

Authoring Personalized Interactive Museum Stories

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Abstract. CHES is a research prototype system aimed at enriching museum visits through personalized interactive storytelling. Aspiring to replace traditional exhibit-centric descriptions by story-centric cohesive narrations with carefully-designed references to the exhibits, CHES follows a plot-based approach, where the story authors create stories around pre-selected museum themes. In this paper we place the CHES system within the Interactive Digital Narrative field, describing the main objectives and requirements addressed. We present the system's architecture and outline its overall functionality. We describe the underlying storytelling model using examples from the stories authored using the CHES Authoring Tool. Finally, we report key results focusing on the authors' perspective for the creation of personalized stories.

Keywords: Interactive digital storytelling, personalization, authoring tools

1 Introduction

The CHES System is a research prototype that has been developed in the context of the CHES (Cultural Heritage Experiences through Socio-personal interactions and Storytelling) project¹. It aims to enrich museum visits through personalized interactive *storytelling*, by (re-)injecting the sense of discovery and wonder in the visitors' experience. It uses personalized information to create customized stories that guide visitors through a museum and employs mixed reality and pervasive games techniques, ranging from narrations to Augmented Reality (AR) on mobile devices [1,2].

CHES targets two "types" of users; visitors, who "consume" CHES stories through their devices, and story authors, who design the experiences. Aspiring to

¹ <http://www.chesexperience.eu/>

replace the traditional set of exhibit-centric descriptions by story-centric cohesive narrations with carefully-designed references to the exhibits, CHESS follows a plot-based approach, where the story authors (curators, museum staff and exhibition designers) write and produce stories around pre-selected museum themes. Two cultural institutions have participated in CHESS: the Acropolis Museum, devoted to the findings at the archaeological site of the Acropolis of Athens, Greece, and the Cité de l' Espace in Toulouse, France, a science centre about space and its conquest.

Similarly to the making of a movie, our approach to interactive story creation includes four main phases, namely scripting, staging, producing and editing. During scripting, the author chooses the main concepts and intervening elements, sketches the plot, and writes the narrative text. In staging, the author associates parts of the script with exhibits, paths and other spots in the physical museum space. Then, a set of multimedia resources is produced for the staged script, including audio-visual material, interactive images, games, quizzes, augmented reality models, and other illustrative applications. Finally, the author edits, selects, and orders the multimedia digital resources to implement the final script into a storytelling experience.

The CHESS experience is a unique non-linear combination of the story presented through the terminal on the mobile device used, the visitor's actions, the exhibits in the cultural heritage site, as well as the surrounding environment itself. When the visitor experiences the story on-site, she is subjected to five interlinked "experience modes": (a) walking from exhibit to exhibit, (b) observing an exhibit, (c) listening to narrations from the terminal, (d) interacting with the terminal to make choices, and (e) using the terminal in interactive activities such as games or AR. Obviously, the design of such experiences requires careful orchestration of different resources.

CHESS provides story authors with the CHESS Authoring Tool (CAT), a powerful authoring tool that enables the design and implementation of interactive stories for the CHESS system. CAT is based on a rich storytelling data model which uses graph-based representations to denote the story structure, along with structured meta-data to semantically describe the graph entities. During the visit, the story graphs authored are traversed by the Adaptive Storytelling Engine (ASTE), which uses visitor and contextual data to appropriately adapt the visitor's experience [3, 4].

In this paper we first place the CHESS system within the IDN field, describing the main objectives and requirements addressed. Next we provide an overview of the system architecture and workflow. We present the underlying storytelling model using examples from digital stories authored for the two cultural heritage sites using CAT, also explaining how these are utilized by the CHESS components during a visit. Finally, we report key experience and evaluation results, focusing on the authors' perspective for the creation of personalized stories.

2 Background and Related Work

To place the CHESS system within the IDN field, we first clarify its main underlying priorities and assumptions. The CHESS project integrates multidisciplinary research results and tools into a system capable of supporting cultural heritage institutions in

the creation of personalized interactive digital stories for their public. Thus, simplicity and ease-of-use for non-programmers are critical priorities for CAT, the primary environment for the crafting of stories. On the other hand, the main objective for museums is to convey accurate information about their collections to different kinds of visitors in a more accessible, meaningful and engaging way [7]. Thus, special emphasis is given to the script that communicates the cultural content and to the capacity to carefully review the knowledge conveyed through the various instantiations of the interactive digital story.

To address these needs, CHESS adopts a branching narrative structure for script modeling and representation. A similar structure is utilized to represent the editing level, where the authors specify the digital resources that will be used to manifest each part of the script. Unlike Storyspace [8], Rencontre [9] and other hyper-fiction approaches, CHESS enables story authors to define a procedural script flow and specify soft or hard constraints over the branches, depending on a variety of factors, such as visitor choices, past actions, visitor features, location, etc. Similarly to the ASAPS system [10,11] CHESS models the state of the experience through global variables, moving from simple branching systems towards a finite state machine. In CAT the script diagram is complemented with an attribute-like graphical user interface (GUI) component where authors can specify conditions over each branch, based on the values of global variables. In this way, story authors can effectively create stories based on a player visitor model and increase visitor agency by defining different story continuations based on the visitor's choices.

In addition, CHESS enables authors to account for a listener model, where the visitor has no agency in the story world. Even so, storytelling in CHESS remains a highly interactive process. A good human performer, museum guides included, continuously observes the reactions of the audience and adjusts the narration accordingly [12]. To simulate this process, the CHESS system implements generic visitor tracking and dynamic profile update techniques, and refines the visitor profile as the experience progresses. CHESS follows an implicit profiling approach, interpreting a predefined set of visitor actions as positive or negative feedback on the corresponding story graph entities. When certain conditions are met, explicit feedback menus are injected into the story to increase profiling accuracy. The visitor profile is used by the ASTE to make a personalized decision whenever a branching point is reached in the story graph [4]. From the authoring perspective, in order to leverage the dynamic profiling functionality implemented by the CHESS system, authors are required to annotate the story graph entities with a set of weighted features.

CHESS allows story authors to define and experiment with any set of visitor features, enabling them to create stories that adapt to a variety of visitor attitudes. They can do that both in the scripting and the editing level, prescribing alternative digital productions for the same script unit, to cope for example with different visitor moods [13]. Annotation based personalization has been widely explored in several personalization applications, as well as in interactive digital storytelling [12]. Aiming to be used by authors who are neither programmers nor experts in personalization issues, CHESS combines semantic annotations (using an open tag vocabulary) with a procedural branching representation of the story (presented in Section 4).

CHESS also pays special attention to the staging of the story in the physical world. Museum visitors experience a mixed reality environment made up of digital characters and media assets that are situated in the physical space. From this perspective, the CHESS storytelling model can be related to the Mobile Urban Drama conceptual framework [14], where graph-based techniques are utilized to represent the story flow and branches may be conditioned on user actions, state, and environmental or other variables. However, in this case the graph is not complemented by annotations, thus accounting only for the users' past actions and ignoring their preferences and attitudes. Most notably, no authoring component is included in the software framework, requiring close cooperation between authors and programmers at all times. An editor environment was provided in the Mscape mobile media gaming platform developed by Hewlett Packard [15], allowing the creation of interactive stories that users can experience by following different storylines, but it targeted towards developers rather than non-programmers. Mobile based interactive storytelling has been supported by several software frameworks, in both urban [14-17] and museum environments [18, 19]. Yet most of these works focus on the visitors experience rather than on the authors, thus not addressing the authoring challenges raised.

A user friendly authoring tool is provided by ARIS², an open-source platform for creating and playing mobile games, tours and interactive stories. ARIS considers the user as a player and it uses a conditional quest model, unlocking quests when certain quests are accomplished. Hotspots are defined over Google maps. Unlike CAT, the platform doesn't allow using rich media (such as games, 3D or AR), nor loading or editing a customized map of a particular site.

CAT has been built upon INSCAPE³ [21], an innovative visual authoring tool resulting from the eponym FP6 Integrated Project. The CHESS project extended and adapted this tool to support new concepts such as the mixed reality dimension of the stories and the adaptation capacities of the story to the visitor profile and context.

3 CHESS System Overview

Figure 1 depicts the high-level architecture of the CHESS system. Story authoring is accomplished with CAT. Besides editing the story graph, the tool enables authors to edit, annotate and enrich 2D and 3D maps, as well as to create narration and QR-scanning activities through activity templates. Additionally, CAT integrates an Asset Management Tool which enables authors to upload new digital assets (e.g. images, videos, audio files, etc.) with associated metadata (e.g. author, copyrights, tags, etc.). Authors can browse, search and display their project digital assets as well as to visualize the relations between them through a graphical, ontology-like diagram (the generation of which is based on the provided tags).

Authors can choose to store their story projects locally, for testing purpose, or to publish them. In the latter case, the story graphs are exported to the ASTE while the digi-

² <http://arisgames.org/>

³ <http://www.inscape3d.com>

tal assets required to realize the story activities are exported to the Hub. The ASTE is responsible for traversing the story graphs while making decisions for personalization, based on the visitors' profiles and actions. It is implemented using Enterprise Java Beans 3.0, hosted inside a JBOSS 7.0 server. The stories are internally represented in CML (CHESS Markup Language) under an XML-based format.

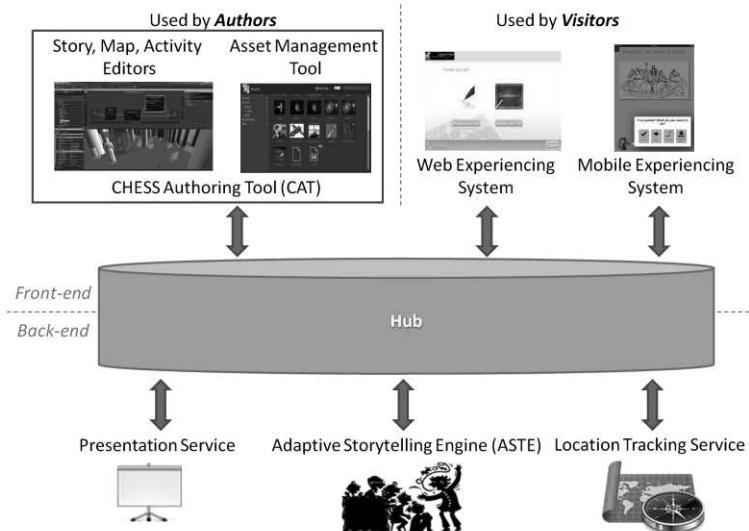


Fig. 1. Overview of the CHES system components.

The Hub lies in between the front-end and back-end components, supporting the communication among them. It is implemented as a web service (written in Python) running on the Tornado Web Server. When a story is published from CAT, the Presentation service processes the digital assets (e.g. images, audio files, etc.), creates alternate versions adapted to different network capacity and mobile device specifications, and then stores them in the Hub (using MongoDB, a “NoSQL” database that allows schema-less data storage). In this way, authors do not have to manage the specific capacity of each potential device used to experience a story; the publishing process of an interactive story has been reduced to pushing a button in the interface.

During the visit, the CHES stories are delivered to visitors through the Mobile Experiencing System (MES), i.e. the framework running the CHES experience on a mobile platform. It is based on InstantAR⁴ App written with HTML5 and JS standards in order to support a large number of devices. The InstantAR Native App is optimized to display 3D content and embeds a state-of-the-art AR engine. In order to display the AR activities, the InstantAR App needs to be first installed in the visitor's mobile device. MES also acts as a sensing device to support adaptation: it gathers, holds and shares data about the user (position, orientation, device status, actions, etc.).

⁴ <http://instantar.org/>

During the experience, MES continuously communicates over HTTP with the ASTE (through the Hub). The ASTE traverses the authored story graph using the visitor's profile to predict the appropriate story parts and informs MES about which activity to fetch and display next. To do so, MES retrieves the appropriate version of the activity, depending on the current network and visitor's device conditions and characteristics. On the other hand, MES notifies the ASTE about the state of the presentation and visitor actions (e.g. completed, paused, skipped, etc.).

In places where GPS technology provides sufficiently accurate information, the Location Tracking Service is employed to create navigation activities, guiding the visitor from his current location to the next hotspot in the story. It has been tested in the environment of Cité de l' Espace, where navigation activities were instantiated upon visitor request, from the appropriate MES interface component.

Finally, CHESS also covers the pre and post visit parts of the experience, which are handled by the Web Experiencing System (WES). For instance, prior to visiting a museum, the visitors may browse information about it, play digital games, etc., while after the visit they can access an overview of their experience in situ. An important part of the pre-visit experience is the completion of a short, interactive questionnaire, the CHESS Visitor Survey (CVS). This is how visitors are registered in the CHESS system and their answers are communicated to the ASTE for initial profile elicitation. The WES uses Ajax technology to communicate with the ASTE Server through a REST protocol where messages are encoded following a specific XML specification.

4 CHESS Storytelling Model

CHESS defines a tiered storytelling data model in accordance to the authoring phases, distinguishing between scripting, staging, editing and producing the digital resources. In this section we describe the main entities under each level, showcasing how they are created by authors and then explaining how they are utilized by the CHESS components during the visit.

4.1 Scripting Level

The script is a directed graph decomposed into script units and script branching points (Figure 2). Script units contain a narrative text and have attributes, such as title, description, narrative text, purpose, etc. In general, the narrative text in each script unit should be kept brief, while at the same time as self-standing and complete as possible. The CHESS script units differ in their narrative purpose and have been defined by purposefully adapting the original "trajectories theory" for cultural experiences [20]. The main script unit categories are: *advance* or connect to main plot, *approach* (navigation hints to locate an exhibit), *engage* (confirm location), *experience* (give information related to the exhibit), *disengage* (closure of the exhibit-based information segment), and *re-connect* to main plot.

Script branching points on the other hand, are special constructs representing decision points where more than one script options are defined. Scripting is performed in

the CAT Story Editor by creating script units and branching point nodes and connecting them with directed edges, denoting the script flow. Branching points are explicitly represented through dedicated nodes, since they have attributes as well. They can be i) *mandatory*, in the sense that a menu should be displayed, informing the visitor about the valid alternative choices so as to choose how to proceed, ii) *automatic*, meaning that ASTE should take an automatic decision about which branch to follow, or iii) *optional*, denoting that ASTE should decide whether a menu will be displayed or an automatic decision will take place, based on its confidence for the visitor's preferences in the available choices.

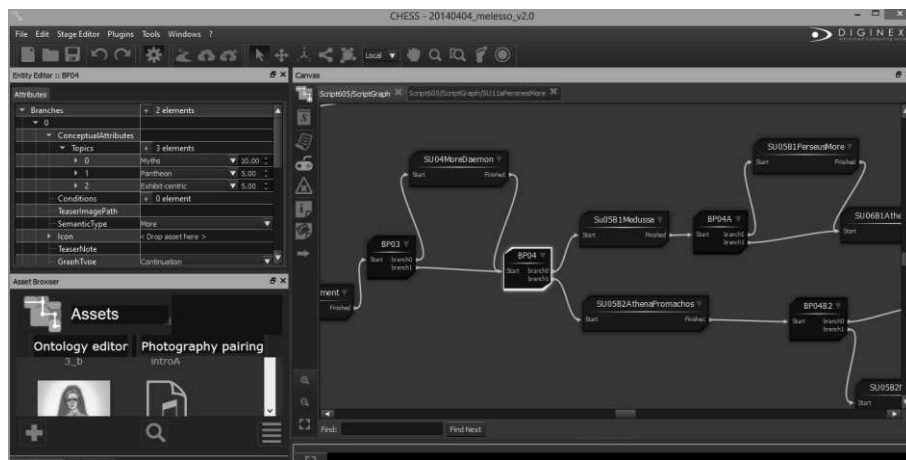


Fig. 2. Sample Script Graph in the Story Editor. The properties of the selected branching point (highlighted in white) are displayed and edited on the left panel

In the case of mandatory branching points, authors also specify the menu title as well as the template that will be employed to display the menu (image or snippet based). In the same way, authors can define conditions for each branch, which need to hold for considering it as a valid candidate continuation of the script. Conditions represent authored hard constraints and they can be based on a variety of visitor or contextual attributes. For instance, if a script unit refers to a previous piece in the experience, then authors can express this constraint on the appropriate edge, requiring that the visitor has previously successfully “consumed” the corresponding optional part.

Besides conditions, authors can also provide a set of semantic annotations for branches and script units. Several works in personalization applications focus on capturing user preferences on topics. Following this approach, authors can divide the narrative in script units based on the topics they cover and then employ (simple or complex) branching structures to link them. To enable the ASTE decide on which path matches best the visitors' preferences, authors need to assign particular topic labels to the script entities. In this way, when a visitor skips, for example, a script unit, the ASTE infers high negative feedback on those script unit topics and updates the visitor profile. Obviously, not all script units need to be annotated in this manner; for instance, those disengaging from an exhibit do not typically cover a topic.

4.2 Staging Level

Unlike a novel or film, where the user's (mental) teleportation to a different location setting may be described, implied or simply shown, in the case of museum experiences the story setting is bound to the museum physical environment. A good visualization of the museum map helps authors have a good understanding of the physical actions that the visitor will need to make during the experience. To that end, CAT enables two things: firstly, to visualize the story environment (i.e. the museum spaces) by adding a 2D or/and 3D maps to the stories project (Figure 3); secondly, to define custom hotspots over the imported maps, denoting areas of interest (areas around exhibits, windows, or any other place on the map). During staging, authors associate script pieces to specific physical locations, indicating explicitly where the user should be located in order to unfold the story.



Fig. 3. 3D representations of the Archaic Gallery (left) & Cité de l' Espace (right) with hotspots (in red)

Whenever location transitions are required to follow the staged script, the visitor needs to be somehow prompted and guided to reach the corresponding physical location. In the case of the Archaic Gallery of the AM, the accuracy of existing radiofrequency-based location tracking technologies (including GPS) was inappropriate because of the spatial proximity of the exhibits, which required a robust sub-metric location mean. In this case, the stories adopted a hints-based approach, in which the narrating character invites the visitor to find the particular physical exhibit and provides a set of clues to do so. In this way, navigation is indirectly achieved and it is integrated with the story. On the contrary, for Cité de l' Espace, the authors did not need to focus on navigation issues, since it was automatically performed by the Location Tracking Service, which computes the best path to reach the target location from the current visitor location and displays it on the site map. In both cases, to ensure that the visitor has actually reached the right place, the authors defined location confirmation branching points in the scripting level, presented through menus or QR code activities.

4.3 Producing Level

Cultural heritage sites own increasing numbers of digital resources about their collections, amongst which high-quality animations and videos, produced by external professionals. A logic objective is to be able to reuse these rich digital resources in dif-

ferent projects. To address this need, and aiming to provide authors with a system that supports them throughout all the phases of the authoring endeavor, CAT enables the creation of audio narration activities. Authors can import digital assets such as images and videos and synchronize them over a timeline, either with existing audio recordings or with new ones, produced with the text-to-speech technology integrated in CAT. In addition, CAT supports the creation of QR code scanning activities, generating QR codes that are assigned to particular hotspots. Authors can print and place them in the museum environment, so that when a visitor scans a QR code, the activity running on the MES translates it into a specific hotspot and MES notifies ASTE about the visitor's location. Finally, authors can import other types of productions, such as AR applications or sophisticated games. However, in this case, a technical expert needs to shortly intervene and create the appropriate manifest files that will enable the integration of the third-party components.

4.4 Editing Level

For each script unit in the script graph, authors create a graph containing the activities (e.g. digital productions) that will be employed to realize the script unit. Similarly to their counterparts in the scripting level, the activity graphs are directed graphs that contain activity nodes and branching points, enabling the authors to use different productions for the same script unit. For instance, different images and/or audio files may be chosen depending on the visitor's age, culture or language. Even entirely different types of activities may be adopted; a script unit about the coloring of statues may be realized with an audio-visual narration, an AR production, or a painting game.

5 Experience and Evaluation Results

The CHESS system was used at the Acropolis Museum and the Cité de l' Espace to author several stories, which were subsequently tested with actual visitors during the project's formative and summative evaluation sessions. Museum personnel participated in a one-day training session and then started to use the authoring tool for several weeks to complete the creation of the stories. The authoring groups were kept small, including two to five museum representatives, as would happen in a real world scenario. The technical partners provided support and guidance when needed and monitored the use of the tools, recording usability issues as well as needs for new functionality. This longitudinal evaluation of the tool has provided valuable insight as to its strengths and weaknesses, guiding its design iterations and refinement.

One of the system main strengths is that it allows quick prototyping of the story and to simulate the designed storytelling experience, thus significantly advancing the iterative process of analyzing and refining the story in all the authoring phases. As a result, several high quality experiences have been produced at both museum sites, with limited resources and in a short time (2-3 weeks), demonstrating the effectiveness of the CHESS concept and implementation [5,6].

Focusing on the authors' perception of the CHES authoring methodology, authors quickly familiarized themselves with the branching structure of the storytelling model. Following the training, they were able to divide the narrative into script units and they created several types of stories (e.g. linear, including minor and/or moderately complex branches, reaching different endings based on prior visitor choices, including small dialogue-like sections with the visitor, etc.). However, authors faced some difficulties in grasping the declarative part of the model, coupled with the implicit profiling techniques, asking repeatedly for examples and directions.

At the beginning of the project, authors were guided to have particular personas in mind during story creation. A set of personas was defined for each museum, capturing the main types of its visitors, while authors annotated the story pieces with regard to the personas they were suitable for. The persona-based approach was very well accepted and efficiently adopted by the authors [22].

Moving towards an individual, rather than a stereotype basis, authors were guided to create stories with several branches, coping with different visitor preferences on one or more features of the story. For example, for the purposes of the summative evaluation of the CHES project, authors created a story containing 13 branching points (4 mandatory, 6 automatic, 3 optional). Authors chose to proceed with story creation in the following way: they first created a linear story and then revisited it to "cut and paste" parts of the story under optional branches. The script tone and style was kept uniform, so branches were defined to cover different topics.

To evaluate the ASTE's decision making performance in the story, 10 visitors experienced the story in the museum's environment and then went through a post-visit interview. During the interview, the script graph was revealed to them, focusing on the branching points. The users were presented with all the available choices in each one and were asked to evaluate the system's decision in a three-point Likert scale (right, neutral, wrong) as well as to explain the reasons.

Table 1. Users' feedback over the experienced decision points in an example story

	Right	Neutral	Wrong
ASTE in all	105	9	13
Users in menus	38	2	10
ASTE in menus	40	2	8

Aggregating over all user experiences, the ASTE took 127 decisions. In the case of menus, ASTE 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 is right. Table 1 summarizes the users' feedback that was collected over the 127 decision points, showing that ASTE reached approximately 89% of right decisions. An interesting observation has to do with the users' effectiveness in the decision making process. Focusing on the cases where menus were displayed and users made explicit choices, we observed that the ASTE slightly outperformed the users. This result highlights the difficulty, from the authors' perspective, to define effective narrative snippets.

Due to the small number of evaluated sessions, and especially due to the strong, inherent dependencies with the particular story's content, the reported results should

not be interpreted as absolute metrics of accuracy. Nevertheless, they provide valuable insights on the ASTE's performance, indicating that the authors can effectively leverage the CHES system in the creation of personalized, interactive stories, so as to make personalized suggestions or even make decisions on the visitor's behalf.

6 Conclusions and Future Work

In this paper we present a general overview of the CHES prototype system and we explain how it supports story authors during the scripting, staging, production and editing phases for the creation of personalized, interactive digital stories taking place in museum environments. Authors were easily familiarized with the branching graph structures and they adopted the persona-based approach for story creation. When asked to put the personas aside and move towards individual preferences, authors decided to follow a traditional topic-based approach, requiring guidance and support in the definition of a story structure that would effectively leverage the underlying profiling mechanisms. As part of our future work we plan to supplement the CHES framework with detailed authoring guidelines, including several "good" and "bad" example stories, to illustrate the various ways that CHES can be used. Finally, further stories are planned to be developed, to investigate and evaluate the system's performance over different story structures, while also adapting to a variety of features.

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CHES: Personalized Storytelling Experiences in Museums

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Abstract. In this work, we present the CHES research prototype system which offers personalized, interactive digital storytelling experiences to enhance museum visits, demonstrating the authoring and visiting experiences.

Keywords: Personalized interactive storytelling, mobile experience, authoring

1 Introduction

Museums routinely “tell stories” through the meaningful presentation of their collections with the help of visual and narrative motifs [1]. Incorporating a form of narrative in a museum visit comes as a natural extension to the museum function as a storyteller. It can contribute to making collections more accessible and engaging for different audiences and a great line of work is being carried out on that front [2, 3].

CHES (Cultural Heritage Experiences through Socio-personal interactions and Storytelling) [5] aims to enrich museum visits through personalized interactive storytelling. Besides visitors, CHES also considers another type of users; museum authors. It follows a hybrid, plot-based approach for story authoring and uses personalized information to create customized stories that guide visitors through a museum. It also employs mixed reality and pervasive games techniques, ranging from narrations to augmented reality (AR) on mobile devices. Two museums participated in the effort, the Acropolis Museum in Greece, and the Cité de l'Espace in France. In this work, we focus on an example story developed at the Acropolis Museum (AM).

2 Creating CHESSEXperiences

CHESSEXperiences are created with the CHESSEX Authoring Tool (CAT), which helps to visually manage and publish them. After defining a plot and gathering the basic exhibits and assets (images, texts, activities), authoring with CAT involves creating the story graph nodes and linking them to hotspots on the museum map and to multimedia assets (Figure 2b). Personalization annotations can be added to the graph through the attributes panel.

CHESSEX stories can be implemented through a wide range of activity types, from simple audio with still images, to animations, games, interactive images, and AR. These activities are integrated in a seamless storytelling flow. For example, AR is not only used as an individual media type but rather as an extension of the presentation form: when pointing the device towards a statue, its original bright colours, along with superimposed text and audio annotations, are presented (Figure 2a). The implementation of these activities is based on web technologies, thus easing their technical integration in the CHESSEX system.

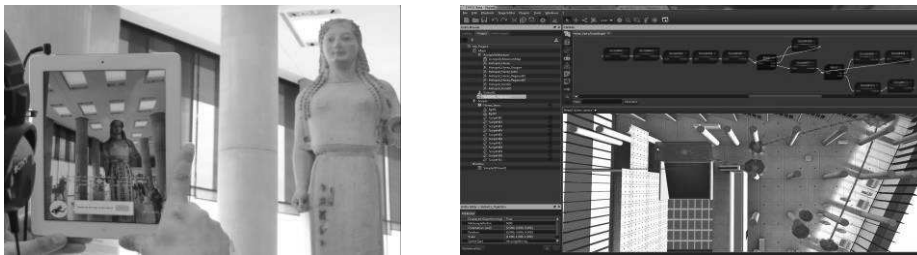


Fig. 1. (a) On the left, an AR activity, (b) on the right, the CHESSEX Authoring Tool

3 A Personalized Storytelling Experience

The visitor's experience starts with a quiz, which can be accessed remotely, through the Web, or at the museum, from the visitor's mobile device. The quiz gathers evidence regarding visitor preferences in order to initialize the user profile. Quiz questions are kept at a minimum (usually 3-5 questions) to minimize the time spent on the quiz. An indirect approach is followed, to avoid visitors feeling "tested" and to make the quiz more engaging. An example is presented in Figure 2a. After initializing the visitor profile, the system chooses the most suitable story and the experience begins.

Let's take for example one of the five stories created at the Acropolis Museum, which is narrated by the fictional character Melesso: "Melesso, a noble woman, talks about her life in Athens during the 6th century BC. 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." The story covers many topics, including love and marriage, women's life, ancient temples, (Figure 2b), mythology and the Persian wars. The narrations guide the visitor in the Gallery and unfold along different paths that all lead to a 6th century bronze statue dedicated by a woman named Melesso.



Fig. 2. (a) On the left, a typical quiz question; (b) on the right, Melesso presents a temple located on the Acropolis of Athens.

The story is constructed so as to allow dynamic personalization of its contents. During the experience, the visitor is presented with menus and action buttons. The visitor selections and actions during the visit shape the visitor profile and influence subsequent choices of the system regarding which part of the story graph will be presented next. The story graph contains script nodes and branching points (BPs) and it is internally represented using an XML-based format. It is accessed at run-time by the Adaptive Storytelling Engine (ASTE), which traverses the graph, retrieves the corresponding digital resources, and then provides them to the visitor’s device.

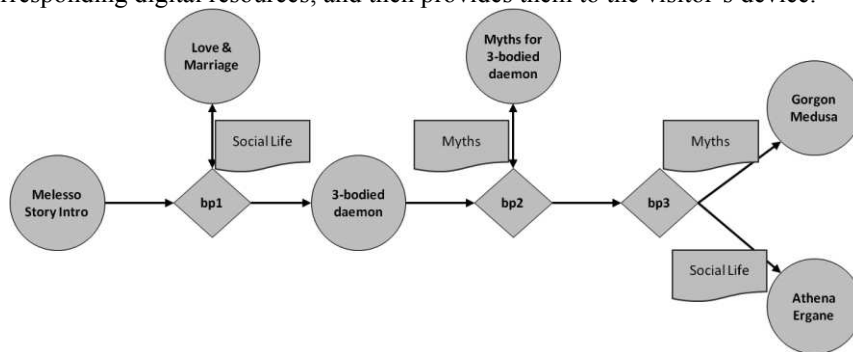


Fig. 3. Part of the Melesso story graph with annotations.

Story adaptation is based on authors' annotations for the different options at the BPs. These annotations summarise the content of each branch. The ASTE uses these annotations in two ways: (a) when a BP is reached, the current visitor's profile is used to rank the possible choices (branches) in descending order of predicted interest, and thus, recommend the top choice to the visitor; (b) when the visitor selects an option, depending on his behaviour during the corresponding story part (successful completion or skip), his profile is updated with positive or negative evidence respectively [4].

In our example (Figure 3), after the introduction to the story, the visitor is presented with a menu (bp1) asking whether he wishes to move on or stay at a nearby showcase to learn about love and marriage in ancient Athens. If the visitor chooses “Love and Marriage” and then decides to skip it, then negative evidence is stored in his profile for subsequent content with the annotation "Social Life". If afterwards he chooses to listen to the part “Myths about the three-bodied daemon” and completes it, positive

evidence is created for content with annotation "Myths". As a result, when bp3 is reached, the ASTE will recommend to the visitor the branch "Gorgon Medusa", related to "Myths", and not "Athena Ergane", related to "Social Life".

It is worth noting that ASTE can handle any vocabulary of annotations, since it is based on a generic content-based approach. In this way, it enables authors to create any type of annotations appropriate for their story. However, when the vocabulary of annotations changes or expands, the CVS needs to be adjusted to effectively represent the relations between the CVS questions and the new concepts introduced.

4 Results and Conclusions

To evaluate the described approach, implemented through the story of Melesso, an in situ evaluation with 28 museum visitors and staff took place at the Acropolis Museum. Users were "shadowed" by two evaluators while experiencing a CHESSE story and then interviewed. The results are still being analyzed and have not been collectively published yet; nevertheless, user feedback has been very positive overall, both from visitors and museum staff. According to museum curators, CHESSE stands out as a very promising system for the creation of different approaches to exhibits, allowing adaptation to different visitor types. Regarding visitors, CHESSE seems to foster interest for the exhibits, even in the case of visitors with no pre-existing interest for the museum, and may encourage re-visiting. As one user expressed, "CHESSE is a fun way of visiting a museum. It can take you back to your childhood where you had your parent playing the role of discreet guide and entertainer."

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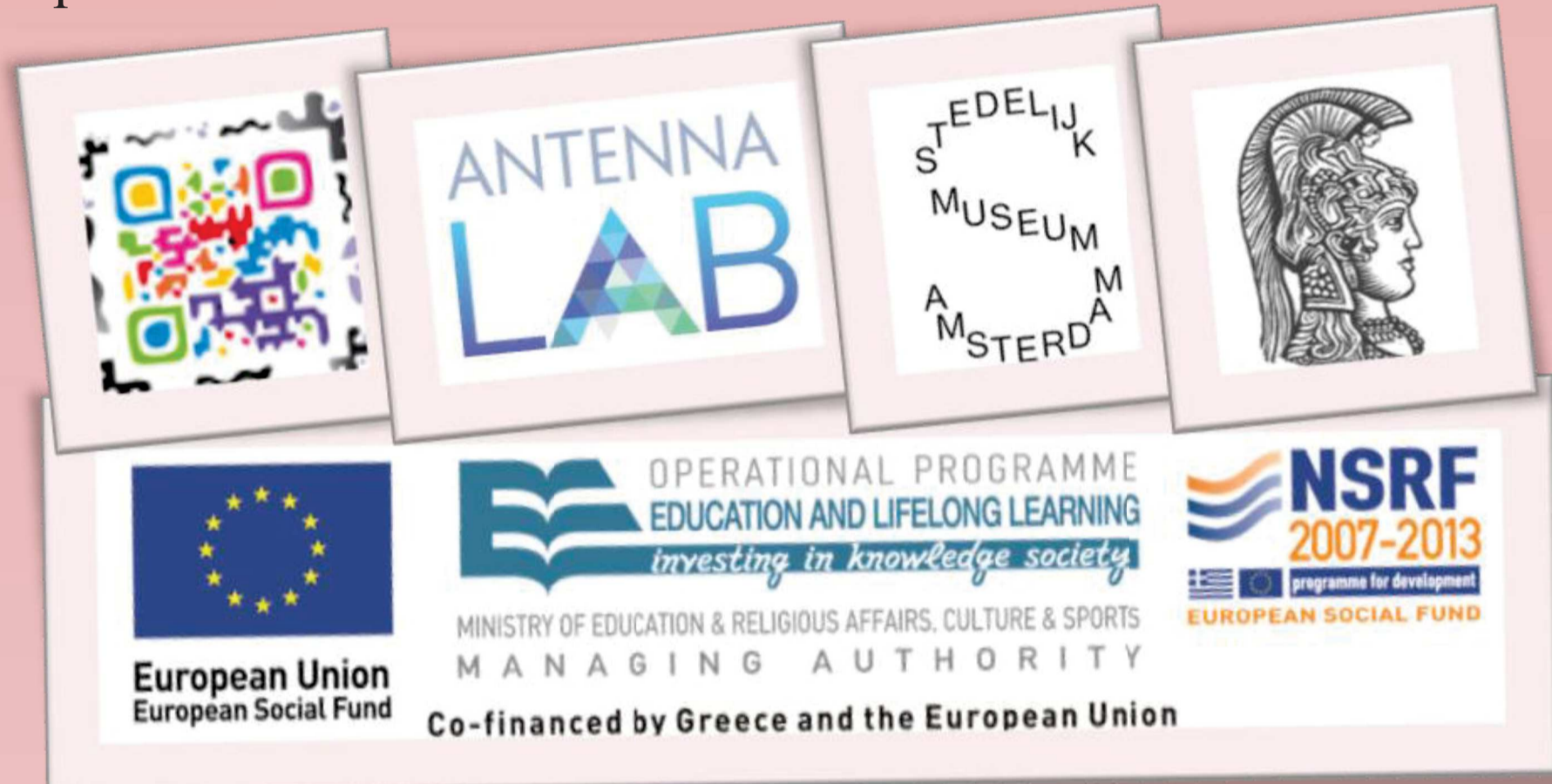
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Interactive Experiences in the Stedelijk Museum A Living Lab Experiment with the CHESSE Framework

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Abstract: This poster presents a small-scale experiment conducted in the Stedelijk Museum Amsterdam (SMA), showcasing the effective use of CHESSE research prototype for the creation and provision of personalized interactive museum experiences.



By tagging and slicing existing content in seven personal themes, we were able to recommend to visitors the objects that would be closest to their preferences; this turned out to be valued higher than the existing “traditional” audio-guide.

The CHESSE Framework

The CHESSE research prototype was developed under the CHESSE project (<http://www.chessexperience.eu/>), aiming to enrich museum visits through personalized interactive storytelling, so as to (re-)inject the sense of discovery and wonder in the visitors' experience. It employs mixed reality and pervasive games techniques on smart phones and tablets.

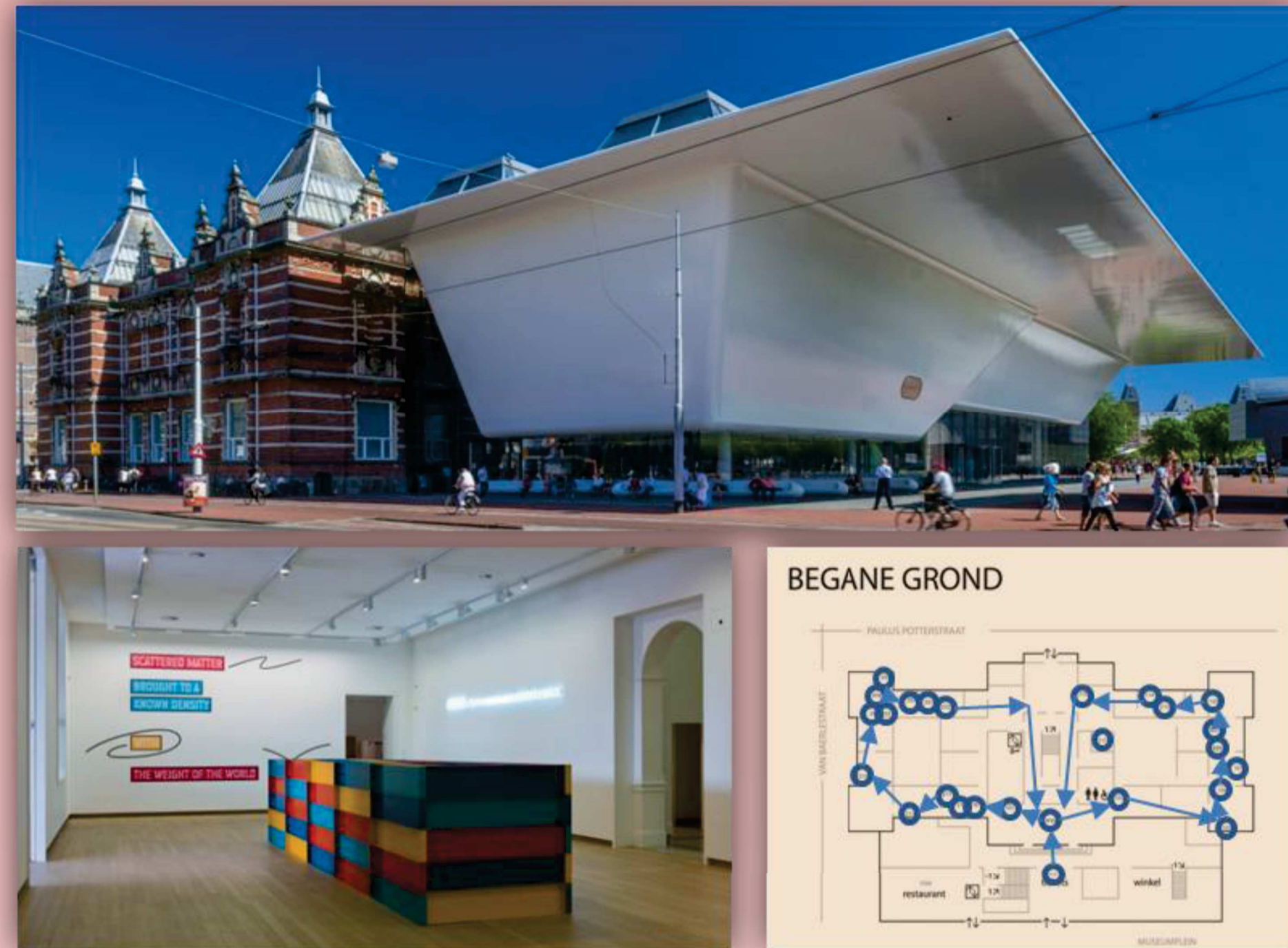


So far, it has been used to create stories for the *Acropolis Museum*, an archaeological site in Athens, Greece, *Cite de l'Espace*, a science theme park focused on space and its conquest in Toulouse, France, and *Catalhoyuk*, an archaeological site in Turkey.

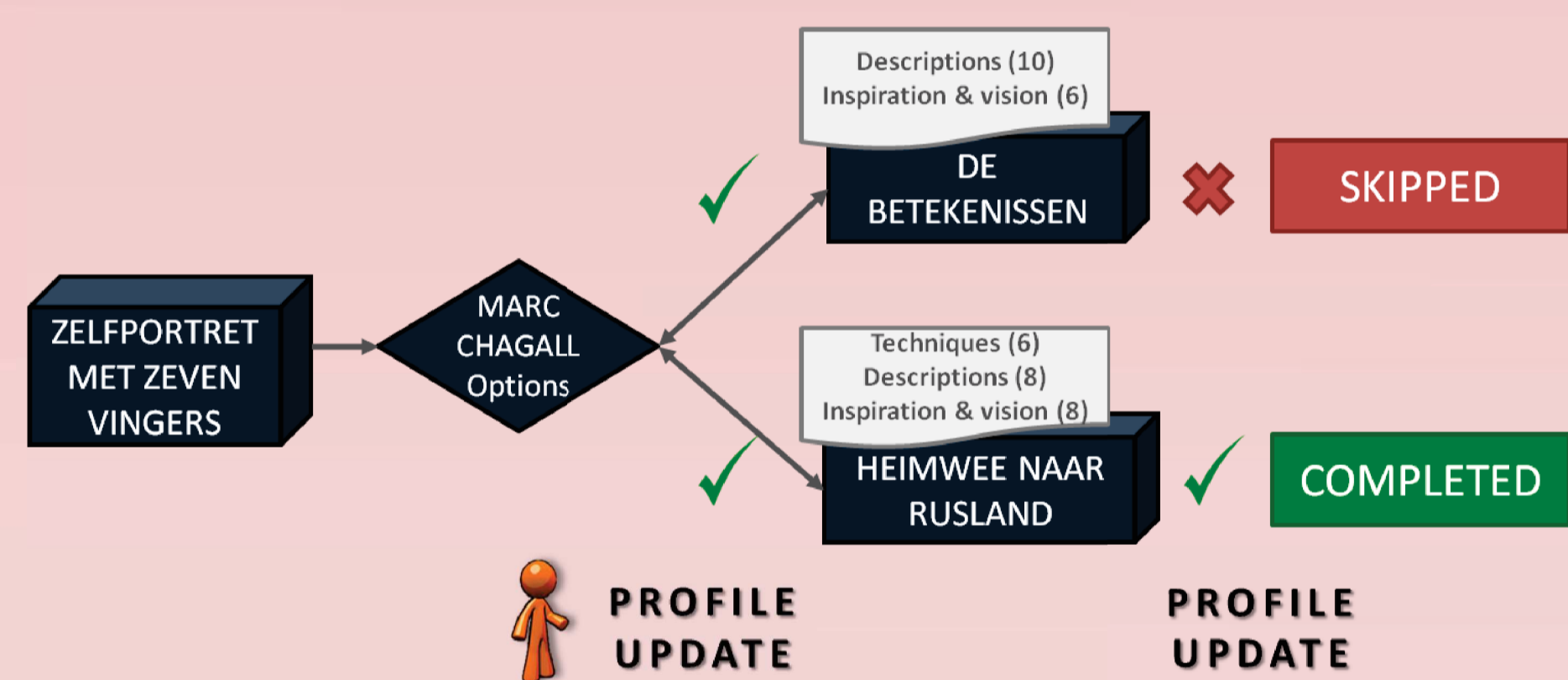
Design of Interactive Experiences in the Stedelijk Museum Amsterdam

For the purposes of the experiment we focused on the ground floor of the SMA, leveraging the digital productions that were already available, so as to design museum experiences that follow the “one size doesn't fit all” approach.

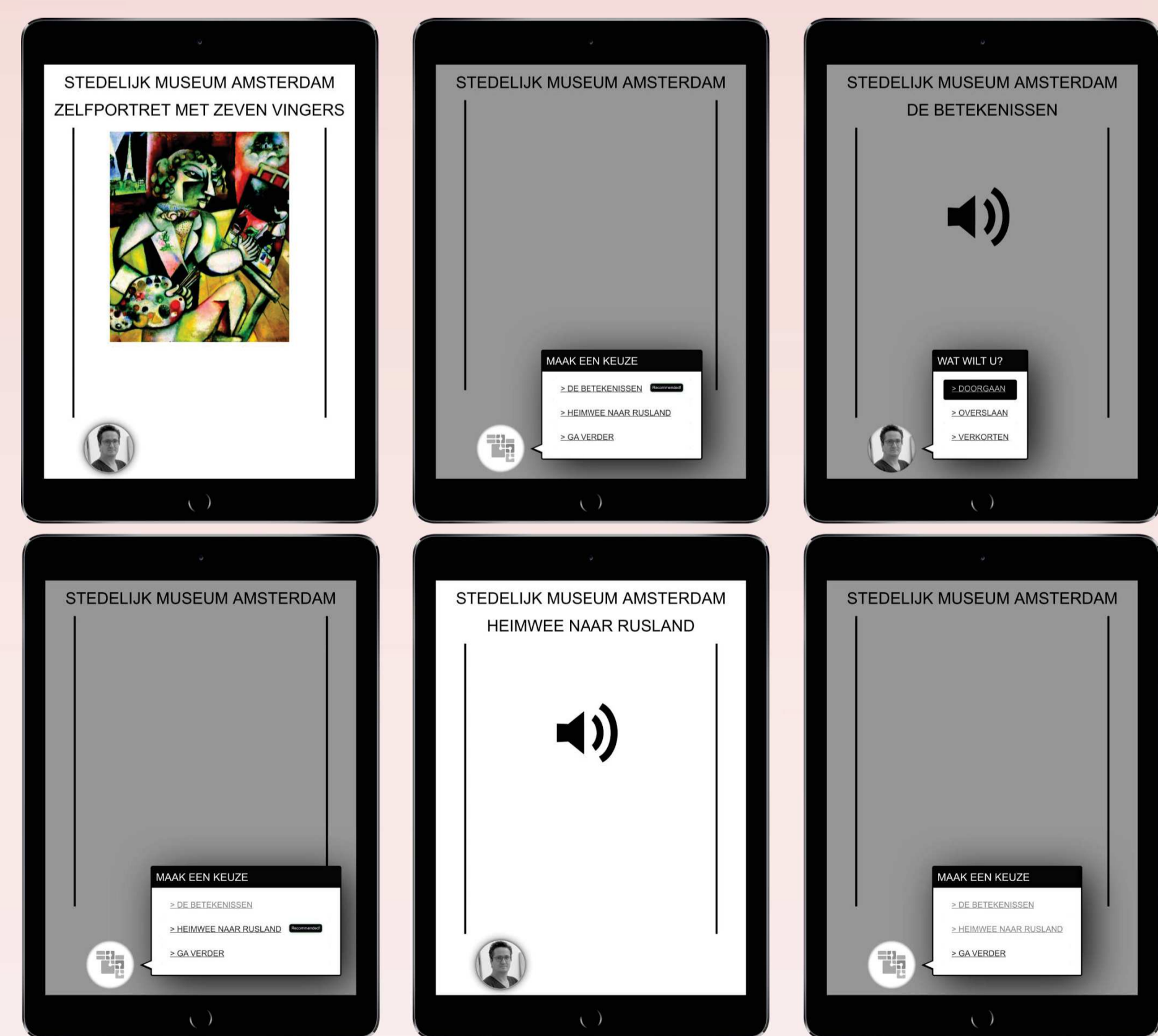
While a single route is currently implied in the SMA, based on the building's structure and the labeling of artworks, several alternative trajectories were defined, enabling visitors to traverse the museum in different routes.



Each one of the digital productions covered a variety of subjects and they were quite long (lasting about three minutes). The SMA team identified seven main themes that were more or less repeating over the whole collection of the available digital productions: *time and age, inspiration and vision, opinions, background information, descriptions, innovations and techniques*. To increase visitor control over the presented content, the productions were divided and annotated so as to include a basic, small narrative for each artwork and the rest were set as optional, through menus.

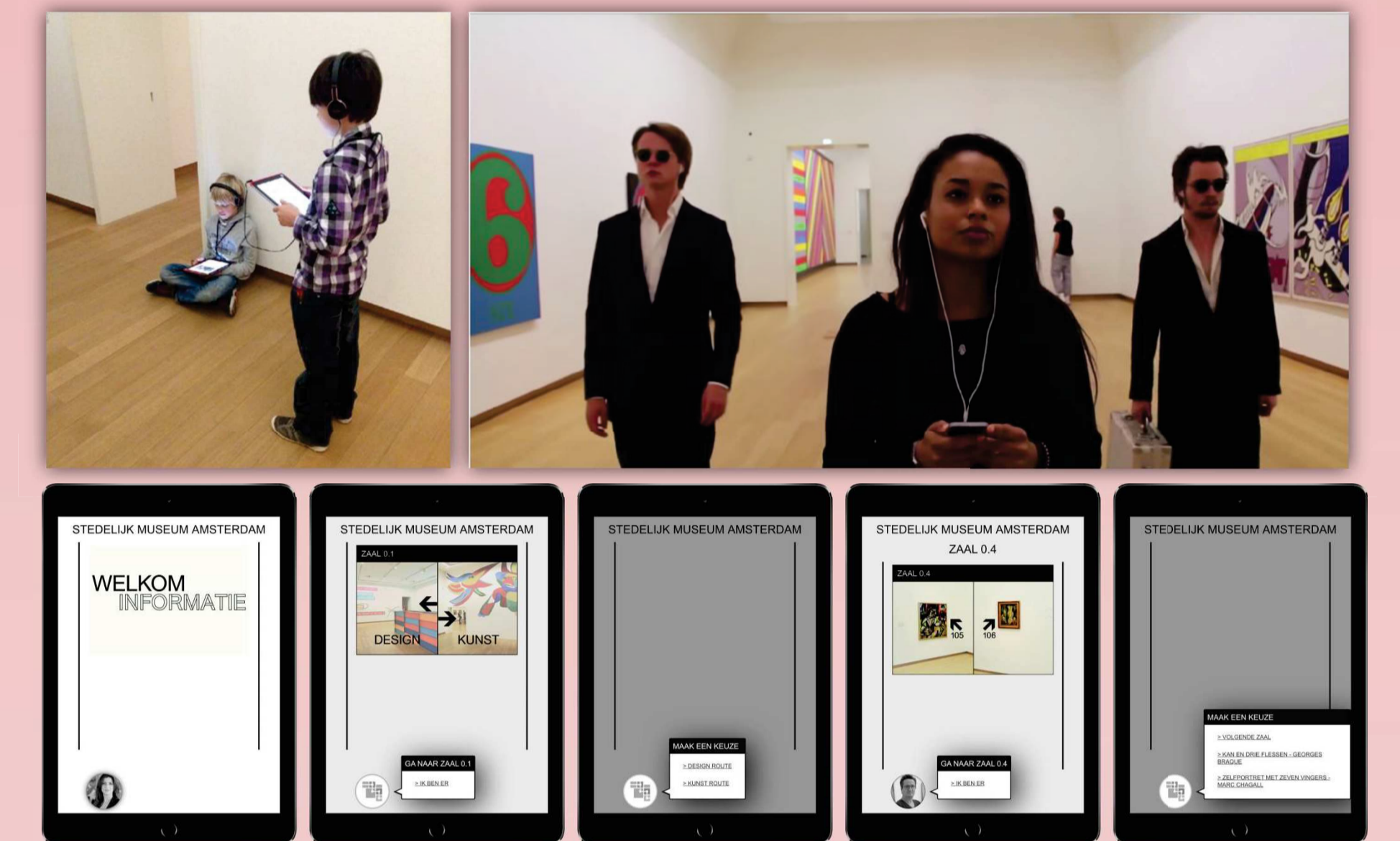


In this way, the visitors are enabled to select what type of information they want to get for each artwork. At the same time, the CHESSE system monitors visitor choices, interprets them as negative or positive feedback and updates visitor profiles, thus capturing visitor preferences over the defined themes. So, as the experience progresses, the visitor profile is enriched and it is leveraged to suggest narrative pieces and artworks where the preferred themes are most dominant.



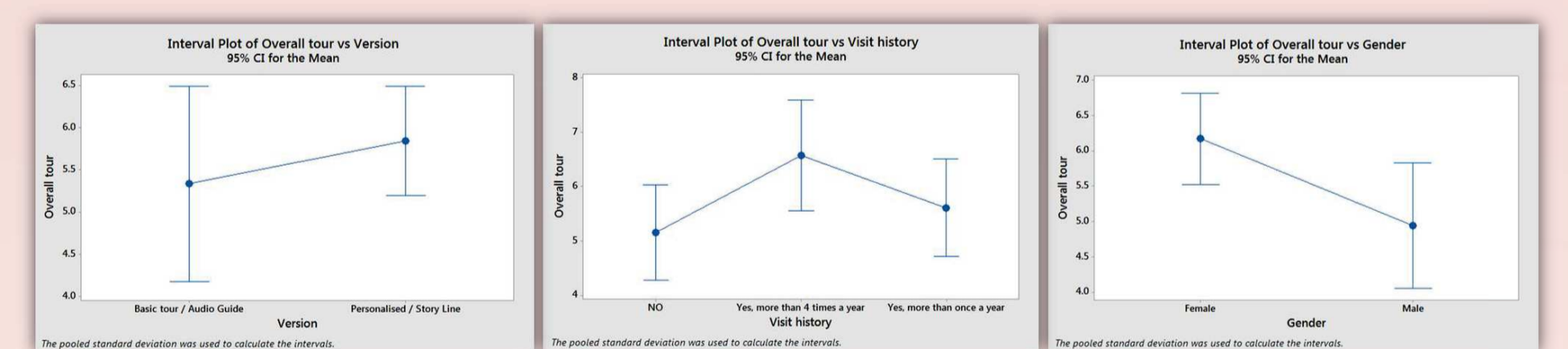
Experiment Description and Results

To investigate the effects of the personalized recommendations to the visitors' experience, the Antenna Lab decided to compare it to the Antenna audio guide, a traditional audio guide experience that is currently provided within the SMA. To address significant differences in several aspects of the experiences provided by the two systems (i.e. different content, interface, functionality, system latency) the CHESSE system was also employed for implementing a baseline version that simulates the Antenna audio guide. The baseline experience provides no guidance within the SMA; a list of artworks is presented, titled according to their labeling in the museum. On the contrary, the personalized experience guides visitors throughout the museum, while enabling them to make choices along the way. Recommendations of narrative pieces are provided in both versions, maintaining an identical look and feel.



The experiment took place from November 21, 2014 to December 15, 2014. The Antenna Lab team handed out the iPads and offered free tours to the participants of the study, constructing a control group. After the tour, a semi-structured interview took place, with questions including demographic and history data, as well as rating and commenting on several aspects of their experience. In total 61 visitors participated in the user study, from a variety of age groups. The experiment results were analyzed and our findings are summarized as follows:

- The average rating of the personalized experience outperforms the baseline, although there is not a clear preference observed.
- The standard deviation of ratings for the personalized experience was much smaller, which points to a more stable experience.
- Frequent visitors are likely to rate both the experiences higher.
- Male visitors rate the experience lower than females.



- Navigation within the museum significantly influenced the overall rating of the experience.
- Most visitors were not acquainted with the themes that curators used to annotate the narrative pieces.
- Visitor preferences seem to be influenced by a variety of factors that were not modeled under this experiment, such as the color, form or the artist of the artwork.
- Behavioral or cognitive traits seem to influence how much the participants like the personalized experience.

Our experience in CHESSE showed that visitor personas can serve as a valuable tool, enabling museums to model their visitors so as to proceed to the design of different experiences.