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Development and Understanding of Automated Capture Environments to Support Long-Term Use: Report I

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Report corresponds to
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Summary

The aim of the research is to integrate flexible hypermedia infrastructures to automated capture environments in order to support long-term use. Previous work by the group at GATECH has aimed at making capture a ubiquitous service at any point in time and over a short period of time. The real use of the infrastructure has created the interesting problem of having too much information available. The objective of the joint research is to find flexible and customizable information access solutions that scale over time, increasing the benefit of captured memories for the human as time passes and more information is captured. This overall goal involves many computer science issues ranging from multimedia manipulation to human-computer interaction. Our approach to this problem is to view capture as only one part of the information acquisition process in any given application. We introduce a spiral model for capture that stresses how the capture repository must be viewed as an ever-growing container for activities and knowledge that occurs before, during and after live capture sessions. As the repository

grows over time, specialized automated services must be created that add structure by highlighting inter-relationships between the captured experiences and activities that occur outside of capture. Moreover, flexible services for structuring and accessing the information must be provided. The main activities of the joint research are:

1. The definition of a spiral model to describe the research challenges of an automated capture service to support long-term activities.
2. A generic **In**frastructure for **C**apture and **A**ccess — **InCA**. InCA provides not only the framework for a run-time environment to support the capture of many live activities, but also an extensible information model for captured experiences that will be used to link activities occurring during a live session to those that occur outside of the live session, as described by the spiral model.
3. The development of a generic and open infrastructure to **S**tore, **E**xtend, **R**etrieve, and **V**isualize **E**volutionary information, that is, to **SERVE** captured information to humans. The SERVE infrastructure will support specialized services that occur outside of live capture and serve to augment the information contained in a capture repository and to generate automatic associations between related experiences.
4. The continued experimentation within the educational domain as well as the development of expertise in the domain of distributed collaborative design meetings.

These activities are split between researchers in the ICMC-USP, Brazil, and researchers in the Future Computing Environments Group at GATECH, U.S.A. These institutions are particularly well positioned to do meaningful research on automated capture environments. The FCE Group, lead by Dr. Gregory Abowd, invented the Classroom 2000 system, the foremost demonstration of a large-scale automated capture environment. The USP Group, with extensive experience in the modeling and design of hypermedia systems, is lead by Dr. Maria da Graça Pimentel, who has worked closely with the FCE Group to extend the capabilities of the Classroom 2000 system over the past year. This collaboration originally involved 8 different graduate students, 3 from USP, as well as Dr. Maria Pimentel and Dr. Renata Fortes, faculty members from USP who visited Georgia Tech in post-doctoral programs. This proposal has been able to feed this collaborative activity. Dr. Abowd's group, funded by NSF, has been involved in building the InCA framework for developing capture applications for different domains. The group at USP has undertaken several activities toward developing of the SERVE infrastructure. Both groups are collaborating in the development of a new educational capture environment and one to support distributed design meetings. The results of the research applied to the educational domain will benefit directly part of the teaching activities in both USP and GATECH, while the research applied to distributed collaborative design meetings could benefit any other software development teams.

Keywords: Ubiquitous Computing, Capture, Access, Store, Extend, Retrieve, Visualize, Hypermedia, Web.

1. Introduction

1.1 Context

Authoring meaningful and useful multimedia documents — those that present effective integration between several media components — is an expensive task. Everyday experiences are rich in information that, if captured and made available as multimedia

documents, may provide a valuable source of information. Moreover, humans need support in capturing the salient memories from live experiences that they can then call upon at a later time. There are many situations in our everyday lives that satisfy both of these criteria. This work exploits the ubiquitous computing approach to instrument an environment so that live experiences can themselves be used to author multimedia records of those experiences.

In this context, the GATECH group had already developed tools and environments, in the context of the *eClass project*, to automate the capture of live lectures to support the teaching and learning experience [1] [2] [9]. The eClass project exploits ubiquitous computing technology — electronic whiteboards, large projected displays, networked computers, and streaming digital audio/video — to create a room that automatically captures much of the rich detail of a lecture experience and provides effective multimedia-enhanced Web-based interfaces for both students and teachers to review the lecture. The result is twofold: the student is free to take on a different, more enriching role in the classroom while the instructor is provided with a tool to generate Web-based material at almost no cost (http://www.cc.gatech.edu/fce/eClass).

Evaluations carried out in the eClass project have shown that over the course of an entire term, there is a clear value added for students in gaining access to captured lectures. They report being able to pay better attention during lecture, having less of an obligation to take stenographer-style notes, and generally being better able to learn effectively in classes that provide the automated capture service. Students have also indicated a desire to access captured classroom lectures in the future, after they have completed a given course. Logged access patterns reveal that within one calendar year more than half of the accesses to captured lectures have occurred outside of the term in which the lecture was given, indicating that long-term access is an important consideration in designing useful capture systems.

1.2 Objectives

Leveraging off the positive experience with the eClass Project, the work in this proposal aims to address several important open problems in the area of automated capture environments. First, the development of a better software infrastructure for capture and access that can be specialized for various domains. This includes a scalable infrastructure to support the capture of information in ubiquitous computing environments and an extensible information model for the captured data that can be applied to different domains. Secondly, the development of services that support human activities that occur before, during and after captured experiences, for short-, medium- and long-term benefits. Finally, the development of living laboratories for long-term evaluation of the impact of automated capture, so as to demonstrate the value of this research methodology for ubiquitous computing research.

1.3 Main Goals

The main activities of the joint research plan are:

1. The definition of a spiral model to describe the research challenges of an automated capture service to support long-term activities.
2. A generic Infrastructure for Capture and Access — InCA. InCA provides not only the framework for a run-time environment to support the capture of many live

activities, but also an extensible information model for captured experiences that will be used to link activities occurring during a live session to those that occur outside of the live session, as described by the spiral model.

3. The development of a generic and open infrastructure to Store, Extend, Retrieve, and Visualize Evolutionary information, or to SERVE captured information to humans. The SERVE infrastructure will support specialized services that occur outside of live capture and serve to augment the information contained in a capture repository and to generate automatic associations between related experiences.
4. The continued experimentation within the educational domain as well as the development of expertise in the domain of distributed collaborative design meetings.

The FCE Group is in charge of building the InCA framework for developing capture applications for different domains. The USP Group is involved in the development of the SERVE infrastructure that, interfacing with InCA, will support the development of flexible and customizable capture-based hypermedia long-term applications. Both groups will cooperate to develop a new educational capture environment and one to support distributed design meetings: these results should benefit a community broader than USP and GATECH. This research could not be carried out at this scale without effective collaboration between these particular partners.

2. Main Results with Respect to the First Year

2.1 Activities as proposed

The macro activities planned for the first year by the Brazilian group are in Table 1.

Table 1: Calendar of Macro Activities to be developed at USP

Macro Activity	Title	Summary	Month	Researcher in charge	Result to be achieved
1	Spiral Model	Definition of model describing issues and proposed approach	1 - 3	Pimentel & Abowd	Report + Full paper
2	Spiral Framework	Definition of framework of InCA and SERVE APIs	1 - 3	Pimentel, Fortes, Moreira & Abowd	Report + Full paper
3	Classroom 2000 + Meeting 2000 environments	Installation of Classroom 2000 and Meeting 2000 physical environments with current Classroom 2000 technology	1 - 3	Moreira & Pimentel	Classroom 2000 and Meeting 2000 environments installed + Report
4	Basic SERVE Store & Retrieve - multimedia	Design and implementation Store & Retrieve components of Basic SERVE API — for multimedia	4 - 6	Moreira	API & Report + Full paper
5	Basic SERVE Store & Retrieve - hypertext	Design and implementation Store & Retrieve components of Basic SERVE API — for hypertext	4 - 6	Fortes	API & Report + Full paper
6	Basic SERVE Extend & Visualize	Design and Extend & Visualize components of Basic SERVE API	4 - 6	Pimentel	API & Report + Full paper
7	Classroom 2000-Basic	Design and implementation of Classroom 2000 application using Basic Serve	6 - 12	Pimentel & Moreira	C2000 Application + Evaluation paper
8	Meeting 2000-Basic	Design and implementation of Meeting 2000 application using Basic Serve	6 - 12	Fortes & Moreira	Meeting Application & Evaluation paper

These activities are oriented to the modeling of capture infrastructures, the development of APIs for capturing and serving information, as well as the construction of one application oriented to supporting classroom environments and one to capture meetings.

During the development of the project, these activities were carried out considering:

- the facilities found in the ICMC-USP with respect to engaging new undergraduate and graduate students in the project and
- the difficulties related to acquiring the necessary equipment, running the software originally developed by Dr. Abowd's group and recruiting DTI researchers.

As a result, people engaged in the project contributed with complementary theoretical and development work of applications and APIs, as detailed next.

2.2 Activities carried out and Results

Macro Activities 1 and 2: Spiral Model and Spiral Framework

The following results have been achieved with respect to this goal.

- The access interfaces built to provide dynamic, extensible and collaborative hypermedia documents to the original eClass and CoWeb repositories have been used to discuss the resulting evolutionary information in a journal paper by Pimentel and her collaborators from Georgia Tech: Ishiguro, Kerimbaev, Abowd and Guzdial [33]. In this paper, the active growth and intrinsic properties of the Spiral Model are described in the context of an education domain.
- Considering the information captured at Georgia Tech, Abowd, Brotherton and Pimentel have compiled a review of the capabilities and use of the eClass infrastructure, as well as of its integration with the CoWeb infrastructure, in order to discuss requirements for environments supporting the education domain. As a result they produced a paper, currently under review [3], discussing requirements to support evolutionary hypermedia documents that include automated capture and access; searching; augmentation; integration and collaboration. Those requirements have been defined as operations to the spiral framework and are supported by the APIs implemented so far.
- In a complementary approach, Aline Miotto, a MSc student working with Renata Fortes, has worked in the definition of a formal model for the specification of Open Hypermedia Documents. This model allows the specification of hyperdocuments to be precise, unambiguous, reusable and independent of implementation and provides the basis for the definition of hyperlinking structures demanded by evolutionary applications [25] [26]. This work has been used in the specification of the Web Linking Service built by Bulcão and Pimentel [11].
- Focusing on the process of constructing structured documents according to open recommendations for the Web, the MSc. candidate Daniel F. Pires, working with Maria Pimentel and Cesar Teixeira, defined a process guiding the modeling and construction of structured documents based on XML [32]. The process demonstrates steps by which evolutionary documents can be created. Applications built by this process have been associated to documents in the eClass repository [37].

Macro Activity 3: Classroom 2000 and Meeting 2000 environments

This activity was related to software installation and use, acquisition of equipment and setting up of physical environments.

- The software of original CoWeb infrastructure was installed without problems. The installation was carried out by Alessandra Macedo, a PhD candidate [24] working with Maria Pimentel. The installation allowed the use of the CoWeb to support real courses by the team in Brazil. This use motivated an investigation of the limitations of the infrastructure [22] and the construction a new version of the CoWeb [4].
- The installation of the original eClass infrastructure, on the other hand, faced many problems both in terms of software and hardware. In terms of hardware, the purchase of an electronic whiteboard was delayed by facts including (change in) price of the equipment and lack of vendors in Brazil. In terms of software, problems included (i) customization for using the Linux operating system, (ii) change in the security procedures with respect to file transfers and user logging and (iii) fixing implementation problems such as dealing with time zones and date formats. An undergraduate student, Paulo Silva, fixed some problems [44]. A DTI researcher, Marinalva Soares, and a MSc candidate working with Maria Pimentel, Jose Guerrero [18], fixed most of the remaining problems. An eClass infrastructure is under use supporting courses in classroom 1-117 in the ICMC-USP, while another installation has been concluded to support meetings in the Intermidia Laboratory (room 1-108 in the ICMC-USP).
- Because the availability of additional equipment would bring better working conditions to the project as a whole, Maria Pimentel applied for complementary equipment by means of an individual research grant to FAPESP in Brazil. The proposal was approved and granted to the project approximately R$ 60.000,00 in additional equipment to the InCA-SERVE project.
- In terms of research staff, the scenario in the first year was such that there was lack of personal to work as DTI researchers: most finishing students from the ICMC-USP and from UFSCar had already positions in industry or academy. Given such scenario, the first year of the project was carried out mostly with support of undergraduate and graduate students from the ICMC-USP working under supervision of the faculty members directly involved in the project: Edson Moreira, Maria Pimentel and Renata Fortes. This was possible given the support resulting from grants from FAPESP, CAPES and CNPq for the MSc, PhD and BSc courses at the ICMC-USP. It is important to observe that, for the remaining two years of the project, some of the students involved in the first year will be able to contribute as DTI researchers.

Macro Activity 4: Basic SERVE Store & Retrieve - multimedia

The **SERVE** infrastructure is being built to provide services related with operations allowing **S**toring, **E**xtending, **R**etrieving and **V**isualizing **E**volutionary information. Those services have been implemented by means of the operations defined to the Spiral Framework, which include automated capture and access; searching; augmentation; integration and collaboration.

In terms of the activity *Design and implementation of Store & Retrieve components of the Basic SERVE API — for multimedia*, work has been carried out by the groups of Edson Moreira and Maria Pimentel at ICMC-USP. More specifically, the following results have been achieved:

- Rudinei Goularte (PhD candidate) and Edson Moreira have worked towards the development of a video server access management system [17]. The system aims to help the insertion, in HTML pages, of objects stored in a video server, allowing that one video (or one part of it) be used in many documents. The main characteristic of the system is the use of a metadata base, which contains attributes of the videos stored in the server. Moreover, searches can be made by title, subject, size, author, content or specific scenes or frames. This is of particular importance for the overall infrastructure of the InCA-SERVE project. The system has been implemented in a client/server model using the JAVA programming language. The communication between the clients and the server is realized through the use of the CORBA standard. The data access from the metadata base uses the JDBC API. A Player for video browsing was built using the Intel Media Framework, which implements the Java Media Framework API.
- In the medium to long term, the results of the project should support a large quantity of data of different types and priorities passing through on high-speed networks. A relevant part of these data, like continuous media (audio, video, and so), needs a control of its Quality of Service (QoS). Mauricio Pissioli (MSc), Rudinei Goularte and Edson Moreira have carried out experiments on the characteristics of the ATM network technology that provide support to quality video streaming transmission [38] [39]. The experiments were carried out considering QoS, connection admission control, network congestion, transmission priorities and bandwidth demand associated to applications and network configuration. Three basic kinds of videos were analyzed – (smooth movies) movies, (action movies) sports and talking head movies. Data about video transmission were collected from an ATM switch, showing results that can be used in the future on ATM channel mapping to multimedia data distribution such as that demanded by InCA-SERVE applications.
- Luciano Martins has carried out an investigation which includes literature review of IPv6, multicasting and ATM; configuration of a test environment and development of an application for transmission of video built with Java IP version Six readY - JIPSY. The focus of the study was the use of IPv6 and multicasting in the development of multimedia applications so as to save bandwidth and resources in the servers. Martins' work, concluded in March 2001, was carried out in the context of a MSc Program under supervision of Edson Moreira.
- Leonardo Andrade, also under supervision of Edson Moreira at the ICMC-USP, has investigated the transmission of compressed video using multicasting by means of two client/server implementations, one using IPv4 and RTP support, other with IPv4/IPv6 support. The problem of sending and receiving packets to future video exhibition by clients was studied and many tests were made with the MJPEG compression and other technique, implemented with wavelet transforms and LZW codification. Measures and performance were compared using Linux and Windows.
- Graciela Leopoldino, a MSc candidate working with and Edson Moreira, carried out the work "Evaluation of Videoconference Systems", were she established and validated a minimum set of parameters for the evaluation of videoconference

systems. Her work, that includes an overview of the models available [19], contributes directly to the design and implementation of the eMeet videoconference application under development by Wagner Bila.

- João B. Santos Jr (PhD candidate), Rudinei Goularte and Gustavo Faria (MSc candidate), under the supervision of Edson Moreira, have been investigating ways in which the user can interact with multimedia objects by means of operations that go beyond the regular controls of a VCR. They also investigated how the presentation of the video can be modified by events happening in the surrounding environment. Their work include a proposal to model user actions from contextual information, in a way to ease its interaction with context-aware interactive applications like Interactive TV (ITV) [41].
- João B. Santos Jr is investigating how Context-Aware Interactive Applications may give contributions to the evolutionary aspects of multimedia information obtained by capture. Investigating particularly the MPEG-4 and MPEG-7 standards, he is currently a visiting researcher at TILab - Telecom Italia Laboratory, at Torino, Italy (http://www.tilab.com), collaborating in the TeleLearning-LinkTV Project. This visit started on June-2001 and it will last until December-2001.

Basic SERVE Store & Retrieve - hypertext

In terms of the activity *Design and implementation of Store & Retrieve components of the Basic SERVE API — for hypertext*, work has been carried out by the groups of Renata Fortes and Maria Pimentel. More specifically, the results achieved include:

- Alessandra Macedo and Renato Bulcão Neto (MSc candidate [11]) have studied the use of a collaborative website in the ICMC during the year 2000. As a result they have specified a set of requirements for the construction of a similar application [22].
- Carlos R. E. Arruda Jr. has been in charge of developing the new version of a CoWeb application so that its underlying infrastructure is made available as an API that can be reused and extended [4]. The application created, called CoTeia, supports some features such as the management of hypertext structures including nodes, links and composites, files (XML, XSLT and HTML) and special characters. Its associated CoTeia API allows other services to make use of those functions. Arruda Jr is an undergraduate student working [5] with Maria Pimentel.
- In a complementary effort, Claudia Izeki is a MSc candidate working with Maria Pimentel in the definition of operations related to supporting annotations as first class hyperdocuments. Focusing in the Web environment, Izeki was able to identify requirements to support collaborative access to annotations specified as RDF resources. Her work includes the definition of a GroupNote API and of the User and Group API. By using these APIs and Arruda Jr's CoWeb API, she implemented the WebNote Application that gives group access to annotations in the Web.
- Renato Bulcão Neto has developed the OpenLink API, which aims at providing support to the management of hypermedia structures (contexts, anchors and links) stored into an external linkbase. The OpenLink API is the core of an Open Hypermedia Linking Service for the Web called Web Linking Service (WLS), that provides hypermedia functionality to XML applications such as Arruda Jr's CoTeia and Izeki's WebNote.

- Given that the presentation of captured documents in instrumented environments demands the user interaction with the hypermedia documents generated, Otavio A. Martins Netto reviewed the literature with respect to heuristics aiming at guiding the design and evaluation of human-computer interfaces. Netto, a MSc candidate working with Maria Pimentel, observed that such heuristics are usually related to a single media, discrete or continuous. His work included a heuristic evaluation of the multimedia hyperdocuments produced by the eClass environment. As a result, he has proposed a set of heuristics related to the design and evaluation of hypermedia documents having multiple media [28]. These heuristics have been used in the design of a new interface to the documents generated by the eClass environment. The corresponding API is available so its modules can be reused. The next steps include the evaluation of the applicability of the new heuristics.
- Laércio Baldochi Jr, a PhD candidate under supervision of Maria Pimentel, has been investigating the problems related to the modeling and construction of databases for storing structured documents based on XML.

Basic SERVE Extend & Visualize

In terms of the activity *Design and implementation of Store & Retrieve components of the Basic SERVE API — for hypertext*, work has been carried out by the groups of Renata Fortes and Maria Pimentel. The results include:

- Marinalva Dias Soares, under supervision of Renata Fortes, has tackled the problem of supporting evolutionary documents in the context of the Web, which is an example of an environment where information evolves very rapidly. Collaborating with Dilvan Moreira, they have defined and built a software tool, VersionWeb, aiming at making Web page version control available during browsing [45] [46]. The main goal of VersionWeb is to provide developers with an easy way of controlling the version of Web pages. The functionally of the tool is also available to other applications by means of the VersionWeb API.
- Alessandra Macedo, Maria Pimentel and Gregory Abowd have investigated an automatic linking service to associated pages in homogeneous repositories based on lexical matching. Experiments with the eClass and CoWeb repositories indicated that the extension of the repositories by means of such services would be of interest [36].
- Alessandra Macedo, Maria Pimentel and José Guerrero have defined a framework for the automatic generation of links based on salient semantic structures extracted from homogeneous web repositories. One instance of the framework was implemented and used to investigate the eClass and CoWeb repositories. The results of the Latent Semantic Analysis linking service with those repositories were positive [23]. The service itself has been implemented as the Latent Semantic Linking API.
- Elisandra Silva, a MSc candidate working with Renata Fortes and Maria Carolina Monard, implemented mechanisms that exploit Machine Learning techniques to evaluate documents according to metrics [43]. The techniques have been used in a variety of tasks including learning to assist users in searches and learning user interests. This approach will be used for gathering information with respect to the InCA-SERVE repositories.

- Enzo Seraphim, while MSc candidate working with Renata Fortes, has studied the problem related to the reuse of links in web repositories: it is the case that, in the InCA-SERVE repository, such reuse happens both in manual and automatic processing. They have built the DB-LiOS tool, developed to verify the reuse of links automatically by implementing processes to extract and classify links [42]. The current implementation of the DB-LiOS is directed to human authors to evaluate the consistency of links; the next step is to make such functionality available by to other applications by means of an API.

Classroom 2000-Basic and Meeting 2000-Basic

In terms of the activity *Design and implementation of Store & Retrieve components of the Basic SERVE API — for hypertext*, work has been carried out by the groups of Renata Fortes and Maria Pimentel. More specifically, the results include:

- Wagner Bila and Pedro Eleutério, MSc students working with Maria Pimentel, are responsible for building a complementary infrastructure to support the capturing of multimedia information in instrumented distributed meeting environments. Wagner's work aims at building an application supporting distributed meetings by means of a videoconference infrastructure that captures the exchanged multimedia contents. Eleutério's work supports the authoring of documents corresponding to those meetings and that can be later reviewed and extended.
- Pedro Eleutério is using Otávio Netto's heuristics in the design of the hyperdocuments corresponding to information captured in distributed meetings. Moreover, Eleutério and Netto are collaborating in the implementation of the software infrastructure that allows the visualization of the captured information. Finally, both Netto and Eleutério are using Claudia Izeki's API that supports the management of users and groups.
- Renan Cattelan, an undergraduate student working with Maria Pimentel, has built infrastructures to support chat over the web so that the service is integrated to other applications supporting meetings and lectures. The service, implemented as an API, is also available as a standalone tool. By recording the messages exchanged as structured documents, the service supports chat-based meetings over the web.
- Renan Cattelan is building a new eClass application that makes use of Khai Truong's InCA infrastructure. Truong is a PhD candidate working with Gregory Abowd at Georgia Tech. Cattelan's implementation, which currently supports whiteboard sharing and text-based conversation, is to be integrated with remaining services built in the project.

2.3 Knowledge acquired

Implications of knowledge acquired during the first year are discussed next.

Applicability: As discussed, the work has been applied to information domains other than the original lectures and co-located meetings. Several types of Computer Supported Collaborative Work applications have been demanded and implemented.

Techniques incorporated: The project has incorporated a wide range of recent concepts and technologies, particularly those related to open specifications. These

include MPEG-4, MPEG-7, XHMBS, XML and related recommendations, as well as techniques such as SVD and machine learning.

Generation of products and processes: The results include a list of requirements demanded by the spiral model and that must be accomplished in the construction of APIs related to the spiral framework. A process for the systematic construction of applications supporting structured documents has been defined. Basic services and related APIs have been built towards the construction of a classroom and a meeting capture-based environment. The new CoTeia collaborative authoring tool is going to substitute the original one that is being used by many groups in the ICMC-USP.

Multiplication effect: Most of techniques and concepts investigated, as well as the products and processes built in the project, have been documented in published papers, technical reports, courses and tutorials. In special, an XML tutorial has been given in regular courses in the ICMC and in several events of the Brazilian Computer Society. Moreover, weekly seminars are carried out each semester where the many members of the group involved in the project exchange the theory and techniques learned. Many students and faculty from other groups have been attending these seminars, where they get acquainted with the lessons learned with the project.

Improvement in human resources: The team as a whole has been exposed to the techniques and technologies dealt with in the project. Moreover, the students have done so while working towards their degrees.

Interaction between partners in U.S. and Brazil: Both the underlying requirements generated and the construction of capture-based environments have already demanded interaction between the partners in Brazil and in the U.S. One Brazilian PhD student is already in Atlanta, and two others are schedule to go next year. One PhD student from Georgia Tech, Khai Truong, should visit the ICMC for two months in the beginning of 2002. Due to the results obtained by the group that will be published in the ACM Symposium on Document Engineering 2001, Maria Pimentel has been invited to be a member of the program committee in the next edition.

Interaction within Brazil: The project has been able to benefit from the interaction with other faculty members in the ICMC-USP and members in other units, in particular in the educational domain. Interaction with other groups in Brazil has just started.

3. Research Team

3.1 Improvement in qualification

Working the in context of this project, the team involved in the project has also obtained improvement on its qualification:

- Maria Pimentel has passed the habilitation exams for the title of "Livre Docente" at USP and is now an Associate Professor.
- Renata Fortes has successfully concluded her post-doctoral visit at Georgia Tech.
- Daniel Pires, Marinalva Soares, Graciela Machado, Leonardo Andrade, Luciano Martins, Maurício Pissioli have concluded their MSc. Program.
- Aline Mioto, Claudia Izeki, Renato Bulcão Neto, Gustavo Faria, Elisandra Silva are concluding their MSc program in 2001.

- Otávio Netto, Pedro Eleutério and Wagner Bila are working towards concluding their MSc Program in early 2002.
- Carlos Arruda Jr. and Renan Cattelan are enrolled as undergraduate students and will start their MSc programs in 2002.
- Paulo Silva has concluded his BSc working in the project.

3.2 Participation in technical and research meetings

Members of the team have been present in many events related with the project, in most cases with the task of presenting results reported in papers or tutorials. This participation has involved not only the faculty but also the students involved in the project. These events, considering some that will occur in the near future, include:

- ACM Symposium on Document Engineering 2001
- Eleventh ACM on Hypertext and Hypermedia 2000
- Brazilian Conference on Computer Networks 2001.
- Brazilian Conference on Multimedia and Hypermedia Systems 2000 and 2001.
- International Workshop on Information Integration on the Web 2001
- VI Congreso Argentino de Ciencias de la Computación
- 1st Workshop on Personalization in Future TV
- Second Argentine Symposium on Software Engineering
- Workshop de Teses e Dissertações do SBMídia 2001
- XVI Simpósio Brasileiro de Engenharia de Software
- IV Workshop de Métodos Formais do SBEs 2001
- XIV Workshop de Teses e Dissertações do CSBC.

3.3 Publications

The main publications resulting from the work so far have been cited in the previous section. A number of other related documents, such as grant proposals submitted to FAPESP for MSc students engaged in the project as well as technical reports, are available from *http://coweb.icmc.sc.usp.br/coweb/mostra.php?ident=5*. Moreover, a few tutorials have been published in the ICMC (and made available in the web), aiming at better disseminate the knowledge gained by the group. The overall numbers include:

- Journals papers: International (4), Brazilian (3)
- Conference papers: International (6), Brazilian (9)
- Technical reports: Portuguese (9)
- Research grants approved: PhD (3), MSc (8), BSc (2).

3.4 Engagement of researchers returning from training

In terms of the training of researchers, so far the trend of using resources from complementary projects brought many benefits to the InCA-SERVE project:

- Dr. Renata Fortes returned from a post-doc visit to Georgia Tech in January 2001 (grant from FAPESP). Both during her visit and after the return, she has been involved in activities regarding the project, in particular in terms of supervising her students in the production of both theoretical (Aline Miotto) and applied work (Elisandra e Enzo).

- João B. Santos Jr's is a visiting researcher at TILab - Telecom Italy Laboratory, at Torino, Italy collaborating in the TeleLearning-LinkTV Project.
- In September 2001, Rudinei Goulart has started a 6-month period collaborating with Gregory Abowd at Gergia Tech. Goulart is supported by FAPESP.

Several of the current MSc students are concluding their work and will start collaborating as DTI researchers in the project. In this context, they will have the opportunity to spend some period at Georgia Tech where they will not only receive training but also be able to install their software in that environment.

4. Conclusion

The activities carried out in the first year had intense engagement of the three faculty members from the team in Brazil as well as of most of their research students. Moreover, other members of the ICMC-USP, both faculty and their students, also collaborated in the project. A wider community from the ICMC-USP has been benefiting from the some of the results available so far, particularly the classroom installation and the collaborative web environment

This first year has been characterized by building the basic model and infrastructure upon which the remaining activities will be developed. The goals proposed for the period have been pursued and the activities have been adjusted as a result of the knowledge acquired and the personal engaged. The overall divide and conquer methodology applied so far, which focus on the integration and reuse of individual results gathered from the activities carried out, has been successful.

The year has been also marked by the aggregation of additional personal and financial resources to the project, both in terms of grants for funding research students (undergraduate, MSc and PhD funded by FAPESP, CAPES and CNPq) and equipment (from FAPESP).

Last, but not least, the students formed in the context project benefit from the overall knowledge gained. The opportunity of having some of them working in the team will be most productive for the remaining of the project.

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