AMuse: A theoretical framework and technology for extending the museum boundaries in the physical world

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Abstract

The use of intelligent presentation systems within a museum is a well-established practice. This thesis deals with connecting the museum experience with novel cultural experiences in the outside world, with attention to the individual in recognizing opportunities and delivering tailored presentations. Our goal is to help keep the user connected to the cultural experience and to help develop further knowledge and intellectual pleasure after the museum visit. The specific goal of this research is to explore the potential of technology 1) to define "contextual opportunities", 2) to identify these contextual opportunities, 3) to select relevant material, and 4) to deliver it, given the right context, in the most appropriate way for the specific user. We review the field of personalized cultural heritage experience and technology, and related research areas, needed to serve as a grounded basis for ideas developed in the framework. We examine user preferences by reviewing data from two surveys, we conducted, in order to develop additional (from those in the background) inputs (points) for the theoretical framework model. We then describe our theoretical frameworks, both finding the next place to go, and connecting back to previous experiences. We describe the System Architecture and give three concrete examples of use cases. We report on an initial evaluation of the system (and the underlying theoretical framework) by a visitor study, followed by a discussion of possible implications.

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1 Introduction

Museums, as cultural heritage (CH) sites, have long been a primary showground for the exploration of new technologies [De Carolis et al. 2018; Ardissono, Kuflik, and Petrelli 2011]. This combination of museum and technologies has led to conferences such as Museum and Web[1], workshops such as PATCH[2] and journals such as JOCCH[3]. The research in this field over the years has undergone a number of phases of development. Initially in the **first** phase a plethora of museum guides/applications were developed and explored. A large portion of research in the field of mobile technologies (guides) for CH has concerned itself with the single museum visit (see [Emmanouilidis, Koutsiamanis, and Tasidou 2013] (represented as a point * covering the actual visit experience (*) in Figure 1.1).

Recent new directions or stages for research in this field, have dealt with:

A) The **second** phase which concerned itself with expanding the on-site visit with prior and post experiences; that is looking at planning, the visit itself and post-visit activities (represented by the parenthesis around the point in Figure 1.1 – red line) primarily at a desktop computer application at home, but not necessarily [Kuflik et al. 2014; Stash et al. 2013], That is the ecosystem of a single museum visit.

B) The ultimate or **fourth** phase (we skipped a phase but we will return to that soon.) which is expanding the visit from a onetime experience to an experience that may repeat itself multiple times over a lifetime[Kuflik, Kay, and Kummerfeld 2010]. On this other end of the time scale there have been a limited number of papers on the topic of looking at the lifelong CH experience [Kuflik et al. 2010; Stash et al. 2013]. This is represented by the whole (green) line in Figure 1.1. Lifelong CH can be defined as:

> *The cultural heritage experience is being viewed as an ongoing lifelong experience: curators and museum researchers are continuously looking at how visitors can be captured and retained over time, both online and onsite (Lord, 2007; Wilkening and Chung, 2009; Falk, 2009). As an interaction continuum, personalization can play a major role by reasoning on past experience and other daily and contextual characteristics of the visitor, making the current cultural heritage experience a link in a lifelong chain. [Ardissono et al. 2011]*

[1] http://www.museumsandtheweb.com/
[2] https://patchworkshopseries.wordpress.com/
[3] https://jocch.acm.org/

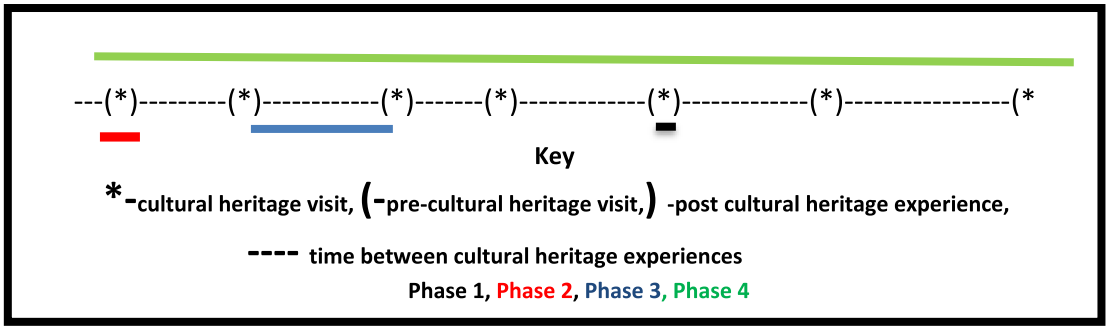


Figure 1.1 Lifelong cultural heritage timeline

A proposed new **third** direction/phase for research/applications in this field, the one we aim to focus on is: **motivating the user to extend his visit to the museum with visits to other cultural heritage sites and enhancing the other experiences outside the museum site, based on experiences at the museum site**. By doing this we can connect our CH experiences to our "daily" lives. Our **goal** is constructing a framework by which we can connect one point to the next (Figure 1.1). That is determining how we can get from one CH experience to the next one (represented by the line (blue) connecting two points). In addition, we look at how to tie the next experience back to the previous ones.

To use the words of Mark Walhimer, Managing Partner of Museum Planning, LLC, an exhibition design and museum planning company:

> ***The Museum / Science Center is without walls, the museum experience starts prior to the visit to the "bricks and mortar" location and continues after the visit to the museum. Museums of the fourth generation can / will use the techniques of museums 1.0, 2.0 and 3.0, plus the museum experience is customized to the visitor (similar to Web 3.0). The visitor experience "meets" the visitor at their level of engagement, interest and knowledge. The museum experience is customized to the visitor prior to the museum visit. I do not know of any museum that I would refer to as Museum 4.0***[4]

In order to accomplish our goal, we assert that *Personalization*, as deemed by many, plays a key role [Pechenizkiy and Calders 2007; Kuflik et al. 2010; Bohnert 2010; Ardissono et al. 2011; Asif and Krogstie 2012], though not all [Kramer, Noronha, and Vergo 2000; Shneiderman and Plaisant 2009].

In this research we use personalization as defined as: *the reuse of personal information elicited from experience gained onsite (e.g. a user model) for providing personalized experience*

[4] http://museumplanner.org/future-of-interactivity/

at multiple sites [Ardissono et al. 2011] along with other persuasive technologies (such as digital nudging) in order to accomplish our goal of connecting CH experiences.

To illustrate such an experience, consider the following two scenarios:

1) After visiting the Tower of David museum[5], a user, who has shown an interest in King David is traveling near Emek HaElah in Israel, the user gets an SMS or short verbal message, that the user is nearing the site of the biblical battle between Goliath and David. While driving, the user can be presented with either classical music or modern Israeli music connected with this theme. When she gets out of her car she can be presented with information (either short videos or pictures) presenting some information on the history of the area and of weaponry from the time of King David which she had seen in an exhibition at the City of David museum some time ago.
2) Users are visiting the Colosseum in Rome, on their electronic mobile device, auxiliary information, i.e. pictures from past visits to the Coliseum, are presented, not only pictures taken by the user, but pictures of historic significance personally related, such as the visitor's parents standing by the Arch of Titus can be shown. In this case the specific text the user is reading is augmented by relevant personal information and additional relevant information that may be available on-line filtered by the user's model.

Both scenarios point to use of information of one CH setting, at another setting external to the original setting. All of the above is enabled by personalized information derived from the numerous digital tracks (choices in electronic guides, positioning information from GPS, etc…) we leave in today's modern digital world. These digital tracks can be both explicit (i.e. asking the users directly what they think - attitudes) or implicit (an electronic guide may derive preferences from user behavior). From these digital tracks, which contain data about the visit to the CH site, we 1) build up a user profile (model), representing the observation of the system about what was found interesting by the visitor and 2) record contextual information.

These dual aspects of personalized user information and contexts are used to contribute to an improved personalized user experience connecting the two experiences. **The contribution of this research is to explore the potential of technology 1) to define the "contextual opportunities", 2) to identify these contextual opportunities, 3) to select relevant material, and 4) to deliver it given the right context** - all this with attention to the individual, both in recognizing opportunities and delivering tailored presentations.

To explore these issues, which concern themselves with how we can use technology to connect the museum experience to additional experiences, we conducted a review of known

[5] https://www.tod.org.il/en/

research, surveys, built theoretical frameworks (which we call AMuse), realized prototypes, and performed visitor studies. In conclusion we were able to provide an initial positive answer to the question: can technology help extending the museum boundaries in the physical world?

We take a Grounded Theory [Hughes and Jones 2003] approach to conducting our research. We formulate the activities described in the previous paragraph in grounded theory terminology. We looked at published work and at user preference surveys, which we conducted to extract "**codes**". These are collected into concepts which we call "Design Insights", which appear in text boxes in the "Background" and "User Preferences" chapters. At the end of the Background and User Preferences chapters we summarize and categorize the **concepts**. These are used to construct a **theory** (frameworks), which is used to build a system which we evaluate and discuss.

In the next chapter Background, we review the field of personalized cultural heritage experience and technology, and related research areas, needed to conduct our research and serve as a grounded basis for ideas developed in the framework. We then examine related research projects, which define the current state of the art. Following that, in the User Preferences chapter, we review the data from two surveys we conducted, in order to develop additional (from those in the background) inputs (points) for the theoretical framework model. We then describe our Theoretical Frameworks, grounding them in the Background and User Preferences chapters. Features of the theoretical framework are referenced in the next chapter which describes the System Architecture and gives a few concrete examples of use cases. We then do an initial evaluation of the system (and the underlying theoretical framework) by a visitor study in the Results chapter. We follow with a Discussion chapter, where we examine our findings' implications, and, end with the Conclusion chapter, where we sum up this research and discuss possible future directions.

2 Background

In this section we begin with a review of several areas which, as noted in our Introduction, are fundamental to this research and serve as a basis for mining design insights for our frameworks (These will appear in text boxes throughout the chapter). The research areas are organized around the questions of inquiry: who, what, when, where and how (why? or motivations were discussed previously in the Introduction). For "who?" we look at museum visitor types, personality and user models. For the question of "what?" we look at issues related to "Content". For the question of "when and where" we look to the fields of Context (Pervasive Computing), and Opportunity Identification. Finally, for questions of "how?" we examine the areas of content delivery, persuasion, and digital nudging. In each of these areas we discuss the major issues which have implications to our research and look particularly how each field relates to cultural heritage. We then discuss several projects and research endeavors that are closely related to this work. Finally, to summarize, we list and categorize the design insights found in this chapter.

2.1 Who? - What does research inform us about visitors

For "who?" we look at personalization, user models, museum visitor types, and personality.

2.1.1 Background regarding Personalization and User Modeling

As mentioned in the introduction, **personalization** is one of the key factors for a satisfactory user experience. An additional definition of personalization (other than the one in the introduction) focuses on: "giving the 'right' information, at the 'right' time, in the 'right' place, in the 'right' way to the 'right' person"[Fischer 2012]. Although one might disagree on whether there is always a "right" unique answer, the categories discussed (information, time, place, method, person) are highly relevant. Looking at User Modeling (UM) as an important technology that enables such personalization, we see that over the past 40 years, User Models have been used as a vehicle for personalization and adaptation, allowing systems to reason about their users and to adapt their services to them [Wahlster and Kobsa 1989]. A user model can therefore be considered as a conceptual abstract representation of the user. Different types of user models can be characterized by the following typical classification: 1) individual vs. canonical, 2) static vs. dynamic, 3) short term vs. long term and 4) explicit vs. implicit acquisition [Rich 1983; McTear 1993]. This classification is discussed as follows:

> *A user model is built up and maintained by observing the users' behavior and preferences over time, though not necessarily of the specific individual user (as in the case of canonical (stereotypical) models). An individual model may be more accurate however it may suffer from the "cold start" problem of not enough information concerning the individual user; a problem which stereotypical systems avoid. After*

building the model, there arises the question of whether to maintain the model and update it (dynamically) or use it statically. For short term applications, the issue of being dynamic may be less critical, hence this issue is tied closely to the next classification category of short term vs. long term models.

In the field of user modeling a great deal of thought has been placed on the long-term reuse of models both for an individual application over time and for a number of applications concurrently [Kuflik et al. 2010; Kobsa 2007]. The benefits are multiple and intuitive, but the implementation costs are high. GUMO, UbisWorld and UserML [Heckmann et al. 2005] are examples of efforts to achieve some sort of agreed upon terminology and interchange format in this area either by the use of ontologies, standards or both, in order to enable reuse. A different technique for interoperability and the cold start problem is mediation [Berkovsky, Kuflik, and Ricci 2008]. Another effort to encourage reuse of user models is the Personis project which uses a central repository with resolvers to filter appropriate information [Gerber et al. 2010; Assad et al. 2007]. [Carmagnola, Cena, and Gena 2011] survey the interoperability of User Models, as means for solving the "cold start" problem and for enriching user models. They discuss such dimensions as: centralized vs. distributed, protocols for communication, exchanged data, representation of exchanged data, integration of exchanged data and privacy. The different categories of systems that have emerged from their analysis include those whose goals are: a) exchange user/learner models, b) provide a user model/adaptation service and c) share user models.

The above (the need to continuously update models over the long term) point to the issue of user models which evolve over time (lifelong user models (LUM)). Reusable lifelong models have been the "holy grail" for user modeling for a long time [Kobsa 2007]. A possible solution to aid universal access and thereby reuse, is to use LDAP[6] as a UM server [Kobsa and Fink 2006]. The issues related to LUM have been examined extensively for the area of lifelong user learning models [Kay 2008]. The emergence of at the very least of interchange standards, if not true interoperability, is critical for lifelong user modeling to be useful, so I will follow the emerging trends in this area.

In acquiring information for user models there may be a need to use both explicit and implicit methods [Shneiderman and Plaisant 2009]. Explicit methods include directly asking the user his preferences. Implicit methods infer part or all of the modeling information from other sources, such as user behavior, location information, etc… One possible way to acquire information about users is seeing which items the user recommends to a friend, enabling us to

[6] Lightweight Directory Access Protocol http://tools.ietf.org/html/rfc4510

pick automatically other candidates that have some similarities to the recommended ones. A specific example may be to follow the context sensitive messaging (e.g. meet me at this exhibit) [Kuflik, Stock et al. 2011].

Some additional issues examined by Personis, in its various incarnations (PersonisJ, PLUS) [Gerber et al. 2010; Assad et al. 2007] include: where should the model be placed (on the client side so the user can control access, and distribute the size of the user model or on a server providing centrality) and scrutability (the user can understand why the system is making certain choices for the user) [Kay 2006].

2.1.2 User Modeling in Cultural Heritage

Museums have been a major site of personalization research, mainly focusing on new technologies, as surveyed in [Ardissono et al. 2011]. There has been considerable research done in this area (PEACH, PIL, CHIP) [Stock et al. 2007; Kuflik et al. 2011; Aroyo et al. 2008]. Primarily in the past, personalization (via user models) has been used for CH frameworks for single visits [Ardissono et al. 2011]. Challenges and a roadmap are discussed in [Kuflik et al. 2010]. They describe the lifelong personalized museum experience as a chain of repeated visits where technology plays an important role in supporting users (through the use of lifelong user models) in their ongoing museum experiences. They list four levels of challenge:

- Single museum, repeated visits
- Related museum
- Unrelated museums
- Links to the rest of the user's life

In [Ardissono et al. 2011] and [Kabassi 2013], the field of personalization in cultural heritage is reviewed. [Ardissono et al. 2011] discuss settings (indoor, outdoor), devices, presentation styles, adaptation types, UM representations, UM initiation, UM updating, matching user and content for approximately 35 projects in the cultural heritage domain. UM representations listed include: Overlay, Feature based, content based, and list of items. Matching users and content will be further examined in connection to my three processes, specifically content selection. In terms of settings only the AVANTI [Fink and Kobsa 2002]and smartmuseum [Kuusik, Roche, and Weis 2009] systems worked both in an indoor and outdoor setting, though there was not a connection between the different venues.

Since the cultural heritage experience is ongoing, the user profile needs to evolve over time. It needs to take into account that a person's interests can change over the course of time, which may be affected by contextual items such as the visitor's accompanying entourage and by the goals for that particular visit [Falk 2009].

Design Insight B-Visitor Model: Use a user model to capture aspects of the visitor in order to provide personalization.

2.1.3 Museum Visitor Types

In general, we can say that: "*Visitors tend to have a more satisfying experience and acquire more knowledge when they are given information about where to go, what to expect, how long it might take to visit, where to find restrooms, etc…*"[S. Bitgood 1992]. The nature of museum visits lends itself to the categorization of patterns that visitors exhibit while traversing the museum (museum visitor types). In addition, these may be related to general tourism personalities. Gretzel et al.'s research titled: "Tell me who you are and I will tell you where to go: Use of Travel Personalities in Destination Recommendation Systems" [Gretzel et al. 2004] discussed the use of Travel personalities as opposed to questionnaires which are considered cumbersome by many travelers. The also suggest that travel personalities may provide better recommendations than standard Big Five personality types, since they can accommodate situational changes.

Travel Personality That Describes Best	Percent of Respondents	Travel Personality That Describes Least	Percent of Respondents
All Arounder	24.6	Gamer	38.8
Sight Seeker	21.6	Avid Athlete	17.1
Culture Creature	14.6	City Slicker	12.6
Family Guy	10.6	Beach Bum	9.3
Trail Trekker	9.5	Boater	8.1
History Buff	7.7	Trail Trekker	4.6
Shopping Shark	4.1	Shopping Shark	3.3
Beach Bum	3.0	History Buff	2.0
Gamer	2.2	Culture Creature	2.3
Boater	1.3	Family Guy	1.1
Avid Athlete	0.6	All Arounder	0.5
City Slicker	0.3	Sight Seeker	0.2

Table 2.1 Frequency Distribution of Travel Personality Categories
Taken from [Gretzel et al. 2004]

The study of museum visitors dates to the early part of the 20th century [Melton 1935]. These studies can lead to a better understanding of visitors needs and to provide services that visitors may want. In some cases, we can use the "types" to predict users' behavior. These categorizations can be based on either personality traits or attitudes or behaviors or some combination of the above. By personality traits we mean what are the users' characteristics, e.g.: organized or not? curious or not? An example of personality type categorization is one based on the visitor's purpose for going to a museum. By attitudes we mean what do visitors think (e.g., did they like a particular exhibit? Do they enjoy going to the museum? For what purposes did they go to the museum?). An example of attitude categorization is one based on the visitor's motivation for going to a museum. By behaviors we mean how did the visitor act, e.g. how long did they stay at a certain exhibit? Do they look at every exhibit carefully or do they jump around? An example of behavior categorization is one based on the visitor's movement pattern in the museum. The traits, attitudes and behaviors can interact and influence each other. We can sometimes use attitudes or behaviors to deduce traits; as well as

using behaviors or traits to determine attitudes. As noted above there are many ways to categorize visitors in a museum, we will examine a few of them for both individual visitors and group visitors.

One characterization of visitors is based on visitor identity. According to Falk [Falk 2009; Falk and Dierking 2016], museums are places of free-choice learning. They argue that the goal of this learning experience is not necessarily to gain further knowledge with respect to the subject matter but to build personal identity. Based on the visit purpose, they postulate that visitors come with certain purposes to a museum, **per each visit** (that is each visit may have its own identity), and thus play certain roles in the museum environment. The typologies of such roles/identities are given in the following table:

Falk Type	Description	Corresponding Gretzel Type[7]
Explorer	**Curiosity driven visitor**	**All Arounder**
Facilitator	**Helps others to have an enjoyable experience**	**Family Guy**
Experience seeker	**Is interested in having a must-see experience**	**Sight Seeker**
Professional / Hobbyist	**Desires to increase his knowledge of items related to the museum content**	**History Buff**
Recharger	**Is interested in a contemplative/spiritual experience**	**Beach Bum**
Respectful pilgrim	**Come to the museum out of a sense of duty or to honor**	**Culture Creature**
Affinity seekers	**Come because the museum speaks to his heritage.**	**Trail Trekker**

Table 2.2 Falk types

Falk's identities came under scrutiny in a series of articles [Dawson and Jensen 2011; Falk 2011; Jensen, Dawson, and Falk 2011; Rowe and Nickels 2011].

Design Insight B-Falk Types: Use Falk types to customize the user experience based on his visit identity

Another set of museum types can be based on visitor motivation using the following paradigms [Packer and Ballantyne 2002]:

- **Learning and discovery** - identified as the desire to discover new things, expand knowledge, be better informed, and experience something new and unusual；
- **Social interaction** - identified as the desire to spend time with friends or family, interact with others, and build relationships；
- **Passive enjoyment** - the desire to enjoy oneself, to be pleasantly occupied, and feel happy and satisfied;
- **Self-fulfillment** - the desire to make things more meaningful, challenge abilities, feel a sense of achievement and develop self-knowledge and self-worth;

[7] Our mapping based on description similarities

- **Restoration**, - the desire to relax mentally and physically, to have a change from routine and recover from stress and tension

In addition to visitors playing different roles/purposes during the museum visit, visitors have been observed to behave in certain stereotypical movement patterns [Zancanaro et al. 2007]. Patterns such as Butterfly, Grasshopper, Ant, and Fish (see Table 2.3) ([Veron and Levasseur 1983]. Or additional typologies such as crawling, swimming, leaping (concerned with velocity through the museum) [Umiker-Sebeok 1994] or greedy, selective, busy (patterns connected with how one chooses which exhibits to see) [Sparacino 2003]. Another study identified a typology of spatial-temporal pedestrian behavior in shopping environments as follows: swift, convenient, discerning, utilitarian, and hedonistic [Millonig and Gartner 2011]. These could have museum counterparts.

Movement Pattern	Description	Gretzel Counterparts[8]
Grasshopper	stays long at exhibits of interest while skipping others	History Buff
Ant	examines each exhibit slowly and methodically	Culture Creature
Butterfly	samples a little bit of everything	All Arounder, Sight Seeker
Fish	stays in the middle and walks by most exhibits	Beach Bum

Table 2.3 Movement Patterns

Design Insight B-Behavior Patterns: Use observed behavioral patterns such as ant, grasshopper, butterfly, fish to personalize visitor experience.

Though our research does not deal with social aspects, as it is out of scope, it is still important to say a few words about groups. Visitors often come to the museum in small groups [Petrelli and Not 2005]. [Johnson and Johnson 1994] have defined small groups as: "*two or more individuals, in face-to-face interaction, who are aware of their positive interdependence as they strive to achieve mutual goals, aware of their membership in the group and aware of the others who belong to the group"*. This definition varies from one group to the other in the weights attached to each element of the definition [McGrath 1995]. Small group perspective should take into account several parameters [Johnson and Johnson 1994; Nixon 1979]: interaction, timeliness of interaction, goals, commitment, mutual influence, conformity vs. deviance, authority, shared norms. All these factors together lead to what is called cohesiveness [Mullen et al. 1994]. There can be additional factors such as leadership, interdependence, etc. Providing an enhanced experience for groups of museum visitors is one of the important frontiers in museum guide research [Stock and Zancanaro 2007]. One

[8] Our mapping based on description similarities

classification of group visitors is based on motivation, and divides groups into two types [Moussouri and Roussos 2013]: 1) Groups with an education/participation motivation, who visit exhibits only 2) Groups with a social event motivation, who spend a considerable amount of time on non-exhibit related activities and socializing with other family members and friends. Another classification is behavior based on how the partners face each other during the visit. Similar to [Veron and Levasseur 1983] they use animal groups to classify the different types of pairs' behavior in a museum [Dim and Kuflik 2012].

2.1.3.1 Methods of Identification of Visitors' Types

We determine museum types based on two broad classes of methods: either explicit or implicit. Explicit can be defined as using methods which directly determine the categorization; while implicit methods can be categorized by the fact that they use other factors to deduce or imply the categories. Example of explicit methods include questionnaires to determine attitudes or asking the user directly his preferences. Examples of implicit methods would be the use of timing and tracking of user movements to determine attitudes or personality traits or watching eye movements to determine if a user liked a particular exhibit or not. Another example of implicit behavior is "triage" where one uses a small subset of initial data to predict the overall behavior in the museum [Dim and Kuflik 2012]. The problem with explicit methods is that users may find them tiresome and cumbersome [Wu and Chen 2015].

In [Yalowitz and Bronnenkant 2009] a brief history is provided of the methodology used in developing visitor types, with reference to several works, which is characterized as follows:

1. Robinson [Robinson 1928] and Melton [Melton 1935]. – Early pioneers based mainly on human observation
2. Cohen, Winkel, & Olsen [M. S. Cohen et al. 1977]; Parsons & Loomis [Parsons and Loomis 1973] - More recent studies again based primarily on human observation and questionnaires.
3. Falk, Koran, Dierking, & Dreblow [Falk et al. 1985], Peart [Peart 1984] Rosenfeld & Turkel [Rosenfeld 1982] – Began renewed interest in the field after the studies of Robinson and Melton in the 20s and 30s.
4. Stephen Bitgood and his colleagues at Jacksonville State Univ. [Bitgood, 2009; S. Bitgood 2006; S. Bitgood 1998; S. Bitgood and Cota 1995; S. Bitgood 1988]- Visitor orientation, circulation, and wayfinding.
5. Beverly Serrell in Paying Attention– Concerned with compiling and comparing visitor behavior data across 110 exhibitions in various types of museums, zoos, and aquariums [Serrell 1997].

In addition, we have:

6. McManus [McManus 1996]-Use of signage and labels.
7. Yalowitz and Bronnekart own work – which describes automatic observation of interaction with exhibits
8. Leinhardt and Knuston [Leinhardt and Knutson 2004]- Social interaction, listening in on conversations

What do we want to observe in determining visitor types? Some of the items to look for as described by [Yalowitz and Bronnenkant 2009] are:

- **Stopping Behaviors** — where people went, where they stopped and what they did:
  - Total time in area
  - Total number of stops
  - Proportion of visitors who stop at a specific element
  - A level of engagement scale for specific elements (i.e., high, medium, low)
  - Duration of a stop at a specific element
  - "Down time" or non-exhibit related behaviors, such as talking on a cell phone
- **Other Behaviors** — what people did, above and beyond the stops and include
  - Visitor path (the route a visitor takes through the space)
  - Social interactions with others in group, with other visitors, with docents or volunteers
  - Using hands-on/interactive elements
  - Watching videos
- **Observable Demographic Variables** — features readily observable
  - Estimated age, Number of adults and children in party, Gender
- **Situational Variables** — situational variables that may affect visitor behavior:
  - Levels of crowding
  - Month or season/ Day of week/ Time of day
  - Any special events or programs going on at the museum
  - Any special events or programs occurring in the exhibition
  - Presence of staff, carts, or other related experiences

The data collected can be made by human observers the traditional way (Figure a) or with more recent positioning devices these can be done automatically (Figure b) (both Figure 2.1)

(a) Human Observer **(b) Beacon**

Figure 2.1 Human vs. Mechanical Observation Methods/positioning beacons

What can we compute when observing visitor behavior? Based on [S. Bitgood 2006], there are three primary measures to analyzing visitor circulation behavior:

. **Attraction power-** the relative incidence of people who have stopped in front of an object or an exhibit during their visit.

- **Holding power-** measures the average time spent in front of an exhibit
- **Velocity-** measures the number of exhibits seen in a given amount of time

Normally these three items are used to measure exhibits, but by using a particular visitor's average time for all exhibits one can construct counterparts that describe the visitor's curiosity (attracting power), attention span (holding power), and speed (velocity)[A. Wecker et al. 2011].

Though against the main stream, Falk and Dierking [Falk and Dierking 2016] warn about too much dependence on these items and talk about other ways of measuring engagement such as measuring the Free-Choice learning that took place.

Design Insight B- Measure Visitors: Use Attracting Power, Holding Power and Velocity as statistics to help define a visitor.

In [Kuflik, Boger, and Zancanaro 2012] a review is conducted of how to analyze the data coming from the observations of visitor's movement patterns. They report about the methodological means used within different prototypes and projects. In synthesis:

- HIPS project (mainly [Marti et al. 1999]).
  - Veron and Levasseur classification
  - They used a Recurrent Artificial Neural Network (ANN) trained to recognize the visiting style of a visitor given her interaction history
- [Chittaro and Ieronutti 2004]
  - Veron and Levasseur's classification
  - A tool that visualizes users' behaviors in a virtual environment.
- [Sparacino 2003]
  - Application employs Bayesian networks to model both the user (interest and style) and the appropriateness of the guide's content (length and order).
- [Hatala and Wakkary 2005]
  - Busy/selective/greedy together with an ontology-based model of the interests.

In these last two works the validity of such a scheme is justified through qualitative analysis, mainly site studies and interviews with the staff at various museums.

- [Zancanaro et al. 2007]
  - Predict visitors' behavior automatically by using manually annotated visitors' logs.
  - Tracked and annotated visitors' paths through a museum exhibition, recording where they stopped and for how long, they then tried to train a variety of classifiers, with different features to predict visitors' behavior.
  - Predict the visitors' next K stops,
    - Based on their interest in already seen exhibits.

        - Based on the visitor's path similarity to that of other visitors through the museum.
    - Experimented with a combination of the two (hence an interest-based classifier, a collaborative classifier, and a hybrid one).
- [Kuflik et al. 2012]
    - Empirically validated Veron and Levasseur's model of visiting style.
    - Look at the consistency of the visitors' exhibited behavior during the visit and tried to identify the visitors' type based on initial observations at early stages of the visit.
    - Log files of 140 visitors with multimedia museum guide,
        - Provide quantitative-based evidence that museum visitors' behavior may effectively be classified according to Veron and Levasseur's mode
        - Analyze their behavior and to try to identify their type

An additional analysis methodology is to use the visitor types to create simulations of museum visits [Bohnert et al. 2011].

2.1.3.2 *Uses of museum types*

Based on the above methods we can create visitor types. To what purpose can we use these types? We can use them like all models to better understand the dynamics of the visit and do appropriate changes to the museum. In an electronic museum guide, we can do personalization and customization based on the museum types (presuming that a type can be used to represent preferences towards information delivery and guidance in the museum). We can build specific tours which are customized to the different visitor types. If we want to reduce the variability among the different visitors, we can create stereotypes and use these for

Design Insight B-Customization Types: Use personalization to customize: Content, Form, and Delivery

customization of the software. Customization of a guide based on museum visitor type can take the form of 1) Content (What is shown to the user) 2) Form (What type of media does the visitor prefer: Text, Audio, and Video) 3) Delivery ("How", "Where", "When" is the material presented). An additional list of customizations/characterizations for the museum domain can be found in [Stock et al. 2007]. One can use techniques from Adaptive Software (deciding between push and pull and where to put the locus of control [Lanir et al. 2011]). For example, for Falk identities; each of these types of visitors has different needs regarding navigation in the museum environment. An explorer may want more choice, an experience seeker may look for attractions, the professional hobbyist may require more time per exhibit, and the recharger may require a more serendipitous approach.

2.1.4 Personality

The use of personality types to tailor software is not new [Hu and Pu 2010; Wu and Chen 2015]. We use the SLOAN or OCEAN (**O**penness, **C**onscientiousness, **E**xtroversion, **A**greeableness, **N**euroticism) Big 5 characterization as it is standard, and much research has been done using it [Higgins et al. 2007]. We focus on two traits we believe are connected to the museum experience: **Openness** which is a measure of curiosity and **Conscientiousness** which also measures thoroughness and the need for structure. This corresponds to characteristics we sought to understand from visitors such as curiosity (which relates well to attracting power) and attention span (which relates to holding power). These corresponded nicely with definitions of the sub characteristics Inquisitiveness and Orderliness. Neuroticism could also play a role especially in items connected to Locus of control [Goren-Bar et al. 2006]. Introversion and Extroversion could also play a part in group visits but is not examined in this research. Personality is also known to play a role in tourism and consumer generated media (CGM)[Yoo and Gretzel 2011; Gretzel et al. 2004]. In addition, preliminary ideas for the connection of movement patterns to personality types have been proposed [Antoniou et al.] A combination of the two sub-characteristics of inquisitiveness and orderliness to form what is known in the MyersBrigTI literature as **temperament** [Y. Cohen, Ornoy, and Keren 2013]

2.1.4.1 Measuring Personality

To measure personality there are many different tests. Given the high rate of correlation of the main characteristic with the sub characteristic (Inquisitiveness : Openness and Orderliness : Conscientiousness) [Schmitt et al. 2007] one could measure the main characteristic to measure the sub-characteristic.

A subset of the Big Five Inventory (**BFI**) (44 item) can be used to measure two traits, Openness (10 questions) and Conscientiousness (9 questions) (19 questions overall). Each item consists of a short statement, and respondents are required to rate the degree to which they agree with each statement on a 5-point Likert scale (1 = ‘‘Strongly disagree’’ to 5 = ‘‘Strongly agree’’). The BFI was deemed to be a good choice for the current study, as it can be completed in less than 5 min, and it has strong psychometric properties. Using standard procedure, someone is classified as possessing the characteristic if their score was above the median score. It the case of small populations one could use published norms connected to Internet use.

Another inventory which is useful for applications and when you don't want to (or can't) bother users is the Ten Item Personality Inventory (**TIPI**), which shows adequate convergence with the BFI-44, test-retest reliability, patterns of predicted external correlates and convergence between self and observer ratings [Gosling, Rentfrow, and Swann 2003]. Each

item consists of a short statement, and respondents are required to rate the degree to which they agree with each statement on a 7-point Likert scale (1 ="Disagree ‘‘Strongly’ to 7 = ‘‘Agree Strongly’’). For each trait there is one positively phrased item and one negatively phrased item. Again, we only use a subset of the TIPI (10 item) to measure two traits, Openness (2 questions) and Conscientiousness (2 questions) (4 questions overall). For scoring, we divide our sample into high-scoring and low-scoring subgroups. One way of doing this is a median split: top 50% vs. bottom 50%. This retains all our cases, but some members of each group will be a lot like some members of the other. Alternatively, we leave those in the middle out of these analyses and create "upper" and "lower" groups that are separated by some range of middle scores. In the testing literature, the usual rule is to compare the top 27% to the bottom 27% [Schmitt et al. 2007].

Design Insight –B- Personality Movement: There may be a connection between movement types and "identity" types proposed by John Falk [Falk 2009].

2.2 What? - What types of content/information should be provided

In this section we discuss what types of content/information the system should provide in the mobile environment (in the subsection on How? we discuss different delivery mechanisms including form). One category of content is information about or related to an exhibit or a place. In addition, the system gives recommendations which are another category of content or information. Techniques from recommendation systems can also be used to choose personalized content. The system provides content/information (in the form of messages) to motivate the user to visit new sites, so we discuss how we can choose the content (e.g. text) such messages. Finally, we discuss overall strategies for choosing content and information.

2.2.1 Content Selection

McCullough [McCullough 2012] notes that in the mobile environment "attention competition" is critical since according to Kahneman's theory [Kahneman 1973] people focus on objects that they are familiar with, have interest in them and demand low attention capacity. McCullough suggests that there is an interaction between cognitive load and focal attention (see Figure 2.2) and certain places there is a preferred combination. Media items vary from those of high cognitive load and high focal attention, which is indicative of watching conventional media, to items which have low cognitive load and local focal, which are indicative of the information present in our surroundings (background info). This suggests that for mobile cultural heritage content selection, one should place emphasis on media which have medium-low cognitive load and medium-low focal attention.

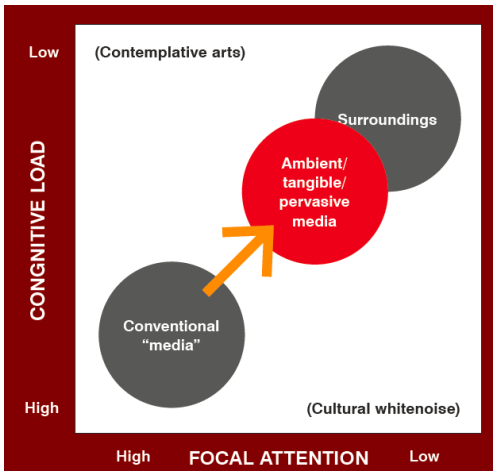


Figure 2.2 Cognitive Load vs. Focal Attention
(Taken from [McCullough 2012])

Design Insight B- Content Design: use items with medium-low cognitive load and medium-low focal attention.

In terms of matching the users and content, ideas from recommendation system may be used to support the process of content selection. [Ardissono et al. 2011] survey the following techniques in recommendation systems: Condition-Action rules, ranking, semantic reasoning, activation/inhibition networks, collaborative filtering, content-based filtering, social recommendation techniques, and hybrid system. [Konstan and Riedl 2012] point out that there are more factors to useful content selection than prediction accuracy and is probably true in our case of CH. [Pu, Chen, and Hu 2012] summarize existing work on recommender systems with details concerning initial preference elicitation, preference refinement, and recommendation result presentation, in addition to providing 20 guidelines for such systems.

Recommender systems have begun to support context, so in a similar manner I can use context to support the content selection process (See section on context awareness for different types of context), even though our challenge may be more complex. [Agarwal et al. 2013] list insights into the challenges that content web portals face that are similar to the ones I face, including: 1) that unlike search, where users are looking for specific content, here one is looking for items that are relevant to users or that they might want to browse 2) that unlike search, where the query is a strong indicator, here one needs to look at long-term history, recent behavior, and trends (popular topics) 3) what one seeks to optimize may not be precision and recall, but user satisfaction, social interaction, and click-through rates. In addition, they list three types of "modules" that provide different types of content: 1) Feature modules (content based on interest) 2) Network Modules (content based on updates from social network) 3) Related content modules (content based on semantic relevance, item popularity, match to user interests). The relevancy and application to CH is readily apparent.

An example of personalized content in CH is "Gifting", where people prepare content (not necessarily informative, for example music to accompany an artwork) for museum items for specific people, with the effect of personalization and socialization [Fosh et al. 2015].

In order to select and eventually retrieve relevant content from various sources, it is clear, in order to be efficient, we will need to make use of nascent standards and methodologies such as: TourML [Watson et al. 2004] which is a standard to connect digital assets to cultural heritage items (stops in TourML terminology). Such standards give us the ability to reason and select information and media gathered from numerous sites in an efficient manner.

Design Insight B- TourML: use concepts such as stops and assets to define visit.

2.2.2 Motivational Information

In the subsection below on When/Where we discuss opportunity identification and the importance of motivation. Motivation can also be used to determine the content of messages.

Motivations (24 items) and incentives for cultural heritage are clearly part of the opportunity identification and are listed by [Jansen-Verbeke and Van Rekom 1996]. The ones that we believe are suitable for Cultural Heritage Tourism are presented in the following table:

Acronym	Verbke Category
FFT	Food For Thought
LS	Learn Something
SSN	See Something New
DSS	Don't Stand Still in life
QOL	Quality of Life
EYL	Enrich Your Life

Table 2.4 Verbke Tourist Motivations

Design Insight B-Motivation Message: Use motivations such as FFT, LS, SSN, DSS, QOL, EYL for messages.

Additional motivational factors have been explored by the Culture Track 17 project[9] they report the following motivators for cultural participation(with percentage of respondents that found them relevant), which we compare them to counterparts in the Verbke list (see Table 2.4 above and Falk Identity (discussed above) (see Table 2.5 below):

[9] http://2017study.culturetrack.com/home

Motivation (Culture 17)	Percentage	Motivation (Verbke)[10]	Falk Identity[11]
Having Fun	**81**	**EYL**	**Experiencer**
Interest in the content	**78**	**LS**	**Hobbyist**
Experiencing new things	**76**	**SSN**	**Explorer**
Feeling less stressed	**76**	**QOL**	**Reflective**
Learn something new	**71**	**LS**	**Explorer**
Feel inspired	**69**	**FFT**	**Pilgrim**
Interacting with others	**68**	**QOL**	**Facilitator**
Feeling transported	**67**	**SSN**	**Experiencer**
Feeling welcome	**64**	**QOL**	**Affinity Seeker**
Gives life a deeper meaning	**61**	**EYL**	**Pilgrim**
Connecting to my community	**56**	**QOL**	**Affinity Seeker**
Bettering health/well being	**55**	**QOL**	**Hobbyist**
Grew up participating	**53**	**QOL**	**Affinity seeker**
Being able to go by myself	**50**	**DSS**	**Explorer**

Table 2.5 Motivational Factors

In addition to positive motivators, they discuss negative motivations such as: It's not for someone like me, I didn't think of it, it's inconvenient, I couldn't find anyone to go with, its value is not worth the cost.

Design Insight B-Motivation Message2: Determine motivational message based on museum visitor type.

2.2.3 Different methodologies for content preparation

Lindauer [Lindauer 2005] talks of 4 different types of meta-strategies, roles played by the curator and how success is measured for the strategy in preparing an exhibit. 1) A smorgasbord (salad bar) which is related laissez faire educational strategy; that is, I will give my visitor a breath of choices and let him choose which interests him. The role is that of a nurturing parent with success measured by "visitors freely exploring and acquiring knowledge relevant to their own interests" 2) A designed program to inform the user, this is related to Tylerian curriculum theory, based on the fact that curator is there to initiate the novice. The curator acts as a mentor and success is measured according to "the extent to which learners enact predetermined measurable objectives". 3) A problem-solving approach which based on constructivist educational theory where curators and visitors are partners in a dialogue. Success is measured by "the extent to which learners engage in problem solving, ideally developing emergent (as opposed to pre-decided) opinions, explanations, or interpretations". 4) Telling a story, which is based on narrative curriculum theory, where the visitor first plays the role of listener and the museum is the storyteller though over time the roles are reversed. Success is determined by "the extent to which visitors craft a narrative that expresses

[10] Based on our own mappings to Verbke motivation types
[11] Based on our own mapping from Falk identity descriptions

knowledge of oneself in relationship to aesthetic, social, historical, and/or cultural relations central to the story told in the exhibition".

Design Insight B- Content Strategy: use either smorgasbord, informative, constructivist or narrative approach as a meta strategy for content.

2.3 When? Where? – Using context to present information

Contextual Information, in particular temporal and location (when? where?), are important facets in mobile applications [Böhmer et al. 2011]; and in personalizing a mobile CH system for the user[Fantoni 2003]. Diallo [Diallo et al. 2012] argues that the purpose of context aware system is to help the user make decisions on the basis of situation awareness (context). They discuss how to methodologically identify and capture relevant contextual information and how to incorporate it into their Geospatial Business Intelligence model. Their emphasis on geo-spatial extension, consideration of human mobility perceptions, local context interactions, information sharing with remote contexts and a hierarchical nature may prove useful in the CH setting. This section is built upon looking at contextual awareness as a determinant of when and where to present information, we then look at specific examples for the CH field, how contextual awareness can be used with the user models discussed above, and finally we look at the field of "Opportunity identification" from marketing theory as another way of trying to determine when and where to present information.

2.3.1 Context-Awareness

Many definitions for context exist as noted in [Kuflik et al. 2011]. They quoted Abowd and Dey [Abowd et al. 1999] as claiming that *"while most people tacitly understand what context is, they find it hard to elucidate."* They further state that*: "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves".* [Winograd 2001] states *"Context is an operational term: Something is context because of the way it is used in interpretation, not due to its inherent properties."* [Wigelius and Väätäjä 2009] organized context into the following classification scheme: Task (interactions with system), Social (people, communities), Infrastructural (technologies, device, system) Spatial (location, temperature, noise), Temporal (time of day, date, deadline, schedules). Location is an important contextual item, in fact some early definitions of context-aware were based entirely on location [Schilit, Adams, and Want 1994]. Context aware, in particular location aware, tourist/museum guide systems have been described in a number of research works (see for example: [Abowd et al. 1997; Cheverst et al. 2000]) and surveys (see for example [Schwinger et al. 2005; Ardissono et al. 2011; Kenteris, Gavalas, and Economou 2011]). [Emmanouilidis, Koutsiamanis, and Tasidou] give a taxonomy

of: for mobile guides. In terms of their taxonomy, they divide between system techniques and characteristics (location techniques), setting (indoor/outdoor), data delivery, context awareness categories/support, and client-side device and components (device type, application type - web, native…), functionality (navigation, bookmarking, games, etc…). They discuss several context awareness taxonomies (active vs. passive, physical vs. mental state, physical vs. conceptual, user-centric vs. environment-centric, state based vs. event based, or categories based on sensed, static, profiled or derived context).

Design Insight B-Context: Use context classifications such as Task, Social, Infrastructural, Spatial and Temporal to help determine content and form.

The field of Pervasive Computing, due to the huge amounts of data involved, has developed a large number of different methodologies and frameworks to deal with context [Dey, Abowd, and Salber 2001; Henricksen, Indulska, and Rakotonirainy 2002; Bardram 2005; Davies et al. 2005; Sheikh, Wegdam, and van Sinderen 2007; Soldatos et al. 2007]. Dealing with context can be viewed as a method to obtain personalized services, for example using contextual services based on location [A. J. Wecker, Kuflik, and Stock 2013]. Some thought has also been given to personalization of pervasive (or context-aware, the terms are used interchangeably) applications [Held, Buchholz, and Schill 2002; Henricksen et al. 2002] which discuss various techniques for providing personalized applications based on user context (history of places visited, eye tracking, rule-based engines) but not user models. Since this context-aware information may come from a variety of sensor sources, each identifying the information in different ways, there is a need for ontology in order to use information from these various sensor sources. Chen, Finin and Joshi [2004] discuss ontology, COBRA-ONT, for reasoning about context in a pervasive computing environment, which is part of the CoBrA, a broker-centered architecture which helps one to reason about context. An additional ontology based infrastructure is Ambisense [Lech and Wienhofen 2005].

Taylor [Taylor 2010] makes a distinction between two types of context, which we adopted:

> *All activity is performed in context. Cole [Cole 1996] makes an important distinction between context as "that which surrounds us" and context as "that which weaves together". This mirrors the distinction made in the technical literature on pervasive computing between context as a 'shell' that surrounds the human user of technology and context as arising out of the constructive interaction between people and technology.*

The context which the proposed research intends to focus on is context as a shell. The reasoning behind this is since at this point of the research the aim is to focus on the problem of connecting the user museum experience to the outside world experience and less focus on

researching what new contexts are created by our use of this technology to accomplish the given goals.

2.3.2 Context Awareness in the Cultural heritage sphere

There are numerous mobile museum **guides** (based primarily on location) that were examined and have served as a proving ground for location based services and context aware applications in the cultural heritage area for example[Satoh 2008; Al Takrouri et al. 2008]. [Raptis, Tselios, and Avouris 2005] surveyed and analyzed mobile museum context aware guide practices: they divide context into **System** (devices, applications), **Domain** (visits, tasks), **Physical** (location, mobility, population), and **Infrastructure** (information accuracy due to connectivity) contexts. Design decisions they discuss include: awareness technology used (RFID, Bluetooth, IrDA), Functionality distribution (client, server), Information flow (passive, active), Complementary devices used (glasses, laser-pointer, active badges, cameras, screens). They also discuss taxonomies based on support of groups (yes, no) and location (topological - e.g. in front of Exhibit A - or Cartesian).

Location is the primary context for such applications. In general, an indoor positioning system [Kuflik et al. 2012] is used to determine what content should be delivered to the user. Due to the inexact nature of current indoor positioning, additional user interface techniques may be necessary [Butz et al. 2001; Mulloni, Seichter, and Schmalstieg 2011; Kuflik, Lanir et al. 2011]. Location context can be used to improve other services, for example, messaging by

Design Insight B-Context2: For museum use contexts such as location and time

automatically incorporating position information into the message [Jones 2007; Jbara et al. 2007]. In addition, social context can be taken into consideration, i.e. people who previously visited a location will not get a message [Aoki et al. 2002; Jbara et al. 2007]. Moreover, temporal context, as in important or commemorative dates, can play an influential role is user satisfaction, and the visiting of CH site at significant dates, can enable the user to undergo important experiences [Hall, Basarin, and Lockstone-Binney 2011]. Time is also considered an important factor in tourist considerations in the western world and Sixth Sense is a mobile application, which helps users to relax schedules and take a more opportunistic view of time [Davies et al 2012] thus enabling people to further enjoy their CH experience. Time of day (e.g. whether a site is open, or is it too hot to walk around) can play a role in recommendations. In addition, congestion is another form of context which can be important to visitors [A. J. Wecker et al. 2011] in particular in the CH situation since it is a leisure activity based on choice [Falk 2009].

2.3.3 Reasoning with User Models and Context

One of the challenges in this area is how to reason with both contextual and user model information. An interesting question is how to divide the information between what is in the user model and what is in the context. Possibilities that exist are: 1) That the user model contains information that is of a stable nature while the context contains information that is more dynamic or some other division 2) that everything is part of the user model[12], and 3) that everything is context (e.g. situational and personal contexts [Espeter and Raubal 2009; Henricksen and Indulska 2006]). [Byun and Cheverst 2001] provide the following table (Table 2.6) for discussing the differences between context and user models. [Asif and Krogstie 2012], in a recent paper, summarize arguments and discuss design issues (scalability, network, context management, lifelong user models, privacy, group presentations, personalized recommendations) related to client vs. server-side personalization. Their claim is that the major advantages of client side are in the areas of privacy, scrutability and security.

Issues	Context	User Models
Data Acquisition	**Largely from sensors**	**Largely from interaction with users**
Coupling to Applications	**Can be insulated from application**	**To be part of application could be more efficient**
Representation	**A data model**	**A data model, a behavior model, or combination of the two**
Period required for Data Acquisition	**There is a no time gap to capture user's context**	**Sufficient time and interactions are needed for a behavior model to learn a user's behavior**

Table 2.6 A comparison of Context Models and User Models
Taken from [Byun and Cheverst 2001]

We now survey and discuss possible approaches to reasoning about context and user preferences:

[Espeter and Raubal 2009] discuss a decision model to reason about items such as location (context) and group preferences. They use a formal multi-criteria decision model (MCDM) to combine preferences and context by the use of simple additive weights (SAW) for scoring and the ordered weighted average (OWA) rule for decisions. They also use time geography, mapping of locations which can be reached in a certain time limit, to project an area onto a map, (i.e. the potential path area) of potential feasible solutions (locations).

[12] Alfred Kobsa, private conversation, February 2013

[Zimmermann, Specht, and Lorenz 2005] discuss context management as a new approach to the design of ubiquitous computing systems that combine personalization and contextualization. While their framework for context is very detailed, their use of personalization is that of a filter applied to the list done by the contextualization process.

[Carmagnola et al. 2005] discuss a semantic framework based on a multidimensional matrix whose different planes contain different types of knowledge (including preferences and context). They use OWL[13] ontology to represent taxonomic knowledge and SWRL[14] (a rule-based system) for rules to combine the different planes (e.g. context and preferences).

The tension between context and user models (profiles) is similar to that of the person/situation debate. Issues of that debate include a comparison of the abilities of personality traits vs. situation variables to predict user behavior [Fleeson and Wilt 2010]. Another key issue of the debate was how much do people differ and the question of the consistency of their differences [Fleeson and Baltes 1998]. The debate seems to have been resolved with conclusions pointing towards user behavior inconsistency at the level of single behavior and consistency at the long-term aggregate level [Fleeson and Wilt 2010]. Another conclusion is that single-level behavior is consistent given a certain situation [Fleeson and Noftle 2009; Fleeson 2004]. This points the way for a similar understanding between context and user models, where certain user traits or preferences are true under certain contexts and that user models have more power in predicting long term trends while context may be better at predicting single-level events.

[13] http://www.w3.org/standards/techs/owl#w3c_all
[14] http://www.w3.org/Submission/SWRL/

Design Insight B-Context User Models: Use advance techniques for handling problems of context and user models. A possible simplification is to use context as a post filter. Use contexts for short term trends and models for long term trends.

2.3.4 Opportunity Identification

Part of our work is based on marketing theory of opportunity identification and exploitation. Opportunity identification is a theme that has been intensively studied for business purposes [Ardichvili, Cardozo, and Ray 2003; Corbett 2005; Gaglio and Katz 2001; Gaglio 2004] and can possibly serve to inform us in the cultural heritage field with the proper adaptations. For example, from Ardicvilli et al. [Ardichvili et al. 2003] we use: "while elements of opportunities may be "recognized", opportunities are made, not found" and "therefore [prefer] opportunity development rather than opportunity recognition." They define opportunity as the chance to meet a market need (or interest or want) through a creative combination of resources to deliver superior value. In addition the field of opportunity identification as related to cultural heritage has been studied under tourism research [Jansen-Verbeke and Van Rekom 1996; Alzua, O'Leary, and Morrison 1998], however not in the mobile context and not in the context of personalization and connection to prior museum experiences. Verbke and Rekom [Jansen-Verbeke and Van Rekom 1996] discuss the concept of the "museumpark" of multiple museums having a positive marketing effect. One could postulate that the indoor-outdoor connection may also have a similar effect. Opportunities for cultural heritage can clearly be tied to location (being near cultural heritage sites) or certain times (planning visits). It can also be tied to certain associations (news items associated with a certain CH topic) which would be more in the vein of opportunity development rather than opportunity recognition as discussed above.

Design Insight B-Opportunities: Recognize contextual opportunities (time, location) to present relevant information and develop opportunities (via associations, advertisement like material).

To do opportunity identification, we need to understand additional motivations and incentives present in the CH field. Amy Jones [Traxler 2009] discusses the motivational factors for success in the mobile learning context. They discuss items such as being able to control the pace of learning, ownership (having a sense of being the owner of the learning experience that it is directed for his benefit), fun (learning is enjoyable), communication (allows to share the experience with others), learning in context (that learning takes place when the subject is aroused by the context), continuity (that threads from the learning experience connect to each other). We believe that these items are relevant for the mobile CH experience that we aim to construct and should be adapted as motivational factors for this experience. The motivational factors listed have their counterparts in the following CH topics (See Table 2.7).

Motivational Factor in Mobile Learning	Relevancy to Cultural Heritage
Control	Pro-activeness [Lanir et al. 2011]
Ownership	Connection, Identity [Falk 2009]
Fun	Quality of Experience [Shneiderman and Plaisant 2009]
Communication	Social Aspects [Szymanski et al. 2008]
Learning in context	Free Choice Learning [Falk 2009]
Continuity between contexts	Coherency [Callaway et al. 2011; Wolff, Mulholland, and Collins 2013; Kray, Krüger, and Endres 2003]

Table 2.7 Motivational Factors from Mobile learning and counterpart in Cultural Heritage

Let us give an example for each of the categories. Pro-activeness can tell us if the users wants push messages or do they want to be in control and only "pull" messages on demand. Connection can mean giving the users information at places that associate with places they have visited previously. Quality of Experience would inform us to give content at points in time that would enhance the user experience (UX). Social Aspects would direct us to give information in certain group situations (out of scope for this research). Free Choice Learning would mean that we try to provide choices to the visitor for learning at the opportune times. Coherency would mean that when we try to inform the visitor we develop a consistent presentation of information that makes sense to the visitor and is not unnecessarily repetitive.

In addition, what we know about the different contexts as discussed by Raptis [Raptis, Tselios, and Avouris 2005] (i.e. System, Domain, Physical, and Infrastructure contexts) can help us to decide when and where to provide content. In addition, context is also relevant to the question in our next section "How?".

Design Insight B-Opportunities Motivations: Knowing motivations can inform us about opportunities

2.4 How? – What techniques to use to deliver content and motivate the user?

In this section we discuss various methods of delivery of information. We start out by quickly looking at the prerequisites such as what system (e.g. devices), environmental, and social context will the information be presented, including the format of the content (media type, and encodings). We then look at the how (using what techniques, including dynamic techniques) will the content be presented to the user (coherency etc…). Additionally, we look at persuasive computing and digital nudging to help us determine how we can use such techniques to motivate the user.

2.4.1 Prerequisites

Context can affect both the format and the method [Lum and Lau 2002] discuss a context aware decision engine for content adaptation. They use a decision engine to combine qualitative preferences and quantitative content values in a Quality of Service (QoS) model.

System context considerations include: modality preservation vs. download time, color vs. download time, network characteristics and device capabilities. These can be used to determine based on context what **form** the information will be presented: text, audio, video, multi-media and at what resolutions.

While hardware considerations are out of scope of this research, we will talk a little about such considerations as they could be incorporated in future work. Mobile pervasive devices such as Kindle and the Google Pixel 2 are popular in society today for reading texts. However, most displays have problems with bright light (such as sunlight at outdoor sites) and electronic ink displays have the limitation that the refresh rate is too low for delivering dynamic images. The use of distributed multiple displays to create an environment which can enhance the user's experience has been explored in projects such as Pebbles [Myers 2001] and others [Allen and Gutwill 2010; Peltonen et al. 2008; Callaway, Stock, and Dekoven 2014]. Mobile projectors have also been considered as part of the pervasive environment [Rukzio, Holleis, and Gellersen 2011; A. Wecker et al. 2011]. These devices can be used as secondary displays, which can enhance the user's primary experience with related content. Another new technology which is based on augmented reality is Microsoft Hololens[15]. In addition, device capabilities (e.g. size) can determine delivery type [Chae and Kim 2004].

2.4.2 Delivery

When trying to inform users of identified opportunities (opportunity exploitation) as discussed in "When?"/"Where?" and the availability of material as discussed in "What", one can take either a passive or proactive approach. There are tradeoffs between notifying and interrupting users and having users explicitly request information [Ardissono and Bosio 2012]. In addition, issues of interrupt management also play a role and issues of relevance and timeliness can play crucial roles [Beja, Kuflik, and Lanir 2011]. Beja et al also discuss 4 guidelines for notifications: 1) User Environment which may determine what interruption methods are feasible and socially acceptable 2) Format- the forms of the methods (e.g. level and type of sound, color of icons, frequency of vibration) 3) Importance and Urgency - relevance to current task 4) Timing -in general interruptions should occur at end of tasks. These issues may also play a role in the opportunity exploitation process. Context can play a role in reducing the cognitive workload and support proactive behavior by providing hints about the user's availability to receive notifications [Ardissono and Bosio 2012; Byun and Cheverst 2002].

[15] https://www.microsoft.com/en-us/hololens

There are cognitive and pragmatic implications of different ways of delivering in different situations. Many techniques, for example, can be used to provoke interest and coherency. Some of these include storytelling and narratives [Lu et al. 2011; Sparacino 2003; Callaway et al. 2011; Wolff et al. 2013; Callaway et al. 2014]. It should also be stated that there is a movement away from information retrieval and retention towards discovery and exploration [Wakkary et al. 2008].

2.4.3 Persuasive Recommender Systems

Out of the methods discussed in persuasive computing the two most relevant to the cultural heritage field are: **tailoring** and **personalization**. Tailoring is considered the principle that "Information provided by the system will be more persuasive if it is tailored to potential needs, interests, personality usage context, or other factors relevant to a user group"[Oinas-Kukkonen and Harjumaa 2009]. Personalization is considered the principle that "a system that offers personalized content or services has a greater capability for persuasion"[Oinas-Kukkonen and Harjumaa 2009].

In the following chart (See Table 2.8), we review the 21 of the 28 principles and their relevancy for a CH recommendation system (We don't review the social support principle as out of scope for this work) [Oinas-Kukkonen and Harjumaa 2009].

In addition persuasive techniques can include semantic variations, play on positive emotions, Cialdini's six principles of Influence, and humor [Cialdini 2001; Andrew, Borriello, and Fogarty 2007; Gatti et al. 2014; H. Nguyen, Masthoff, and Edwards 2007; Yoo, Gretzel, and Zanker 2013].

Design Insight B-Persuasive Techniques: Use persuasive techniques such as Tailoring and Personalization to motivate user.

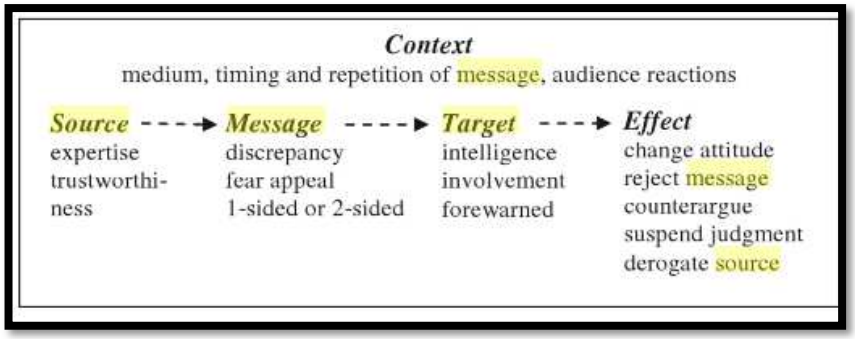
Design Insight B-Content Delivery: Use different forms (audio, video, text) to deliver information based on personal preferences. use environment, relevance and timing to determine how to deliver.

	Principle	Relevancy	Comments
Primary task support	Reduction	Yes	Make it easier for the user (provide maps)
	Tunneling	No	Not applicable
	Tailoring	Yes	
	Personalization	Yes	
	Self-monitoring	Maybe	Possibly let the users track, how often do they go to cultural heritage sites
	Simulation	No	
	Rehearsal	No	
Dialogue Support	Praise	No	Too overt for cultural heritage advisory system
	Rewards	Yes	Must be subtle, can't be too overt for cultural heritage advisory system. For example, the reward can be providing assets to enrich the user experience. Non-subtle rewards could be discounts on entrance to sites.
	Reminders	Yes	
	Suggestion	Yes	
	Similarity	Yes	Messages tailored to their personality type
	Liking	Yes	
	Social Role	Maybe	(Not in Scope)
System credibility support	Trustworthiness	Yes	
	Expertise	Yes	
	Surface Credibility	Yes	Use museum branding
	Real-world feel	Yes	
	Authority	Yes	
	Third-party endorsements	Maybe	Possibly tourism board or Ministry of Culture
	Verifiability	No	Overkill

Items in green are relevant

Table 2.8 Persuasion methods and their relevancy to Culture Heritage Advising

An important part of persuasive recommendation systems is the Communication- Persuasive paradigm [Yoo et al. 2013]. The extent to which a system succeeds in changing behavior or attitude depends on 1) form and content of the message 2) the source 3) the receiver and their characteristics 4) contextual factors. The interplay of these factors and the possible effects are shown in Figure 2.3.



Key- potential concepts are highlighted in yellow

Figure 2.3 Communication-Persuasion Paradigm
(taken from [Yoo et al. 2013])

Design Insight B- Communication Persuasion Paradigm: Adopt the paradigm for motivating user.

2.4.4 Digital Nudging

Digital Nudging [Mirsch, Lehrer, and Jung 2017; Weinmann, Schneider, and vom Brocke 2016; Schneider, Weinmann, and vom Brocke 2018] also known as Control Architecture[Thaler, Sunstein, and Balz 2014] are fields which can be used to influence a visitor to enact change or take action. Digital nudging can be defined *as "the use of user interface design elements to guide people's choices or influence users' inputs in online decision environments*" [Weinmann, Schneider, and Vom Brocke 2015]. Selection of **NUDGES** principles, descriptions, and examples (based on [Weinmann et al. 2016])

Nudge principle	Description	Example
iN**centive**	Making incentives more salient to increase their effectiveness	Telephones that are programmed to display the running cost of phone calls
Understanding mapping	Mapping information that is difficult to evaluate to familiar evaluation schemes	Mapping megapixels to maximum printable size instead of pointing to megapixels when advertising a digital camera
Defaults	Preselecting options by setting default options	Changing defaults (from opt-in to opt-out) to increase the percentage of people who consent to being organ donors
Giving feedback	Providing users with feedback when they are doing well or making mistakes	Electronic road signs with smiling or sad faces depending on the vehicle's speed
Expecting error	Expecting users to make errors and being as forgiving as possible	Requiring people at an ATM to retrieve the card before they receive their money in order to help them avoid forgetting the card
Structure complex choices	Listing all the attributes of all the alternatives and letting people make trade-offs when necessary	Online product configuration systems that make choices simpler by guiding users through the purchase process

Table 2.9 Digital Nudging Principles
Taken from [Weinmann et al. 2016]

In addition other techniques include: Framing, Status quo bias, Social norms, Loss aversion, Anchoring and adjustment, Hyperbolic discounting, Decoupling, Priming, Availability Heuristic, Commitment, Mental accounting, Messenger effect, Image motivation, Intertemporal choice, Representatives and Stereotypes, Endowment effect, and Spotlight effect [Weinmann et al. 2016]. If we want to apply the **NUDGES** principles to Cultural Heritage see Table 2.10 for relevancy.

Principle	Relevancy	Comments
Incentive	Maybe	Similar to Rewards in persuasive systems
Understand mappings	Yes	Given walking distances in terms of time
Default	Yes	Sort recommendation by what we think is the most relevant to the user. Use default behaviors to simplify things
Giving feedback	Yes	Show connection to previously visited items
Expecting error	Yes	Make the interface easy to undo and retrace steps
Structure complex choices	Yes	Provide sorted lists of choices

Table 2.10 Digital Nudging methods and their relevancy to Culture Heritage Advising

Design Insight B-Digital Nudging: Use appropriate digital nudging techniques.

If we wanted to define the difference between persuasive technology and digital nudging, one would say that persuasion concerns itself with how best to develop the content so that

users can be optimally influenced; while digital nudging concerns itself with how best to present (deliver) information in a manner which will optimally influence the user.

2.5 Related Work

In this sub-section, systems and projects which are close to the goal of examining lifelong systems to connect the indoor and outdoor experiences in addition to items described in the Background section. Currently we know of no personalized mobile guides which try to connect the indoor and outdoor CH experiences automatically based on user past experiences. There are mobile guides which handcraft an experience consisting of an outdoor an indoor portion. In general, a good overview of intelligent tourism recommender systems can be found in [Borràs, Moreno, and Valls 2014]. They discuss the functionality of such systems listing: designing a whole tourist experience (8%), suggesting attractions (98%), planning a trip (51%), and promoting social aspects (21%) (percentages are out of all systems examined). Below, we examine related personalized outdoor guides and guides with reusable user models and other similar features to my proposed research.

- In the PEACH project at the Torre Aquila in Trento Italy (indoor guide) had several aspects, including the adaptivity and personalization of multimedia, including linguistic material (e.g. dynamic production of personalized documentaries) [Stock and Zancanaro 2007]. In one experiment visitors were subjected to either an adaptive guide (AD) or a non-adaptive guide (NAD) and their preferences were measured against personality factors such as locus of control (LoC) [Goren-Bar et al. 2006]. The research showed a correlation between Conscientiousness and Neuroticism and high LoC with non-adaptivity.
- The PUP museum guide [Stash et al. 2013] creates outdoor city tours based on the CHIP museum guide methodology (ontology, user models, etc.) [Aroyo et al. 2008]. The user model can be reused from one application to another thus addressing the cold start problem. The system uses the same user models for indoor and outdoor addressing our concerns of interoperability between indoor and outdoor models. This is preliminary work where they explored the potential of the CHIP technology to support both scenarios. In addition, the authors discuss the future addition of contextual items such as time of day, hours of operation, and weather. The system showed the reuse of the model in the two cases indoor and outdoor, and did show model reuse, however did not develop a general framework other than reuse of the model (an important first step though).
- The CULTURA project [Hampson et al. 2013] aims at providing personalized access to digitalized collections. They use a four-phase approach of **guide**, **explore**, **suggest**, and

reflect project [Hampson et al. 2013] . This four-phase approach allows them to cater to different levels of expertise and interests. While this project concerns itself with a high degree of personalization, it does not concern itself with connecting various experiences and its focus is on digitized cultural heritage collections. However, their four-phase approach should be applicable and beneficial for our scenarios.

- A project in Greece, Experimental Blue, which tries to determine cognitive styles from either a short quiz on-site, a Facebook game off-site, or museum movement. They combine visitor behavior and personality to provide personalized information [Naudet et al. 2015]. They do not use implicit personality determination as in our research.
- POST-VIA 360, a platform devoted to support the whole life-cycle of tourism loyalty after the first visit. The system is designed to collect data from the initial visit by means of pervasive approaches. Once data is analyzed, POST-VIA 360 produces accurate after visit data and, once returned, can offer relevant recommendations based on positioning and bio-inspired recommender systems [Colomo-Palacios et al. 2017]. This a much broader system for tourism in general as opposed to cultural heritage. Much of the information gathering is the same but it appears to include less of the persuasive and digital nudging methods that we use.
- The MNEMOSYNE project uses passive observation based on computer vision so that the system can build a profile of artworks of interest for each user [Karaman et al. 2013; Karaman et al. 2016]. These in turn can be used to build a user profile of interests that can be used for recommendations.

Design Insight B-Passive Observation: Use passive observation to avoid being cumbersome.

- Another project that has bearing on my work is Google Field Trip[16], an application which provides local sites that match a user's interest. From the description in the App Store[17]:

Field Trip is your guide to the cool, hidden, and unique things in the world around you. Field Trip runs in the background on your phone. When you get close to something interesting, it pops up a card with details about the location. No click is required. If you have a headset or bluetooth connected, it can even read the info to you.

[16] http://www.fieldtripper.com
[17] https://play.google.com/store/apps/details?id=com.nianticproject.scout

Field Trip can help you learn about everything from local history to the latest and best places to shop, eat, and have fun. You select the local feeds you like and the information pops up on your phone automatically, as you walk next to those places. The hyperlocal history experts of Arcadia and Historvius will unveil local lore in places you never expected. Trend-setting publications like TimeOut, Thrillist, Food Network, Zagat, and Eater will point out the best places to eat and drink. Experts at Sunset, Cool Hunting, WeHeart, Inhabitat, and Remodelista will guide you to the latest unique stores and products. Atlas Obscura, Dezeen and Daily Secret help you uncover hidden gems no matter where you are. Songkick and Flavorpill guide you to local music.

Field Trip uses three different modes of frequency (frequent, occasional, on request) to update users about possible opportunities. Differences between our research and Field Trip are 1) an emphasis on the cultural heritage domain 2) the concept of connecting items seen in museums with outdoor sites. The later difference holds true for other state of the art outdoor applications and distinguishes this research from them.

In other fields there are research projects that try to derive personality in order to make recommendations:

- In the SUMI project, lifelong user modeling (LUM) was examined with emphasis on interoperability, scrutability and privacy [Kyriacou 2008; Kyriacou and Davis 2008]. This was not connected to a CH application but was meant as first step towards an infrastructure. He also examines the use of social network and e-commerce sites to enhance LUM [Kyriacou 2009].
- Another form of a recommendation system in the healthcare field that has similarities to what we intend to research is the Proactive Advisory System. It is an extension of traditional Recommender System. The major novelty is the proactive push of suggestions and advice while adapting to the context of the user [T. S. Nguyen et al. 2014] .

> ***Design Insight B-Proactive: Adopt an advisory approach as opposed to a recommendation system approach.***

- The eMate intelligent Coaching system for health therapy adherence brings the Computerized Behavior Intervention model (COMBI) [Mogles, Klein, and Wissen 2013]. They use a trans theoretical model based on: "social cognitive theory, self–regulation theory, planned behavior theory, attitude formation, the health belief model and the relapse prevention model". They base their work om a five-stage process of pre-contemplation, contemplation, preparation, action and maintenance. The primary determinants for the model in order to affect change are Awareness, Motivation, and

Commitment. Items such as emotion, moods, social norms, and attitudes are also used as determinants. The system uses personalized message which can "express empathy, cheer-on, compliment the user and support the user's self-efficacy, and positive emotions." The messages are designed to minimize boredom and annoyance. They were composed of three parts: health status, motivational message, and a link to relevant information. Methods here are similar to digital nudging and persuasive systems discussed above. Differences from the CH field include the fact that behavior change should be voluntary, and there are no serious negative consequences to failed behavior change.

- In the recommendation systems field, [Hu and Pu 2010; Hu and Pu 2011] showed how personality (measured by quizzes) can help the cold start problem. [Wu and Chen 2015] took this further and showed how to develop an inference model based on a Gaussian Process to implicitly determine personality traits in order to determine movie recommendations. Features used to infer personality are: User watching duration, Users' motives behind watching movies, User preference for movie diversity, User rating behavior, User demographics.

Design Insight B-Stages: Use stages such as Pre-Visit, Visit, Post Visit, In Between, Near Opportunity, At Opportunity to provide different services

Design Insight B-Sub-goals: For different processes set sub goals of Awareness, Motivation and Commitment.

2.6 Summation of Derived Design Insights

The following table summarizes the insights grounded from previous research literature. We will trace the use of these design insights in the section on the theoretical framework.

	Label	Insight (Highlight)	Basis
1.	**B-Visitor Model**	**Use a user model to capture aspects of the visitor in order to provide personalization**	**[Ardissono et al. 2011]**
2.	**B-Falk Types**	**Use Falk types to customize the user experience based on his visit identity**	**[Falk 2009]**
3.	**B-Behavior Patterns**	**Use observed behavioral patterns such as ant, grasshopper, butterfly, fish to personalize visitor experience**	**[Zancanaro et al. 2007]**
4.	**B- Personality Movement**	**There may be a connection between movement types and "identity" types proposed by John Falk**	**[Falk 2009] [Zancanaro et al. 2007]**
5.	**B- Measure Visitors**	**Use Attracting Power, Holding Power and Velocity as statistics to help define a visit.**	**[S. Bitgood 2006]**
6.	**B- Content Design**	**Use items with medium-low cognitive load and medium-low focal attention**	**[McCullough 2012]**
7.	**B- TourML**	**Use concepts such as stops and assets to define visit**	**[Watson et al. 2004]**
8.	**B- Content Strategy**	**Use either smorgasbord, informative, constructivist or narrative approach as a meta strategy for content**	**[Lindauer 2006]**
9.	**B-Motivation Message**	**Use motivations such as FFT, LS, SSN, DSS, QOL, EYL for messages**	**[Jansen-Verbeke and Van Rekom 1996]**
10.	**B-Context**	**Use contexts such as Task, Social, Infrastructural, Spatial and Temporal to determine content and form.**	**[Wigelius and Väätäjä 2009; Raptis et al. 2005]**
11.	**B-Context2**	**For museum use contexts such as location and time**	**[Kuflik et al. 2011]**
12.	**B-Opportunities Motivations**	**Knowing motivations can inform us about opportunities**	**[Jansen-Verbeke and Van Rekom 1996; Traxler 2009]**
13.	**B-Opportunities**	**Both recognize opportunities (time, location) and develop opportunities (via associations, advertisement like material)**	**[Ardichvili et al. 2003]**
14.	**B-Stages**	**Use stages such as Pre-Visit, Visit, Post Visit, In Between, Near Opportunity, At Opportunity to provide different services in different contexts**	**[Mogles et al. 2013]**
15.	**B-Motivation Message2:**	**Determine motivational message based on museum visitor type**	**[Jansen-Verbeke and Van Rekom 1996]**
16.	**B-Content Delivery**	**Use different forms (audio, video, text) to deliver information based on personal preferences**	**[Beja et al. 2011]**
17.	**B-Context User Models**	**Use advance techniques for handling problems of context and user models.**	**[Zimmermann et al. 2005]**
18.	**B-Persuasive Techniques**	**Use persuasive techniques such as Tailoring and Personalization to motivate user.**	**[Oinas-Kukkonen and Harjumaa 2009]**
19.	**B-Communication Persuasion Paradigm**	**Adopt the paradigm for motivating user**	**[Yoo et al. 2013]**
20.	**B-Digital Nudging**	**Use appropriate digital nudging techniques**	**[Weinmann et al. 2016]**
21.	**B-Passive Observation**	**Use passive observation to avoid being cumbersome**	**[Wu and Chen 2015; Karaman et al. 2016]**
22.	**B-Proactive**	**Adopt an advisory approach as opposed to a recommendation system approach**	**[T. S. Nguyen et al. 2014]**
23.	**B-Sub goals**	**For different processes set sub goals of Awareness, Motivation and Commitment.**	**[Mogles et al. 2013]**

Table 2.11 Summary of design insights
grouped by: Who (grey), What (light green) Where/When (pink), How (yellow)

3 User Preferences

To gather data in addition to the design insights that could be extracted from the literature, as described in the Background chapter, we conducted two surveys to further derive more design insights. Their results contribute in guiding us in the development of the theoretical framework described in the next chapter. In this chapter we try to ground insights that were used for the design of the framework by soliciting the user's preferences through a survey. Due to the inherent complexity for a serious quantitative study of these topics, they are only qualitative insights and not proofs or even validations. These also reflect primarily users' beliefs and attitudes as we only measured their own self-reported responses. Throughout this chapter "Design Insights" will be noted by ***S-name*** and will be referenced in the next chapter on the "Theoretical Framework". Survey results for frequencies are presented as a percent followed by the actual numbers in parenthesis **pp% (nn).**

3.1 Survey 1: Users' attitudes and preferences

In this brief survey (14 questions in addition to ones on demographics – see the questionnaire in Appendix C), sent out to experts in the CH field (tourist guides, researchers, etc…) we examined the users' beliefs concerning the need for a system which connects museum visits to additional visits at CH sites. Also, we examined when, where and how often would they want the system to inform them about nearby CH sites. We also asked what type of information they would find enjoyable/useful and what messages would motivate them to visit. The survey confirmed a diversity of styles and preferences in all areas, though some choices had definitive majorities.

3.1.1 Participants

Participants were a group of 25 people (13 females, 11 males, 1 did not answer) ranging from 30-69 (with the biggest group (20s, 30s, 40s…) being from 30-39 age group and 40-49 each 28%), from 4 different countries (mainly US 52%, Israel 36%, and one person each from Canada and Europe). They were highly educated (88% Graduate level (Masters and above), 8% College degree). They were rather familiar with museums (40% visited museum 2-5 times a year, 40% more than 5 times, 16% once a year and none had not visited a museum in the past year). They were also very familiar with museum technologies such as audio guides, video guides, kiosks and smartphone apps (over 60% in each category familiar of very familiar in each category).

3.1.2 Results- General

To make references to the question easier to follow we label the results with **S1-Qnn** (where nn is the question number)

The first question concerned itself with a social aspect (patterns of visitation) of cultural heritage site visits. In **"How do you go to archeological sites** (**S1-Q1**)", the subjects could choose multiple answers. The results are shown in ascending order in Table 3.1 and confirm that the culture heritage experience by large is group activity (see [Petrelli and Not 2005]). Yet, as pointed out earlier, the social aspect will be out of scope for this research.

Visit Pattern	Go alone	One or more friends	Other types of groups	With family
Frequency (Total 25)	28% (7)	36% (9)	40% (10)	52% (13)

Table 3.1 Visitation Patterns (mutiple choices allowed)

Design Insight S-Group: There is a need for the framework/system to support group visits.

The second question concerned itself with the visitor's propensity for preplanning. In answering the question (**S1-Q2**): **Do you allocate time for the visit in advance** 60% (15) said yes. With one person writing "it *depends on what the goal of the trip is and what is available. We usually do make the time.*".

Design Insight S-Preplan: The system should provide mechanisms for allowing the user to pre-plan his visit but not require it.

3.1.3 Results- Notifications

Answers to the question (**S1-Q3**): **If there was an archeological site related to an item you saw at the museum; you would be interested in receiving notification about this** were rated on 1-7 scale. Based on standard practice we group 1-3 as negative, 4 is neutral and 5-7 are positive. Two percent (1 person) had a negative answer to this question, 16% (4) had neutral answers and 72% (18) had a positive answer. **This question shows the motivation, justification and need by the users for the framework we wish to develop**.

In terms of **how they would like to receive the notification in advance** (**S1-Q4**), 76% (19) said email, 20% (5) said SMS, and no one 0% wanted a telephone call.

Design Insight S-Notify: The system should provide mechanisms for notifying users of nearby attractions (but it should have the option of being disabled).

Design Insight S-Notify Methods: There can be different ways to notify, the default can be email (if it is an advance notification). From additional clarification made with some of the surveyed.

In terms of **how often or when they wanted to receive notification** (**S1-Q5**). In general people preferred to get notifications in specific occasions when there is a reason for that and not frequently. There were two types of notifications, one based on temporal frequency and the second one based on context. These were rated on a 1-7 scale. Based on standard practice

we group 1-3 as negative, 4 is neutral and 5-7 are positive. The results are sorted by type and then by increasing order of popularity. Notice only at "Once a week" the positive result goes above 50% for temporal frequencies. (See Table 3.2) (Percentages are out of 25 respondents.)

Temporal Notifications	Negative	Neutral	Positive	Missing
Many times a day	88% (22)	0%	8% (2)	1
Once a day	68% (17)	8% (2)	20% (5)	1
Once a week	28% (7)	16% (4)	52% (13)	1
Contextual Notifications	**Negative**	**Neutral**	**Positive**	**Missing**
Only upon request	16% (4)	24% (6)	48% (12)	3
Using an outdoor tour guide	16% (4)	16% (4)	60% (15)	2
When meeting a person who has a connection to a certain spot	12% (3)	24% (6)	60% (15)	1
At new locations	12% (3)	8% (2)	72% (18)	2

Table 3.2 Frequency (out of 25) of Notification Timings

Note to see the diversity of answers we can look at the distributions of cases of Many times a day, Once a day, Once a week (See Key * - exceptions, biggest groups Table 3.3). Note also that for temporal frequencies there is consistency in the Temporal area, that is if they didn't like it for Once a week, they did not like it for any lesser period (except for 3 cases marked with a *). The reasons for the exceptional cases might be that people preferred a certain frequency of notifications and were neutral to other options. In general, we see two big groups (which cover 66% of all respondents (24) with 1 Missing): one who is negative to all (7 respondents), and the second one who is negative to everything but Once a week (9 respondents). The table is sorted in increasing positivity towards notifications.

Number of cases	Many times a day	Once a day	Once a week
7	Negative	Negative	Negative
1	Negative	Negative	Neutral
9	Negative	Negative	Positive
1*	Negative	Positive	Neutral
4	Negative	Positive	Positive
2*	Positive	Neutral	Neutral
Total: 24			

Key * - exceptions, biggest groups

Table 3.3 Distribution of cases

A related question was **how many times would you like to be notified before the application assumes you are not interested** (**S1-Q6**). Thirty-two% (8) said once, 48% (12) said twice, while 16% (4) said thrice.

Some of the comments in this section (Q5, Q6) include:

- "*I hate being bombarded in my inbox. It might feel very intrusive to be told what to go visit just because I was going somewhere*"
- "*Try to ensure the signal to noise ratio is low, so your emails don't get treated like junk mail*"

- "*Two at maximum. If I am interested I will attend to it. If not, the repeated alerts would be annoying*"

> ***Design Insight S-Notify Freq: Control the frequency of notifications as options including an option only on demand.***

Other answers include:

- "*I like my privacy*"
- "*Just because I don't want to be reminded doesn't mean I am not interested in the spot. It might but really it means I am not interested in multiple reminders. The information to clue me in is sufficient*"
- "*Two is the absolute maximum. If I'm interested I will attend to it, If I'm not, repeated alerts would be annoying*"
- "*Would be nice to have an immediate notification in the least obstructive way so that I can add to my itinerary in the most unobtrusive way*"
- "*Provide easy ways to find notifications, no reason to make them impossible to find later on, like many offers that expire and can't find them again*"

As noted, contextual answers (location) received higher ratings than the fixed intervals and non-proactive answers (upon request).

> ***Design Insight S-NotifyTrigger: There can be different triggers (opportunities) for notification including historical occasions and meeting relevant people. Contextual notifications (location, timeliness) were especially valued. Providing value such as directions is important.***
>
> ***Design Insight S-NotifyAccess: Provide a way to get to past notifications on demand.***
>
> ***Design Insight S-NotifyOptions: Provide a way to turn off notifications and tailor the maximum number of notification.***

3.1.4 Results - Information Content and Format

In terms of **what sort of information would be informative/useful/enjoyable** (**S1**-**Q7**), the users were asked to rate them with up to 5 stars (0-2 stars low rating, 3 medium, and 4-5 high). The results are given in decreasing popularity of the High rating (percentages out of 25).

Content Type	High	Medium	Low	Avg	S.D.	Missing
Personal stories told by a famous person about the site	40% (10)	12% (3)	36% (9)	3.0	1.6	3
Background Information	48% (12)	32% (8)	20% (5)	3.5	1.1	0
Personal stories to by people about the site	32% (8)	24% (6)	32% (8)	3.0	1.4	3
Music	24% (6)	16% (4)	44% (11)	2.6	1.2	4
Plants, Vegetation	20% (5)	34% (8)	36% (9)	2.6	1.2	3
Food	16% (4)	32% (8)	40% (10)	2.5	1.2	3
Pictures of family, friends or teachers who visited	4% (1)	16% (4)	48% (12)	1.9	1.0	8

Table 3.4 Types of Content

Design Insight S-Connections: Provide different types of information (Background Information, Navigation, Recommendation, and Personal Stories to different people.

Note that the last item (picture of family, friends or mentors) had a high number, 32% (8), that gave no stars. A comment on this question stated: *"If I am at the site, those categories might be fun to have information about."* This could also be related to privacy concerns or misunderstanding of the question (as also evidenced by the high number of missing).

The following question is related: **I would be interested in material that is linked to my previous experiences (S1-Q8**), resulting in Disagreed 16% (4), Neutral 16% (4), Agreed 60% (15). A comment on this stated "*Except this might feel invasive*". This contradicts the category of the previous question (Pictures of family, friends or teachers) which, as noted, may have not been understood.

Design Insight S-Connections Social: Using information from past experiences or from family and friends can be especially sensitive and should be able to be controlled by the user.

The next question concerned itself with scrutability and transparency: **Is it important to understand why something is recommended** (**S1**-**Q9**). 4% (1 person) was neutral while 88% (22 people) thought it was important/very important.

Design Insight S-Connections Reasons: Scrutability and understanding why certain things were recommended is important.

The question after that concerned itself with length of material (**how long should it take to experience** (**S1**-**Q10**): 20% (5) answered less than a minute, 32% (8) less than two minutes and 40% (10) less than three minutes. A comment on this question *"A short blurb with an option if interested to read in detail, so both ideally less than a minute and no more than 5*".

Design Insight S-Info Length: In general, short material less than 3 minutes is preferred. Can have optional more button for additional detail.

The next question concerns itself with the **importance of reliability of the source,** formulated as the source of the information is important to me (**S1**-**Q11**): Only 4% (1) disagreed, 4% (1) was neutral, and 88% (22) agreed with this statement.

Design Insight S-Info Trust: Source and reliability of information is important, make this known to the user.

The next set of questions concerned themselves with the genre of the information presented. (**S1**-**Q12**): The users were asked to rate items with up to 5 stars. (0-2 stars low rating, 3 medium, 4-5 high). The results (Table 3.5) are given in decreasing popularity of the high rating. They were asked to rate each item separately, thus the only the rows add up to 100%. The list is sorted from the item that got the largest "High" rating to the smallest. (Percentages are out of 25.)

Category	High	Medium	Low	Avg.	S.D.	Miss.
Short text article	68% (17)	16% (4)	12% (3)	3.96	1.0	4% (1)
Personal stories by people connected to site	48% (12)	24% (6)	12% (3)	3.62	1.2	16% (4)
Short informational film	44% (3)	16% (4)	32% (8)	2.86	1.3	8% (2)
Fictional Dramatization	40% (10)	0	44% (11)	2.86	1.6	16% (4)
Connected artwork	32% (8)	20% (5)	36% (9)	2.86	1.3	12% (3)
Personal account by a famous person	32% (8)	16% (4)	36% (9)	2.86	1.4	16% (4)
Comics	32% (8)	12% (3)	32% (8)	2.74	1.5	24% (6)

Table 3.5 Information Genre

If we take the answers of Short text article, Personal stories by people connected to site, Short informational film, Fictional Dramatization, Connected artwork, Personal account by a famous person, Comics as a vector that for each dimension has a possible answer of Low, Medium, and High, we can compare such vectors. Out of the 25 responses only 2 were exactly the same (they both rated everything High) otherwise all vectors were different, thus, showing clearly that we had a wide variety of responses.

Design Insight S-Info Variety: Different genres of information appeal to different people.

The next set of questions concerned themselves with the form of the information presented. (**S1**-**Q13**): The users were asked to rate different forms with up to 5 stars. (0-2 stars low rating, 3 medium, 4-5 high). The results are given in decreasing popularity of "High". (Percentages are given out of 25.)

Media type	High	Medium	Low	Avg.	S.D.	Miss.
Video	48% (12)	16% (4)	28% (7)	3.48	1.4	8% (2)
Text	36% (9)	44% (11)	12% (3)	3.52	1.0	8% (2)
Pictures	36% (9)	40% (10)	20% (5)	3.29	1.0	4% (1)
3D model	36% (9)	20% (5)	40% (10)	3.04	1.3	4% (1)
Slide Presentation	28% (7)	24% (6)	40% (10)	2.83	1.3	8% (2)
Audio	16% (4)	40% (10)	32% (8)	2.77	1.1	12% (3)

Table 3.6 Information Format

If we take the answers of 3D model, Slide presentation, Video, Pictures, Audio, Text as a vector that for each dimension has a possible answer of Low, Medium High, the highest

frequency of vector values is 2. Out of the 25 responses, only 2 pairs of 2 vectors were exact matches, thus, showing we had a wide variety of responses.

An open-ended comment on this "*Format should be appropriate to what you are conveying.*" It is interesting to note is the contradictory result with the previous question concerning text.

Design Insight S-Info Format: Different types of formats appeal to different types of people. Though text and audio may have lower appeal for most people.

The last question concerned itself with coherency: is it important that information be delivered in a coherent manner, that it tells part of a complete story and does not repeat itself (**S1-Q14**): Only 4% (1 person) was neutral while 92% (23) agreed with this statement. Though one person gave a caveat: "*critical points should be repeated for emphasis and for a greater possibility of long term retention*". Given the overwhelming positive response rate perhaps this question was too trivial, however it does make an important design point.

Design Insight S-Info Coherency: Telling a coherent story is important, as is not repeating details. However critical points can be repeated for emphasis.

3.2 Survey 2: Stereotypical attitudes and correlations

In this survey, we examined the connections between personality characteristics of Openness and Conscientiousness as defined by 22 of the 55 question of the Big Five Index (BFI) [Higgins et al. 2007], and such items as their self-assessed museum visiting style, and Falk Visitor type. In addition, we asked about the attractiveness of motivational statements. This built upon the previous survey to discover ways personalization and personality characteristics could be used to improve the model - and subsequently the system used to demonstrate portions of the model. The survey also involved more respondents. The survey question can be found in Appendix D. To make references to the results easier to follow we label them with **S1-Rnn** (where **nn** is the table result number for this survey. We use this numbering as opposed to the question numbers since some of the results that interest us were cross tabulation of question results, as opposed to overall answers for the entire population).

3.2.1 Participants

There were 149 people (62 female, 83 male, 4 did not answer question about gender) participated with age range 20-79. The biggest group was from the 50-59 age group (34.9%). They were from 35 different countries (mainly US 27.5%, Israel 26.8%, and Italy 6%). Several professions were present (largest groups were Education 25.5%, Science and Technology 18.8 %, and Research 16.8%) and they were mostly highly educated (50.3% PhDs). Familiarity with museums was high (51.8% visited museum 2-5 times a year, 27.5% more than 5 times, 16.1% once a year and only 3.4% had not visited a museum in the past year). They were also very

familiar with museum technologies such as audio guides, video guides, kiosks and smartphone apps (over 60% familiar or very familiar in each category)

The characteristics we sought to understand from visitors was curiosity and attention span. These corresponded nicely with definitions of the sub characteristics Inquisitiveness and Orderliness. Given the high rate of correlation of the main characteristic with the sub characteristic (Inquisitiveness : Openness and Orderliness : Conscientiousness [Schmitt et al. 2007]), we used the Big Five (44 item) questionnaire [Gosling et al. 2003] to measure two traits, Openness (10 questions) and Conscientiousness (9 questions). The standard distributions for Israel (from which most respondents where from) is Conscientiousness M=52.40 and s.d. =9.36 and Openness M=50.95 and s.d. = 10. 13(data from [Schmitt et al. 2007]). Using standard procedure, we classified someone as possessing the characteristic if their score was above the median score. Thus, inquisitiveness was 49% (73 visitors) and non-inquisitive was 51% (76 visitors). For orderliness we measured 48.3% (72 visitors) and unorderly we measured 51.7% (77 visitors). The nonparametric One Sample Binomial Test showed that both categories here divided up equally (Inquisitiveness sig. = .87 and Orderliness sig .743).

The distribution of the temperaments (see 2.15, Personality) using the median score as a cutoff point in the sample population was as follows: IO is Inquisitive, Orderly; IU is Inquisitive, Unorderly; NO is Non-inquisitive, Orderly; NU is Non-inquisitive, Unorderly.

To see a greater influence of the personality characteristics we decided to take the top 27% of all scores to create smaller groups who may show stronger personality characteristics [Schmitt et al. 2007][18]. We use the prefix "S" (Strong) for this group. The number of people that fit this category was 49, out of 149. This gave us a slightly less even distribution, with people being mostly IO or NUs. This could be due to the type of population that answered our survey (highly educated etc…)

Temperament	IO/SIO	IU/SIU	NO/SNO	NU/SNU	Total
Standard 50%	25.5% (38)	23.5% (35)	22.8% (34)	28.2% (42)	100% (149)
Strong (27%)	30.6% (15)	14.3% (7)	20.4% (10)	34.7% (17)	100% (49)

Table 3.7 Inquisitiveness * Orderly Top 50% 27% Cross tabulation

Design Insight S-Personality: People with different personality characteristics visit museums. This can be measured to determine the strength of the characterization. This information may be used to tailor many aspects of a system including both the content and format of information provided.

[18] Also private conversation with Shlomo Berkovsky at IUI 2016

3.2.2 Results - Visitor Movement styles

In the following table we wanted to see visitor's beliefs about their movement patterns in a museum. We asked the users to classify their behavior, based on verbal descriptions of the movement type (see 2.1.3), both when they had sufficient time for a visit and when they were under time pressure (Predominant type

Table 3.8). Note the difference between the two scenarios: we see a distinct shift from ant behavior to grasshopper behavior and, to a certain extent, fish and butterfly behavior. The sentences (S2-R2,3) used to determine movement behavior, and the results were as follows:

Type	Question (choose 1)	Enough time	Time pressure
Grasshopper	I prefer to concentrate on items that interest me the most	35.6% (53)	54.4% (81)
Ant	I prefer to go around slowly and look at items one by one	49.7% (74)	4.0% (6)
Butterfly	I prefer to go around and sample many items quickly	6.7% (10)	20.1% (30)
Fish	I prefer to go around and just get a general impression	6.7% (10)	20.1% (30)
Fisher Exact	11.238 sig=.294	Total 149	Total 147

Predominant type

Table 3.8 Movement Type (self desctibed)

In Table 3.9 we compare the believed movement pattern having sufficient time to visit or not having sufficient time to visit, versus personality traits. Percentages are per column. Note the only entries with clear differentiation for Inquisitiveness are ants with no time, butterflies with time and fishes with no time. Note also the only entries with clear differentiation for Orderliness are ants, and fishes with no time. Percentages are for totals in column.

	Which of the following sentences best describe you at a museum that interests you (S2-R5,6):								Total
	Grasshopper		Ant		Butterfly		Fish		
	Time	No Time	Time	No Time	Time	No Time	Time	No Time	
I	51% (27)	57% (46)	53% (39)	33% (2)	20% (2)	40% (12)	42% (5)	37% (11)	73
N	49% (26)	43% (35)	47% (35)	67% (4)	80% (8)	60% (18)	58% (7)	63% (19)	76
Total	53	81	74	6	10	30	12	30	
Fisher's Exact	Time=4.031 sig=.258						No Time=5.375 sig =.160		
O	47% (25)	57% (46)	49% (36)	33% (2)	50% (5)	40% (12)	50% (6)	33% (10)	72
U	53% (28)	43% (35)	51% (38)	67% (4)	50% (5)	60% (18)	50% (6)	67% (20)	77
Total	53	81	74	6	10	30	12	30	
Fishers exact	Time=.161 sig=1.00						No Time=6.301 sig=.096		
IO	31% (16)	68% (32)	34% (25)	33% (2)	40% (4)	20% 6	33% (4)	23% (7)	49
IU	31% (16)	45% (21)	25% (19)	17% (1)	20% (2)	27% (8)	33% (4)	37% (11)	31
NO	15% (8)	30% (14)	14% (10)	0	0	13% (4)	17% (2)	7% (2)	20
NU	21% (11)	26% (12)	27% (20)	50% (3)	40% (4)	40% (12)	17% (2)	33% (10)	37
Total	52	47	74	6	10	30	12	30	
Fisher's Exact	Time=11.124 sig=.904						No Time=20.394 sig .143		
SIO	25% (5)	36% (10)	32% (7)	25% (1)	50% (1)	37% (3)	40% (2)	11% (1))	15
SIU	20% (4)	14% (4)	9% (2)	(0)	(0)	13% (1)	20% (1)	22% (2)	7
SNO	20% (4)	25% (7)	23% (5)	(0)	(0)	25% (2)	20% (1)	11% (1)	10
SNU	35% (7)	25% (7)	36% (8)	75% (3)	50% (1)	25% (2)	20% (1)	56% (5)	17
Total	20	28	22	4	2	8	5	9	
Fishers exact	Time=5.104 sig= .962						No Time=11.947 sig= .352		

Table 3.9 Movement (self-described) and Personality

In the qualitative open comment section on S2-Q6 7 people commented (variety of temperaments) that it depends on type, size and who they are with at the museum. An IO and a NO commented that they don't like museums but try to look for interesting items.

Four IOs described grasshopper (mixed with a little butterfly behavior):

1) "*If I return to visit a museum previously visited: I prefer to concentrate on museum items that interest me the most If is a first-time visit: I prefer to go around slowly and look at items one by one. In any case I try to prepare the visit studying the museum collections before to go to the place*"

2) "*In art museums, I usually scan rooms quickly to find a patiently that calls to me, then I spend 10-20 minutes with that painting. I might do that for 3 or four paintings. People hate going to museums with me"*

3) "*it's really a combination, sometimes I move about quickly, and when I come upon a room or particular exhibit, I will take my time to look slowly"*

4) " *I do concentrate on those that interest me, and examine them in detail, but this is in combination with viewing 95% of items 1 by 1*."

Two IUs described a mixed strategy first butterfly then grasshopper or grasshopper then butterfly:

1) " *I prefer to go around and just get a general impression and after this to concentrate on museum items that interest me the most*"

2) "*I am a former art student and have learned to use a museum like others use a library. This means it can be very focused on just one or two exhibits, but sometimes if there are other items of interest outside my original intent I will browse those too*".

An NO described a similar strategy: " *Actually I like to think of it as somewhere between slowly and quickly. I of course will slow down when I get to items that are of particular interest to me.*" As well as a NU: "I *like going around slowly but probably skip some bits of the museum*"

Design Insight-Movement Type: Movement types may correlate to personality. However, factors such as context (e.g. how much time do I have for the visit, first visit) may have a greater influence on movement type. In addition, some people may adopt mixed strategies.

In the qualitative open comment section on S2-Q6:

- *T*wo IOs commented: *"if I don't have time why should I go"*.
- Another IO commented: "*it just means I spend less times on those that don't interest me, we still usually visit all cases and displayed items*" (ant behavior).
- Additionally, an IO commented: "*that he would plan further visits to concentrate on other specific items*".

- One IU described a mixed behavior "*first go around quickly and see what's there and then concentrate on items of interest*".
- Another IU said: *"if I know in advance I'm going to be there I'll research and go to the main exhibits I want to see*" (grasshopper behavior).
- An NO stated "*I am not a fan of museums and usually will to see interesting objects (explorer)*.
- An NU stated his behavior depends on the type of museum.

3.2.3 Results- Falk Types

In this next question we used picture sets (see Figure 3.1 and for more detail see Appendix D Survey 2), provided by John Falk, to determine different museum identities (see above in 2.1.3). In contrast to Falk's usage, we tried to see how people identify themselves in museum visits in general as opposed to a particular visit. (This must be taken with a caveat as John Falk himself says that identities are very dependent on context (social, duration of visit, type of museum). From Table 3.10 we see that most people (> 50%) identified themselves as explorers, followed by reflective (at > 25%). Percentages are out of the total who responded to this question (148).

Look at the following picture sets and decide which one best describes you when you go to a museum.

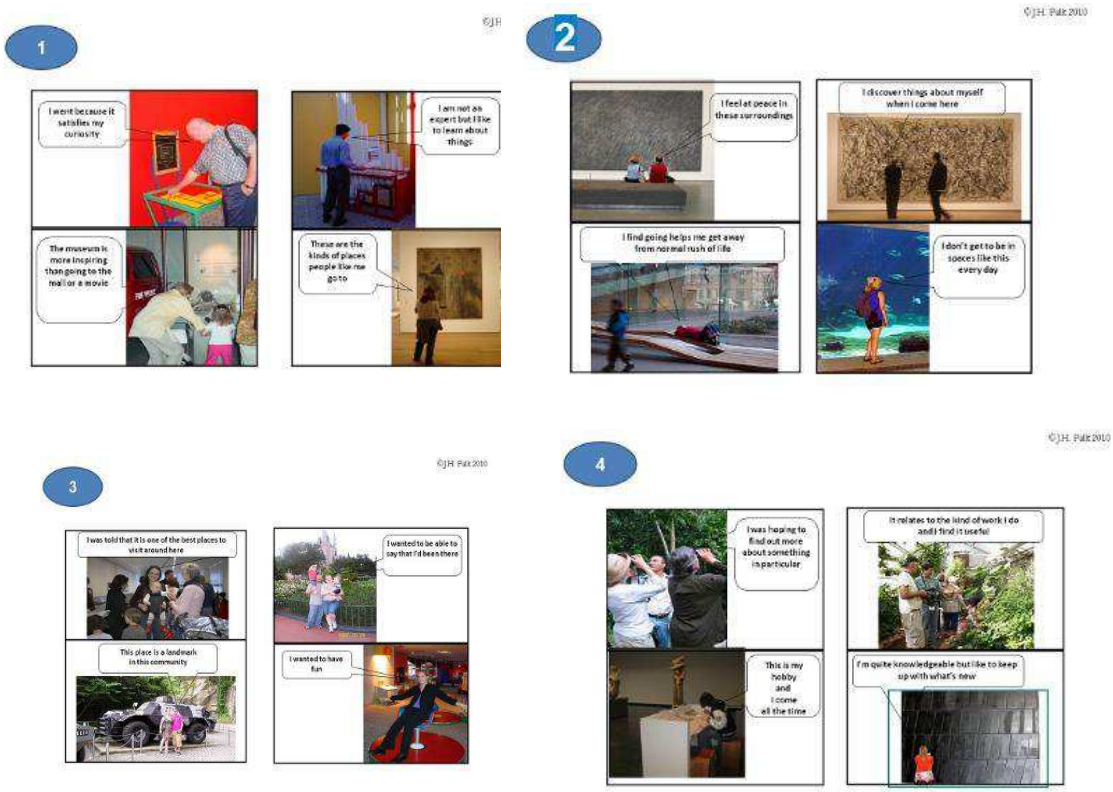


Figure 3.1 Falk Identity Types

Which of the above picture sets best describes you at a typical museum visit (S2-R7):					
	Explorer	Reflective	Experience	Hobbyist	Total
ALL	51.7% (77)	26.2% (39)	11.4% (17)	10.1% (15)	148

Table 3.10 Falk Identities Percentages

Design Insight – Identities: Default Design should be for explorers.

We now try to see using cross tabulations, whether certain personality type (which are more stable) correspond to the Falk types (Table 3.11). We use a variety of personality grouping - Inquisitiveness (Yes, No), Orderliness (Yes, No), Temperaments (IO, IU, NO, NU), and the people with "Strong" ("**S**", > 27%) in each category (SIO, SIU, SNO, SNU) to see if any could have some predicative value. Inquisitiveness seems to point to Explorers; while Explorers may be anything but SIU, with Reflectives SIO, Experiencers SNU and Hobbyist there was not that much of a difference. Percentages are out of the total who are of that personality grouping.

Which of the above picture sets best describes you at a typical museum visit (S2-R7):					
	Explorer	Reflective	Experience	Hobbyist	Total
I	46% (33)	32% (23)	8% (6)	14% (10)	72
N	58% (44)	21% (16)	14% (11)	7% (5)	76
Total	77	39	17	15	
Fishers' Exact 5.753 sig= .122					
O	52% (37)	25% (18)	10% (7)	13% (9)	71
U	52% (40)	27% (21)	13% (10)	8% (6)	77
	77	39	17	15	
Fisher's Exact 1.249 sig =.766					
IO	50% (24)	29% (14)	6% (3)	15% (7)	48
IU	49% (20)	29% (12)	12% (5)	10% (4)	41
NO	60% (12)	20% (4)	10% (2)	10% (2)	20
NU	57% (21)	24% (9)	16% (6)	3% (1)	37
	77	39	17	15	
Fisher's Exact 16.899 sig .327					
SIO	40% (6)	40% (6)	0	20% (3)	15
SIU	14% (1)	43% (3)	29% (2)	14% (1)	7
SNO	50% (5)	30% (3)	10% (1)	10% (1)	10
SNU	47% (8)	18% (3)	24% (4)	12% (2)	17
	20	15	7	7	
Fisher's exact 14.359 sig=.183					

Dominant Type in column (green)

Table 3.11 Falk Identities (self-described) and Personality

In the qualitative open comment section an NO commented: "*I am not a fan or expert, but usually if I visit a country and it has a famous museum, I would like to visit it and see and explore new things*".

Also, 4 people commented on technical difficulties with this question. The results showing a lack of correlation make sense since identities are very much related to contextual issues and not connected to stable items such as personality.

Design Insight S- Identity Type: Identity types don't seem to correlate to personality and perhaps need to be asked explicitly. Certain identity types may predominate a personality type.

In looking at Falk types opposed to Animal Behavior patterns (Table 3.12) we see that Grasshoppers are mainly Explorers (52.8%), with the remaining grasshoppers spread evenly among the other types. Ants tend to be Explorers or Reflective. Butterflies are mainly Explorers, with some Reflectives. Fish are mainly Explorers or Experiencers. Percentages are across columns. Looking the other way around Explorers are grasshoppers or ants, Reflectives are ants (which is counter intuitive), Experiencers are anything but butterfly (also counter intuitive) and Hobbyists are mostly grasshoppers (as expected) or to lesser extent ants (also reasonable).

	Explorer	Reflective	Experience	Hobbyist	Total
Grasshopper	36% (28)	26% (10)	35% (6)	60% (9)	53
Ant	48% (37)	62% (24)	35% (6)	40% (6)	73
Butterfly	8% (6)	8% (3)	6% (1)	0	10
Fish	8% (6)	5% (2)	24% (4)	0	12
Total	77	39	17	15	148

Dominant Type (green) Fishers Exact = 10.994 sig = .217

Table 3.12 Correlation Behavior Types vs Falk types

3.2.4 Results- Attractiveness of motivational statements

The following table showed people's attitudes to different forms of motivational message (see Table 2.4 for list of messages and their connections to tourist motivations for visiting, and Table 5.6,Table 5.9, and Table 5.13 for actual messages used by application, and

Table 3.13 for messages used in the survey).

Acronym	Formulation for survey
FFT	Get food for thought by visiting this point of interest
LS	Learn something by visiting the point of interest
SSN	See something new by visiting the point of interest
DSS	Do something special and different by visiting the point of interest
IQL	Improve your quality of life by visiting the point of interest
EYL	Enrich your experiences by visiting the point of interest

Table 3.13 Survey Motivational Messages

The users were asked to rate on a 5 item Likert scale, from Strongly negative to Strongly positive, (0-2 low rating, 3 medium, 4-5 high). The numbers are members of the group who rated the message in the High positive range, percentage is percentage of all respondents that gave High response (see Table 3.14). Certain messages are more successful than others. In general, the LS, SSN got the highest ratings; DSS and EYL fairly positive response (> 50% of the people); IQL and FFT had low positive ratings (which was also reflected in high negative ratings). The columns are sorted in decreasing popularity.

How would the following motivational messages used to describe a point of interest connected to a museum you visited, encourage you to visit that point of interest?						
LS	SSN	EYL	DSS	FFT	IQL	T
72.5% (108)	70.5% (105)	61.7% (92)	61.1% (91)	43.6% (65)	23.5% (35)	149

Above 60% Below 40%

Table 3.14 Motivational Messages (All)

The following table showed people's attitudes to different forms of motivational message (see Table 2.4 for list) and how these correlates to their personality (see Table 3.15). Certain messages are more successful than others across all types; while some may correlate better with certain types. We have different orders of popularity of motivational messages for different personality group compared against the total population. Also, for the strong personality types (top 27% of characteristic), most of them (strong personalities) liked all messages except IQL; and the exception of the SNU group who don't seem to have any strongly favored messages. The numbers are members of the group who rated the message in the High positive range, percentage is percentage of all respondents that gave High response. Again, messages are in order of decreasing popularity.

Type	LS	SSN	EYL	DSS	FFT	IQL	Total
I	69.9% (51)	74.0% (54)	58.9% (43)	65.8% (48)	52.1% (38)	24.7% (18)	73
N	75% (57)	67.1% (51)	64.5% (49)	56.6% (43)	35.5% (27)	22.4% (17)	76
Total	108	105	92	91	65	35	
Fisher Exact	.536 Sig=.830	1.898 Sig=.391	1.161 Sig=.557	1.826 Sig=.408	4.115 Sig=.124	.230 Sig=.912	
O	70.8% (51)	72.2% (52)	59.7% (29)	58.3% (42)	40.3% (29)	20.8% (15)	72
U	74.0% (57)	68.8% (53)	63.6% (49)	63.6% (49)	46.8% (36)	26.0% (20)	77
Total	108	105	92	91	65	35	
Fisher Exact	.282 Sig=.895	.847 Sig=.707	.290 Sig=.890	2.140 Sig=.340	.811 Sig=.675	1.852 Sig=.403	
IO	67.3% (33)	75.5% (37)	59.2% (29)	55.1% (27)	38.8% (19)	18.4% (9)	49
IU	78.0% (32)	68.3% (28)	61.0% (25)	68.3% (28)	61.0% (25)	26.8% (11)	41
NO	80% (16)	60% (12)	65% (13)	70% (14)	50% (10)	25% (5)	20
NU	70.3% (26)	73.0% (27)	64.9% (24)	59.5% (22)	29.7% (11)	27.0% (10)	37
Total	107	105	91	91	65	35	
Fisher Exact	12.10 sig=.29	10.271 Sig=.451	9.256 Sig .505	10.046 Sig=.412	17.073 sig=.037	7.601 Sig =.703	
SIO	73.3% (11)	93.3% (14)	73.3% (11)	73.3% (11)	53.3% (8)	33.3% (5)	15
SIU	71.4% (5)	85.7% (6)	57.1% (4)	71.4% (5)	71.4% (5)	14.2% (1)	7
SNO	90% (9)	60% (6)	70% (7)	90% (9)	60% (6)	10% (1)	10
SNU	47.1% (8)	58.8% (10)	47.1% (8)	41.2% (7)	23.5% (4)	17.6% (3)	17
	33	36	30	32	23	12	
Fisher Exact	9.976 Sig=.184	8.841 Sig=.317	5.361 Sig=.716	7.318 .461	9.393 Sig =.287	2.436 Sig= .980	

Above 60% Below 40%

Table 3.15 Motivational messages and Personality

In the qualitative open comment section (13 comments 5 IOs and 7 IUs out of the 147 respondents), 5 respondents talked about methodological issues with this question. Another 4 respondents thought that motivational messages were bad (though the fourth one thought it was bad because more people would come.

Three said:

1) "*Generic messages have no power, the message would at least have to refer to specific content to be more than neutral*"

2) " *My impression is generally negative because I think it is hard to make such guesses without knowledge of the person*"

3) " *Motivational Messages are horrible*".

Two responses thought that messages were obvious:

1) *Improve quality of life simply by looking at things that are important and beautiful in my eyes*"

2) " *Is obvious. You always learn something*"

Two people talked about how motivational messages could help:

1) *" xxx (oldest, best, biggest) in the yyyy (nation, world, etc) would motivate me to not want to miss it!"*

2) " *If I can understand how point of interest adds to my overall understanding of the subject matter, I am very interested in pursuing it."*

If we look at cross tabulation with Falk identities, we don't see much difference between groups. The preferred messages (

Table 3.13) are LS and SSN (See tables 3.13), we could use type preferences to choose between LS and SSN. DSS and EYL have high enough ratings that they could be used to vary messages so that they are not too repetitive. The numbers are members of the group who rated the message in the High positive range, percentage is percentage of all respondents that gave High response. Again, messages are in order of decreasing popularity.

Type	LS	SSN	EYL	DSS	FFT	IQL	T#
Explorer	**72.7% (56)**	**68.8% (53)**	**59.7% (46)**	**57.1% (44)**	**40.2% (31)**	**22.1% (17)**	**77**
Reflective	**75% (29)**	**67.1% (30)**	**64.5% (29)**	**56.6% (28)**	**35.5% (17)**	**22.4% (12)**	**39**
Experience	**70.8% (11)**	**72.2% (13)**	**59.7% (10)**	**58.3% (9)**	**40.3% (7)**	**20.8% (2)**	**17**
Hobbyist	**74.0% (12)**	**68.8% (9)**	**63.6% (7)**	**63.6% (10)**	**46.8% (10)**	**26.0% (4)**	**15**
Total	**108**	**105**	**92**	**91**	**65**	**35**	
Fisher's Exact	**4.5 sig=.60**	**2.5 sig=.88**	**7.96 sig=.22**	**6.76 sig=.32**	**6.40 sig=.38**	**5.33 sig=.50**	

Above 60% **Below 40%**

Table 3.13 Motivational messages and Falk Identities

The next table compares motivational messages (

Table 3.13) for different believed movement patterns. Grasshoppers didn't like FFT and IQL but liked SSN and LS. Ants liked almost everything except FFT and IQL. Butterflies are similar to ants. Fish liked LS best and most of the others equally well except for IQL which they didn't like. Fish seemed to like FFT better than most other groups. From statistical significance we see that most messages had a different rating by each type that was statistically significant except for EYL. The numbers are members of the group who rated the message in the High positive range, percentage is percentage of all respondents that gave High response. Again, messages are in order of decreasing popularity.

Type	LS	SSN	EYL	DSS	FFT	IQL	Total
Grasshopper	67.9% (36)	73.6% (39)	50.9% (27)	58.4% (31)	39.6% (21)	15.1% (8)	53
Ant	73% (54)	67.6% (50)	68.9% (51)	62.2% (46)	44.6% (33)	31.1% (23)	74
Butterfly	90% (9)	90% (9)	70% (7)	70% (7)	40% (4)	20% (2)	10
Fish	75% (9)	58.3% (7)	58.3% (7)	58.3% (7)	58.3% (7)	16.7% (2)	12
Total	108	105	92	91	65	35	
Fisher's Exact	1.811 Sig=.957	4.620 Sig=.576	8.814 Sig =.152	4.174 Sig .647	3.454 sig=.766	5.755 Sig=.448	

Above 60% Below 40%

Table 3.14 Motivational messages and Movement Types

Design Insight S-Motivational Message: Motivational message effectiveness can vary per person with certain messages being more appealing to certain personality types. For some motivational messages needs substance in order to be effective. Also, the base reaction (like, dislike) may vary from person to person. Subtlety may also be a factor.

3.3 Summation of Derived Design Insights

The following table summarizes the insights learned from the two surveys. We will trace the use of these design insights in the next section on the framework. The main findings relate to the diversity of preferred notification strategy, types and forms of information, personalities, use of motivational messages and behavioral movement types. Our framework will try to take advantage of this through personalization.

	Label	Insight (Highlight)	Basis
1.	S-Group	There is a need for the framework/system to handle group visits	S1-Q1
2.	S-Preplan	The system should provide mechanisms for allowing the user to pre-plan his visit but not require it	S1-Q2
3.	S-Notify	The system should provide mechanisms for notifying users of nearby attractions (but it should have the option of being disabled).	S1-Q3
4.	S-Notify Options	There can be different ways to notify, the default can be email (if it is an advance notification).	S1-Q4
5.	S-Notify Freq	Control the frequency of notifications as options including an option only on demand.	S1-Q5,Q6
6.	S-Notify Trigger	There can be different triggers for notification including historical occasions and meeting relevant people.	S1-Q5,Q6
7.	S-Notify Access	Provide a way to get to past notifications on demand.	S1-Q5-6
8.	S-Notify Options	Provide a way to turn off notifications and tailor the maximum number of notification	S1-Q5,Q6
9.	S-Connections	Provide different types of information (Background Information, Navigation, Recommendation, Personal Stories to different people	S1-Q7
10.	S-Connections Social	Using information from past experiences or from family and friends can be especially sensitive and should be able to be controlled by the user.	S1-Q8
11.	S- Connections Reasons	Scrutability and understanding why certain things were recommended is important.	S1-Q9
12.	S-Info Length	In general, short material less than 3 minutes is preferred. Can have optional more button for additional detail.	S1-Q10
13.	S-Info Trust	Source and reliability of information is important, make this known to the user.	S1-Q11
14.	S-Info Variety	Different types of information appeal to different people	S1-Q12
15.	S-Info Format	Different types of formats appeal to different types of people	S1-Q13
16.	S-Info Coherency	Telling a coherent story is important, as is not repeating details. However critical points can be repeated for emphasis.	S1-Q14
17.	S-Personality	People with different personality characteristics and temperament visit museums. This information may be used to tailor many aspects of a system including both the content and format of information provided	S2-R1-R4
18.	S- Movement Type	Movement types may correlate to personality. However, factors such as context (e.g. how much time do I have for the visit, first visit) may have a greater influence on movement type	S2-R5-6
19.	S- Identity Type	Identity types may not correlate to personality	S2-R7
20.	S-Motivational Message	Motivational message effectiveness can vary per person with certain messages being more appealing to certain personality types. Also, the base reaction (like, dislike) may vary from person to person. Subtlety may also be a factor.	S2-R8

Groups and Pre-planning (grey), Notifications (light green) Connections (pink), Information/Content (yellow), Stereotypes based on personality and Falk Types (blue) , Motivational messages (red)

Table 3.16 Summary of Design Insights

4 Theoretical Frameworks

Two theoretical frameworks are proposed to enhance the user experience when visiting CH sites. The first concerns itself with encouraging the visitor to find additional relevant CH experience. The second concerns itself with a present point of interest and connecting the visitor back to prior experiences (See Figure 4.1). The purpose of the first theoretical framework is to setup a system which uses past visitor experiences to model the visitors and to advise, and even perhaps persuade, the visitors concerning relevant points of interest that they might visit when the right opportunities present themselves. A purpose of the second framework is that when at a point of interest, it connects the visitor back to previous experiences to provide a more meaningful experience that may encourage more visits.

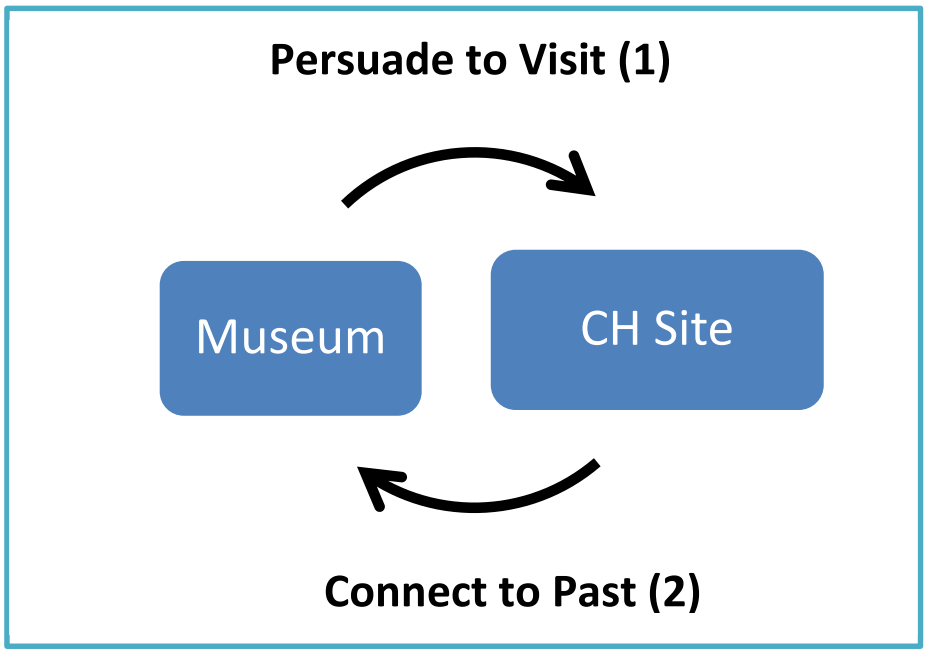


Figure 4.1 The dual frameworks for cultural heritage

Dubin's methodology [Dubin 1978] was used to develop the frameworks. The first five phases of the methodology: concepts, relationships, boundaries, system states, and propositions are related to the structural elements of the theory. The last three phases: empirical indicators, hypotheses, and evaluation are related to validation. Though both parts are important to theory development, the two groups are often realized as distinct efforts. The results of Dubin's methodology for the structural phase are described in this section using **concepts** (in **bold**), ***states*** (operative conditions in *italics*) and describe in words the **relationships** between the concepts. In addition, we describe the boundaries and propositions of our theory as they relate to the Cultural Heritage domain.

We will first describe the various theoretical facets which makeup the first framework; afterwards, in the next chapter, System Description, we describe, with examples, how they

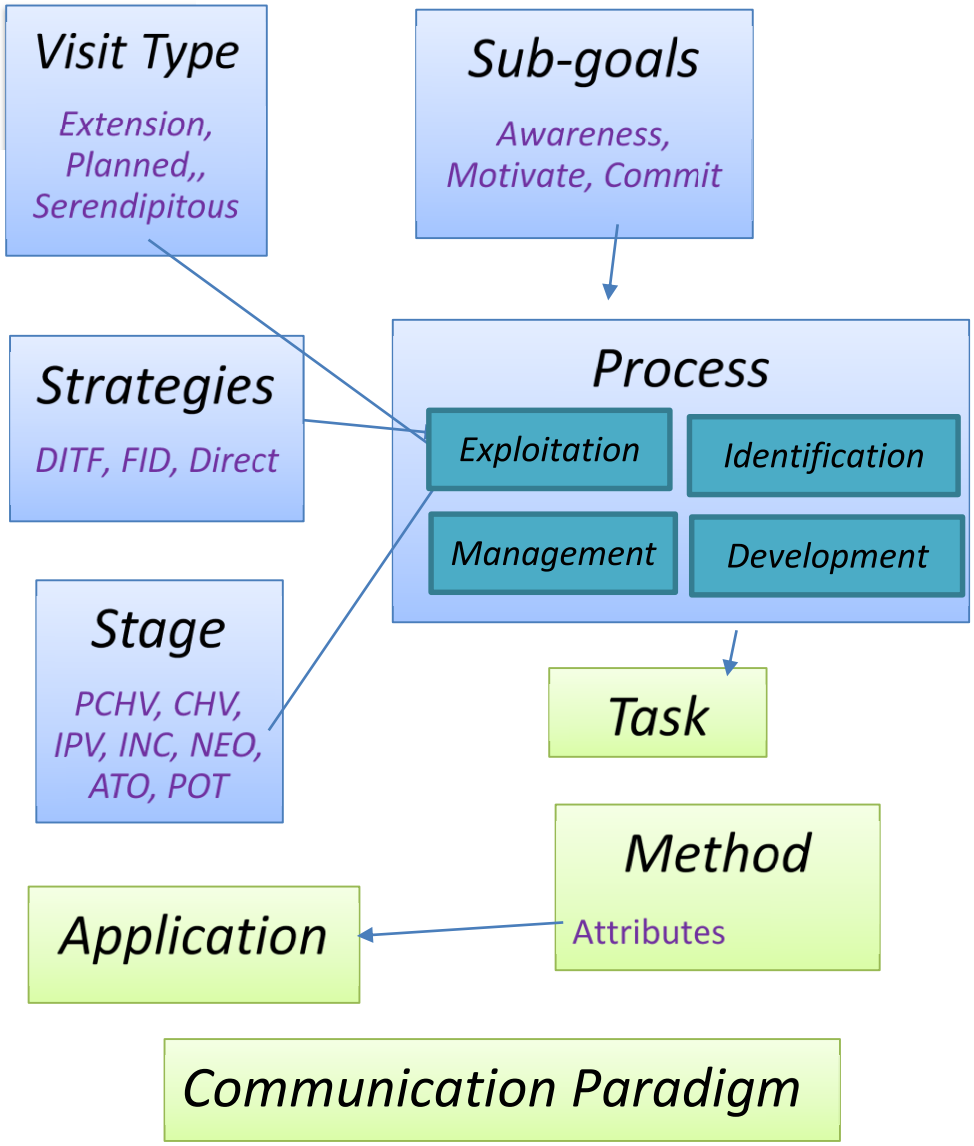
interact over a concrete timeline. A similar description is provided for the second framework. Though these facets may have applicability to other domains we will concentrate on the items that make them unique for the cultural heritage domain. In the end we summarize the various concepts and link them back to design insights from the background research and user preferences (traceability table) [Pohl 2010].

We will use the following color scheme for figures and tables to categorize. The categories will be explained in the next Chapter: Command and Control, Applications, Content Bases, User

4.1 Encouraging the user to visit connected site

The framework (see Figure 4.2) takes into account a varied group of **concepts** in order to accomplish its purpose: **sub-goals**, that are various changes in the visitor attitudes/behaviors that need to be induced in order to cause the visitor to visit a new site; **types,** which describe the categories of connected visits/experiences we want to try to encourage; **processes**, which are used in order to achieve our sub-goals; **stages**, which are temporal periods which the visitor goes through where we can apply our processes; **frequency**, which is how often to apply the methods; **tasks,** which are activities which use the various methods to accomplish process goals; **methods**, various categories of means which can be used during the task; and **applications** which are implementations of the methods for specific tasks. Applications use the **communication persuasion paradigm** (See Figure 2.3 for background). The paradigm consists of a **source**, **message**, **target** and **effect**. The target can be described by two categories of knowledge: the lifelong user **profile** and **contextual information**. The profile (which can include the visitor history) and contextual information are used to provide connections which can enrich the visitor experience.

One aspect not considered in the framework is the social aspect. A group can be thought of as an entity, though the relationship between the group's user model and its constituent members is not clear.



Key- Categories Command and Control, Applications
Figure 4.2 Framework elements

4.1.1 Processes

The potential to visit subsequent points of interest may be thought of as an opportunity. We use opportunity marketing theory (see section 2.3.4) to describe the various processes used to bring an opportunity to fruition. These processes include: ***identification***, ***development***, ***exploitation***, **and** ***management*****.** Opportunity identification (or recognition) in the context of our cultural heritage scenario is the discovery or perception of possible sites and gathering data to generate actionable knowledge about the visitor which could assist in matching the visitor to possible sites. Of the possible methods of identification or recognition, perception and discovery are relevant in our context, while the third, opportunity creation, is not applicable as it is not possible to create cultural heritage sites "on the fly" (perhaps in the future it might be possible to build virtual reality cultural heritage sites that "fit" the opportunity).

Opportunity development is the process of making the visitor aware of such opportunities. Or in the case of surprising the visitor, preparing him for the surprise. For opportunity development, possible **process strategies** exist, they are described as: 1) "***door in the face***" (DITF), 2) "***foot in the door***" (FITD), or 3) **"direct"**. (Strategies taken from the model of persuasive recommender systems, see above). Another way of expressing these strategies is as a continuum on a scale of subtleness (transparency is another related issue). Given that cultural heritage experiences are voluntary activities on the one hand and most cultural heritage providers are responsible organizations would lead us to do opportunity development that is subtle (to engage the voluntary user) but also transparent (being responsible providers of content). The strategies that best may meet these demands are either "FITD" (advantage in subtleness) or "direct" (advantage in transparency). Opportunity exploitation is advising, encouraging, and persuading the visitor of potential sites in the proper contexts in order that they visit such a site. **Contexts** that would be useful for implicitly triggering the exploitation process can be *Spatial* (e.g. being near the target site), *Temporal* (e.g. a certain significant date in history), *Social* (e.g. meeting a person who is connected to a site, *Informational* (e.g. a certain topic is in the news, or is read by the user in his browser), *Physical* (e.g. being near a smart object with an association with the site), *Environmental* (e.g. time of day when light is good) and additionally some combination of the above, perhaps via a ruled based system. In addition, explicit requests can be used to trigger the process (alternatively even certain signals, such as gestures, movement can be used to trigger the process). Opportunity management is the handling of the data, information and knowledge about the sites and the visitors so that they can be used effectively in the other processes and in in a lifelong scenario in subsequent visits. In terms of our sub-goals identification is connected primarily to awareness, development is connected primarily to motivation, exploitation is primarily connected with commitment and management is connected to overall handling of the opportunity and the gathering of information for further opportunities.

4.1.2 Stages

The experience takes place sequentially through the following stages:

1. Prior to the **cultural heritage** (museum) ***site visit (PCHSV)***
2. The **cultural heritage** (museum) ***site visit (CHSV)***
3. ***Immediately post visit (IPV)***
4. ***Incubation (INC),*** (post visit to pre-next visit)
5. ***Near an Opportunity (NEO),***
6. ***At the Opportunity (ATO),*** and
7. ***Post Opportunity (POT).***

During the different stages, different methods are used by different tasks to accomplish our goals. These stages have parallels to the COMBI model (See Background Related Work) of 1) Contemplative (to CHSV), 2) Planning (to IPV, INC, NEO), 3) Action (to NEO, ATO) and 4) Maintenance (to POT).

4.1.3 Sub-goals

To encourage or persuade the visitor to visit additional sites, we need to affect the following sub-goals: firstly, making the visitor aware (**awareness**), or have conscious knowledge of opportunities for visiting, or alternatively be prepared; secondly, providing motives (**motivation**), and incentives, to perform actions related to visiting; and thirdly, getting the visitor to commit (**commitment**), that is an intellectual or emotional binding to a course of action (i.e. visiting the site). These sub-goals are taken from the Computerized Behavior Intervention (COMBI) integrated model of behavior change (discussed in Background 2.5 Related Work).

4.1.4 Visit Type

Three types of sequential visits/experiences have been identified: **extension** where the subsequent visits are a natural extension of the original visit; **planned**, where the subsequent visits are no longer a natural extension of the original visit, but are the result of planned behavior that comes as consequences of the original visit and the persuasive effects of the framework; and perhaps the most interesting, **serendipitous**, where an opportunity arises due to certain contextual factor (primarily location, but possibly dates or social situations).

4.1.5 Tasks

Different tasks that we perform at the different stages in order to advance our sub-goals are: ***Market, Plan, Navigate, Learn/Experience, and Reflect.*** During PCHV, CHV, IPV, INC, we identify and develop the opportunities by marketing them in order to make the visitor aware and motivate him towards the next visit. During INC, (and perhaps NEO) we try to get the user to commit to visit the next opportunity by having him construct a plan (concrete) to visit or alternatively by having him construct a mental plan that includes a visit to the opportunity. During NEO, ATO we help him navigate in order to facilitate his visit allowing the optimal exploitation. Helping him learn/experience at the site (ATO) also enhances the exploitation. Finally post visit (POT) allows the use to reflect on his visit, thus facilitating management of this cycle by providing feedback on the experience. How we implement these tasks depends on the type of visit, whether it is sequential, extension or serendipitous.

4.1.6 Methods

Our methods are taken from two fields: persuasive computing (e.g. tailoring and personalization), and digital nudging (e.g. incentives and structuring complex choices). We now list different properties that our methods can have.

Timing (Frequency/Repetition/Timeliness): major factors from persuasive research frameworks are when and how often (**frequency**) you send content or messages, and possible repetition of messages. Each strategy has its pros and cons. Constant bombardment of the user is obviously a wrong strategy, which will cause user to be annoyed, however too infrequent notification could allow the user to miss your message. Sending a message at the time when the user is open to receive it is beneficial, as opposed to sending a message while the user is busy talking on the phone (timeliness). **Timeliness** can also be a positive factor not only to avoid communication when the user is busy, but to arrive just in time or when a user is doing something related so that the information arrives in context and is most useful to him. Timeliness can be an important part of the opportunity identification process. The opportune moment to present additional sites is similar to the opportune moments to connect the visitor to previous visits; which will be discussed in the next section. What would be specific to this framework would be identification of times when the user is planning a cultural heritage activity or near a prospective cultural heritage site. In addition, **repetitiveness** is similar to frequency; too many repetitive messages can be boring, and not repeating the message ever could cause it to be lost similar to frequency. Some of these factors are personal also with different people having different tolerances or needs for repetition or being frequently reminded; while other may be less fazed by messages that come at busy times. This factor applies both to the notification and to the content.

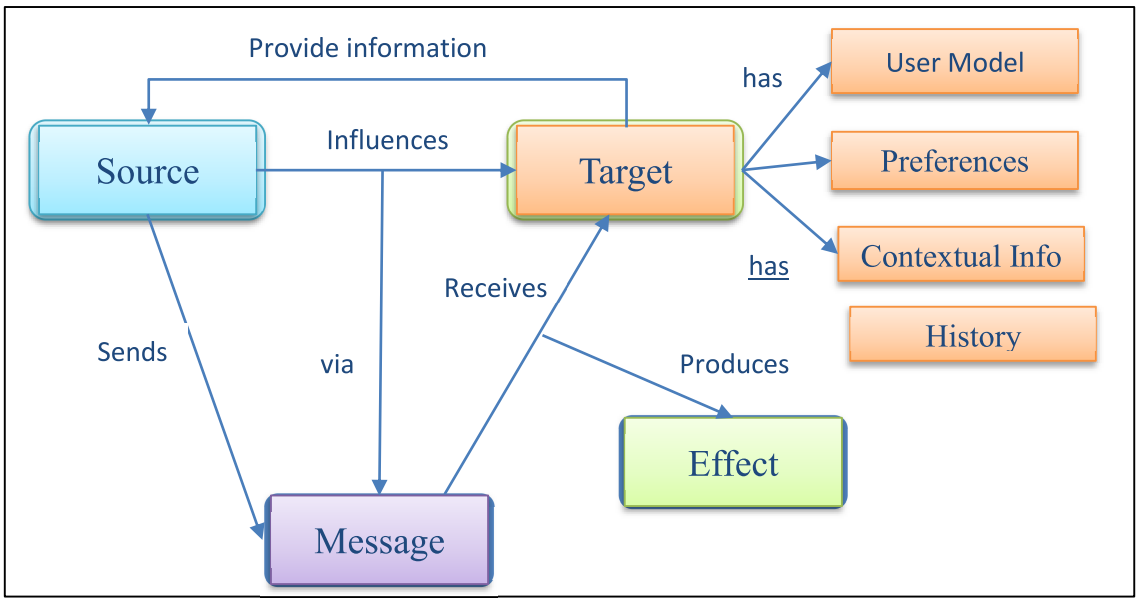
Notification Modality: how do we inform the users that there is content waiting for them? Rephrased: what are the methods we employ for interrupting the user. When we (the senders) make a notification, we must make sure that the notification is noticeable, that they (the receivers) realize they are being notified. In addition, we don't want the notification to interrupt them (the receivers) too much (unless the message is important and urgent) and allow them to continue to work in the background (that is we want the notifications to be non-modal). We can use **Visuals** such as text (messages), graphics (icons), animation (gifs), and even video (though not recommended as it would take too long to receive the notification); or **Audio** such as spoken text, a tune or jingle; or **Tactile** such vibration of the device, or the device changing temperature (becoming colder or hotter); or possibly even smell.

Interactivity mode: the methods can be ***interactive*** and engage the user in a dialog, or they can be ***passive*** and be consumed (read) by the user without any additional feedback. In CH applications we may prefer that parts of the application which occurs at the site be passive as not to take away from the CH opportunity itself.

Applications: the methods can be packaged in/with various applications that can be used as tools to accomplish the tasks. These include e-mails, specialized web/native applications, calendar apps, and social messaging tools.

4.1.7 Communication Paradigm

The framework, in order to describe the interaction between the user and the system uses the persuasive recommendation system communication paradigm (See Background 2.4.3 Persuasive Recommender Systems). This paradigm is used to accomplish the **task**.



Key- Categories Command and Control, Applications, Content Bases, User
Figure 4.3 Communication Paradigm

Source: the source (or system) can play a role in the giving of advice. How much is the system trusted? Considered an authority? Is it reliable? Is it impartial? Branding here can play an important role. The source can contain important contextual Information such as location, opening hours and whether there are special activities that are taking place.

Message: Our primary form to develop and exploit opportunities is through messages. The message takes different forms and content based on framework factors such as: the stage, type of visit, strategy and additionally information based on the source and the target. The form and structure of the message are influenced and can be constructed in similar ways to what was mentioned for the factors of timeliness, receptiveness, modality, and interactivity based on the characteristics of the target. The target (visitor) may have preference for text over audio or vice a versa. Additionally, the length of the message can be influenced by target characteristics. We believe form and structure are primarily influenced by personality factors as opposed to preferences; content of the message can be influenced by target characteristics, both personality and preferences. Determining which CH sites to suggest can be based on personal preferences. Based on which marketing strategy is used for the message, the wording can be picked with additional tailoring according to personality type. Other attributes of the content can be: one-sidedness (which we will discuss in a separate chapter), discrepancy and

emotional appeals. Other attributes, taken from the field of persuasion theory include: specificity, affect, adaptive affect, argumentation strategy, overtness, and explicitness.

Target: the target of the visitor can be modeled by two items, a user profile (which generally describes the user in a static matter) and contextual information, which describes the user's dynamic state.

The **User Profile** can be described in the following general parts: a user model (which describes the user's characteristics), user preferences for content, context, and interaction, the user's social network, and a user history (which can be used to build up the user model).

User Model: the user model can be described as having elements that are natural and those which are induced. In natural characteristics, we include: Involvement, Self Esteem, Intelligence, Demographic Factors, and Personality. For induced characteristics, we include: Inoculation, Forewarning, and Trained skills.

History: Tracks where users have gone and how long they has been there both for "TourML" stops and assets. This can be used to calculate: holding power, attracting power and velocity.

Preferences: when we discuss content preferences we refer to topics the user is interested with a given degree. When we discuss context preferences we refer to preferences in the activity realm (when the user is doing activity x, they are open/not open to getting messages), social realm (they prefer visiting with friends), spatial realm (when they are away from home location they is open to travel suggestions), and temporal preferences (they like getting messages in the evenings). In addition, there can be combinational/contextual preferences (for example, they like opera but only on weekends).

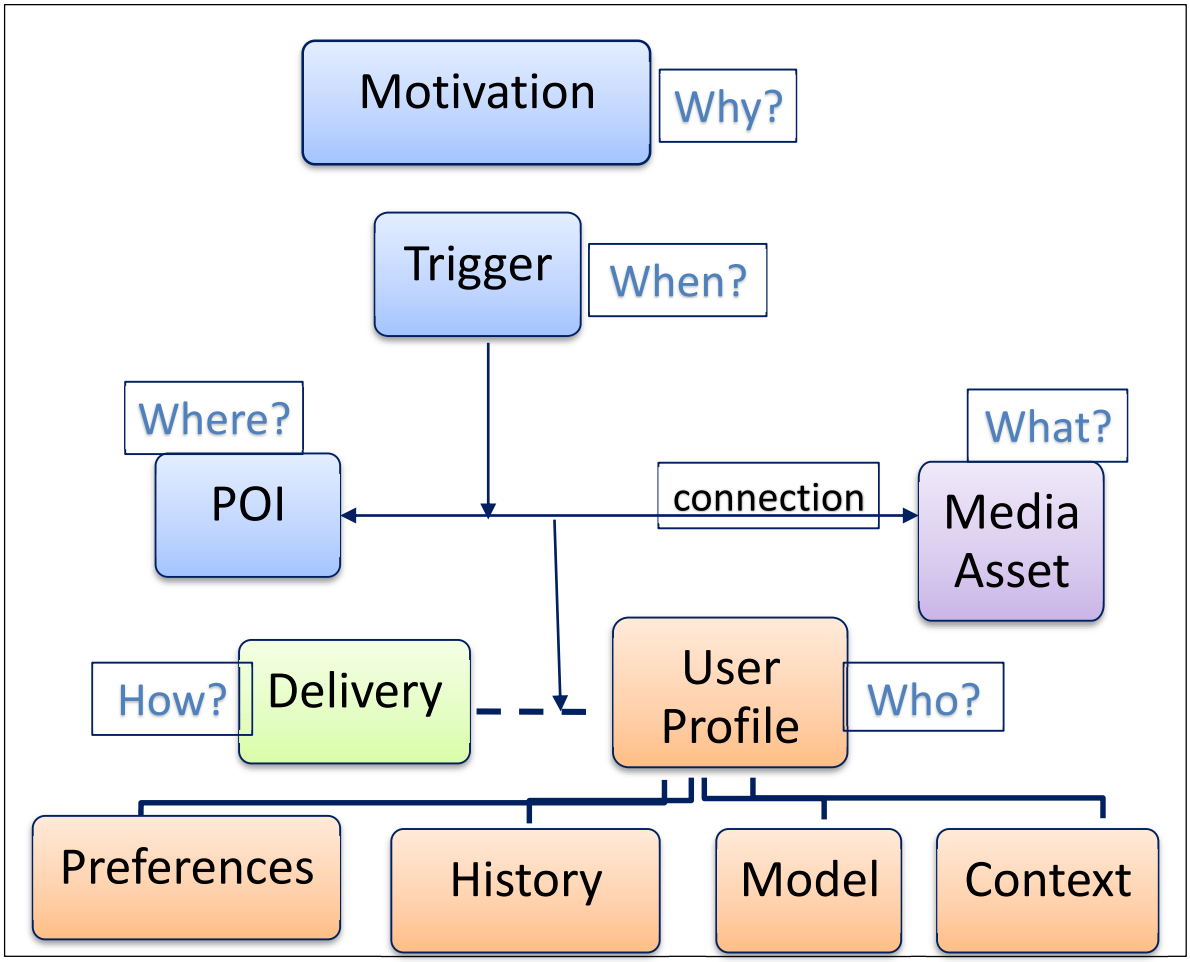
Contextual information: it can include item such as what activity is the target doing at the moment, their social context (who are they with), their spatial context (location), their system context (what type of display and device do they have at their disposal, software, network connection), user context (disposition/mood, busy/free) and environmental context (time of day, weather, visibility, crowds, etc.)[Dey et al. 2001].

Effect: As described in the Culture Track 17[19] presentation, users want their ideal experience to be: **Social** (34%), **Interactive** (32 %), **Lively** (30%), **Hands-on** (30%), **Active**(28%), **Calm**(24%), **Immersive**(23%), **Reflective**(20%).

[19] http://2017study.culturetrack.com/home

4.2 Connecting the user back to prior experiences

Whereas the previous framework sought to encourage (persuade) a visitor to visit a CH site, our second framework seeks to elicit a much more passive response. If the first framework relied on methods of marketing/persuasion/digital nudging, our second is in the realm of user experience (UX).



Key- Categories Command and Control, Applications, Content Bases, User
Figure 4.4 Framework 2 Connections

The framework consists of a **Trigger** which triggers a **connection** from **POI** to **assets**. This **connection** can be characterized by **motivation**, **context**, and **delivery.** The **connection** represents an association from the **POI** to **media asset** seen in the past or related to the POI by a personal (social) connection**.** Each of our major elements can be associated with a question of inquiry such as: Who, What, When, Why and How. Let us examine each of these elements in detail.

A **POI** is a place/point of interest (POI), essentially a location, which has a cultural heritage meaning. It can be a war memorial, a gravesite, a historic building, a place of religious significance, etc…. In TourML a POI is called a stop. The attributes of a POI are its *coordinates* (which can be expressed in a number of different units), *categories* and *classification*.

Categories are a system of assigned labels to the different POIs. It can be a formal ontology (such as OWL) or formal hierarchical system used by DBPedia, or an informal system. *Classifications* are groupings of similar objects together. Other attributes of a POI may be its name, id and media assets associated with it. The POI is concerned with the element of "***Where***?" in the connection framework.

A POI can be connected to a number of **Assets** (similar to an asset in TourML). It can be a Media Asset such as a picture, video, 3D model, audio, or HTML text or it can be a Knowledge Asset such as a factoid, event, person or place. An asset can have attributes such as*: location, name, type, access control, property rights, length/size,* and *timeliness (importance of the asset, urgency (in a cultural heritage context this should be low, and expiration date (perhaps the asset is no longer relevant)*. An asset is like a POI in that it has the attributes *categories and classifications*, these can be used by a specialized search engine to find associated items which can connect the asset to the POI without manual intervention or to search for additional assets. A Uniform Resource Identifier (URI) fragment is used to locate the asset. The asset has a name which can be used as a label. In terms of *type* an asset can be a combination of: informative, emotional, social/personal, and controversial content[A. J. Wecker et al. 2013]_.

Informative assets are *content* items which contain information (either textual, audio or visual) about an object; or they can be instructions such as navigational directions, or directions how to operate a certain feature of the object; or recommendations concerning the object.

Emotional assets are those that intend to evoke emotional response. Examples are: Personal Stories connected to POI, Writings or impressions about POI (including Poetry connected to POI), Music related to POI, Food related to POI, and Recommendations related to POI based on emotional feedback or that will cause emotion.

Social/personal assets are assets belonging to/or connected to people in the visitor's social network or items belonging/connected to the visitor. Examples of such items are: Picture of family at the particular POI. It is important to stress that when we are looking for assets, we are looking for items which connect to the POI but additionally have an association that is rooted in the Visitor's past. Thus, what we are searching for in this category is not informative information concerning the POI, but objects/assets that relate to previous cultural heritage experiences or friends or teachers related to POI, Material related to Public figure on network related to POI, Recommendations related to POI based on social network, and Feedback given by members of the social network concerning the POI.

Controversial assets consist of two or more opinions or alternatively one opinion asking/presenting a controversial opinion/question. The purpose of this type of asset is to foster interest and inquiry.

Attributes such as access control and property rights, help with privacy and intellectual property issues. The question that the Assets relate to is "***What***" in what do we show the visitor.

A **Trigger** is a piece of contextual information, which can cause media assets associated with the **POI** to be played. Trigger are usually locations. Other triggers can be connected to temporal events i.e. an historical date, or social events i.e. meeting a person who is connected to a CH site. The Trigger is concerned with the element of "***When***?" in the connection framework and is based on an opportunity.

An important element in determining visitor connections is their **motivations. A visitor's** motivation/goal is not necessarily to have a learning experience (though it can be) rather the goal may be better served by tying the present cultural experience to previous ones. This, connection to prior experiences, is desirable for a number of reasons in that it can enhance the user experience. In addition, it may tie in to other user goals such as: long term goals (Learning about xxxx), User self-monitored reflection and planning, User control and sharing, PIM & lifelogging. Motivations answer our questions concerning the "***Why***" of the connection.

Another critical element is of course the **User** who is represented by the User Profile which was described in the first framework. The User element answers our question about the "***Who***".

The final element is the **Delivery System** which concerns itself with delivering the asset, so that the presentation is coherent (does not repeat an asset too many times), scrutable (the user understands why this asset is being brought his attention) and the form (interruption method, format (audio, video, text, etc…). The delivery system provides the answers to the questions concerning "***How***". **Contextual information** which was described in the previous framework helps inform decisions in the delivery concerning the "***How***".
As with any system there is importance of being able to **Reflect** and give feedback.

4.3 Summary

In this section we make some general points about the framework and then look at why this framework differs from other context frameworks that is what are their unique aspects that pertain specifically to the CH Domain. In summary we then layout the traceability table back to the design insights gathered in the Background and User Preferences chapter.

The purpose of the framework is to guide the design of cultural heritage visiting systems. ***Not every system implementation has to have every aspect of the framework, but the long-term process-oriented thinking, establishing sub goals and incorporation of ideas from marketing theory, persuasive computing and digital nudging will allow the creation, we believe, of applications that will have a greater impact and influence on the user.***

Many of the concepts in the framework could be applied to other domains. In addition, choices of methods are influenced by the fact that CH tourism is a voluntary leisure activity, thus methods and their attributes should be chosen accordingly. Privacy, openness, lack of deviousness should characterize the methods used. Lack of bias, hidden agendas should be considered detrimental factors which would adversely affect the system's trustworthiness. What makes the first framework specific to the CH domain are primarily the tasks and stages. For the second framework, what makes the framework specific to the CH domain are primarily the methods by which assets are chosen for connections. In addition, choices of the delivery system are influenced again by the fact that CH tourism is a voluntary leisure activity, thus methods and their attributes should be chosen accordingly.

The following three tables summarize the concepts from the two frameworks described in this chapter (first column), examples or possible values that such concepts can take (second column) and show the connection from concepts in the framework back to the design insight of the Background and User Preferences (third column) and form a traceability table.

Concept	Example/Values	Basis
F1-Process	**Opportunity Identification** **Opportunity Development** **Opportunity Exploitation** **Opportunity Management**	**B-Opportunities** **B-Opportunities Motivation** **B-Proactive**
F1-Process Strategies	**Door in the face (DITF)** **Foot in the Door (FID), Direct**	**B-Opportunities** **B-Content Strategy**
F1-Context (triggers)	**Spatial, Temporal, Social** **Informational, Physical,** **Environmental**	**B-Context** **B-Context2** **S-Notify Trigger**
F1-Sub-goals	**Awareness, Motivate, Commit**	**B-Sub Goals**
F1-Visit Type	**Extension, Planned,** **Serendipitous**	**Original**
F1-Stage	**PCHV, CHV, IPV, NEO, ATO,** **POT**	**B-Stages**
F1-Task	**Market, Plan** **Navigate, Learn/Experience** **Reflect**	**B-Opportunities** **S-Info Variety** **S-Connections**
F1-Method	**Tailor** **Personalize** **Incentives** **Structure Complex Choices**	**B-Digital Nudging** **B-Persuasive Techniques** **B-Motivational Message** **B-Motivational Message2**
F1- Method Attributes	**Timeliness** **Notification modality** **Interactive mode, Application**	**S-Notify, S-Notify Options,** **S-Notify Freq, S-Notify Trigger,** **S-Notify Access, S-Notify Options**
F1-Communication Paradigm	**(See next chart)**	**S-Persuasion Communication**

Table 4.1 Framework 1 Traceability Table

The next table shows the traceability table for the communication paradigm within the first framework

Concept	Examples/Values	Basis
F-Source	Museum, Tourism Board Independent Application	B-TourML S-Info Trust
F-Target	Visitor	See F-User Model
F-User Model	Involvement, Self Esteem, Intelligence Demographic Factors, Personality Inoculation, Forewarning Trained skills	B-Visitor Model, B-Falk Types B-Behavior Patterns, B-Personality Movement, S-Personality S-Movement Type, S-Identity Type
F-History	Stops visited Assets seen	B-TourML B-Passive Observation
F-Preferences	Content Preferences Context Preferences	B-Measure Visitors
F-Contextual Info	Location, Time of Day, Date	B-Context B-Context2
F-Message	Text, Audio, Video	B-Motivational Message B-Motivational Message2 B-Content Strategy, B-Content Design S-Info Length, S-Info Variety S-Info Format, S-Info Coherency S-Motivational Message
F-Effects	Interactive, Social, Lively, Hands-on Active, Calm, Immersive, Reflective	B-Content Design B-Motivational Messages

Table 4.2 Framework 1 Communication Paradigm Traceability Table

Here is the traceability table for the second framework

Concept	Example/ Values	Basis
F2-Connection	Association between POI & Asset	S-Connections S-Connections Social S-Connection Reasons
F2-POI	War memorial, Gravesite Historic building Place of religious significance	B-TourML
F2-Asset	Informative, Emotional Social, Controversial	B-Content Design S-Info Length, S-Info Variety, S-Info Format
F2-Motivations	Tie present cultural experience to previous ones, Learning	B-Opportunities Motivations B-Motivational Message S-Motivational Message
F2-Trigger	Location, Historical Date	B-Context2
F2-Delivery	Text, Audio, Video	B-Content Delivery
User Contextual Information	See table above	
User Model		
History		
Preferences		

Table 4.3 Framework 2 Traceability Table

5 System Description

In this chapter we look at the system which we built (**AMuse** – **A**ssociating **Muse**um) to evaluate the framework. We first look at the components which comprise the system. In table 5.1 we summarize by tracing back from the components to the theoretical framework discussed in the previous chapter. We then examine how the system works over time through different phases of a cultural heritage experience and summarize by listing the activities at each phase. In the end we look at three implementations of the system and discuss why they vary.

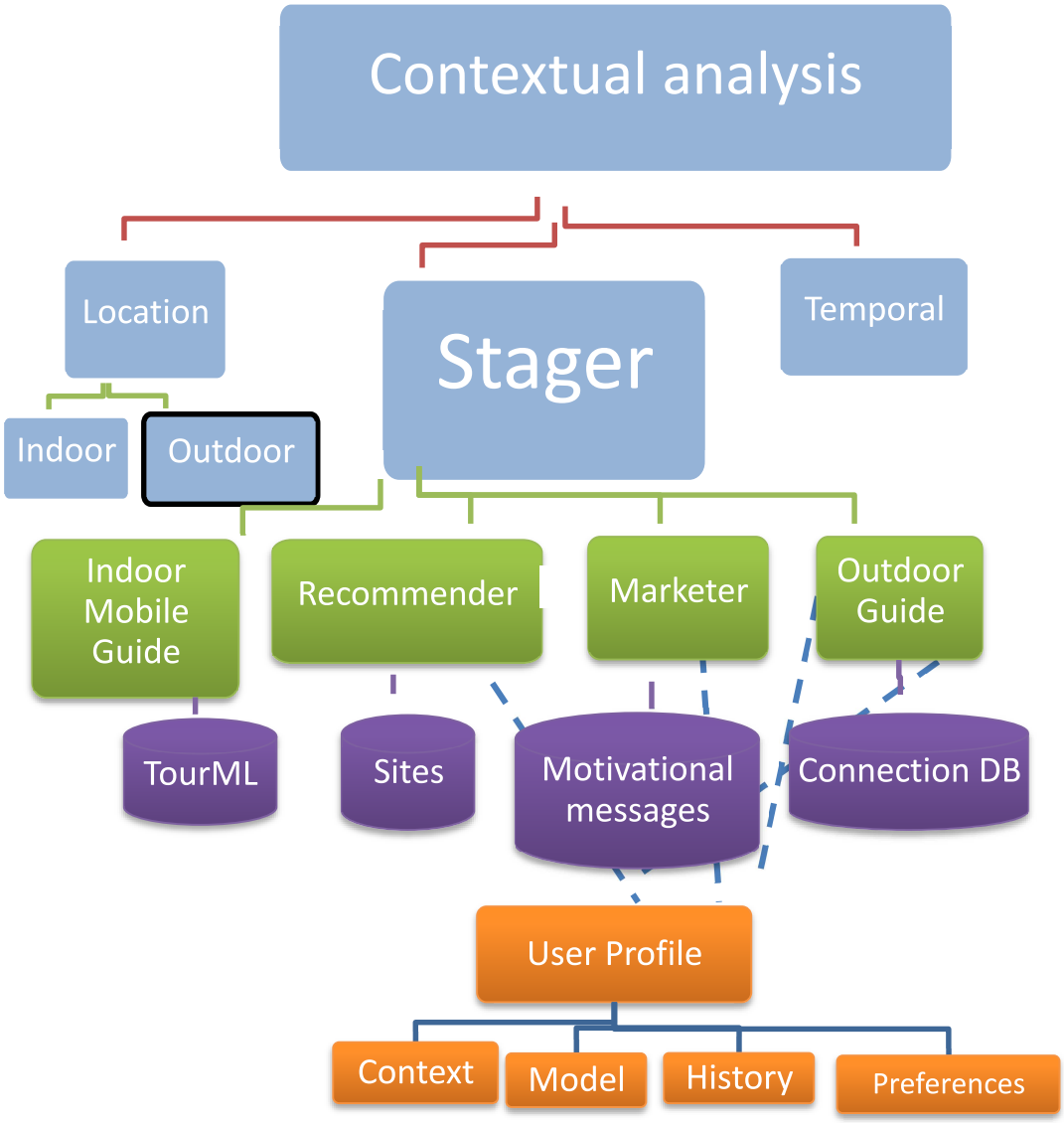
As general background, the system is written as a web application using the Vaadin Framework[20] 7.x (which is a lightweight client / heavy server framework) which is written in Java. The server side runs on an Apache Tomcat Server 8.x[21]. The client runs on a mobile device on an Android WebKit browser (e.g. Chrome), though since it is a web application it can theoretically run also on IOS. In addition, since web applications can't handle BLE beacons a small part of the code is written is Javascript (which can be compiled into native Android or IOS by Cordova[22] or run on Evothings Viewer[23]) and run natively.

5.1 System Components

In this section we look at the major components which comprise the system which tries to implement the principles of the framework discussed in the previous section. The components of this system can be divided into several categories based on their primary purpose: Command and Control (which receive and analyze events and decide what actions to take), Applications (which deliver information to the user based on Command and Control), Content Bases (which are used by the various Applications to find content) and User Representation (which is used to represent the User). The system architecture is presented in Figure 5.1.

[20] http://vaadin.com/framework
[21] http://tomcat.apache.org
[22] http://cordova.apache.org

[23]



Key- Categories Command and Control, Applications, Content Bases, User

Figure 5.1 System Components

In the category of ***Command and Control,*** we have:

Stager which is used to determine at what stage the user is in and thereby which application to run or if the application is already running which actions to take.

Context Analyzer receives events and provides information to the Stager. The two types of context it deals with are **Location** and **Temporal.** The **Location** can be further divided up into **Indoor** (which are based on Bluetooth Low Energy (BLE) beacons) and **Outdoor** (which based on GPS).

In the category of ***Applications,*** we have:

Mobile Museum Guide – based on position, content is provided to the visitor and visitor information is gathered for future use. For a detailed description and analysis of a mobile museum guide see [A. J. Wecker 2012]

Site Recommender - this component is responsible for the system goals of awareness (and to a lesser extent motivation). Based on user data (such as exhibits visited and content (assets) consumed) and a Content Base of potential sites to visit the system provides a ranked list of sites. This component is activated at the end of museum visit using the mobile guide.

Marketer/Advisor – this component takes the ranked list proved by the Site Recommender and attempts to persuade (coax) the visitor to visit sites in the list. Through actions which advance the sub goals of awareness, motivation it tries to get the visitor to commit (e.g. add to his calendar) to visit an additional cultural heritage site. The primary action uses a Content Base of tagged motivational messages combined with data from the User Profile to provide personalized messages (both in format and content, at the "right" time (based on contextual information (such as being close to a recommended site).

Outdoor Guide – this component, besides giving content about the site presently being visited (thus providing an incentive to visit), implements the "Connection to Past Experiences" framework. Through use of a Content Base (which may be shared with the Mobile Museum guide) provides media assets to previous items viewed by the visitor which have a connection (association) with the present site the visitor is at. In future versions we can see the content being enhanced by personalized media-assets (i.e. pictures taken by the visitor at the connected exhibit, or social-media related to the connected exhibit).

In the category of ***Content Bases*** (CB) we have:

Museum CB - this contains content or assets in TourML terms which pertain to Museum stops such as exhibits. For a detailed description and analysis of such a Content Base see [A. J. Wecker 2012]

Sites CB - this contains tagged information concerning CH sites that might be relevant to users to visit based on their past experience at the museum. The tagging can be used find a personalized list and filter the list for contextual appropriateness. In terms of ownership (discussed above in Theoretical Framework) this CB could be either provided by the museum, the Ministry of Culture and Tourism, or by an independent party.

Marketing CB - this contains motivational material (in our case messages) which can be used to persuade (coax) the visitor to visit sites in the recommended list. These messages are categorized by known cultural heritage motivations and tagged with museum visitor identities that they may be appropriate for. In future versions this

may not necessarily be message but also other forms of media-assets (video, audio, longer texts, etc…)

Connections CB – This contains tagged media assets which can be retrieved to find appropriate material (e.g. if visiting the Coliseum in Rome then seeing pictures related to museum exhibits that were previously visited that relate to the Coliseum. In the future it could be personalized pictures (i.e. taken by the visitor himself of the fore-mentioned exhibits) or social media (e.g. pictures or thoughts by friends or relatives when visiting the Coliseum).

In the category of ***User Representation,*** we have:

User Profile – this component is responsible for the storage, retrieval and reasoning about the user. It is aided by four sub-components: **User Contextual Info, User Model**, **User History, and User Preferences.** See in the Theoretical Framework for a more detailed discussion what these components do.

5.1.1 Component Summary

The following table summarizes the components and traces their connection to the theoretical framework of the previous chapter. Most trace backs of the connection to the framework (in Basis column) focus on the Marketer and Site Advisor components since they are at the core of the novelty of the research.

Component	Inputs	Outputs	Basis
Context Analyzer	Location, Temporal, Environment	Higher Level Context, Events	F1-Context, F2-Trigger
Location	GPS, iBeacon	Position	F2-Trigger
Temporal	Clock	Date	F2-Trigger
Stager	Context	Stage, Application	F1-Process, F1-Stage
Indoor Mobile Museum Guide	Context, User Profile	Media Assets	F1-Task, F1-Method Attributes, F2-Asset, F2-Delivery
Site Advisor	Context, User Profile	Recommended Sites	F1-VisitType, F1-Task, F1-Method, F1-Method Attributes, F1-ommunication Paradigm, F2-POI, F2-Delivery
Marketer	Context, User Profile	Marketing Content	F1-Process Strategies, F1-SubGoals, F1-VisitType, F1Task, F1-Method, F1-Method Attributes, F1- Communication Paradigm, F-Effects, F2-Motivations, F2-Delivery
Outdoor Guide	Context, User Profile	Media Assets	F1-Task, F1-Method Attributes, F2-Connection, F2-POI, F2-Asset, F2-Delivery
Museum CB	Position	Media Assets	F-Source, F-Message, F2-Asset
Site CB	User Profile, Context	Sites	F-Source, F-Message
Marketing CB	Sites, Context, User Profile	Motivational Messages	F-Source, F-Message
Connections CB	Context, User Profile, Site	Media Assets	F-Source, F-Message, F2-Connection, F2 Asset
User Profile	Queries	Advice	F-Target
User Model	History, Preferences, Context		F-User Model
User History	Events	Attracting Power, Holding Power	F-History
User Preferences	Context, Assets Consumed, History	Filtered Preferences	F-Preferences
User Context	Context	Preferences	F-Contextual Info

Key- Categories Command and Control, Applications, Content Bases, User

Table 5.1 Components Traceability

5.2 Tracing the system through the Framework stages

We now take a look at the system through the lens of how the system operates over time using the framework which consisted of 7 stages (See section4.1.2 Stages in chapter on Theoretical framework). The first stage occurs prior to the CH site visit (PCHV), here we encourage the user to use our guide and in evaluation scenarios we give him a short personality test [Gosling et al. 2003]. The second occurs in the museum, during a users' visit (CHSV). There we provide the users with multi-media content concerning the exhibits they see.

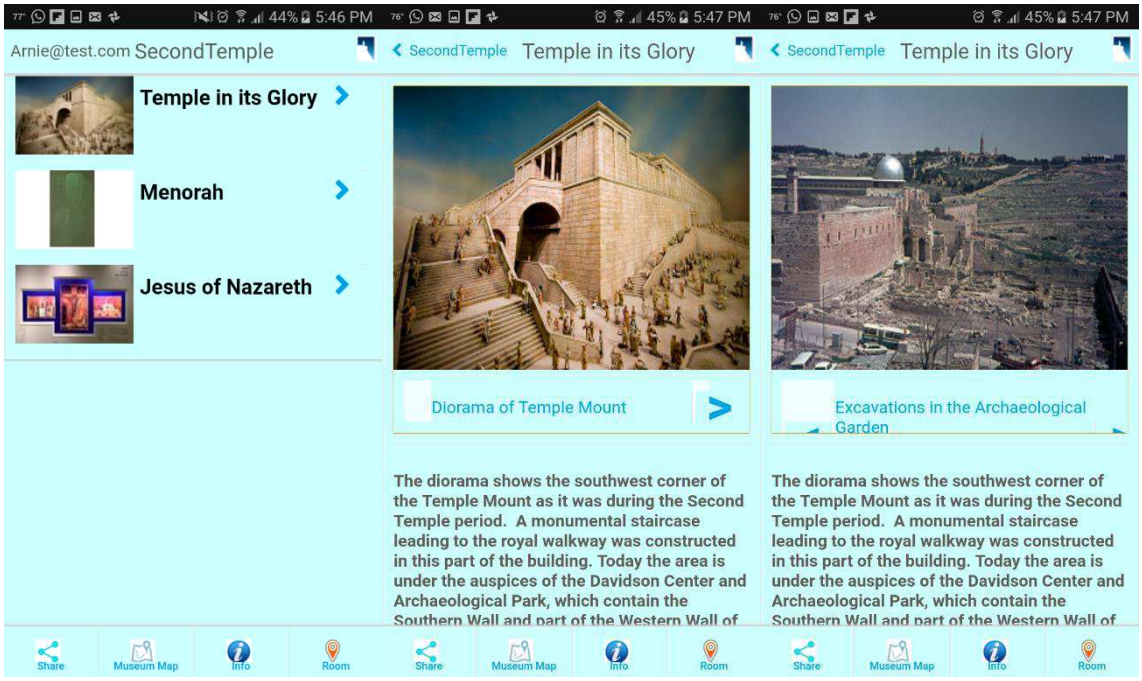
During this time, based on the way they move and consume content we build a user model. In addition, in the content itself we may make them aware of possibilities that exist outside the museum. The third occurs immediately post-mortem of the visit (IPV), we identify opportunities (a list of potential sites, which the visitor might be interested in), then we make him aware of these opportunities, and try to motivate him to visit these potential sites. During the incubation stage (INC), due to the nature of the scenarios we examined, the system does not implement any of the strategies discussed in the framework. At the next stage when one is near an opportunity (NEO), we wish to make the user aware of an opportunity, motivate the user to visit, and nudge him to commit to visit by showing him a map. In the penultimate stage, at the opportunity - ATO - we provide the user with content and connect him back to materials concerning his visit (social, historical, information). In the last stage, after (post) visiting the opportunity (POT), the user is given a chance to reflect and post to social media. These stages can be grouped into 3 phases, where we essentially try to achieve common sub-goals through similar processes. The first phase is learning about the user, which is done in stages (PCHV, CHV). The second phase advising and motivating the user concerning additional CH sites is done during the stages (IPV, NEO). Finally, connecting the user back to the museum experience, is done in the third phase consisting of stages (ATO, POT).
We now discuss each of these phases in more detail using examples from the Tower of David (ToD) museum to illustrate what occurs in each phase.

5.2.1 Phase 1 Learning about the user - Connecting personality to motivation

The mobile guide, at each position of interest (POI), presents a list of relevant media assets. The mobile guide system continuously logs the POI visited, which assets are chosen, for how long the asset is viewed, and in general how long did the user stay at the point of interest. We derive two types of information, the first to determine specific topic interests and the second to determine general personal characteristics. We use time viewing presentations to determine user topic preferences. We use movement styles, to predict user characteristics (such as personality characteristics). The time viewing presentations at a particular exhibit is taken as an indication of user topic preference by using a normalized form over a certain threshold. This determines the most popular exhibits for the particular user. In the following section, we show how we use tools to map these exhibits to particular terms in an ontology. We then use this as indication in our user model of the user's interests. This technique has been used in a number of guides which provided user recommendations [A. J. Wecker 2012; Bohnert et al. 2008].

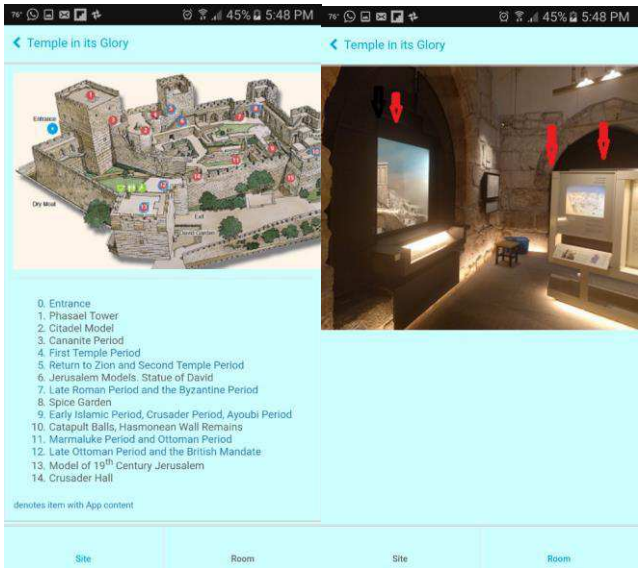
We see in Figure 5.2a how when the user arrives at a room in the museum (in this case the Second Temple period) one is shown 3 exhibits which have content associated with them

Technical Aspects of beacon placement in the Appendix for more on that issue). As shown in Figure 5.2b & c when an exhibit is selected content is seen. There are two elements in the content frame. A slide-show of pictures on top and a scrollable text field containing first a description of what is seen in the museum followed by general content. In Figure 5.3 we see navigation aids, figure 5.2(a) shows the different rooms in the museum that have content (blue circles around number), figure 5.2 (b) shows, with the red arrows, where are the exhibits that have content associated with them. Figure 5.4 shows content for the Cardo, which we will use as an example for the external site.



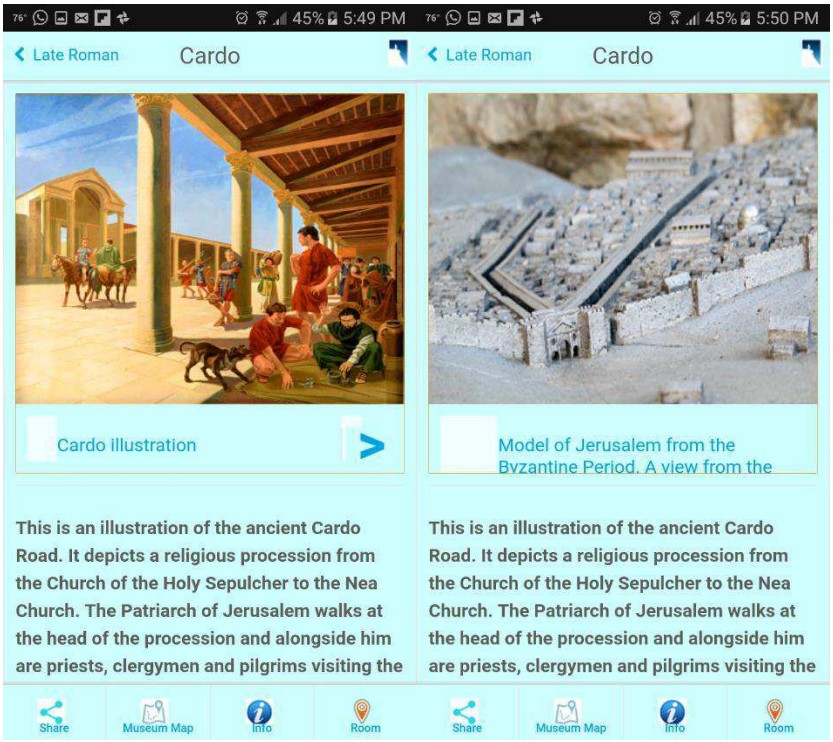
(a) (b) (c)

Figure 5.2 Screenshot of Content



(a) (b)

Figure 5.3 Screenshots of In Museum Navigation



(a) **(b)**

Figure 5.4 Additional content screenshots

5.2.2 Phase 2 Advising and motivating the user concerning additional CH sites

After the user has finished his museum visit, we are ready to go on to the next phase. We have observed the visitor and can make a number of assumptions regarding his preferences based on his behavior in the museum. This phase can be broken down into two stages: 1) determining potential sites to recommend to the visitor based on his previous museum visit (**IPO**) and 2) delivering this advice in a manner which will encourage the user to visit them (**INC**, **NEO**). During both phases we provide a map (implementing the persuasive strategy of Reduction).

The first stage uses the preferences information gathered in Phase 1 to provide a ranked list of places to visit. Contextual information, e.g. opening times, weather, can be used to influence the contents of the list and the rankings. For this implementation we do this simply by weighted matching of keywords of the preferences to keywords used to describe the site. This is done immediately post-visit.

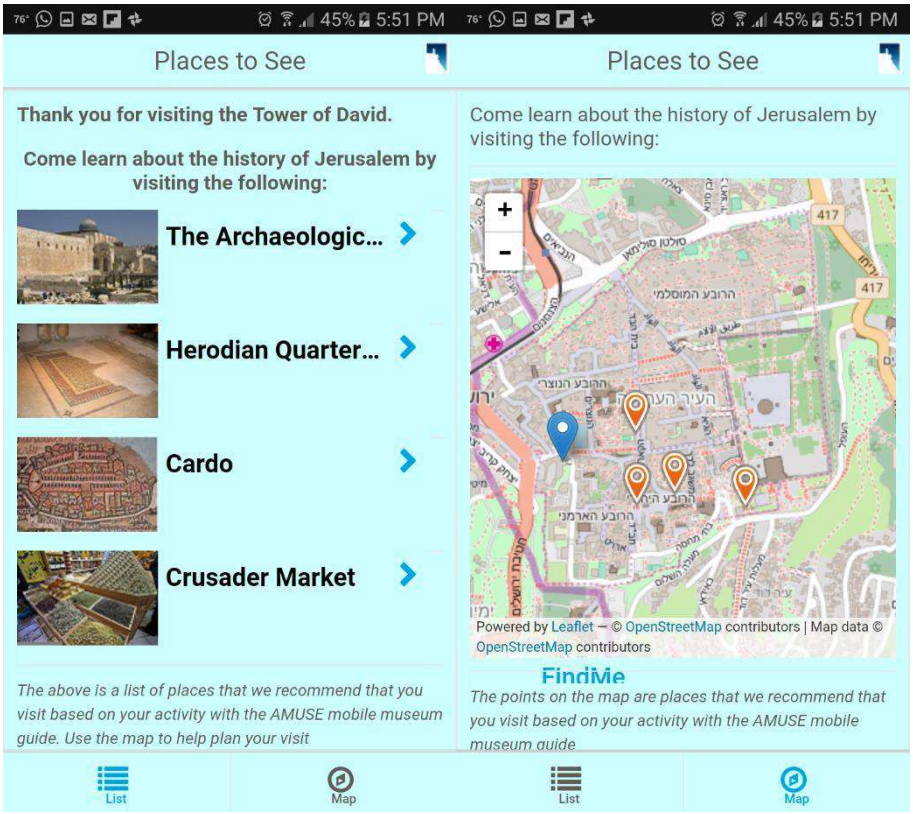
We also try to determine the user movement type. We use the following statistics: 1) "Number of POIs Visited" (**NPV**) – number of positions where a person stayed more than 9 seconds as detected and logged by the mobile guide's positioning system. Nine seconds is a number we have used for previous analysis and has provided good results[A. J. Wecker 2012]; 2) "POIs Where Presentations Seen" (**PPS**) – the number of positions where the visitor viewed at least one media asset connected to that position as computed from the logs of the mobile guide; 3) "Number of Presentation Seen" (**NPS**) – the total number of media assets the visitor viewed as computed from the logs of the mobile guide; 4) Total Number of Presentations at Exhibits

Visited (**TNPEV**) which measures the potential number of presentations the visitor could have viewed at the sites visited. We can think of the ratio of PPS/NPV as measuring the user's curiosity (with a high ratio (closer to 1) typical of the Inquisitive personality types) and the NPS/TNPEV ratio as measuring the user's attention span (with a high ratio, close to 1 being typical of the Orderly personality type). The various **T**s represent different thresholds. Table 5.2 shows our mapping of movement based on the above formulas to: the types of Veron and Levasseur, 2) SLOAN personality types and 3) Falk identity types. In the following table we present what we consider the connections between personalities and movement types and Falk types. However,, as we have seen from our surveys, contextual reasons can override the mappings. Percentage (%) is of Movement patterns at Hecht from a previous study [A. J. Wecker 2012].

O	A	%	Movement pattern	Big 5	Falk type	*Formula*
Low	High	41	Grasshopper	NO	Professional Hobbyist	((PPS/NPV < = T_1) &(NPS/TPNEV < T_3))
Low	Low	33	Fish	NU	Recharger	(PPS/NPV > T_1) & (NPS/TPNEV > T_2)
High	High	10	Ant	IO	Explorer	(PPS/NPV > T_1) & (NPS/TPNEV < T_2)
High	Low	16	Butterfly	IU	Experience Seeker	(PPS/NPV < T_1) & (NPS/TPNEV > T_3)

O-Open, A-Attention Span
NU- Non-curious – Unorderly, IO-Inquisitive – Orderly
NO-Non-curious – Orderly, IU-Inquisitive – Unorderly
Table 5.2 Connecting the user behavior to personality and Falk types

In Figure 5.5 we see the results of advice to a “grasshopper” (See below and Table 5.3 for additional strategies for the other types). There are four sites related to the exhibits that the visitor spent most time reading material about. We see the personalized motivational message (type LS) of "Come learn about the history of Jerusalem by visiting the following". This follows the reasoning that grasshoppers are specialists/hobbyists (in Falk terms) and they want a few things that they had strong interests in, so they could spend a lot of time on them. In figure (b) we see this same information as (a) but in map form.



(a) List **(b) Map**

Figure 5.5 Recommendations of Places to see

During the second stage, which starts from the moment the first sub-phase ends and the user is presented with a list of possible venues, we seek opportunities (in this implementation, primarily location) to accomplish our sub-goals (content purpose): Awareness (A), Motivation (M), and Commitment (C).

Using behavior types or personality types we can tailor the amount and presentation of information. For example, for “ants” and “butterflies” we can give ten items. For “grasshoppers” and “fish”, we may only give two items. “Ants” and “grasshoppers” may be given places while “butterflies” and “fish” may be given events. In addition, for “ants” and “grasshoppers” we can give detailed information while “butterflies” and “fish” may be given less detailed items or overviews. Additional personalization may be possible. In Table 5.3 we show for the different personalities and behavior types what strategies may be invoked to get the user to commit to visit an additional site. In the table for each personality we look at what opportunities are possible: Triggers e.g. News Event (NE), Relevant Date (**RD**), or near a Place (**PL**); what type of messages are preferred to use as incentives (see Motivational Messages - MM - in Background Chapter for abbreviations); what are the sub-goals (see 4.1.3) - **A**wareness, **M**otivate, **C**ommit - whether to include details which allow for commitment; how important is scrutability (that is understandability of why we have made certain choices). As for Content, both format (media) and topics are determined by individual preferences. In terms of Triggers the primary one used in this implementation is place (PL).

Personality	Trigger	Incentive (MM)	Sub-goal	Additional Content	S.
IO ant	All	FFT, LS, SSN	A, M, C	Yes-detailed (many items)	Y
IU grasshopper	NE, RD, PL	FFT, LS, SSN	A, M, C	Yes Focused (limited # of items)	N?
NO butterfly	ALL	DSS, QOL, EYL	M, C	Only if content sub goal is C	Y
NU fish	NE, RD, PL	DSS, QOL, EYL	M, C	Only if content sub-goal is C (limited number of items)	N?

S = Scrutability

Table 5.3 Strategies for motivating visits to additional cultural heritage sites

In Figure 5.6 we the popup that is given when someone is near an item (**NEO**). Notice again an additional personalized motivational message stressing practicality.

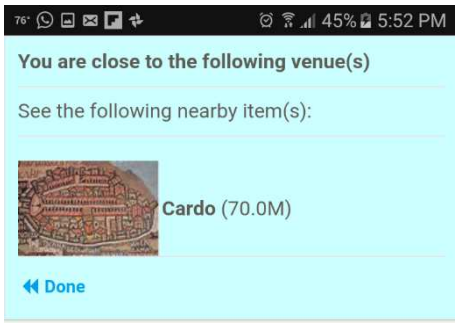
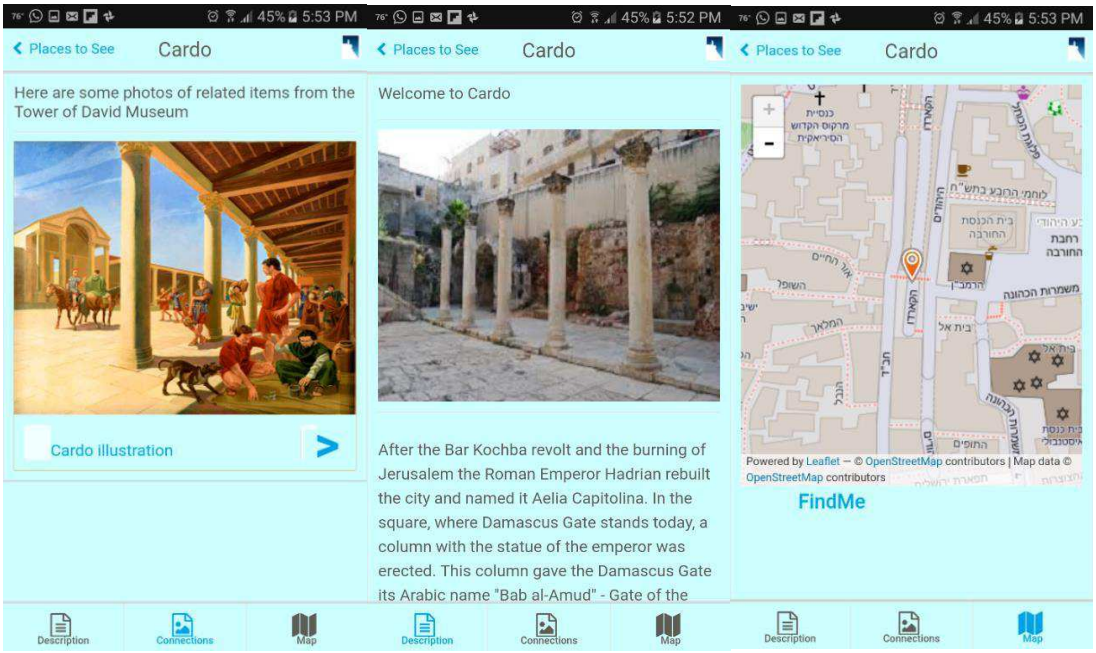


Figure 5.6 Notification that you are near an attraction

5.2.3 Phase 3 Connecting the user back to the museum experience

If the user decides to visit the additional site (stage **ATO**) we can give him the normal guides' explanations (media assets that are associated with the site). A purpose of providing explanations is to increase the value to the visitor and serve as an incentive to use the application. In addition, while the user is at the additional cultural heritage site, we give him media assets that are from previous cultural heritage experiences that can be associated with the present site. This is done by using the second theoretical framework discussed in the previous chapter. The algorithm used to do this is based on the use of a weighted keyword matching of descriptions of past media assets with keywords associated with the present site. In a certain sense this is the reverse function of the algorithm used to choose the sites. The goal here is to enrich the visitor's user experience in a novel and non-trivial way and encourage him to visit additional sites. In Figure 5.7 we see the arrival at the Cardo (a). The user gets a picture of the site and some text describing the history and importance of the Cardo under the Description tab. If they wish, they can choose the connection tab (b) and see pictures of items that are related, pertaining to the Tower of David. As always, for convenience they can use the Map tab (c) to see where they are.



(a) **(b)** **(c)**

Figure 5.7 At the site

5.2.4 Summary of Visitor Activity

The visitor (and system) go through the following activities as described above:

Phase 1 – Learning about user

1. Enter a room (detected by beacons)
2. (Present exhibits that may have content of interest)
3. Select exhibits and see content
4. View content of interest (while the system monitors selections, duration)

Phase 2 – Advising and motivating

5. Exit the museum (detected by beacon)
6. See List of Recommended Sites (as computed by system based on behavior)

Phase 3 – Connecting the user

7. Get notifications when approaching sites
8. View content about outside site

5.3 Concrete Examples of the System

In this section we describe three examples of the framework and system and how it was applied to concrete examples. In one instance, the system was implemented and deployed, in the second it was implemented but not deployed and tested, while in the third it was only designed. The first is the Tower of David museum in Jerusalem, the second is the Hecht Museum in Haifa and the third is the National Museum of Judaism and the Shoah (MEIS) in Ferrara, Italy.

5.3.1 Tower of David Museum

The Tower of David Museum[24] in Jerusalem tour consists of seven small rooms, which have a natural order to their viewing. In each room there is an Estimote® BLE beacon which is used to determine visitor's location by means of proximity to the beacon. Within the room there are a number of exhibits (total 13). Automatic location detection is used to determine the room and, due to the proximity among exhibits in the room, a menu is presented to further identify which exhibit the user is interested in. If the user is interested in an exhibit, a number of photos related to the exhibit and read a short text can be viewed. The visitor tours around the museum are conducted primarily in a linear fashion, due to the layout of the museum. At the end of the visit, the users get a recommendation, based on their visit, for additional places to visit with a personalized motivational message. The number of items to visit is vetted by the determined personality type. When they approach within a few hundred meters of the outdoor site they get an additional motivational message to go to that site. The system keeps track of the number of times the individual user approaches a site as not to bombard the visitor with messages and not to repeat messages. If one goes within a few meters of the site, information concerning the site is given. In addition, pictures which are connected to what was viewed at the museum can be seen.

Here is the list of exhibits, room and keywords:

Name English	RoomId	Keyword
Markets	**CRUSADER_ROOM**	**Crusader Market**
Dome of the Rock	**CRUSADER_ROOM**	**Dome of the Rock**
Tower of David Museum	**ENTRANCE**	**City of David**
Temple in its Glory	**TEMPLE2_ROOM**	**Davidson Center**
Menorah	**TEMPLE2_ROOM**	**Wohl Museum**
Jesus of Nazareth	**TEMPLE2_ROOM**	**Cenacle**
Under Assyrian Siege	**TEMPLE1_ROOM**	**Broad Wall**
In the Days of Hezekiah	**TEMPLE1_ROOM**	**City of David**
Mishkenot Shananim	**MAMLUK_ROOM**	**Mishkenot Shananim**
Cardo	**BYZANTINE_ROOM**	**Cardo**
Holy Sepulcher	**BYZANTINE_ROOM**	**Holy Sepulcher**
Distinguished Visitorsג€¦	**T19CENTURY_ROOM**	**Russian Compound**
End of Ottoman	**T19CENTURY_ROOM**	**Jaffa Gate**

Table 5.4 ToD exhibits

[24] https://www.tod.org.il/en/

Here is the list of external sites and keywords

SITE ID	Keyword	Lattitude	Longitude	At Distance	Near Distance
crusadermarket	Crusader Market	31.77713	35.2309	0.05	0.1
domeoftherock	Dome of the Rock	31.778	35.2354	0.05	0.1
towerofdavid	Tower of David	31.7764	35.2284	0.05	0.1
templemountcourt	Davidson Center	31.775	35.2346	0.05	0.1
menorahdrawing	Wohl Museum	31.7754	35.2322	0.05	0.1
cenacle	Cenacle	31.7718	35.299	0.05	0.1
widewall	Broad Wall	31.77587	35.23172	0.05	0.1
cityofdavid	City of David	31.77361	35.23556	0.3	0.6
mishkenot	Mishkenot Shananim	31.7714	35.22435	0.3	0.6
cardo	Cardo	31.77507	35.23092	0.05	0.1
sepulcher	Holy Sepulcher	31.77875	35.2296	0.05	0.1
russiancompound	Russian Compound	31.78208	35.22171	0.3	0.6
jaffagate	Jaffa Gate	31.7766	35.2276	0.1	0.1

Table 5.5 ToD external sites

Personalized messages for Jerusalem Sites (primarily the Old City).

	Category	Sentence
FFT	**Food For Thought**	**Did you know that there was a debate about how to rebuild the Old City?**
LS	**Learn Something**	**Come learn about the history of Jerusalem by visiting the following:**
SSN	**See Something New**	**There is something new on the Jerusalem landscape.**
DSS	**Do Something Significant**	**Here is your chance to see the important features of the Jerusalem skyline.**
QOL	**Improve Quality of life**	**Take a break, enjoy and reflect on Jerusalem.**
EYL	**Enrich your life**	**Add the following important places to the sites you have seen:**

Table 5.6 ToD motivational messages

5.3.2 Hecht Museum

The Hecht Museum[25] in Haifa consists of several large rooms which contain a large number of exhibits, of which over 40 have content associated with them. The museum does not have an enforced route for viewing (except for the first entrance/exit hallway). In each room there are a number of beacons which help determine the proximity to a many exhibit groups (often glass boxes). Due to the possibility of a number of exhibits being in one glass box, a menu is presented to disambiguate which exhibit the user is interested in. For the exhibit of interest, a number of questions are presented, as an answer to which the user is offered short video presentations. At the end of the visit the user gets a recommendation, based on the visit, of additional places to visit with a personalized motivational message. The number of items to visit is vetted by the determined personality type. When they approach the outdoor site within a few kilometers, they get an additional motivational message to go to that site. The system keeps track of the number of times the user approaches a site as not to bombard him with messages and especially not to repeat the same message. If the users go within a few

[25] http://mushecht.haifa.ac.il/default_eng.aspx

kilometers of the site they get information concerning it. In addition, they can see pictures connected to what they viewed at the museum.

What follows is a list of categories (Table 5.7) that each media asset was categorized into. We do not show here the list of rooms and exhibits and keywords since it is fairly large and can be found in the appendix of [A. J. Wecker 2012].

Code	AS	DB	EC	GI	JIS
	Arts and Symbols	**Death and Burial**	**Economy and Commerce**	**General Information**	**Judaism, Land of Israel**
Code	**MC**	**MPE**	**MT**	**RC**	**DA**
	Mediterranean Civilization	**Museology and Parallel Exhibitions**	**Materials and Technology**	**Religion and Cult**	**Drama**

Table 5.7 Hecht Categories

Here is the list of external sites and their keywords for the Hecht Museum, unlike ToD or MEIS, they can be fairly distant from Haifa University, where the Hecht Museum is located, and one would not necessarily visit them in one day. There are of course some sites that are close, such as the Road of the Millennia, Haifa Auditorium, and the Maritime Museum. However most of the other ones are dispersed all over the Galilee.

Site Name	Keyword	Lattitude	Longitude	Near	At
Millennial Road Haifa	**MC**	**32.74064**	**35.0385**	**1000**	**100**
Mona Lisa Tzipori	**AS**	**32.74556**	**35.27671**	**10000**	**100**
Burial Cave Beit Shean	**DB**	**32.70222**	**35.12694**	**10000**	**100**
Shuk Acco	**EC**	**32.92778**	**35.08167**	**10000**	**100**
Ancient Yodfat	**JIS**	**32.836944**	**35.273611**	**10000**	**100**
Safed Old City	**RC**	**32.96583**	**35.49833**	**15000**	**100**
Crusader hall Acco	**MT**	**32.92315**	**32.92315**	**3000**	**100**
Maritime Museum	**MPE, GI**	**32.828944**	**32.92315**	**3000**	**100**
National Park Caesarea	**MC**	**32.5**	**34.891667**	**15000**	**250**
Haifa Auditorium	**DA**	**32.80322**	**34.98522**	**3000**	**50**

(Distances in meters)

Table 5.8 Hecht External Sites

As for personalized messages, the theme here is to connect the museum and the wide context of the Galil.

	Category	Sentence
FFT	**Food For Thought**	**Did you know that for there has been a continuous Jewish presence in the Galilee for over 3000 years**
LS	**Learn Something**	**Come learn about the history of the Galilee**
SSN	**See Something New**	**There is something new to see in the Galilee!**
DSS	**Do Something Significant**	**Here is your chance to see the important sites in the Galilee**
QOL	**Improve Quality of life**	**Take a break, enjoy and reflect on the beauty of the Galilee**
EYL	**Enrich your life**	**Add the following important places to the sites you have seen:**

Table 5.9 Hecht motivational messages

5.3.3 MEIS

The initial, temporary exhibition (now the first part of the permanent exhibition is in place) of the new MEIS Museum[26] in Ferrara, Italy, consisted of three small rooms, with a natural order to their viewing. We refer to the initial and very limited setting, for which we made a preliminary technology design. In each room there is an Estimote® BLE beacon which is used to determine proximity to the exhibit. Within the room there are a number of exhibits. If the user is interested in an exhibit, a number of photos related to the exhibit and read a short text can be viewed. The visitor tours around the museum primarily in a linear fashion due to the layout of the museum. At the end of the visit the user gets a recommendation, based on his visit, for additional places to visit within the city with a personalized motivational message. The number of items to visit is vetted by the determined personality type. When one approaches the outdoor site within a few hundred meters, an additional motivational message to go to that site is shown. The system keeps track of the number of times the user approaches a site as not to bombard the user with messages and avoid repetition of messages. Within a few meters of the site, information concerning the site is given. In addition, pictures connected to what was viewed at the museum can be seen. Here is a list of abbreviations of keywords for MEIS themes:

Code	Description
JRF	**Jewish Rabinical Figures**
JI	**Jewish Italians**
JL	**Jewish Life**
JP	**Jewish Places**
JH	**Jewish History**

Table 5.10 MEIS keywords

Here is the list of rooms and exhibits and keywords:

Exhibit Name	RoomId	Code
MEIS overview	**ENTRANCE**	**JL**
Italian jewry	**ENTRANCE**	**JI**
Rabbi video	**SALA1**	**JRF, JL**
Ark	**SALA1**	**JL**
Pahad Yitzhak	**SALA1**	**JRF**
Wedding	**SALA2**	**JL, JI**
Bat mitzvah	**SALA2**	**JL, JI**
Manzini 95	**SALA3**	**JP, JH, JL**
Lampronti	**SALA3**	**JRF**
Nuta	**SALA3**	**JL**
Lampronti video	**ATRIUM**	**JRF**
Marcella video	**ATRIUM**	**JI**

Table 5.11 MEIS Exhibits

[26] https://www.meisweb.it/en/

Here is the list of external sites and keywords

Name	Keyword	Lattitude[27]	Longitude	At Distance (M)	Near Distance (M)
Synagogue	**JL, JP,JH**	**44.83422**	**11.621754**	**500**	**5**
Lampronti Grave	**JRF**	**44.84356**	**11.63022**	**1000**	**3**
Bassani Grave	**JI**	**44.84356**	**11.63022**	**1000**	**3**
Lampronti Birthplace	**JRF**	**44.851256**	**11.6493271**	**500**	**3**
Gardens of Conti Finzi	**JP, JI, JH**	**44.84356**	**11.63022**	**500**	**5**
Jewish School	**JP, JL**	**44.852690**	**11.6495341**	**500**	**5**
Jewish Ghetto	**JL, JH**	**44.852461**	**11.6493391**	**500**	**10**
Nuta	**JL**	**44.853179**	**11.678221**	**300**	**10**
Castle	**JH**	**44.8375**	**11.619444**	**500**	**15**

Table 5.12 MEIS External sites

Personalized messages:

	Category	Sentence
FFT	**Food For Thought**	**Did you know that the Jewish community in Ferrara was once one of the most important in Italy?**
LS	**Learn Something**	**Come learn about the history of the Jews in Ferrara**
SSN	**See Something New**	**See the newly restored synagogue in Ferrara**
DSS	**Do Something Significant**	**Here is a chance to see a part of tradition that goes back 500 years**
QOL	**Improve Quality of life**	**Take a break, enjoy and reflect on the beauty of the ancient city of Ferrara**
EYL	**Enrich your life**	**See an important part of Jewish life in Italy**

Table 5.13 MEIS motivational messages

5.3.4 Discussion: Differences between the Scenarios

Interesting differences occurred in each of the implementations (ToD, Hecht, MEIS). In the Hecht Museum, the floor plan has a few different paths and a large number of exhibits and a number of media assets (video presentations < 1 minute long) associated with each of the exhibits. The additional sites are spread all over the Galilee. The Tower of David has a fairly sequential linear path with a small number of exhibits. To each exhibit there is one media asset connected, which consists of a number of pictures and a one-page textual description. The additional sites are fairly close by. MEIS is similar to Tower of David but has a less constrained path, a number of text assets connected to each exhibit (similar to Hecht). The additional sites are relatively close by, but not within walking distance, you need to go to the city center for most of them and some, like the historical cemetery, require additional transportation. In terms of "Visit Type" 4.1.4), ToD and MEIS are sequential, while Hecht has a more serendipitous nature. All this has implications for the system design and implementation. For Hecht museum, we can look at the number of exhibits viewed as a general sign of curiosity, at the number of presentations viewed as a sign of holding power, as watching a video

[27] Both latitude and longitude here need to be re-verified and are given as examples

presentation can be assumed to be engaging (at least for the length of the video). In Tower of David we need to use other measures. For number of exhibits, we can use the number of exhibits the visitor chose to look at content. Holding power here is much harder to calculate as we are not sure how long the visitor read the text, so we use approximations such as time from start of view of text asset to either next view of an asset or leaving the room. Other differences can be in the recommendation, since Tower of David consists of model and dioramas of actual items in the Old City, interest in them naturally points to an interest in the real item in the Old City, while in Hecht, which consists of actual artifacts, they may point to more than one additional site. In light of these differences in the system we allow different methods to be plugged in for each museum to calculate visiting behaviors (ant, butterfly, grasshopper, and fish).

6 Evaluation

In this chapter we discuss questions of methodology, describe the experiment (visitor study), examine the results and summarize them. In particular, a user study was run, in which previous experiences at a museum are taken into account, when the subjects are situated outside the museum. This study compares the values obtained using personalization (UM) and persuasive techniques, with those of no UM and no persuasive techniques. The purpose of this study was demonstrative and exploratory, we did not set out to prove anything. Rather, our goal was to gain insights on how to proceed in this new field of study and to demonstrate its usefulness.

6.1 Objectives and Methodology

In order to provide an initial evaluation of our research (with the limits stated above), we used a variety of methods from: Visitor Studies [S. Bitgood 1998] and Grounded Theory [Hughes and Jones 2003]. Specifically, in evaluating the technologies, i.e. the different types of personalized associative reader applications, we used a variety of methods from User Studies and HCI (tracking, observations, and questionnaires) [Tullis and Albert 2008].

Of the situation concerning evaluation methods in mobile systems [Kjeldskov et al. 2005] said: "*Mobile guide take many of the well-known methodological challenges of evaluating the usability of both stationary and mobile computer systems to the extreme.*" They observed that usability evaluation for stationery computers is a well-established discipline within the HCI field, as opposed to that of mobile systems. They examine the costs vs. benefits of doing field studies vs. laboratory experiments vs. heuristic walkthrough vs. rapid reflection in the mobile ecosystem [Kjeldskov and Stage 2004; Kjeldskov et al. 2004] and arrive at the conclusion that, for finding related to usability problems, lab studies are easier and as effective as field studies. Yet there are certain situations which warrant the use of field studies (see also [Kallio and Kaikkonen 2005; S. Bitgood 1998] for a museum study point of view and non-mobile point of view). They also examine the tradeoffs between using real users, surrogates or experts in the mobile environment and comment about the differences on this issue to the stationery environment. Other methods for mobile evaluation include: semi-controlled outdoor tests, real time lo-fi Wizard of Oz, simulations, focus groups, user workshops with demonstration walk, diaries, video observations, and simulated use in the wild [Kirsten 2010].

In our research we used a combination of visitors (users) and students (surrogates) for the field studies. To study them we used automatic logging through the application, a quick online personality quiz before use of the application, a post visit questionnaire and a post visit interview.

6.1.1 System Usability Scale (SUS)

One set of questions used post visitor experience is the System Usability Survey, which examines user's attitudes to a system they used. SUS is described as: "*The System Usability Scale (SUS) provides a "quick and dirty", reliable tool for measuring usability. It consists of a 10-item questionnaire with five response options for respondents; from Strongly agree to Strongly disagree. Originally created by John Brooke in 1986, it allows you to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications*"[28]. To give a raw score on a scale from 1 to 100, each characteristic was scored as follows:

(((Positive Question – 1) + (5-Negative Question))/8) * 100

Equation 6.1

A table showing the interpretation of the scores is shown in Table 6.1 (in general above 68 is above average) [Brooke 2013]. In our research the primary motivation will be to show the differences between the control group and the experimental group as opposed to getting a good score for the system.

Adjective Ratings	Worst Imaginable	Poor	OK	Good	Excellent	Best Imaginable
SUS Score	0-25	26-38	39-52	53-73	74-85	86-100

Table 6.1 Interpretation of SUS Scores

6.1.2 SWOT-ASEB Analysis

A method of analysis from the tourism research field that we are using is SWOT analysis. It has four levels or hierarchies of demand for CH (referred to with the acronym **ASEB**); namely, in the first place demand for a particular CH 'activity' (Level 1), in a particular CH 'setting' (Level 2); these then link with the 'experiences' gained in that setting (Level 3) and with the ultimate 'benefits' that flow from the satisfying experience (Level 4) [Beeho and Prentice 1997]. These are measured against **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats (Acronym SWOT) in a grid. Here are the definitions of each of these "levels" of ASEB:

> **Activities** are the museum mobile guide, learning about the visitor, giving him a personalized recommendation, making him aware, motivating and getting him to commit to visit an additional outside site, giving mobile guidance at that additional site, showing the visitor how this new visit at the additional site connects back to previous experiences

[28] https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

Settings, Level 2 of the hierarchy, represent the various contexts in which activities take place, including environmental, social and management settings, and also, the visitor's expectations of the settings for the activity being pursued. This differs for every museum and site therefore will not be discussed.

Experiences occur in the different settings; they can be emotional, educational (learning), societal, insightful. According to Beeho and Prentice [Beeho and Prentice 1997] they can be: thoughts, feelings, reactions, motivations, satisfactions and desired psychological outcomes.

B**enefits** represent the ultimate positive outcomes, psychological or societal, which people feel they gain from satisfying experiences and participation in a certain cultural heritage activity.

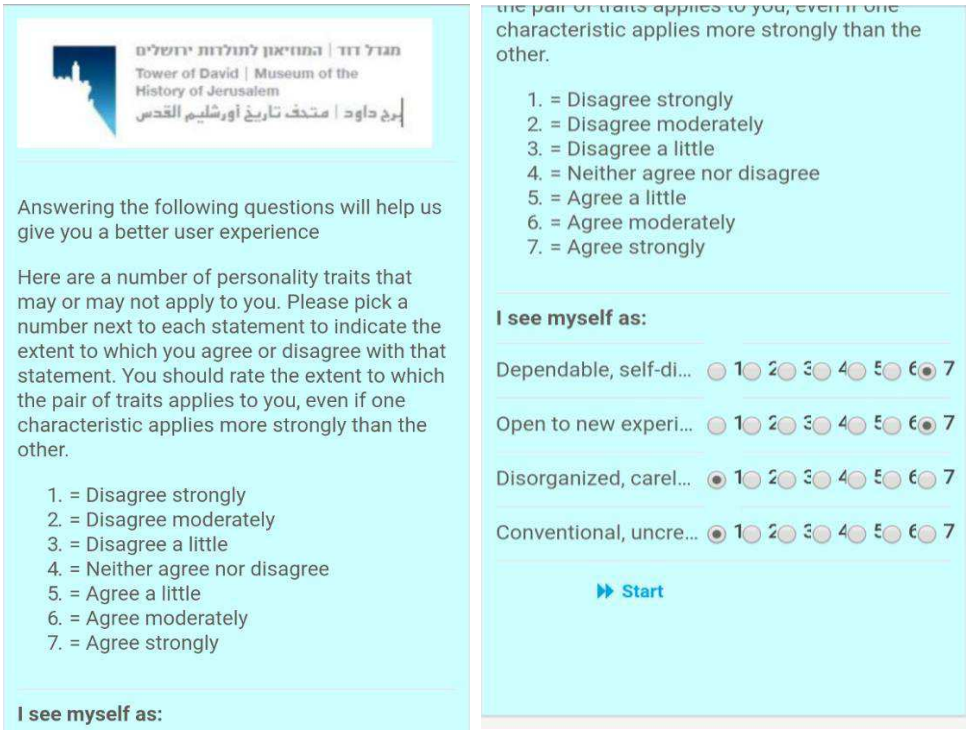
We will use this methodology in the "Discussion" chapter as a way of tying together the many results of the study into an overall analysis.

6.2 Visitor study

To run the field studies, a prototype mobile system was developed for the ToD museum as described in the previous chapter, which advises visitors, and an experiment was setup, in order to gain insights to user behavior and reactions. The experiment worked as follows for the experimental group:

1) The visitor visits the museum
2) At the beginning of the visit, the visitor fills out a brief questionnaire, an abbreviated TIPI (4 questions - 2 each for Openness and Conscientiousness - See Figure 6.1).
3) During the course of the visit, information is gathered about the user, in order to build a user model.
4) After the visit the visitor is advised with a list of potential sites to visit.
5) When the visitor is geographically near, a motivational message is sent to go and visit nearby CH sites
6) When at the site the visitor gets content to read and a connecting image back to something relevant that had been seen at the museum.
7) We monitor (for approximately an hour) if the visitor visits the sites.
8) After the study, the visitor fills out a brief questionnaire and has a short post experience interview.

In the control situation the user gets a fixed list of sites to visit (Step 4), no notifications (step 5) and no personalized messages and no connecting material (step 6). Thus **Error! Reference s ource not found.** only contained a fixed list of 15 sites and no motivational message and Figure 5.6 did not appear and in Figure 5.7, figure (b) did not appear.



(a) Top of screen **(b) Scroll down**

Figure 6.1 Online TIPI (O & C)

In the following sections we examine the differences between the experimental group and the control group. In the beginning, we examine the demographics of the two groups of **participants**. We then examine the results from the post-experience questionnaire and post experience interview to determine **attitudes**, following which we look at data from the application itself to determine **behaviors**. In general, the experimental group responded more favorably in general attitudes and in behavior, by visiting more outside sites. We did not see a difference in behavior within the museum as expected. We also take a look at **connections between personality and behaviors** (movement patterns) mainly through cross tabulations.

6.2.1 Participants

We used surrogates for the experiment, one group of 25 people (an extended family on a museum visit) for the control group (**C**) were invited to participate in the study and 30 people (mainly first year psychology students) for the experimental group (**X**) were asked to participate. Country of residency for the participants of both groups was Israel. We combine 20-30s and 40-60s to get two groups, and education to two groups until High School (HS), and post HS. Stats show no significant difference between groups (Table 6.2).

	Gender		Age		Education Level	
	M	F	20-40s	50-60s	HS	Coll.
Experimental Group (X)	47% (14)	53% (16)	90% (27)	10% (3)	3% (1)	97% (29)
Control Group (C)	48% (12)	52% (13)	44% (21)	16% (4)	16% (4)	84% (21)
Fisher Exact	1.000		.689		.165	

Asymptotic significances are displayed. The significance level is .05

Table 6.2 Demographics

The following analysis was done using the **TIPI** questionnaire (discussed in Section 2.1.4.1). We used 4 of the 10 questions for personality characteristics specifically those related to Openness and Conscientiousness (2 each, 1 positive question 1 question framed in a negative manner i.e. "I am not creative"). The questions were presented at the beginning of the use of the application. In the following tables we see the distributions. In general, they are similar (see Table 6.3). In general, in Frequency (Freq) we use show numbers for positive/ negative possessors for trait. The nonparametric sample means test (ISMT) compares the experimental group to the control group. The sig. >0.05 means that the experimental and control groups medians for Openness and Conscientiousness do not significantly statistically differ (which is what we expected and hoped for, that the two groups experimental and control were similar in their personality characteristics).

		X		C	
		Freq.	Freq. 27%	Freq.	Freq. 27%
Openness	Pos.	60% (18)	61% (11)	56% (14)	67% (14)
	Neg.	40% (12)	29% (7)	44% (11)	33% (7)
Total		30	18	25	21
Conscientiousness	Pos.	70% (21)	50% (8)	44% (11)	50% (8)
	Neg.	30% (9)	50% (8)	56% (14)	50% (8)
Total		30	16	25	16

(a) Frequencies

	X				C				
	Range	Mean (100)	Median	S.D.	Range	Mean (100)	Median	S.D.	ISMT
Openness	0-100	75.50	83	28.148	33-100	77.80	92	20.367	.245
Conscientiousness	0-100	74.87	83	24.034	50-100	80.08	75	14.358	.676

(b) Descriptives

Asymptotic significances are displayed. The significance level is .05

Table 6.3 Openness and Conscientiousness

Now using the data for both groups together (experimental and control), we look at temperaments which is the 4 possible combinations of Open (**I**) (non-open (**N**)) and Conscientiousness (**O**) (unconscientious (**U**)) using 50% as the cutoff point. The "Frequency Strong (**S**)" column uses 27% mark as the cutoff point (as discussed in 2.1.4.1).

Temperament	Frequency	Frequency Strong
IO / SIO	83.6% (46)	81% (25)
NO / SNO	10.9% (7)	13% (4)
NU / SNU	5.5% (2)	6% (2)
IU / SIU	0	0
Total	55	31

Frequency of Temperaments
Table 6.4 Quiz Temperament

6.2.2 Attitudes

As noted above, the findings in this section result mainly from a post experience questionnaire and a very short post experience interview. The questionnaire was made up of the SUS questionnaire (see below), a few questions concerning the application (using a Likert scale), and a free-text space to comment on each of these questions.

6.2.2.1 System Usability Scale (SUS)

A set of questions we used was the standard SUS questionnaire. The purpose was to get a general feel for the user's satisfaction with the system. The system was a prototype non-commercial system, so we did not expect high SUS scores, the important point for us was the differences between the experimental group and the control group. The results showed that the experimental group had a better experience. To understand the low scores for the control group remember they were evaluating both experiences, both indoor and outdoor, while the indoor was the same, the outdoor experience was essentially having a map and the ability to lookup sites from a list. Statistic can be found in Table 6.5., they show a statistically significant difference between the groups (in favor of the experimental group); that is given the null hypothesis the median of SUS is the same across the experimental and control group, the nonparametric Independent Samples Mean Test shows with asymptotic sig =0.0 to reject the null hypothesis at significance level of .05.

	Range	Mean	Median	Mode	SD	ISMT
Control	13-58	44.30	50.00	50	11.92	Sig=0.0
Experimental	25-93	69.33	70.00	88	17.29	

Table 6.5 SUS scores

As described in the table 6.1 the control group rated the system on average in the OK range while the experimental group rated the system on average in the Good range. Based on the informal post-interviews we believe this difference to be based on the added value that the experimental group got (motivational messages, personalized advice, and connections)

R12	***People in the experimental group gave higher SUS scores M=69.33 vs. 44.30***

6.2.2.2 Application Specific Questions

A set of questions concerned itself with the application itself. We asked whether the information given inside the museum was useful (***Inside Useful Info***), whether the information given outside the museum was useful (***Outside Useful Info***), whether the information given outdoor and connecting back to the museum was useful (***Connection Info***), whether the advice about sites to visit was useful (***Advice***), and whether notifications were useful (***Notifications***). In general, the experimental group responded more favorably, with 2 exceptions. For "Inside Useful Info" the results are about the same; this is to be expected as they got the same materials and experience. That "Outside Useful Info" and "Connection Info" are better is what we expected, given that the experimental group had an enhanced outside experience (of course they could have had a worse experience which would have negated our hypothesis). The same goes for "Advice", the control group got a fixed list of 10 spots, while the experimental group got a shorter personalized list based on their experience in the museum. "Notifications" is interesting, since the results are about the same (the control group fared slightly better); this might be explained by the fact that though the control group got no notifications outside the museum, the GPS in the narrow alleys of the Old City of Jerusalem has many problems. This is backed up by a number of comments. The differences are statistically significant for "Outside Useful Info" and "Advice" using the nonparametric Independent Sample means Test (ISMT) at significance level .05. The results are shown in the following table:

Question	X			C			
	Range	Mean	Std. Dev.	Range	Mean	Std. Dev	ISMT sig
Inside Useful Info	2-5	3.83	.913	2-5	3.60	.975	.975
Outside Useful Info	1-5	3.27	1.202	1-4	2.48	.016	.016
Connection Info	1-5	3.53	1.7408	1-4	2.72	.119	.119
Advice	1-5	4.03	1.098	1-5	3.04	.002	.002
Notifications	1-5	3.13	1.279	1-5	3.24	.796	.796

Key- Significant differences

Table 6.5 Application specific questions

R2	***People, on average, after using the experimental system found the advice, outside info more useful than those who used the control system.***
R6	***Most people liked having the connection back to the museum.***

6.2.2.3 Qualitative Findings from Application Specific Questions

We briefly recall some qualitative answers for these questions including both groups (in general the experimental group was more talkative). Regarding **useful inside** Information people wrote:

- *"The information was very detailed and interesting"* (X)
- *"The systems timing worked in the best possible way. At the entrance to each room the application detected the passage and provided relevant information" (X).*
- *"Provided useful and interesting information" (X).* They also added a point about using directions in addition to maps for outside sites.
- *"Was very nice, especially the pictures were very enriching" (X)*

To sum up the qualitative answers, what was relevant to our research was the interest in both text and pictures and the variety of preferences.

Regarding **useful outside** Information people wrote:

- *"I struggled finding the locations since I couldn't get my current location from the app, but I was interested in finding most of the places I've been suggested by the app*." (X)
- *"Sometimes I didn't get notifications, but I used workarounds and the information was relevant*". (X)
- *"The application identified where I was according to how close I was to sites and in the application relevant information appeared" (X)*
- *"The application did not notify me about places on time during the tour in the city" (X)*
- *"Agree, but many times you couldn't open the information and it did not appear automatically"* (X)
- In addition, 4 people (C) wrote about technical problems.

To sum up, with respect to what was relevant to our research, GPS sometimes can be very hard in Cultural Heritage areas (especially in the Old City of Jerusalem), there need to be fallbacks or workarounds to overcome difficulties as a visitor commented.

Regarding **Connection** Information people wrote:

- "*Didn't understand the question*" (N)
- "*The information that appeared in the application was very broad. It succeeded in bringing a broader picture on what was being described*" (X)
- *"Yes. Very interesting to see the connection inside the museum to life today. Also, interesting to read about what is happening at those spots today" (X)*
- Two people had technical problems and 2 people complained that the information was in English

To sum up, what was relevant with respect to our research, users are unclear what it means to connect to past experiences in a mobile guide as this is a relatively new phenomenon. However, when they understand, some (not all) seem to like this. Regarding **Recommendation/**Advice Information one person wrote" "Obvious". Which indeed is one of the dangers with a recommendation system, especially on something as central as Jerusalem.

Regarding **Notifications** people wrote the most:

- *"Annoying Irrelevant*" (X)
- "*I didn't get the ping for any of the sites I visited*" (X)
- "*The operation was not so comfortable, just very near the place, without an accompanying map"* (X)
- "*You can press on the application if you're not near the place, and not always nearness is detected. Recommend that there be a manual way to get into everything to avoid such problems*" (X)
- "*One of the significant advantages of the application*"
- *"I didn't get notifications, but beyond a doubt they are very useful*" (X)
- *"Yes, Very helpful" (X)*
- *"Nice that the cellphone vibrates and understand that it identified me" (C)*

To sum up, what was relevant in respect to our research, besides technical difficulties, most people liked the notification and found them useful, while to some they were annoying.

6.2.2.4 Qualitative Findings from Post Experience Interview

The post experience interview consisted of the following basic questions (if something interesting came up, we asked a follow-up question to clarify):

- How was your experience?
- What were the most positive aspects?
- What were the negative aspects?
- What did you think about the recommendations? Notifications?
- Given an ideal system without the technical difficulties involved with the present system would you use it?

The **experimental group** in the qualitative post interview said they ***"enjoyed the experience"*** or something similar **93% (28).** The idea of connecting the museum inside and outside sites was useful and if they had the chance ***"would use such a system myself"*** or something similar ***90% (27)*** (the others 10% (3) thought they could find places themselves). Many **"**liked the idea**"** or something similar of showing the ***connecting image at the sight 80% (24)***. More than half found ***the motivating messages "useful" 54% (18)*** though some found them obvious and

trite 20% (7). Things that bothered them were GPS accuracy for map and notifications and poor internet within the museum (they sometimes had to go outside to load content) 54% (18). One user expressed privacy concerns saying: "**I don't know if I like that the system knows so much about me**".

The **control group** in the qualitative post interview said they ***"enjoyed the experience"*** or something similar **72% (18)** and the idea of connecting the museum inside and outside sites was useful and if they had the chance would **use such a system themselves 80% (20)**; though they weren't sure about the present implementation. Things that bothered them were also GPS accuracy for the map and poor internet within the museum (they sometimes had to go outside to load content) 84% (21). This resounds with some of the written comments in the post- questionnaire. Here too another issue that 1 person commented on is that the system "**knowing what they are doing is creepy**" (privacy).

Notice that the positive answers were higher in the interview than the questions asked in the post experience questionnaire; this is probably due to the fact that the questionnaire asked them to evaluate the actual system, whereas in the post-interview they were asked about a theoretical similar system. This is true for all questions except things that bothered them, which concerned itself primarily with the present system, though some professed concern about theoretical issues for all systems such as privacy.

6.2.3 Behaviors

The next set of statistics come from the application logs. It reports the number of rooms and the number of exhibits viewed in the museum (we don't expect to see a difference between groups and this was confirmed approximately 6 rooms and 6 exhibits on average for both) and the number of places visited outside (where there is a difference in favor of the experimental group as we had hoped **(2.7 sites vs 1.9 sites).** The nonparametric independent samples – median test (**ISMT**) was performed on the hypothesis that the medians of items (rooms, exhibits outdoor sites) viewed are the same for both experimental and control group, confirming that the only significant difference between the groups was at the outdoor sites. See Table 6.6 for details and statistical significance. In the table the percentages refer to the items viewed out of the possible items viewed.

	Experimental				Control				ISMT
(Total)	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	sig
Rooms (9)	33.3% (3)	100% (9)	73.7% (6.63)	1.6	33.3% (3)	77.7% (7)	66.7% (6.00)	1.1	.053
Exhibits (15)	0	100% (15)	42.4% (6.37)	3.9	13.3% (2)	66.7% (10)	43.7% (6.56)	2.5	.080
Outdoor (15)	6.7% (1)	40% (6)	17.8% (2.67)	1.3	0	20% (3)	12.5% (1.88)	.8	.024

Table 6.6 Application Data

R3	*People, on average, with the experimental system saw more outside sites.*

We now look at movement patterns within both groups together (since there is little difference in how they experienced the museum). We look at two ways of measuring this, one which was used by the application and described in the chapter on System Description and the second one, a more simplified, applied post-facto, which used percent of rooms visited to determine orderliness and percent of exhibits viewed to determine inquisitiveness. The simplified algorithm discerns a more balanced view of the groups. Thus, in the simplified algorithm **ants** are people that viewed lots of rooms and exhibits, **grasshoppers** only certain rooms but in those rooms, they viewed lots of exhibits, **butterfly** visited lots of rooms but few exhibits (by definition, in our study there were no butterflies) and **fish** few rooms and even fewer exhibits. With the application classification, most of the participants were classified as grasshoppers, with the simplified classification, there are mostly ants and grasshoppers with slightly more fish.

	Ant	Grasshopper	Fish	Butterfly	Total
Application	78.2% (43)	14.5% (8)	7.3% (4)	0	55
Simplified	41.8% (23)	47.3% (26)	10.9% (6)	0	55

Table 6.7 Movement patterns

6.2.4 Connections between personality and behavior

We compare the quiz temperament with the movement behavior pattern (both types, see above) to see if there is predictive value. We take the temperament we got from the quiz at the start of the application and see how many of each temperament is an ant, grasshopper or fish. We see that it correlates for ants (IO, SIO), other categories are hard to predict as we may need more data of people of this particular type.

		Movement Temperament Application			Movement Temperament Simplified		
		ant	grasshopper	fish	ant	grasshopper	fish
Quiz Tempera.	IO	87.0% (40)	8.7% (4)	4.3% (2)	47% (21)	49% (22)	7% (3)
	SIO	92% (23)	4% (1)	4% (1)	36% (9)	60% (15)	4% (1)
	NO	33.3% (2)	50.0% (3)	16.7% (1)	29% (2)	43% (3)	29% (2)
	NU	33.3% (1)	33.3% (1)	33.3% (1)	0	50% (1)	50% (1)
Fisher's Exact (without SIO)				15.126 sig =.002			6.461 sig=.099

Table 6.8 Comparison of Temperament and Behavior

In order to see how well personality predicts movement type, we constructed the confusion matrix[29] (template taken from there); specifically, we looked at how accurately did Inquisitive/Orderly predict Ant movement pattern (using the application's algorithm) vs the

[29] https://en.wikipedia.org/wiki/Confusion_matrix

other two types (Grasshopper and Fish) in order to get a 2x2 matrix (in blue). Measurements are given in yellow. Numbers for Accuracy, False Discovery are reasonable, while the Negative predictive value (NPV) is high.

		True condition			
	Total population	**Ant** **43**	**GRSHPP, Fish** **12**	Prevalence 46/55 =0.84	Accuracy (ACC) 46/55 =0.84
Predicted condition	**Ant** **46**	**True positive, Power** **40**	**False positive, Type I error** **6**	Positive predictive value (PPV), Precision 40/46 = 0.87	False discovery rate (FDR) 6/46 =0 .13
	GRSHPP, Fish **9**	**False negative, Type II error** **3**	**True negative** **6**	False omission rate 3/10 =0.30	Negative predictive value (NPV) = 0.50
		True positive rate (TPR) Recall, , 40/43=0.93	False positive rate (FPR), Fall-out, 6/46=0.13	Positive likelihood ratio (LR+) = 7.15	F_1 score= 0.90
		False negative rate (FNR), 3/43=0.07	True negative rate (TNR), Specificity (SPC) 6/12=0.50	Negative likelihood ratio (LR−) = .0.14	Diagnostic odds ratio (DOR) = 51.07

Table 6.9 Confusion matrix IO predicts Ants

Other items we looked at were predictive power of Quiz temperament and movement patterns to estimate the number of places visited. Given the sparsity of the other types the most we can say is IO tend to visit more places (SIO averages were even higher). Due to the number in each category only IO is statistically significant to look at. See the green highlighting for significant concentrations.

Quiz		Room			Exhibits		
Temperament	N	Range	Mean	S.D.	Range	Mean	S.D.
IO	46	3-99	6.59	1.326	0-15	7.00	3.141
NO	6	3-7	5.17	1.602	2-8	4.33	2.875
NU	3	4-6	5.00	1.000	0-5	2.33	2.517
Total	55	3-9	6.35	1.136	0-15	6.45	1.136
Spearman rho		-0.372 sig=.005			-.387 sig=.004		

Table 6.10 Temprament and Museum Visits

For the outdoor statistics we only looked at the experimental group (total 30) since they got the "better" exposure to an application encouraging them to visit. The SIO was less than IO but not in a statistically significant fashion. Again IOs seem to see more outdoor sites.

Quiz Temperament	N	Range	Mean	SD
IO	26	1-6	2.62	1.329
SIO	25	0-6	2.2	1.155
NO	1	1	1.00	.----
NU	3	1-3	1.67	1.155
Wilcoxon SR	-5.266 sig=.000			

Table 6.11 Temprament and Outdoor Sites Visited

If we look at movement patterns (both application calculated and simplified), we see that with the simplified calculations it was even more pronounced that ants tended to see both more rooms and more exhibits. Next in order are grasshoppers and then fish. These results are about the same whether we use the application's method of calculating or the simplified.

		Movement Calculated				Movement Simple			
		N	Range	Mean	SD	N	Range	Mean	SD
Rooms	Ant	43	4-9	6.79	1.125	23	5-9	7.09	1.041
	Grasshopper	8	4-7	5.25	1.165	26	4-9	6.27	1.151
	Fish	4	3-5	3.75	.957	6	3-5	3.83	.753
Fisher's exact		28.083 sig=.00				27.992 sig=.00			
Exhibits	Ant	43	3-15	7.60	2.727	23	8-15	9.52	2.150
	Grasshopper	8	2-4	2.75	.707	26	2-7	4.77	1.608
	Fish	4	0-3	1.50	1.732	6	0-4	2.00	1.673
Fisher's exact		43.373 sig=.00				66.827 sig=.00			

Table 6.12 Movement Types vs Items Visited

R13 IOs are primarily ants and visit more rooms, exhibits and outdoor sites. Other types there are fewer correlations.

6.2.5 Rankings and Behaviors

In this section we try to see if there is a correlation between satisfaction scores and actual places visited. Indeed, we see that as satisfaction grows people visited more. Note this doesn't apply to rooms in ToD since the number of rooms seems to involve contextual factors (How willing to climb stairs, time, etc…). However, we see a connection between satisfaction and increase in number of exhibits seen, and outdoor sites visited. A relationship that seemed unusual was "Outside Info Useful", we then examined only the experimental group (Table 6.14) and indeed also there you have an increasing number of visited places (except for those who scored 5, but 2 visitors isn't statistically significant. However, satisfaction for

			Rooms			Exhibits			Outdoor		
C	R	N	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
I	1	0									
	2	8	4-8	5.88	1.642	2-10	5.50	3.071	1-3	2.13	.641
	3	9	3-7	6.11	1.268	2-8	5.56	2.242	0-3	1.89	.938
	4	28	3-9	6.57	1.399	0-15	6.50	3.405	1-3	2.29	.713
	5	10	4-9	6.30	1.567	3-14	7.90	3.873	0-6	2.90	2.132
	Spearman rho			.095 sig=.491			.212 sig=.121			.154 sig=.261	

Key:
I-Inside Info Useful,
Table 6.13 Satisfaction vs Items Visted

recommendations of the experimental group did not have this property of increasing items visited, though we are not sure why. The SUS scores also show a positive correlation with more outdoor sites visited (Pearson Correlation .286, two tailed sig=.034 p=0.05).

O (X)	1	4	5-9	7.50	1.915	0-10	6.50	4.509	2-3	2.50	.577
	2	4	3-11	6.75	2.062	3-11	6.75	3.500	2-3	2.75	.500
	3	4	4-8	6.25	1.708	2-6	4.00	1.816	1-3	2.25	.957
	4	22	3-9	6.56	1.548	0-15	7.13	4.380	1-6	2.94	1.526
	5	2	5-7	6.00	1.414	3-5	4.00	1.414	1-2	1.50	.707
	Spearman's rho			-.187 sig=.716			-.045 sig=.813			.065 sig=.756	
R (X)	1	1	7-7	7	---	5-5	5	---	3-3	3.00	---
	2	2	4-8	6.00	2.828	2-3	2.5	.707	2-3	2.50	.707
	3	5	4-7	6.20	1.304	3-10	6.40	2.702	1-3	2.20	.807
	4	9	5-9	7.67	1.414	0-15	9.11	4.485	1-6	2.78	1.394
	5	14	3-9	6.15	1.523	0-14	5.15	3.13	1-6	2.77	1.423
	Spearman's rho			-.141 sig=.459			-.094 sig=.623			.041 sig=.830	

Key: I-Inside Info Useful, O-Outdoor Info Useful, R-Recommendations Useful

Table 6.14 Satisfaction vs Items Visited (Experimental Group)

R14 People who are more satisfied visit more exhibits and outdoor sites.

6.3 Summary of Major Findings

Again, to put things in perspective, this was not a controlled experiment over all possible variables, and with large numbers, so we need to be careful with claims of success. This said, in general our findings point to acceptance of a system which connects users to their next experience and makes connections from their present experience back to prior experiences. We see also the diversity of preferences especially with notifications. The repercussions of these findings/insights will be discussed in the next chapter. We categorize the findings into three groups: Visitor attitudes, Visitor Behavior, Associations between attitudes, behaviors and personalities and Improvements. The attitudes here differ from those in the surveys as they were measured after the user was exposed to the system.

ID	Finding	Basis
R1	Most people want a system which will advise them on where to go next	Post Interview, Design Insight S-Notify
R2	People, on average, after using the experimental system found the advice, outside info more useful than those who used the control system	Post Questionnaire
R3	People, on average, with the experimental system saw more outside sites	Behavior
R4	People in general liked the motivational messages, though some thought them trivial	Post Questionnaire
R5	People in general liked the notifications, though some intensely dislike	Post Questionnaire, Post Interview
R6	Most people liked having the connection back to the museum	Post Interview, Behavior
R7	There should be workarounds for technology difficulties	Post Questionnaire
R8	Some users are unfamiliar with the idea of connecting back to prior experiences	Post Interview
R9	People like personalized content	Post Questionnaire, Post Interview
R10	Provide value through maps, directions, open hours, etc.	Post Interview
R11	Some people are concerned with privacy issues	Post interview
R12	People in the experimental group gave higher SUS scores	Post Questionnaire
R13	Inquisitive-Orderly (IO) are primarily ants and visit more rooms, exhibits and outdoor spots. Other types there are less correlations	Behavior
R14	People who are more satisfied visit more exhibits and outdoor sites	Post Questionnaire, Behavior

Key: Visitor attitudes, Visitor Behavior, Associations between attitudes, behaviors and personalities, Improvements

Table 6.15 Summary of major Findings

7 Discussion - Connecting Episodes of CH Experience

In the chapter we discuss general aspects that arise from our research: the need for such a framework (as part of this we do a SWOT analysis), the importance of personalization and context, limitations of our approach, methods and materials that can be used to accomplish goals of making connections, and future areas of research. References to insights/findings/results of the previous chapter are designated by **{R*nn*}**.

7.1 The need for the Cultural Heritage connection frameworks

Looking at both the surveys used to determine user preferences, their behavior with the system **{R3}**, and the post questionnaire and interview, there is supporting evidence (though not proofs or validations) that people do want such a kind of system and find it useful. The supporting evidence covers both the a priori cases, when they were asked about a theoretical system and the answers after being exposed to a concrete system. This is supported also by their behaviors, when they went to more outside sites than the control group, showing that the system influenced behaviors. What caused this to happen will be discussed in sub section 7.3.4. The evidence is stronger for the first framework of advising the user where to go next **{R1}** as opposed to the second framework of connecting back to previous experience **{R6, R8}**. From post-interviews it became clear that while subjects had been exposed to advisory or recommendation systems in the past (and they also have human counterparts), the same could not be said of the framework connecting back to previous experience. They were unfamiliar to such an experience, which would be almost impossible to accomplish without today's modern information systems technology (or with a dedicated individual's "cultural attendant"). Looking back at our section on Related Work, we see that there are very few systems that have goals similar to ours in mind [Stash et al. 2013]. The ones that do are designed to be very specific, such as to a particular museum and to a particular city or region. Though our test system was similar in this respect, the design is to allow for broader systems. Also, few systems connect the experiences going forward (advice on the basis of what was done in the museum) and none, to the best of our knowledge, ties automatically back from the outside site to the museum (though some in their outside content may refer back to the museum).

Another important issue that arose from our research in this regard is the importance of **delivering value {R10, R14}.** Whether it be in the content that is presented to the user, maps/directions used to help find potential sites, information about the site whether it be contextual is it open now, is it suitable to today's weather, how far is it from my current location, is there congestion at the site; or static, such as entrance fees. Care should be taken in how the information is presented, as users want information in a relevant format, for

instance, not only distance but how long will it take me to get there by different modes of transportation, and not only a map but step by step directions (see Google Maps[30] for examples of such services). Another result that supports this is that as satisfaction increased people saw more outdoor sites.

7.2 SWOT ANALYSIS

Since this is exploratory research, it may benefit us to examine the frameworks in terms of SWOT analysis, used to examine tourism offerings. The following table gives as a summary the SWOT ASEB (Strengths, Weakness, Opportunities, Threats vis a vis Activities, Settings, Experiences, Benefits) analysis as explained in the previous chapter. We do not include the column for Settings since each individual site can contribute in many ways and, also, the number of different types of cultural heritage sites is vast. In the Activities we provide a basis for their inclusion based on our findings from the previous chapter. (Exploitation for commercial purposes can be considered an extension of privacy concerns).

	Activities	Experiences	Benefits
S	Provide personalized content {R9} Provide personalized advice {R1} Provide persuasive/ motivational messages {R4} Connects the user back to previous visits {R6}	A personalized experience A meaningful experience due to new sites being placed in context Exploration Motivations (as listed in the motivational types above) A feeling of being understood	Added value to the visitor A better CH experience A lifetime of CH experiences which are set in context More visitation of cultural heritage sites (both museum and outdoor sites) ***Societal***
W	Not everyone fits in mold so content, advice, and connections may not be relevant. {R1} Only having partial information about visitors so content, advice, and connections may not be relevant {R2, R4, R5} Content, advice, and connections may be trivial or obvious {R2, R4,R5}	Triviality Boredom Bothersome (e.g. digital nudging and persuasive techniques)	Benefits perhaps are limited to those who seek additional cultural heritage experiences. Other may be uninterested Pushes to certain sites ***Societal***
O	Making visitor aware of nearby sites {R1} Motivating the visitor to nearby sites {R4} Helping the visitor commit to visit by maps and directions{R10}	Personalized, tailored experience that increases chances for the next opportunity to visit Having an aware and motivated experience	Potential new sites of interest to the visitor Maximizing visitation of known sites Increase Traffic to sites and museums ***Societal***
T	Technical failures {R7} Feeling of privacy invasion {R11} Wrong assessment of personality or movement type {R12} Advice may be exploited for commercial purposes {R11}	A bad experience will cause people to be more cautious in following advice in the future	Benefits could be negated due to visitors not using the system due to severity of bad experiences Benefits can be exploited to pursue commercial agendas. ***Societal***

Table 6.10 SWOT-ASEB analysis

[30] https://maps.google.com

7.3 The Connected Cultural Heritage Experience

In this section we examine the overall personalized framework system and what methods we use to accomplish our goals. We start by comparing our frameworks to the two health models discussed in Related Work. We then discuss the importance of the different methods to accomplish our goals: for different locations, use different applications with different technologies, and, for different people, use personalization.

7.3.1 Healthcare Proactive Advisory Systems

In a sense what we are trying to create is a Personalized Proactive Advisory System **{R2, R9}** (see discussion of [T. S. Nguyen et al. 2014] in Related Work) in terms of our goals and accepting their definition of what is the difference between recommendation and advice. In addition, we adopt goals such as Awareness, Motivation and Commitment taken from the COMBI framework (see discussion of [Mogles et al. 2013] in Related Work). What makes the cultural heritage different from the healthcare domain are several factors. Healthcare is an activity that requires much more frequent contact and use (practically daily, vs CH, which occurs during vacations and leisure time). It is also sometimes a life threating issue, while cultural heritage is a leisure activity [Falk and Dierking 2016]. Thus, healthcare can use all sorts of competitive methods that wouldn't be appropriate for the cultural heritage domain. E.g. it would be okay to say your peers “Run 3 kilometers a day”, it would not be appropriate to say you have visited 3 museums this year while your friends have visited 5.

7.3.2 Different Contexts

Per our framework (see Theoretical Frameworks) we use a number of different applications at different places/stages to accomplish our goals.

- **In the museum** – We provide normal mobile museum guide services with the addition of monitoring behavior. Here, in the future we may make use of personalized content **{R9}**
- **At right opportunity** – We make the visitor aware of possibilities / opportunities and motivate them towards commitment. We use technologies such as persuasive computing, digital nudging **{R4}** and notifications **{R5}** to accomplish our goals. We also try to provide added value through contextual and informative content **{R10}.** This application is the heart of our first framework. Again, we must be aware of differences in people in their reactions to the use of these technologies **{R12}**.
- **At the location** - Besides showing useful content like any other outdoor guide, we also show connection to previous experiences, which is the heart of our second framework. As mentioned above, some of the new ideas for content can be connected to social content. Our exploratory research shows that people tend to like this **{R6}**, though some people are unfamiliar with this **{R8}**.
- **Other locations** – Allow for review and reflection upon visits.

As mentioned, Digital Nudging and Persuasive Computing are methodologies used at the different contexts. We think the primary difference between these two technologies concerns form vs content. While Digital Nudging concerns itself with technology connected with how and when to deliver the content (frequency of notifications etc.), Persuasive Computing concerns itself with the content itself, trying to make the arguments more acceptable to the user, or with communication means, influencing the actual behavior of the target by using effective communication strategies, and with specific techniques coming from psychosocial studies. As stated by Fogg [Fogg 2003]: "The purpose of persuasion is to modify attitudes and behaviors through technology interaction, without coercion or deception". In line with this is the following quote (references removed) from the following MSc paper by Castmo and Persson[31]:

> *Persuasive design systems use psychological foundations to affect users in their decision-making. To create user engagement, designers labor with emotional and behavioral barriers in order to trigger a certain decision or behavior to occur…. Further, Tøring(2008) states that rhetoric and persuasive technologies are related since both share the belief of addressing persuasion in a deliberate fashion. In addition, he states that computer-mediated persuasion is not that well-established.*
>
> *Nudging can be related to usability, as both have the strategy of removing roadblocks and obstacles to make users reach the goal easier but nudging has not been thoroughly investigated in the information system field.*

Another factor dependent on being at different situation (and hence a different application) is Locus of Control: (See Appendix H Push vs Post for more on this debate):

- In museum – we have a mixed model. Position awareness (that is updating which room the visitor is in is proactive, while information viewing concerning exhibits is done on request.
- At right opportunity – proactive notification, information viewing at the initial level is also proactive since it short. If there exists a secondary level of further information (such as maps how to get to a place, it is on request. One of the things we saw is that users requested to be able to get to this information not only proactively, but also on request **{R7}**
- Near location - this is similar, in terms of locus of control to being in the museum
- Reflection and Review – on request only as it would be very aggressive to ask the users to reflect or review when they don't want to.

[31] http://lup.lub.lu.se/student-papers/record/8950219

Another issue of concern is the "portability of the framework/system". By applying it to three different scenarios we were able to explore and gain insights into portability issues. We saw that measurement of interest depends on the affordances of the museum and what type of assets are presented. For example, in measuring attracting power, in some places it is enough that they visit a location since there is choice in the flow (and just their presence at a location is important), while, at other museums, you may need an adjusted time spent, since the flow through the museum can be dictated by the floor plan or consumption of media at that location. In measuring holding power, for text media it is harder to measure interest, differently from dynamic images; for the latter, as a first approximation, interest can be inferred from video viewing which were uninterrupted.

7.3.3 Different People – Personalization

In the beginning, we envisioned a strong connection between personality, museum movement types and personalities, such as in Table 5.2. As the research went on, we began to see a lot of holes in these correlations. We began to see that contextual issues can take precedence over personality and movement type. Falk already has stated that museum types can vary from one visit to another depending on contextual issues [Falk and Dierking 2016].

We saw that the actual movement type correlates better than personality types to the number of places visited inside and outdoors. There are some predictions concerning motivational messages than can still be made based on personality. All in all, the applying of the connection of behavior with personality to the design of applications is an extremely interesting field that has a lot of potential in many areas. In terms of predicting what content or sites the visitor prefers, the use of duration of media content consumed is a good predictor for those items. Predicting based on personality or behavior, how, when and in what form (media type) to present content to the user is harder; and at this stage may be best served by asking the user explicitly {**R13**}.

In general, our results resound nicely with what was said in Culture Track 17[32]

> ***"Many have tried to segment audiences into experiential typographies: grouping people based on their desired characteristics of an experience. But in 2017, there is no ideal type of cultural experience. Audiences have different needs and wants at different times or even simultaneously".***

[32] http://2017study.culturetrack.com

7.3.4 "Making connections" between exhibits and CH sites

Other issues concern themselves with the content and form of the connections (second framework). From our early surveys we saw that different users would like different types of content delivered in many ways. This was also confirmed in the post interviews. Much research has been done on what types of information to present within the museum. We should build on this to pick items from this collection of media assets to present relevant ones at the right opportunities. Both the preliminary surveys and the post questionnaire and interview showed that many users would like a system that would make such connections. We saw that some users did not like them because of privacy concerns. Few systems suggest the use of social, personalized media as ways of establishing this backward connection (for something about use of social media content within the museum for making connections see [Van Dijk, Kerstens, and Kresin 2009]). While Van Dijk et al. [Van Dijk et al. 2009] showed that users enjoyed a system that make personalized social connections, our preliminary survey only showed 20% of respondents interested in such types of connections. This could be due to the fact that they demonstrated to the visitors a concrete system, where users could think about the benefits while we only asked about a theoretical possibility.

Another important issue is the format in which content is presented. From our preliminary study we saw a wide variety of personal preferences for formats. As previously noted form preference could be connected to context. E.g. on a sunny day it may be very had to read a screen and audio would be more appropriate, while in a noisy area perhaps images would be better as they can convey medium amounts of information with low cognitive load (as per [McCullough 2012] in our subsection on Content in the chapter on Background. Besides using context and explicit user preferences to choose the format of the content one could envision the use of personality or perhaps Solomon / Felder index of learning styles to determine which format our presentation should take. [Felder and Spurlin 2005]. Our preliminary surveys point to the importance of coherency. In constructing the system, we tried to avoid sending duplicate information to the user, especially for the motivational messages (though one user said it was okay to be repetitive to stress important points, i.e. “repetita juvant”).

In creating this system, the issue arises of methods to make connections (first framework). For the experiment, we used manually constructed connections. In related work [Bue et al. 2015] and a yet to be published experiment on constructing connections between ToD and Jerusalem DBpedia[33] entries, we examined how we could implement the process of connecting exhibits to sites automatically. This involves doing graph-based connections of the catalog

[33] https://wiki.dbpedia.org/

description text of the exhibits (using DBpedia Spotlight) to sites described by the DBpedia ontology. Having automatic methods can allow a lower entry cost to constructing systems such as ours. This is important in order to free up creation of site databases and prevent their exploitation for commercial purposes against the user's best interest (See SWOT analysis of Threats). With automatic systems users can base themselves on neutral bodies such as DBpedia or, for example, the MiBAC database in Italy[34].

7.4 Limitations

In this section we focus on major limitations of our research: 1) size and length of study and 2) determination of cause of why it was mostly people with the system that visited a larger number of sites and had a better experience.

Given the time limits, the need for cooperation with museum curators and sometimes communities, we looked at a limited number of people over a short time. Given our venue, it is very hard to arrive at the numbers for a long term longitudinal study, within the short period of time of a thesis. Ideally, a long-term study would look at multiple sites and multiple areas over a longer period of time.

Another limitation due to time limits is the fact that we did not ask the users to rate themselves as Falk Types, or Believed Movement Types. Having that information, we could have checked our predictions with observed behavior. However, due to the fact that we wanted the test scenario to be as close as possible to a real visit, we kept the questions prior to application use to a minimum of the four TIPI questions.

An additional limitation is breaking down the causes for more people in the experimental group visiting more outdoor sites, and the higher scores expressed by that group towards the application. There were three differences between the systems (control and experimental): personalized recommendations, motivational messages, and digital nudging notifications), and each one of the three differences (or some weighted average of the three) could be the true cause for the difference in the results or alternatively the true causes could be different for each individual. Another possible cause, though to us this one seems highly unlikely, is the age difference between the control group and the experimental group (the experimental group was mainly in the 20-30s range, while the control group was 30-40s). From the post interviews, we believe that each one of our causes/factors played a role, but this needs to be validated. Also because of the inclusion of these three differences (stated above) we did not wish to

[34] http://www.beniculturali.it/mibac/export/MiBAC/index.html#&panel1-2

further widen to study the contribution of an additional variable coherency, which we believe to be important (see pre-survey) to the visitation of additional connected sites.

Despite these limitations we believe this research contributes significantly to our understanding of what can contribute to a lifetime of cultural heritage, specifically what can be done for designing systems that help in extending to the outdoors the cultural experience of the museum, considering the specificity of the individual visitor.

8 Conclusions and Future Work

In this work we explored and demonstrated our newly defined "third phase" of cultural heritage research/applications, that is **motivating the user to 1) extend a visit of the cultural heritage site (e.g. museum) with visits to other cultural heritage sites (primarily outdoors) and 2) enhancing the new experiences at the new site (outdoor), based on experiences at the original site (museum).** We also looked at how personalization and persuasive technologies can be used to accomplish our goals. Following a ground theory evaluation approach [Hughes and Jones 2003] "**fit**" was shown by tracing back to the previous stages of research; **workability,** through building a system based on the theory (frameworks); and **modifiability,** by showing how it would work in three scenarios. We showed **relevance** as follows: by looking at both attitudes and behaviors, we obtained indications that users enjoy this approach and that because of it they may visit additional cultural heritage sites.

Personalization and persuasive techniques (including digital nudging) were demonstrated as contributing to user satisfaction. In terms of the use of personality traits we have shown that it can be useful, with the caveat that context can override the effects of personality or preferred museum visitor behavior or identity.

Our hope is that this research will lay the groundwork to additional studies and applications, in this newly defined phase of extending the cultural visit experience.

8.1 Future: Long term Connections

Possible future avenues for research include 1) shorter term projects, such as removing limitations and extending the system and frameworks, 2) ideas that will expand the lifelong cultural heritage experience.

Firstly, we would try to remove the limitations by doing further studies, in particular those of a longer-term nature. In addition, we would try to expand the system by including social media as part of the connection media. We would also try to experiment with more types of triggers other than those which are of a spatial nature. We would extend the system to allow revising the model over time as people visit new places. As discussed in [Konstan and Riedl 2012] there is a need for considering user taste change and evolving user goals. We would like to be able to go in both directions (that is: from a museum to an outdoor site, and from the outdoor site to museum exhibits). This may be difficult since an outdoor site might be the equivalent of a one exhibit museum and therefore difficult to determine preferences. Yet it is not insurmountable as it is possible to provide a wide variety of media assets and make determinations from the history of the user's asset consumption (viewing). Another avenue to explore would be the connection between personality and persuasive techniques as in [Oyibo, Orji, and Vassileva 2017], perhaps focusing on the CH environment.

In terms of future ideas that would expand our CH experience, we list two about which we have written position papers. The first, at the level of a single CH visit experience, would be providing multiple voices/narratives for our cultural heritage experiences and then provide a mechanism for the user to choose which ones he wants to hear [A. J. Wecker and Kuflik 2015]. The second, at the level of lifelong CH experience, would allow the user to collect cultural heritage experiences and connect them along different dimensions such as by topics, geography or time period [A. J. Wecker, Kuflik, and Stock 2016].

8.2 Closing Quote

> ***"Of course, context matters more in an age of mobile, embedded and tangible computing. Yet despite current obsessions with smartphones, mobility isn't everything; there are situated technologies, too. Layers of technologies accumulate in the sites of everyday life, which they seldom replace but often transform. So it's worth remembering that underneath todays rush to augment the city fixed forms do persist, and noticing and working with them can improve other sensibilities."***[35]

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[35] Malcom Mcullough (Interactions, Nov/Dec 2012)

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Appendices

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B. Technical Aspects of beacon placement

Vertical Mounting

The biggest problem we have had with the Tower of David exhibition was that of being able to determine which beacon is actually the closest to the user. The exhibition is in a single room, with very little separation between areas. We found we would often be detecting a beacon from the other side of the room with equal or greater strength than a beacon much closer to us. This was despite putting various post-processing checks in place to eliminate signal spikes and using averages of readings.

It should be noted that many other scenarios would not have this problem – if the beacons are in different rooms or are sufficiently spaced out then the physical separation would make it much easier to differentiate between beacons.

The angle at which the beacon faces the phone is very significant. The strongest signal will be detected if the phone is in the same plane as the beacon and facing it. However, this is not usually the way we would hold a phone in a gallery. If beacons were flat against the wall as would typically be the case it would mean we got the strongest signal by holding the phone away from us, parallel to the wall.

It would be more usual to hold a phone at an angle of between 0º and 45º to the ground. This is just about the worst possible position to detect the signal from a beacon mounted on a wall in front of you.

Power Setting

We noticed that the power setting of the beacon also has an impact on how well we can judge the distance from the beacon. This was slightly counter-intuitive as it may be presumed that using a lower power setting might make it easier to detect when we are close to the beacon. However, we found that at a higher power setting the difference between the received signal strength at close distance (< 2m) and intermediate distance (>8m) is much more pronounced. The power setting on Estimote beacons ranges from -30 dBm to +4 dBm. We used the maximum setting for our tests, and the beacons in the Tower of David exhibition are also set to this value. This is unfortunate as this will reduce the beacon battery life. We would recommend using a lower power setting if you are not using multiple beacons in a single small space.

C. Survey 1

Part one – personal details

Age: _____ **Sex**: ❑ male, ❑ female

Occupation: _____ **Education**: ❑high-school ❑bachelor ❑graduate

English level: ❑native speaker (fluent) ❑ very good ❑good ❑medium ❑ basic

Hebrew level: ❑native speaker (fluent) ❑ very good ❑good ❑medium ❑ basic

Part two – previous experience in museum and technology

1. How many times a year do you visit museums (or archaeological sites) in Israel or abroad?
   ❑ more than 10 ❑ between 6 and 10 ❑ between 2 and 5 ❑ once a year ❑ never
2. Have you visited the Hecht museum at the University of Haifa?
   ❑ yes ❑no If so, how many times? _____
3. On a scale of 1 to 7, please mark your level of interest in archaeology:

No interest	1	2	3	4	5	6	7	Very interested

4. On a scale of 1 to 7, please mark your level of interest in biblical studies:

No interest	1	2	3	4	5	6	7	Very interested

5. Please mark your level of knowledge with the following technological devices used in museums
   Audio guides:
   ❑ not familiar ❑ minimal ❑ medium ❑ good ❑ very good
   Audio-video guides (handheld multimedia guide):
   ❑ not familiar ❑ minimal ❑ medium ❑ good ❑ very good
   Information kiosks:
   ❑ not familiar ❑ minimal ❑ medium ❑ good ❑ very good
   Smart phone Applications
   ❑ not familiar ❑ minimal ❑ medium ❑ good ❑ very good
6. Do you own a smartphone
   1 No 2 An old type 3One that can surf the web and run applications 4 One of the latest models

Part 3 General Questions

When you go to archeological sites
❑ visit on my own ❑ visit with one or more friends
❑ visit with family ❑ visit with another type of group
Did you allocate an amount of time for the visit in advance?
❑ yes ❑no ❑depends If so, how long: _____

Part 4 Notification

If there was an archeological site related to an item you saw at the museum would you be interested in receiving a notification: Absolutely No 1 2 3 4 5 6 7 Positively Yes
If you answered 3 or above answer the following questions:
How would you like to receive the information that something of interest is close by

1. Smartphone Notification 2. E-mail 3. SMS 4. Telephone call 5. Other _____

When would you prefer to get notification? Rank each option on a scale of 1 to 7

1. Many times a day
2. Once a day
3. Once a week
4. Every time I come to a new location
5. On certain historical occasions
6. When meeting a person who has a connection to a certain spot
7. When reading on the internet about a certain place or verse that is connected to a place
8. When reading with an Electronic Bible
9. When I am on vacation
10. Only upon request

How many times would you like to be reminded about a possible opportunity before the application assumes you are not interested in a certain spot
0 1 2 3 4 >4

Part 5 Content

What would you be interested in hearing about: (Rate each item on a scale of 1- 7)

1 No Interest 7 Extreme Interest

a. Sites connected to the bible.
b. Important dates or seasons in the bible connected to biblical sites
c. Sites connected to persons mentioned in the bible
d. Books or web-sites connected to sites in the bible
e. Themes connected with sites in the bible (battlefields, Kings, etc…
f. Object (e.g. Pomegranates)

Would you like the material linked to previous personal experience? Rank on a scale of 1-7

1 No Interest 7 Extreme Interest

What sort of information would you want to receive when on-site? Rank each option on scale 1-7

1. Information about the site or verse connected to the site
2. Navigational Directions to parts of the site
3. Recommendations on Items to see at the site
4. Personal Stories told by a famous person about a site
5. Poetry connected to a verse or place
6. Music connected to a verse of place
7. Food connected to a verse or place
8. Pictures of family or friends or teachers related to a verse or place
9. Material related to a controversy or debate about interpretation of a verse or the meaning of a particular site

How long should it take to read, hear or view the material?

- Less than 1 minute, Less than 2 minutes, less than 3 minutes Greater than 5 minutes

Part 6 Delivery

Which genre appeal to you? (Rate each item on a scale 1-7)

a. Information in a short article
b. A fictional dramatization presented by a group of actors
c. A personal account by a well know person
d. A personal narrative by someone connected to the site
e. A short informational film
f. Artwork connected to the focus of interest

In what format would you want to receive the information? (Rate each item on a scale 1-7)

1. 3D Models
2. Video
3. Presentation
4. Visual (Pictures)
5. Audio
6. Text

How important is that the information delivered is coherent (that is tells parts of a complete story and does not repeat itself)

- Not important 1 2 3 4 5 6 7 Extremely important

How important is it that you understand why something was recommended

- Not important 1 2 3 4 5 6 7 Extremely important

D. Survey 2

1. Which of the following sentences best describe you at a museum that interests you and you have sufficient time to visit

- I prefer to concentrate on museum items that interests me the most
- I prefer to go around slowly and look at items one by one
- I prefer to go around and sample many items quickly
- I prefer to go around and just get a general impression

2. Which of the following sentences best describe you at a museum that interests you and you don't have sufficient time to visit

- I prefer to concentrate on museum items that interests me the most
- I prefer to go around slowly and look at items one by one
- I prefer to go around and sample many items quickly
- I prefer to go around and just get a general impression

3. How would the following motivational messages used to describe a point of interest connected to a museum you visited, encourage you to visit that point of interest?

	Strongly negative	Somewhat negative	Neither positive or negative	Somewhat positive	Strongly positive
Get food for thought by visiting this point of interest					
Learn something by visiting the point of interest					
See something new by visiting the point of interest					
Do something special and different by visiting the point of interest					
Improve your quality of life by visiting the point of interest					
Enrich your experiences by visiting the point of interest					

Look at the following picture sets and decide which one best describes you when you go to a museum.

©J.H. Falk 2010

1

©J.H. Falk 2010

2

©J.H. Falk 2010

3

©J.H. Falk 2010

4

4. Which of the above picture sets best describes you at a typical museum visit

○ 1 ○ 2 ○ 3 ○ 4

5. Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please choose one of the options next to each statement to indicate the extent to which you agree or disagree with that statement. (**BFI**)

I see Myself as Someone Who...
Disagree Strongly, Disagree a little, Neither agree or disagree, Agree a little, Agree strongly

Tends to be lazy
Does a thorough job
Is inventive
Is original, comes up with new ideas
Perseveres until the task is finished
Can be somewhat careless
Values artistic, aesthetic experiences
Is curious about many different things
Does things efficiently
Is a reliable worker
Prefers work that is routine
Is ingenious, a deep thinker
Makes plans and follows through with them
Tends to be disorganized
Likes to reflect, play with ideas
Has few artistic interests
Has an active imagination
Is easily distracted
Is sophisticated in art, music, or literature

6. Age _____ **7. Gender** ○ **Female** ○ **Male**

8. In which country do you live? _____

9. What is your profession? _____

10. **What is your highest level of education**? ○ Elementary ○ High School ○ College ○ Masters ○ PhD

11. **How often did you visit a museum during the past year**? ○ Never ○ Once ○ 2-5 times ○ 6-10 times ○ More than 10 times

12. How familiar on a 1 to 5 scale with the following museum technologies

	Never	Used Once	Somewhat Familiar	Familiar	Very Familiar
Audio Guide					
Video Guide					
Information Kiosk					
Smartphone Application					

E. Questionnaire Post Application Use

1 Application Specific Questions

1. I found that the system provided interesting information for perusal inside the museum

1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly Other (please specify)

2. I felt the system provided interesting information outside the museum

1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly Other (please specify)

3. I found the information that connected back to the museum entertaining/interesting

1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly Other (please specify)

4. I found the recommendations of outside sites useful

1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly Other (please specify)

5. I liked getting notifications about sites that were nearby

1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly Other (please specify)

2 System Evaluation (SUS)

6. Mark all: 1 - Disagree Strongly 2 - Disagree 3 - Neutral 4 - Agree 5 - Agree Strongly
    1. I think that I would like to use this system frequently.
    2. I found the system unnecessarily complex.
    3. I thought the system was easy to use.
    4. I think that I would need the support of a technical person to be able to use this system
    5. I found the various functions in this system were well integrated.
    6. I thought there was too much inconsistency in this system.
    7. I would imagine that most people would learn to use this system very quickly.
    8. I found the system very cumbersome to use.
    9. I felt very confident using the system.
    10. I needed to learn a lot of things before I could get going with this system.

Additional Comments

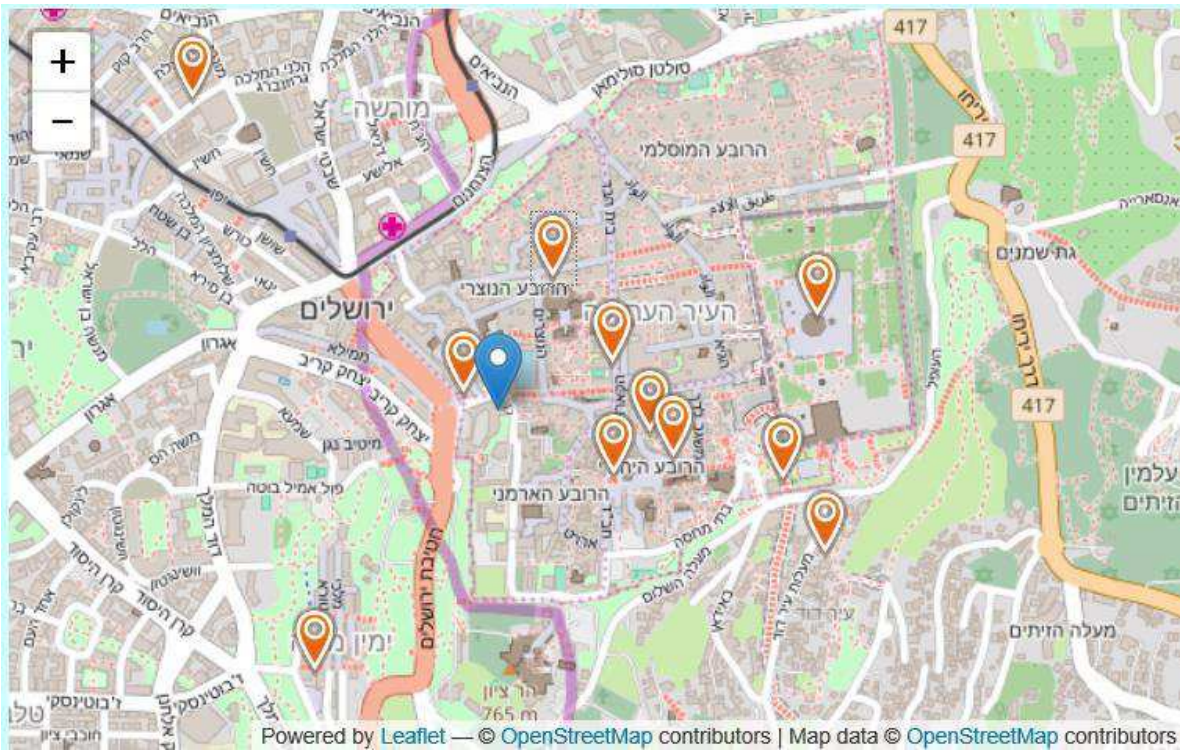
3 Tell us a little about yourself! (Demographics)

7. What is your gender? Female Male
8. What is the highest level of education you have completed?
9. In what country do you currently reside? United States Israel Other (please specify)
10. What is your age?

17 or younger, 18-20, 21-29, 30-39, 40-49, 50-59, 60 or older

11. In what language do you read most often? English Hebrew Arabic Russian Other (please specify)

F. Map of places in Jerusalem



G. Letter of permission from ethics committee (Hebrew)

כ"ד אב, תשע"ז
16 אוגוסט, 2017

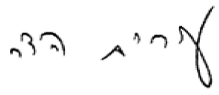
לכבוד
פרופ' צביקה קופליק
מר אהרון ווקר

שלום רב,

הנדון: <u>אישור ועדת אתיקה פקולטטית למחקר בנושא:</u>
User study of an application that connects Cultural Heritage sites to a museum
אישור מס' 283/17

ועדת האתיקה של הפקולטה למדעי החברה לבדיקת מחקרים בבני אדם בחנה את הצעת המחקר והמסמכים הנלווים שהגשת. הנני שמחה להודיעכם כי הוועדה התרשמה שמדובר במחקר שעונה על הקריטריונים של מחקר אתי, ומאשרת אותו ככזה.
יש לציין שהאחריות על ביצוע המחקר לפי הכללים של אתיקה מחקרית ומדעית, ועל פי הפירוט שנמסר לוועדה, נשארת אצל החוקרים. במידה וחל שינוי כלשהו בשיטת המחקר, יש להגיש את הצעת המחקר המעודכנת לוועדה לשם חידוש האישור.
אנו מבקשים שתציינו את מס' האישור על כל הצעת מחקר, דו"ח, פרסום וכדומה, לדוגמא: "מספר אישור ועדת אתיקה לניסויים בבני אדם, אוניברסיטת חיפה: (מס' אישור)".
אנו מאחלים לך הצלחה במחקר.

ב ב ר כ ה,



ד"ר עירית הדר
(סימוכין1728)

H. Push vs Post

Push vs. Post[36]

Sending the same push message to every user should not be part of an app's marketing strategy, especially considering our last post proved that personalized push is a better strategy than broadcast marketing. For instance, there is a 3X improvement in conversion rates when push notifications are personalized to user preferences.

> *IT ALL STARTS HERE: IN ORDER TO BETTER SERVE USERS AND NOT HAVE PUSH MESSAGES BE SEEN AS ANNOYING, COMPANIES NEED TO MAKE A BETTER EFFORT TO LEARN MORE ABOUT THEIR MOBILE USERS.*

This means collecting both customer profile and behavioral data to inform personalized push content. It also means testing and optimizing for important factors, like the volume and send time of messages, to find out when users are most receptive. When data is used to inform smart push engagement strategies, the mindset of users is quite different, as we'll see next.

But the Other 50% of Users See Push Notifications as Helpful

When it comes to how people feel about push notifications, there are two sides to the coin. The other half of the survey respondents found push messages to be helpful - either because the messages alert users to things they are interested in or because the content provides valuable information.

So how do companies make sure the viewpoint that push notifications are helpful becomes the norm? The first step is to stop treating push notifications as an extension of email. Mobile marketing requires its own rules and strategies. Mobile requires personalization, on a scale that isn't possible on the web, so it should be no surprise that consumers want MORE personalization.

The Most Requested Type of Push Notification? A Personalized One

When we asked survey respondents what they actually wanted from push messages, the top three responses all had one common theme: personalization. Personalization can come in many different forms, and it's all dependent on how well companies know their users. Personalized content can be a user's favorite sports teams, a pair of shoes they looked at on the app, or their physical location

Flip side

Here is the other post, that although they are annoying they are effective.
http://info.localytics.com/blog/2015-the-year-that-push-notifications-grew-up?utm_campaign=pr-push1-dec-2015&utm_source=blog_post_consumers_view_on_push

[36] From http://info.localytics.com/blog/the-inside-view-how-consumers-really-feel-about-push-notifications?utm_campaign=pr-push2-consumer-view-jan-2016&utm_medium=push-v-in-app&utm_source=cross-promotion

אהרון ווקר

תקציר

השימוש במערכות מצגות חכמות במוזיאון מבוסס היטב. תזה זו עוסקת בחיבור חוויית המוזיאון לחוויות תרבותיות חדשות בעולם החיצוני, תוך הקפדה על הפרט בהכרה בהזדמנויות ובהצגת מצגות מותאמות. השאיפה היא לעזור לשמור על המשתמש מחובר לחוויה התרבותית ולעזור לו לפתח ידע נוסף והנאה אינטלקטואלית לאחר הביקור במוזיאון. המטרה הספציפית של מחקר זה היא לבחון את הפוטנציאל הטכנולוגי 1) להגדיר "הזדמנויות הקשר", 2) לזהות הזדמנויות הקשר אלה, 3) לבחור חומר רלוונטי, 4) כדי לספק אותו, בהתחשב בהקשר הנכון, ב הדרך המתאימה ביותר למשתמש הספציפי. אנו בוחנים את תחום החוויה והטכנולוגיה של המורשת התרבותית המותאמת אישית, ואת תחומי המחקר הקשורים, הנחוצים כדי לשמש בסיס מבוסס לרעיונות שפותחו במסגרת. אנו בוחנים את העדפות המשתמש על ידי סקירת נתונים משני סקרים, ערכנו, על מנת לפתח נתונים נוספים (מאלה ברקע) של תשומות (נקודות) עבור מודל המסגרת התיאורטית. לאחר מכן אנו מתארים את המסגרות התיאורטיות שלנו, הן למצוא את המקום הבא ללכת, ואת החיבור בחזרה חוויות קודמות. אנו מתארים את ארכיטקטורת המערכת ונותנים שלוש דוגמאות קונקרטיות של מקרי שימוש. אנו מדווחים על הערכה ראשונית של המערכת (ועל המסגרת התיאורטית הבסיסית) על ידי מחקר המבקר, ולאחר מכן דיון על ההשלכות האפשריות.

מסגרת תיאורטית וטכנולוגיה להרחבת גבולות המוזיאון בעולם הפיזי

מאת אהרון ווקר
בהנחיית : פרופ. צבי קופליק, פרופ. אוליביארו סטוק, פרופ. ניקולאי סבי
חיבור לשם קבלת התואר" דוקטור לפילוסופיה"

אוניברסיטת חיפה
הפקולטה למדעי החברה
החוג למערכות מידע

אוניברסיטת טרנטו
בית הספר הבין-לאומי לטכנולוגיות מידע ותקשורת
החוג להנדסת מידע ומדעי מחשב

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יולי 2018