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An investigation on the relationship between the user model and graphic representations for the automated generation of multimedia presentations

K. Schwarz

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ABSTRACT
This thesis investigates a possible solution to adapting an automatically generated presentation to an anonymous user. We will explore the field of User Modeling, specifically Adaptive Hypermedia, to find suitable methods. In our case study, we combine the methods we find to develop a concept for generating user-adapted multimedia presentations about the virtual collection of the Rijksmuseum of Amsterdam in their website.

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An investigation on the relationship between the user model and graphic representations for the automated generation of multimedia presentations

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Statement

Hiermit erkläre ich, Katharina Schwarz, dass ich die vorliegende Diplomarbeit selbständig und nur unter Verwendung der angegebenen Hilfsmittel und Literatur erstellt habe.

Amsterdam, 21. März 2003

Katharina Schwarz

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Chapter 1

Introduction

The primary aim of museums is to collect, preserve and support the study of historical, artistic or scientific artefacts. The development of rich media technologies has enabled museums to create a digital representation of their collection. Generally the biggest challenge of exhibiting a museum's collection has to do with limited space. Many museums resort to the vastness of hyperspace to permanently exhibit the greater part of their collection. However, in a web environment, a new problem arises that has the same restricting effect as limited space: that of understanding a visitor's requirements. In a museum, visitors can seek advice and guidance from attendants. In a virtual space, the visitor is confronted with a machine. It is impossible to predict the individual user's requirements or the requested material in advance. If the user is not able to communicate her goal to the machine, the virtual collection might as well not exist, for all the good it does.

A mechanism must be provided to allow the user to convey her requirements to the system. Based on this user input, the desired information should be presented in a way that the user understands. Because the users of the world wide web are an immense and diverse group, users of different ages, educational backgrounds and levels of computer literacy must be taken into consideration. Web designers face a gargantuan task when trying to cater to the diverging requirements of different users.

One solution to this problem is to make the presentation of information adaptive to an individual user. The first big hurdle to realizing this aim is creating a user profile that is a viable representation of the user's expectations. This is especially difficult in the world wide web, where users are anonymous and demand instant gratification. The system has to learn enough relevant information about a user in a very short period of interaction. The next hurdle is to deduce from the user profile the best solution for presenting information in a manner that is coherent to a particular user.

This thesis investigates a possible solution to adapting an automatically generated presentation to an anonymous user. We will explore the field of User Modeling, specifically Adaptive Hypermedia, to find suitable methods. In our case study, we combine the methods we find to develop a concept for generating user-adapted multimedia presentations about the virtual collection

of the Rijksmuseum of Amsterdam in their website.

1.1 Structure of the Thesis

In chapter 2 we explain concepts and terms of user modeling that are relevant for this thesis. We concentrate especially on the kind of user modeling that has been developed for Internet systems, in particular Stereotyping and Persona Theory. This type of user modeling addresses the anonymous user, meaning that the system has no knowledge about the individual when the session begins, and has no option for long term memory capture, as the time a user spends on a site is limited.

In chapter 3 we discuss the field of Adaptive Hypermedia which is of particular interest for the work described in this thesis, as it specifically researches user modeling and adaptation in dynamic environments. We describe a user modeling method that was developed in this field for the requirements of adaptive web applications visited by short term users, namely Collaborative User Modeling. Finally we discuss what adaptivity consists of in a system that automatically generates multimedia presentations.

In chapter 4 we explain the environment we performed our research in and apply the theory accumulated so far to solve the problems. First, we describe the real-life context in which we apply the results of our theoretical investigation. We explain the architecture of the presentation generation engine Cuypers, and present the part of the Rijksmuseum website which we intend to use it in. After a short analysis of the Rijksmuseum website aimed at defining the actual target group it was developed for, we apply Persona Theory to define several additional user groups of the Rijksmuseum virtual collection. Finally we present our conceptual approach on modeling short term users in dynamic web environments. We demonstrate how an initial user profile based on very little user input can be created, how an automatically generated presentation can be adapted to that user profile, and how the user can give feedback to improve and update the user profile.

In chapter 5 we conclude with a summary of the results and a short overview of further research.

Chapter 2

User Modeling

The field of user modeling attempts to improve the interaction between the human and the machine. Its approach is to make the machine understand and adapt to the user instead of forcing the user to understand the machine in order to work with it ([8], pp 16,17). A key element in adaptive systems is a flexible user model. Specific user data is collected and stored in individual user profiles, which serve to distinguish users from each other and to adapt the interface to the individual requirements. The goal is to make applications and information easily accessible to as many people as possible, ideally regardless of their limitations and disabilities.

In this chapter we want to explain concepts and terms of user modeling that are relevant for this thesis. We concentrate especially on the kind of user modeling that has been developed for Internet systems. This type of user modeling addresses the anonymous user, meaning that the system has no knowledge about the individual when the session begins, and has no option for long term memory capture, as the time a user spends on a site is limited.

First we explain the different viewpoints that exist in user modeling. Next we define which features of a user are to be modeled. Before we describe methods of gathering this data from a user, we discuss the user categories "short term" and "long term". It will become evident that user modeling so far focused on long term users. Nevertheless, on the WWW there is a great demand for solutions to reconcile user modeling to short term users. Therefore short term user modeling is the problem we address in this thesis. In the last section we present the short term user modeling methods that we will apply in our concept.

2.1 Points of view

In any system with a specific function and a target audience, three points of view have to be distinguished.

- The system designer has a model of the typical user. This model influences important decisions concerning features of the system like functionality, presentation and navigation.

- Based on this, an abstract model of the user is implemented into the system. It might deviate significantly from the designer's model of the user.

- Finally, a user develops a model of the system's functionality and logic, which is unlikely to correspond fully with the actual system.

In adaptive systems, the user model implemented into the system is flexible. A user profile is created for every user containing individual information, resulting in the adaptation of some features of the system to the user's requirements at run-time. In the following section we describe what user data is relevant for the system's model of the user.

2.2 User features

Relevant features of the user model are goal, knowledge, preferences and background [2].

2.2.1 Goal

Recognizing the user goal is very important for an adaptive system. The goal is an answer to the questions "why is a hypermedia system used?" and "what is the desired achievement?". It is the most changeable user feature, as it is liable to alter several times in a single session.

2.2.2 Knowledge

User knowledge can be divided into declarative and procedural knowledge.

Declarative knowledge defines the domain specific knowledge. It also refers to general knowledge that is commonly known.

Procedural knowledge tells how familiar a user is with the technical environment. This just describes the experience of the user with computers and the web.

Changes in a user's knowledge state must be recognized and updated in the user profile. Knowledge is most accurately represented in an overlay model. In a closed knowledge space, an overlay model is a copy of the domain concepts and their relationships. In this copy, the concepts that a user is familiar with are marked. This can be done in varying degrees of detail, for example

- in two states: known/ not known,

- in three states: known poorly/ average/ well,

- in 100 states of probabilities expressed in percentage.

In an open knowledge space, such as the web, it would be impossible to create a copy of all concepts. Instead a generic ontology could be used, or the overlay model could be non-existent until a user had her first presentation, after which the concepts in the presentation would make up the overlay model. It would grow at the same rate as the user learned new concepts and represent everything the user had seen.

The overlay model is a powerful and flexible technique that is used in intelligent tutoring and educational systems. It can be used to represent both declarative and procedural knowledge.

2.2.3 Background

A user's background refers to cultural conventions, such as the direction of reading, and beliefs. Depending on the application, it could also be important to represent a user's profession and experience in domain-related areas in the user model.

2.2.4 Preferences

Preferences apply to the presentation of content, for example language, font size, colours, etc. In a multimedia environment, they influence the modality of a presentation, for example the choice between text and audio.

Sometimes users' preferences are versatile, depending on the mood they are in. However, allowing a user to set preferences is not just a playful feature. Personal preferences can break the barrier to the access of content. Some examples of this are setting language, font size or media type. The most common preference on the web is that of language. For many people the size of font is a stumbling block. Not having the option of audio can exclude users who have difficulties in reading. Therefore preferences are an important user feature.

The four user features goal, knowledge, background and preferences form the basis for a user model. They represent the structures a system needs to learn about a user. The remainder of this chapter deals with methods to extract relevant information from a user that can fill these structures.

2.3 Long term vs short term user modeling

When we think about how to retrieve user features, we first have to settle on the functions of the system. The essential questions are: What types of users are likely to use it and how? One important distinction at this level is whether it will serve long term or short term users. This distinction influences the choice of appropriate user modeling methods.

Short term users are anonymous. Whether they make use of a system sporadically or frequently, the system retains no knowledge about them, so that in every session they appear like a new, first-time user.

Long term users are those that register to a system and thus allow the system to establish "memory structures". Adaptive systems make sense especially for these kind of users, because only on a basis of constant observation can a

user profile come close to accurately representing a user. Typical applications for long term users are, for example, educational systems and personalized information systems.

Most user modeling methods are directed towards long term users. However, many web applications are geared especially towards short term users. The big challenge of modeling a short term user is to get enough information from a user to create a valuable user profile without interfering with the current task. In the next section we explain why this is such a difficult attempt.

2.3.1 Explicit vs implicit information about a user

All interaction of a user can be considered as the disclosure of information about the user's features. The information can be provided either explicitly or implicitly.

Explicit user data is the kind of information specifically supplied by a user when prompted to do so by the system. Typically, the user is asked to give some straightforward details, such as age, gender, occupation, preferences, disabilities. Inferences are drawn from this data to determine for example a user's approximate knowledge, goal and preferences. Though appearing to be a fast and easy method to retrieve information about a user, it is in practice very unreliable for several reasons.

First of all, people may not answer the questions. An interesting trait has been observed in users [8]; most people are subject to the "paradox of the active user". This means that they are unwilling to do anything that appears unrelated to the task they set out to do, such as answering a questionnaire. They usually don't like to be deterred by reading introductions or explanations either. The paradox is that doing these things would support their task and help them succeed sooner and better.

Another reason for not answering questions or giving wrong answers deliberately is privacy. Many users are suspicious of the motivation behind the questions. Especially in environments like the Internet, people want to divulge as little personal information as possible, because they have no control over what it is used for. Surveys as described in [9] have shown that 77% of users are (extremely) concerned about being tracked online (Forrester 1999) and 74% are concerned about revealing personal information online (AARP 2000). Sites that require registration information are left immediately by 41% of users (Boston Consulting 1997) and 32% enter fake information (Forrester 1999).

Even if users enter their data completely and truthfully, it has become clear in psychological literature that people are unreliable sources of information about themselves ([13], page 326). This is a problem especially when users are asked to classify themselves according to their level of knowledge in a domain.

Moreover, the value of user data like education, age or gender is debatable. Inferences based on this kind of data will often lead to wrong and discriminating conclusions. What can be inferred from a user who indicates her gender as female, age as 13 and occupation as student? It would be very hard to map these facts to the user's presumed knowledge and preferences, and might annoy her more than being of help.

Explicit questioning is a technique to quickly get data about a short term user. However, because of all the problems described above, it appears to be very unreliable. Therefore it is important to find alternative techniques so that a short term user modeling system does not rely on explicit user data alone.

Implicit user data is gathered by tracking a user's interaction with the system, such as the links they click on or the media items they choose to work with. This might lead to assumptions about the user's goal and knowledge.

For example, a click on an explanation of a term can give rise to the assumption that the user is ignorant of its meaning. On the other hand, it is possible the user is simply curious to see what is hidden behind the link, or wants to reassure herself of her knowledge. The action might even have been random. The problem with implicit data is that there are many explanations for a single action. Only one explanation is correct at a time, and the system has no way of knowing which one it is. It will decide on the most likely explanation, but the decision is mainly based on heuristics. If another action of the user contradicts that assumption, the system must have a mechanism for resolving the conflict. Conflict resolution is a common feature in user modeling systems.

Implicit data only becomes a reliable source once there is enough information available to detect a pattern. Thus, purely implicit modeling is most useful for long term users of a system.

As explicit questioning is no ideal option because it is unreliable, and implicit inferencing makes no sense for a short term user, it looks like we are at an impasse. Yet there can be no adaptation to a user without a minimum of knowledge about her. In the following section, we describe other methods suitable for gathering information about a short term user.

2.4 Short term user modeling methods

One common solution to the dilemma described above is to resort to stereotyping.

2.4.1 Stereotypes

Stereotyping is a user modeling technique that needs very little user input to make inferences about relevant user features. It was first introduced by Elaine Rich in 1979 in the system GRUNDY [13], which models users in order to give personalized book recommendations.

One definition of a stereotype is

> a conventional, formulaic, and oversimplified conception, opinion, or image. [16]

It is assumed that a person whose obvious traits coincide with those of a certain stereotype also has all the other traits that belong to that stereotype. An example of a stereotype is "a woman with an asymmetrical haircut, a single dangling earring and alternative clothes is a feminist. It is assumed she has an academic background, has strong political opinions and buys groceries at organic food stores".

Stereotypes help people to classify their fellow men. Stereotypes have a negative connotation because many people take the assumptions for facts and are sometimes unwilling to revise them.

In user modeling, a stereotype is a mere collection of traits that often occur together in the world around us. When a user triggers a stereotype, all the traits of this stereotype are assigned to her. These traits come with a *value* that indicates to which degree the system assumes that the trait is part of the user's characteristics. A second value, called the *rating*, indicates how sure the system is that this assumption is correct. Each rating comes with a *list of reasons* that explain why the system believes this value to be true.

As mentioned earlier, one important problem in user modeling is how to resolve conflicts that occur when inferences based on user actions result in contradicting traits in the user profile. In stereotyping, the *rating* that shows how sure the system is of the assumption and the *list of reasons* that explain why a particular trait was activated are employed to reason about the validity of either trait in conflict.

Besides implicit assumptions other sources of information influence the user profile, such as direct statements from the user or answers to questions that were generated by the system. These will override assumptions based on inferences [12].

The success of the stereotype method depends on how representative the stereotypes really are, on how accurately a user is mapped to a stereotype and on the veracity of the assumptions made about the user ([8], pp 19,20).

2.4.2 Persona Theory

Persona Theory [4] is a form of stereotyping that was developed for web environments. The user is a central figure in web design. However, it is nearly impossible to reconcile all user characteristics in one typical user, due to the diversity of web users. Once web designers do have a notion as to what types of users they are to expect in the target audience, it is still a difficult task to design the site so that most users within that audience are taken into consideration.

In persona theory, web designers make up a fictitious user, the *user persona*. The more individual and realistic the persona is, the better. Another persona is made up to represent the person or voice who speaks through the site, called the *author persona*. This persona is not to be confused with the web designer or the owner of the site. The site is designed along the lines of communication between the author persona and the user persona. Real users are intended to play the role of the user persona when they visit the site.

Characteristics of the author persona that have to be defined are

- presence of the author persona (e.g. anonymous or identifiable, strong or weak),
- role(s) of the author persona (e.g. tutor, salesperson, advisor, neutral provider of information),
- values of the author persona (e.g. serious, trustworthy, entertaining).

Analogous, necessary characteristics of the user persona are

- role(s) of the user persona (e.g. customer, student, traveler, information seeker),
- values attributed to the user persona (e.g. characteristics, preferences, dislikes, interests).

Various personas can be made up to represent different groups of the target audience. The characteristics of personas are comparable to the traits of stereotypes. The advantage of this approach is that the diversity of a target audience is boiled down to one or a few stereotypes in the form of personas. The website is designed to cater to the personas' requirements, and real users can identify in parts with the persona whose role they decide to play on the web site.

In this chapter we have described the core of an adaptive system: the user model. We have stated that our area of interest are dynamic presentation engines for environments such as the web, and we discussed the user features that a user model in such engines consists of. We have explained that one of the biggest difficulties of applying user modeling to such engines is the short term nature of users' interaction with websites, because they are anonymous so nothing is known about them up front, and there is little time to learn anything relevant about them. We have presented the method of Persona Theory derived from stereotyping, which is useful to overcome that problem. In the next chapter, we explain how the user model is employed to trigger effective adaptation.

Chapter 3

Adaptive Hypermedia

As pointed out in the introduction, the types of systems we are dealing with automatically generate multimedia presentations in dynamic environments. Therefore, the field that specifically researches user modeling and adaptation in dynamic environments, namely Adaptive Hypermedia, is of particular interest for the work described in this thesis.

In this chapter we discuss what adaptation to a user consists of. First we sum up the development of the field of Adaptive Hypermedia and position our work in this field. Then we describe a user modeling method that was developed in this field specifically for the requirements of adaptive web applications visited by short term users. Last we discuss the adaptivity of a system that generates multimedia presentations automatically and point out the difference to regular adaptive hypermedia systems.

3.1 The development of Adaptive Hypermedia

As pointed out, the WWW has made the Internet a desirable platform for communication in many areas, like commerce, education, information, entertainment etc. A characteristic of WWW users is their huge diversity in every aspect, ranging from demographic data to knowledge, skills and preferences. Many sites have to cope with the problem of trying to adapt content, presentation and navigation to short term users, about whom nothing is known and who are not expected to reveal information about themselves readily. The field of Adaptive Hypermedia investigates solutions for these problems [2].

In 1996 Brusilovsky [2] made the following working definition of adaptive hypermedia systems:

> "[...] by adaptive hypermedia systems we mean all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user." (page 88)

Two forms of adaptation are distinguished: adaptive and adaptable.

adaptive systems adapt to a user automatically, based on the values in the user profile.

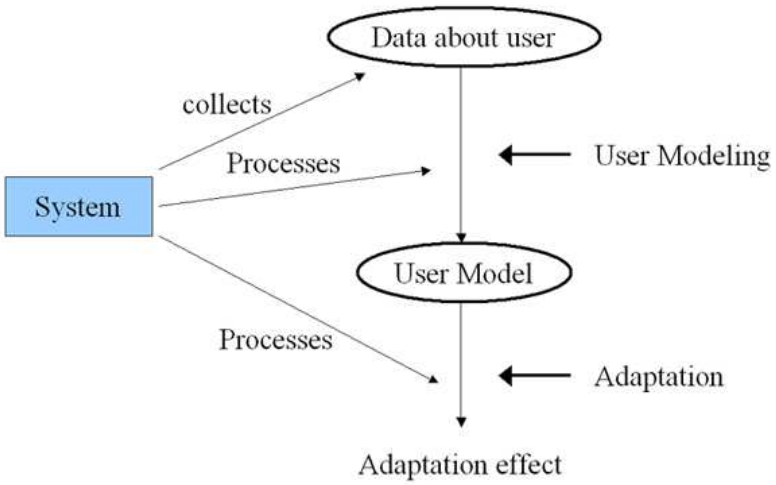


Figure 3.1: Adaptation loop (taken from [2], page 88)

adaptable systems put the user in charge of adapting the system to their liking.

However, making interfaces adaptable is a simple method of letting users convey their preferences to the system. The two forms of adaptation are often combined.

According to Brusilovsky (in [3] on page 89) there are six kinds of adaptive hypermedia systems:

- educational hypermedia
- on-line information systems
- on-line help systems
- information retrieval hypermedia
- institutional hypermedia
- systems for managing personalized views in information spaces

The greater part of research focuses on the first two areas. The system we are dealing with in this thesis belongs to the category of on-line information systems. Examples of classical on-line information systems are electronic encyclopedias and documentations. Amongst more recent applications, information kiosks, virtual museums, handheld guides, e-commerce systems and performance support systems are representatives of this category.

Figure 3.1 on Page 11 shows the overall adaptation process in adaptive software systems. It consists of 3 stages:

1. the system collects user data,
2. this data is processed to form or update a user model,

3. the user model is applied to provide adaptation.

This process is continuously instantiated every time there is new user data. We want to point out here that Brusilovsky uses the term "user model" in a broader sense than we do. In this thesis, we call the generic model of a user "user model", but when we refer to data about an individual user we call it the "user profile".

In chapter 2 we introduced the user modeling method of stereotyping which serves to make a user profile with initial assumptions about a user based on very little input. Adaptive Hypermedia provides a method for letting the user show whether the assumptions are correct, providing the system with new user data that is processed to improve the user profile, as described in Figure 3.1. This method is called "Collaborative User Modeling".

3.2 Collaborative User Modeling

Especially in a short term environment, explicit input from the user is needed to be able to update and improve a user profile, so that the adaptation can hit the mark. The user has to be provided with various feedback options on what has been presented. We employ two methods, namely:

1. Make the presentation adaptable. The way content is presented can be adaptable, as well as the content itself. This will give some information about a user's preferences, knowledge and goal.

2. Let users express their level of satisfaction with the presentation. This indicates to which extent the presentation was able to fulfill a user's expectations, which coincide strongly with the user's goal.

Input gained from the user in this way will update the user profile, so that everything that was learned about a user in one setting can be applied in other contexts.

We now have enough methods to create a user profile for a short term user. In the next section, we discuss the methods that serve to adapt a system to a user based on their profile.

3.3 Adaptivity of an automatically generated presentation

Most adaptive hypermedia systems are the solution to the following problem: Information needed by users with varying goals and levels of knowledge is presented in the same static information space. Users can easily get lost in an information jungle if there is no form of guidance. Adaptation provides guidance. Based on a user profile, the best path through the information is made visible to users with the techniques of *adaptive presentation* and *adaptive navigation support* [2]. Many techniques aim at hiding or disabling content or links that are considered irrelevant or inappropriate for a specific user's state of knowledge and goal.

Content	Style	Structure
Topic	Look&Feel	Navigation
Complexity	Layout	Spatial order
Amount	Colours	Temporal order
Media	Rhythm	Choices/ Links

Figure 3.2: Adaptable features of a generated presentation

These techniques are quite useful to adapt a presentation in which the content is defined in advance. However, a presentation that is generated automatically poses a completely different situation. Adaptation does not begin after the content, style and structure have been defined. It applies right before that step, because the complete presentation is adapted to the user. Adaptable presentation components are the content, the style and the structure [20]. Figure 3.2 on Page 13 shows what these components consist of.

This means that before a presentation is generated, the system already needs to have a user profile. The complete presentation depends on a user's expectations. In the following chapter, we describe how we solve the problem of gathering enough information from a short term user to create a user profile that serves to effectively adapt an automatically generated presentation to the user's expectations, specifically goal, knowledge, background and preferences.

Chapter 4

Short term user modeling in an adaptive presentation generation environment

In the second chapter we defined user features that need to be modeled for presentation engines in dynamic environments. We argued that the user modeling method of *stereotyping* is the most suitable for short term users and described a stereotype technique developed for application in the web, *Persona Theory*. In the third chapter, we introduced the term *Collaborative User Modeling* which applies in adaptive hypermedia, signifying that short term users must collaborate and provide some information about themselves, to significantly improve the user profile. Relevant user information is obtained by providing feedback options. Finally we defined the presentation components that form the basis for user adaptation.

In this chapter, we want to explain the environment we performed our research in and apply the theory accumulated so far to solve the problems. First, we describe the real-life context in which we apply the results of our theoretical investigation. We explain the architecture of the presentation generation engine Cuypers, and present the part of the Rijksmuseum website which we intend to use it in. After a short analysis of the Rijksmuseum website aimed at defining the actual target group it was developed for, we apply Persona Theory to define several additional user groups of the Rijksmuseum virtual collection.

Finally we present our conceptual approach on modeling short term users in dynamic web environments. We demonstrate how an initial user profile based on very little user input can be created, how an automatically generated presentation can be adapted to that user profile, and how the user can give feedback to improve and update the user profile.

4.1 The context

This work has been performed at the Centrum voor Wiskunde en Informatica (CWI), in the context of the research within the Multimedia and Human-Computer interaction group. This group has developed a database-driven hy-

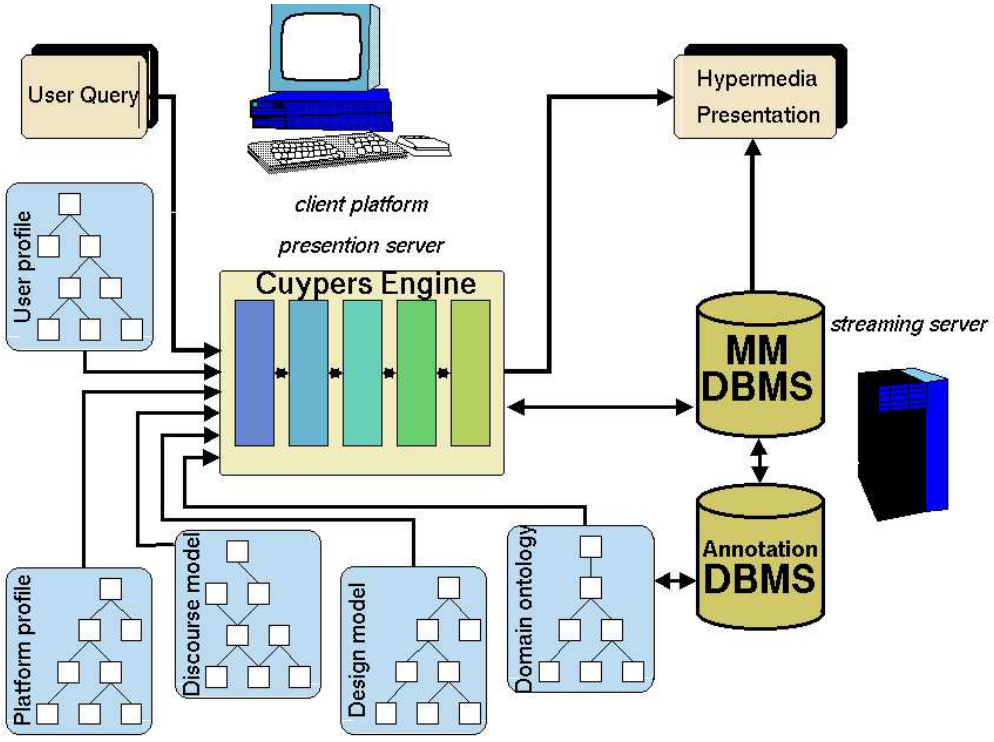


Figure 4.1: The architecture of the Cuypers system (taken from [21], page 5)

permedia environment named Cuypers [18], [19], that supports the generation and presentation of web-based multimedia. Its demonstrator accesses the ARIA database of the Rijksmuseum in Amsterdam to generate multimedia presentations on the virtual collection. In the following we describe these two components of our case study.

4.1.1 The presentation generation engine

The Cuypers engine is an experimentation platform for automatically generating adaptive multimedia presentations on the web [19]. Figure 4.1 on Page 15 shows which information sources are needed to create such a presentation. The module "User profile" is designated to provide the relevant user features described earlier: goal, knowledge, background and preferences. The profile is empty until the system has gathered this information from the user. The same applies to the module "Platform profile". Its task is to supply information about the user's platform and internet connection which it can only gather at run-time. The module "Domain ontology" models the domain at hand. The overlay model that represents a user's knowledge is a copy of this ontology. The "Discourse model" provides a framework to structure presentations, and the "Design model" contains rules that dictate the style of a presentation. Our main focus lies on the module "User profile".

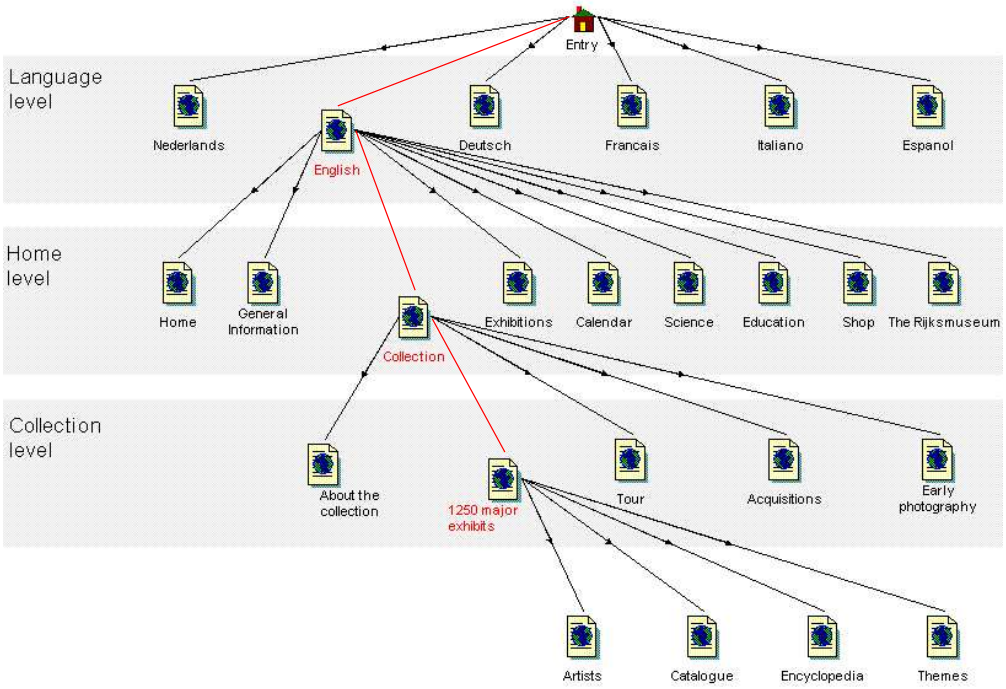


Figure 4.2: Illustration of the sitemap of the Rijksmuseum website and of the path to the menu item "1250 Major Exhibits"

4.1.2 The cultural heritage environment

We investigate in our case study the use of the Cuypers generation engine in a cultural heritage environment, specifically in the website of the Rijksmuseum in Amsterdam [14]. Figure 4.2 on Page 16 presents the sitemap of the Rijksmuseum website. Various scenarios of applying the Cuypers engine are possible, e.g. in the areas "Collection", "Exhibitions", "Education" or "Science" on the Home level. All these areas provide the sort of information that can be adapted to the user needs. A counter-example is the area "General Information", which contains static information that is the same for every user, such as opening times, prices, route description etc. We have selected the area "Collection", and here especially the menu item "1250 Major Exhibits", which is highlighted in figure 4.2, to outline our approach for short term user modeling in adaptive presentation generation.

The virtual collection that is presented in this part of the Rijksmuseum website was originally developed for an information kiosk system in the Rijksmuseum itself. The information content that was to be displayed in this system was designed to fit on a small kiosk screen with low resolution. It was targeted at museum visitors with little knowledge about art. The aim of the kiosk is to facilitate easy access to information about the artefacts and their location in the museum. At a later stage the kiosk, including its ARIA database, was added into the Rijksmuseum's web environment. As the pages shown to users in this part of the web environment are already automatically generated, this section forms the ideal situation to apply our work. Thus, we first de-

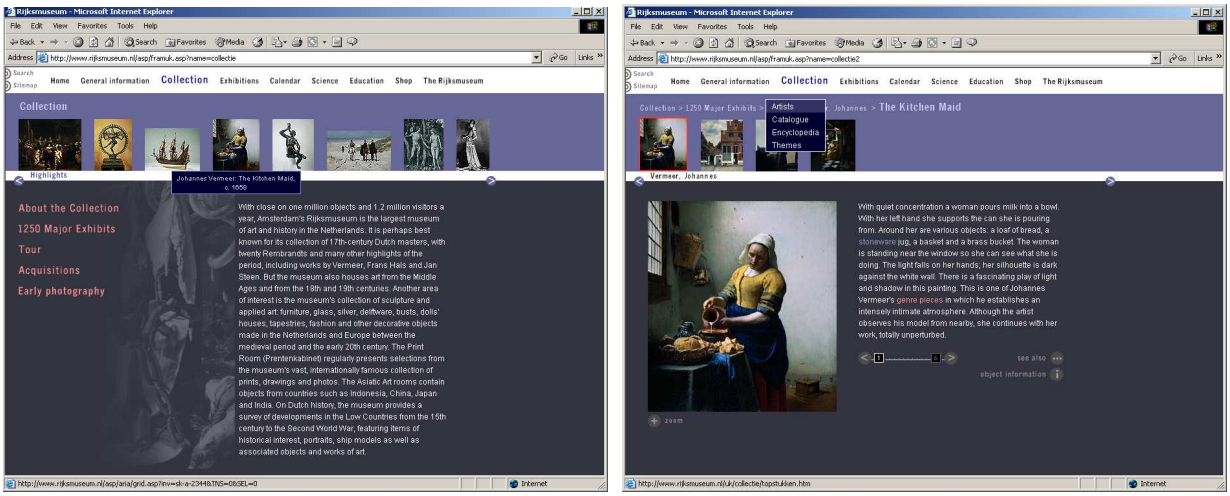


Figure 4.3: Screenshots of the Rijksmuseum website to illustrate navigation and design

scribe its current functionality and its target group, then show how it could be improved with the help of the Cuypers presentation generation engine.

Currently, the user can search for any of the 1250 major exhibits by artist, encyclopedia, catalogus or theme. The resulting screen of a search query is exemplified in the second screenshot in Figure 4.3 on Page 17. The content area presents the artefact to the left and an accompanying text to the right, and the purple, horizontal navigation bar above provides thumbnails of related artefacts as links.

Before we can develop a concept for making the presentation of the collection user adaptive, we need an understanding of the current target group of the Rijksmuseum virtual collection. In the following section we describe the target group that the current author reconstructed from analyzing that part of the website.

Target group analysis

From interacting with the Rijksmuseum virtual collection we have discerned a target group with the following characteristics (all explanations of the Rijksmuseum website in the following description refer to Figure 4.3 on Page 17):

High procedural knowledge The user has to be familiar with various navigational concepts to be able to surf this site comfortably. In the left screenshot of figure 4.3 we see that the home level navigation is horizontal and occupies the white space at the top of the page. The second level (here: Collection) navigation is vertical, placed on the left side of the black content area. The purple bar above contains short-cuts to the images presented in it as thumbnails. Rolling over these thumbnails with the mouse produces a black text box with the name and date of creation of the artefact. On one screen three types of navigation are combined that all lead to three different levels of the website.

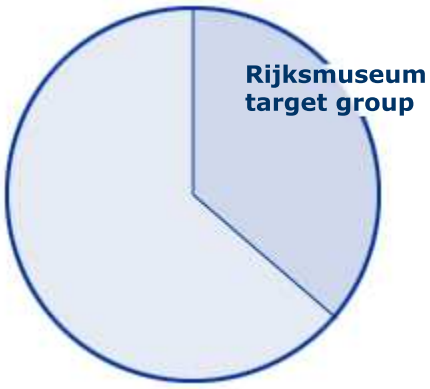


Figure 4.4: All potential users of the Rijksmuseum website and the selected target group

Explorative The level of interactivity in this site is very high. The navigation is highly interactive, as it provides many short-cuts to users who know what they want. The content itself is also very interactive. There are two different types of links in the text, distinguished by colour. One type has the function of a glossary. Clicking on it opens a text box with an explanation of the term that was clicked on. The other type takes the user directly into a new presentation describing the subject of the link. The interactivity makes it possible to explore any alley that appears interesting, but it is hard to find the way back. Thus, the target user is assumed to be explorative, playful and curious.

Modern and Mature The user appreciates a sophisticated design and the use of innovative funky flash animations. The user's platform has to fulfill many requirements to do this site justice, as it only works in Internet Explorer, needs a flash player and contains many images. It also contains a lot of unscalable text, so the ideal user has good eyesight and likes to read information (as opposed to hearing or watching it).

In summary, the **Rijksmuseum user** is a regular WWW user familiar with its presentation techniques, has good equipment and a fast connection to the Internet. She is curious and explorative and likes to be challenged by a website. She uses the virtual collection of the Rijksmuseum website to read up on artefacts that especially interest her, and to leisurely browse and wander through the virtual collection.

However, which percentage of users visiting this website can identify with the user persona described above? Many potential user groups are obviously excluded by this website, for example children, users with less powerful equipment and users that are unfamiliar with the Internet. Other users may be put off by the design or the form in which content is presented. Here we are confronted with the classical problem of web design: a website has to address a large and diverse user group, so the web designer chooses to cater to one target group and leave out all others, instead of trying to please everyone and succeeding only in the opposite, see Figure 4.4 on Page 18.

This is an unsatisfactory solution, because too many users are excluded. In chapters two and three we described techniques from the fields of User Modeling and Adaptive Hypermedia that can compensate the restrictions of static websites. In the rest of this thesis we will demonstrate the application of these techniques in the part of the Rijksmuseum website that presents their collection. The presentation of the collection becomes adaptive with the help of the presentation generation engine Cuypers.

First we look at possible scenarios of usage to determine what types of users we can expect. Some typical short term users could be:

- a tourist who has visited the museum and wants to learn more about a specific painting that was particularly fascinating,
- a student who has to write an essay on an art topic,
- somebody solving a crossword puzzle,
- a teacher who needs to look up information while preparing slides for class,
- a child who is surfing the website.

Long term scenarios are also possible:

- art students and teachers who consult the site regularly,
- art amateurs around the world,
- pupils of primary or secondary education whose teacher uses the website in art class for the duration of a term.

There is much scope for intelligent adaptation to users who register at the site and use it regularly. However, we draw the line here and concentrate on short term users. After all, everyone is a short term user to begin with.

The first and toughest problem to solve is getting enough information about an unknown user before the generation of the first presentation, without demanding explicit information. We apply persona theory to develop a solution.

4.2 Personas of the Rijksmuseum website

We approach this problem from the perspective of a web designer, that is, we define the user group, only that we define it based on various persona types, as described in Figure 4.5 on Page 20.

A target group can be described by a stereotype. We have chosen three of the most prevalent stereotypes besides the existing one. These are:

Serious user This user is looking for facts and wants them fast. She expects functionality similar to a dictionary. The information should be comprehensive yet concise, revealing facts specific to the subject as well as its role in art and history. We call this the *dictionary* stereotype.

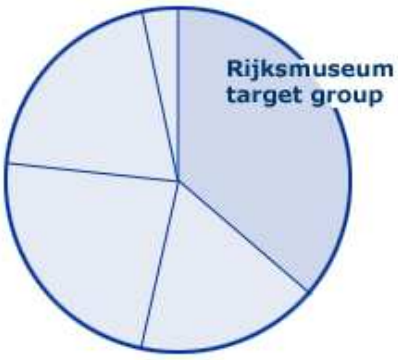


Figure 4.5: All users of the Rijksmuseum website divided into various target groups

Passive user The passive user expects to be informed but also entertained. The presentation should make the subject come alive by adding the wider context of a search topic, touching on social, political and personal matters. All this information should be structured in the shape of a story, spiced with interesting facts and anecdotes. The passive user is characterized by preferring little interaction, so she can lean back and watch. We call this the *storyteller* stereotype.

Child user A young user has specific requirements that deviate completely from the three other stereotypes. This user needs to be motivated by the site to remain on it. She does not necessarily have the goal to learn something about art. Her goal is mainly hedonistic, she wants to be entertained and integrated. This demands a high level of interactivity and a cheery colourful design, ideally in the context of a game. We call this the *game* stereotype.

Please note that these stereotypes are not empirically justified. They only serve as placeholders to illustrate the concept of adapting to short term users. The results of a thorough target group analysis can easily replace the user types described above.

The stereotypes can in turn be expressed in persona theory by defining an author persona and a user persona for each user type, see Table 4.1 on Page 21.

In the next section we explain how these personas are applied to our system.

4.3 The channel idea

The problem we are trying to solve is, getting relevant user data before the first presentation is generated. If a user were to convey to the system which persona she currently embodies, it would be enough data to start with. So, we need to present the personas in such a way that users recognize their character and can choose the one which they identify with at that moment, or which suits their goal and mood.

Figure 4.6 on Page 22 depicts the introduction screen users are confronted with. We chose graphics to convey the message because they are the common

Stereotypes	Author Persona	User Persona
Dictionary		
Presence	weak	
Role(s)	Information provider	Researcher Information seeker
Values	reliable scientific thorough precise	knows what is best critical determined independent
Storyteller		
Presence	strong	
Role(s)	Expert Museum guide	Consumer Voyeur
Values	confidential entertaining experienced	curious compassionate gossipy
Game		
Presence	apparently weak but strong in the background	
Role(s)	Supervisor	Pleasure seeker
Values	challenging captivating educational	playful imaginative
Rijksmuseum		
Presence	weak	
Role(s)	Host	Guest
Values	cutting edge hip creative	sophisticated modern mature

Table 4.1: The author and user personas of the Rijksmuseum collection

denominator of all four personas. Additionally, rolling the mouse over each image could trigger an audio track and an alternative text explaining their meaning.

Once a user has chosen a channel, she is assigned to that stereotype. The system is triggered to adapt all further interaction and presentation to the stereotype's rules and templates. After this point *Collaborative User Modeling* techniques (see section 3.2 on Page 12) are applied to individualize the style, structure and content of a presentation to the particular user. The choice of a channel is followed by defining the topic of the presentation. This is done in terms of a search query. Once the topic and style are determined, the presentation can be generated. Note, this general procedure is slightly different in the game channel, as here no query is required.

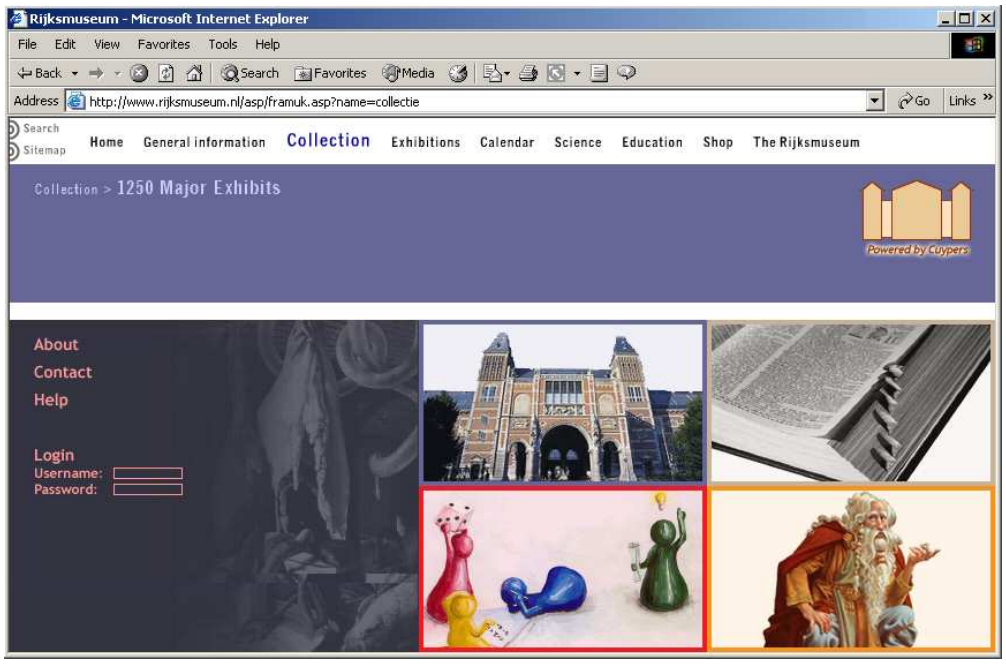


Figure 4.6: The four channels: Rijksmusem, Dictionary, Game, Storyteller (left to right, top to bottom)

4.3.1 The search query

In the search query, users tell the system what the content of the presentation should be. This preliminary step already offers scope for adaptation. The user personas are assumed to have different preferences in the manner in which they convey to the system what they are looking for.

The Dictionary search query should offer an extensive mechanism with which the user can specify exactly which topics are of interest. All graphics are omitted in favour of short loading time. It is assumed that this user has a clear notion of the designation of the search topics.

In contrast, the Storyteller search query has reduced functionality to ensure minimal interaction. It contains graphics to enhance the attractivity of the interface and facilitate the search. The assumption is that Storyteller users sometimes rely on the visual memory of a search topic. A Storyteller presentation requires the user to specify additional parameters such as duration and character of the story.

In the Game channel the search query is omitted. The user jumps straight into the game.

The Rijksmuseum search query is similar to that on the Rijksmuseum website, using the same taxonomy and design.

Once the search query is established, the system knows what the *content* of the presentation should be. The stereotype determines the *style* and the *structure* of the presentation. These three variables are all the information that is necessary to generate a presentation for an individual user (see section 3.3 on Page 12).

4.3.2 Feedback through interaction with the presentation

The interaction with the presentation is set up to serve the technique of Collaborative User Modeling. This means that presentations in every channel provide opportunities for giving feedback.

Preferences can be inherited directly from changes the user makes in the navigation bar. This influences the manner in which content is presented. Feedback on the content itself is derived from other actions. Three feedback possibilities are considered.

1. The user likes the presentation as it is.
2. The user wants something slightly different.
3. The user wants something completely different.

In the first case, the user presumably matches the persona very well. In the last case, the user hates the persona that she chose. She will either make another attempt at finding what she wants through another channel, or leave the site. Any of these actions are clear. A more subtle task is to elicit the corrections that are needed in the second case. Users must be provided with the opportunity to influence the direction of the presentation.

We only consider feedback within a persona. A further possibility is to allow switching between personas, but the time constraints on this thesis did not allow us to investigate this feature.

The remaining part of this chapter gives a detailed explanation of the channels Dictionary, Storyteller and Game, as well as a scenario visualizing their functionality and look&feel. The Rijksmuseum channel is omitted, because it resembles the Rijksmuseum website.

4.4 Dictionary channel

To recall the most distinctive characteristics of the Dictionary channel; it is best characterized by the credo “form follows function”. The highest priority is to present relevant information quick and concise. Design’s only function is to guide users and make them aware of the options they have. Any element that does not contribute to this goal is superfluous, and thus omitted. This channel does not impose restrictions on the user. The user is expected to know exactly what she wants and how.

4.4.1 Data structure

Figure 4.7 on Page 24 represents the data structure in this channel. It depicts five information nodes and their relationships to each other. The topics are artist, artefact, style, genre and technique. This choice is based on an investigation of classifications on art sites such as the Rijksmuseum [14] and the Getty Museum [6], and a small analysis of an art dictionary [5]. We understand these concepts as they are defined in the Art & Architecture Thesaurus (AAT) [6]:

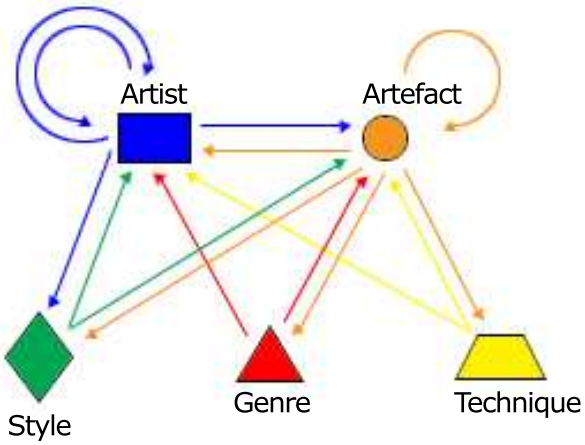


Figure 4.7: Dictionary information nodes and their relationships

Artists Refers specifically to people who produce work in the visual arts.

Artefacts Objects made, modified, or used by humans.

Style Configuration of artistic elements that together constitute a manner of expression peculiar to a certain epoch, people, or individual.

Technique The manner in which an artist or craftsman uses the technical elements of a medium to achieve a desired aesthetic effect.

The term "genre" is ambiguous, as it is used both for the concept "genre" and for an element in it, "genre piece". The AAT defines "genre" in the latter sense:

Genre Use for pictorial representations, which may be in various media, that represent scenes or events from everyday life; usually used with another term such as "paintings" or "prints".

We use genre in the sense that the AAT defines it, namely as **Visual works by subject type**. This covers a classification of the theme of an artefact into categories such as history, landscape, still life, portrait, genre piece, etc.

To understand the relationships in Figure 4.7 on Page 24 it is necessary to consult Table 4.2 on Page 25. This table shows what we define as relevant information for each node. The first column lists the facts belonging to a specific subject of a node. The second, third and fourth columns define the possible type of relationship between information nodes, and the cardinality. Every line in these columns corresponds to one arrow in Figure 4.7 on Page 24.

For example, the relationships of an artist should be read in the following way:

1. An artist was influenced by one or more other artists,
2. an artist influenced one or more other artists,
3. one or more of the artists' artefacts are considered to be the most important works,

4. an artist was part of one or more style movements.

Relationships marked with an (o) are optional, because they might not exist for a specific artist. In this case, all relationships are optional except artefact. Every artist must have one or more artefacts that characterize her art.

	Facts	**Relationships**	**to**	**Cardinality**
Artist	Image	Influenced by (o)	Artist	1:many
	Full name	Influence to (o)	Artist	1:many
	Date of birth	Most important works	Artefact	1:many
	Date of death	Part of movement (o)	Style	1:many
	Place of birth			
	Place of death			
	Education			
	Introduction			
Artefact	Image	Artist	Artist	1:1
	Name	Similar to (o)	Artefact	1:many
	Date	Type of Style	Style	1:1
	Artist	Type of Genre	Genre	1:1
	Material	Type of Technique	Technique	1:1
	Size			
	Description			
Style	Name	(First) used by	Artist	1:many
	Definition	Examples	Artefact	1:many
	Period			
Genre	Name	Typical for	Artist	1:many
	Definition	Examples	Artefact	1:many
Technique	Name	(First) used by	Artist	1:many
	Definition	Examples	Artefact	1:many

(o) = optional

Table 4.2: The relevant data pertaining to the information nodes of the Dictionary channel and their relationships to each other

On the request of a presentation about one of these topics, all facts and relationship data belonging to this topic as listed in Table 4.2 on Page 25 are retrieved. It is likely that the result set contains too much material to present concisely. Therefore we employ Rhetorical Structure Theory to structure the data in nucleus-satellite relations [15]. In a nucleus-satellite relation the nucleus is a piece of knowledge and the satellite is a related, though less important piece of knowledge. There are over twenty possible categories of satellites. We have chosen three of them for this work, settling on *example*, *elaboration* and *justification*. To apply this construct to the presentation we determine that of

Figure 4.8: First screen after choice of Dictionary channel

Figure 4.9: Choice of topics

all facts and relations that belong to a topic, only the nuclei are shown, and links to their satellites are provided. This gives users a good general overview over the important information belonging to a specific topic, and puts them in control of what else they can see.

In the Dictionary channel the user is presented with an overview and has to take charge from there. It is important that the logic of the system is transparent to users, because the users make the decisions. In the following section we demonstrate a concrete example of a search query and the resulting presentation.

4.4.2 Scenario Dictionary channel

We introduce Max, the user. Max is following a course about the history of art at college. This term, every student has to write an essay about a painting from a specific era. Max chose for Vermeers "Kitchen Maid" which represents Dutch art from the 17th century. Now he is searching for material for the essay. Max knows that Johannes Vermeer painted "The Kitchen Maid", he also remembers that Pieter de Hooch was a contemporary of Vermeer, and he vaguely knows that genre has something to do with it. He wants in-depth information about all these topics, and especially about other important influences in this context that he does not know about.

He has clicked his way through the Rijksmuseum website and found the section "1250 Major Exhibits", Figure 4.6 on Page 22. He has also recognized that the picture depicting a dictionary probably holds the most relevant information for his cause, and clicked on it. Now he sees the screen shown in Figure 4.8 on Page 26.

Here the user specifies which of the five information nodes artist, artefact, style, genre or technique should be in the search query. Any combination is allowed. The order in which topics are selected conveys to the system how the user ranks them. Max chooses the topics artist, artefact and genre in that order, Figure 4.9 on Page 26.

The process of querying is started, which results in a new window as de-

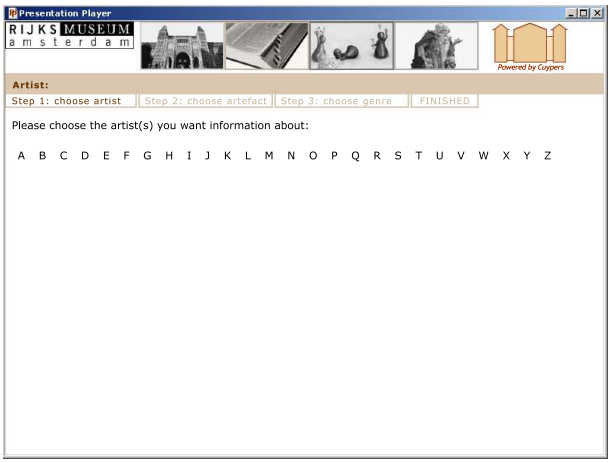


Figure 4.10: First screen of search query, starting whith the artist

Figure 4.11: Clicking on the letter V...

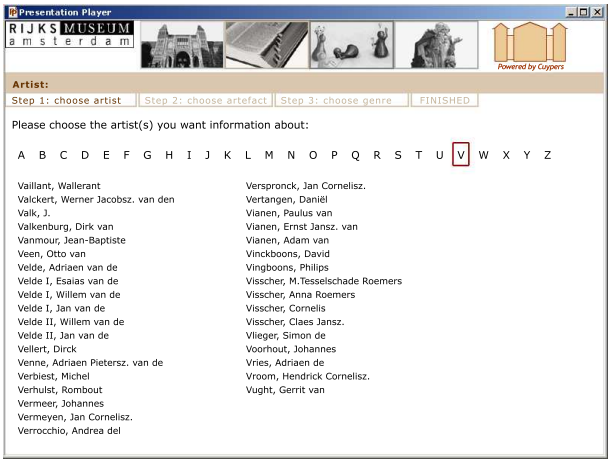


Figure 4.12: ...returns all artists with V

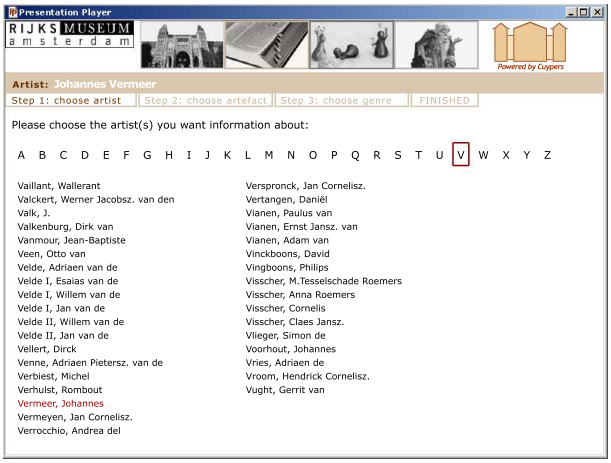


Figure 4.13: Choice of Johannes Vermeer

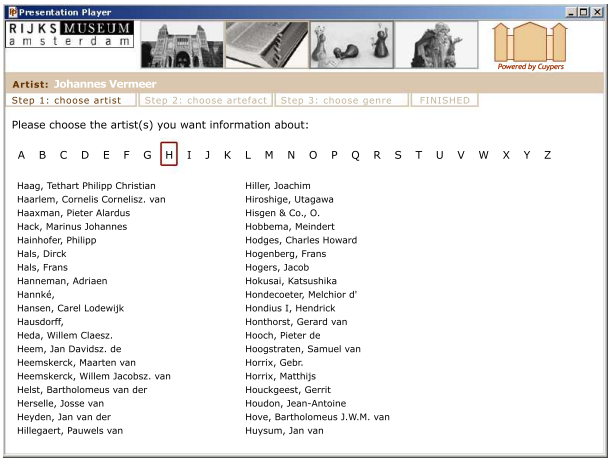


Figure 4.14: Same procedure with the letter H

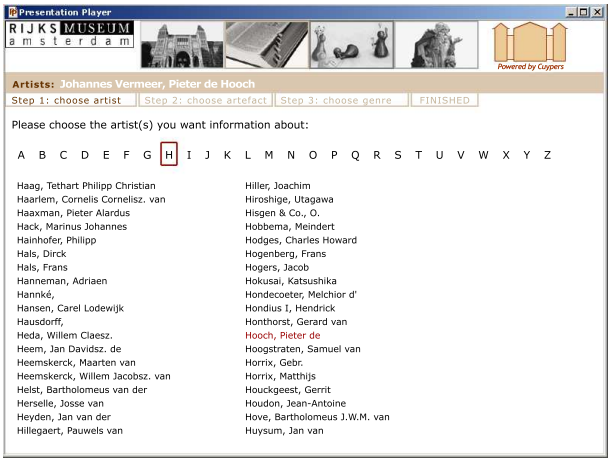


Figure 4.15: Choice of Pieter de Hooch

Figure 4.16: Step 2, choosing an artefact

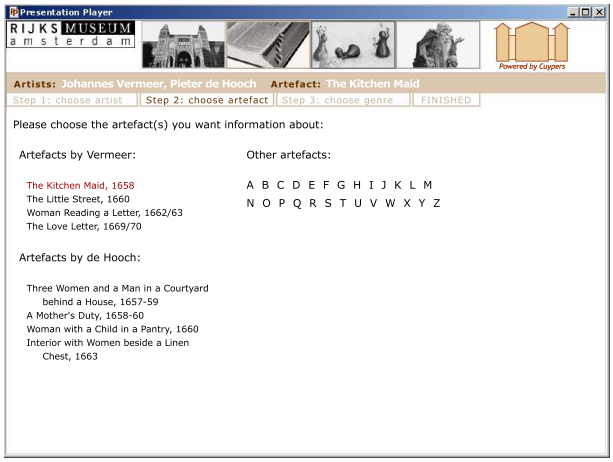


Figure 4.17: Choice of "The Kitchen Maid"

scribed in Figure 4.10 on Page 27. It intentionally looks very bare, because it contains only strictly relevant elements. The search query is organized in a linear fashion. Because the art domain is quite large, selecting the subject for each topic is a task of various steps. The interface is designed so that the user knows exactly what will happen and understands the necessity of the procedure.

The logos of the Rijksmuseum and the Cuypers engine grace the top of the page, indicating that the presentation is still part of the Rijksmuseum website, in spite of the fact that it looks completely different. Between the logos the images are placed that depict the four channels, of which all are greyed out except for the active one, in this case the Dictionary channel. Besides the functionality of a reminder, the row of images could also serve as mechanism to facilitate channel swapping. The thesis does not cover this feature, but it is definitely a part of the concept that needs further investigation.

The next element below is the query bar. It contains the single word "Artist", the first topic that was chosen. The following line of information presents the number of steps that are necessary to complete the query, of which the current one is highlighted. The number of steps depends on how many topics were chosen. Finally, the content area prompts for a specification of the subject of the first topic.

Max clicks on the letter V in the alphabet, Figure 4.11 on Page 27, and gets a list of all artists beginning with V, Figure 4.12 on Page 27. Here he selects Johannes Vermeer. The artist's name appears in the designated query bar, indicating that the system has acknowledged the user's choice, Figure 4.13 on Page 27. Since Max is also interested in Pieter de Hooch, he clicks on the letter H in the alphabet, to get a list of all artists beginning with H, Figure 4.14 on Page 27. After he selects Pieter de Hooch both artists are displayed in the query bar, Figure 4.15 on Page 27. There is no limit to the number of subjects a user can select. The user determines when it is time for step 2 by clicking on it.

In the next step the name of the artefact will be determined. The data supplied by the user is already taken into account to adapt the information

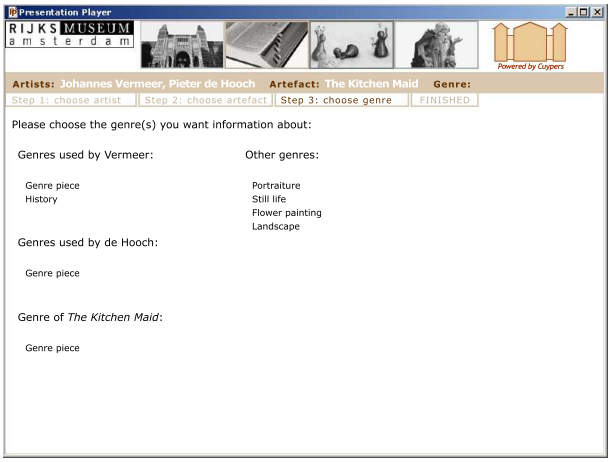


Figure 4.18: Step 3, choosing a genre

Figure 4.19: Choice of "genre piece"

structure to the user's goal, Figure 4.16 on Page 28. In this case, knowing that the artists of interest are Vermeer and de Hooch, the system lists all artefacts by these artists in a prominent position, distinguished in groups. The artefacts are listed with title and date in order of creation, to give the user a good overview. For other artefacts the user can click on the alphabet to search by title.

Max finds the artefact he was looking for right at the top: "The Kitchen Maid", painted in 1658 by Vermeer. He selects this painting and it appears in the query bar, Figure 4.17 on Page 28.

The last step follows exactly the same pattern. Previously gained information is used to supply the user with a good overview of the connection between the topic genre and the other topics of interest, Figure 4.18 on Page 29. The genres used by Vermeer and de Hooch are distinguished, as is the genre of "The Kitchen Maid". Max selects the genre "genre piece", because he is curious to know the difference between either, Figure 4.19 on Page 29.

Max has finished his search query. The system is busy processing the query and taking decisions. At this point all modules of the Cuypers engine, Figure 4.1 on Page 15, are consulted. Every module has to contribute some intelligence to the process of generating a presentation. In this case, the *user profile* tells the system that the user is of stereotype "Dictionary", and that his goal is to learn about Vermeer, de Hooch, "The Kitchen Maid" and "genre piece". The *Platform profile* informs the system about the software and hardware used by Max, so that the presentation does not exceed his machine's capability. The *Discourse model* provides the structure of the presentation. Based on the user profile, Dictionary discourse is selected. This is a structure in nucleus-satellite relationships, as explained earlier. In the *Design model* decisions are made concerning colour of text and background, layout of elements on the page etc. Again the user profile demands that the design be mainly functional. Other influences on design can be for example rules ensuring that Corporate Identity colours are considered. In the module *Domain ontology* relevant information for this presentation is selected. Criteria for determining relevance are that pieces of knowledge be suitable for Dictionary mode and have the subject of

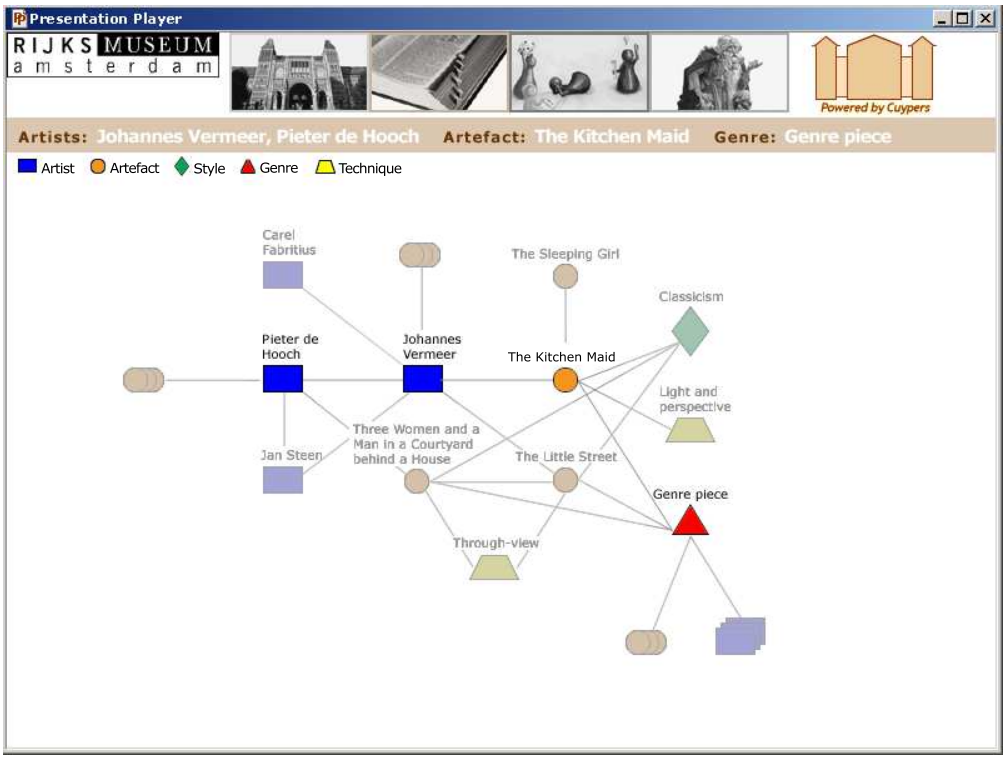


Figure 4.20: The network

any topic of the search query, or be closely related to these topics.

4.4.3 Data visualization

A network is generated showing the subjects of the search query as nodes as well as further related nodes, and the relations between all nodes, Figure 4.20 on Page 30. The categories of the nodes are represented by both geometrical structures and colours. This information is redundant so that colour blindness is no obstacle. Through the network the underlying data schema becomes transparent to the user. The topics that Max selected are highlighted, all other parts of the network are greyed out. Moving the mouse over other nodes in the network highlights them, indicating that any node of the network is a link to information about it, Figure 4.21 on Page 31.

In this way Max gets the big picture. He sees what artists were related to Pieter de Hooch and Johannes Vermeer, which paintings they made that compare to each other, and which paintings compare to “The Kitchen Maid”. Furthermore he learns what the style, genre and technique of “The Kitchen Maid” are. In addition, more examples of artefacts and artists related to the genre “genre piece” are available.

Max clicks on the node of “The Kitchen Maid”. She is, after all, the object of his interest. The shape representing the artefact blows up to a rectangle containing the presentation, Figure 4.22 on Page 31. It is still connected to the network around it at two points on either side. The presentation is structured

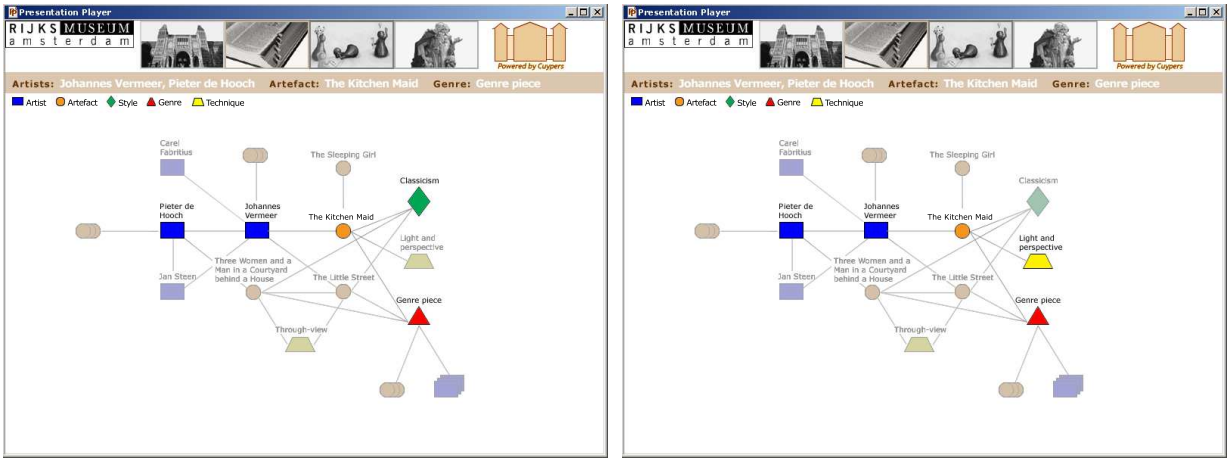


Figure 4.21: The roll-over effect

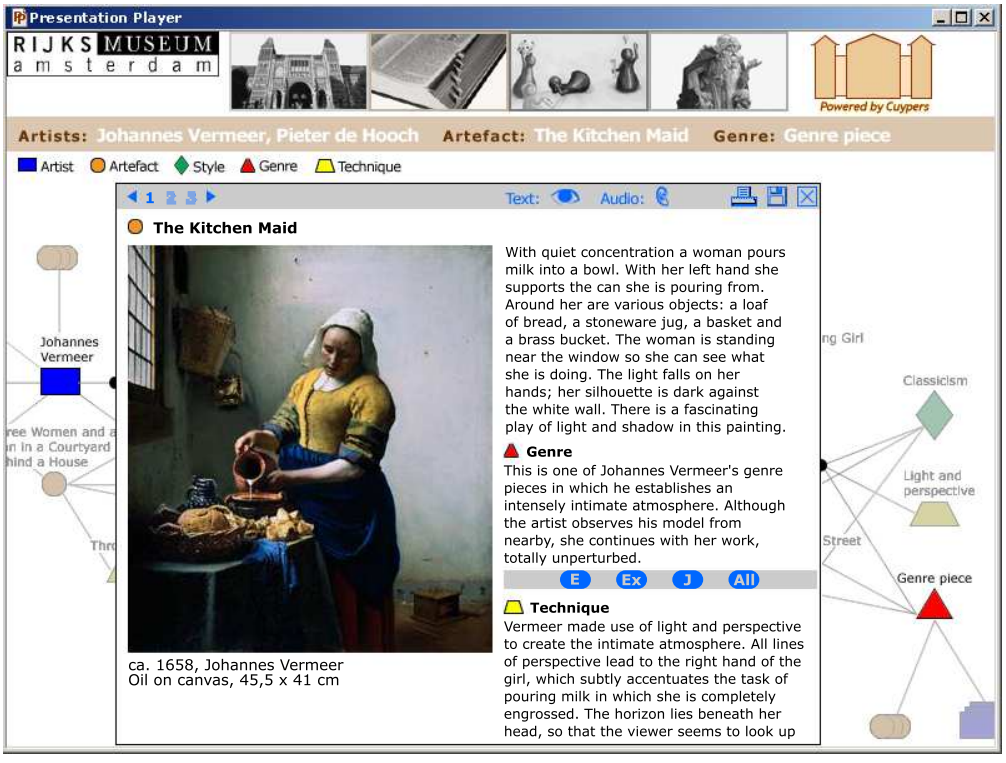


Figure 4.22: The presentation

Figure 4.23: The navigation bar

Figure 4.24: The presentation in disabled text mode

in pages. Users can read each page at leisure, and move freely between them with the help of the navigation bar.

The presentation has a navigation bar at the top, Figure 4.23 on Page 32. At the left the number of pages is displayed, where each page number is a link. The next two icons in the navigation bar serve to disable or enable text and audio. Per default both are enabled. The audio file contains the same information as the text. Text is the default allowing quick perusal of the content. The last group of icons embody the functions print, save and close.

The content of the presentation is structured according to the data schemata explained earlier (see Figure 4.7 on Page 24 and Table 4.2 on Page 25). First all the facts pertaining to the artefact are displayed: name, image, date, artist, material, size and description. After this, the relationships follow. In this presentation the type of genre comes first, then type of technique, on subsequent pages type of style, artist and similarity to other paintings, if available. Of these relationships only the nucleus is shown, and links to their satellites elaboration, example and justification are provided. A user can choose to click on any one of them or on the link "all" for all.

First we demonstrate what happens when text is disabled. If users want to listen to the text and focus their vision completely on graphical data, they

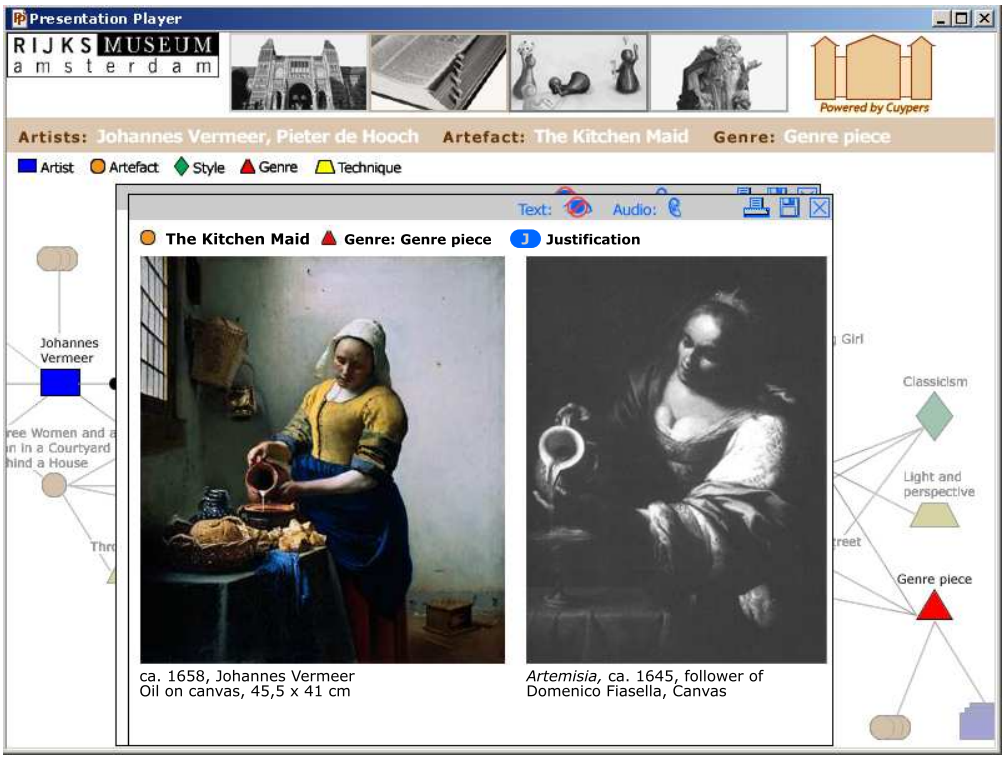


Figure 4.25: The presentation in disabled text mode, satellite justification

can disable text in the navigation bar, Figure 4.24 on Page 32. It appears that the only graphical data on the nucleus level of the presentation is the image of "The Kitchen Maid", because all the data now fits on one page. The links to other pages in the navigation bar are removed. There is even enough space to enlarge the image. In the textfield to the right, all relations are listed with their satellites. The relation "similar to" does not have the satellite "example", because nothing was found in the database. Synchronized with the audio files, the headings of the relations will be highlighted as they are being described. Thus the user has the same options as in enabled-text mode.

Now we will look at what happens if the user clicks on a satellite. Max really wants to know what makes "The Kitchen Maid" a genre piece, so he clicks on justification. A new window opens, Figure 4.25 on Page 33. It is not connected to the network, but it is a subwindow of the first. It has the same settings as the parent window, text is disabled, audio enabled. The title of the window indicates the current position and the path that led to it. The justification for the claim that "The Kitchen Maid" is a genre piece is delivered by an audio file.

Max wants to read the text at his own speed, so he enables text and disables audio, Figure 4.26 on Page 34. The content spreads over multiple pages and the page navigator reappears in the navigation bar.

Closing this window brings Max back to the parent window, the presentation on "The Kitchen Maid" with disabled text. On closing this Max returns to the network and can decide what other node he wants to investigate.

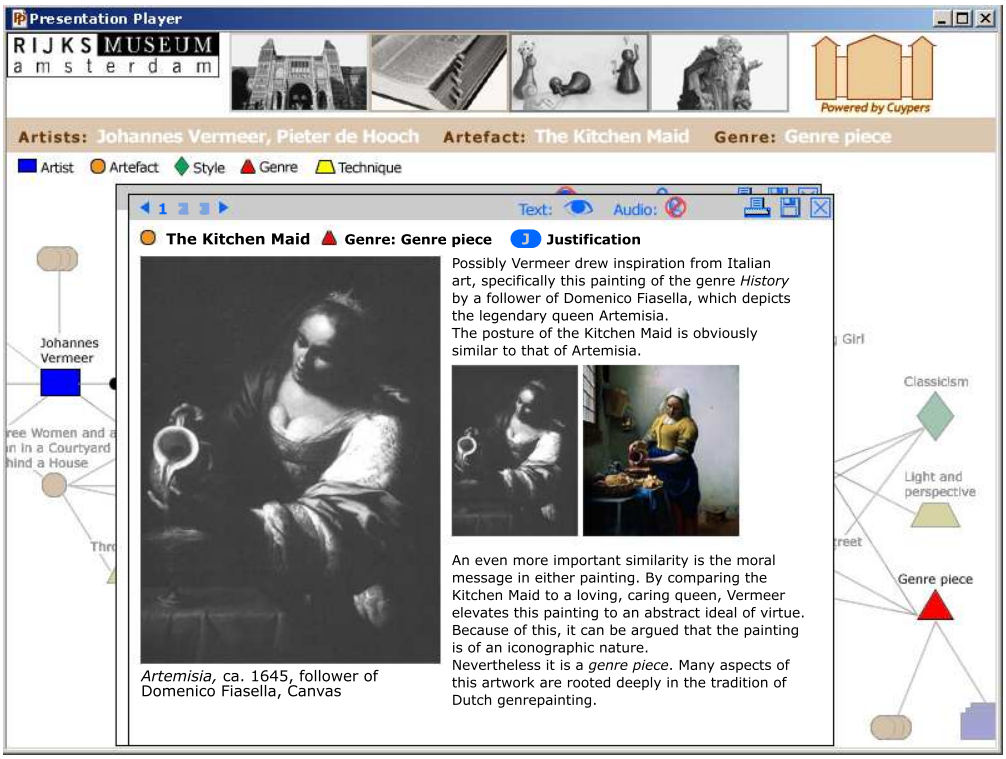


Figure 4.26: The presentation in enabled text and disabled audio mode, satellite justification

4.4.4 Feedback

The presentation leaves the user in full control over direction and depth of the information. Adaptation has little effect on the nodes of the network and their content, because the final decisions are made by the user, not the system. The user chooses the direction by clicking on a specific node, and the depth by viewing a Rhetorical Structure element. Adaptivity is manifested in two ways. First, the system gives the user feedback by visually distinguishing the nodes that have been visited. Internally, information that has been requested by the user is represented in the overlay model. Second, the parameters that are set by the user in the navigation bar for text and audio will replace the default values.

4.5 Storyteller channel

The storyteller mode is characterized by little interaction. Its target users are passive, either because of little procedural knowledge, or out of preference. They want an informative and entertaining story about a subject that conveys the context in which it lived or was created. They trust the system to choose the content of the story.

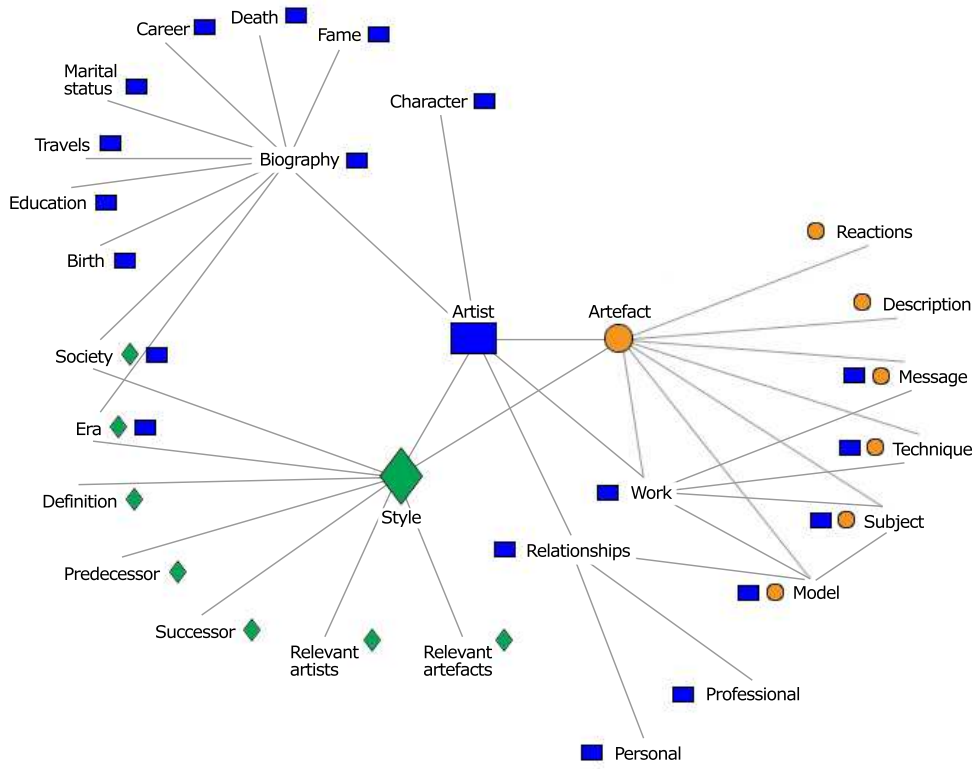


Figure 4.27: Storyteller information nodes and their relationships

4.5.1 Data structure

The topics to choose from have been reduced to *artist*, *artefact* and *style*. To learn what the components of stories about these topics are, we dissected art stories about the following subjects:

Artist:	Johannes Vermeer on webpages [11], [17] and in book [1]
Artefact:	The Kitchen Maid on webpages [11], [22], [17] and in book [1]
Style:	Classicism on webpage [11], Baroque, Rococo, Neoclassical Art and Romanticism on webpage [10].

The results of this analysis are depicted in Figure 4.27 on Page 35. It is an overview over the data we considered relevant for piecing together an informative story, and their relationships. A huge amount of data has amassed that is necessary to provide a complete impression of the context.

Knowing the topic narrows the choice down to about a third of all data items, but still there is too much variety. What are the criteria by which single items are selected from this net to make a story for an individual user? The system cannot make these decisions on its own, it needs more specific information from users about their goal. One obvious further constraint is time; how much time does the user want to spend? Knowing this parameter is still not enough. The diversity of the data items is so large that at least one

more constraint is necessary. We chose the property "character" of a story and divided it into the three characteristics *prosaic*, *documentary* and *voyeuristic*.

- A prosaic story is captivating and entertaining. It presents those data items first that best distinguish the subject of choice from all others. The story contains a balanced and pleasant mixture of serious facts and anecdotes.
- A story with documentary character is very predictable, like something found in a schoolbook. The system will select biographical data first, telling the story about the topic in chronological order. After that more information will be added.
- A voyeuristic story is full of juicy gossip. It should tell the kind of story that would be spread around at a cocktail party, containing details of scandals, terrible mishaps and crime. All information that is closely or loosely related to the subject, and has gossipy content, will be assembled first.

The data items need a ranking to distinguish core information from secondary information, especially in the face of time constraint.

We define core information for each topic in Table 4.3 on Page 36.

Artist:	**Artefact:**	**Style:**
Lifespan	Description	Definition
Turning points/ Milestones	Artist	Example artist
Style	Style	Example artefact
Example artefact		

Table 4.3: The core data pertaining to the information nodes of the Storyteller channel

Without a time limit, all users will eventually get the same information. All that differs is the structure of the story and the order in which data is presented, depending on user-specific priorities.

The distinctions described above demand that particular metadata be added to the data items. Basic categories are, for example, "serious fact vs anecdote", "distinguishing fact vs common fact", as well as Rhetorical Structure elements like "elaboration, justification or example" which are also needed in the Dictionary channel. Hence, metadata does not just serve the Storyteller channel, it is accessed by queries from all channels. A lot more research needs to be done in this area to develop a framework for classifiying all data items and determining which classifications are used in all channels, and which are specific for a single channel.

4.5.2 Scenario Storyteller channel

It is very well possible that Max has learned the facts about "The Kitchen Maid" in his first query, but the painting is still lifeless to him. He wants to

Figure 4.28: First screen after choice of Storyteller channel

Figure 4.29: Choice of topic

envision the situation in which it was created, the people who took part in it more than 300 years ago, and what the painting meant to them. He now tries the Storyteller channel to see what insights it has to offer.

Max first chooses one of the main topics: *artist*, *artefact* or *style*, Figure 4.28 on Page 37. In contrast to the Dictionary channel, a combination between them is not possible. This is a conscious decision based on the main characteristics of the Storyteller channel which are little interaction, low complexity and lots of background information. Restricting the query to a single topic shortens the search query, simplifies the structure of the generated presentation and promotes easy understanding of structure and content. This is enforced in the interface through the use of radio buttons instead of checkboxes. Even with focus on minimal interaction, the choice of a single topic can still take quite a few steps, due to the extent of the domain.

In the course of reducing the amount of clicks, the choice of a topic alone triggers the generation of the search query and the presentation, Figure 4.29 on Page 37. This way we avoid the "generate" button which is no longer necessary. Max chooses "artefact", the most complicated search query of the three.

The search query that is now generated has the same basic layout as in Dictionary mode, but the attractivity of the page has higher priority, Figure 4.30 on Page 38. It is meant to emanate a warm and inviting look&feel. This is created by using a warm orange for dominant colour, an old-fashioned Oldstyle typeface (here: Georgia) in the content page and a flowery script typeface (here: Monotype Corsiva) in the query bar as fonts. Furthermore, decorative elements have been added to the page.

The first step is to determine the duration, Figure 4.31 on Page 38. The default value of 5 minutes can be changed to any number of 3 digits. Naturally, the story can only be so long as there is material. If the available material exceeds the desired duration, the system discards the least important data items first. It continues selecting and discarding as long as necessary and stops when it has reached the core data. This is always presented completely. The number of minutes entered is considered as a rough measure. A slight deviation from the specified time is acceptable to avoid the presentation ending abruptly

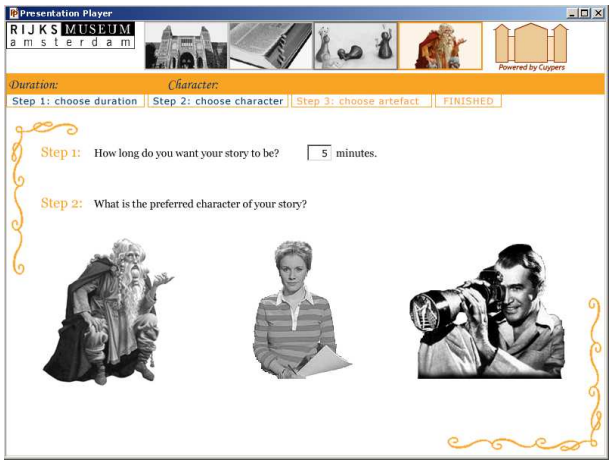


Figure 4.30: First screen of the search query

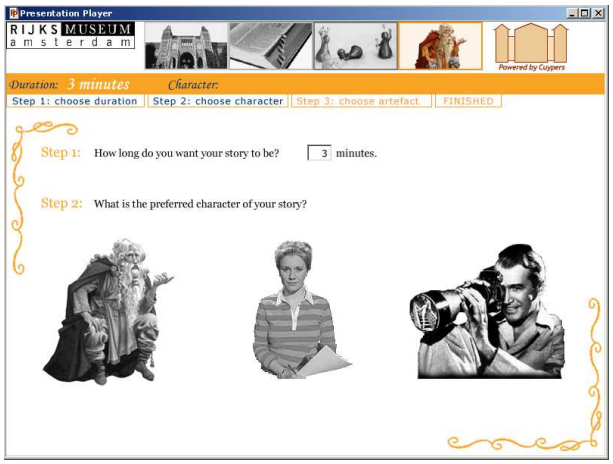
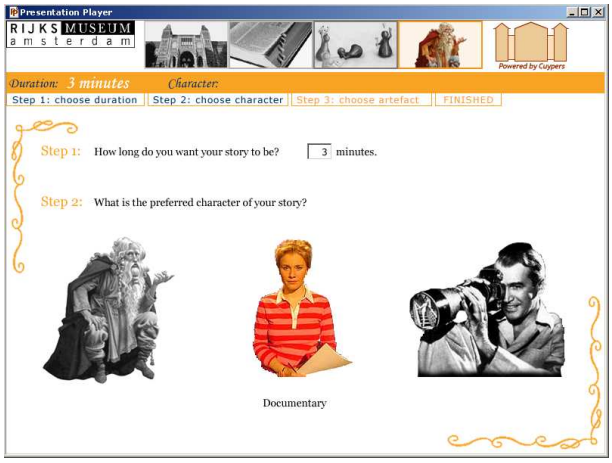


Figure 4.31: Setting the duration



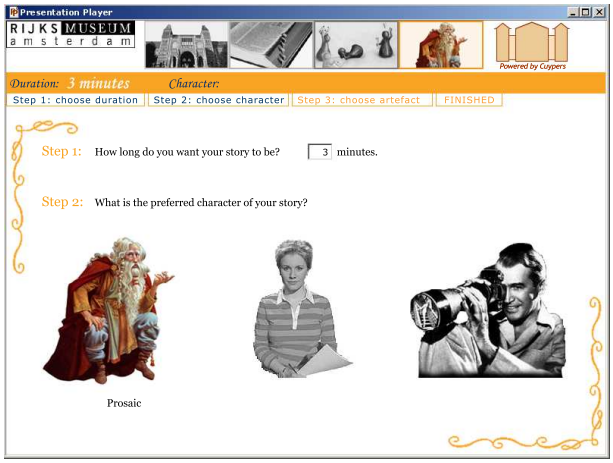


Figure 4.32: The roll-over effect

after the time has elapsed. Max orders a 3-minute long presentation.

In the second step the user chooses the character of the story. Here, three different figures are presented that personify the character of a story. The first is a gnarled old man with the connotation of wisdom and experience. He stands for a prosaic story. The second is a young woman with some notes in her hands, who looks a bit like a newsreader, but less boring. She stands for a story with documentary character. The third is a man watching someone through a telescope, a voyeur. He promises a story full of juicy rumours and gossip about the topic.

On roll-over, the characters become coloured, Figure 4.32 on Page 38, and a sample audio track of their voice is triggered, which explains shortly what the user can expect from him or her. This way the user can already decide whether the voice is agreeable. Max decides to query a prosaic story first, he expects it will contain useful data for his essay.

In the last step the user chooses the topic. Searching for artefacts is compli-

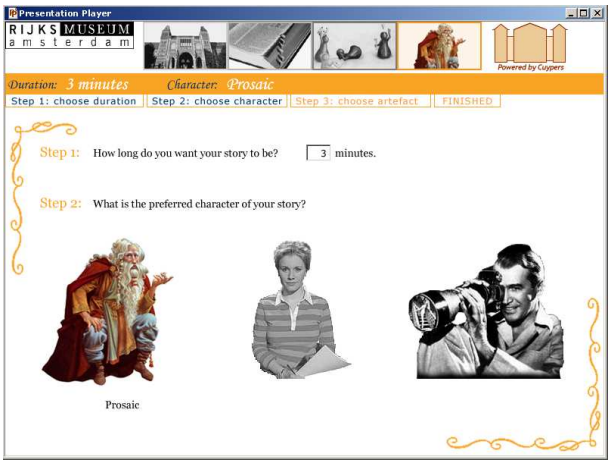


Figure 4.33: End of steps one and two

Figure 4.34: Three properties to choose from

Figure 4.35: Clicking on the letter V...

Figure 4.36: ...results in an overview over all artists with V

cated, because people remember different properties of them. Some know the name of an artefact, some only remember the name of the artist who made it, and some just see it in their mind and know the content, but no names. The user can therefore search on any one of these properties, Figure 4.34 on Page 39. The taxonomy of content is taken and adapted from that on the Rijksmuseum website [14].

Although Max is looking for the artefact "The Kitchen Maid", he prefers to search by artist. A click on the letter V in the artist's alphabet, Figure 4.35 on Page 39, provides all painters whose last name starts with a V, Figure 4.36 on Page 39. Max chooses the name of Johannes Vermeer, Figure 4.37 on Page 40, and gets an overview over all artefacts made by this artist, divided in those that are physically located in the Rijksmuseum, and all others, Figure 4.38 on Page 40. In the Dictionary mode, artefacts are just represented by a list of names and dates. In contrast, here they are shown with a graphical excerpt from the original. This allows for leisurely perusal of the elements.

Figure 4.37: Choosing Vermeer...

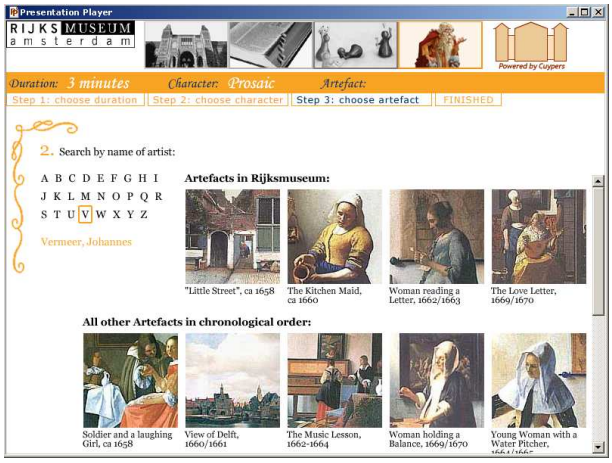


Figure 4.38: ...leads to an overview over all artefacts by Vermeer

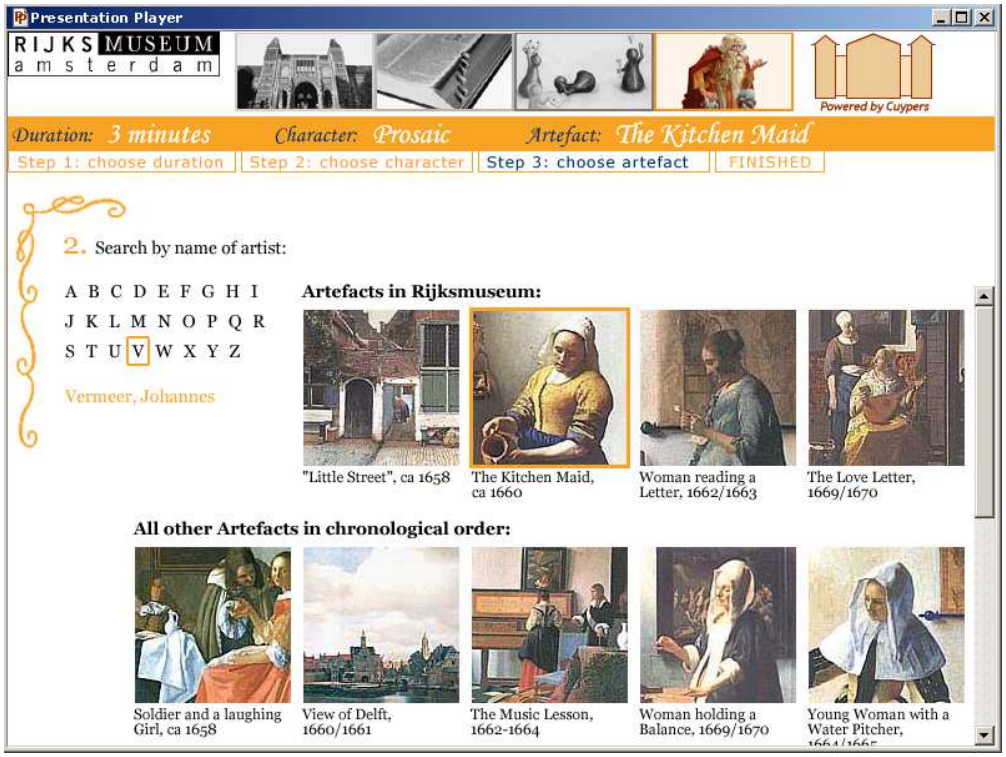


Figure 4.39: The search query is complete

Figure 4.40: Navigation bar in Storyteller channel presentation

Max clicks on "The Kitchen Maid" to complete the query, Figure 4.39 on Page 40. The desired presentation should be 3 minutes long, have prosaic character and deal with the artefact "The Kitchen Maid" by Johannes Vermeer. These specifications work like a filter that enable the system to retrieve relevant items from the multimedia database and assemble them in a story.

4.5.3 Presentation adaptation

The presentation is very different from that in the Dictionary channel. Instead of an information space through which the user actively navigates, there is a show that runs from beginning to end without requiring any intervention from the user. Nevertheless, users can adapt some parameters of the show to their liking in the navigation bar, Figure 4.40 on Page 41. The navigation elements are explained in the following.

Text Text is disabled per default. Users who want to read a text as well as hear it can enable text by clicking on the icon depicting an eye. This would slightly alter the structure of the presentation, because initially all the space in the content area is occupied by graphics. The complete presentation will spread over more screens without omitting any information.

Audio Audio is enabled per default. Users that are distracted by sound can disable audio and concentrate on reading text.

Speed The rhythm of the presentation can be altered with the speed slidebar. It does not, however, affect the speed of audio files! A display is static for the duration of the audiofile that describes it. Speed is here an indicator for the time spent on transactions between displays.

Timeline The timeline is adapted to the parameter "duration". The units could be minutes, or the points at which content changes. The latter would enable the user to jump to and fro between the beginning of each section. The little red indicator will move along as the story progresses. It can be stopped or paused.

Now we describe the presentation Max gets after having sent off his query. A possible result for a 3-minute prosaic story about "The Kitchen Maid" is a story in four parts. First comes the core information, which is a description of the artefact. In the next part the story draws the attention to special highlights contrived by the technique used. The third part sets the artefact in relation to previously painted artefacts in order to explain its message. The last part is an anecdote, as provided by the WebMuseum [11].

Figure 4.41:
With quiet concentration a woman pours milk into a bowl. With her left hand she supports the can she is pouring from. Around her are various objects: a

Figure 4.41: Description

Figure 4.42: Special highlights

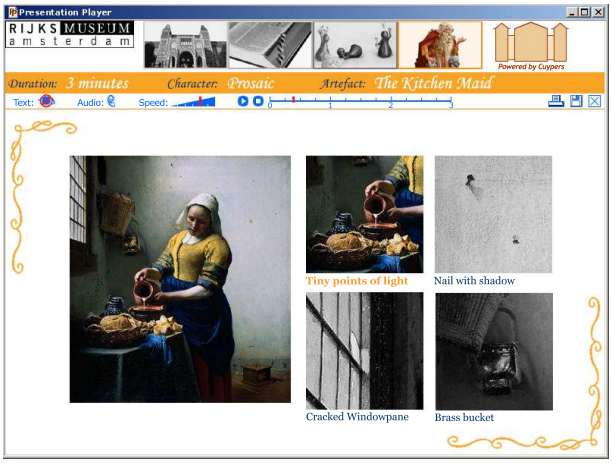


Figure 4.43: Tiny points of light

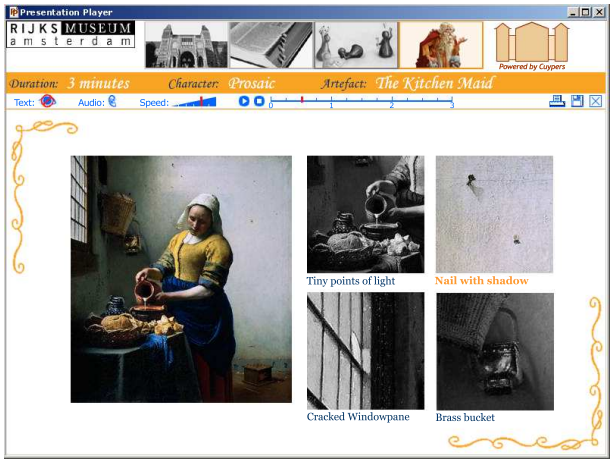


Figure 4.44: Nail with shadow

loaf of bread, a stoneware jug, a basket and a brass bucket. The woman is standing near the window so she can see what she is doing. The light falls on her hands; her silhouette is dark against the white wall. There is a fascinating play of light and shadow in this painting. This is one of Johannes Vermeer's genre pieces in which he establishes an intensely intimate atmosphere. Although the artist observes his model from nearby, she continues with her work, totally unperturbed.

Figure 4.42:
The lighting in Vermeer's Milkmaid is extraordinarily subtle. Light falls from the left through the window. Beneath and beside the window it is somewhat shadowy, but the woman is standing in full brightness.

Figure 4.43:
When you look carefully at the painting you see that Vermeer has introduced tiny points of light all over the canvas: on the edges of the jug and the bowl, but also on the fastening of her yellow dress, and on the bread in the basket.

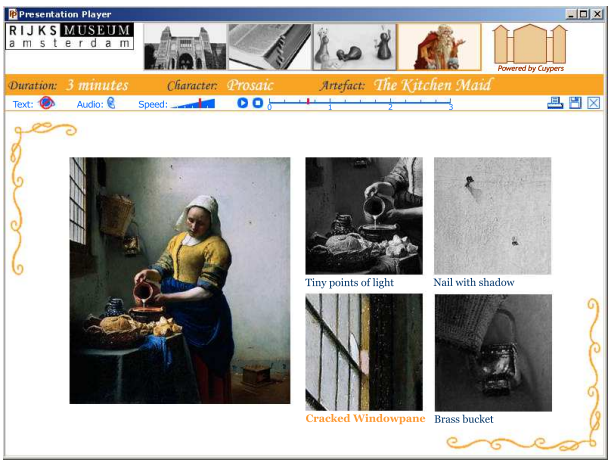


Figure 4.45: Cracked windowpane

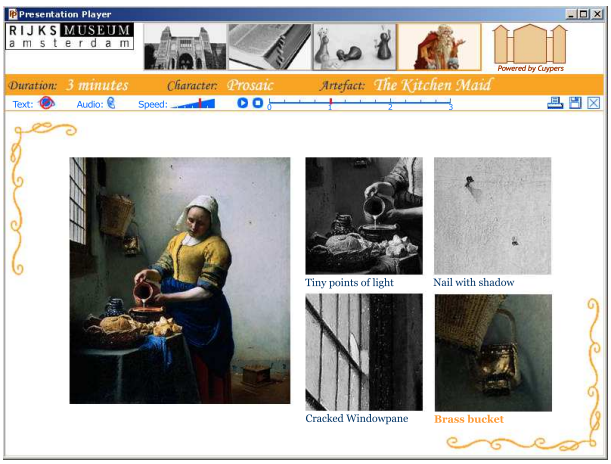


Figure 4.46: Brass bucket

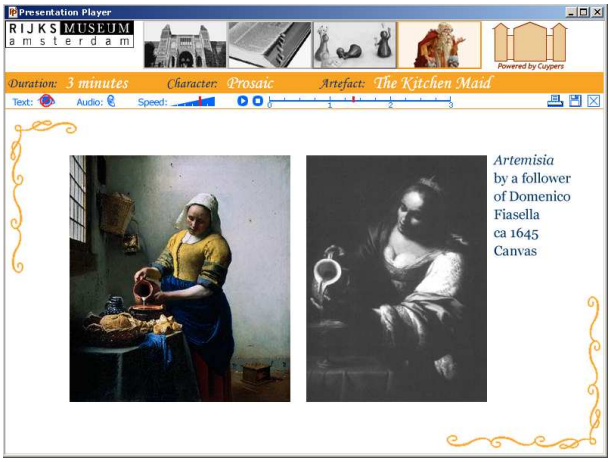


Figure 4.47: The message

Figure 4.48: The anecdote

Figure 4.44:
Vermeer paid great attention to details. He has painted tiny rough patches into the texture of the white plasterwork. Also, he gives careful thought to a nail set high in the white wall,

Figure 4.45:
as well as to the light entering through a cracked windowpane.

Figure 4.46:
The structure of various objects is expertly rendered: gleaming brass and crumbly bread.

Figure 4.47:
Perhaps this painting by Vermeer is an embodiment of the virtue of Temperance. The image of a woman pouring out of a jug was sometimes used in this way in the seventeenth century, for example by a follower of Domenico Fiasella.

Figure 4.48:
Vermeer's Kitchen Maid was highly appreciated at an early date. In an auction catalogue of 1696 the painting is described as follows: A Maid pouring out milk,

Figure 4.49: Last page

exceptionally good. The Milk Maid, as the painting is commonly called, was sold for 175 guilders at that auction - a large sum for those days. At the beginning of the twentieth century the painting arrived in the Rijksmuseum. The Rembrandt Society bought the work together with 38 other paintings, thereby saving it for the Dutch public. There was a heated discussion both about the quality of the 39 paintings as well as the price - 750,000 guilders. Many satirical cartoons were published in this connection. Today the painting is unquestionably one of the museum's finest attractions.

The story ends with Figure 4.49. This last page is very important from a user modeling perspective, because it elicits feedback from the user. What can be learned about the user from this page is described in the next section.

4.5.4 Feedback

The last, static page of a story, Figure 4.49 on Page 44, is an overview over closely related topics. It is likely that the first story that is generated does not fulfill the user's goal, because it is only based on the selected persona and the searchquery. At the end of that presentation, the user is better able to indicate to the system what her goal is. This is the point where the iterative process of Collaborative User Modeling begins.

If the presentation fulfilled the expectations of a user after all, she might want more information on the same topic. Clicking on the query bar will take the user back to the search query, where duration and character can be

altered and a new query on the same topic is generated. If these parameters are retained, their values are written into the user profile as default values for all subsequent stories that the user queries in her session. The media items that were previously shown are added to the overlay model representing the user's knowledge. A link to previously shown material is included in the presentation that is generated next.

Instead, if users want something slightly different from their first story, they can orientate themselves in the overview of related topics. A click on any of the keywords will launch a new search query where the topic is set and the user can change the parameters for duration and character. The same applies as mentioned before, if the user does not alter these values, they are written into the profile and applied as default setting for this user.

For a completely different presentation the user can simply close the window and start all over again.

If the user altered the settings in the navigation bar, these actions provide the system with information about the user's preferences. They are written into the user profile and applied as default settings in the next presentation that is generated for that user.

4.6 Game Channel

The Game channel is targeted at children. A website usability study for children by Jakob Nielsen [7] has come up with some distinct requirements.

Children are attracted by colourful and entertaining content. They appreciate multimedia effects and are willing to explore a page with their mouse to find areas that produce a funny sound or other effects.

Children are explorative, but this does not extend to the navigation of a site. The navigation should be simple and direct, conforming to web standards. If children do not understand how a site works, they leave. The study has shown that geographic navigation metaphors worked very well. Children could orientate themselves easily in maps that provided an overview over the site.

It is further important to realize that children are not one single target group. They are very conscious of age differences, and of which material is appropriate for them, or directed at younger or older kids.

This area in our concept requires input from experts in paedagogics. For now, we provide the framework and the idea, and we adhere to the following general requirements. Graphical visualizations are accompanied by audio. We minimize the use of text. The language is composed of easy words and short sentences. Ideally the user's hardware is equipped with a microphone, so that all interaction in this channel is done through speech recognition. However, if this is not possible, regular interaction using the keyboard and the mouse is the alternative. Therefore our target audience has to be able to read and write. We take no knowledge for granted and aim at explaining all art concepts at a basic level.

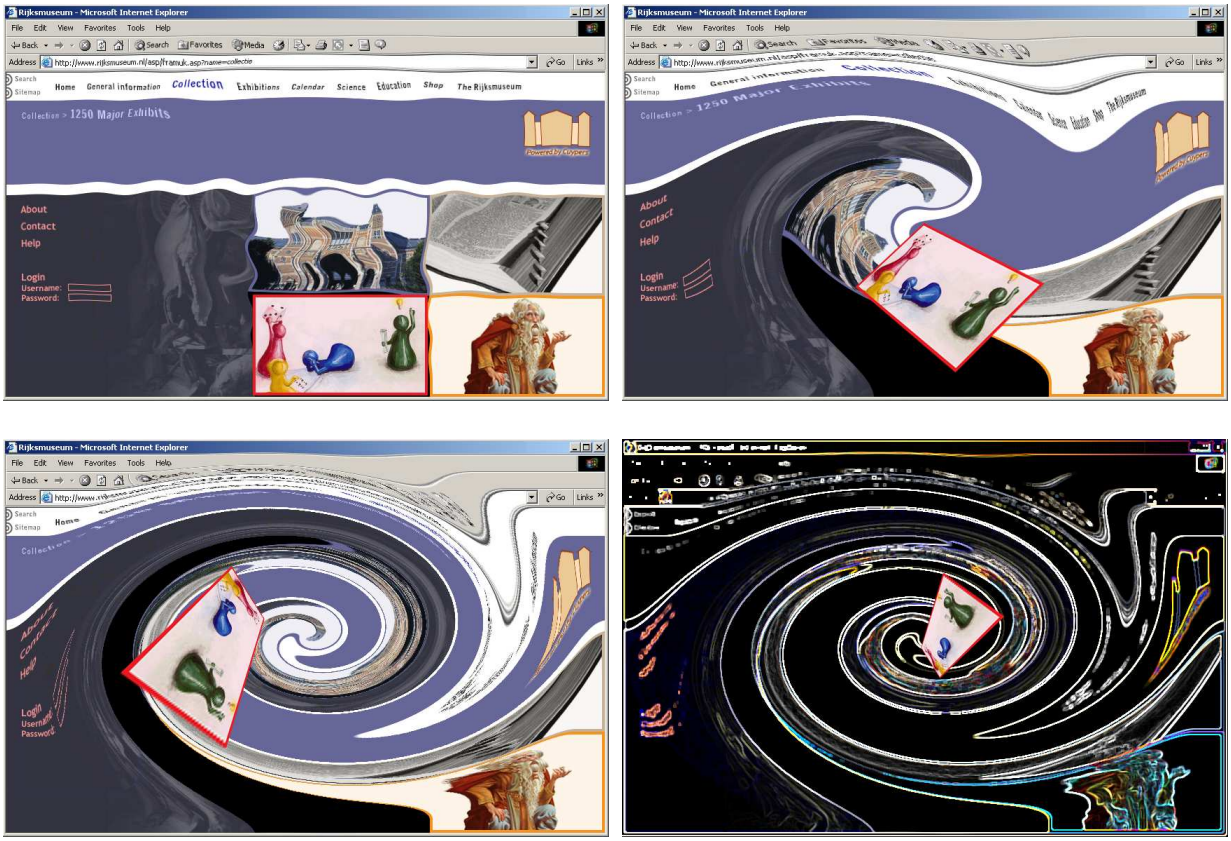


Figure 4.50: The journey into the Game channel begins...

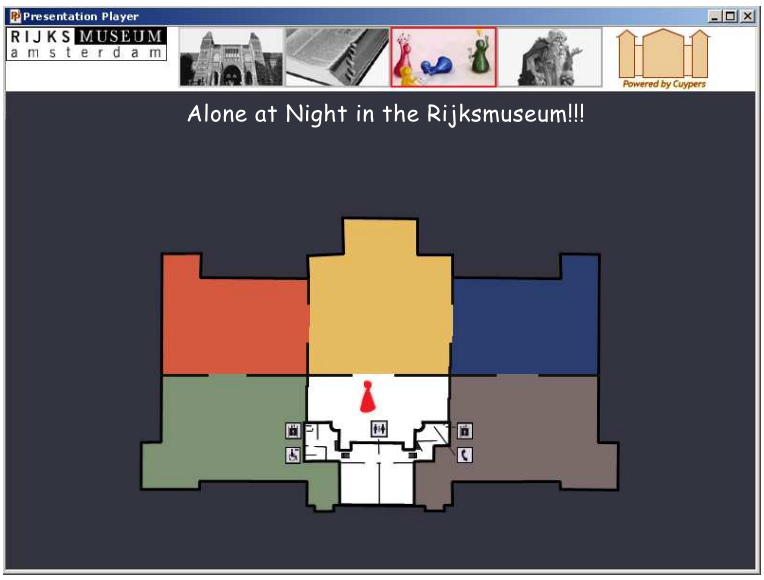


Figure 4.51: The floor plan of the Museum is the navigation menu of the Game channel

4.6.1 Scenario Game channel

Max is tired of doing research. He wants to take a break and decides to check out the Game channel. He clicks on the graphic and the screen starts spinning faster and faster, looking as if it is being sucked down a drain, Figure 4.50 on Page 46. The screen turns black, and suddenly a voice begins telling the following story, accompanied by comic-like illustrations.

Today, you went to the Rijksmuseum with your parents. You were bored out of your skull. At closing time, a big crowd moved toward the exit. Suddenly you heard a weird noise. (weird noise). What was it?? Without thinking, you quickly slipped behind a bench, wanting to investigate before you left the museum. After a while everything went quiet. Too quiet. Ooooops, you realized... YOU ARE ALONE AT NIGHT IN THE RIJKSMUSEUM!!! It is dark and cold. There is a stale smell in the air. Panick makes your hands sweaty. As you reach into your pocket looking for a piece of chewing gum, you find a floor plan of the museum. You check where you are.

The floor plan becomes the menu in which the user navigates, Figure 4.51 on Page 47. It provides a bird's eye view of the location of the user.

After the introduction, Max finds his player peering through the keyhole of a closed door into a room. He then sees what his player sees. It is the ghost of a painter, who is talking to a girl resembling the model in "The Kitchen Maid". The ghost turns around and looks Max square in the face. He begins speaking in an old-fashioned style of language: *Hello there, who is disturbing me at this hour? I can see you, hear you and smell you lurking behind the door. Come in and show yourself!! I am Johannes Vermeer of Delft. What do you seek? Have you come to talk to me, or do you want to have breakfast served by my kitchen maid Rosa?*

The idea is to give the user two options. One option is to interview an artist,

Figure 4.52: Jan Havicksz. Steen, The Merry Family, 1668

the other option is to enter into an artefact and interact in that context. The interaction should always involve a concrete task, such as "clean up a messy Jan Steen room", Figure 4.52 on Page 48, or "do the egg-dance" in a Pieter Aertsen painting, Figure 4.53 on Page 49, or "play a game of ice hockey" in a Hendrick Avercamp painting, Figure 4.54 on Page 49.

4.7 The fate of the user profile

There are two possible fates for a user profile. Either, a user registers and becomes a long term user, consolidating the user profile, or she leaves the site. In this case, we can either discard the user profile immediately, or we can save it for a while, in the expectation that the user will come back and register eventually.

In both cases, privacy issues must be taken into consideration. If a web application wants to offer personalized services based on user modeling, it should comply with the following guidelines taken from [9] to stay legal.

- Make personalization an explicit purpose of the site.
- Obtain the informed and voluntary consent of the user.
- Provide organizational and technical means for the users to inspect, block, rectify and erase their data.

Figure 4.53: Pieter Aertsen, The Egg Dance, 1552

Figure 4.54: Hendrick Avercamp, Winter Landscape with Iceskaters, ca 1608

- Provide adequate security mechanisms.
- Allow anonymous or pseudonymous access if this is technically possible and reasonable.

Chapter 5

Conclusion

The goal of this thesis was to investigate a solution for adapting multimedia presentations, automatically generated for short term users in web environments. The difficulty with short term users is that the system knows nothing of their expectations and requirements, and there is no quick and easy way for the user to convey these to the system. The additional problem in web environments is that the potential user group of a system is very large and diverse.

We based our solution on Persona Theory, a method that applies representations of user stereotypes to make inferences about a user from very little input. In such a way the potential user group of a system is split into various roughly homogenic target groups, where one user persona represents a target group. Each persona characterizes simple yet distinct expectations of the target group it represents. The user interface should convey the character of each persona to the user and let the user choose which of these roles she identifies with at that moment. An individual user profile is created that contains all the characteristics of the chosen persona. This is enough information to generate a first, adaptive presentation.

The presentation that is generated marks common ground between the system and the user. The user's interaction with the presentation provides the information needed by the system to approximate the user profile to the real user.

In our case study we regard a system that generates presentations about the virtual collection of the Rijksmuseum within its website. We have developed models of three user personas, namely Dictionary, Storyteller and Game. Each of these personas adapts the presentation to its specific characteristics with respect to function and form. These particular presentation forms allow persona related alterations of the user profile - as the interaction mechanisms are designed for this purpose.

The contribution of this concept to User Modeling is to exemplify the application of existing user modeling techniques in the area of Adaptive Hypermedia.

However, much further research is needed before a system like the one suggested in this thesis can be implemented. Especially the creation and structure of content need to be addressed. The ideal size, content and description of pieces of information has to be determined so that they can be combined to

create individual and coherent presentations. Moreover, more effective adaptation can be contrived the longer the user works with a system. A transition model between short and long term user modeling should be included in an implementation.

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