Project Title: **Cultural Heritage in an Interactive Multimedia Environment**

Project Acronym: CHIME

Principal Investigator: prof. dr. Lynda Hardman (Centrum voor Wiskunde en Informatica)

Classification:	application area	"Opleiding en Cultuur" (Education and Culture)
	scientific areas	"Gebruiker" (User)
		"Kennisveredeling" (Knowledge Enrichment)

Composition of the Research Team

CWI: Multimedia and Human-Computer Interaction
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prof. dr. L. Hardman	*multimedia user interaction*
dr. J.R. van Ossenbruggen	*Web and Semantic Web document languages*
dr. F.M. Nack (postdoc)	*semantic annotation of multimedia*
Sc.D. L.W. Rutledge	*multimedia languages and discourse structure*
prof. dr. P.M.E. De Bra	(part-time, main position at TUE)
prof. dr. M. Kersten	*multimedia databases*
oio (vacancy)	

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prof. dr. P.M.E. De Bra	*adaptive hypermedia, adaptive web-based applications*
dr. ir. G.J. Houben	*generation of hypermedia structures from database structure*
dr. L. Calvi	*usability of adaptive hypermedia, cultural applications*
dr. A.I. Cristea	*adaptive distance education systems*
drs. W.J.M. Lemmens (programmer)	*generation of hypermedia interfaces for databases*
prof. dr. L. Hardman	(part-time, main position at CWI, appointment as full professor approved but not yet formalised)
oio (vacancy)	

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prof. dr. B. J. Wielinga	*knowledge engineering, ontologies*
oio (vacancy)	

| **Rijksmuseum** | provider of (cultural) multimedia data |
| **Koninklijke Bibliotheek** | provider of (cultural) multimedia data |

Research School
SIKS: School for Information and Knowledge-based Systems

Summary

The goal of the CHIME project is to investigate the use of semantic models for tailoring the presentation of cultural information extracted from existing repositories to different types of users. While database query and full text search interfaces are able to provide access to the information, they do not take into account the richness of expression of multiple media types. In this project we will build on the presentation generation framework developed in previous ToKeN2000 work and focus on the user and domain modelling aspects, paying particular attention to the knowledge representation problems introduced by multimedia aspects.

The research in the project will concentrate on the creation of ontological descriptions of the domain which can be revealed in different levels of detail to different users, on the creation of user profiles to facilitate both this process and the hypermedia presentation generation process. Experience gained in the use of the user profiles and domain ontologies during the presentation generation process can then feed back into their development.

Description of the Proposed Research

National bodies such as the Rijksmuseum and Koninklijke Bibliotheek maintain repositories of cultural heritage that are mostly inaccessible to the general public and experts distributed around the world. Large investments are being made to capture as much of this information as possible digitally, and projects have been carried out to give broader access to the digitised material. There are two limitations with the current approaches, however. First, they focus on a single type of user, e.g. novice user in the Rijksmuseum ARIA system and expert user in the Rijksmuseum AdLib database. Second, the system is unidirectional, i.e. "experts" input information into the system and "users" query this information.

The goal of CHIME is to remove these restrictions and allow information to be presented to a broad range of users in a suitable way and to allow all users to add their own information to the repository, while respecting the integrity of the original historical sources. This allows a decentralized approach to the enrichment of the information in the repository by all its users to the benefit of all its users.

An example scenario to illustrate the expected usage of such a system is the following. A class of students are involved in a project (e.g. "studiehuis") and have been given an assignment on a topic in Dutch history. In addition to querying the CHIME system to find pertinent information, they are also able to add their own, private, remarks to the repository. Relevant multimedia data, such as figures, video material, photos, newspaper articles, and spoken commentary can also be added to the repository. When they are completed, the assignments are reviewed by the teacher and then included with their reviews in the repository. In the final stages of the assignment, each group gives a presentation of their work, which is recorded on video. The teacher is also able to include (fragments of) the videos of the best groups in the repository.

Note that the goal of this research is *not* to create a computer-aided learning system. Instead, to realise this scenario, our research needs to address three different areas. First, the process of generating a hypermedia presentation from retrieved media items requires many different types of knowledge from numerous sources [OGCHR01]. Consequently, ontologies need to be developed to describe and relate the key concepts of each of the components to enable a shared understanding throughout the system [SAAH99]. Second, the relationship between ontologies and multimedia has received little attention. In particular, multimedia specific requirements of web-based knowledge sharing and the management of ontology-based multimedia annotations in large-scale multimedia

repositories are yet to be addressed. Third, the evolutionary development of the ontologies, the information repository and the user's knowledge of or relationship with the available information needs to be investigated. Throughout these areas, the research needs to take into account different access levels, privacy and scalability issues and the varying degrees of reliability of the data entered by different users.

Specific research questions to be tackled are:

- At which granularity level do users need to be modelled? For example, is a user group level sufficient, or do individual user profiles need to be created? How do we reduce the required amount of user-effort needed to create these profiles? Can common ontology-based models and tools support the development, interchange and maintenance of user profiles?

- Which characteristics of a user need to be modelled in order to facilitate retrieval and presentation of information, and also to assist the user in entering information in the repository? For example, which parts of the annotation ontologies need to be made available to which user?

- In addition, the user characterization (or classification) will play a key role in deducing the trustworthiness of the entered annotations. For example, information entered by a museum curator is more reliable than that entered by a student. Which levels of reliability of data and metadata (note that the distinction between these is relative) are required?

- How should the current state of the art on the Semantic Web be extended in a way that makes user, domain and presentation-specific ontologies applicable for describing multi-media content? Which other types of metadata need to be assigned to the information in the database to allow user-centred filtering and presentation generation to be automated? Do media items need explicit annotations that add information relevant to the discourse model, such as "this is an explanatory text", "this video fragment is an example of that concept in the subject domain"? How should domain and multimedia ontologies be related to ensure that terms from multiple ontologies could be used within a single instance?

The role of the project partners is the following:
- The TUE has a proven track record in adaptive hypermedia and adaptive web-based applications [DBH99, DHW99, DC98]. The past (and ongoing) research has focused on adaptation, based on single user profiles, in a stable information repository. In the recently started AHA! project (funded by the NLnet foundation) an open adaptive hypermedia environment will be developed. In the Token2000 context the combination of individual user profiles and group profiles will be studied and the open generic platform will be extended with support for adaptation based on user and group profiles. Also, the use of ontologies for defining adaptation at the conceptual level will be investigated (and incorporated in the platform).
- SWI is an established centre of excellence for knowledge engineering. The CommonKADS methodology, which is used worldwide, was to a large extent developed here [SAAH99]. SWI has contributed significantly to research on ontology development [SWJ95,vHSW97]. In the GRASP project [WSS97], one of a long list of European projects, SWI has worked on exploiting ontologies for the cultural-heritage domain in an application for recovering stolen art objects. In this context SWI has worked extensively with resources such as the "Art and Architecture Thesaurus" (AAT), ICONCLASS and WordNet. In recent years, SWI is contributing to the state of the art developments on the Semantic Web [BPMF98], in particular using the annotation standards RDF and RDF Schema [BG00]. In the context of

the Dutch ICES-KIS project "Multimedia Information Analysis" SWI has developed an RDF-based annotation tool, which will provide important input for the project. SWI will guide the ontology work in the project.

- CWI's expertise lies in the (automated) presentation of interactive multimedia to users [RBOH00, RDOH00], in the integration of multimedia in a Web-based environment [SMIL00] and in multimedia semantic annotation techniques [MPEG-7b, MPEG-7e]. Past work has concentrated on the creation of hand-authored hypermedia presentations, resulting the in the development of the Amsterdam Hypermedia Model (which contributed to the theoretical basis of the W3C SMIL recommendation), and the GRiNS authoring system (currently being sold by the CWI spin-off Oratrix b.v.). Newer research has been focussing on the process and knowledge sources required for generating hypermedia presentations more automatically. Part of this has been carried out in the preliminary ToKeN2000 project and will be continued with the recently approved I2RP project.

The results of the CHIME project will lead to scientific publications from the research results and to prototype tool implementations, building on the presentation generation framework Cuypers [OCGRH01], created at CWI during the first phase of ToKeN2000, and the adaptive engine being developed in the TUE AHA! project. The prototype tools will be designed in a generic way so that they are not tied to the specific collections of cultural multimedia data and the specific ontologies with which they will be demonstrated. Building on the expertise of the first phase ToKeN2000 project and the collaboration with cognitive scientists from participating institutes in the first phase the CHIME project team is composed of partners with expertise in computer and cognitive science. Especially one of the two more purely technical partners, TUE, has recently hired staff with a suitable background and expertise to research the cognitive science aspects of CHIME (in particular dr. L. Calvi).

In addition we expect the results of the project to influence the construction of the Semantic Web. In particular, at the time of writing, a large amount of international effort (European as well as American) is being devoted to the construction of the Semantic Web. To date this effort has been predominantly text-centric. To exploit the Web to its full potential, multimedia needs to become an integral part of the Semantic Web infrastructure. Although it is not the primary research goal of CHIME, the results from the project will be relevant to the Semantic Web community.

The research methods used will involve an interdisciplinary approach, combining knowledge acquisition techniques from AI and user driven design from HCI. In particular, software prototypes and ontologies will be developed, based on discussions with representative users of the final system, and literature studies will be carried out to ensure the novelty of the work. The usability of the prototypes will be evaluated empirically and subsequently improved.

This research fits into the ToKeN2000 framework in a number of ways. First, it concentrates on user-centric problems already relevant to institutions such as the Rijksmuseum and Koninklijke Bibliotheek, not to mention future problems with national archiving of electronic media. Second, it enriches the information search process, not by presenting results as an ordered list, but by combining relevant information into a coherent hypermedia presentation, allowing details to be requested through links and otherwise presenting the most appropriate material in the most appropriate form. Third, the nature of the research requires an interdisciplinary team. Fourth, the results can only be satisfactorily demonstrated through the implementation (and evaluation) of a working software environment to test out research hypotheses. Finally, the work will capitalize on previous and ongoing related work, such as the NWO Dynamo project on semi-automatically generating hypermedia presentations, the ITEA RTIPA project, for creating presentations adapted to user device and network conditions, the AHA project on a general-purpose adaptive hypermedia

architecture [DAHW00, DBH99, DC98, DHW99], and the HERA project, on providing hypermedia interfaces to semi-structured databases [H00, HL00]. (Both TUE and CWI participate in the Dynamo and RTIPA projects.) In addition, the work complements research which will be carried out in the ToKeN2000 I2RP project on intelligent retrieval and presentation of museum information.

The research results of CHIME will also be made available to a broader community in a number of ways. In particular, CWI has strong links with W3C's working groups and intends to continue in its tradition of influencing relevant developments with its research results. A European Semantic Web initiative is currently being set up and results from the project will be relevant to this initiative. Currently, both CWI and SWI are partners in the European OntoWeb thematic network. Expertise from the knowledge representation community, in particular from the SWI group, can also feed back into developments in RDF and RDFS at W3C. Software components from the project are likely to be usable by a broader community, in particular the components relating to the Semantic Web.

While the museum domain is particularly suited to the enrichment of information contained in a repository by different groups of users, such as art historians, artists, curators and the general public, the research has potential application in broad areas. Any content provider interested in providing content to different users, through different networks on different hardware platforms can potentially benefit from the research results. For example, news providers, such as NOS and ANP, want to be able to deliver their content rapidly to many different end-users. The prototype tools will be designed with different applications in mind in order benefit a large audience.

Work Programme

The project will benefit from close involvement from the senior researchers in the different groups, as reflected in the (minimum) contributions from the applicants. In addition, adequate supervision of the project requires a major commitment from a post-doc. Frank Nack, CWI, will perform this role since his expertise lies in the research areas of both knowledge representation and multimedia. Before joining CWI he was heavily involved with the development of the ISO MPEG7 standard, has continued to track it as part of the Dynamo project.

The main research of the project will be carried out by the OIO's at the different institutions. While the different parts of the research are to some extent dependent on the results of the other participants' research, success or partial failure in one a particular stream of research should not have major consequences for the other streams or for the project as a whole.

In the work plan for the individual project members we do not indicate the planned publications. Of course all researchers are going to publish research results at conferences and in peer-reviewed journals.

CWI post-doc

Year 1, continued in year 2

The post-doc will investigate the requirements for the overall CHIME architecture in collaboration with the I2RP project. The CHIME architecture requires the incorporation of user modeling components, ontology repositories, inference mechanisms and hypermedia presentation components. An important research contribution of this work will be to make explicit how the different types of knowledge – user, domain and hypermedia presentation models – influence the overall hypermedia generation process. In particular, the post-doc will investigate the different types of multimedia metadata and the different roles of the annotators. Consequently, research is also required into the combination of multiple ontologies within a single annotation. In addition, the

post-doc will coordinate the activities of the 3 OIO's and ensure that the OIO's are kept up to date with relevant developments within W3C and ISO.

Year 2

The post-doc will ensure that the developments within CHIME will feed back into the software framework being developed in the I2RP project and will influence the development of the Semantic Web within international standardization bodies such as W3C and ISO.

CWI OIO

Year 1

The CWI OIO will work closely with the CWI OIO working in the I2RP project. The I2RP OIO will mainly investigate the stages of the process of hypermedia presentation generation. The CHIME OIO will concentrate on making explicit the requirements for incorporation of knowledge needed at different stages of the process. In particular, the CWI CHIME OIO will investigate the boundaries of the Semantic Web and multimedia, the most important being the domain and the user models, and how they influence the process of generating hypermedia presentations.

Year 2

The requirements derived in the first year will be evaluated by means of an initial prototype. During the development of the prototype more explicit questions can be answered. These include: how do user models (being developed by the TUE OIO) and domain ontologies (being developed by the SWI OIO) influence the hypermedia generation process; what aspects of the user and domain need to be modeled to improve the generation process (this will feed back into the TUE/SWI/I2RP OIOs' work); how do user, domain and presentation-specific ontologies need to be extended for multimedia.

Years 3/4

Theoretical and technical issues that are identified during the first two years will be studied more in depth. The OIO will also assist in the creation of a common project demonstrator, integrating the ontology work (SWI), adaptation (TUE) and presentation (CWI).

Year 4 is devoted to writing and defending the PhD thesis.

TUE OIO

Year 1

The TUE OIO will investigate both the expressibility of current user models and the languages in which these are written down. In particular concentrating on the areas where multimedia contributes extra demands compared with (hyper)text-based systems. The TUE OIO will coordinate with the SWI OIO in terms of which language and processing systems to use to construct the ontologies required. Questions to be answered are: which levels of granularity can be used and/or combined in a user model; how the effort in creating an initial user model can be reduced; how a user model can be expressed using the languages of the Semantic Web; do existing ontology workbenches need to be extended for the specific case of user models.

Year 2

The TUE OIO will first investigate the creation of group (user) models from the combined (browsing and retrieval) behavior of users, as well as the automatic identification of user groups. (The OIO will most likely draw from the expertise of dr. Cristea in the area of neural networks to automate the processes of group identification). The research will then continue on the problem of combining individual user profiles with a group profile in order to perform adaptation based on both.

Years 3/4

Theoretical and technical issues that are identified during the research of the first two years will be studied more in depth. The OIO will also assist in the creation of a common project demonstrator, integrating the ontology work (SWI), adaptation (TUE) and presentation (CWI).

Year 4 is devoted to writing and defending the PhD thesis.

SWI OIO

Year 1

The main research question to be tackled is how the ontologies should be organized in order to allow for different users (or user groups). The SWI OIO will first investigate the spectrum of viewpoints that different users may want to take on the target domain. The OIO will construct the relevant ontologies making as much use as possible of existing resources such as AAT and other domain standards. The ontologies will be represented in one of the web knowledge-representation standards (probably either RDFS or DAML+OIL [FHvH*00]). The user viewpoints will initially be represented by differences in scope and granularity of the ontology.

Year 2

The OIO will evaluate the ontology organization. It may be possible that it turns out that a simple ontology organization is inadequate and that different ontologies with incomplete mappings between them are required. The OIO will also construct an adapted version of the MIA tool (see earlier) to support annotation and search with help of the ontologies. This work will be carried out in collaboration with the TUE OIO. The SWI OIO will also work with the CWI OIO to ensure that the ontology-based annotations supply the required information for presentation generation.

Year 3/4

Further experimentation; deepening of theoretical work on ontology organization supporting multiple viewpoints.

Year 4 is devoted to writing and defending the PhD thesis.

Note that ontologies in the case of the SWI OIO are the object of study, whereas for the other 2 OIOs they are one of the tools available to the research.

Requested Budget

Personnel	amounts in kfl
1 post-doc, Frank Nack, at CWI for 2 years:	220,00
1 OIO, to be appointed at CWI:	286,00
1 OIO, to be appointed at TUE:	286,00
1 OIO, to be appointed at UvA:	286,00
Travel	
standard travel budget CWI:	20,00
standard travel budget TUE:	10,00
standard travel budget UvA:	10,00
Total requested subsidy (salaries include 35% overhead)	1118,00
Contribution from applicants (also including overhead)	
research and coordination	
H.L. Hardman: 7% of kfl 265 x 4 years	74,20
M. Kersten: 5% of kfl 340 x 4 years	68,00
P.M.E. De Bra: 5% of kfl 379 x 4 years	75,80
L. Calvi: 5% of kfl 230 x 4 years	46,00
A.Th. Schreiber: 5% of kfl 265 x 4 years	53,00
B.J. Wielinga: 5% of kfl 340 x 4 years	68,00
Total matching	385,00

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[MPEG-7e]   ISO MPEG-7(2000e). "Text of ISO/IEC 15938-5/CD Information Technology Multimedia Content Description Interface - Part 5 Multimedia Description Schemes", ISO/IEC JTC 1/SC 29/WG 11 N3705, October 2000

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Research Team's Key Publications

CWI

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TUE

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SWI

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