TOWARDS MEETING INFORMATION SYSTEMS
Meeting Knowledge Management

Vincenzo Pallotta°, Hatem Ghorbel°, Afzal Ballim[$]
°Faculty of Information and Communication Sciences, Swiss Federal Institute of Technology, Lausanne, Switzerland
[$]Business Processes Services, Japan Tobacco International Inc.
Email: Vincenzo.Pallotta@epfl.ch, Hatem.Ghorbel@epfl.ch, Afzal.Ballim@jti.com.

Agnes Lisowska[+], Stéphane Marchand-Maillet[*],
[+]School of Translation and Interpretation, [*]School of Computer Science, University of Geneva, Switzerland
Email: agnes.lisowska@issco.unige.ch, marchand@cui.unige.ch.

Keywords: Meeting Knowledge Management, Tacit Knowledge, Modelling Concepts and Information Integration Tools, Requirements Analysis, Ontology Engineering, HCI on Enterprise Information Systems.

Abstract: Interaction through meetings is among the richest human communication activities. Recently, the problem of building information repositories out of recordings of real meetings has gained interest. We report here a summary of the first two years of research carried out within the Swiss funded research project (IM)2, together with some lessons learned and future perspectives.

1 INTRODUCTION

Recently, the problem of building information repositories out of recordings of real meetings has gained interest, and several research projects have started[1]. [AL1]The National Centre of Competence in Research (NCCR) on Interactive Multimodal Information Management, in brief (IM)2[2]. (IM)2 is a network of Swiss research institutions with different competencies and research traditions, and it is composed of several individual projects (IPs). The work reported here, is the contribution to the (IM)2 project by researchers belonging to the Multimedia Dialogue Management (MDM) and to the Information Indexing Retrieval (IIR) IPs. A partnership between (IM)2 project and another existing project on the same topic, the ICSI Meeting Broswer project (Morgan et al., 2001) has been settled. Within this project, a corpus of recorded, transcribed and annotated meetings has been collected (Janin et al., 2003) and made available to (IM)2 partners.

1.1 Meeting Recording Scenarios

The *application scenarios* envisaged in (IM)2 for meeting recording, understanding, storage and retrieval are the following.

- For *collaborative work*, suppose someone missed one group meeting (new/sick/distant employee) and needs information about "what happened" at the meeting.
- For *high-level management*, a manager might be interested in searching the meeting repository as a whole, by tracking and documenting the progress of a project over a year, by tracking and documenting the performance of a team/employee, or by monitoring the communication and leadership inside a team.

Recording meetings implies the storage and structuring of a large set of heterogeneous information scattered over time and media. In the one hand, the raw data, obtained from the various recording devices, is neither directly usable for the

[1] Among the most representative we quote here: http://www.is.cs.cmu.edu/meeting_room/, http://www.icsi.berkeley.edu/Speech/mr/, http://www.m4project.org/, http://www.amiproject.org/.
[2] http://www.im2.ch/.

creation of indexes, nor for content-based access to the relevant parts of the meeting recordings. On the other hand, meeting minutes are considered as a fundamental source of information for building knowledge bases and repositories as pointed out in (Corrall, 1998), but they are not always available, especially for informal meetings. For our goals, we need effective methods to map meeting events to tractable and accessible information sources. The type of knowledge contained in meetings is often referred to as *tacit* knowledge (as opposed to *explicit* knowledge). Tacit knowledge, in order to be useful to anyone beyond the person who owns it, should be made available to other people through the process of communication and sharing, but also converted into explicit knowledge if that knowledge has to be reusable for knowledge management. These two processes are referred to respectively as *socialization* and *externalization*, and can be fruitfully supported by collaborative technologies (Romaldi, 2002). The goal of this paper is to consider collaborative technologies as the foundation for the design of Meeting Information Systems.

2. WHAT IS A MEETING?

Following the methodology adopted in (Marchand-Maillet, 2003), we start by identifying meeting activities. That is, all possible activities happening during a face-to-face meeting. Figure 1 presents these activities as an activity diagram gathered around a central transition state since we assume that any combination of activities can be envisaged. Clearly, the figure shows a *factored view* of meeting activities.

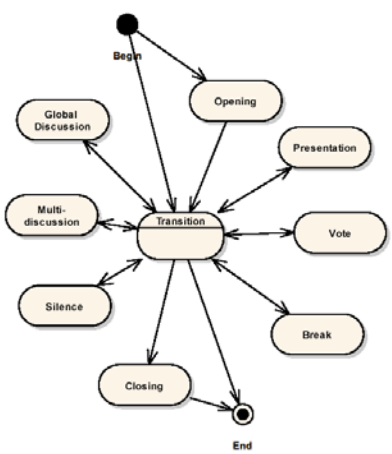

Figure 1 . Meeting activities

In this paper we will focus more on the abstract characterization of the knowledge management process in discussion activities. However, other multi-modal meeting activities have been discussed in detail in (Marchand-Maillet, 2003).

2.1 Use cases for Meeting Information Systems

Users for Meeting Information Systems have been identified and three possible classes of these users have been defined:

1. Participant: a person that is physically present in the meeting;
2. Customer: a participant of a project (aware of the topic), absent from a meeting, or a person unfamiliar with the project;
3. Analyst: responsible for the post-processing of the meeting (e.g. minutes, summaries, meeting records).

These users may have other roles in the enterprise as well (e.g. giving a role to a participant like “manager”).

User's requirements have been initially gathered, primarily by guessing, and then by classifying possible user's queries. Browsing is another modality of access to meeting information systems not discussed in this paper. The interested reader may refer to (Marchand-Maillet, 2003). A first attempt has been proposed in one of the project’s first deliverable reports (Lalanne and Sire, 2002), from which some interesting query examples are classified and reported below.

Situation: Where was taking place the meeting?
Participants: Who were the participants? Who was the president/moderator of the meeting?
Turn taking: I want to see the turn-taking flow of the overall meeting. Who talked most during the meeting?
Actions and Events: Which document was projected when X was talking about topic A? Were there (and when) votes made? Were there (and when) decisions taken? Were there (and when) any presentations? Was there any break?
Agenda: What was the agenda of the meeting?
Topics: What were the different topics treated during the meeting? What did participant A said about topic 1? What were the questions opened about topic 1? What was the conclusion for topic 1? What solutions have been chosen concerning topic 1? Who have accepted solutions X1 concerning topic 1? Which decisions has been taken concerning topic 1?
Dialogue acts: What were the questions asked concerning topic A and their corresponding answers?

Tasks: On what issues group members disagreed on? Which members disagreed and on what subject? What were the tradeoffs being made and what were the criteria (dimensions) used to make up a decision? What were the decisions being made? Which criteria were chosen to take the decision? What were the competitive issues? Which members were competing against each other and on which corresponding issues? What information has been disseminated and by who?

2.2 Elicitation of real user queries

A better characterization of user requirements has been performed by means of a user queries elicitation experiment. This study was run in July/August 2003 to find out what types of things users want to know about (e.g. people, topics, decisions, agenda) and how they ask about them (e.g. language, modalities). Details are available in (Lisowska, 2003). The experiment was conducted in the following manner.

A questionnaire was sent and received by e-mail, which briefly presented the (IM)2 project, explained the use cases and asked participants to pick one (or more), and think of questions they might want to ask to get answers in the specified circumstances. The following use cases (or scenarios) were chosen in order to constrain the task, which allows for easier analysis and acquisition of a more coherent set of results across participants:

1. A manager tracking employee performance;
2. A manager tracking project progress;
3. An employee reviewing a meeting they missed;
4. A new employee trying to learn about a project.

A total of 28 responses were gathered, 14 by (IM)2 project members and 14 by people external to the project, resulting in 297 queries. We can summarize the results of the analysis of the user queries by highlighting 3 types of knowledge required in order to interpret the queries and provide a relevant answer to them:

User models: The fact that people tend to make assumptions about their dialogue partners based on various factors and alter their own behaviour accordingly (e.g. vocabulary, background, goals, preferences) suggests that a set of representative user models for the meeting domain is needed.

Domain ontologies: The user, depending on his/her degree of acquaintance with the domain, is expected to formulate their queries using a domain-specific terminology.

Natural language understanding: There are queries for which various degrees of natural language understanding are required. In general, the level considered is semantics and pragmatics, but it also seems that robust syntactic models are required in order to extract the right answer type from queries. Some examples of these types of issues are:

- The use of anaphoric expressions.
- The contextual interpretation of general concepts.
- The use of indirect questions.
- The use of highly domain-specific abstract concepts.

The latter seems to be the most difficult issue since its solution requires the construction of a meeting ontology and its use in the interpretation of user queries. For instance, in the query "Who made constructive criticisms about the proposal?" one might ask what constitutes a constructive criticism. To answer this last question the system needs to know this term has an operational interpretation (e.g. based on an argumentative model).

2.3 Meeting Data Model

The meeting data model we propose, described in detail in (Marchand-Maillet, 2003) and in (Pallotta, 2003), assumes that a meeting is part of a project, held in a given meeting room that will capture the multimedia data from the meeting room (e.g. video, audio, shared electronic documents). The data recorded during the meeting is then stored in parallel with documents associated with the meeting (e.g. distributed/shown during the meeting). A meeting may be structured in terms of its temporal activities (episodes). These are defined by the meeting states presented earlier. Minutes, as a set of notes (taken or not during the meeting) and the text transcripts will also be stored in this meeting repository. Text transcripts can be enriched by annotations following the *shallow dialogue model* proposed in (Armstrong et al., 2003).

Similar use case analyses have been carried out in the context of Electronic Meeting Systems (EMS). See (Antunes and Costa, 2002) and (Antunes and Carriço, 2003) for a thorough survey. It is worth to draw attention here to the fact that our model must be less constrained and abstract than the EMS models, since we cannot foresee all possible types of interactions and processes in face-to-face meetings. However, the EMS models proposed so far can be adapted and reused to capture the rationale of meetings and superimpose a logical structure to multimedia documents obtained from the meeting recordings. We will certainly look at those models at later stages of the project.

2.4 The construction of the meeting ontology

Ontologies are essential in order to define precise *guidelines* for the transcription and annotation of a large number of recorded meetings, including their semantic/conceptual annotation (i.e. metadata) and the annotation of the dialogue structure. We consider two types of meeting ontologies:

1. A *meeting-type-specific ontology* can be used to represent the information related to the purpose and nature of the meeting, regardless of the technical domain in which the meeting takes place.
2. *Domain-specific ontologies* complement the task-related information with structured knowledge about the domain in which the dialogue is taking place.

These ontologies must be somehow formalized and built in a flexible and efficient manner. For both types of ontologies, their (semi)automatic production must be also accompanied by mechanisms that automatically attach the proper ontologies to the meetings. The attachment will be obtained by dialogue model detection and the classification of the different tasks (reporting, decision making, vote, etc.) that can be observed during meetings and characterized by specific *interaction patterns*. For instance, meeting events are often introduced by summaries, recaps, conclusions, sign-offs (i.e. agreements), disagreements, rejections, etc.

A first rough classification of meeting types has been considered, where three main classes were decided upon:

1. *Meetings for Executive Strategies*. These types of meetings are aimed at goal formation and are typically unconstrained. Examples are Board meetings, Steering committee meetings.
2. *Management meetings* are aimed at plan formation for task management (e.g. human resources and task allocation). They are generally along the lines of *project* and *staff* meetings and are more structured.
3. *Business Processes Meetings* are more structured, disciplined, and often have an invariant structure (i.e. follow templates). They are aimed at plan execution (i.e. control).

All the above types of meetings might be part of another class of meetings characterized by two essential features: *decision making* and *action point* events. We refer to this class as *breakdown meetings*. Action points can be defined as task assignment with deliverables and delay.

2.5 Argumentative structure of meetings

In order to answer the types of questions exemplified in the previous section, we need to structure the meeting records at a deeper level, by further annotating them with appropriate meta-descriptions: "argumentative structures". A simple but expressive model of an argumentative structure is the "Issue Based Information Systems" (IBIS) model, proposed by (Kunz and Rittel, 1970) and adopted as a foundational theory in some *computer-supported collaborative argumentation* (CSCA) systems such as Zeno (Gordon and Karacapilidis, 1999), HERMES (Karacapilidis and Papadias, 2001), Questmap (Conklin et al., 2001), and Compendium (Selvin, 2001). We adopt this model as the reference model for the description of the argumentative structure of decision-making events in meetings. The model captures and highlights the essential lines of a discussion in terms of what issues have been discussed and what alternatives have been proposed and accepted by the participants.

2.6 The Meeting Description Schema

The description schema we propose, discussed in (Ghorbel et al., 2003), is the starting point for the construction of *general meeting model.* It is formalised using XML-schema[3] and reflects the substantial aspects of the IBIS model. The Meeting Description Schema (MDS) is based on the previous observation that there exist a number of sequencing regularities in dialogue, *adjacency pairs*, describing facts such as, for instance, that questions are generally followed by answers, issues by solutions, proposals by acceptances or

[3] http://www.w3.org/XML/Schema/

rejections, etc. In MDS, the dialogue contexts are represented by *argumentative episodes* and can be viewed as snap-shots of the discussion. When analysing the dialogue, a single tree structure is not sufficient to represent the adjacency pairs: consider an answer that refers to two questions in the discussion. For this purpose we add a dependency relation ("replies_to"), which links the answer to both the two questions. The "replies_to" relation induces a *chain structure* on the dialogue which is local to each episode and which enables the visualization of its context. There is an invariant parametric structure of discussion episodes which is reported below:

```
DISCUSS(issue)
  PROPOSE(solution/idea/alternative/opinion)
    ASK_FOR(explanation/justification)
      PROVIDE(explanation/justification)
        ACCEPT(explanation/justification)
        REJECT(explanation/justification)
    ACCEPT(solution/idea/alternative/opinion)
    REJECT(solution/idea/alternative/opinion)
```

This structure mirrors, in terms of episodic structure, the IBIS model.

3. TOWARDS A MEETING QUERY ENGINE

Searching meeting dialogues poses several problems when using standard Information Retrieval (IR) indexing techniques. One important point is that users may ask different types of queries depending on their needs, and therefore one single retrieval strategy may not be sufficient. We believe that standard text-based IR techniques are partially adequate to meet the requirements for retrieving meeting dialogues as we have observed, in the user's queries elicitation analysis. The link to additional knowledge (present in the meeting repository in the form of annotations or links to other knowledge sources such as, for instance, related documents) may increase the robustness and performance of the search engine. We need to improve the efficiency of a meeting search engine by combining heterogeneous indexes having different natures (lexical, semantic) and different modalities (speech, documents) in the following way:

Indexing techniques:

- *thematic information* obtained by adapted indexing techniques;
- *semantic/structural information* described in the form of metadata in annotations (e.g. topic segmentation, dialogue acts, argumentative structure);
- *aligned information* (e.g. speech transcription with related documents);
- *knowledge about the structure of the meeting* (e.g. information from the meeting database).

Query interpretation techniques based on deep linguistic (semantic/pragmatic) analysis of the user's query in order to identify *query expansion (reformulation) strategies* and *search strategies* (e.g. selecting the index granularity, selecting the filtering strategy).

We also propose to consider knowledge-based methods for flexible query expansion and/or reformulation. Let's consider for instance a simple query like:

Who disagreed on issue T?

Following a classical IR approach, one can imagine enhancing indexing by attaching an additional "disagreement" term to all the turns included in episodes which are part of the argumentative chains induced by the "replies_to" relation of type:

```
DISCUSS(issue)
  PROPOSE(alternative)
    REJECT(alternative).
```

This solution allows us to have indexed both the content of the argument (i.e. terms of the episode DISCUSS(issue)) and the names of the people who have disagreed (supposing that this information is indexed for each episodes). However, by collapsing this information in term-based indexes we loose the argumentation structure and thus might obtain a false positive: the person who started the discussion of issue T is considered to be one of the people who disagree. Moreover, if there are several disagreements, the speaker corresponding to a PROPOSE(alternative) episode can be erroneously paired with the speaker of the REJECT(alternative) which is not in the "replies_to" relation. A different approach, which does not suffer from the above problems is to answer the first query by gathering all the episodes with content T of type DISCUSS(issue) and, for each of the retrieved episodes, following the argumentative chain to select the associated PROPOSE-REJECT(alternative) pair.

4. CONCLUSIONS

Multimodal meeting recordings are an extremely rich source of information, which needs to be converted into explicit knowledge for its exploitation in the context of enterprise knowledge management. Speech technology can help in supporting extraction of knowledge (McCowan et al., 2003), and dialogue act disambiguation (Bhagat et al., 2003). As pointed out in (Brown et al., 2001), a more formal approach to meeting capture and analysis, based on a formal theory of argumentation (e.g. IBIS), must be taken so that the decision-making process can be more easily traced and understood.

In this paper we have discussed a possible foundation of Meeting Information Systems and proposed a preliminary model based on user requirements analysis. This work has been carried out in the framework of the (IM)2 project, which, reaching its second year, has showed a clear roadmap for future research.

REFERENCES

Antunes P., Costa C.J., 2002. A Descriptive Framework for Electronic Meeting Systems Based on the UML Language. *Technical Report DI/FCUL TR-02-05*, Department of Informatics, University of Lisbon, Portugal. http://www.di.fc.ul.pt/tech-reports/abstract.php?report_ref=2002-05.

Antunes P., Carriço L., 2003. Modeling the Information Structures of Meetingware. In *proceedings of Workshop de Sistemas de Informação Multimédia e Cooperativos*, COOP-MEDIA '03. Porto, Portugal, October 8, 2003. http://www.di.fc.ul.pt/~paa/papers/coopmedia-03-mware.pdf

Armstrong S., et al., 2003. Natural Language Queries on Natural Language Data: a Database of Meeting Dialogues. In *Proceedings of NLDB'2003,* Burg/Cottbus, Germany.

Bhagat S., Carvey H., Shriberg E., 2003. Automatically Generated Prosodic Cues to Lexically Ambiguous Dialog Acts in Multiparty Meetings. In *proceedings of ICPhS 2003 conference*, Barcelona, August 2003.

Brown E.W., Cooper J.W., Srinivasan S., Amir A., Coden A., Poncelon D., 2001. Towards speech as a knowledge resources. In *IBM Systems Journal*, vol. 40(4), 2001.

Conklin, J., Selvin, A., Buckingham Shum, S., and Sierhuis, M. 2001. Facilitated Hypertext for Collective Sensemaking: 15 years on from gIBIS: Knowledge Media Insitute, Open University.

Corrall S., 1998. Knowledge Management. Are we in the knowledge management business? In *ARIADNE: the Web version*, issue 18, December 1998, http://www.ariadne.ac.uk/issue18/knowledge-mgt/.

Gordon, T., and Karacapilidis, N. 1999. The Zeno Argumentation Framework. In *German Artificial Intelligence* 3:20-29.

Janin A., et al., 2003. The ICSI Meeting corpus. In *ICASSP-2003*, Hong Kong, April 2003.

Karacapilidis, N., and Papadias, D. 2001. Computer Supported Argumentation and Collaborative Decision Making: The HERMES system. In *Information Systems* 26, no 4:259-277.

Kunz, W., and Rittel, H. W. J. 1970. Issues as elements of information systems. *Working Paper* n. 131, Universität Stuttgart, Institüt für Grundlagen der Planung. May 1979.

Marchand-Maillet S., 2003. Meeting Record Modelling for Enhanced Browsing. *Tech. Rep. 03.01*, Computer Vision and Multimedia Laboratory, Computing Centre, University of Geneva, Switzerland, March 2003.

McCowan I., Gatica-Perez D., Bengio S., Lathoud G., 2003. Automatic Analysis of Multimodal Group Actions in Meetings. In *IDIAP research report* n. IDIAP-RR 03-27. Martigny, May 2003.

Morgan N., Baron D., Edwards J., Ellis D., Gelbart D., Janin A., Pfau T., Shriberg E., and Stolcke A., 2001. The Meeting project at ICSI. In *Human Language Technologies Conference*, San Diego, March 2001.

Lalanne D., and Sire S., 2002. Smart Meeting Minutes Application Specification. *IM2 Technical Report*, ver. 2.4, University of Fribourg, Switzerland, August 2002.

Lisowska A., 2003. Multimodal Interface Design for the Multimodal Meeting Domain: Preliminary Indications from a Query Analysis Study. Technical Report IM2.MDM-11, November 2003. http://www.issco.unige.ch/projects/im2/mdm/docs/MDMReport-11-AL.pdf

Ghorbel H., Pallotta V., 2003. Argumentative Segmentation and Annotation Guidelines. *Technical report IM2.MDM-08*, June 2003. http://lithwww.epfl.ch/im2/docs/argument-annot.pdf.

Pallotta V., 2003. A computational dialectics approach to meeting dialogues tracking and understanding. In *Giacalone Ramat A., Rigotti E., Rocci A. (eds.) Linguistic and new professions*, Special Issue of Materiali Linguistici vol. 1095.41, Franco Angeli.

Romaldi, V., 2002. Collaborative Technologies for Knowledge Management: Making the Tacit Explicit? In *proceedings of IS2002 conference on Informing Science and IT Education*. Cork, Ireland June 19-21, 2002.

Selvin, A. et al. 2001. Compendium: Making Meetings into Knowledge Events. In *Proceedings of Knowledge Technologies 2001,* March 4-7, Austin TX.