A MULTIMEDIA APPROACH TO REQUIREMENTS CAPTURE AND MODELING

David P Wood
Michael G. Christel
Scott M. Stevens

Reprinted from the PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON REQUIREMENTS ENGINEERING, Colorado Springs, Colorado, April 18-22, 1994

IEEE Computer Society
10662 Los Vaqueros Circle
P.O. Box 3014
Los Alamitos, CA 90720-1264

Washington, DC • Los Alamitos • Brussels • Tokyo

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. IEEE COMPUTER SOCIETY

A Multimedia Approach to Requirements Capture and Modeling

David P. Wood Michael G. Christel Scott M. Stevens

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, Pennsylvania, USA 15213-3890

Abstract

The Advanced Multimedia Organizer for Requirements Elicitation (AMORE) embodies a synthesis of technologies adapted specifically for application to requirements elicitation processes and models. Elicitors will use AMORE as a platform for storing requirements in as close to their natural forms as possible to maximize traceability and to promote understanding of original intentions and motivations. AMORE fills the gap that exists between raw requirements source material and the more formalized requirements representations commonly used by specification methods and CASE tools. The concepts and technologies demonstrated by AMORE are suitable for inclusion as a front-end augmentation to existing CASE analysis tools.

1. Introduction

There is a persistent failure in the software engineering community to produce satisfactory software requirements [1], and this failure may be attributed in part to several factors [2,3,4]:

> It is difficult to create structured models from natural language customer descriptions.
>
> In the transition from raw requirements data to increasingly formal specifications, potentially important information is lost, and traceability is difficult to maintain.
>
> Engineering legacy from project to project is often lost, rendering reuse and reengineering difficult or impossible.
>
> Policy, process, and methodological information may be available but is often difficult to access.

The Software Engineering Information Modeling Project (SEIM) is developing technology in support of the capture, representation, analysis, and access of requirements engineering information. The methods and techniques under development are embodied in a prototype modeling environment, the Advanced Multimedia Organizer for Requirements Elicitation (AMORE), which focuses particularly on the area of requirements elicitation.

2. AMORE: An Elicitor's Assistant

Requirements elicitation is the process of identifying needs and bridging the disparities among the involved communities for the purpose of defining and distilling requirements to meet the constraints of these communities [I]. Requirements analysts, customers/funders, developers, and end users are involved with requirements elicitation to differing degrees, and thus requirements elicitation involves social, communicative issues as well as technical issues. Elicitation is often plagued with problems of traceability, inadequate conflict detection and resolution, poor communication between these elicitation stakeholders, and the loss of important process and system information [2]. AMORE provides a multimedia environment which can address these shortcomings by capturing and organizing the information generated during requirements elicitation.

A prototype of AMORE has been developed and populated with requirements from a US Army movement control system, the Highway Operations System (HOS). The following subsections describe the concepts underlying the AMORE system and the ongoing evolution of AMORE from a basic prototype focusing on capture and organization of requirements information with integrated process assistance, to an advanced prototype featuring knowledge-based search and retrieval, automated transcription, and large-scale visualization technologies.

This work is sponsored by the U.S. Department of Defense.

0-8186-5480-5/94 $03.00 C 1994 IEEE

2.1. The Motivation for an Elicitor's Assistant

Requirements for systems exist in many formats. Depending on the nature of the customer, problem domain, and extant systems, raw requirements data may arise in many ways, such as:

- Informal technical notes
- Notes from meetings
- Statements of Work
- Requests for Proposal
- Operational Concept Documents
- Interviews with customers or users
- Manuals or operational features
- Technological surveys

Despite the fact that requirements arise in many forms, most existing technologies for capture and representation of requirements primarily focus on formal or semi-formal textual and graphical notations. In this process, raw requirements information is obscured and full traceability is lost. With AMORE, we propose to address the deficiencies of existing requirements modeling technologies by providing the means for capture, representation, and manipulation of raw requirements data by the use of media most suited to the original forms.

2.2. AMORE as a Modeling Tool

In the process of gathering requirements for a new system, the elicitor may become inundated with a large volume of data in a wide variety of formats. To promote the likelihood of successful analysis and design of the new system, an elicitor must be able to populate AMORE's database as raw requirements data become available. For example, either during an interview with a customer or during follow-up analysis of the video transcript of the interview, the elicitor will be able to identify, capture, and store segments of the interview which support a certain requirement and associate those video segments with that requirement. Further, AMORE must provide organizational tools that promote reasoning about the requirements by facilitating browsing, navigating, and searching through the captured data.

The basic organizational unit of AMORE is the requirement. A requirement may comprise a large number of attributes, the simplest of which is a natural language textual description of the requirement. Other attributes, chosen to best suit the nature of the raw requirement source material, include various graphic, audio, and video representations of the requirement, a formal specification, examples from other systems, interviews capturing the underlying rationale, design restrictions or suggestions, conflicting opinions, and so forth.

Because large-scale systems may contain many thousands of requirements, it is necessary to provide some type of structural principles for organizing multiple requirements. AMORE is supportive of hierarchical or networked organizational structures, the most common of which are leveled data flow and control flow diagrams, object hierarchy diagrams, and task decompositions. An example of one level of such a hierarchy is shown in Figure 1.

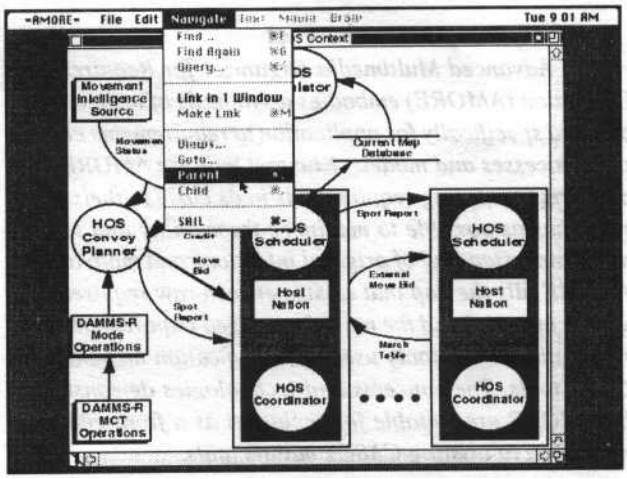

Figure 1. Example Hierarchical Level for Organizing Requirements

For the elicitor, the selected organizational structure is the primary mode of navigation through AMORE. For example, the elicitor can move about different levels of the system hierarchy by means of double-clicking through parent/child relationships, similar to the type of navigation commonly found in CASE tools for analysis and design. The elicitor can modify the hierarchy, adding, moving, modifying, and deleting branches as necessary.

Requirements are located at primitive nodes in the chosen hierarchy. The elicitor may add information to any of the requirement attributes at any time to create a story that will be meaningful to future browsers of the requirements. For example, a designer may need a better understanding of the core motivations behind a certain requirement. By examining the attributes of that requirement in AMORE, the designer is able to examine the original rationale in its raw format, which might include video clips of a debate among various stakeholders discussing possible trade-offs and explaining the resulting design constraints. Charts, graphics, and formal descriptions might also be available as supporting documentation (see Figure 2)

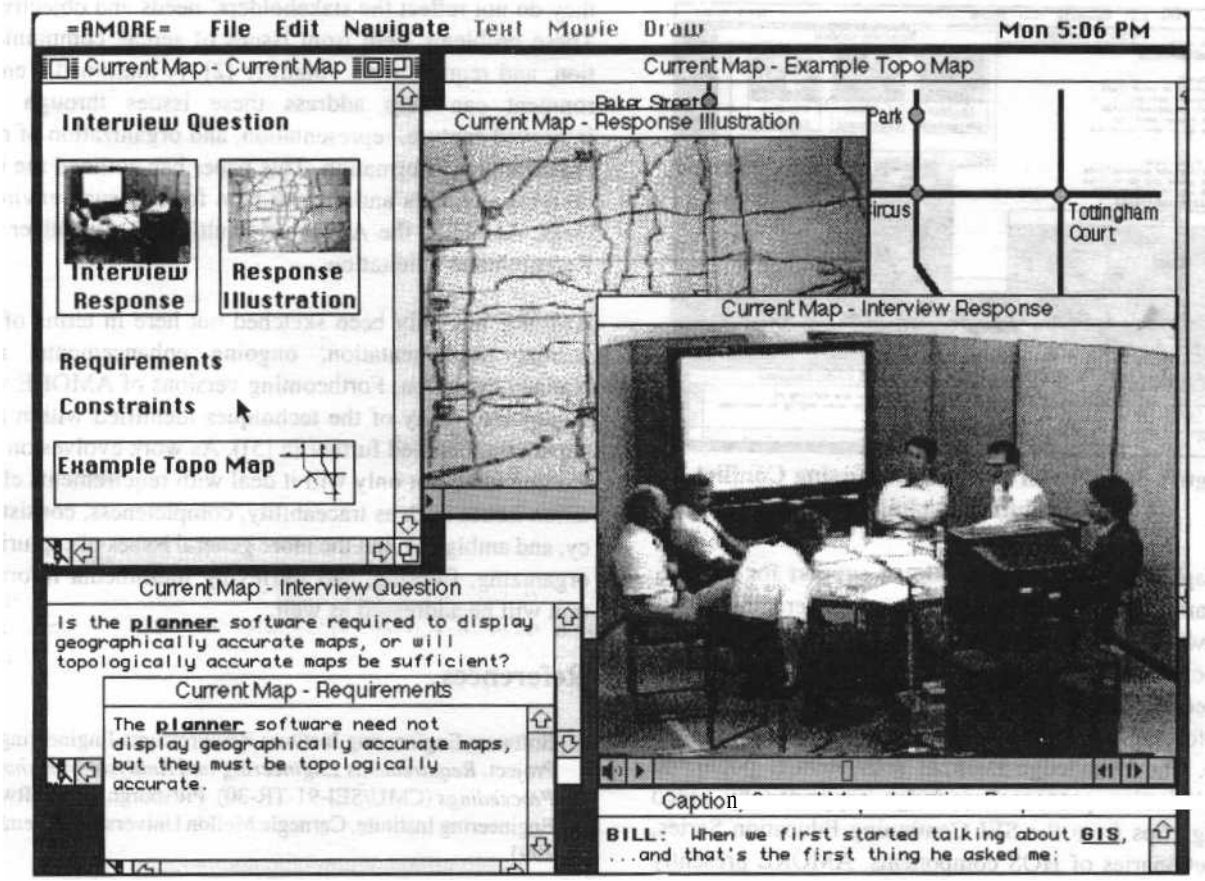

Figure 2. Different Representations Associated with a Requirement

2.3. AMORE as a Knowledge Assistant

While gathering requirements data and populating the database, the elicitor may have need of assistance. To provide as much on-line, instantaneous assistance as possible, AMORE includes knowledge about the elicitation process and how to perform the various tasks comprising elicitation. The knowledge-based component of AMORE provides the tools necessary to:

Capture and preserve knowledge about the requirements elicitation process.

- Teach useful skills that the user needs to be an effective elicitor of requirements.

Provide the means for preserving and manipulating information about the system under development, as well as preceding developments in the same domain, or other systems of relevance to the system under development.

These broad objectives can be met in a number of ways. In its simplest form, users may interact with AMORE as a repository of diverse information in forms such as context-sensitive help, a data and object dictionary for the system under development, and an electronic process handbook of elicitation tools, techniques, and enterprise practices. The repository may be accessed directly via icon or menu selection or indirectly via multimedia hyperlinks.

As the repository grows and increasing amounts of domain and elicitation process information become available to the user, more effective information filtering will be required. Navigational guides, better information visualization, rule-based agents, and other techniques surveyed in [5] may be incorporated in the future to improve AMORE's versatility as a knowledge assistant (see Figure 3).

3. Status of AMORE

The SEIM Project is presently developing a fully operational prototype of AMORE. This prototype is hosted on a Macintosh-based platform supporting QuickTime video, utilizing Intel's Digital Video Interactive (DVI) technology for hardware-assisted compression. The prototype is oriented toward a single user configuration and supports interactive capture of digital audio and video, in addition to text

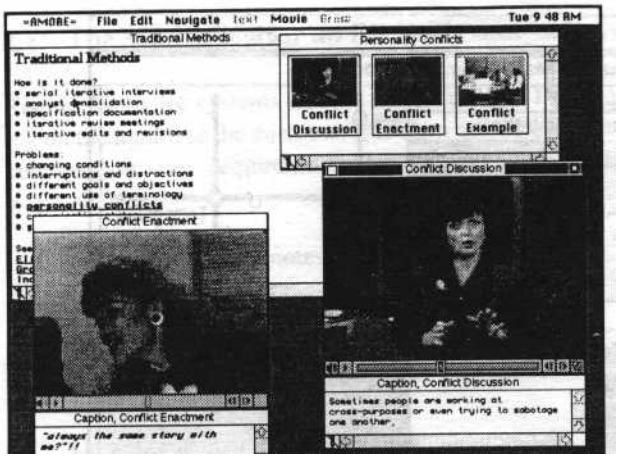

Figure 3. Elicitor Advisor Discussing Conflict Resolution Technique

and graphics editing. Organizational support for requirements are available in the form of leveled hierarchical diagrams with an integrated object dictionary. The system has been populated with requirements objects (including digital video and audio clips) gathered during elicitation sessions for the U.S. Army Highway Operations System (HOS). The knowledge-assistant subsystem is populated with elicitation process knowledge supported by video training clips from the SEI Continuing Education Series, and dictionaries of HOS components. AMORE presently supports information retrieval based on casual browsing as well as direct links and query-based searching.

Future versions of AMORE will support user-chosen organizational representations. AMORE will evolve toward wider support of varied domain and system models, supported by user selectable graphical visualization mechanisms. AMORE will emphasize growth toward increasingly intelligent performance support for information retrieval. Likely directions include implementations of guides, case-based reasoning, and pattern-recognizing intelligent agents [5]. The planned integration with CMU's *SPHINX-II [6],* a speaker-independent, continuous speech recognition system, will increase the likelihood of technological solutions to queries of audio and video data, de-emphasizing the labor-intensive aspects of transcription. The AMORE user may then search through audio and video data as well as text with equal ease, and natural language queries on large-scale multimedia data would become feasible.

4. Conclusions

Many requirements problems are due to poor requirements elicitation, including the resulting requirements being ambiguous, inconsistent, irrelevant, and incorrect because they do not reflect the stakeholders' needs and objectives. These problems stem from issues of scope, communication, and requirements volatility [2]. A multimedia environment can help address these issues through the improved capture, representation, and organization of raw requirements information. This paper has outlined the underlying concepts and growth plan for one such environment: AMORE, the Advanced Multimedia Organizer for Requirements Elicitation.

AMORE has only been sketched out here in terms of its current implementation, ongoing enhancements, and planned evolution. Forthcoming versions of AMORE will incorporate many of the techniques identified within this paper (and detailed further in [5]). As work evolves on the environment, not only will it deal with requirements elicitation issues such as traceability, completeness, consistency, and ambiguity, but the more general issues of capturing, organizing, filtering, and retrieving multimedia information will be addressed as well.

References

[I] Software Engineering Institute Requirements Engineering Project. *Requirements Engineering and Analysis Workshop Proceedings* (CMU/SEI-9I-TR-30). Pittsburgh, *PA:* Software Engineering Institute, Carnegie Mellon University, December, 1991.

[2] Christel, Michael G.; & Kang, Kyo *C. Issues in Requirements Elicitation* (CMU/SEI-92-TR-12). Pittsburgh, *PA:* Software Engineering Institute, Camegie Mellon University, September, 1992.

[3] Wood, David P.; & Kang, Kyo C., *A Classification and Bibliography of Software Prototyping* (CMU/SEI-92-TR-13). Pittsburgh, *PA:* Software Engineering Institute, Carnegie Mellon University, October, 1992.

[4] Communications-Electronics Command. *Proceedings of the Requirements Engineering and Rapid Prototyping Workshop.* Fort Monmouth, NJ: Center for Software Engineering, U.S. Army Communications-Electronics Command, November 14-16,1989.

[5] Christel, Michael G.; Wood, David P; & Stevens, Scott M. *AMORE: The Advanced Multimedia Organizer for Requirements Elicitation* (CMU/SEI-93-TR-12). Pittsburgh, *PA:* Software Engineering Institute, Carnegie Mellon University, June, 1993.

[6] Huang, Xuedong; Alleva, Fileno; Hon, Hsiao-Wuen; Hwang, Mei-Yuh; & Rosenfeld, Ronald. *SPHINX-II Speech Recognition System: An Overview* (Research Paper CMU-CS-92-112). Pittsburgh, *PA:* Camegie Mellon University School of Computer Science, January, 1992.