploying it (i.e. installing it along with its dependencies) can be done automatically remotely, with little to no configuration required.

Constraints and assumptions: Deploying the Hub does not include copying data.

Covered (Yes/No): Yes

Comments: An installation script has been created to deploy the Hub easily. However, the user had to install the pre-required packages (python, mongoDB, tornado). To simplify even more the Hub deployment, we created in parallel virtual machines containing a pre-installed Hub server. This was particularly useful for the temporary exhibits we did during the project.

FS/WS/16	A user can download large assets in chunks.	Interesting
Cf. EUR/WE/05	Download material	Medium

Description: For very large assets, it may be that only part of an asset is needed by the client. For example, perhaps only the beginning of a large film will be downloaded if the user pauses or cancels the playback. In that case, it would be useful to request only parts of an asset.

Constraints and assumptions: This could be done using the *Range* HTTP header.

Covered (Yes/No): Yes

Comments: The Hub supports Range HTTP headers since it is mandatory for iPad support. Indeed, iOS devices assume that servers delivering media (video, audio) supports Range headers. We had to develop partial header in order to support videos on iPad.

FS/WS/17	An administrator can cache the Hub with proxies.	Interesting

Description: For performance reasons, it may be useful for an administrator to set up HTTP proxies (such as Squid) to improve speed and reduce load on the Hub when handling series of redundant queries.

Constraints and assumptions: Besides properly providing HTTP caching directives, the CHESS system should not be required to make additional efforts to support caching.

Covered (Yes/No): No

Comments: We did not had to add such a proxy as the Hub performances seemed to suffice for the project. This configuration is independent of the Hub implementation and could be setup in the future if needed. However, due to the wide variety of requests and the asset size, a cache mechanism may not improve a lot the experience.

FS/WS/18	Visit Recording	Important
Cf. EUR/VI/04	Protecting the user personal data	High
Cf. EUR/VI/27	Taking into account previous visits	High
Cf. EUR/AU/05	Recording the user profile	High

Description: The Hub should record all evidences regarding the experienced visit, namely the provided scenarios, routes, plot, as well as user actions within activities, user feedback, selections, ratings, location, as well as additional explicit and implicit interactions, for each particular user and groups of users.

Constraints and assumptions: Depends on the type of empowered interaction and adaptation, profiling requirements, as well as on the type of statistics that will be required by the museum stuff.

Actors & interactions: Involves interaction with all the major CHESS components, namely the Web and Mobile experiencing systems, the Interaction Service and Storyteller, as well as with the profiling component which fetches the recorded data for transforming and processing it.

Covered (Yes/No): Yes

Comments: The visitor experience is regularly stored on the Hub. As soon as the visitor ends an activity, his profile is updated on the Hub as well as the related souvenirs. If he skipped the activity, this is also notified on the Hub. Regularly the visitor position is send in order to retrieve his path inside the museum. More generally, an activity can store specific data on the Hub for a future analysis. Then the WES post-visit experience gather these data to present them to the visitor in a suitable way.

FS/WS/19	The Hub keeps statistics on the visit	Important
Cf. EUR/AU/05	Recording the user profile	High

Description: The Hub should keep enough data on the user visit to be able to extract useful statistics for the story authors and the museum. This should contain information such as time spent during the whole visit, or time spent in each zone. In addition, the Hub may keep information about the user preferences, such as language.

Constraints and assumptions: The data stored should be anonymous and at least protect the user privacy.

Covered (Yes/No): Yes

Comments: Specific HTTP requests have been added to request statistics on the past experiences. These requests have been used in the CAT to give some feedback to the authors about the created experiences, on the popularity of each node for example. As the database request mechanism is generic, it could be easily extended to retrieve specific statistics.

FS/WS/20	Clients can send partial updates	Important
Cf. EUR/VI/20	Adapting to user equipment	High

Description: Rather than sending the complete state of an entity to the hub, clients can send only the part that changed. This technique, often called *patching*, not only saves bandwidth but allow allows multiple clients to change the entity in parallel, as long as they modify different attributes. **Constraints and assumptions**: A standard patching syntax should be used, such as JSON Patch.

Covered (Yes/No): Yes

Comments: A JSON patch can be sent to the Hub in order to change only a part of an object.

For example the following request:
PUT
http://chesshub.diginext.fr/space/<SPACE_ID>/entity/<ENTITY_ID>?format=patch
with the attached document:

```
[
	{
		"replace": "/content/pastActivities",
		"value": [	{
				"result": {"status": "ended"},
				"activity": "login"
			   }
```

```
            ]
    },
    {
        "replace": "/content/storyActivityResult/completed",
        "value": true
    },
    {
        "remove": "/content/storyActivityResult/nextActivity"
    }
]
```


This document contains a list of changes that have to be applied to the object. In this case, this patch will only update the "content/pastActivity", "/content/storyActivityResult/completed" attributes and remove "/content/storyActivityResult/nextActivity" attribute.

5.2.2 The Interaction Service (DXT)

FS/PL/01	The Interaction Service can send content to the user.	Mandatory
Cf. EUR/VI/01	Respectful interactions	Medium
Cf. EUR/VI/02	Avoid interrupting others	Medium

Description: The Interaction Service can generate HTML content to send to the user mobile phone via internet connection. The Interaction Service is not directly connected to the visitor mobile application, but sends the content via the Hub. For example, a HTML menu can be generated and ordered according the Story Telling Engine suggestions to be submitted to the visitor.

Constraints and assumptions: The internet connection provided to the user should have enough bandwidth to transmit HTML pages and images. Larger content (e.g. sound, 3D models) may be transferred to the user mobile phone previously.

Covered (Yes/No): Partially

Comments: As the STE was able to generate the HTML content by itself, this feature has not been implemented . However, the Interaction Service acts as a proxy to provide these content from the STE to the MES. This behaviour was required to avoid cross domain security checks.

FS/PL/02	The Interaction Service can receive input from the user.	Mandatory
Cf. EUR/VI/01	Respectful interactions	Medium
Cf. EUR/VI/03	Transparent recording of the user profile	High
Cf. EUR/VI/04	Protecting the user's personal data	High
Cf. EUR/AU/05	Recording the user profile	High

Description: The Interaction Service can listen to HTTP queries sent from the user mobile phone via internet connection. The user mobile application is connected to the Hub and can send information to the Interaction Service through the Hub connection.

Constraints and assumptions: Upload transfers are supposed to be few and not very big. These are meant to send position, mobile application queries and quiz results to the Interaction Service.

Covered (Yes/No): Yes

Comments: The interaction service is able to forward HTTP requests coming from the MES to the STE such as the visitor location or the request for retrieving the next activity that the STE would suggest for a given visitor.

FS/PL/03	The Interaction Service adapts its output to the visitor’s device.	Mandatory
Cf. EUR/VI/20	Adapting to user equipment	High

Description: The Interaction Service must be able to receive the list of capabilities from the user mobile and the generated content is targeted to these capabilities. The Interaction Service must not send content the user cannot visualize or interact with.

Constraints and assumptions: All user mobiles should handle HTML5 and JavaScript for minimal content and interaction.

Covered (Yes/No): No

Comments: We chose to adopt an opposite vision and delegate this task to the MES itself since it is the best location to know the device capabilities. Thus, the device is now requesting specific content according to its capabilities. For example, it the mobile requires to display a video, it will select from the list of the asset variations, the best one (according its codec, its size, ...)

FS/PL/04	**The Interaction Service tracks the state of the visitor.**	**Mandatory**
Cf. **EUR/VI/04**	**Protecting the user personal data**	**High**
Cf. **EUR/AU/05**	**Recording the user profile**	**High**

Description: The Interaction Service keeps the current state for each visitor. If the visitor is disconnected, its previous state is restored to resume its visit. The state includes the last recorded position, the activities previously sent to the user, and the exhibits she already saw.

Constraints and assumptions: If the visitor is disconnected for a long period, the Interaction Service then consider them as having quit, and therefore remove their state from the active system.

Covered (Yes/No): No

Comments: As the tracking of the visitor state is already done only by the Hub, this feature uses the Hub capability of tracking the visitor changes. The synchronisation is done automatically on the MES side and based on backbone features.

FS/PL/05	**UPDATE : This feature is now ensured by the Hub FS/WS/18, not by the Interaction Service. The Interaction Service loads Authoring Tool projects.**	**Mandatory**
Cf. **EUR/AU/06**	**Quick authoring**	**High**

Description: The Interaction Service manages stories by loading projects exported by the CHESS authoring tool. The project contains all information necessary to replay the stories on the user mobile application.

Constraints and assumptions: The Interaction Service should check and diagnose any versioning incompatibility. The project once loaded may not be directly changed by any other tool.

Covered (Yes/No): No

Comments: Projects are uploaded on the Hub at the end of the authoring process. This package is then downloaded on the MES for the experience.

FS/PL/06	**The Interaction Service informs the Storyteller of visitor progress.**	**Important**
Cf. **EUR/AU/05**	**Recording of the user profile**	**High**
Cf. **EUR/VI/04**	**Protecting the user personal data**	**High**

Description: On certain visitor state changes, the Interaction Service sends some information about the visitor progress in the scenario to the story telling engine (through the Hub connection).

Constraints and assumptions: The author should be able to set specific conditions to send profiling update to the story teller, but this could also be done automatically at the end of each activity or whenever the user logs in or out.

Covered (Yes/No): Yes

Comments: Each time the visitor starts, finishes or skips an activity, information is sent to the Interaction Service for the Story Telling Engine. The storytelling engine keeps a track of the time spent on the activity, the feedback of the visitor and all the experience related information relevant to suggest relevant content to the visitor.

FS/PL/07	**The Interaction Service sends a profiling questionnaire to the visitor.**	**Important**
Cf. **EUR/AU/05**	**Recording of the user profile**	**High**

Description: The Interaction Service can send to the user mobile (through the Hub connection) a profiling questionnaire based on the story teller input. The questionnaire result is then uploaded back to the Hub for the Storytelling Engine in order to refine the user profiling.

Covered (Yes/No): Yes

Comments: As for the other communications with the STE, the profiling questionnaire (generated from the STE side) is sent either to the MES or the WES using the Interaction Service. This is mandatory to avoid cross domain security issues.

FS/PL/08	**Constraints and assumptions: The questionnaire should appear at the beginning of the scenario to in order to help decide which scenario to play for that visitor. The Interaction Service manages the visitor location.**	**Important**
Cf. **EUR/VI/04**	**Protecting the user's personal data**	**High**
Cf. **EUR/VI/12**	**Changing visit trajectories**	**High**
Cf. **EUR/VI/14**	**Proposing trajectories**	**High**

Description: The visitor location using the user mobile application is sent to the Hub whenever he enters or leaves specific zones or when the user do a particular action (for example if he scans a QR code). The Interaction Service may then send different content to the visitor if he obviously leaves the path of current played story or scan another QR Code. For example, the Interaction Service may ask if she wants to resume the current scenario later or be lead to another story.

Constraints and assumptions: The visitor physical position could be approximate given the used geo-location system. The zone drawn in the authoring tool should take that into account.

Covered (Yes/No): Yes

Comments: In general, the questionnaire is achieved during the pre-experience phase, from the Web Experiencing System (WES). Then the visitor profile is stored for his future visit to the museum. The visitor location is updated regularly to the STE (through the Interaction Service) so that it can suggest different content in case of deviation.

FS/PL/09	**The Interaction Service manages the visitor logins.**	**Important**
Cf. **EUR/VI/01**	**Respectful interactions**	**Medium**
Cf. **EUR/VI/50**	**Interaction continuing beyond the exhibit**	**High**

Description: The visitor can log in and out several times during a visit, that being accidental or intentional. The Interaction Service should tracks these events and allow the scenario to resume if this can be handled by the new state of the visitor.

Constraints and assumptions: The Interaction Service should only start or resume to play a scenario if the user logs in inside or near the museum. If the visitor is logged out for too long, the Interaction Service may assume he has left the museum.

Covered (Yes/No): Yes

Comments: The Interaction service after receiving the login request, asks the STE for starting a new experience. We are using the visitor e-mail address as a unique ID for the connection and retrieve his profile and CVS results. In case of an existing past experience, the storytelling engine, will keep it into account to suggest to the visitor new content.

FS/PL/10	**The Interaction Service informs the visitor of opening hours.**	**Interesting**
Cf. **EUR/VI/33**	**Adapting to on-the-ground contingencies**	**High**
Cf. **EUR/VI/35**	**Legibility of environment**	**Medium**

Description: The Interaction Service can send to the user mobile some content about opening hours of the museum or for some specific parts or exhibitions of the museum. The visitor can receive information about what parts of the museum is accessible.

Constraints and assumptions: General information about the museum could be stored in the user mobile application as static data. The Interaction Service would notice the visitor of exceptional changes in the museum or exhibits opening hours.

Covered (Yes/No): No

Comments: In our design, this is part of the storytelling engine to take into account the museum opening hours and to adapt transparently the story according to these opening hours. What is more we integrated an "hurry-up" mode that can be activated by the visitor if he wants to terminate the story quickly without interrupting it too suddenly.

FS/PL/11	**The Interaction Service directs visitors to alleviate crowd congestion.**	**Interesting**
Cf. EUR/VI/32	**Adapting to existing visitor flow**	**Low**
Cf. EUR/VI/34	**Location in the environment**	**High**
Cf. EUR/VI/36	**Orientation to exhibits**	**Medium**
Cf. EUR/VI/25	**Adapting to the visitor style**	**High**

Description: Depending of the user visiting patterns, the other visitors using the CHESS experience and input from the museum about the crowd density in the different exhibition places, the Interaction Service can steer the visitor toward less crowded zones using the story teller engine profiling to help him find exhibit pieces that can interest him.

Constraints and assumptions: Approximate positions of visitor using the CHESS system can be used. There must be extra data about the physical congestion in the system. Some of it could be added in the authoring tool, using some kind of congestion map for given hours and days. It would be useful to add an interface for unplanned congestions.

Covered (Yes/No): No

Comments: As the priority of this requirement was only interesting and as it would take a significant amount of time to develop it, we chose not implementing this feature in the scope of the CHESS project.

FS/PL/12	**The Interaction Service gives directions to the visitor.**	**Interesting**
Cf. EUR/VI/34	**Location in the environment**	**High**
Cf. EUR/VI/36	**Orientation to exhibits**	**Medium**

Description: In the case the path finding cannot be handled on the user mobile application, the visitor routing to specific places (restrooms, exit, cafeteria…) could be managed by the Interaction Service. Using the visitor position, the Interaction Service would compute the most direct path to the visitor desired location.

Constraints and assumptions: There should be some kind of navigation graph setup in the authoring tool for this to work correctly in all cases.

Covered (Yes/No): No

FS/PL/13	**Comments: The localisation service and navigation activities can run directly on the mobile. We simplified these activities in order to only show the current visitor position and his final destination or to show him the different steps to follow to reach the final destination in order to not having to compute a complex path finding algorithm on the mobile. The Interaction Service manages residual assets.**	**Interesting**
Cf. EUR/VI/51	**Souvenirs**	**Medium**
Cf. EUR/VI/50	**Interaction continuing beyond the exhibit**	**High**

Description: Some visitor states stored by the Interaction Service may be marked as residual. These states will be stored by the Hub alongside some persistent user profile. These states could represent achievements during the story the user played during her visit, the parts of the museum visited that time or some other assets that could be accessed later using the mobile application or the web experience.

Constraints and assumptions: The residual assets should not be too large in order to be stored with the visitor CHESS account. They should be stored along the profiling data and statistics.

Covered (Yes/No): Yes

Comments: Residual assets were called souvenirs in CHESS. In the monster factory game for example, the monster designed by the visitor is the save on the Hub. At CITE, the visitors were able to take pictures and save them on the Hub. After the visit, the visitors can retrieve these souvenirs from the WES.

FS/PL/14	The Interaction Service integrates Storyteller changes.	Important
Cf. EUR/VI/26	Adapting to user preferences	Medium

Description: The Storytelling Engine can update the state of the Interaction Service given the visitor profiling status. This will effectively change how the scenario currently played will enfold.

Constraints and assumptions: Not all the states of the Interaction Service can be modified.

Covered (Yes/No): Partially

Comments: The storytelling engine changes are transmitted to the MES through the Interaction Service. However, all the story narration behaviour has been moved from the Interaction service to the storytelling engine.

5.2.3 The authoring tool (DXT)

FS/AT/01	An author can manage a set of scenarios.	Mandatory
Cf. EUR/AU/08	Supporting re-usability	High
Cf. EUR/AU/01	Creating material for different user groups	High
Cf. EUR/AU/02	Creating material for different visit objectives	High

Description: The list of scenarios is displayed in the authoring tool. Basic management functions must be provided to sort and reorganize this list. Scenarios can be renamed, created and deleted. Metadata can be attached to each scenario.

Constraints and assumptions: The basic data attached to a scenario should be its name, a description, and a version number.

Covered (Yes/No): Yes

Comments: Scenarios in the Authoring Tool are represented as a regular entity which icon symbolise a book. Thus different scenarios can be created in the same project.

FS/AT/02	The museum is represented in 3D.	Mandatory
Cf. EUR/AU/03	Digital reconstructions	Medium
Cf. EUR/AU/06	Quick authoring	High
Cf. EUR/AU/11	Setting hotspots on the exhibition map	High

Description: The CHESS authoring tool must be able to represent in 3D the parts of the museum in which the story telling will take place. The museum should be referenced in geographic space so that the different zones or "stages" can be easily linked.

Constraints and assumptions: For easier representation and navigation, the different floors of a museum should be split in different stages.

Covered (Yes/No): Yes

Comments: There are various representation of the museum map. The author can either represent the museum with a 3D map and place the 3D representation of the statues in order to have an accurate vision of the museum. But the authors also requested to be able to load 2D maps as they may not have the 3D model of the museum and navigation is easier using such a 2D map. Hotspots can be defined in both modes around the exhibitions.

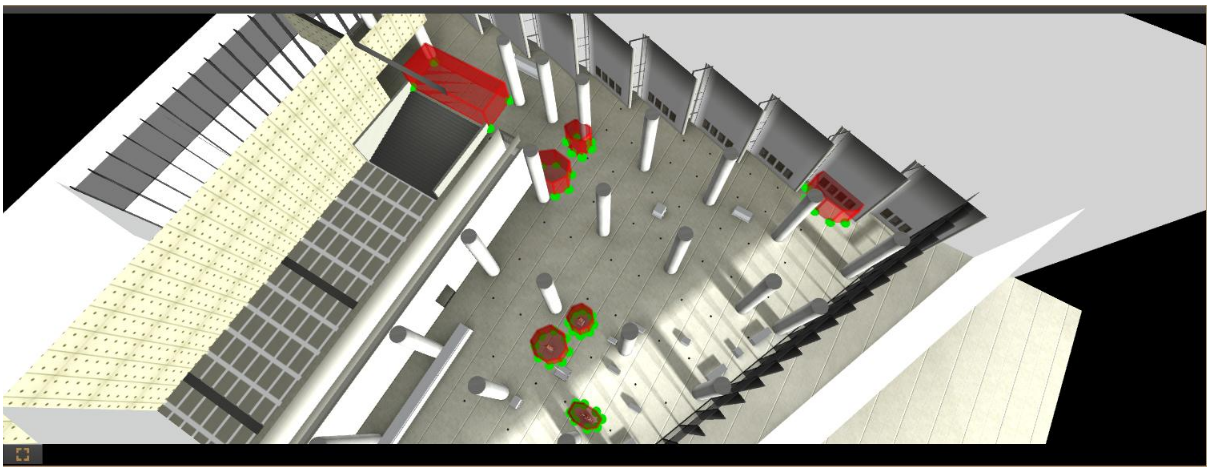


Figure 103 - Stage Editor.

FS/AT/03	The author can associate activities with geographical zones.	Mandatory

Cf. EUR/AU/08	Supporting re-usability	High
Cf. EUR/AU/11	Setting hotspots on the exhibition map	High

Description: The author can select 3D geographical zones in the tool. Each space can be referenced later by the scenarios or the activities. Metadata can be attached to each location.

Constraints and assumptions: Metadata such as tags will be used to search for locations in the museum. Some activities will only be sent to the user mobile by the Interaction Service if the visitor is inside the given location.

Covered (Yes/No): Yes

Comments: In order to associate a piece of the story to a hotspot in the authoring tool, the author only has to drag and drop the story node on the corresponding hotspot on the map to bind the story node to this location.

FS/AT/04	The author can designate exhibits.	Mandatory

Cf. EUR/AU/03	Digital reconstructions	Medium
Cf. EUR/AU/08	Supporting re-usability	High
Cf. EUR/AU/11	Setting hotspots on the exhibition map	High

Description: The author can put place 3D place marks inside any stage defined in the project. These place marks can be associated with content and tags. These exhibit pieces can be referenced in the scenarios.

Constraints and assumptions: The Asset Manager is responsible for choosing the level of details for 3D models sent to the user model. Any level of detail can be displayed in the authoring tool.

Covered (Yes/No): Yes

Comments: Hotspots can be drawn directly into the 3D map, around the exhibition representations. These hotspot zones appear into the project list of entities. They can be associated to a piece of the story, only drag and dropping this piece of story onto the hotspot.

FS/AT/05	The author can edit activities.	Mandatory

Cf. EUR/AU/07	Supporting creativity	High
Cf. EUR/AU/08	Supporting re-usability	High
Cf. EUR/AU/13	Designing activities	High
Cf. EUR/AU/14	Designing narration activities	High

Description: The Authoring Tool allows the author to generate activities that can take place during the story telling. Some basic activities include slide shows, text, audio and video content, etc.

Constraints and assumptions: Additional activities will be coded as authoring tool plugins and will be added to the list of existing activities automatically. The authoring tool should provide a way to customize the inputs of these activities.

Covered (Yes/No): Yes

Comments: The authoring Tools offers an activity library with a predefined set of common activities. Each activity can then be configured in the CAT. Indeed, each activity can expose a number of parameters to customize its content or behaviour. For example narrators activities are configured thanks to a user friendly timeline.

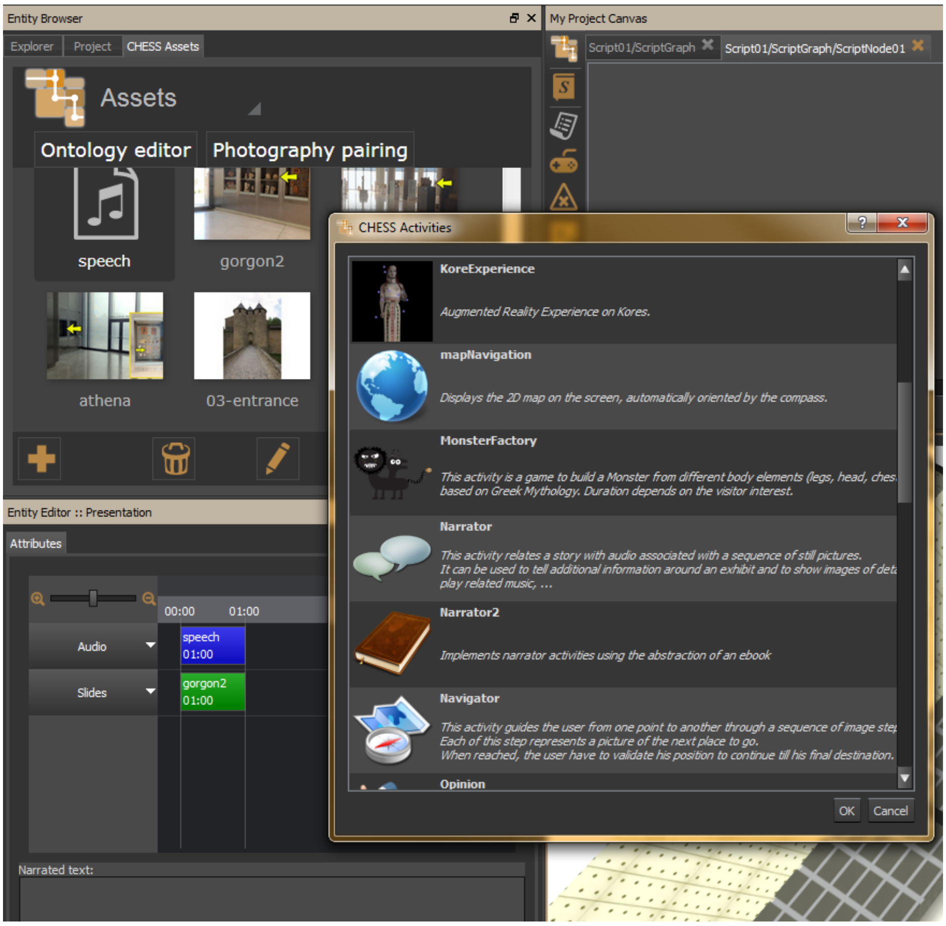


Figure 104 - Activity Editor.

FS/AT/06	The author can edit the storytelling model.	Mandatory
Cf. EUR/AU/01	Creating material for different user groups	High
Cf. EUR/AU/10	Designing the experience outline	High

Description: The author will be able to edit the different levels of the storytelling model. The story editor will have to support the level of hierarchy for the different levels. Each story and story element can be edited, tagged with metadata and associated with relevant content chosen into the asset browser.

Constraints and assumptions: The different levels and parts of the story will have to follow the storytelling model as it evolves.

Covered (Yes/No): Yes

Comments: The CAT fully implements the storytelling concepts, such as scenarios, story nodes, activities, branching points, ... The scenario is a set of script nodes and contains a graph of script nodes (scripting level). Each script node contains a graph of activities (editing level). Each node can be tagged with data used for the personalisation engine.

FS/AT/07	The author can choose content templates.	Mandatory

Cf. EUR/AU/06	**Quick authoring**	**High**
Cf. EUR/AU/08	**Supporting re-usability**	**High**

Description: The author can choose in a list of templates which HTML template to use for a given activity. Some variable in the HTML template can be filled at this time. Other will be set by the Interaction Service during the visit, depending on the story teller engine profiling and the explicit choices of the visitor.

Constraints and assumptions: Some HTML will have to be created in other tools. The HTML content editor is there to choose the HTML template, set some values and to use it inside an activity.

Covered (Yes/No): Yes

Comments: In order to facilitate a story creation, we introduce in the CAT the notion of project template. This template not only defines the look and feel of the mobile application (CSS, JQuery style), but also defines the museum topics, the personas, the museum map, and also advanced parameter (such as the network configuration).

FS/AT/08	**The author can browse assets.**	**Mandatory**

Cf. EUR/AU/06	**Quick authoring**	**High**

Description: The author can browse the assets created with the Asset Manager. She can view, modify and add metadata and tags to those assets. The author can also see and define the different levels of details for any relevant media and their targets.

Constraints and assumptions: Some assets won't be manipulated directly in the authoring tool but in the Asset Manager. The author will always manage assets by the URL the Asset Browser is providing her.

Covered (Yes/No): Partially

Comments: The asset manager allows asset browsing either directly inside the CAT or from a web browser. The author can visualize all the assets (but their variations are automatically generated and hidden to the author). Some tags can be associated to each asset, and a search feature allows the author to find assets from these tags.

FS/AT/09	**An author can edit the environment.**	**Important**

Cf. EUR/AU/03	**Digital reconstructions**	**Medium**
Cf. EUR/AU/04	**Continuous use of the system**	**Medium**

Description: Global information and floor plans of a museum can be stored in assets that can be easily imported in a CHESS project to start a new set of scenarios.

Constraints and assumptions: This setup will be in at least once for a museum. There will likely be several assets for one museum (different exhibitions, special events, splitting into several zones, etc.).

Covered (Yes/No): Partially

Comments: The museum ma is part of the template. Thus when starting a project, the author already has the museum map configured and don't have to import it. The hotspots can also be part of the map to avoid redefining them each time.

FS/AT/10	**The author can simulate visitor activity.**	**Important**

Cf. EUR/AU/06	**Quick authoring**	**High**

Description: The author can test the scenario she designed by simulating visitors inside the tool. The author can see what the user receives and interact with the CHESS framework inside the authoring tool.

Constraints and assumptions: During the simulation, the author can start and stop the story at will. All interfaces presented to the visitor will be displayed in the authoring tool.

Covered (Yes/No): Yes

Comments: A mobile view for debugging purpose has been integrated into the authoring Tool. This view hosts the story as the mobile will host it. However the authoring debugging view has some restrictions regarding to the mobile: the location may not work properly as well as InstantAR specific activities (augmented Reality activities or activities involving 3D). Some HTML/JS debugging features have also been integrated in order to visualize the network communications, the console output and other standard tools.

FS/AT/11	The author can create navigation paths.	Important

Cf. EUR/AU/04	Continuous use of the system	Medium

Description: The author can create paths inside the tool and reference them in the scenarios.

Constraints and assumptions: Paths could be used to direct the user during the story telling.

Covered (Yes/No): Partially

Comments: Paths can be created in the authoring tool to help the author designing the story but they can't be used inside the story. However, the Authoring Tool can compute the path that a visitor will follow if he plays the story. This feature allows the author to forecast the path of the visitors and eventually reorganize the story to short the distance the visitor has to walk.

FS/AT/12	The author can edit the user characteristics.	Important

Cf. EUR/AU/01	Creating for different user groups	High
Cf. EUR/AU/09	Designing profile recording	High

Description: There should be an interface to create visitor personas or stereotypes. Those visitors will have a state that matches a scenario designer persona. These personas will be shortcut for the author to assign interest points in a scenario by persona rather than by tags. Moreover visitors attributes can be added in order to be recorded by the hub during the experience.

Constraints and assumptions: This has to agree with the user characteristics used throughout the system and mainly from the storytelling engine.

Covered (Yes/No): Partially

Comments: The author can define personas for his story. However, during the project, the authors had difficulties in binding the story nodes with the personas. We then chose to replace the personas in the script parameterisation by the museum topics. These topics are usually much less complex than the personas and authors can manage them. The binding with the personas is done when defining their interests.

FS/AT/13	The author can map user characteristics to story characteristics.	Important

Cf. EUR/AU/06	Quick authoring	High
Cf. EUR/VI/19	Adapting to user interests	High
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf. EUR/VI/21	Adapting to computing literacy	Medium
Cf. EUR/VI/22	Adapting to the visitor's language	Medium
Cf. EUR/VI/23	Adapting to narration style	High
Cf. EUR/VI/24	Adapting to physical capacities	Medium
Cf. EUR/VI/25	Adapting to the visitor style	High

Cf.	**EUR/VI/26**	**Adapting to user preferences**	**Medium**
Cf.	**EUR/VI/27**	**Taking into account previous visits**	**High**
Cf.	**EUR/VI/28**	**Adapting to visit duration**	**High**
Cf.	**EUR/AU/01**	**Creating material for different user groups**	**High**
Cf.	**EUR/AU/02**	**Creating material for different visit objectives**	**High**

Description: An author can define the mappings between visitor characteristics (and more specifically the *personas* variables) to the characteristics of the various entities used to build the stories. This supports generality, i.e., the adaptation of the system and different configurations at different installations.

Constraints and assumptions: Depends on the story elements metadata structure (and the ontologies/typologies used to describe the museum objects or concepts) and the definition of the user characteristics. This is a system wide configuration scheme used by the authoring tool and the profiling components.

Covered (Yes/No): Yes

Comments: Binding visitor characteristics can be done on each story node or activity. For each of them we can define the topics they are related to and the personalisation engine will deduce the relevant persona for who these activities stands for. What is more, on the branching points, we can consider in addition to these topics, characteristics of the visitor (his age, his visit objectives, the time he wants to spend, ...) leading to a completely customisable story model.

FS/AT/14	**The author can link/relate objects to story elements.**	**Important**

Cf. EUR/AU/06	**Quick authoring**	**High**

Description: The author can create relations between the story and objects such as items in the museum shop and items in external digital libraries.

Constraints and assumptions: The Storytelling Engine can use these relations to propose objects related to the story at hand. It could also be used for the after the visit experience.

Covered (Yes/No): No

Comments: The importance of this feature has been lowered during the project. We preferred instead integrating these links as a post-visit experience. Indeed, the post-visit experience can offer extra content on the activities achieved during the experience (external digital libraries, links to the virtual shop or ordering their custom souvenirs printed on a cup, a T-Shirt, ...).

FS/AT/15	**An author can undo and redo actions.**	**Interesting**

Cf. EUR/AU/06	**Quick authoring**	**High**

Description: There should be undo/redo functionality for any action in the CHESS authoring tool. **Constraints and assumptions**: Some actions may be irreversible. They should be documented as such.

Covered (Yes/No): Yes

Comments: Most of the actions done in the authoring tool can be undone/redone thanks to the interface of the classical shortcuts (Ctrl-Z/Ctrl-Y).

FS/AT/16	**The author can use a navigation path-finding tool.**	**Interesting**

Cf. EUR/AU/04	**Continuous use of the system**	**Medium**

Description: The authoring tool allows the creation or import of a navigation mesh. The graph can be linked to place marks, and path-finding to be sent to the user (e.g. exit, toilets, cafeteria, etc.).

Constraints and assumptions: The path-finding tool may not be able to respond to a highly dynamic environment (closed exhibitions, etc.).

Covered (Yes/No): No

Comments: The navigation capabilities have been move to the mobile. The advantage of this approach is that it can work without a reliable network connection. Path finding algorithms are too resource consuming to run on the MES.

FS/AT/17	**The author can monitor active visitors.**	**Interesting**

Cf. EUR/AU/05	**Recording the user profile**	**High**

Description: The Authoring Tool can be connected to the Interaction Service (though the Hub) to get the approximate location and the states of the visitors currently logged into the system. The visitor will be shown on the 3D views and their current state and some statistics can be displayed.

Constraints and assumptions: The interface will be similar to the visitor simulator, but the input will come from the Interaction Service.

Covered (Yes/No): No

Comments: Visitor activity can't be done in real-time, but the author can retrieve statistics from the Hub on the past experiences.

FS/AT/18	**The author can view visit statistics.**	**Interesting**

Cf. EUR/AU/05	**Recording the user profile**	**High**
Cf. EUR/VI/27	**Taking into account previous visits**	**High**
Cf. EUR/AU/06	**Quick authoring**	**High**

Description: The analysis of all the evidence regarding past visits will provide statistical results that will reveal a variety of trends, temporal and behavioural patterns, identifying visitor characteristics as well as various usage-based story aspects (indicating, for instance, popularity reports and comparisons between the authored scenarios, routes or plots, or even on activities and assets. The results of this should provide further feedback to the museum stuff and allow them to refine/extend the authored stories, edit the visitor characteristics, edit the user model elements, or design other applications related to CHESS stories.

Constraints and assumptions: To be defined based on the requirements of museum stuff.

Actors & interactions: Used by the museum stuff.

Covered (Yes/No): Yes

Comments: Statistics on the popularity of each activity has been integrated into the authoring tool as a proof of concept. As the statistic mechanism used by the Hub is generic, we can imagine retrieving any kind of statistics in the Authoring Tool.

FS/AT/20	**Allow authors to define/edit rules**	**Important**

Cf. EUR/AU/01	**Creating material for different user groups**	**High**
Cf. EUR/AU/02	**Creating material for different visit objectives**	**High**
Cf. EUR/AU/07	**Supporting creativity**	**High**
Cf. EUR/AU/08	**Supporting re-usability**	**High**

Description: Authors and museum stuff are given a tool to define and later on edit the rules that govern some of the behaviour of the adaptive storytelling engine (branching) as described in section **Erreur ! Source du renvoi introuvable.**. These rules may be defined at all story layers (plot sketching, taging or casting & shooting) and may involve profiling, system or environmental parameters.

Constraints and assumptions: depends on the specific characteristics of the rules.

Actors & interactions: The author is the person who should sufficiently define the rules. Other interactions involve the use of functionalities related to the retrieval of visitor or museum resources characteristics and their values.

Covered (Yes/No): Yes

Comments: The author can define the conditions on the branching points that will be used by the personalisation engine to personalise the story. Some of the branching points can display menus, some other can be transparent for the visitor. In this case the personalisation engine will be able to take some decision thanks to the information given by the author during the authoring process.

5.2.4 The authoring preview system (DXT)

FS/AP/01	**The author can visualize and modify the visitor position with a map explorer.**	**Mandatory**
Cf. EUR/VI/15	**Recommending parts of the collection**	**Medium**
Cf. EUR/VI/34	**Legibility of environment**	**Medium**
Cf. EUR/WE/03	**Extend the visit through the website**	**High**

Description: The author previewing system uses a map component to enable navigation and localization of the user in the virtual museum. This map component has three different modes which can be activated during the story:

- Hidden: The map component is not visible and not available to the visitor.
- Read-only: The map is only used to display the virtual position of the visitor.
- Edit: As well as displaying his position, the visitor can also modify it to navigate virtually through the site.

Constraints and assumptions: The preview system needs JavaScript support for interactivity.

Actors and interactions: The map explorer will receive and send positioning information to the storytelling engine.

Covered (Yes/No): No

Comments: Debugging the visitor position has been done scanning QR code. Once the visitor scans a QRCode, it works as if the visitor was teleported to the hotspot location. This mechanism allows an easy way of debugging the story.

FS/AP/02	**The author can preview the story in the story explorer.**	**Mandatory**
Cf. EUR/VI/08	**Providing an interactive story experience**	**High**

Description: The author preview system displays the story content in a separate component. This content is generated by the Presentation Service of the CHESS system.

Constraints and assumptions: The Presentation Service must format the content in HTML5.

Covered (Yes/No): Yes

Comments: The CAT includes a previewing window where the story can be played as if it was on the mobile. There is however one restriction regarding the activities that requires instantAR (the platform the MES is based on) to work properly such as the AR activities or the 3D map activity. These activities includes specific calls to instantAR API that are not available in the CAT debugger.

FS/AP/03	**The author can control the flow of the presentation.**	**Mandatory**

Description: Provide controls to suspend, resume or repeat (a section of) the CHESS Story.

Constraints and assumptions: None in particular.

Covered (Yes/No): Yes

Comments: The author is able to start, stop or resume an activity from the preview window. However, as the personalisation engine depends on the past activities, the preview window has to restart the story from start each time.

FS/AP/04	**The author preview system connects to the web service over a RESTful interface Mandatory .**

Description: The CHESS author preview application connects to the Web Service over a RESTful interface. The data received (stories, content, messages, etc.) is in JavaScript Object Notation (JSON).

Constraints and assumptions: The author preview system must support network communication with HTTP protocol.

Covered (Yes/No): Yes

Comments: Since the preview system is based on the same source code as the MES, the connection with the web services (Hub, STE, Interaction Service) is done in the same way.

FS/AP/05	**The author preview system's user interface has a consistent design.**	**Mandatory**
Cf. EUR/VI/52	**Adapting to visual aesthetics**	**High**

Description: User interface CSS style sheets for a consistent design. Defines UI elements, colours and grids of the application.

Constraints and assumptions: Each partner should use the same stylesheet for his developments. Enhancements should be contributed to the stylesheet and provided to the other developers.

Covered (Yes/No): Yes

Comments: Since the preview system is based on the same source code as the MES, the user interface design used by the previewing system is the same as the MES, including the CSS and the JQuery mobile styles.

5.2.5 The storytelling engine (NKUA)

FS/SE/01	Adaptive story evaluation and selection based on visitor profiles	Mandatory
Cf. EUR/VI/05	Providing a guided experience	High
Cf. EUR/VI/06	Providing an audio guide experience	Medium
Cf. EUR/VI/19	Adapting to user interests	High
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf. EUR/VI/21	Adapting to computing literacy	Medium
Cf. EUR/VI/22	Adapting to the visitor's language	Medium
Cf. EUR/VI/23	Adapting to narration style	High
Cf. EUR/VI/24	Adapting to physical capacities	Medium
Cf. EUR/VI/25	Adapting to the visitor style	High
Cf. EUR/VI/26	Adapting to user preferences	Medium
Cf. EUR/VI/27	Taking into account previous visits	High
Cf. EUR/VI/28	Adapting to visit duration	High

Description: Evaluate the candidate set of available story spaces and storylines according to the details of a visitor profile (i.e., the characteristics of the visitor deemed important in the story selection) and select the top-k most promising candidates.

Constraints and assumptions: Depends on the story elements metadata structure (and the ontologies/typologies used to describe the museum objects or concepts) and the definition of the user characteristics.

Actors & interactions: Interacts with the profiling engine to retrieve the visitor profile characteristics.

Covered (Yes/No):Yes

Comments: Story selection is modeled and handled similarly to all the decision points within the stories, through an initial branching point leading to different stories. Whenever a branching point is reached in the authored story space, the STE interacts with the Profiler, providing the set of candidate branches. The Profiler evaluates them and returns a list of the valid ones, ranked according to the visitor's profile. The STE then examines the author's directive for the particular branching point and it either generates a dynamic menu, with the options ranked according to the Profiler's directions, or automatically follows the branch ranked at the first position.

FS/SE/02	Generate a story based on a visitor profile	Interesting
Cf. EUR/VI/07	Providing a linear story experience	High
Cf. EUR/VI/08	Providing an interactive story experience	High
Cf. EUR/VI/19	Adapting to user interests	High
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf. EUR/VI/21	Adapting to computing literacy	Medium

Description: Given the details of a visitor profile (i.e., the characteristics of the visitor deemed important in the story selection), match these with the characteristics of storytelling objects so as to select the most promising candidates and hence generate personalized, fully grounded stories. Since this should be able to take place in any of the story layers (plot sketching, staging or casting & shooting), it's important to define the metadata structure and elements of the participating storytelling objects expressively and as thoroughly as possible.

Constraints and assumptions: Depends on the story elements metadata structure (and the ontologies/typologies used to describe the museum objects or concepts) and the definition of the user characteristics.

Actors & interactions: Interacts with the profiling engine to retrieve the visitor profile.

Covered (Yes/No): Yes

Comments: Matching between visitors' profiles and storytelling objects has been assigned to the Profiler. It is applied on the scripting level, exploiting the subject annotations for the script units and scripts, while in the editing level some stories have exploited the visitors' preference on technology type to accordingly rank the available productions. The staging layer hasn't been explored on that front. In all cases, the matching is performed according to the authored story space, whenever a decision point is reached.

FS/SE/03	**Present a story based on a visitor mobile technology**	**Interesting**
Cf. EUR/VI/20	**Adapting to user equipment**	**High**

Description: Given the characteristics of the visitor mobile equipment, select the appropriate assets of the corresponding story elements.

Constraints and assumptions: Depends on the story elements metadata structure (and the ontologies/typologies used to describe the museum objects or concepts) and the definition of the visitor equipment characteristics.

Covered (Yes/No):Yes

Comments: This task has been assigned to the CAT (story preparation) and the MES (story rendering), not to the STE.

FS/SE/04	**Maintain visit history and update state variables**	**Important**
Cf. EUR/VI/07	**Providing a linear story experience**	**High**
Cf. EUR/VI/08	**Providing an interactive story experience**	**High**
Cf. EUR/VI/19	**Adapting to user interests**	**High**
Cf. EUR/VI/18	**Adapting the experience to the user's characteristics**	**High**

Description: Maintains and updates the variety of state variables which are required for representing the current visit's data and evolution, such as the visited points of interests and consumed story sub-parts, as well as the output of experienced activities (i.e. for building comic strip souvenirs or for accumulating the acquired points when scoring system is employed).

Constraints and assumptions: Depends on the typed input and output of the storytelling objects.

Covered (Yes/No): Yes

Comments: The STE maintains and updates the visit's state to gradually traverse the story graph according to the visit's history, e.g. by shading options that the visitor has already seen. It also sends several state variables (such as the output of experienced activities) to the Profiler, who is responsible for validating the related conditions on branches. Information regarding souvenirs is handled by the HUB (souvenir storage) and the MES (souvenir generation), not the STE.

FS/SE/05	**Play out the rules**	**Important**
Cf. EUR/AU/07	**Supporting creativity**	**High**
Cf. EUR/AU/08	**Supporting re-usability**	**High**

Description: The storytelling engine should be able to decipher and play out the author defined rules in order to allow for easy adaptation of the visitor experience.

Constraints and assumptions: On the specific characteristics of the rules.

Actors & interactions: Interacts with other components to retrieve values for the system wide or environment specific values, and with the profiling component.

Covered (Yes/No): Yes

Comments: The author can define rules within each story by specifying conditions on branches (acting as hard constraints) and defining alternative story parts (representing different system actions) for each case. The play out of such rules has been extensively tested and it is efficiently supported by the STE. Moreover, two general rules have been defined and the STE currently applies them successfully to all the available CHESS stories, namely i) if many skip events are detected in a story part (i.e. the script units between two branching points), a menu is displayed, asking the visitor for the reasons of his skipping behaviour and acting accordingly (hurry up or profile update), and ii) if the visitor makes some actions that do not match with the profiler's predictions (e.g. selects something that the profiler estimated (s)he wouldn't be interested in), then a menu is displayed to get some visitor feedback on that front.

FS/SE/06	**Story Transitioning**	**Important**
Cf. EUR/VI/32	**Adapting to existing visitor flow**	**Low**
Cf. EUR/VI/33	**Adapting to on-the-ground contingencies**	**High**
Cf. EUR/VI/34	**Location in the environment**	**High**

Description: The storytelling engine should perform smooth transitions from story to story (or more precisely when changing scenarios, or staged scenarios or plots). Based on the defined criteria (rules) it finds the first opportunity to move the visitor onto an alternative, tailored to the visitors profile, *authored* scenario/staged scenario/plot that happens to cross the original selection.

Constraints and assumptions: Depends on the story elements metadata structure and the rules defined by the authors.

Actors & interactions: interacts with the profiling engine to retrieve the most up-to-date visitor profile (including interactions and context).

Covered (Yes/No): Yes

Comments: Story transitions are modelled as decision points, using branching points that may be conditioned on hard or constraints, seamless to all the decision points within the stories. In this way, story transitioning is effectively supported by the STE. However, it is the author's responsibility to assure the smoothness of the possible transitions. Several transition points have been defined between the main authored stories and smaller, secondary stories, but no crossing points have been specified between the main, primary stories.

FS/SE/07	**Recommender services**	**Important**
Cf. EUR/VI/50	**Interaction continuing beyond the exhibit**	**High**
Cf. EUR/VI/51	**Souvenirs**	**Medium**
Cf. EUR/WE/02	**Taking into account previous visits**	**Medium**
Cf. EUR/WE/03	**Extend the visit through the web**	**High**
Cf. EUR/WE/06	**Receive notifications**	**Low**

Description: Based on the selected story(-ies) the system should be able to recommend relevant stories or other objects related to the story (e.g., items in the museum shop, items in external digital libraries). This is a functionality which can possibly be used for the after the visit experience.

Constraints and assumptions: The types of recommendations depend on the exact definition and structure of the storytelling model (i.e., how the various external entities are linked to the stories and their elements).

Covered (Yes/No): Yes

Comments: The recommendation technology has been implemented in a generic way. It has been applied and extensively tested for the recommendation of scripts, script units, and activities during the visit. It hasn't been applied to the post-visit experience, since souvenirs are generated based on the visit's history and they are handled by the WES.

FS/SE/08	**Visitor freedom**	**Mandatory**
Cf. EUR/VI/31	**Choosing parts of the collection**	**High**

Description: Despite the desire of the CHESS project to propose adapted stories to visitors, these same visitors should be able to choose for themselves parts of the museum to see or ignore, and the Storytelling Engine should adapt as necessary.

Constraints and assumptions: In the case that visitors do not follow recommendations, it may be not longer possible to retain story coherency.

Covered (Yes/No): Yes

Comments: The visitors may choose what parts of the story to see through the menus, which are dynamically generated by the STE whenever a branching point is met. Moreover, the STE supports a set of MES functionalities, such as skip, enabling the visitors to omit certain parts of the story, as well as pause and continue, enabling them to adjust the pace of the story to their needs. It also notifies the Profiler for "Hurry-up" requests, so as to provide the shortest possible version of the remaining story.

5.2.6 The profiler (NKUA)

5.2.6.1 The Off-line profiler

FS/PR/01	Data Collection: Fetching, Integration and Storage	Mandatory
Cf. EUR/VI/03	Transparent recording of the user profile	High

Description: Log data is fetched via the CHESS Hub from the various sources and stored into a temporary space. Input sources include: CHESS Hub logs (recording on-site visitor actions), CHESS web server logs (recording web-visitor actions), external user profile sources (user profiles retrieved from external applications), external complementary sources (IP to country mappings, robot lists, taxonomies/thesaurus/etc.) The output is an integrated profiling database.

Constraints and assumptions: None

Actors & interactions: The actual log data is gathered from the other CHESS components, mainly from the mobile reporting results of profiling activities (e.g., questionnaires) and the logs of the Web Experiencing system.

Covered (Yes/No): Yes

Comments: The MES sends the user's actions (activity skip, activity completion, hurry-up, qr code scanning e.tc) to the STE, and a subset of them is sent to the Profiler. The Profiler processes the logs as they are created, and produces an adequate user profile. When the user logs out his profile is stored in the CHESS Server as an xml file for later retrieval.

FS/PR/02	Log Processing & Transformation	Mandatory
Cf. EUR/VI/04	Protecting the user's personal data	High

Description: This is mainly pre-processing of the log data originating from the web experiencing system. Past experience in log analysis has shown that the provision of customized logging functionality and the involvement of log converters usually entail the recording of erroneous entries, such as unknown or blank identifiers and values, malformed text due to special syntax notations or diverse encodings employed, etc. Such application-specific issues need to be analyzed, in order to be subsequently identified and resolved by appropriate filtering & transformation procedures.

A set of **cleaning and filtering techniques** is applied, such as robot filtering in web-log data, noise removal, removal of irrelevant/site-specific content, etc.

A set of **transformation steps** takes place such as country of origin identification based on web client's IP and GeoIP data, normalization, classification and representation of user actions based on specific types/categories of actions, etc., hence enabling the implementation of various aggregations.

Constraints and assumptions: To be defined on the way.

Actors & interactions: No interactions with other components.

Covered (Yes/No): Yes

Comments: Erroneous entries recorded from the MES (during the visit) have been investigated and they have been addressed by refining the logging behaviour of the corresponding system components. User selections in the CVS, which is provided by the WES (Web Experiencing System), are sent to the Profiler, along with an XML file containing interpretation directives, and the Profiler process them accordingly so as to reach the initial visitor profile.

FS/PR/03	Computation and pattern extraction	Important
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High

Description: With the combination of methods from various areas, such as statistics, artificial intelligence, database management, etc., it's important to analyze the usage logs to extract useful patterns for subsequent usage either by the interpretation and extension mechanisms of the profiling component or by the museum's stuff to extract further knowledge on the visitor behaviour. Based on the nature and the volume of the incoming data (some of the proposed techniques require large sets of data) the following may be carried out:

Stereotype Discovery: The application of usage mining techniques may reach the extraction of significant user clusters, based on certain user aspects, thus reaching the specification of novel, usage-based stereotypes.

Extraction of Behavioural Patterns: By monitoring user behaviour, a variety of common behavioural patterns may be extracted, such as particular paths, choices, interactions.

Social Network Analysis: Makes use of mathematical tools and concepts that belong to graph theory, in order to exploit social relations between users, because it assumes that the way users are connected to each other, affects their behaviour.

User Similarity Computation: A set of metrics used to compare user profiles over a variety of dimensions, so as to discover which users exhibit similar behaviour and have common preferences.

Implicit Feedback, Aggregation & Representation: While the user keeps navigating in the system, his movements are recorded and the new data are processed and incorporated with the old ones.

Opinion Mining/ Sentiment Analysis: The employment of natural language processing, computational linguistics and text mining in reviews, ratings, recommendations and other forms of online expression, in order to determine a user's opinion and attitude with respect to some topic.

Constraints and assumptions: To be defined on the way.

Actors & interactions: No interactions with other components.

Covered (Yes/No): Yes

Comments: A set of pairwise similarities is computed for all the branches defined in the authored stories. The pre-computed similarity values enable the efficient execution of the interest estimation algorithm that takes place on-line.

To improve the predictions on the branching points, we also investigated a collaborative filtering approach. The collaborative algorithm employed defines a user similarity based on two aspects of visitor behavior: (i) menus activity (selection act and selection rank), (ii) script units activity (skips and completions). Thus, the user similarity is defined as a combination, i.e. weighted average, of menu similarity and script-unit similarity.

- For the menu similarity we treat each menu as a vector that has implicit ratings depending on the order that a branch was selected and whether it was selected at all or not. The algorithm then averages the overall similarity on every menu activity, according to its importance.

- For the scrip-unit similarity we define a metric that uses information on the number of different and same moves made by a pair of users. A move is defined as a skip or complete action. We again normalize this metric according to the amount of information that we have on a user's activity.

The algorithm computes the overall similarity and outputs a ranking of users. The top-N users are selected and their menu vectors are combined to derive the final prediction for the current visitor. Currently, all the similarity computations take place at run-time.

FS/PR/04	Interpretation and extension of the user profile	Important
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High

Description: All patterns and statistics produced during the computation and pattern extraction stages are interpreted as user preferences and are added as parts of a user profile. This is essentially a set of derivation mechanisms for user-profile creation based on identifying patterns and generating inferred links between objects. These are appropriately interpreted within the framework of the user model to obtain profile elements, which may then be recursively processed further to extend profiles with additional elements. Both profile interpretation and extension is done, ideally, according to cognitive and psychological theories.

Constraints and assumptions: These depend on the specifics of the user model.

Actors & interactions: No interactions with other components.

Covered (Yes/No): Yes

Comments: Visitor's actions provide implicit feedback and they are interpreted to preferences on the story elements (s)he interacts with. This is conducted on-line, as the visit evolves, and the profile is updated accordingly. Profile extension takes place whenever a branching point is met, to estimate the visitor's interest in the candidate branches. However, the estimated values are not stored in the profile; they are re-computed when a set of candidates are provided. The algorithms and technologies are presented in D5.2.

FS/PR/05	Profile storage	Mandatory
Cf. EUR/VI/04	Protecting the user's personal data	High
Cf. EUR/AU/05	Recording the user profile	High

Description: After the final interpretation step, the user profiles that were produced are stored in a database.

Constraints and assumptions: Visitor IDs have to be unique throughout the system and special attention has to be paid to user personal data privacy.

Actors & interactions: None

Covered (Yes/No): Yes

Comments: The Profiler sends the profiles to the STE, where they are stored (in the CHESS Server database). Besides the username standing for the visitor ID, no other personal information is obtained, hence raising no data privacy risks.

FS/PR/06	Profile retrieval	Mandatory
Cf. EUR/VI/04	Protecting the user's personal data	High
Cf. EUR/AU/05	Recording the user profile	High

Description: Retrieve the requested visitor profile(s). Integrate mechanisms that are capable of sending one or more profiles through a data channel in a secure, asynchronous manner.

Constraints and assumptions: None

Covered (Yes/No): Yes

Comments: The visitor's profile is retrieved by the STE and it is sent to the Profiler as soon as the visit starts. Data about past visits (including visitor's actions, rather than preferences) are retrieved via HUB RESTful API. See the HUB reference manual Hub User Guide (Version 0.2)

Actors & interactions: Called by the online profiling or the storytelling engine components. Special attention has to be paid to user personal data privacy.

FS/PR/07		Museum typologies management	Interesting
Cf.	EUR/AU/07	Supporting creativity	High
Cf.	EUR/AU/08	Supporting re-usability	High
Cf.	EUR/VI/19	Adapting to user interests	High
Cf.	EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf.	EUR/VI/21	Adapting to computing literacy	Medium
Cf.	EUR/VI/22	Adapting to the visitor's language	Medium
Cf.	EUR/VI/23	Adapting to narration style	High
Cf.	EUR/VI/24	Adapting to physical capacities	Medium
Cf.	EUR/VI/25	Adapting to the visitor style	High
Cf.	EUR/VI/26	Adapting to user preferences	Medium

Description: This is a general functionality (probably to be broken down) which allows the museum stuff to enrich the system with typologies describing the museum resources and consequently the story elements.

Constraints and assumptions: Depends upon the typologies to be used (flat, hierarchical, etc.)

Actors & interactions: The system administrator (the person who installs and configures the application for the specific museum) will use this functionality with consultation from the museum stuff.

Covered (Yes/No): Yes

Comments: The Profiler supports the annotation of storytelling objects with museum/storytelling or other typologies in a generic way; the authors may add as many features as they wish and define their domain values. These typologies are entered in the CAT during the setup of a project and then the author can employ them for annotating the story elements during authoring.

FS/PR/08		User characteristics mapping	Important
Cf.	EUR/AU/07	Supporting creativity	High
Cf.	EUR/AU/08	Supporting re-usability	High
Cf.	EUR/VI/19	Adapting to user interests	High
Cf.	EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf.	EUR/VI/21	Adapting to computing literacy	Medium
Cf.	EUR/VI/22	Adapting to the visitor's language	Medium
Cf.	EUR/VI/23	Adapting to narration style	High
Cf.	EUR/VI/24	Adapting to physical capacities	Medium
Cf.	EUR/VI/25	Adapting to the visitor style	High
Cf.	EUR/VI/26	Adapting to user preferences	Medium

Description: This allows the museum stuff to map specific user characteristics (or their values) to the defined museum typologies.

Constraints and assumptions: Depends upon the typologies to be used (flat, hierarchical, etc.) and the visitor characteristics to be considered.

Actors & interactions: The system administrator (the person who installs and configures the application for the specific museum) will use this functionality with consultation from the museum stuff.

Covered (Yes/No): Partial

Comments: Instead of correlating user characteristics to museum typologies, authors are enabled to correlate personas (i.e. groups of characteristics) to story elements, indicating the persona(s) for which each story part is more suitable for.

FS/PR/09	**User characteristics to persona mapping**	**Important**
Cf. **EUR/AU/07**	**Supporting creativity**	**High**
Cf. **EUR/AU/08**	**Supporting re-usability**	**High**
Cf. **EUR/VI/19**	**Adapting to user interests**	**High**
Cf. **EUR/VI/18**	**Adapting the experience to the user's characteristics**	**High**
Cf. **EUR/VI/21**	**Adapting to computing literacy**	**Medium**
Cf. **EUR/VI/22**	**Adapting to the visitor's language**	**Medium**
Cf. **EUR/VI/23**	**Adapting to narration style**	**High**
Cf. **EUR/VI/24**	**Adapting to physical capacities**	**Medium**
Cf. **EUR/VI/25**	**Adapting to the visitor style**	**High**
Cf. **EUR/VI/26**	**Adapting to user preferences**	**Medium**

Description: This maps the user characteristics used in the personalization component to the variables used in the definition of a *persona*, which will assist in the initial classification of a visitor.

Constraints and assumptions: Depends upon the defined visitor characteristics.

Actors & interactions: The system administrator (the person who installs and configures the application for the specific museum) will use this functionality with consultation from the museum stuff.

Covered (Yes/No): Yes

Comments: Persona definition is supported in the CAT, where authors can choose from a set of key characteristics for the definition of a new persona.

FS/PR/10	**User model elements description**	**Interesting**
Cf. **EUR/AU/07**	**Supporting creativity**	**High**
Cf. **EUR/AU/08**	**Supporting re-usability**	**High**

Description: This functionality allows the CHESS system to be generic and configurable as far as the user profiling is concerned. It involves the descriptions of the user characteristics, the museum resources (schema) and the relationship types among the model objects. When necessary it may involve the description of general rules used in the interpretation and extension profiling stages.

Constraints and assumptions: The generality of the model can be up to a point (a graph model) and cannot possibly be achieved for everything.

Covered (Yes/No): Yes

Comments:

FS/PR/11	**Engage web applications for retrieving user data**	**Interesting**
Cf. **EUR/WE/01**	**Preparing the visit**	**High**

Description: Based on the defined user characteristics, engage external applications (e.g., social networks attached apps) to retrieve user data and extract user attitude and behaviour.

Constraints and assumptions: Depends on the definition of the user model.

Actors & interactions: The system administrator (the person who installs and configures the application for the specific museum) will use this functionality with consultation from the museum stuff.

Covered (Yes/No): Partial

Comments: A module exploiting Facebook profiles has been implemented, retrieving users' Likes at Facebook pages. Pages and stories are both mapped to entities of the YAGOS2s[17] Knowledge base, so as to be compared. This module hasn't been integrated into the CHESS system; it is developed as a proof of concept for testing purposes, so as to investigate the effectiveness of an alternative approach to initial story selection. Our approach is described in D01.13 Periodic Activity Report Y3.

FS/PR/12	Computation of visit statistics	Interesting
Cf. EUR/AU/05	Recording the user profile	High
Cf. EUR/VI/27	Taking into account previous visits	High
Cf. EUR/AU/06	Quick authoring	High

Description: Analyzes evidence regarding past visits to provide statistical results that will reveal trends, temporal and behavioural patterns, visitor types and their characteristics, as well as various usage-based story aspects, computing, for instance, popularity metrics on authored scenarios, routes or plots, or even on activities and assets. Results will be provided through the authoring tool, aiming to provide further feedback to the museum stuff and allow them to refine/extend the authored stories, edit the visitor characteristics, edit the user model elements, or design other applications related to CHESS.

Constraints and assumptions: To be defined based on the requirements of museum stuff.

Actors & interactions: The computed results are provided to the authoring tool for being presented to CHESS authors and museum stuff.

Covered (Yes/No): Yes

Comments: This functionality is implemented by the HUB and the CAT accesses them through HTTP requests to the Hub (See FS/WS/19).

FS/PR/13	Automated story annotation	Interesting
Cf. EUR/AU/07	Supporting creativity	High
Cf. EUR/AU/08	Supporting re-usability	High

Description: Based on the metadata structure of the various story elements as well as their contents, the system design should be able to support possible extensions to include functionalities that perform data mining operations so as to further automatically annotate the story at any of the levels (scripting, staging or authoring).

Constraints and assumptions: To be defined based on the story entities metadata structure, the ontologies/typologies used to describe the museum concepts and objects, as well as the nature of the storytelling objects and their values.

Covered (Yes/No): Yes

Comments: At each branching point the system must decide which branch to follow so as to better match the visitor's preferences. To make such a decision, it examines the features of each branch and finds the branch that is most similar to the profile of the current visitor. We assist the authors by providing an automated process to derive i) annotations for each script unit based on its script, using a dictionary that relates keywords and phrases to topics, and ii) annotations for each branch, based on the annotations of the story elements it includes. The algorithm is described in D01.13 Periodic Activity Report Y3.

[17] http://www.mpi-inf.mpg.de/yago-naga/yago/

5.2.6.2 The Online profiler

FS/PR/14	Fetch/Log current session's action data	Mandatory
Cf. EUR/VI/03	Transparent recording of the user profile	High
Cf. EUR/VI/09	Interactive activities	Medium

Description: Action data is recorded from the moment the visitor enters the CHESS space (physical or virtual) and this is used to enable the system to fully personalize and adapt during the visit. The output is an integrated profiling database. However, the current session's log data is discriminated between the whole set of profiling data so as to build short term and contextualized profiles that will better reflect the current visitor's task/goal, preferences, performance, mood and context.

Constraints and assumptions: None

Actors & interactions: The actual log data is gathered from the other CHESS components, mainly from the mobile reporting back location and interaction, as well as the logs of the Web Experiencing system.

Covered (Yes/No): Yes

Comments: The STE sends the session's action data to the Profiler (the API is reported in D5.2)

FS/PR/15	Match visitor feedback to personas	Mandatory
Cf. EUR/VI/19	Adapting to user interests	High
Cf. EUR/VI/18	Adapting the experience to the user's characteristics	High
Cf. EUR/VI/21	Adapting to computing literacy	Medium
Cf. EUR/VI/22	Adapting to the visitor's language	Medium
Cf. EUR/VI/23	Adapting to narration style	High
Cf. EUR/VI/24	Adapting to physical capacities	Medium
Cf. EUR/VI/25	Adapting to the visitor style	High
Cf. EUR/VI/26	Adapting to user preferences	Medium
Cf. EUR/VI/27	Taking into account previous visits	High
Cf. EUR/VI/28	Adapting to visit duration	High

Description: On departure, the visitor is initially presented with a small questionnaire. The answers are processed and evaluated so as to appropriately classify the visitor into the predefined personas.

Constraints and assumptions: Individual answers will be evaluated with regard to each persona using heuristic functions and an integrated score will be computed based on all the provided answers for each persona, indicating the user's classification to the considered personas. The employed heuristic techniques will be evaluated and tested through user studies.

Actors & interactions: Visitor answers are sent by the Interaction Service to the storytelling engine which in its turn asks the on-line profiler to match the provided feedback to the specified personas.

Covered (Yes/No): Yes

Comments: This approach had been implemented and tested during the first year of the project. It is currently replaced by a content-based technique for initial story selection. Finally, an alternative approach exploiting visitors' Facebook profiles has also been investigated on that front.

FS/PR/16	Short term profile creation	Mandatory
Cf. EUR/VI/25	Adapting to the visitor style	High
Cf. EUR/VI/19	Adapting to user interests	High

Description: Performs a small amount of computations on selected visitor answers from the questionnaire, as well as the on the available recent logged data (i.e. user-session actions) and interprets the results as the user's current preferences and goals for that specific time period/visit.

Constraints and assumptions: based on the characteristics/attributes of the short term profile.

Actors & interactions: Receives input for the system variables.

Covered (Yes/No): Yes

Comments: The employed algorithms and technologies for the creation of short term profiles are described D5.2

FS/PR/17		Contextual profile creation	Mandatory
Cf.	EUR/VI/28	Adapting to visit duration	High
Cf.	EUR/VI/24	Adapting to physical capacities	Medium
Cf.	EUR/VI/43	Supporting different ages in groups	Medium
Cf.	EUR/VI/39	Group variations	Medium
Cf.	EUR/VI/40	Supporting families	Medium
Cf.	EUR/VI/41	Supporting school visits	Medium

Description: Processes selected visitor answers from the questionnaire, as well as additional input (i.e. visitor's device) and interprets the results as the user's contextual constraints and preferences, so as to ultimately form the user's contextual profile.

Constraints and assumptions: based on the characteristics/attributes of the context parameters to be evaluated (system, environmental, groups).

Actors & interactions: Receives input for the system variables.

Covered (Yes/No): Yes

Comments: Preferences and constraints are modelled and handled in a generic way, so there was no need for a separate contextual profile. Contextual aspects of the visit are stored in the short-term profile and they are handled in a seamless way.

FS/PR/18		Management of short term and contextual profiles	Mandatory
Cf.	EUR/VI/03	Transparent recording of the user profile	Medium

Description: Short term and contextualized profiles are stored in the database. They are periodically updated (during the visit) and they are retrieved from their storage for being integrated with the long term visitors' profiles, resulting in refined, enriched profiles.

Constraints and assumptions: Based on the profile user characteristics and on characteristics/attributes of the context parameters to be evaluated (system, environmental).

Actors & interactions: Receives input for the system variables. Called by the storytelling engine for subsequent matching with story elements.

Covered (Yes/No): Yes

Comments: Short term profile is maintained in memory during the visit. As soon as the visit's session ends, the Profiler sends the derived graph-based profile (represented with an XML-based format) to the CHESS Server, who is responsible for managing it and storing it in the CHESS Server database.

FS/PR/19	Profile adjustment	Important
Cf. EUR/VI/12	Changing visit trajectories	High

Description: Combines a visitor's long term profile (already produced during the offline profiling stage) with her current short-term profile (produced during the online profiling stage), so as to incorporate them in a single profile, depicting both her current and more constant preferences.

Constraints and assumptions: Based on the profile user characteristics.

Actors & interactions: None

Covered (Yes/No): Yes

Comments: The algorithm that is employed for combining the short-term profile (derived from the current visit) and the long-term profile (derived from previous visits) is described in D5.2.

FS/PR/20	Support group profiles	Interesting
Cf. EUR/VI/39	Group variations	Medium
Cf. EUR/VI/40	Supporting families	Medium
Cf. EUR/VI/41	Supporting school visits	Medium
Cf. EUR/VI/43	Supporting different ages in groups	Medium

Description: Adapt a visitor's profile to represent a group.

Constraints and assumptions: based on the group characteristics and context parameters.

Actors & interactions: None

Covered (Yes/No): No

Comments: A single visitor profile is employed for group visits, similarly to the visits of individuals.

5.2.7 The asset browser and editor (RF)

FS/AS/01	The asset author can import text assets.	Mandatory
Cf. EUR/VI/23	Adapting to narration style	High

Description: The system should be able to import textual assets.

Constraints and assumptions: The asset editor and browser must support Unicode rich text in HTML format. It is assumed the user has an external tool to format the text.

Covered (Yes/No): Yes

Comments:

FS/AS/02	The asset author can import audio assets.	Mandatory
Cf. EUR/VI/06	Providing an audio guide experience	Medium
Cf. EUR/VI/23	Adapting to narration style	High

Description: The system should be able to import audio assets.

Constraints and assumptions: The asset editor must import audio assets in the major formats: WAV, AIFF, MP3.

Covered (Yes/No): Yes

Comments:

FS/AS/03	The asset author can import image assets.	Mandatory

Description: The system should be able to import image assets.

Constraints and assumptions: The asset editor and browser must support image assets in the major formats: JPEG, PNG, TIFF, SVG.

Covered (Yes/No): Yes

Comments:

FS/AS/04	The asset author can import video assets.	Mandatory
Cf. EUR/VI/07	Providing a linear story experience	High

Description: The system should be able to import video assets.

Constraints and assumptions: The asset editor and browser must support video assets in the major formats: MPEG2, MPEG4, MOV, WMV, AVI.

Covered (Yes/No): Yes

Comments:

FS/AS/05	The asset author can import 3D assets.	Mandatory
Cf. EUR/AU/03	Digital Reconstructions	Medium

Description: The system should be able to import 3D model assets.

Constraints and assumptions: The asset editor and browser must support 3D models in major formats: OBJ, VRML, X3D, or point cloud data for scans. If the model is made up of multiple parts and textures, or separate material definitions like OBJ, it should be packaged in a single folder.

Covered (Yes/No):Partial

Comments: Point cloud data required a specific lengthy process. RealFusio has provided a tool for this task (see CHESS Year 2 presentation), however this tool has not been yet integrated to the Asset Adapter.

FS/AS/06	**The asset author can import map assets.**	**Mandatory**
Cf. EUR/WE/01	**Preparing the visit**	**High**

Description: The system should be able to import map assets.

Constraints and assumptions: The asset editor and browser must support 2D or 3D maps. 2D maps must be geo-referenced images like GeoTIFF or images with a separate world referencing file as supported by the GDAL library. The available file formats can be found here: http://www.gdal.org/formats_list.html. 3D maps must be geo-referenced 3D models in the KML / KMZ format.

Covered (Yes/No): No

Comments: Each activities use a very specific format for the maps. In the context of R&D, supporting so many formats has been barred from the core features because it is very expensive in term of development and has little interest since no agreement has been found on a common format.

UPDATE: Depending on the ability to make a map activity generic (with only few parameters for both multiple floors indoor and outdoor maps), the map content will either be seen as an asset or as a whole activity specifically designed for each museum needs.

FS/AS/07	**The asset author can add meta-data to each asset.**	**Mandatory**

Description: The asset editor can import asset data but should also be able to link meta-data to each asset.

Constraints and assumptions: A number of predefined metadata fields can be filled when importing assets. This metadata structure follows a system wide configuration scheme, as it has to be known to the Authoring and Storytelling components. Metadata should be based on international standards (e.g., Dublin Core, Europeana ESE).

It has to be noted that the metadata structure of an asset can be dynamically changed, or configured at a specific installation.

Below is a list of the metadata fields that are considered relevant to CHESS:

Field	Description	Mandatory	Source
Identifier	A unique number automatically assigned by the system to each asset	Yes	Dublin Core
Title	A name/title given to the asset. The name of the asset is automatically filled by the asset editor, taking the asset file or folder name as source. The user can then override it.	Yes	Dublin Core
Description	A description of the asset, more detailed than the title. A small text describing more precisely the asset.	No	Dublin Core
Subject	The subject/topic/theme of the asset. In the future this could come from a CHESS ontology (a set of content themes defined by the author). This could be a list of space separated user keywords or key / value pairs in "key=value" format that define the asset or its scope.	Yes	Dublin Core

Creator	The creator of the asset (i.e., the entity primarily responsible for making the asset). This may be a person, organisation or a service.	No	Dublin Core
Publisher	The name of the publisher of the asset.	No	Dublin Core
Contributor	The name of contributors to the original asset. This could be a person, an organisation or a service.	No	Dublin Core
creationDate	The date that the asset was created.	No	Dublin Core
Type	The type of the original analog or born digital object as recorded by the content holder, this element could include values such as 'image', 'photograph', 'sound', etc.	Yes	Dublin Core
Format	The file format of the asset	Yes	Dublin Core
Source	A related resource from which the described asset is derived in whole or in part (e.g. citation, URL).	No	Dublin Core
Language	The language(s) associated with the asset.	No	Dublin Core
Coverage	The spatial or temporal topic of the asset, the spatial applicability of the asset or the jurisdiction under which the asset is relevant. This may be Europeana Semantic Elements specifications a named place, a location, a spatial coordinate, a period, date, date range or a named administrative entity.	No	Dublin Core
Rights	Any suitable copyright information. This is a free text element and should be used for information about intellectual property rights or access arrangements for the asset.	No	Dublin Core
Country	The name of the country of the provider of the asset.	No	Europeana Semantic Elements
isReferencedBy	A related resource that references, cites, or otherwise points to the described asset.	No	Dublin Core
insertionDate	The date of insertion of the asset in the CHESS platform, automatically filled by the asset editor.	Yes	CHESS
Platform	A list of available platforms for the asset.	No	CHESS
appropriateForUsers	The types of CHESS users (visitors/personas) that the asset is appropriate for.	No	CHESS
inappropriateForUsers	The types of CHESS users (visitors/personas) that the asset is not appropriate for.	No	CHESS
Comments	Any comments related to the asset.	No	CHESS

Covered (Yes/No): Yes

Comments: Implemented via the tag system. The fields are present but no input format validation has been provided.

UPDATE : Change the metadata to match International standards.

FS/AS/08	The Asset browser displays platform each asset is available in.	Mandatory

Description: A clear indication of what platform an asset supports must be visible for each asset.

Constraints and assumptions: A small icon, one for each available platform in the CHESS framework, next to each asset shows the platforms in which it is supported.

Covered (Yes/No): Yes

Comments: The detailed view of an asset displays its format variations. See Asset Editor manual.

FS/AS/09	The authors can browse and search the assets.	Mandatory
Cf. EUR/AU/01	Creating material for different user groups	High
Cf. EUR/AU/02	Creating material for different visit objectives	High

Description: The asset browser has a number of tools to search and filter assets by type, name, date, etc. , in other words by all the metadata fields. Full text search capability for textual assets.

Constraints and assumptions: Visibility of each media type in the asset browser will be easily turned on / off. Assets can be filtered further by meta-data fields with a simple “contains” test of a user key in each asset for each meta-data field with an interactive update of the search result.

Covered (Yes/No):Yes

Comments: The filtering is implemented via a search box and a tag filter. The ontology graph add-on also provides a graphical mean to explore and edit the assets based on tag relations.

FS/AS/10	The authors can have a sorted view of the assets.	Mandatory
Cf. EUR/AU/01	Creating material for different user groups	High
Cf. EUR/AU/02	Creating material for different visit objectives	High

Description: The asset browser has a number of tools to sort the assets by type, name, date, etc. when browsing, in other words by all the metadata fields.

Constraints and assumptions: The list of assets in the browser can be sorted according to an asset’s media type, or any of its meta-data field, in ascending or descending order. Only one primary sort key will be available.

Covered (Yes/No):Yes

Comments: The assets can be sorted by name, date or type. The ontology graph add-on also displays a graph of tags allowing the user to get an overview of assets sorted by tags.

FS/AS/11	The authors can organise the assets in collections.	Mandatory
Cf. EUR/AU/01	Creating material for different user groups	High
Cf. EUR/AU/02	Creating material for different visit objectives	High
Cf. EUR/AU/06	Quick authoring	High

Description: The asset browser provides the capability to create folders(i.e., collections) for organising assets.

Constraints and assumptions: Collections (folders of assets) can be created, renamed, and removed. Each asset can belong to more than one collection or none. When a collection is removed, the assets contained in it should be moved outside of the collection.

Covered (Yes/No): Yes

Comments: Provided through a hierarchy of tags displayed as a tag tree. The ontology graph add-on also provides an alternate way to apprehend the hierarchy, through a graph.

UPDATE : This is a new specification due to the experience acquired during the 2nd year.

FS/AS/12	**Assets can be imported to the Assets Management tool**	**Mandatory**
Cf. **EUR/AU/01**	**Creating material for different user groups**	**High**
Cf. **EUR/AU/02**	**Creating material for different visit objectives**	**High**
Cf. **EUR/AU/06**	**Quick authoring**	**High**

Description: Assets already organised in other collections management tools or databases can be imported in the CHESS Assets Management tool.

Constraints and assumptions: The system should be able to import a collection of assets using XML format, which should specify all metadata fields. If a field is not present, a reasonable default should be assumed. The associated media files should accompany the XML file. The XML file will also specify the identifier for each asset, which should be used, unless there is a conflict with an already existing asset. In this case, the existing asset will be overwritten by the imported one. The format of the export should be defined using XML schemas.

This will allow for interoperability with other museum collection management tools and sustainability of the project, as defined by the CHESS User Group in workshops).

Covered (Yes/No): Partial

Comments: The tags are stored in JSON array available via the HUB. Converting the json to XML file would be trivial.

UPDATE : This is a new specification due to the experience acquired during the 2nd year.

FS/AS/13	**Assets can be exported from the Assets Management tool**	**Mandatory**
Cf. **EUR/AU/01**	**Creating material for different user groups**	**High**
Cf. **EUR/AU/02**	**Creating material for different visit objectives**	**High**
Cf. **EUR/AU/06**	**Quick authoring**	**High**

Description: The contents of the Assets Management tool can be exported, with all associated metadata.

Constraints and assumptions: The system should be able to export the entire collection of assets, or a selected subset of it. The format of the export should be XML, and the assets should be exported as separate files. A full export followed by import should not change the asset base.

This will allow for interoperability with other museum collection management tools and sustainability of the project, as defined by the CHESS User Group in workshops).

Covered (Yes/No):Yes

Comments: The asset editor provides such downloading tool. Only JSON format is supported.

UPDATE : This is a new specification due to the experience acquired during the 2nd year.

FS/AS/14	**The presentation service must create material for different hardware platforms. Mandatory**	
Cf. **EUR/VI/20**	**Adapting to user equipment**	**High**

Description: The system should be able to create different types of material for all the supported hardware platforms (mobile, web).

Constraints and assumptions: All heavy assets (images, sounds, videos, 3D models) must be automatically converted without any user interaction into manageable assets for each supported hardware platform.

Covered (Yes/No): Yes

Comments: This is ensured by the Asset Adapter.

FS/AS/15	**The asset author imports assets available to the story author.**	**Mandatory**
Cf. EUR/AU/01	**Creating material for different user groups**	**High**
Cf. EUR/AU/02	**Creating material for different visit objectives**	**High**
Cf. EUR/AU/03	**Digital reconstructions**	**Medium**

Description: The asset editor posts assets to the Web Service.

Constraints and assumptions: The asset editor locally builds each final asset for each platform and posts these files directly to the Asset Web Service. This conversion could be done on the server side to lighten the client's CPU load. The supported platforms and corresponding formats should be further defined.

Covered (Yes/No): Yes

Comments: This is ensured by the Asset Adapter. On an incoming asset, the Asset Editor tags the asset and stores it on the HUB. On a backend server, the Asset Editor polls the HUB seeking for incoming assets. It converts the asset in several formats and uploads the variants on the HUB.

FS/AS/16	**The Asset browser must be available in the Authoring Evironment.**	**Mandatory**
Cf. EUR/AU/01	**Creating material for different user groups**	**High**
Cf. EUR/AU/02	**Creating material for different visit objectives**	**High**

Description: The asset browser must be integrated inside the authoring software.

Constraints and assumptions: The asset browser should be a part of the CHESS ecosystem. It should store and retrieve assets and asset metadata from the CHESS ENGINE, as it is the case with the CHESS Authoring environment. The Engine will ensure the logical consistency of the assets to the rest of the model, and also will supply the domain definition for some of the attributes that are no free form. In particular, when it comes to "Subject", the Engine should supply access to the Site Ontology. For the "appropriateForUsers" attribute, the engine will supply the current list of personas.

Covered (Yes/No):Yes

Comments: The Asset Editor and its add-on, the ontology editor are HTML5 rich application. The former has been integrated as a standalone web client OS native executable and started by the CHESS authoring tool (CAT).

FS/AS/17	**The authors can modify and delete the assets.**	**Mandatory**

Description: The asset editor must be able to modify and asset already in the database as well as remove it completely. Such removal however, could make activities that use those assets no longer functional, and the CHESS Engine could either prevent or warn the user about the consequences of this action.

Constraints and assumptions: The asset editor must contain the asset browser to select existing assets. There will be functionalities for deletion, modification of all the meta-data fields as well as replacement of asset source files. In addition to that, the Asset Editor should make use of the search capabilities of the CHESS Engine (such as simple search, or semantic search).

Covered (Yes/No):Yes

Comments: These services are provided by the Asset Editor.

FS/AS/18	The Asset Editor must be designed with a simple-to-use interface.	
Cf. EUR/VI/21	Adapting to computing literacy	Medium

Description: The asset browser and editor should be useable by someone with poor computer literacy.

Constraints and assumptions: The user interface for both the browser and editor must be extremely simple and clear.

Covered (Yes/No): Yes

Comments: As an HTML5 rich application, the Asset Editor implements only simple interactions (left mouse click and drag & drop).

FS/AS/19	The Asset browser must displays previews of each asset.	Important

Description: The asset browser should display a small preview of each asset to facilitate browsing and asset selection by the story author.

Constraints and assumptions: A small thumbnail representing the asset will be displayed alongside the asset's name. Below is a resume of the various thumbnail previews for each asset type.

Covered (Yes/No): Yes

Comments: Done in the Asset Editor main view and detailed view.

	Thumbnail
Text	First few lines of the text.
Audio	Waveform of the audio with the possibility of playing the track.
Image	Downscaled version of the image.
Video	Downscaled version of a non-blank frame of the video.
3D model	Thumbnail render of the asset.
Map	Thumbnail render of the map.
Games	Thumbnail render of the HTML page.

FS/AS/20	The asset author can import games.	Interesting
Cf. EUR/VI/09	Interactive activities	Medium

Description: Younger visitors would like to play games related to the collections and exhibits.

Constraints and assumptions: The asset browser and editor should import HTML 5 pages to support small interactive games (This is already the case for iPhone and Android platforms). A game will be imported in the editor as a folder containing all the HTML pages and media necessary for the game.

Covered (Yes/No): Yes

Comments: This task has been devolved to the CAT.

FS/AS/21	The author can create composite assets.	Interesting

Description: The asset editor is able to allow authors to construct composite assets. The composite asset is a collection of simple assets, as it is the case when activities are defined. Composite assets will include their own metadata fields, which are identical to those of simple assets.

Covered (Yes/No):Yes

Comments: This task has been devolved to the CAT.

5.2.8 The off-site experience system (RF)

FS/WE/01	**The user can experience the off-site system on a reasonable platform.**	**Mandatory**

Description: The web experiencing system must be fully useable on the maximum number of reasonable mid-range hardware platforms.

Constraints and assumptions: The web site will be developed entirely in HTML 5 without any external plug-ins like Flash or Java.

Covered (Yes/No): Yes

Comments: The Web Experiencing System (WES) is built on HTML5 technologies, free from any plug-ins. Therefore it could run on a large set of desktop platforms, providing they have a Internet Browser with a decent HTML5 implementation. However, due to development constraints, only Google Chrome has been tested.

FS/WE/02	**The visitor can plan his visit.**	**Interesting**
Cf. EUR/WE/01	**Preparing the visit**	**High**
Cf. EUR/VI/16	**Optimisation of visit trajectories**	**Medium**

Description: The visitor can access all necessary content on museum exhibits, layout, etc. in order to prepare for the visit.

Constraints and assumptions: The web site should propose a floor plan of the museum with clear indications of all the different exhibits, opening times and schedules (e.g. for Imax or anything else popular). Each exhibit should have a short description of its contents and age limits. If the museum supports online ticket purchase, a link to this service will be available.

Covered (Yes/No):Yes

Comments: The WES provides a museum presentation web page built from a dynamic mash-up of the Acropolis Museum web pages.

UPDATE: After the second User workshop, we discovered that the post visit is more interesting than the pre visit. That's why we downgrade this feature to an Interesting level and upgrade the FS/WE/24 feature to important.

FS/WE/03	**The visitor can jump to the main museum site.**	**Mandatory**
Cf. EUR/WE/01	**Preparing the visit**	**High**

Description: The visitor can jump to the main museum site for general information so the user can retrieve general information on ticket rates, opening hours, etc.

Constraints and assumptions: A link to the main museum site must be clearly visible.

Covered (Yes/No): Yes

Comments: The WES contains a museum presentation web page allows the user to jump to Acropolis Museum web pages.

FS/WE/04	**The visitor fills his user profile.**	**Mandatory**
Cf. EUR/AU/05	**Recording the user profile**	**High**

Description: Visitors must inform the system of their profile for the storytelling engine to adapt the story, once on site. This may be presented in the form of a short questionnaire.

Constraints and assumptions: The web experience system must be able to record information in the user's profile.

Covered (Yes/No): Yes

Comments: The WES relies on the CVS and MES to store the user profile.

FS/WE/05	The off-site experience connects to the web service over a RESTful interface.	Mandatory

Description: The CHESS web application connects to the Web Service over a RESTful interface. The data received (stories, content, messages, etc.) in JavaScript Object Notation (JSON) will be rendered in HTML5 using JavaScript.

Constraints and assumptions: Therefore a JavaScript library has to be developed for rendering data in the defined style sheets and can be used by all developers.

Covered (Yes/No): Yes

Comments: The WES components (CVS, STE, MES, souvenir player) are all based on RESTful interfaces.

FS/WE/06	The off-site experience's user interface has a consistent design.	Mandatory
Cf. EUR/VI/56	Adapting to visual aesthetics	High

Description: User interface CSS style sheets for a consistent design. Defines UI elements, colors and grids of the application.

Constraints and assumptions: Each partner should use the same stylesheet for his developments. Enhancements should be contributed to the stylesheet and provided to the other developers.

Covered (Yes/No):Yes

Comments: The WES is designed to follow CHESS Acropolis Museum look & feel.

FS/WE/07	The visitor can visualize his off-site visit trajectory.	Important
Cf. EUR/VI/14	Proposing trajectories	High
Cf. EUR/VI/16	Optimisation of visit trajectories	Medium
Cf. EUR/VI/43	Reflect group trajectory	
Cf. EUR/VI/53	Transforming the profile into an experience	High

Description: The web experiencing system can display trajectories in the museum. Trajectories can be textual indications like sequences of rooms, halls or exhibits.

Constraints and assumptions: The web service must be able to record the history of each web visit in the user profile.

Covered (Yes/No):Partial

Comments: At the time of the writing, only one story path is available, therefore a single path is displayed in the souvenir player. Moreover, for now, only the visit nodes are displayed, the path is not yet rendered.

FS/WE/08	The visitor can view their previous visits.	Important
Cf. EUR/WE/02	Taking into account previous visits	Medium
Cf. EUR/VI/27	Taking into account previous visits	High

Description: Visitors who look for an in depth experience in the museum would like to be able to have an overview of which parts of the collections they have visited and what information they have reviewed in the website.

Constraints and assumptions: The website must propose a user account system, shared with the mobile experience, to track previous visits. This data is stored on the Web Service. Each web page already browsed by the logged on user will have a clear visual indication of this. The same way, every web page corresponding to an exhibit already visited with the mobile experience system by the user, will be clearly marked as so, with a different visual indication. A specific web page will also be available to list all the exhibitions visited by the user during previous visits in the museum. If an exhibit has changed during the user's last visit, it will be indicated on this page or on the exhibits specific web page.

Covered (Yes/No): Partial

Comments: The WES souvenir web page displays the records for each played activity. Since the MES does not completely implement the visit resuming, the souvenir web page rendering has not been finalized to manage such the many occurrences of souvenirs generated by multiple visits.

FS/WE/09	**The visitor can visualize his on-site visit trajectory.**	**Important**
Cf. EUR/WE/03	**Extend the visit through the website**	**High**
Cf. EUR/VI/53	**Transforming the profile into an experience**	**High**

Description: The visitor can visualize trajectory of previous visits on-site in the Web experience. This enables him to re-tell his experience to someone else.

Constraints and assumptions: Each previous visit on-site can be selected and re-played.

Covered (Yes/No): No

Comments: See above.

FS/WE/10	**The visitor can visit as a group.**	**Important**
Cf. EUR/VI/39	**Group variations**	**Medium**
Cf. EUR/VI/40	**Supporting families**	**Medium**
Cf. EUR/VI/41	**Supporting school visits**	**Medium**
Cf. EUR/VI/42	**Supporting different ages in groups**	**Medium**

Description: Visitors may not be alone when using the Web experiencing system and as such visitor profiles can correspond to group profiles.

Constraints and assumptions: The web experience system must be able edit user profiles of single persons or groups of different nature (family, school visits). The visual presentation of the profile must adapt in accordance.

Covered (Yes/No):Yes

Comments: The CVS records user profiles on the STE. It is up to the STE to build groups and serves the stories adapted to them.

FS/WE/11	**The visitor can explore the content through different "characters".**	**Important**

Description: The presentation of the museum content is based around "characters", fictional or historical, that present different aspects of the exhibits. Visitors can choose to follow a character in particular, thus orienting their visit on a certain aspect. A character can propose a number of missions.

Constraints and assumptions: None in particular.

Covered (Yes/No):Yes

Comments: This task is assumed by the CAT (story preparation), the CVS (user profiling) and the STE (story chaining upon user profiling).

FS/WE/12	**The visitor can schedule exhibits.**	**Interesting**
Cf. EUR/VI/32	**Adapting to existing visitor flow**	**Low**

Description: When planning his visit, the user can get access to a schedule with an optimized sequence of exhibits that reduces his queuing time as well as the routes between each exhibits.

Constraints and assumptions: The web site must have access to a booking database to determine which exhibits will be congested during a user's visit.

Covered (Yes/No): Yes

Comments: The WES museum presentation page display exhibition date. In order to complete this page with a crowd congestion prevention system, such service should be provided the Acropolis Museum website backend.

FS/WE/13	**The visitor can buy tickets.**	**Interesting**
Cf. EUR/WE/01	**Preparing the visit**	**High**

Description: The visitor can buy tickets off-site and download them as QR codes on their mobile.

Constraints and assumptions: These tickets must be stored in the user profile.

Covered (Yes/No):Yes

Comments: : The WES museum presentation page provides a link to online ticketing system. Like the previous item, completing the RESTFul interface of the Acropolis Museum ticketing system would improve its integration within the WES.

FS/WE/14	**The visitor can download the on-site application.**	**Interesting**

Description: The visitor can download the on-site application on his mobile through the off-site web page.

Constraints and assumptions: The on-site application must be deliverable from a web page.

Covered (Yes/No): No

Comments: The main target of the WES is a desktop hardware PC. Matching with mobile specification requires additional developments.

FS/WE/15	**The off-site experience can adapt to the visitor's language.**	**Interesting**
Cf. EUR/VI/22	**Adapting to user language**	**Medium**

Description: The web experience should be available in the appropriate language for the user.

Constraints and assumptions: The preferred language of the visitor should be changeable and saved with his profile for the next visit.

Covered (Yes/No): Partial

Comments: Some activities are built with a custom internationalization system. However this system is not used by all activities. Moreover it is not easily edited through the CAT and the MES does not allow language selection.

FS/WE/16	**The off-site experience can adapt to the visitor's language physical capacities. Interesting**	
Cf. EUR/VI/24	**Adapting to physical capacities**	**Medium**

Description: The web experience should take into account differences in physical capacities.

Constraints and assumptions: The web experiencing system should follow the WAI-ARIA specifications.

Covered (Yes/No): No

Comments: No study has been done for accessibility. Due to the tablet target, many interactions are mainly based on drag & drop interactions. Therefore, adapting such actions for better accessibility is not a trivial task.

FS/WE/17	**The visitor can play games.**	**Interesting**
Cf. EUR/WE/04	**Play games**	**Medium**

Description: Younger visitors would like to play games related to the collections and exhibits.

Constraints and assumptions: HTML 5 will be considered the minimum requirements to enable rich interactive applications in the web experiencing system.

Covered (Yes/No):Yes

Comments: The WES embeds a version of the MES, enabling the visitor to play activities.

FS/WE/18	**The visitor can choose “missions”.**	**Interesting**

Description: Visitors can choose which “mission” they want to accomplish once on-site.

Constraints and assumptions: The choice of missions must be recorded in the user profile.

Covered (Yes/No):Yes

Comments: This is provided by stories generated by the authors.

FS/WE/19	**The visitor can receive notifications.**	**Interesting**
Cf. EUR/WE/06	**Receive notifications**	**Low**

Description: Visitors should be able to receive notifications through mail and/or SMS if new material is available.

Constraints and assumptions: The web experience system’s user profile must contain the mail address and / or mobile phone number of the user, as well as authorization for notifications.

Covered (Yes/No): Partial

Comments: The WES uses the visitor email in the MES and the souvenir players. This identifier could also be used by the WES to notify the visitor. However, there is no such frontend implementation since it would require a specific backend module fetching the latest changes on the assets.

FS/WE/20	**The visitor can log in with existing social network profiles.**	**Interesting**

Description: Instead of filling a number of fields to create the profile, users can use their existing profile on common social network sites to identify themselves.

Constraints and assumptions: The web experience system must provide a mean of querying profile information on various social network sites (Facebook, Twitter, etc.) through their respective APIs.

Covered (Yes/No): Yes

Comments: Early versions of souvenir player provide such social network connection.

FS/WE/21	**The visitor can interact with social networks.**	**Interesting**

Description: Some social networks like Facebook enables a user to tag a specific web page as “liked”. The web page will then be referenced on his wall. Other CHESS experience users, friends of the current visitor, having “liked” a CHESS exhibit will show up on the exhibit’s web experience page. A visitor will then know what exhibits their friends have liked.

Constraints and assumptions: Same as FS/WE/20.

Covered (Yes/No): Yes

Comments: See FS/WE/20.

FS/WE/22	**The visitor can access post-visit extra content**	**Interesting**

Description: Additional material is available to the visitor once he has finished a mission or a visit on-site.

Constraints and assumptions: The exhibits visited and missions accomplished during the on-site visit must be logged into the user profile.

Covered (Yes/No):Yes

Comments: The WES contains a souvenir player able to render souvenirs produced at the end of each activity.

FS/WE/23	**The visitor can use on-site visit content**	**Interesting**

Description: Content created during the on-site visit on the mobile like photos, videos or sound recordings can be collected to create a comic book or photo album.

Constraints and assumptions: The media collected during the visit must be stored or referenced in the user's profile. An editor must be available to create a comic book or photo album.

Covered (Yes/No):Yes

Comments: Some activities let the user to store photo as souvenirs. Then, these photos are displayed in the WES souvenir player.

FS/WE/24	**The visitor can register souvenirs through the website**	**Important**

Description: During the experience, the visitor can collect souvenir that will be accessible from the website during an off-site experience.

Constraints and assumptions: Souvenir activities have to be designed with the corresponding website to access them.

Covered (Yes/No):Yes

Comments: See FS/WE/23

5.2.9 The on-site experience system (IGD)

FS/MC/01	**Hardware compatibility iOS**	**Mandatory**

Description: The on-site Mobile Experiencing Applications will run on current and future mobile devices, such as an Apple iPhone 4, Apple iPad2 tablet and newer.

Constraints and assumptions: Minimum requirements of devices are important, with respect to battery life, processor power, network speeds, localization capabilities, video & camera access, and headphones (for listening to the audio narration). Support for different platforms requires using open standards (i.e. the recent web-app approach) instead of native development.

Covered (Yes/No): Yes

Comments: Employing a web-app-based approach, with a server<>client structure turned out to be quite successful in terms of the interplay of different components and mixed media alike. It allows the system to scale beyond the boundaries of native implementations in the future. A minor drawback, however, is the fact, that some presentations, e.g. 3D content lacks performance sometimes. But this can be considered to be solved due to the increasing capabilities of future mobiles.

UPDATE: The main target platform will be the Apple IPad because of the screen size which allow a better interaction and visualisation quality.

FS/MC/02	**Beta application distribution**	**Mandatory**

Description: Beta applications will be delivered by the developing partners themselves via Ad-Hoc distribution and Android APKs.

Constraints and assumptions: Beta distribution enables direct installation on the devices instead of going through the official markets with long review processes. This is totally sufficient for the beta tests even with end users. It also ensures quick response times when adding features or solving bugs.

Covered (Yes/No): Yes

Comments: This process turned out to work very well, especially during the migration of components throughout the consortium or other partners. And it is way more effective and efficient in terms of debugging.

FS/MC/03	**Hardware compatibility Android**	**Interesting**
Cf. EUR/VI/20	**Adapting to user equipment**	**High**

Description: The on-site Mobile Experiencing Applications should also run on current and future Android Phones (Android 2.3 and higher) and tablets.

Constraints and assumptions: Due to a lot of different Android versions and phones from different manufacturers the platform is far more fragmented than iOS with its 8-10 devices. Thus developing for the Android platform is more complicated than for iOS, especially when dealing with cutting edge technology like Computer Vision and Augmented Reality.

Covered (Yes/No): Partly Covered

Comments: Since the Android platform turned out to even more heterogeneous, than originally expected, especially for the access of hardware components and the implementation of 3D and augmented reality apps, the system now basically runs partly on the latest Android platform. However, some CHESS features run only on two to three dedicated mobile devices and face strong limits for the usage of inertial sensors, vision based components and augmented reality.

UPDATE : This requirement has a lower importance than previously mentioned as we are not yet in the production phase.

FS/MC/04	Application distribution via App Stores	Interesting
Cf. EUR/WE/01	Preparing the visit	High

Description: The applications will be distributed via official channels like Apple's App Store and the Android Market and will run as native applications (Apps) on the device.

Constraints and assumptions: Applications have to fulfil requirements set by Apple and Android in order to be placed in the App Store and Android Market. Beta applications will be delivered by the developing partners themselves via Ad-Hoc distribution and Android APKs.

Covered (Yes/No): Yes

Comments: The CHESS system has been implemented and designed in a way that it matches the compliance requirements of current app markets. For the final system as being by now, the distribution is not so much defined by technical limitations, but more by the question of licensing, given the interplay of the development through different partners. Right now, there are several options that need further investigation. One is e.g., that the CHESS system will be served on prepared devices, where the app comes from an "inHouse" app-store. Another could be a balanced modality, where it needs definition for which parts of the CHESS system will be deployed in an official app, i.e. whether such an app holds already the full content or, whether it rather acts as a player, that downloads relevant content on demand.

FS/MC/05	Links to application sources	Interesting

Description: Applications should be promoted in order to be found. Links and QR-Tags to the applications will be provided on the CHESS website and by the local partner sites.

Constraints and assumptions: Links to App Store Items and QR are provided on the page of the app.

Covered (Yes/No): Yes

Comments: During the project, we have been working with several ways of indicating and advertising the CHESS app and system. Since both, iOS and Android, market support such "jump links", this is a feasible functionality.

FS/MC/06	Web service rendering	Mandatory
Cf. EUR/VI/20	Adapting to user equipment	High

Description: The CHESS mobile application connects to the Web Service over a RESTful interface. The data received (stories, content, messages, etc.) in JavaScript Object Notation (JSON) will be rendered in HTML5 using JavaScript.

Constraints and assumptions: Therefore a JavaScript library has to be developed for rendering data in the defined style sheets and can be used by all developers.

Covered (Yes/No): Yes

Comments: In fact, the entire CHESS system is based on this functionality right now, more on this, please refer to deliverable D08.1-ChessBetaRelease.

FS/MC/07	Application Framework	Mandatory

Description: Fraunhofer IGD's Mobile AR Framework will constitute the base of the mobile CHESS applications.

Constraints and assumptions: Like PhoneGap it provides a Webview rendering the application via HTML and a set of JavaScript interfaces for communicating with OS features like the camera, GPS and compass. This generic application approach layers a transparent WebKit implementation (Webview) over a X3D render engine, which can directly intercommunicate with our computer vision engine. The engines itself can be fed using declarative descriptions in form of XML, JSON or URLs (see also Figure below).

One of the benefits is that parts of the applications can be developed independent and tested in common browsers by the partners.

Covered (Yes/No): Yes

Comments: The CHESS system as is incorporates Fraunhofer IGDs instantAR or mobileAR framework, as a native implementation, that acts as a runtime and execution context for all other web-based components. It especially serves 3D rendering and augmented reality functionalities, where both the execution context and the vision engine can be fed via network. A majority of CHESS components run also in usual and mobile browsers.

FS/MC/08	Computer Vision Engine (Vision)	Mandatory

Description: InstantVision is a computer vision engine for enabling AR on mobile devices. It's integrated in Fraunhofer IGD's Mobile AR Framework's.

Constraints and assumptions: The vision engine (InstantVision) allows Algorithms to be described inside declarative descriptions in form of conditional fixed function pipes in XML. The used tracking data itself can be stored inside an internal hierarchical database for optimized access. While data of database objects can be transferred via network it is possible to transfer parts or full tracking data via network to and from a server infrastructure.

CHESS mobile application will feature custom computer vision algorithms based on InstantVision developed for different application scenarios.

Covered (Yes/No): Yes

Comments: The computer vision system is fully integrated and enables the use of Augmented Reality inside CHESS activities. It can be fed via network, which allows tracking information to be changed and adapted without touching CHESS activities.

FS/MC/09	User interface CSS style sheets	Mandatory
Cf. EUR/VI/25	Adapting to the visitor style	High
Cf. EUR/VI/26	Adapting to user preferences	Medium
Cf. EUR/VI/52	Adapting to visual aesthetics	High

Description: User interface CSS style sheets for a consistent design. Defines UI elements, colors and grids of the application.

Constraints and assumptions: Each partner should use the same stylesheet for his developments. Enhancements should be contributed to the style sheet and provided to the other developers. One could also think of templates and style for different user types/profiles/preferences – as needed concluded throughout the project's progress. The style sheets can therefore behave like style templates and skins.

Covered (Yes/No): Yes

Comments: During the migration and integration, several schemes have been developed that fit to the stories and the linked persona, i.e. user preferences. They are used coherently throughout the entire system.

FS/MC/10	Application standard is HTML5	Important
Cf. EUR/VI/20	Adapting to user equipment	High

Description: In order to provide as much platform independence as possible all CHESS mobile applications interfaces will be based on HTML5, JavaScript and CSS Style sheets.

Constraints and assumptions: The most common way of creating interaction and applications on mobile devices can be archived using HTML5 and JavaScript (JS). Every mobile platform itself delivers derived WebKit or similar implementations. Application Frameworks like PhoneGap (http://www.phonegap.com/) and jQTouch (http://jqtouch.com/) are successfully demonstrating this approach. They are providing native wrapper application consisting of a Webview, a seamless integrated programmable browser window, and interfaces between JavaScript and the native mobile operating system (OS).

The goal is to use primarily HTML5 features (video, audio, etc) where possible instead of developing features with native code.

Covered (Yes/No): Yes

Comments: The recent system is not so much based on jqTouch or other non-CHESS-related frameworks anymore. Instead, there is now a own implementation that bases on NKUAs Narrator component.

FS/MC/11	User interface guidelines	Important
Cf. EUR/VI/20	Adapting to user equipment	High

Description: The mobile CHESS applications will conform the standard mobile application end user requirements of the supported mobile platforms (see for example the Apple Mobile Application Guidelines).

Constraints and assumptions: User interface guidelines for mobile platform are the foundation of CHESS mobile application user interfaces. On top of them we'll apply the CHESS UI style guides.

Covered (Yes/No): Yes

Comments: Where possible, CHESS matches HMI guidelines of the mobile platform. However, since there exists little to none reading about interaction standards for Augmented Reality on mobile devices, several techniques have been explored and aligned to existing guidelines as much as possible.

FS/MC/12	Custom Native Plugins	Interesting
Cf. EUR/VI/20	Adapting to user equipment	High

Description: Enhancements to the application framework which are mandatory for the project and not available in Webkit and other webviews.

Constraints and assumptions: The goal is to use primarily HTML5 features (video, audio, …) where possible instead of developing features with native code. Native plug-ins developed in Cocoa (iOS) and Java (Android) should be only considered when they are absolutely necessary for a feature and not available in Webkit. Each plug-ins decreases the platform independence and interoperability of the platform.

Covered (Yes/No): Yes

Comments: In fact, almost none of the existing CHESS activities, except 3D and augmented reality, make use of custom native plug-ins. For the latter it is still case, because there is not yet a component inside the official HTML5 framework. However, interfaces to direct and integrated such content is already set on JavaScript and based on web-technologies.

FS/MC/13	Broadcast locative information and notifications	Mandatory
Cf. EUR/VI/15	Recommending parts of the collection	High
Cf. EUR/VI/34	Location in the environment	High

Description: Alert the visitors of choices of content (story elements) available due to the proximity to specific exhibits, environmental conditions ("the museum closes soon"), terminal situations ("no network connectivity"). Receive notifications ("your IMAX movie will start in 5 minutes").

Constraints and assumptions: Alerts have to follow user interface guidelines in order to avoid user confusion.

Covered (Yes/No): Yes

Comments: Depending on the profile and story, these alert boxed are part of the schemas mentioned earlier.

FS/MC/14	2D Map	Mandatory
Cf. EUR/VI/13	Overview of the collection	High
Cf. EUR/VI/15	Recommending parts of the collection	Medium
Cf. EUR/VI/14	Proposing Trajectories	High
Cf. EUR/VI/34	Location in the environment	High
Cf. EUR/VI/54	Transparent navigation	High

Description: A 2D Map providing information about multiple floors, locations of: yourself, location of exhibits, other story elements / content, group members, bathrooms, etc.

Constraints and assumptions: Floor plans of the sites have to be delivered by the sites or be designed. Outdoor maps could use Google Maps. Developers have to decide if native Map Views will be used or HTML5 maps.

Covered (Yes/No): Yes

Comments: Depending on the profile, the system provides both possibilities, one that rather hides (i.e. in a case where the visitor profile is based on: "I'd like to be guided for an hour, don't bother me with details, bring me where I need to be") and another that exposes these overviews or trajectories (i.e. in case where the visitor profile is based on: "Show me where I am and where I can go explore something on my own").

Technology-based and automatised indoor localisation services have been explored on a technical level for now, since none existing technique is as standardized as outdoor positioning.

UPDATE: The visitor location will depend on the quality of the localisation service.

FS/MC/15	Presentation flow control	Important
Cf. EUR/VI/12	Changing visit trajectories	High

Description: Provide "presentation flow control": suspend, resume, repeat (a segment of), the CHESS content flow

Constraints and assumptions:

Covered (Yes/No): Yes

Comments: This functionality is part of the Story Telling engine, the Narrator and the Hub component. While the mobile app basically features these functionalities, it is connected to the profile and visitor demands.

FS/MC/16	Content cache	Important
Cf. EUR/VI/11	Providing additional information	High
Cf. EUR/VI/17	Access to headline information	Medium

Description: A reasonable amount of content will be stored locally in order to keep the application running when networks errors happen.

Constraints and assumptions: Since the Application can't guarantee continuous network coverage, due to the nature of network traffic in the context of crowded areas with lots of radiating mobile terminals, a reasonable amount of content will be stored locally, in order to manage a temporary loss of connectivity. Should the connectivity be lost, the application will pause and display a reasonable message to the visitor.

Covered (Yes/No): Yes

Comments: The CHESS system includes structures so that content can be accessed locally or remotely for each CHESS activity separately. This can be chosen by authors during the distribution process.

FS/MC/17	Location cache	Interesting
Cf. EUR/VI/34	Location in the environment	High
Cf. EUR/VI/54	Transparent navigation	High

Description: A reasonable reaction to changing location of the visitor when location determination is not available.

Constraints and assumptions: Since the localization system cannot track the visitor to high precision, the application should take in to account the location ambiguity. Since localization could suffer from coverage holes, we need to accommodate a temporary loss of localization.

Covered (Yes/No): Yes

Comments: Several fallback strategies have been explored to cope with situation, where an automatised localisation is not available or fail-safe enough. On, e.g. is on an UI level, where there is a dialogue between system and user asking, whether the user reached the intended position, before the story continuous.

FS/MC/18	Bookmarks	Interesting
Cf. EUR/VI/51	Souvenirs	Medium

Description: Bookmarks for making notes of items related to the exhibits that can be purchased from the museum store.

Constraints and assumptions: Depends on the local site.

Covered (Yes/No): Yes

Comments: Technological structures have been created so that users can "store" entire CHESS activities, create photos or screenshots for later consumption.

FS/MC/19	Messaging	Interesting
Cf. EUR/VI/45	Group fragmentation	Medium
Cf. EUR/VI/48	Sharing information across the group	Medium

Description: Exchange messages with other visitors (possibly only in the same group).

Constraints and assumptions: Messages are coordinated by the CHESS Hub. Sent messages are delivered via REST to the server and polled by the receiver's client.

Covered (Yes/No): Partly Yes

Comments: This is not fully employed in the final release, since CHESS primarily focuses on single persons. However, the backend components are designed in a way to be easily extended by such functionalities.

FS/MC/20	Taking photos	Interesting
Cf. EUR/VI/46	Group awareness	Medium
Cf. EUR/VI/51	Souvenirs	Medium

Description: Take and save photos (possibly shared with the group). This could help not only for souvenirs, but for group awareness

Constraints and assumptions: Photos are taken on the mobile device and sent via REST to the CHESS Hub. Clients of the same group are able to receive other's shared photos.

Covered (Yes/No): Yes

Comments: see above.

FS/MC/21	Physical device interaction	Interesting
Cf. EUR/VI/10	Playful Engagement	Medium

Description: Certain stories may require coordination between multiple devices. Or they may include different interaction types (other than touch-only) – like shaking the device.

Constraints and assumptions: Tapping two devices together in order to exchange data for example. Developers have to investigate hardware restrictions and possibilities (Bluetooth, Wi-Fi, NFC).

Covered (Yes/No): Yes

Comments: Multimodal interaction is especially addressed in the Augmented Reality CHESS activities. Here spatial interaction techniques have been explored that either are vision based (distance<>proximity) or rely on inertial sensors (e.g. a flip gesture that allows to consume AR on a 3D basis by simply lowering the device).

FS/MC/22	Social Network integration	Interesting
Cf. EUR/VI/04	Protecting the user's personal data	high

Description: Connecting CHESS with social networks like Facebook and Twitter.

Constraints and assumptions: "Like" Facebook places within an environment for example. It could be also interesting to use already available user profile features and information for the personalization features.

Covered (Yes/No): Yes

Comments: Especially for the login to CHESS, a Facebook account can be used as well. Since all content is web-based and thereby web-ready, photos and screenshots can be shared easily.

FS/MC/23	Comment/Annotation system	Interesting
Cf. EUR/VI/09	Interactive activities	Medium
Cf. EUR/VI/08	Providing an interactive story experience	High

Description: Read and leave comments and virtual annotations on an exhibit

Constraints and assumptions: Will likely need moderation by the site or by voting. Should be developed mainly in the Web Experience System; but would also work on-site based on available localization features, where comments and annotations can be geo-referenced.

Covered (Yes/No): Yes

Comments: These functionalities are part of the CHESS Narrator component and the STE and are integrated to a certain degree.

FS/MC/24	Limited interaction modes	Interesting
Cf. EUR/VI/08	Providing an interactive story experience	High
Cf. EUR/VI/09	Interactive activities	Medium
Cf. EUR/VI/37	Engagement with exhibits	Medium

Description: The mobile can be put into modes of limited interaction, where the visitor is not able use all of the normal features. This can be used in order to encourage respectful behaviour around certain exhibits.

Constraints and assumptions: The visitor could always quit the application and use the phone normally, but constraining the mobile device to only use the CHESS application is beyond the scope of the project.

Covered (Yes/No): Yes

Comments: The basic CHESS system supports such limited interaction modes on a technical level. This is a task during the design of story elements to make use of it.

6 Summary and conclusions

This deliverable has focused on five topics key to an understanding of the work of CHESS in Y3 of the project. These are:

- An evaluation of the CHESS authoring methodology
- An evaluation of CHESS user experience deployments
- An evaluation of CHESS personalisation and adaptation facilities
- A technical validation of CHESS components
- An assessment of the coverage of user requirements and functional specifications

Collectively, these:

- Illustrate the efficacy of CHESS authoring technologies in relation to cultural heritage environments
- Present research results of interest to the cultural heritage community
- Help to identify future issues for both research and development in relation to user experiences and authoring technologies

7 Appendices

7.1 CAT usability and functionality issues

Development of the CAT will continue beyond the end of the CHESS project, and the usability evaluation presented in section 1.3.2 has identified issues to be taken into account during the development process. These issues are summarised in the following table for reference.

Table 16 Summary of interface issues identified through summative usability analysis

ID	Issue title	Priority	Category	Issue description	DXT notes
1	Branching point and SU Conceptual Attributes editing	Medium	Bug	When adding a new topic if you do not click somewhere outside the Topic before going to another SU, the topic is not saved.	Fixed
2	Export and print functionality for the text of the story	High	Feature	Maybe follow an approach that when a branching point is reached, print first all SUs of the first branch, then of the second, then of the third etc, and then continue.	Done
3	Add support for Greek in CAT for Navigator labels and menus.	Low	Feature	Would be very nice for AM to be able to create stories in Greek. TTS is a probable issue in this case.	The next version will enable to select the TTS in a combox listing the SAPI compliant TTS installed on the computer.
4	Renaming SU with the same name	Medium	Bug	When trying to rename an SU without changing the name, if you press OK it says that the name is already in use.	Fixed
5	Renaming SU: does not allow numbers in the beginning of name	Low	Feature		Known limitation, due to Lua scripting rules
6	Cloning a Script Unit does not work: The cloned SU does not appear in the hierarchy on the left.	Medium	Feature		You can clone simple object such as activities, but complex one are not yet possible. It will be done in a future version.

ID	Issue title	Priority	Category	Issue description	DXT notes
7	Narrator->Slides->Add new element->"Unroll to edit" does not work anymore as the small arrow does not appear. The arrow appears in already created slides.	High	Feature	Very important to be fixed as soon as possible. the only way to work at the moment is to copy activities with already created slides...	Done
8	Add help (in the form of a "tooltip") to each field	High	Interface		Done for most of them. Only few explicit functions have not yet their tooltip.
9	The window name / title of the "Activity list" says Inscape instead of CHESS	High	Interface		Done
10	Add a "Fit to window" button / functionality, i.e., the ability to view the entire graph in a single window	Medium	Feature	This is useful when the graph is large; it is needed to get an "overview" of the whole graph.	Done
11	Ability to print the graph (export in some kind of format, e.g. jpg, xml)	Medium	Interface		Done
12	In the Attributes, the term "Subjects" should be renamed to "topics"	Medium	Interface	The term Subjects is usually used for people. "Topics" or "themes" is more appropriate to characterize categories of concepts.	Done
13	To add new elements to Subjects, use a '+' to the right of the word Subjects	Medium	Interface	It is simpler and more immediate than having to right click and select Add element	Done
14	Make left arrow icons more visible	Medium	Interface	Where left arrows are used, their color is close to that of the background. Make their color brighter.	Done

ID	Issue title	Priority	Category	Issue description	DXT notes
12	Edit template after it has been created	Medium	Feature	Template editing should be possible for many reasons (e.g., there may be simple errors such as spelling mistakes that need to be corrected "Heroes" - "Heros" or a new theme might need to be added, etc). We suggest allowing the author to edit the template but issue first a warning if the template attribute being edited or deleted is being used in a story.	Done
15	Enrich template with additional features	Low	Feature	Persona characteristics should be added among others	Style information has been added Geolocalisation data has been added
16	It would be useful to have both Script unit name and Title available on the attributes.	Medium	Interface	Script unit name and Script unit title could be 2 separate attributes.	In order to simplify the attribute list, we prefer keeping it merged.
17	Ideally we would like displayable upon request, both on Script Unit and Activity: Title, Synposis, Script Text, Script Unit Name	Medium	Feature		In order to keep the blocks coherent, the name is always displayed (to identify the block easily) and only the description field can be displayed. Branching points, activities, script units share the same mecanism. The author can however put the same text as in the in the description.
18	*DisplaySynopsis* and *Synopsis* why are they separate fields?	Medium	Interface	Why not keep only the field Synopsis and add a check box next to it for "toggling" its display on/off ?	Done: Both fields have been merged

ID	Issue title	Priority	Category	Issue description	DXT notes
19	Many icons are not obvious (e.g., the Open Canvas icon)	Low	Interface		This is a tricky request as the obviousness of icons depend on the culture and tools used by the users. End-users should suggest ideas for more obvious icon sets.
20	The shape of the branching point	Low	Interface	The shape of the branching point representation should be distinguished from the shape of the script node	The square is handy for the pins. Currently, We can distinguish using the colour and the popup help.
21	Renaming Script Unit inconsistency.	Low	Interface	Trying to set Script Unit Name to "1" on the canvas (right click) works but from the Project hierarchy (right click on the hierarchy node) it is not allowed - Inconsistency here	Done (forbidden in both cases)
22	On the Attributes, "Add element" should not start with "0" but with "1"	Low	Interface	In general, numbering in lists etc. should start from the commonly used 1 and not "computer" numbering...	This is a known limitation due to Lua scripting feature of INSCAPE.
23	Type of info	Medium	Personaliz	possibly an extra option is needed along with "Real" and "Mythical", tbd with personalization team	personalization attributes have been re-designed, issue no longer relevant
24	Should be able to define main and secondary characters on the Script and then have these available as a drop down on the "Characters" attribute on the Script Units	Medium	Feature	Note to the NKUA ontology team: All story characters, not only narrating ones should be considered for the ontology.	Done
25	Main and secondary characters should be one after the others on the attributes list	Low	Interface		Personalization attributes have been re-designed, issue no longer relevant

ID	Issue title	Priority	Category	Issue description	DXT notes
26	Alphabetical order of the attribute list	Low	Interface	Maybe attributes instead of alphabetically should be conceptually grouped	Categories can be created in the attribute editor. The name of these categories has to be defined.
27	Customizable order for the attribute list	Very Low	Feature	Maybe attributes list order should be configurable by the author.	Nice idea but discarded considering the effort to implement and the priority given by end-users to this request.
28	set "Type of info" set for the whole Script		Personali		Personalization attributes have been re-designed, issue no longer relevant
29	What does "Connection to exhibits" mean for the whole script?	Low	Personalizati	Maybe percentages of "Strong" "Loose" or "None" according to how many Script units correspond to each one.	personalization attributes have been re-designed, issue no longer relevant
30	User related attributes need to be re-defined		Personali	To be discussed between AM and personalization team	Done: Unnecessary personalisation attributes have been removed
31	Provide shortcut for "Top view" in 3D, like the one shown in the manual.	High	Feature		Done
32	3D manipulation is very complicated. Should find ways to simplify it.	Medium	Interface		Developments are in progress to customize the navigation. But 3D manipulation with a mouse and a screen always require some training even for FPGs.
33	Add support for 2D maps in industry standard formats (i.e., .jpg, .png)	High	Feature	It would be desirable to be able to add a simple .jpg image of a map in the template.	Done with PNG and JPG
34	Manipulation of the map should be less complicated in 2D	Medium	Interface		Should be better with the "fit view" button that is available (only middle button mouse is needed)

ID	Issue title	Priority	Category	Issue description	DXT notes
35	Option to be able to import directly on CAT an exhibition 2D image ("map") and edit hotspots on it	Low	Feature	Although 3d maps are useful, using a 2D map of the exhibition is more realistic in most cases	Done
36	Possibility to create hotspot automatically when selecting an exhibit	Low	Feature	Exhibits are not separate object in the 3D map. Are exhibits somehow represented on the map?	Exhibits could be represented in 3D as the statues in the AM.
37	Be able to see which Script Unit is related with a particular Hotspot by clicking on the Hotspot	Medium	Feature		We currently highlight the hotspot when a script node is selected in the canvas, because a script unit can only be linked to 1 hotspot. However, 1 hotspot may be linked to many script nodes. Selecting such a hotspot would require selecting multiple script units/entities which is not possible as this would trigger issues such as consistency of an open editor. The handling of multiple selection is in our roadmap but this is tricky.
38	The hotspot name (for example "Zone 2" is not visible on the map. If you have many hotspots it is not easy to locate which is which.	Medium	Feature		Selecting the hotspot on the map highlights the corresponding item in the tree allowing to identify it. Putting the name on the map would overload the map.
39	An option is needed that brings the graph on focus/on the center of the screen even after the user had manipulated it and it is not visible or has zoomed out.	High	Feature		Done (right click in the tree)

ID	Issue title	Priority	Category	Issue description	DXT notes
40	Actions like New Script unit could be available also on the Project tab hierarchy with right click pop-up menu (for example "New script unit" when right clicking on the Script). only the delete button from the keyboard deletes them.	Medium	Interface		Done
41	On the property tab hierarchy, although "delete object" is available on the right-click pop-up, it does not work for script or script unit. The delete button on the keyboard works.	Medium	Interface		Done
42	When selecting a different script on the Project tab hierarchy, it does not appear on the Canvas area	Medium	Interface		Done: Use double click to open the graph
43	Branching point attributes need to be simplified in terms of interface and functionality.	High	Interface/ Feature	personalization team input is needed as a first step towards this	Done: Unnecessary personalisation attribute have been removed, annotation suggestion have been integrated on branching points contextual menu.
44	Map management: Add more than one maps	Low	Functionality		This feature would be helpful indeed but would require a new mapping system enabling the import of multiple "map". It is in our roadmap.
45	Map management: We should be able to add a 2D map image directly, not through making it an ".entity" file. Is this possible?		Feature		Done: You can now select an image (JPG or PNG) as map.

ID	Issue title	Priority	Category	Issue description	DXT notes
46	QR code to download BaseMobile package is scannable from inside instantAR's landing page (the blue demo screen) but cannot open the page by tapping. It seems to have a "QRCode:" prefix and not "http://"	Low	Bug	This could be an instantAR's issue	Fixed
47	Crash when adding TTS	Medium	Bug	While the TTS audio is being created you can click and manipulate other parts of the interface. If you do this CAT crashes	Fixed
48	What is the right click menu choice "Edit attribute" on attributes?	Medium	Feature	it is not clear what this option does if selected. in some cases copy and paste menu options appear as well. If this option is not needed, can it be made invisible?	This is an INSCAPE feature. It is currently locked for the edition in CHESS.

7.2 *Theseus story written with trajectories framework*

Concepts from the trajectories framework, established by Benford et al (2009), have been integrated directly into the design of the story written around Theseus, a character present in the Archaic Gallery at the Acropolis Museum. This appendix presents a detailed design of the story of Theseus, expressed in the language of the trajectory framework. This design is included in the format in which it was produced, as an illustration of the production process.

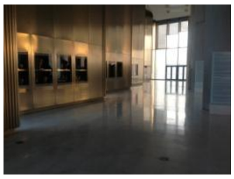
Location	Trajectory	Text	On-screen
Anywhere between museum foyer and top of stairs		System voice: Please stand at the top of the stairs for the story to begin.	
Top of the stairs	**Connect (to plot)**	**Theseus:** Hello? Is anybody there? Can you hear me? Oh finally! Someone's found me! Please stay with me, this is serious! My name is Theseus, Prince of Athens. I have come to the far island of Crete to save my fellow Athenians from a terrible monster, the Minotaur. This monster was part bull part man and lived in a labyrinth. After a fierce fight I managed to kill him. And now, we are on our way out of the labyrinth, with the cunning help of Ariadne, the island's princess. Ariadne gave me a ball of yarn before entering the maze and I used it to leave a trail and find the exit. Yet, the problem is that the king's army is probably waiting for us outside. If so, how are we going to make it to the ship to go back to Athens? Here's where you come in. I need you to gather the mightiest warriors you can find there and send them to me with the help of your device.	 

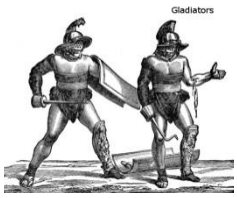
	Approach (Teaser + Locate)		
	Engage		
	Experience		
	Disengage		
	(Re) Connect (to plot)		
Hercules	**Connect (to plot)**		
	Approach (Teaser + Locate)	Let's begin searching, shall we? See the huuuge stone, er, thing, taking up so much space? It is part of an old temple. To the left is my good old friend Hercules, fighting with Triton, who was a sea monster with a human body and a fish tail!	
	Engage	Go closer to the left side of the temple pediment and look at Hercules wrestling with Triton.	
			Are you in front of Hercules and Triton? [I am there!]
	Experience	Triton was not only a sea creature but also a god and the messenger of the sea. Can you see the different colours on his scaly tail? Hercules is a fantastic hero, who performed all sorts of feats because he was very brave and strong. Hercules was also good and noble, and the gods allowed him to live with them in their palace on Mount Olympus. So Hercules was the most famous hero in Athens. Until I came along, that is, and became even more famous!	

	Disengage	But, hey, stop admiring Hercules, you're supposed to be helping me!	
	(Re) Connect (to plot)	So, what do you think? Should we take Hercules with us?	Should we take Hercules with us? [No, he looks busy fighting the Triton] [Yes, he is a great hero!]
Three-bodied demon	**Connect (to plot)**	Mine was a world of heroes and monsters. We would represent them on our temples so that everyone would respect and fear the gods… but also the rulers who had built the temple! Look on your screen to see what this old temple looked like.	 XBR for the temple?
			Look at the image and swipe to move on when you are ready
	Approach (Teaser + Locate)	To the right of the temple pediment, there's another monster, a three-bodied daemon. Have you spotted him? Come on, he's staring at you in the face - all three faces are staring at you!	
	Engage	Walk along the stone temple until you are facing the daemon too!	
	Experience	**Daemon**: Don't let our smiles fool you; we're a proper daemon. 3 male figures with wings and intertwined snake tails. Each one of us holds in his hands a different object: the first one holds a wave, the second a bolt, and the third, a bird. Can you tell which is which? They say that we symbolize the three elements of nature: water, fire and air. You're probably wondering why we're smiling. Well, you'd be grinning too if you had hundreds of scientists in a lather, arguing about who you really are. Don't you think? Look at our magnificent beards.	 Exhibit browser

		Some call us Bluebeard because of their bright blue colour. The colour has faded with time; it was an even brighter blue when we were found. ...But we don't like talking about ourselves!	
		Theseus: It would not be bad to have such powers on our side! Which one of the elements do you think I should take with me on my journey?	Which element do you choose? [Water] [Fire] [Air]
	Disengage	Good, you chose one, because we need to move on.	
	(Re) Connect (to plot)	The wave will come in really handy when we are out of the labyrinth. It can calm down the sea when we sail back for Athens.	The element of Water
		Good, you chose one, because we need to move on.	
		The bolt will come in really handy when we are out of the labyrinth. Fire can burn down our enemies and open a safe way to the ship.	
		Good, you chose one, because we need to move on.	
		The bird can come in really handy when we are out of the labyrinth. The wind will blow and our ship will reach Athens more quickly.	
Theseus (showcase 8, n. 3)	**Connect (to plot)**	I am sure you are wondering how I got myself into this mess...	
		(branching point)--Yes, tell me all about it --No, we will lose time while Minos is already gathering his army	

		Well, the thing is that the prince of Crete was killed by my family because he had won at the athletic games in Athens. After winning the war, the mighty King Minos imposed to Athens a tribute of seven boys and seven girls to be sent to Crete every nine years. There, they would be thrown into the labyrinth to be devoured by the Minotaur. Till he met his match in me. I volunteered to travel to Crete as one of the seven young men to be sacrificed with the intention to kill the monster. And I did it!	
	Approach (Teaser + Locate)	To the right of this three-headed daemon there's a series of glass-windows. And there - well, there I am. Can you find me?	
			Can you find me, in glass case 8? [Yes, you are on a plate!]
	Engage	Brace yourself now, cause you're about to meet me for the first time.	
	Experience	That's me in the middle, slaying the Minotaur with a sword that I had wisely hidden inside my clothes. Brainy Ariadne is on my left, ready to flee but making sure I don't get lost. And that beast, Minotaur, is on my right, with his bullish head. He is trying to defend himself with rocks he carries in his hands. But he didn't stand a chance: can you see the red blood running from his wound?	Meet Theseus! 
	Disengage	Let's move on, we don't have time to waste.	Let's move on!
	(Re) Connect (to plot)	Now that the monster is dead, we need to find more fighting mates to be able to safely reach the ship.	
Megakles (showcase 25)	**Connect**	Maybe we need a professional in our team.	Megakles

	(to plot)		
	Approach (Teaser + Locate)	There's a warrior near here; he's carrying a big shield and a spear in his left hand. He's what we call a Hoplite, which is like a modern-day foot-soldier. Can you find him? He's stuck behind a glass case like me, towards the windows! I can tell you that his name's Megakles.	
		Have you spotted him yet?	Have you spotted him? [Yes, he is in glass case 25]
	Engage	Perfect! Look carefully at the plaque made of clay. Do you see the words on the plaque?	
			Do you see the words on the plaque? [Yes, I can see the words!]
	Experience	The painter tells us that this brave young man is called Megakles, and that he is beautiful. Back in my time, we men weren't admired only for our raw strength, courage, or skills, in battle, but also for our good looks. If somebody fancied you, they ordered an artist to paint your portrait and write that you're gorgeous. You couldn't do the same thing with women though, because in my time women were considered to be property of their fathers and husbands, so you couldn't go around flirting with them and calling them beautiful.	
	Disengage	Here I am blathering on and there's no time left!	
	(Re) Connect (to plot)	This professional fighter will be a great back up for our escape! Should we take him on board?	Should we take Megakles with us? [Yes, his skills will be useful] [No, he will slow us down!]
Lebites	**Connect (to plot)**	Still, the help that we collected so far is no way near enough. We need fighters with bows and arrows. Do you know what they	

		were called?	
		Is it gladiators, is it musketeers or is it archers?	Is it… […gladiators?] […muskateers?]] […archers?]
			BP02
		Nah, gladiators were slave professional fighters in the Roman arenas.	
		I don't think so! Musketeers carried long rifles in modern European armies.	
		Yes, archers! Archers were used in armies all over the world since the earliest times. But in the 17th century, bows and arrows were substituted by firearms. Still, archery continued to be practiced as a sport, and is even included in the Olympics.	
	Approach (Teaser + Locate)	So where do we find archers? Concentrate now, 'cause this is a hard one. The clue is that there are several soldiers and archers fighting each other. Ooh clever you, you know I can't be talking about so many statues, or you'd have spotted them already. So yes, it's a painting. No, no, no, not in the glass-cases, they're somewhere else, on something that's round. I can tell you, you wouldn't want it to fall on your feet!	

	Engage	It is a big vessel, in its own showcase… Can you find it?	
			[Yes, I have found the vessel]
	Experience	Good, you found the big vessel that was used to mix wine and water. How much wine do you think would fit in there? You know, my fellows always drank watered wine, to enjoy it longer, without getting drunk! Can you see the archers on horseback shown near the center? Walk around the showcase to see them all!	
	Disengage		
	(Re) Connect (to plot)	Archers were an important part of warfare in ancient times, so we may want to take them with us.	
Artemis – Peploforos	**Connect (to plot)**	But… wait a second! In this space we can find the best archer of all! The Goddess Artemis!	
	Approach (Teaser + Locate)	She is standing towards the centre of the room, represented as a young woman wearing a long and straight beautiful dress, a peplos. That is why she is known with another name, the Peplos Kore. Can you find her?	[I found her]
	Engage	Artemis was the twin sister of Apollo, and goddess of hunting, wild	

		animals, and forests. She was quick and slender and liked to run in the mountains with her hunting companions. Lift your device in front of the statue to see the colours of her peplos in all their glory.	
	Experience		
	Experience		Peplos Kore Augmented Reality experience
	Disengage	Artemis is a great ally and we need her with us, so send her on board and let's move on!	
Persian rider	**Connect (to plot)**	Apart from foot soldiers and archers, armies need something else. Especially if we are to catch up with Artemis. We need something that can cross fast through the enemies that will be waiting outside. Look around. Which is the fastest and strongest animal in this place?	
	Approach (Teaser + Locate)	Yes, you've got it, horses! Having a cavalry gives an army a big advantage. There is a rider near here and he can help us. Try to find him. Or at least what's left of him. Pay attention: the one we are looking for is wearing a colourful outfit.	
			Did you find the rider with the … trousers. ["I found him!"]
	Engage	Yes, that's him!	

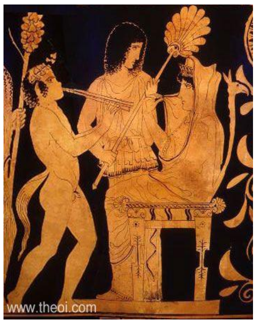
	Experience	Hmm… But I'm not sure if he 'll do. Walk around the rider and look at his outfit. It is very different from ours. It comes from the East, and was worn either by Persians, a mighty neighboring empire, or by Scythians, a tribe of riders from central Asia. How come a barbarian had a statue at the Acropolis? Well, because Scythians and Persians were not always our enemies. At some points they had fought alongside our armies, either as allies or as hired mercenaries. Friend or foe, for him to have a statue at the Acropolis he was surely a great warrior. So, what do you think? Should we risk taking him with us?	
	Disengage		
	(Re) Connect (to plot)		
			BP03 Should we take the rider with us? [Yes, we should take him!] [No, we should not take him]
Group of horses	**Connect (to plot)**	Still, I am not sure we can trust a barbarian… Quickly find me another horse and rider, and this time not a probable Persian please.	*If user chooses YES*
		Quickly find me another horse and rider, and this time not a probable Persian please.	*If user chooses NO*
	Approach (Teaser + Locate)	Look around and you can find three more horses with their riders. Well… parts of their riders, actually! Can you find them?	
	Engage	They're not very far.	Can you see all three horse riders? ["I have found all three of them!"]

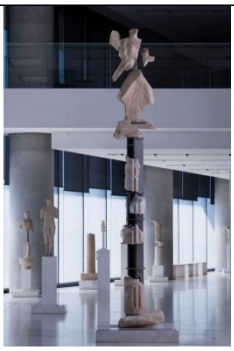
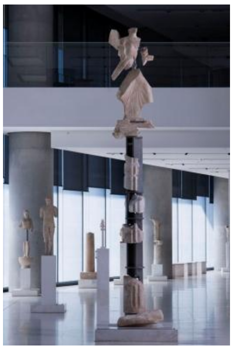
		I am not sure which one we should take with us. What do you think?	
			BP04: Which horse rider should we take with us? [The one on the horse with the blue mane] [The one with the smiling rider] [The one on the bigger horse]
	Experience	Great! Let's go closer. This horse and rider are just what we need. Look at the horse's beautiful mane. It is blue! And the rider is wearing red sandals. Horses were so wonderful and expensive in Ancient Athens that only a few people could afford them - the aristocrats. And anyone who had a horse wanted to show off, a bit like driving around town in an expensive convertible. One way of showing off how aristocratic they were was to commission a marble statue and dedicate it to the gods on the Acropolis. This one here is one such dedication.	
		Great! Let's go closer. This horse and rider are just what we need. Look closely at the beautiful young rider, smiling on his horse. Horses were so wonderful and expensive in Ancient Athens that only a few people could afford them - the aristocrats. And anyone who had a horse wanted to show off, a bit like driving around town in an expensive convertible. One way of showing off how aristocratic they were was to commission a marble statue and dedicate it to the gods on the Acropolis. This rider though, is not a warrior. He sports a wreath on his head because he has won in a horse race!	

		Great! Let's go closer. This horse and rider are just what we need. Look carefully at this big horse. Horses were so wonderful and expensive in Ancient Athens that only a few people could afford them - the aristocrats. And anyone who had a horse wanted to show off, a bit like driving around town in an expensive convertible. One way of showing off how aristocratic they were was to commission a marble statue and dedicate them to the gods on the Acropolis. This one here is one such dedication. I guess you are wondering what happened to it. This horse had its curved sections hammered off probably because after the destruction of the Acropolis by the Persians it was reused to reinforce the Acropolis' protective walls.	
	Disengage	Ok, don't be disappointed by the horse's size. I am sure he will be very quick and agile.	
		Ok, he is not a warrior, but being a champion, I am sure he will be of great help for our escape!	
		Ok, he may be a bit flat, but he still is the biggest horse on the Acropolis. He should be strong enough!	
Theseus & Procrustes	**Connect (to plot)**	But… forget about horses. The best is about to come! Since all great people and animals have their statues, it wouldn't be fair for me to have just a tiny plate in here!	
	Approach (Teaser + Locate)	There is a greater statue of me nearby. Walk by the windows. Can you find it?	Did you find my statue? [Yes, I have found it!]
	Engage	Ok, so my head, hands, and parts of my legs may not have survived, but you can still see my fit body.	

	Experience	Walk to the right side of the statue and look at the hand grabbing my shoulder. This is the only thing that remains of my enemy, Procrustes. Procrustes, which means the Stretcher, was a very dangerous bandit that I fought alone on my way from my mother's land to Athens. He had two beds, one small and one large, which he offered to travelers to lay for the night (the large bed to the short men and vice versa). He made them fit into it, either by stretching them or by cutting off their feet.	 XBR
		Hah, he thought he was smart! Look at your screen, how I turned the tables on him, cutting off his legs and head with his own axe.	
			Have a look at the image and move on when ready.
		Would you like to know why I was traveling alone to Athens?	Would you like to know why I was traveling alone to Athens? [Yes, please tell me!] [No, let's move on!]
		I was raised in my mother's land, because my father, the king of Athens, wanted to protect me from my envious cousins. When I grew up, I went to Athens to claim my birthright. To journey towards Athens, I could choose to go by sea, which was the safe way, or by land, following a path full of dangers. Young, brave, and ambitious, I decided to go alone by the land route, and performed many deeds, much in the same way as Hercules' labours. This is how I built my fame as a great hero!	
	Disengage	So you have finally seen a proper statue of me. But we are running out of time, we need to go on.	
	(Re)	Well, you've found almost everything I need. You're as clever as	

	Connect (to plot)	Ariadne and that's saying something!	
Gigantomachy pediment (Athena)	**Connect (to plot)**	But no matter how many horses, foot-soldiers and archers we gather, we need extra-strong help. From above.	
	Approach (Teaser + Locate)	No silly, what are you looking at the ceiling for? When I say from above I mean divine help. From a god. Or, again, from a goddess. Remember what I told you that back in my time we men were famous not only for our bravery but also for our good looks? Well, some women were famous for their prowess at war and bravery too. And who's the cleverest, bravest and most important goddess for us Athenians? Come on, think!	
	Engage	Ok, I will help you…The one I need you to find for me is huge because she was located on the pediment of a temple!	
			Did you find the goddess? ["I have found her!"]
	Experience	Walk up to the figure in the middle, and admire her at work! She's not carrying all her weapons right now, but she is holding a snake! Actually it's more than a snake, it's a kind of snake-infested cloak made from the skin of a legendary monster she slew. Can you please guess who this goddess is? Come on, it's easy!	
			BP06 Which goddess is it? [Hera] [Athena]

		Hera was the sister-wife of Zeus. She was the goddess of women and marriage. She was usually represented sitting on a throne and wearing a high cylindrical crown. As the queen of gods she was certainly very powerful, but it is not her that we find on this pediment.	
		Yes! It's Goddess Athena. She's the warrior goddess, wearing spear, helmet and shield, but also protector of law and justice, the crafts and the arts. Athens got its name from her, when she beat Poseidon, the god of the sea, in a contest to see who would be protector of the city. Oh, and of course, she is also shrewd companion of heroes (like me!).	
		Walk along the pediment from left to right to see more closely all the figures more closely. This scene represents a colossal battle that took place between the Olympian Gods and the Giants, children of the Earth. The Olympian gods defeated the Giants and exiled them to the netherworld, where they still make volcanoes erupt. Athena had a very important role in this war and defeated the king of the Giants, Enceladus. To keep him from causing trouble again, she threw an entire island on him, Sicily. That's why there's a volcano there, which erupts each time Enceladus coughs.	
	Disengage		
	(Re) Connect (to plot)	With Athena on our side I am sure we will reach the ship safely! You've saved us! Victory is ours! Uh oh, almost! There's one more thing we need to ensure our victory against the enemies…	We need something more!
Victory	**Connect (to plot)**	To be victorious, we must find Victory. Back in my time Victory was so important that we turned her into a proper goddess,.	
	Approach (Teaser +	There's one in this room, a bit rough for wear after thousands of years buried in the ground, but she's	The statue of Victory

	Locate)	standing tall and proud. I said tall! There's no one taller in here. It helps when you're standing on a high column, doesn't it? We always put Victory on columns or rooftops for all to see. Can you find her?	
	Engage		Did you find the statue of Victory? ["I have found her!"]
	Experience	Stand at the bottom of the statue and look up at her. Her name in Greek is Nike, meaning Victory. Ring any bells? Yes, that's where the sports gear has got its name from. This victorious Nike was placed on the Acropolis when the Athenians defeated the Persians, in the first Persian War, at Marathon, a tiny village outside Athens. Yes, that's where the marathon race comes from. When the Athenians won, a foot-soldier ran from the battlefield all the way to Athens, a full 42 kilometres away, to tell Athenians of their victory. He made it, and as soon as he breathed out 'We've won', he died of exhaustion. The victory was dedicated to Callimachus, because with his vote, it was finally decided to fight the Persians back. Callimachus fell in the battle, but this winged victory will keep his memory forever. If you want to understand what she looked like before she was toppled and buried, there's a small reproduction right next to her.	 Or 
	Disengage		

	(Re) Connect (to plot)	We've made it! Now I'm out of the Labyrinth, and you have provided all the help I and my fellow Athenians will need outside to reach the ship safely. Your job here's done. Ariadne is coming to Athens too! And hey, thanks!