1) I-GUARD for Science Centers

1a) Intelligent Guidance in Archives and Digital Dossiers

1b) I-GUARD[1]

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2) Summary:

2a) Summary

In the European Union, the science faculties are loosing students. To get more young people involved with urgent issues related to science and technology (e.g., ecogenomics, climate change, nuclear power), science centers such as NEMO (Amsterdam), Museon (The Hague), and Naturalis (Leiden) employ Web-based Internet applications to dispense their archived and digitized information to the public or to provide a sneak preview of their latest exhibitions. However, for the younger generation, this type of information technology (i.e. Web sites) has become the standard and may fail to be attractive in the future. We intend to develop and test the next generation of information technology that can be used to explore archived information in novel ways, tailored to the needs of the user. We focus on intelligent navigation and interaction with a digital dossier, which contains all (multimedia) information necessary for an adequate understanding of science and technology artifacts, installations, and issues. An essential part of our research is to support guided tours that may take the form of a walk-through in virtual space, an automated story-line in a concept map, or allow the non-expert to play with the parameters of a laboratory experiment. The latter application may also be used by the professional curator to experiment with the parameters of a new exhibition, such as light and space. An important research aspect is to provide for the possibility to adapt the guided tour to the personal information need of the user. The results of our research will on the one hand contribute to making science and technology more accessible to a large audience and on the other hand to supporting the complex task of the conservation and re-installation of exhibited installations in a more effective way. These results are also of interest to the presentation of cultural heritage information (i.e. art objects), in particular by means of personalized guided tours.

2b) Abstract for lay persons (in Dutch)

In de Europese Unie verliezen de Bèta-faculteiten steeds meer studenten. Om meer jongeren te betrekken bij dringende kwesties die gerelateerd zijn aan wetenschap en techniek (ecogenomics, klimaatverandering, nucleaire energie), gebruiken wetenschapscentra zoals NEMO (Amsterdam), Museon (Den Haag) en Naturalis (Leiden) Web gebaseerde Internet applicaties om hun gearchiveerde en gedigitaliseerde informatie onder de aandacht te brengen bij het publiek en om een voorproefje te geven van hun jongste tentoonstellingen. Voor de jongere generatie is dit type informatietechnologie (m.n. Web sites) reeds standaard en zal wellicht z´n aantrekkingskracht in de toekomst gaan verliezen. We willen de volgende generatie informatietechnologie ontwikkelen en testen waarmee men gearchiveerde informatie op nieuwe

[1] http://www.cs.vu.nl/~eliens/research/i-guard.html

manieren kan verkennen, aangepast aan de behoeften van de gebruiker. Wij richten ons op intelligente navigatie en interactie met een digitaal dossier, waarin al de (multimedia) informatie is opgenomen voor een adequaat begrip van voorwerpen, installaties en kwesties uit wetenschap en techniek. Een essentieel onderdeel van ons onderzoek is de ondersteuning van rondleidingen in de vorm van een wandeling door een virtuele ruimte, een geautomatiseerde verhaallijn in een concept-kaart, of het laten spelen van de niet-deskundige met de parameters van een laboratoriumexperiment. Deze laatste toepassing kan ook de professionele conservator gebruiken om te experimenteren met de parameters van een tentoonstelling, zoals licht en ruimte. Een belangrijk aspect van het onderzoek is de virtuele rondleiding zodanig te maken dat de applicatie op adaptieve wijze in de persoonlijke informatiebehoefte van de gebruiker voorziet. De resultaten van ons onderzoek zullen aan de ene kant wetenschap en techniek toegankelijker maken voor een groot publiek en aan de andere kant de conservator helpen bij het uitvoeren van de complexe taak om tentoonstellingsinstallaties te onderhouden en (opnieuw) op te stellen. Deze resultaten zijn ook van belang voor de presentatie van informatie over cultureel erfgoed (m.n. kunstvoorwerpen), in het bijzonder d.m.v. gepersonaliseerde rondleidingen.

3) Classification:

computer science / digitale beleving

4) Composition of the Research Team:

name	Expertise	affiliation	hours/week
Prof. dr. J. Willems	science communication	VU/WTC	2 (promotor)
Dr. A. Eliëns	multimedia/game development	VU/IMSE	8 (supervision)
Dr. J. Hoorn	science communication/CHI	VU/WTC	8 (supervision)
Drs. C. Visser	agent technology/DLP	VU/CS	12 (programmer)
C. van Riel *)	student MMC	VU	32-36 (OIO)

The research will be executed within the VU, under the daily supervision of dr. A. Eliëns and dr. J. Hoorn. *) C. van Riel will obtain his master degree Information Science, within the specialization Multimedia and Culture, October 11, 2006. As student/contributor to the digital dossier(s), he is the proposed candidate for the OiO position within the project.

5) Research School: SIKS

Most project-members fall under SIKS (the Dutch Research School for Information and Knowledge Systems, www.siks.nl). Willems falls under NeSCoR (Netherlands School of Communication Research, www.nescor.nl)

6) Description of the Proposed Research

Adolescents in the European Union show less interest in choosing science and technology as a career than before [Durant, Evans, & Thomas, 1997][Osborne, 2003][Noailly et al., 2005]. This clashes with the Lisbon agenda to achieve a 15% increase in the number of scientists and to remain competitive with the US as well as the Asian and Eastern European countries. The Netherlands are among the worst investors in science research [Nauta & Van den Steenhoven, 2003][Traag, 2005] and the Dutch government, therefore, wishes to attract more students to the science faculties [Kabinetsnota, 2003].

The public communication of science is one way to make the audience aware of the importance of science and technology for society, economy and history in general. Science centers such as NEMO in Amsterdam, Museon in The Hague, Naturalis in Leiden, or Metropolis in Mechelen (Belgium) increasingly rely on digital resources for the public communication of science [Henriksen & Frøyland, 2000]. They

attempt to interest younger people for science and science-related issues so to contribute to a more positive attitude to studying science. Yet, the main software products these science centers apply are Web-based Internet applications, which most of the time are hierarchically ordered and close to the traditional 'turning of book pages' (see also Jet-Net or Technica10).[2]

Young people have a negative attitude towards science and scientists, which are generally seen as boring [Berkhout & Van Leeuwen, 2000][Nes, 2004][Van Sark & Den Hartog, 2004]. Teens are underrepresented when it comes to visiting science Web sites [Weigold & Treise, 2004]. Information technology can counter such attitudes (e.g., [Prensky, 2003]) but then it should capitalize on the experience of the contents (the scientific message) as well as on the experience of the information technology itself (cf. affective computing [Reynolds & Picard, 2005]).

In our research, we address the issue of providing access to virtual science and technology exhibitions as an extension of and addition to the exhibitions at the science centers. This could attract potential visitors and inform the public in a playful manner about science and technology-related matters. Our approach is not only of interest to a lay audience; our tooling is such that curators are supported in archiving, conserving, and the possible re-installation of the installations on show.

Given that meta-analysis by [Miller and Pardo, 2000] showed that the most important determinants of scientific literacy are socio-demographic (i.e. age, gender, and educational level), we want to investigate the mediating and moderating effects of three multimedia presentation forms on the public's willingness to use the application and on their engagement with science (Table 1).

Table 1. Determinants of engagement with science through multimedia presentation.

Socio-demographics	Applications to be developed	User experience
Age Gender Education	Walk-through in virtual space Automated story-line in a concept map Experimentation with construction and lab parameters	Intentions to use the application Engagement with science and technology

Table 1 shows three forms of multimedia presentation we wish to develop. The intersection of these presentation forms is a so called digital dossier [Hoorn, et al. 2004], which we developed for works of contemporary art. For our science applications, the digital dossier is a collection of information needed to understand scientific artifacts and issues in the context of the work of particular scientists or in the context of society (cf. [Burns, O'Connor, & Stocklmayer, 2003]). The information consists of descriptive text, images depicting the work(s), and possibly video registrations, 3D simulations, demos as well as interviews with the scientists. From the perspective of the experts in charge of conserving the installations on show, the dossier must contain all the information needed for (proper) re-installation.

For the presentation of the digital dossier, we deploy a rich media presentation environment with which we gained ample experience in our research in intelligent multimedia[3], among others in previous pilots with the Institute Collection Netherlands (ICN), in which we realized comparable environments for the Dutch artist Marinus Boezem[4], the Serbian-Dutch artist Marina Abramovic[5], and the Australian media artist Jeffrey Shaw[6].

For the science applications, we wish to focus on intelligent navigation and interaction with the digital dossier. To accommodate the diversity of potential (young) users, we want the dossier to be approached from a variety of perspectives (Table 1). The presentation environment, therefore, must offer a multitude of possible interaction scenarios. As we have demonstrated in the prototype implementations, a guided tour may take the form of a walk-through in virtual space, an automated story-line in a concept map or allow the (professional) user to experiment with the (de-)construction of, for example, an installation, or to experiment with exhibition parameters, such as light and space (inquiry-based learning). For adapting a guided tour to the personal information need of the user, there is a variety of solutions, as for example explored in the CATCH/CHIP project[7]. In the present I-GUARD project, we will investigate the use of

[2] http://www.jet-net.nl/intro.html; http://www.technika10.nl/
[3] http://www.cs.vu.nl/~eliens/research/
[4] http://www.cs.vu.nl/~eliens/dossiers/boezem/application/
[5] http://www.few.vu.nl/~dossier05/
[6] http://www.few.vu.nl/~casus05/
[7] http://www.chip-project.org/

filtering on concept node types in the concept map, according to the interests indicated by the user. In addition, we will explore how to utilize the navigation behavior of the user as an indication of his/her interests to construct a personalized tour.

As a starting point, we will take the digital dossier developed for Marina Abramovic (the abramovic dossier) [Eliens et al., 2006] , since it provides the most clear and innovative solution to the problems of navigation and presentation:

- navigation -- by means of a concept graph
- presentation -- by means of a presentation gadget that allows for the simultaneous inspection of multiple media items

Apart from allowing the presentation of 2D information (text, images, and video), the abramovic dossier also allows for the incorporation of 3D models of artifacts and installations in a seamless (immersive) way.

6a) Scientific aspects

Given the need to represent information of one or multiple scientific issues in a digital dossier, which allows for the presentation of that information in a rich media presentation environment, we address, from a research perspective, the following issues:

- navigation using a concept graph
- presentation of 2D and 3D information in a unified fashion
- interaction with support for (personalized) guided tours

The presentation of information in a 3D environment will not be the central focus of our research, although our experience in this area is an essential pre-requisite for our research. Instead we will concentrate on navigation, presentation issues, and interaction with support for guided tours. In addition, we will tackle more broad issues of representation of information and investigate a generic approach to the construction of digital dossiers.

Navigation:

Given the complexity of the information space related to scientific issues and technological devices, interactive facilities must be provided for the user to gain a quick overview of the information available as well as the means to deepen the inspection rapidly, avoiding needless and cumbersome detours. At the same time, the user must be allowed to inspect the (multimedia) material related to the work of art, such as a collection of images or video recordings.

To accommodate the complex structure of the information space we have developed a 3D representation of a concept graph, a semantic device well-known from artificial intelligence, which allows the user to expand a node representing a particular concept or aspect into a collection of related nodes. Moreover, for the presentation of (multimedia) information we have developed a (generic) presentation gadget, that displays images or video and textual information simultaneously. The actual content of the presentation gadget depends on the node of the concept graph from which it is expanded. The presentation gadget allows for limited browsing following (textual) links, within the material presented. At each moment, the presentation gadget can be collapsed to continue navigation in the concept graph.

Using the concept graph in conjunction with the presentation gadget resolves the duality of information and presentation that is inherent for (multimedia) digital dossiers, and thus promotes what may be called the immersive experience of scientific digital dossiers.

Presentation:

Apart from the presentation gadget, which allows for the simultaneous inspection of multiple media items, in a variety of formats, we explored the use of guided tours as a means to present the information in a story-like way (cf. “narrative explanation in science,” [Norris, et al., 2005]). This relieves the user from the often cumbersome task to interact with the computer.

Guided tours, in the digital dossier, may take one of the following forms:

- automated (viewpoint) navigation in virtual space
- the (narrative) presentation of a sequence of concept nodes
- an animation explaining, for example, the construction of a technical device

In practice, an actual guided tour may be constructed as a combination of these elements, interweaving, for example, the explanation of concepts, or biographic material of the scientist, with the demonstration of the positioning of an installation in an exhibition space.

The research issues, then, encompass:

- the selection of items in the guided tour, as well as
- the presentation of these items in an immersive way

Immersion, here, means that we strive for a seamless transition between the presentation of conceptual and visual material, such as video registrations or 3D models of apparatus, of a weather chart, or atomic nuclei.

Interaction:

Our aim is to arrive at a general framework for scientific digital dossiers, which provide intelligent guidance to both the expert user, responsible for the future re-installation of the work(s), and the interested lay person, who wishes to get acquainted with a particular scientific finding or device. In general, there are two techniques that we can apply to provide such guidance:

- filtering the information space according to the user's perspective, and
- intelligent agents that (pro)actively aid the user in searching the information space

Filtering the information space may be used to restrict the concept graph that defines the navigation structure, by stating assumptions with respect to the relevance of particular categories from a user's perspective.

The intelligent agents approach stems from artificial intelligence and allows for providing guidance in a variety of ways, possibly even in an embodied form using a face or humanoid figure to give suggestions to the user on what interactions to perform. We already investigated the use of embodied agents in a digital dossier for the artist Marinus Boezem [Hoorn et al., 2004]. We will investigate to what extent we can use an agent model, possibly with learning capabilities to provide guidance and support interaction [Hildebrand et al., 2003].

From there, we could arrive at an advice function that offers the user at any navigation point a choice of continuations and/or a selection of guided tours, focusing on a topic of interest.

For selecting the items to be presented in a guided tour, the most obvious way is to pre-define a sequence based on user profiles. This can most probably be done in a more flexible way in a rule-based manner, applied to a template tour. More interesting, however, is to investigate whether guided tours can be generated dynamically based on tracking actual user interaction of (expert) users, using techniques from prediction theory, as explained in section 6b.

To allow for meaningful interaction with 3D models, allowing to view for example information about the materials used or its installation procedure, we should find a way to connect that information to user actions in a generic way. In other words, there is an information representation problem, namely, how to relate contextual information in a generic fashion to elements of a 3D model representing an exhibited

installation. Although such interactions can be realized by embedding invisible action/event objects in the model, a more generic way of representing such relations is desirable, to avoid the need for the time-consuming hand-crafting for which in practice there may not even be the necessary (human) resources.

6b) Method of research

For our science communication research we will rely on the models on user interaction and methods of questionnaire design explained in [Van Vugt et al. 2006]. Here, models of human-computer interaction (i.e. affordance theory [Gibson, 1979]) are fused with models of user engagement. These approaches can easily be adapted to measure the engagement with science. User groups will be segmented according to age, gender, and educational level and each sub group will search for scientific information in the three multimedia presentation modes. Willingness to use the application and engagement with science will be measured by means of structured questionnaires before and after using the application.

For our technological research, explorative design and development is most fruitful [Grau, 2003]. Given the variety of information materials related to science and technology and the need to present these materials in a visually compelling way, we will apply techniques used in the development of interactive narrative games, as described in [Hawkins 2005].

For the selection of items in guided tours and the generation of interesting sequences, we will explore the use of prediction theory. As explained in [Cesa-Bianchi and Lucosi 2006], prediction theory uses a model of prediction based on expert advice. However, instead of the traditional loss function, used in a stochastic approach, prediction theory uses a regret function, which expresses the difference between an actual prediction and the advice of a collection of experts. An expert, in this context, is an abstract entity, which may be either embodied by an algorithm, a random selection, or an actual expert.

We will investigate, for the construction of guided tours, whether it is possible to generate interesting sequences by using a (sequence of) prediction(s) that minimizes the regret function, with respect to the navigation sequence(s) recorded from actual expert users. In particular, we will strive for implementing the advice function, in a generic way, by means of a learning mechanism that extracts recommended continuations and guided tours from tracking expert user navigation.

6c) Scientific interest

Although digital archives or digital libraries[8] are not a new phenomenon, our concept of digital dossiers contains a number of innovative elements. A digital dossier provides a unified information and presentation space. In this sense, it differs significantly from a digital archive with a traditional Web interface, where navigation and presentation are distinct. To a greater extent, digital dossiers allow for an immersive experience of the information related to science and technology. As such, it is reminiscent to explorations in virtual archeology[9].

As concerns intelligent guidance, again, agent technology itself is not new but our use of it offers novel ways to explore the information. Generating guided tours based on (expert) user tracking on the one hand allows the user to follow the path that leads to cognition but on the other, allows for detours and special-interest side paths as well. This may enhance the experience of enquiry based learning without getting lost in a load of information.

6d) Relation to other research

Our work has started as an extension to the International Network for the Conservation of Contemporary Art (INCCA project[10]), which provides a digital archive of meta-information indicating sources of information on (the conservation of) contemporary art. Our research aims at developing the (information) technologies needed to implement such practices and techniques, and more in particular to develop a framework for realizing digital dossiers with intelligent guidance, adapted to the particular perspective of

[8] http://www.ifla.org/II/etext.htm
[9] http://library.thinkquest.org/18261/?tqskip1=1
[10] http://www.incca.org/

its users, which may be conservation experts, school kids or the general public. The framework will be built on open standards and may eventually be donated to the science centers and cultural heritage communities.

6e) Relation to current research

The background of our research is provided by our previous research on intelligent multimedia[11]. Our intelligent multimedia platform supports interactive 3D graphics, multi-user virtual environments, as well as embodied agents. See [Eliëns et al. (2002)] and [Huang et al. (2003)]. It uses distributed logic programming, [Eliëns (1992)], and is built on object-oriented programming technologies, [Eliëns (2000)]. It has been applied in student projects, done in cooperation with ICN, while developing digital dossiers for respectively Marinus Boezem, Marina Abramovic and Jeffrey Shaw.

As a complement to the theoretical and technical research we also plan to continue our empirical human-computer interaction studies, as reported in [Hoorn et al. (2004)], to assess the viability of our approach.

The contribution of the science centers, for example NEMO and Naturalis, will be to provide the materials, assist in finding relevant categorizations, and to function as the touchstone against which our efforts will be evaluated. The Science Communication group of the VU has an official agreement with Naturalis to facilitate this type of research.

Our current interest focuses on the use of game technology for immersive educational applications. This research provides the necessary background for the presentation of multimedia material as well as the construction of narratives (see [Eliëns and Bhikharie (2006)], [Eliëns (2006b)]).

7) Work Programme

We provide a brief summary of the issues that will be tackled and the deliverables that we expect to produce during the four years of the project.

We distinguish, over the four years, between a theoretical/study track and a practical/application track.

theorectial track

- year 1: identification of major issues -- study of prediction theory, CHI, and communication
- year 2: adaptive guided tour -- study of personalization and user profile issues
- year 3: guided tour based on user tracking -- study of agent technology and narrative theory
- year 4: writing of the thesis

In the first stage of the research, the work to be done by the proposed candidate, Chris van Riel, will be a follow-up on his master thesis, which describes a first exploration in the development of guided tours for digital dossiers.

target application(s)

- year 1: extension of abramovic dossier with user navigation tracking and questionnaires
- year 2: prototype realization of guided tour based on user tracking and questionnaires
- year 3: implementation of an advice function offering continuations and (limited) guided tours
- year 4: development of a generic digital dossier construction kit for curators

The candidate researcher will work in close cooperation with the other members of the intelligent multimedia and science communication research group, in particular dr. A. Eliëns and dr. J. Hoorn to explore the topics mentioned and to apply the intelligent multimedia technology that is being developed to digital dossiers of science communication.

[11] http://www.cs.vu.nl/~eliens/research/

education track

The advanced education of the candidate researcher will mainly be taken care of by the standard courses offered by the SIKS research school. (See www.siks.nl)
In addition, courses on experimental design and statistical analysis as well as models of communication may be followed at NeSCoR research school (www.nescor.nl). Also the course on museology at the Dept. of Science Communication VU is recommended. The candidate is supposed to become familiar with the literature in multimedia and communication as well as projects in the domain of cultural heritage, in particular CATCH, with which there will be close cooperation.

In the education track of the candidate, there will be specific focus on the mathematical background of decision and prediction theory, personalization and user-profile issues, human-computer interaction, and the application of agent technology for learning and the realization of the advice function.

8) Literature

Our papers, mentioned below, are available online at:

- www.cs.vu.nl/~eliens/research/research-dossiers.html

As our five most important papers, in the area of this research, we would like to mention: [Ballegooij and Eliëns (2001)], [Eliëns et al. (2002)], [Eliëns et al. (2006)], [Hildebrand et al. (2003)] and [Hoorn et al. (2004)].

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9) Requested Budget

personell	period	euro
OIO	4 year	172.371
	benchfee	5.000
		177.373

As indicated, the amount of euro 177.373 includes the 5000 euro benchfee for travel expenses and other support.