IST PROGRAMME

Action Line: IST-2002-8.1.2

End-User Development

Empowering people to flexibly employ advanced information and communication technology

Contract Number IST-2001-37470

D.3.1 Survey of member research projects, tools, and PhD studies

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Summary

This document gives a survey of research projects, tools, and PhD studies relating to end-user development and coming from the members of EUD-Net.

December 2003

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Executive summary

This survey summarizes the key research projects, tools, and PhD-studies from the members of EUD-Net related to end-user development. The survey is not comprehensive in the sense that it includes all projects, tools, studies, etc. that touch upon EUD if only to a small extend. Instead, it tries to give a selection of work that illustrates both the breadth and most prominent approaches of the respective organizations. Where applicable and available, references to publications and web sites have been included.

1. EUD-Net members

No.	Participant name	short name	Country
1	ISTI Istitute - Consiglio Nazionale delle Ricerche	CNR	
2	University of Mancherster Institute of Science and Technology	UMIST	
3	Fraunhofer-FIT	FhG-FIT	
4	Università di Bari, Dipartimento di Informatica	UNIBA	
5	HCI group at LRI, Université Paris-Sud	LRI	
6	Laboratoire de l'IRIT en Interaction Homme-Systèmes, Université Toulouse 3	UPS	
7	Cambridge University	U-CAM CLAB	
8	University of Oslo	UiO	
9	Think3 corporate info	Think3	
10	Paderborn University, Dept. of Computer Science	UPB	
11	Siemens Business Services GmbH & Co. OHG	SBS	
12	Blekinge Institute of Technology	BTH	
13	Telecom Italia Lab	TILAB	
14	Philips Research Eindhoven	Philips	
15	HCI Group, University of Brescia	UNIBS	
16	Centre d'Etudes de la Navigation Aérienne	CENA	

2. Survey of work by EUD-Net members

2.1 HIIS Laboratory at ISTI-CNR

2.1.1 Introduction

The research activity of HIIS Lab at ISTI-CNR is in methods and tools to support user interface designers and software developers to obtain usable systems that can be accessed from different contexts of use. The main goal is to propose new solutions in basic and applied research in the field of human-computer interaction and user interface software, mainly under the aegis of national programs, international programs and research contracts. Research activities are carried out in collaboration with research groups in Europe. The main research areas concern Methods and Tools for the Analysis, Design and Development of Interactive Applications, Intelligent Interfaces, Interfaces for Mobile Devices, Multimedia Interfaces, Usability Engineering and Models for HCI.

2.1.2 Research projects

2.1.2.1 CAMELEON

The CAMELEON Project (Context Aware Modelling for Enabling and Leveraging Effective interactiON) is a Shared-Costs RTD three-year IST Project started on October, 1st 2001, whose goal is to build methods and environments supporting the design and development of highly usable context-sensitive interactive software systems. To reach its goals, CAMELEON will build upon established and forthcoming principles of user-centred design, universal design, usability engineering and modelling techniques, taking into account emerging technologies in middleware, networking and user interface software technology to address the opportunities and requirements for highly effective interaction. CAMELEON addresses these challenges by bringing together a multi-disciplinary number of knowledgeable partners that provide a balanced coverage of all the project objectives. Within the project, the TERESA tool is being developed (see 2.1.3.1).

See: http://giove.cnuce.cnr.it/cameleon.html

2.1.3 Tools

2.1.3.1 TERESA

TERESA is a transformation-based environment designed and developed under the aegis of the CAMELEON IST project. It is intended to provide a complete semi-automatic environment supporting a number of transformations useful for designers to build and analyze their design at different abstraction levels and consequently generate the concrete user interface for a specific type of platform. Within the project it has been used for developing user interfaces for Web applications. It has been downloaded by several universities and labs, enterprises (Philips, SAP), and used by a Motorola research group during an evaluation session as well.

See http://giove.cnuce.cnr.it/teresa.html.

2.1.3.2   CTTE

CTTE is a tool that provides feature-rich automatic support for developing and analyzing task models. The tool's functionalities give designers useful indications concerning aspects that they should consider when developing interactive software applications. The tool can be used to easily edit and analyse such models in order to gain useful insights, as well as the underlying algorithm of the interactive simulator. In addition, the tool has been applied in various projects to indicate its level of maturity, and has been used in various projects for several application areas by many groups in academia and industry. It has been found useful in clarifying design issues, and supporting analysis and evaluation of design options.

It is freely available at **http://giove.cnuce.cnr.it/ctte.html** and has already been downloaded from hundreds of sites all over the world.

2.1.3.3   WebRevenge

WebRevenge is an environment to automatically reconstruct the task model of a Web application. In particular, we consider task models represented in the ConcurTaskTrees notation (see link below). The tool receives as input the Web pages of the site. Using the classes provided by Tidy it first checks that the HTML code is well-formed and if not it corrects it and then creates the corresponding DOM which describes the structure of the page (all the elements contained in it). Then, it creates the task model associated with each page. The final part of the underlying algorithm is dedicated to describing higher-level tasks that involve multiple pages. The resulting task model can be saved either in XML format or in a format that can still subject to modifications or adjustments by the designer using the CTTE for this purpose that can help also to analyse the model with features such as dynamic interactive simulations.

See http://giove.cnuce.cnr.it/webrevenge.html and
http://giove.cnuce.cnr.it/concurtasktrees.html.

2.1.3.4   PortableCicero

PortableCicero is a context-dependent, location-aware application. It is realized to support users during museum visits, providing them with information about the artworks that surround them. PortableCicero is developed as a case study of our research regarding interaction between humans and mobile devices: the mobility of the user, the new characteristics of the devices involved and the new input devices open new scenarios of use: the old paradigms of interaction need to be rearranged taking into account this new feature to guarantee the usability of the new systems. We consider the museum domain because it is characterised by mobile users without a precise goal and with the need of information dependent on the current context. In our case we have addressed this problem and then tested the results in a real museum (the Marble Museum of Carrara), which gives us also the opportunity to receive feedback from real users. PortableCicero provides the users with information about the artworks located in the Marble Museum using the multimedia capabilities of the devices. To localize the user in the Museum we use Infrared stand alone devices, installed at the entrance of each room: the application uses the location information to offer the information taking into account the users' position. PortableCicero is currently available to all Carrara Marble Museum visitors. Its use is free.

See http://giove.cnuce.cnr.it/cicero.html.

2.1.4 PhD-Studies

2.1.4.1   Renata Bandelloni: *Runtime device aware migration of web applications*

The goal of this work is the design of an environment for supporting run time migration of Web applications among different platforms. A user interacting with a Web application will be able to change devices and continue its interaction from the same point where it left, without having to restart the application on the new device. The migration engine takes into account both the runtime state of the interactive application and the different features of the devices involved in migration.

2.1.4.2   Barbara Leporini: *Criteria to Improve web site accessibility and usability when interacting through screen readers: definition, application, and evaluation*

This research is related to the usability and accessibility of Web sites. Guide lines for Web site usability already exist, but they only marginally consider the exigencies of "special users", such as blind people or subjects with high levels of vision deficit. This study specifically aimed at defining, in a more precise way, the usability of Web sites, in order to improve their accessibility for "special users", who are obliged to navigate on the internet through screen readers.

2.1.4.3   Luisa Marucci: *Designing and developing Adaptive Multiplatform User Interface in Context Aware Environments*

The aim of this thesis is to investigate the user interface requirements for multiplatform applications, and to develop novel adaptive methods and techniques for supporting adaptivity in such environments based on such requirements. To address these issues, the thesis provides an introduction to adaptive systems and then to such systems in multiplatform environments. Types of adaptivity as well as means of supporting them in multiplatform environments are discussed. Finally, an adaptive support to multiplatform interactive applications is presented along with an example of application.

2.1.4.4   Carmen Santoro: *Model-based design of innovative interactive systems*

In this thesis an approach for the design and development of interactive applications is investigated, showing how the use of different models (e.g. task models and system models) and various levels of abstractions can provide a useful support for the generation of effective user interfaces.

2.1.5 References

(Berti & Paternò, 2003), (Mori, Paternò, & Santoro, 2002), (Mori, Paternò, & Santoro, 2003), (Marucci, Paternò, & Santoro, 2003), (Paganelli & Paternò, 2003)

2.2   University of Manchester Institute of Science and Technology

2.2.1 Introduction

End-user development research in the Department of Computation exists at the intersection of the Emergent Information Systems group (Software Engineering) and the Interactive Systems Design group (Human Computer Interaction). Currently we are concerned with establishing a framework for the critical evaluation of EUD tools, un-

derstanding the cost-benefit to end-users and investigating the barriers to the successful adoption of EUD tools and techniques by organizations. Overall, our interest lies in developing a perspective of the way EUD tools are used today, combining this with knowledge of state of the art technology to take a position on the impact on future commerce and society.

2.2.2 PhD-Studies

2.2.2.1 "End User Development" Darren Lee

A work in progress defining the nature and use of EUD artifacts through a critical evaluation framework at the level of the tool extended by analysis of the social barriers to the adoption of EUD technologies in an organizational context. The framework looks at the three major attributes of EUD technology: Abstraction of the discourse, scope of the tools used and the level of system initiative present. The work on organizations attempts to identify social barriers and provide prescriptive approaches to discount or remove them.

2.3 FhG-FIT

2.3.1 Introduction

At Fraunhofer FIT, activities related to end-user development are headed by Prof. Dr. Volker Wulf. Some of the activities mentioned below have been or are carried out at Prof. Wulf's former group at the University of Bonn or his new group at the University of Siegen.

At Fraunhofer FIT, work on EUD centres around three areas. Firstly, the general technical approach for adaptable systems is component-based architectures. Subjects of interest are integrity and consistency checks for adaptation activities (Won, 2003), component-based architectures for groupware systems and the relation to classical software engineering processes. Secondly, the relation between system adaptability and adaptivity is an important research question. The assumption is that both user-driven adaptations as well as system-driven automatic adaptivity are necessary and can be combined to their mutual benefit (Klann, Eisenhauer, Oppermann, & Wulf, 2003). Thirdly, collaborative EUD activities are a major field of interest (Kahler, 2001), in particular with respect to groupware systems.

2.3.2 Research projects

2.3.2.1 Adaptable Shaping of Groupware

In this project the component-based framework FreEvolve has been developed (see 2.3.3.1). The application domain in the context of this project has been groupware systems. The goal has been to show how crucial parts of groupware systems can be implemented in a component-based architecture, allowing the users to substantially change the groupware's behaviour by changing the component composition. Empirical research has been conducted on how users adopt these adaptation opportunities, what problems they encounter and how these can be supported. See (Stiemerling & Cremers, 2000).

2.3.2.2 SAiMotion

In the SAiMotion project a fair-guide has been developed that uses WLAN-based tracking to provide visitors with location-based information adapted to their interest profile, using PDAs as the interaction device. Also, users can adapt the system's functionality to their interests and cognitive preferences. In the context of this project the relation between context-aware system adaptivity and user-driven adaptations has been investigated.

2.3.3 Tools

2.3.3.1 FreEvolve

FreEvolve is an extension to the JavaBeans component architecture, allowing run-time changes to the component structure that makes up an application. As such, FreEvolve is a development platform that can be used to develop and execute adaptable component-based applications. On top of FreEvolve a number of extensions have been developed that allow end-users to change the component composition by manipulating graphical 2D- and 3D-representations. Also, extensions for adaptable access control management have been developed (Stevens & Wulf, 2002; Stiemerling & Cremers, 2000).

See www.freevolve.de.

2.3.3.2 Contextualization Framework

In order to consolidate the various functionalities relating to automatic context-aware adaptivity, a framework has been developed that allows for easy integration and extension with adaptivity modules. Also, the aggregation of context information, subsequent interpretation and selection of appropriate system behaviour is supported by this framework. Currently, work is being carried out on making the framework adaptable by way of a component-based implementation. The goal is to empower domain experts to specify or modify the potentially very complex chain of modules that carries out the processing of context information and selection of system behavior. In particular, easy to understand graphical representations are a goal here.

2.3.4 PhD-Studies

2.3.4.1 Markus Won: *Interaktive Integritätsprüfung für komponentenbasierte Architekturen - Technische Unterstützung für Endanwender beim Anpassen komponentenbasierter Software (Interactive Integrity Checks for Component-based Architectures – Technical Support for End-users for Adapting Component-based Software)*

Modern software now allow for a certain degree of adaptation. Especially for standard software and groupware systems such opportunities for adaptation are very important. To foster and support such adaptation activities, adaptation environments should be as easy to learn as possible and they should provide technical support for the act of adaptation. For this purpose, component-based architectures are particularly well suited to realize technically highly flexible applications that can nevertheless be adapted easily by the users. This thesis focuses on a technical support of adaptation activities. The goal is to use complementary information to technically check to what extend a given adaptation makes sense in terms of compliance with expectations as well as executability. Such integrity checks are performed on the basis of complementary semantical in-

formation on the functionalities and interplay of the components. The primary goal of these checks is not to guarantee integrity but to foster the users' understanding of their applications. Therefore, the choice and expression of suitable integrity constraints is as important as a suitable interaction between the integrity checks and the users.

2.3.4.2   Gunnar Stevens: *Computer Supported Tailoring*

The approach of „component-based tailorability" tries to transfer the idea of software components to the domain of end-user development. A component-based application is composed of basic components and their compositions. The application is executed in a run-time environment, in this case FreEvolve that allows the users to adapt the components to their needs at run-time. A previous case study by the author has shown that components can be modelled such that they constitute a meaningful entity for the users and that the technical complexity can be encapsulated in the components. But the existing FreEvolve platform still falls short when it comes to end-users connecting and aggregating components, because the platform only addresses the technical side. In user tests a strictly technical view on component connections has proven insufficient. Therefore, this study tries to combine a gentle slope of adaptation complexity on the technical level with supporting the end-users in connecting components on a use-oriented level.

2.3.4.3   Markus Klann: Interoperable Personal Information Spaces

Personal and collaborative knowledge-intensive activities pose distinct requirements on supportive IT-systems. Personal activities are characterized by the individual's personal history, development, skills, working style, current perspective and interests. Collaborative activities are characterized by varying degrees of established group structures, communicative and collaborative behaviour patterns etc. and a mix of participants with their individual competencies and interests. IT-systems for both computer-supported cooperative work and computer-supported personal work must cater to these distinct requirements by empowering their users to continuously adapt them to their respective evolving requirements. In order to better shape the field of tension between personal and group requirements, this study proposes a new kind of architecture that replaces or at least complements collaboration through dedicated groupware systems by peer-to-peer collaboration through interoperable personal systems. One corner stone of this architecture is empowering the individual users to adapt their personal systems for both their individual needs and the needs of the various group contexts that they participate in. Consequently, this includes adapting one system for various contexts of use and it also includes supporting groups of users in negotiating consistent and effective adaptations for their group purposes.

2.4   Universita' di Bari, Dipartimento di Informatica (DIB)

2.4.1 Introduction

The research of the group involved in the EUD-Net project concerns primarily multimedia and multi-modal human-computer interaction, visual languages, and visual query systems for knowledge bases.

2.4.2 Research projects

The main efforts of the research activity are toward modelling the HCI process: in this sense UNIBA is part of the Pictorial Computing Laboratory (PCL) that developed the theory of "visual sentences" (Bottoni, Costabile, & Mussio, 1999).

In the PCL approach, HCI is a process in which the user and the computer communicate by materializing and interpreting a sequence of messages at successive instants of time (the visual sentences). Two interpretations of each message and of each action arise in the interaction: one performed by the user achieving the task, depending on his/her role in the task, and the second internal to the system, associating the image with a computational meaning, as determined by the developer that implemented the system.

2.4.2.1   FAIRSNET

Born from the FAIRWIS project (IST-1999-12641 FAIRWIS – Trade Fair Web-based Information Services) as a trial project, FairsNet is a European Project (IST-2001-34290 FairsNet - On-line Solutions for Trade Fairs) with the aim to improve the system developed during the previous project and put it on the market. The system designed and implemented as a prototype in that project was an integrated environment to support all the activities involved in the organization of a trade fair, real or virtual, from the creation of the web site to all services to the exhibitors.

The main end-user of such system is the fair organizer, to whom is supplied a number of EUD features to manage all the aspects of the trade fair. In particular authoring tools are also provided to permit the creation of the web site and all the services of the trade fair.

2.4.2.2   VICE

The VICE project aims to develop an innovative framework to develop and to use high quality learning tools having a huge technological support. The main motivation of the project is based on the observation that organizational, methodological, and technological frameworks are needed in the fields of e-learning and e-business. Such frameworks would guarantee to professionals and workers, in a certain company, a continuous training during all their professional life.

The EUD features of such framework can be divided into two classes: tailoring and development. Tailoring can range from preference setting (low level) to changes to application/information structure (high level). Platforms for distance education should provide the possibility to tailor the information structure (in this case, the way in which learning material is presented and structured) during the teaching/learning cooperative process.

2.4.3 PhD-Studies

2.4.3.1   Antonio Piccinno: *Software environments for supporting End-User Development* (work in progress)

The thesis aims to provide end-users with environments in which they can perform some programming activities by tailoring, personalizing and also building from scratch, software environments.

The theoretical basis of the ongoing thesis is the PCL model in which a method to translate the specification into a verifiable program is investigated.

2.4.3.2 Rosa Lanzilotti: *Personalization through Agent-based systems* (work in progress)

This thesis aims to support EUD in adapting Visual Interactive Systems (VISs) to the evolution of its users. This process is called co-evolution of users and systems.

The approach is based on the identification of the patterns of interaction between the user and the VIS to facilitate novel usages introduced by the user.

2.4.4 Master Thesis

2.4.4.1 Maria Teresa D'Aprile (work in progress)

In this study the state of the art of the various EUD systems is now being investigated.

2.5 In Situ at LRI, Université Paris-Sud, France

2.5.1 Introduction

The In Situ project develops novel interaction techniques, new tools to develop these techniques, and new methods to control the design process of interactive systems. The goal is to develop situated interfaces, i.e. interfaces that are adapted (or adaptable) to their contexts of use by taking advantage of the complementary aspects of humans and computers. In the long run, the project seeks to create a new generation of interactive environments as an alternative to the current generation of desktop environments.

New interaction paradigms

The project addresses novel interaction techniques such as multi-scale (or zoomable) interfaces, interactive information visualization, bimanual interaction, and the use of video and non-speech audio, as well as the integration of these techniques within a consistent environment. The project also addresses augmented reality, i.e. the integration of computation and interaction within physical objects and environments. Finally the project studies the integration of cooperative services to all aspects of interactive systems.

Participatory design

Participatory design involves users at all stages of the design process. It turns users into innovators and helps understand the situated aspect of the users' activity. The project develops participatory design methods and techniques that make the role of context explicit in the design process.

Engineering of interactive systems

Novel interaction techniques and interaction paradigms require the development of specific tools to facilitate their integration and adoption. The project studies component-based architectures where components implementing e. g. interaction techniques, may be added, removed or substituted dynamically.

2.5.2 Research projects

2.5.2.1 InterLiving

Design and development of tools, methods, probes and prototypes to help family members stay in touch.

Dates: January 2001 - December 2003
Funding: IST Disappearing Computer
Partners (all academic): KTH (coordinator), LRI Université, Paris-Sud, INRIA
Scientific contribution: Technology probes (CHI Paper 2003)
Web site: interliving.kth.se

2.5.2.2 Indigo

Design and development of tools, methods, probes and prototypes to help family members stay in touch.

Dates: January 2001 - December 2003
Funding: IST Disappearing Computer
Partners (all academic): KTH (coordinator), LRI Université, Paris-Sud, INRIA
Scientific contribution: Technology probes (CHI Paper 2003)
Scientific contribution: Distributed software architecture (no publication yet)

2.5.2.3 Micromegas

This project aims to enrich current methods of information visualization and navigation, exploring new approaches on multiple scales.

Dates: October 2003 - September 2006
Funding: French Government - ACI Masses de Données
Partners: LMP Univ. Méditerranée - LRI Univ. Paris-Sud - INRIA
Scientific contribution: none yet - project just starting

2.5.3 Tools

2.5.3.1 biok

The Biology Interactive Object Kit (biok) is a tool to analyze biological data and to support tailorability and extensions by the end user through an integrated programming environment.

Example, project or context

Bioinformatics

Users of the tool

Biologists, bioinformaticians

Achievements

The tool is installed on several platforms and systems, and it is aimed at public distribution; it has been used for several months by 4 bioinformatics students.

Challenges

Final packaging for public distribution. Actual cooperative and open source development.

2.5.3.2 OADymPPaC

Tools for Dynamic Analysis and Debugging of Constraint Oriented Programs

Web site

http://contraintes.inria.fr/OADymPPaC/

2.5.4 PhD-Studies

2.5.4.1 Olivier Beaudoux: DPI: *A Conceptual Model Based on Documents and Interaction Instruments*

I am working on the DPI model (Document-Presentation-Instrument) that aims at designing interactive and collaborative workspaces centred on documents and instruments. This model is based on the "disappearing applications" idea: applications are replaced by D, P and I components that communicate with each other within the workspace.

2.5.4.2 Renaud Blanch: *Software architectures and tools for advanced human computer interfaces*

One part of my research into 'software architectures and tools for advanced human computer interfaces' centres around the addition of control structures into programming languages, which are adapted (adaptable) to both the descriptions and specifications of interaction techniques so that they can be used as first class objects by software developers. I am also interested in techniques that improve pointing within interactive environments.

2.5.4.3 Caroline Appert: *Modeling, Evaluating and Generating Interaction Techniques*

Today, only a small part of the whole range of interaction techniques is used in the design of interfaces. This is in part due to the lack of comparison criteria. We are looking to formally describe these interaction techniques and evaluate their efficiency in accordance with various tasks that can be performed with each technique.

2.5.4.4 Pascal Costa-Cunha: *Augmented laboratory notebooks*

In collaboration with biologists from the Pasteur Institute, we are designing an augmented laboratory notebook which has the advantages of paper (transportable, ease of access) and also digital media (searchable and archivable). We are using an Anoto pen, which allows us to use paper as an interface to a computer.

2.5.4.5 Emmanuel Nars : *Computer support for personnel communications*

The goal of FamilyNet is to create a software infrastructure making it possible to the members of a group to communicate by way of small sized networks, managed with tangible objects. For the user, the tangible objects represent the place where shared information is stored.

2.6   LIIHS-IRIT, University Paul Sabatier (Toulouse 3)

2.6.1 Introduction

LIIHS research group at Université Paul Sabatier is working in the field of software engineering for interactive systems. To this end we define and develop methods, notations and tools for dealing with engineering of interactive systems.

The work carried out in this group integrates work from different, usually unrelated, domains such as Formal Description Techniques, Software Engineering and Human-Computer Interaction.

One of our research work goals is to take into account the end-user perspective (knowledge, skills, cognitive capabilities, needs and activities) while designing tools and systems for the engineering of interactive applications. We thus mainly focus on the issues related to the construction and the development of software artifacts and how the integration of HCI concerns in such system can empower their users.

2.6.2 Research projects

2.6.2.1   ADVISES

ADVISES is a Research Training Network within EU Framework 5 programme dealing with the "**Analysis, Design and Validation of Interactive Safety-critical and Error-tolerant Systems"**. It is a 4 years project that started in October 2002 (end September 2006).

In this project we address the issues of notation and software tools that could help improving both the usability and the reliability of interactive systems. Within this project we are extending previous work in this field by focusing on the end-user activities (in this case a software engineer) and improving the CASE tool called PetShop. This software environment provides means of building formal models of an interactive application and simulating it at the same time. We believe that this kind of approach will make such notations and tools understandable and usable by users without specific background in formal methods and advanced mathematics.

See (Barboni, Bastide, Lacaze, Navarre, & Palanque, 2003) and (Palanque & Bastide, 2003).

2.6.3 Tools

2.6.3.1   PetShop

As stated above, PetShop is a CASE tool dedicated to the construction and the simulation of formal models for interactive software. More information about PetShop can be found on the web site: http://liihs.irit.fr/petshop

While focussing at first on the edition, analysis and simulation of a formal model of an interactive system, current issues address the way in which the user interface and its underlying architecture can empower PetShop's users.

2.6.4 PhD-Studies

2.6.4.1 Olivier Esteban : *Programmation visuelle pour la construction d'interfaces hautement interactives (Visual Programming for the building of Highly Interactive Interfaces)*

See Stéphane Chatty (INTUILAB) for a description of the PhD.

2.6.5 References

(Esteban, Chatty, & Palanque, 1995a, 1995b), (Esteban, Chatty, & Palanque, 1995c).

2.7 University of Cambridge CLAB

2.7.1 Introduction

Research into End-User Development at the University of Cambridge is headed by Dr. Alan Blackwell. Dr. Blackwell has been active in the development of end-user programming tools for 20 years - first in New Zealand, as a commercial developer of systems for laboratory and factory automation, then in Europe at the Hitachi Europe Advanced Software Centre, the Medical Research Council Applied Psychology Unit, and now as a lecturer in the Computer Laboratory at Cambridge University. Blackwell's research is mostly directed toward the human factors involved in end-user development, especially psychology of programming - cognitive theory and empirical studies of end-user development tasks. He is very active in the organization of the European Psychology of Programming Interest Group, and has worked with the American Empirical Studies of Programmers Foundation.

2.7.2 Research projects

End-User Development research in Cambridge is focused on domestic automation, educational applications, and theoretical issues in end user development.

2.7.2.1 Media Cubes

In this project a system for end-user programming of facilities in an intensively networked home environment is developed. The resulting tangible programming language is a radical programmable alternative to the familiar domestic remote control.

See (Blackwell & Hague, 2001).

2.7.2.2 Industrial use of Visual Languages

In this project a survey of scientific end-users of a laboratory instrumentation and control language is being produced.

See (Whitley & Blackwell, 2001).

2.7.2.3 Cognitive Ergonomics for Ubiquitous Computing

Our Cognitive Ergonomics project is concerned with the nature of so-called 'programming' activities by end-users in the home. We are running two studies under this project. One is an ethnographic study of how household members choose and use their domestic appliances, and in particular how household members share responsibility for use of appliances that need to be set up ahead of time to do a task in the future, and for use of appliances that can be set up with a customized default setting to make com-

monly repeated tasks easier. The second study is a lab-based investigation of usability issues with respect to VCR programming.

See (Blackwell, Hewson, & Green, 2003).

2.7.2.4   End User Functions for Excel

In this project Microsoft Excel is modified, introducing end user programmable functions that can be implemented in the spreadsheet itself.

See (Peyton Jones, Blackwell, & Burnett, 2003).

2.7.3 Tools

2.7.3.1   The Attention Investment Model

A fundamental cognitive model of the initial stages of a programming task: characterising the decision taken by an end-user when investing in a new task abstraction.

See (Blackwell & Burnett, 2002).

2.7.4 PhD-Studies

2.7.4.1   Rob Hague: *Interlingua*

2.7.4.2   William Billingsley: *Adaptive tutorial systems*

2.7.4.3   Silas Brown: *Automatic conversion of notations*

2.7.4.4   Richard Watts :Video user interfaces

2.7.4.5   Calum Grant - Software Visualization in Prolog

2.8   InterMedia, University of Oslo

2.8.1 Introduction

InterMedia, UiO (http://www.intermedia.uio.no) is a research centre at the University of Oslo, affiliated with the Faculty of Education conducting research in new media and net-based learning. A focus is on designing, developing, and evaluating computer support for distributed collaborative learning in interplay with face-to-face learning. We address learning environments in schools, workplace and at the University.

2.8.2 Research projects

2.8.2.1   NAUTICA: New Approaches to User Tailoring In Component-based Applications

This project has been running in parallel to the EUD-Net (July 2002 – present) and is a research project conducted by Anders Mørch and funded by InterMedia, UiO. The goal is to investigate the borderline issues of end user tailoring in particular: user participation in component-based design, comparisons of object-oriented programming and component-based development, evolutionary application development, and intersection of science and art. Two papers have been produced: (A. I. Mørch, 2002), (A. Mørch, 2003).

2.8.2.2   DoCTA: Design and use of Collaborative Telelearning Artifacts

In DoCTA (http://www.intermedia.uib.no/docta/) we investigate how the pedagogical design of an ICT-mediated collaborative learning environment enables students to learn complex concepts and how they can go about discussing these concepts in the broader learning community. Students collaborated both in co-located and distributed settings. We have implemented pedagogical agents to assist in this process. EUD issues in this project include allowing end-users (instructors) to modify the agents' rules. The project lasted from 2001 – 2003 and is funded by ITU (IT in Education) and UFD (Norwegian Ministry of Education and Research). Numerous papers have been produced, including: (Jondahl & Mørch, 2002), (Dolonen, Chen, & Mørch, 2003).

2.8.2.3   LAP: Learning and Knowledge Building at Work

This project investigates how users can be involved in participating in developing learning solutions for their specific needs at work. The technological focus is on e-learning and the organizational focus on super users (power users). The project started in 2002 and continues through 2004. The Research Council of Norway funds it. Paper: (A. Mørch, Dolonen, Åsand, & Svanæs, 2003).

2.8.3 Tools

2.8.3.1   Student-Assistant Agent, Rule Editor

In most of our projects we employ open source software and reuse these assets (e.g. Future Learning Environment, http://fle3.uiah.fi/) and we add components to extend them when we need to (e.g. software agents) or customize them to specific needs (e.g. translate user interface to Norwegian). The tools we have developed include a Student Assistant (SA) Agent and a Rule Editor. They have been written in Java with use of some Python code. Master students have been involved in this.

2.8.4 PhD-Studies

2.8.4.1   Hege-René Åsand: *Facilitating Learning in Knowledge Organizations: The Role of Super Users in Two Norwegian Organizations*

2.9   think3

2.9.1 Introduction

think3 is a privately held start-up company with headquarters in Santa Clara, California and about 250 employees worldwide. think3 produces software for designing common, everyday physical objects, ranging from home appliances, children' safety products and engine parts to boutique home accessories and custom automobiles.

Formerly known as CadLab, it was funded in Bologna (Italy) in 1979, and since then it has always had its core in its R&D: 80% of the company completely focused on providing innovative, powerful, affordable, easy-to-learn 3D design software for millions of 2D designers.

2.9.2 Research projects

2.9.2.1 FIORES II - Character Preservation and Modelling in Aesthetic and Engineering Design

FIORES-II was a project funded by the European Commission working in the field of Computer Aided Aesthetic Design (CAAD) completed in the period 1 April 2000-31 March 2003, in which 14 Partners from 6 European Countries participated: think3, the University of Kaiserslautern, l'Université de Provence, Le Pole Universitaire Leonard de Vinci, IMATI-CNR, CAxOPEN, Samtech, UDK, Formtech, Eiger, Saab, BMW, Alessi and Pininfarina.

The genesis of the project has been explained by the will to extend the Engineering in Reverse approach (issued from the previous European project FIORES) to the more qualitative domain of feeling, fashion and shape characters. It has been proven that the **qualitative** domains of emotions and shape characters are accessible to a **quantitative** analysis via Case based reasoning (**CBR**) and adequate Computer Aided Geometry Design (**CAGD**) techniques. Another important result is the fact that the **style** is very often a **social construction** that can be described by two languages, the language of trades (designers) and the language of trends (marketing). Therefore the modifications of shapes are as (or even more) important as their generations. See 2.9.3.1.

For further information and publications please see www.fiores.com.

2.9.2.2 TnD – Touch 'n Design

TnD is a project proposed to the European Commission at this moment at a negotiation phase, in which 8 partners from 4 European countries are going to participate: Politecnico di Milano, Université de Provence, Universitat de Girona, think3, Eiger, FCS, Alessi and Pininfarina.

The project aims at developing a novel system for shape generation and modification based on novel haptic interaction and intelligent shape manipulation operators in order to exploit existing manual skills of designers. Haptic technology will be integrated together with modelling operators for providing a working environment offering a high degree of usability and acceptance, comfort of usage, flexibility for any kind of user, including inexperienced users. The system will capture the design intent, inferring commands to apply from designers haptic gestures. Designers will be able to manipulate generative constraints using their hands, and not mathematical equations and formula.

2.9.3 Tools

2.9.3.1 FIORES II Modifiers

The Fiores II analysis lead to the generation of innovative CAGD operators called **Modifiers**.

The end-users' tests of the Modifiers and the propagation of their influence through the whole shape showed a **quick** users' **acculturation**. The prototype implementation demonstrated the power and flexibility of a software **component** architecture that permitted the "dialog" between four very different systems (i.e. User Interface, CBR, CAD, and Optimization) and led to a prototype that can be used in an industrial environment on actual applications.

The scenario opened by FIORES-II will offer better ways to modify and create shapes, while getting closer CAS language to professional language. The possibility of providing tools that allow stylists, designers and engineers to be directly successful in design intent has been demonstrated. Moreover it can be foreseen that Engineering in Reverse applied to the aesthetic will become a new Computer Aided Design Paradigm.

For further information see http://rkk.mv.uni-kl.de/FIORES/FIORES2/FIORES2.html .

2.10 University of Paderborn, Germany

2.10.1 Introduction

The research of the database and information systems group of Prof. Dr. Gregor Engels at the University of Paderborn is centred upon the areas of visual languages, object-oriented modelling techniques (around the Unified Modeling Language (UML)), software process models, software development environments and tools, graph transformation, and applications thereof for the development of multimedia, real-time, embedded, or agent-based systems.

Further information about the group and its activities can be obtained from http://www.upb.de/cs/ag-engels/index_engl.html.

2.10.2 Research projects

The following projects focus on adapting software engineering principles for the development of multimedia and Web applications as well as on the integration of software engineering and user-oriented software development. The active participation of designers and media experts (who can be regarded as domain expert users) as well as of end-users in the software development process is a central requirement for these projects. It is an important objective of the projects that development practices, methods, and tools used by the different members of such heterogeneous development teams are integrated with software engineering methodology. Further information on these projects can be obtained from the research Web page of the group at http://www.upb.de/cs/ag-engels/ag_engl/Research.html.

2.10.2.1 OMMMA: Object-oriented Modeling of MultiMedia Applications

The objective of the OMMMA (Object-oriented Modeling of MultiMedia Applications) project is to develop a modelling language for specifying and describing important aspects of multimedia applications in a coherent model. The OMMMA modelling language is defined as an extension of the Unified Modeling Language (UML) which is the standard modelling language in software engineering. Supporting development tools for the OMMMA modelling language and the associated methodology are currently being built.

The OMMMA modelling language is designed to be widely independent of application domains, but is itself specializable. Applicability towards interactive embedded systems such as automotive infotainment systems and multimedia Web applications has been investigated. OMMMA is an ongoing research activity that was started in 1998. It was temporarily integrated with a project on extending the UML towards automotive systems (Automotive UML) which was cooperation with DaimlerChrysler AG.

See (Engels & Sauer, 2002) and (Sauer & Engels, 2001).

2.10.2.2 WebDev :Model-based Development of Web Applications

Development of (dynamic) Web sites is often performed by teams consisting of graphic designers and software developers. Communication between these different team members has to be supported with a simple modelling approach that considers their different academic and professional backgrounds. Dynamic Web sites can contain multiple modules that may reappear on different pages. Reuse of both business logic and visual design modules would be desirable. The goal of this project is to provide a simple modelling approach based on the Unified Modeling Language (UML) that supports code and prototype generation from the models to enable rapid application development in this area.

The conceptual work on this topic is accompanied by the development of a software development environment for dynamic Web sites ProGUM-Web (Prototype Generation from UML Models for Web applications). ProGUM-Web is described in Section 2.10.3.1. The WebDev project was started in 2001 and is ongoing.

See (Lohmann, Sauer, & Schattkowsky, 2003) and (Schattkowsky & Lohmann, 2002).

2.10.2.3 USE: User-oriented Software Engineering

The USE project focuses on the integration of software engineering and user-oriented development techniques. The initial objective is to integrate user-centred design and model-based software development. Visual modelling and development techniques are to be developed that allow heterogeneous development teams to effectively cooperate and communicate their ideas and concepts. The different views are integrated in a common overall model and project repository. The approach shall account for the collaboration of different developer roles as well as for the active participation of end-users during conceptualization and design. To this end, notations that are usable by end-users and tools to support their active participation in software development beyond requirements gathering and prototype evaluation will be developed.

This project was started in 2003 and is a joint effort with the Usability Engineering Group of the C-Lab, Siemens Business Services, Paderborn.

See (Engels, Sauer, & Neu, 2003).

2.10.3 Tools

2.10.3.1 ProGUM-Web

ProGUM-Web is a tool that supports model-based development of Web applications using an extension of the UML (see Section 2.10.2.2). It accounts for the characteristics of Web applications and their specific development. Code templates are generated from the model for both graphic designers and software developers. These code templates can iteratively and independently be advanced and are reintegrated within ProGUM-Web. Prototypes of Web applications can automatically be generated throughout the development.

2.10.4 PhD-Studies

2.10.4.1 Stefan Sauer: *Model-based Development of Multimedia Applications*

The objective of this PhD project is the definition of an object-oriented modelling language for interactive multimedia applications and the development of a methodology

for model-based development of interactive multimedia applications. The modelling language consists of a family of languages supporting the integrated specification of all important aspects of the interactive multimedia application in a coherent model. It comprises application functionality, system requirements, and user interaction. The modelling language is defined as an extension of the UML using its built-in extension mechanisms. The graphical syntax is designed to be understandable and usable by the different stakeholders in the development process. In addition to syntax and semantics of the modelling language, the pragmatics of the language is incorporated in a development methodology that follows a model-based and prototyping-oriented paradigm. The methodology accounts for the different developer roles in heterogeneous development teams for interactive multimedia applications. It supports their respective tasks and activities by providing specialized views that accommodate each stakeholder's interests, needs, and backgrounds.

This PhD project is strongly related to the OMMMA project (see Section 2.10.2.1). The PhD is expected to be completed in March 2004.

2.11 Blekinge Institute of Technology

2.11.1 Introduction

'Design for Change' is the heading we use for our take on the design of tailorable systems allowing for End User Development. Software is more and more used in co-operative settings mediating between different work practices and integrating a range of data sources. Especially in so-called data centred businesses – in so diverse areas as telecommunication, municipal service provision but also banking and insurance – software becomes part of a technical infrastructure intrinsically interlaced with the work and business practices it supports. Neither can be changed without also changing the other. Systems are not developed as a monolith anymore, they incorporate middleware bought from diverse sources, and powerful tools are used when developing other parts. The flexibility such software has to provide requires advanced technical solutions that make use of the malleability of information technology; and it affords the intertwining of use, design in use, tailoring, smaller changes and major development tasks.

2.11.2 Research projects

2.11.2.1 Architectures for usable and flexible systems

The project is a subproject to the project 'Blekinge Engineering Software Quality' led by Prof. Claes Wohlin. The goal of the project is to explore how to reflect different user aspects in software architectures to achieve usable *and* flexible systems that adapt to altered conditions and requirements in the end-user's environment. It is also interesting to discover how to achieve flexible systems that have a construction that is so clean and flexible that the end-user can visualize the possibilities in the system and be able to alter the system in a way unforeseen by the system designers.

2.11.2.2 Design in Use of Database Applications

Flexible and adaptable software was the subject of this co-operative research project, led by Yvonne Dittrich, with a telecommunication provider and a small software developing company. The original intention of the project was to explore the usefulness of a meta-modelling database. The meta-modelling database turned out not to be suit-

able for the reference project. Instead the final solution used lightweight technologies to implement flexibility and that fitted well with the close co-operation between users and developers. The necessity to take use, development and technical contexts into account and how to do so is one of the results of the project. In the light of the industrial case we explored several technical solutions with the help of prototypes.

2.11.2.3 Design of IT in Use – Supportive Technologies for Public Service Provision

Project leader was Dr. Sara Eriksén, Department of Human Work Science and Media Technology. In this project, we started to explore practices around the deployment, design and development of technical infrastructures for public service provision. As the development of service provision and of the services itself implies a parallel change in the infrastructure, the support systems have to be highly flexible as well. Use, design in use, tailoring and further development become highly intertwined. As traditional software development models do not support such needs, the software development practices that developed in this context do not comply with state of the art software engineering methods and processes. We explore recently developing discourses around agile processes and extreme programming to see how these lightweight methodologies relate to our field studies.

2.11.2.4 The Billing Gateway – Flexibility in Large Telecommunication Systems

Project leader is Prof. Lars Lundberg. The overall project focuses on performance aspects of multithreaded large telecommunication systems. The need for customization after delivery is increasing in many performance demanding real time systems. The Billing Gateway is a mediation device that connects network elements with post processing systems. It contains an interface that allows tailoring of the filters and formatters for the incoming call data records to the interfaces of the post processing systems. The interpretation of the tailoring language turned out to be a performance bottleneck for the multiprocessor system. Implementing a compiled solution solved the problem.

2.11.3 PhD-Studies

2.11.3.1 Jeanette Ericsson: *Architectures for usable and flexible systems*

Start was August 2003. The main research question is how to make the software architecture for business applications match the user view to make it easy for the end-user to overview the possibilities and make changes. The research involves how to reflect different user aspects in software architectures to achieve usable and tailorable systems that adapt to altered conditions and requirements in the end-user's environment. It also includes how to achieve flexible systems that have a construction that is so clean and flexible that the end-user can overview the possibilities in the system and be able to alter the system in an unforeseeable way.

2.11.3.2 O. Lindeberg: *Designing for Flexibility – A case for Artful Integration*

Start was January 2000. The relation between design and context when developing flexible systems is studied. How does a software project manage to take care for use, business, design and technical contexts of a future system while still producing a good technical design? In the participatory design area it is argued that mainstream software engineering takes too little consideration to the use context. We here argue that there is a corresponding problem and forgetting the technical considerations. To make a successful tailorable system both concerns must be accommodated. Based on the case

study we argue that a solution to this conflict is to view software design as an 'artful integration' (Lucy Suchman) of all the contexts to the project, seeing also the technical environment as a context.

2.11.4 References

(Dittrich, Mørch, & Wulf, 2003), (Eriksson, Warren, & Lindeberg, 2003), (Dittrich & Lindeberg, in press), (Lindeberg, Eriksson, & Dittrich, 2002), (Dittrich, Eriksén, & Hansson, 2002)

2.12 TI LAB

2.12.1 Introduction

TI Lab acts as R&D for the Telecom Italia group that is primarily a network and service provider so the great interest is toward the user and his facility using services and increasing telecommunication traffic.

2.12.2 Research activities

The group that is more involved in the EUD theme is the Service Lab that is a group devoted to develop services and products (acting with external manufacturers) by using the "User Centred" methodology. The goal of the work is to create services that are easy to use and solve the actual needs and problems of the end-user.

The group includes different skill, technical and psychological, in particular dedicated to meet the end-user, understanding his need and behaviours.

The participation to the NoE allowed clarifying the concept of EUD, defining the actors in the process, different views, the interests and possible trade-off.

TELECOM ITALIA, as services and network provider, is devoted more towards the mass market area where the programming skill is not so extended. So, in order to achieve the goal, the devices must be easy to personalize (usability), must have the possibility of fast personalization (profile inserted) and provide filters and facilities to manage both push and pull information.

In addition it must be thought as modular, allowing the downloading of "my services". As an additional point we highlight that the evolution of Software Programs (new versions) usually maintains the compatibility of the files among the different versions but does not maintain the compatibility of the mental skill of the user (Very often if I change the program version (in particular if I jump some intermediate versions), I am no more able to use the program).

2.13 HCI Group, University of Brescia – UNIBS

2.13.1 Introduction

The UNIBS group adopts a model-based approach to design and development of EUD systems. To this end, the group has participated in the development of the PCL (Pictorial Computing Laboratory) model of Human-Computer Interaction (HCI) processes. This model is aimed at supporting the design, specification and implementation of multi-modal interactive systems, usable by and acceptable to end-users. The model is

used as a frame to study, from a uniform point of view, the phenomena which affect the HCI process. The phenomena taken into account are the communicational gap often existing between designers and systems, the user diversity within a user community, the co-evolution of systems and users, the grain imposed by software tools, the tacit information and implicit knowledge that influence user behavior while interacting with software systems (M.F. Costabile, Fogli, Fresta, Mussio, & Piccinno, 2003c), (M. F. Costabile, Fogli, Mussio, & Piccinno, 2004).

2.13.2 Research projects

The research activity of UNIBS capitalizes on the model of HCI processes and on the theory of visual sentences developed by the PCL (Bottoni et al., 1999). In the PCL approach, HCI is a process in which the user and the computer communicate by materializing and interpreting a sequence of messages at successive instants of time. Two interpretations of each message and of each action arise in the interaction: one performed by the user achieving the task, depending on his/her role in the task, as well as on his/her culture, experience, and skills, and the second internal to the system, associating the image with a computational meaning, as determined by the programs implemented in the system (Bottoni et al., 1999). Starting from these premises, the UNIBS group has developed a) a method for specifying interactive systems both from the user's and designer's points of view, and b) a method to translate the specification into verifiable programs.

2.13.2.1 Software Shaping Workshop (SSW) Methodology

This project is carried out in collaboration with the University of Bari and involves ETA Consulting, a company producing systems for factory automation. It started at the end of 2000 and is still in progress. It is financed by university and industry funds.

The project concerns the development of a design methodology to create easy-to-develop-and-tailor multi-modal interactive systems that are organized as Software Shaping Workshops (SSWs), i.e. software environments designed to support various activities of End-User Development (EUD) and tailoring. Within the SSW methodology, EUD is obtained in two ways: 1) domain experts may use a SSW to create other SSWs suitable to the domain at hand, by using simple facilities, such as drag-and-drop; 2) domain experts may create new tools, for example as a result of an annotation activity. In both cases, users are required neither to write codes, nor to know some programming language or paradigm. Users simply create programs by interacting with the system through visual languages resembling the activities they usually perform in their daily work. Related publications are (Carrara, Fogli, Fresta, & Mussio, 2002), (M.F. Costabile, Fogli, Fresta, Mussio, & Piccinno, 2003b), (M.F. Costabile, Fogli, Fresta, Mussio, & Piccinno, 2003a), and (Fogli, Piccinno, & Salvi, 2003).

2.13.2.2 IM^{2}L

This project is carried out in collaboration with the University of Bari and CNR-CNUCE. It started in 2000 and is still in progress. It is financed by university and CNR funds.

The project is concerned with the definition of IM^{2}L (Interaction Multimodal Markup Language), an XML-based language, whose mark up tags permit the description of the physical representation and the computational meaning of interactive systems. The underlying idea of IM^{2}L is the separation between representation and content (meaning),

which is at the basis of the XML technology. The separation is also emphasized by the formalism we use for system specification and design. Related publications are (M.F. Costabile et al., 2003a) and (Fogli, Fresta, Mussio, & Salvi, 2003).

2.13.2.3 DimmiBene

This project is funded by CNR-Agenzia 2000. It started in June 2001 and ends in October 2003.

UNIBS is studying methods and techniques for the formal specification, design and development of tools supporting interactive multimedia self-illustration of electronic devices. Such tools should replace or integrate the traditional user manuals. In particular, UNIBS has studied the concept of electronic document, to be used as the basis for the development of ipermanuals. Related publications are (Fogli, Fresta et al., 2003), (Arondi, Baroni, Fogli, & Mussio, 2002).

2.13.3 Tools

2.13.3.1 Software Shaping Workshops and BANCO

BANCO (Browsing Adaptive Network for Changing user Operativity) is a software tool that allows users to create, manage and interact with multimodal electronic documents, whose content is distributed over the Web. BANCO develops on SVG (the XML specification for vector graphics). It is the tool recursively applied to generate a network of SSWs. BANCO has been adopted to implement prototypes of SSWs in the environmental science domain (glacier images interpretation and classification), in the medical domain (diagnosis support through collaborative radiographies interpretation and annotation) and in the industrial domain (automation system management).

2.13.4 PhD-Studies

2.13.4.1 Alessandro Bianchi: *Una metodologia orientata all'utente per il progetto di sistemi interattivi visuali*

This doctoral thesis presents a participatory methodology to the design of visual interactive systems, based on a) the PCL model of interaction, b) the star life-cycle for interactive software, c) the development of visual languages to describe the task to be performed and the interaction. The thesis results in a working system for the immune system studies.

2.13.5 Master Thesis

2.13.5.1 Denise Salvi: *Progettazione di ambienti integrati per la produzione di sistemi interattivi*

This master thesis was aimed at defining and developing a methodology and a set of tools for the implementation of environments allowing users to perform EUD activities. These environments enable domain expert users, not expert in computer science, to design, develop and tailor programs devoted to themselves or to other experts. Such environments are built adopting notations and languages of the considered user community. A prototype in the automation system field has been developed to demonstrate the main features of the approach.

2.14 IntuiLab

2.14.1 Introduction

IntuiLab is a company created in 2002 by researchers in Human-Computer Interaction from CENA (Toulouse France) and IRIT (France). IntuiLab's line of business is the generalization of intuitive user interfaces based on multimodal interaction techniques. Central to the company's activity is IntuiKit, a software environment which supports user interface designers prototyping user interfaces and programmers implementing the final design into products. Designing and then implementing user interfaces is a creative activity that often involves several actors, some of which are not professional programmers. It mixes activities ranging from pure programming to pure visual design, thus blurring the limits of professional and end-user programming. Furthermore, describing a multimodal user interface involves the description of multiple facets of a program, which requires the use of multiple models: event-oriented models for graphical interaction, rule-oriented for voice interaction, sequence-oriented for animation, etc. As a consequence, IntuiLab spends most of its research time in identifying software architectures and programming paradigms that can meet the above requirements.

IntuiLab's research on these themes follows two main lines. The first line is research on software models for describing/programming user interfaces which is a major part of the necessary work. This rejoins the more general software research themes on software engineering for HCI. The specificity here lies in the research methods and the criteria applied to select models: models are researched and selected based on their ability to be grasped by non-professional programmers. The second line is research on the "interface" provided to designers and programmers that is the programming languages or the interface builders. This research aims at identifying the constructions that lead to "natural programming" as described by Myers, so as to offer both professional programmers and designers the ability to manipulate their user interface "programs" in an efficient way.

On both these lines, IntuiLab's research follows up on research led by one of its founders at CENA. The following details thus merge the two research histories.

2.14.2 Research projects

2.14.2.1 CENA's project Toccata

Project Toccata is an ongoing research project carried out by CENA with funds from the national French Air Traffic Control operator. Toccata was launched circa in 1997. Its aims are to propose new user interfaces for air traffic control. The project is structured in a series of actions, among which the "génie logiciel des interfaces" (software engineering for user interfaces) action. Other actions include research on cognition, research on new interaction styles, etc.

The research action on software engineering for user interfaces has produced results on:

- Models and tools for the architecture of user interfaces. Tools: the TkZinc toolkit and the Ivy software bus. Publications: (Jacomi & al., 1997), (Accot & et al., 1997)

- "Natural Programming", oriented both toward programmers and non programmers. Publications: (Jacomi & al., 1997), (Esteban et al., 1995a), (Esteban et al., 1995b), (Leblanc, 1999)

See http://www.tls.cena.fr/divisions/PII for more information.

2.14.2.2 IntuiLab's IntuiKit

IntuiLab's research on IntuiKit started in 2002 with funds from IntuiLab and the French Ministry of Research. The first public version of IntuiKit based on this research is due in the first semester of 2004. No public details are expected before that date.

2.14.3 PhD-Studies

2.14.3.1 Stéphane Chatty: *La programmation d'interfaces homme-machine animées*

Thesis presented in 1992. This thesis concerns the construction of animated user interfaces. Many different aspects of graphical interfaces are presently studied: graphical techniques, software architectures, and tools for building them. Sound and video are sometimes added to such interfaces, but animation is rarely used, and only as a secondary feature. Only algorithm animation systems use it intensively, but they are very specific applications, and are not highly interactive.

Adding animation to user interfaces raises several questions. What are the applications of animation? Which techniques should be used to enable animation and interaction simultaneously? Which formalisms or models could describe animated interfaces? Which tools are required to build them?

Whizz is a toolkit for building animated user interfaces. It is an extension of Xtv, a user interface toolkit designed for direct manipulation interfaces. The model introduced with Whizz is based on objects which communicate through data streams and events. Some objects initiate movement by spontaneously emitting information. Other objects are used to describe movement by altering that information. Finally, graphical objects use that information to drive their evolution. This model allows a homogeneous description of the whole dynamic behaviour of an interface, be it driven by time, the user's actions, or the evolution of application data. Moreover, the existence of two ways of transferring information allows the description of continuous phenomena as well as isolated ones. They also offer a means of structuring communications within an interactive application.

The main application of Whizz to date is a debugger named Witness. In addition to traditional debugging capabilities, Witness allows the animated representation of program data. Using Witness, programmers can debug a program with their own graphical representations, built with a direct manipulation drawing tool.

2.14.3.2 Olivier Esteban: *Programmation visuelle pour la construction d'interfaces hautement interactives*

Thesis presented in 1997. No abstract in English available.

3. Acknowledgements

This survey is based on input from the EUD-Net members. I gratefully acknowledge all of their contributions and comments that helped in setting up this document.

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6. References

Accot, J., & et al. (1997). Formal transducers: models of devices and building bricks for the design of highly interactive systems. Paper presented at the DSVIS97.

Arondi, S., Baroni, P., Fogli, D., & Mussio, P. (2002, May 2002). Supporting co-evolution of users and systems by the recognition of Interaction Patterns. Paper presented at the AVI 2002, Trento, Italy.

Barboni, E., Bastide, R., Lacaze, X., Navarre, D., & Palanque, P. (2003, September 26-27, 2003). Petri Net Centered versus User Centered Petri Nets Tools. Paper presented at the 10th Workshop Algorithms and Tools for Petri Nets, AWPN 2003, Eichstätt, Germany.

Berti, S., & Paternò, F. (2003). Model-based Design of Speech Interfaces. Paper presented at the DSV-IS 2003.

Blackwell, A. F., & Burnett, M. (2002). Applying Attention Investment to end-user programming. Paper presented at the IEEE Symposia on Human-Centric Computing Languages and Environments.

Blackwell, A. F., & Hague, R. (2001). AutoHAN: An Architecture for Programming the Home. Paper presented at the In Proceedings of the IEEE Symposia on Human-Centric Computing Languages and Environments.

Blackwell, A. F., Hewson, R. L., & Green, T. R. G. (2003). Product design to support user abstractions. In E. Hollnagel (Ed.), Handbook of Cognitive Task Design: Lawrence Erlbaum Associates.

Bottoni, P., Costabile, M. F., & Mussio, P. (1999). Specification and Dialog Control of Visual Interaction. ACM TOPLAS, 21(6), 1077-1136.

Carrara, P., Fogli, D., Fresta, G., & Mussio, P. (2002). Toward overcoming culture, skill and situation hurdles in human-computer interaction. Universal Access in the Information Society, 1(4), 288-304.

Costabile, M. F., Fogli, D., Fresta, G., Mussio, P., & Piccinno, A. (2003a, October 28-31, 2003). Building Environments for End-User Development and Tailoring. Paper presented at the HCC'03, Aukland.

Costabile, M. F., Fogli, D., Fresta, G., Mussio, P., & Piccinno, A. (2003b). Computer Environments for Improving End-User Accessibility. In N. Carbonell & C. Stephanidis (Eds.), Universal Access - Theoretical Perspectives, Practice, and Experience (2615 ed., pp. 129-140).

Costabile, M. F., Fogli, D., Fresta, G., Mussio, P., & Piccinno, A. (2003c, April 2003). Software Shaping Workshops: Environments to Support End-User Development. Paper presented at the Workshop on End-User Development. CHI 2003, Fort Lauderdale, USA.

Costabile, M. F., Fogli, D., Mussio, P., & Piccinno, A. (2004). End-User Development: the Software Shaping Workshop Approach. In H. Lieberman, F. Paternò & V. Wulf (Eds.), Submitted to End User Development - Empowering people to flexibly employ advanced information and communication technology.

Dittrich, Y., Eriksén, S., & Hansson, C. (2002). PD in the Wild: Evolving Practices of Design in Use. Paper presented at the PDC 2002, Malmö, Sweden.

Dittrich, Y., & Lindeberg, O. (in press). Designing for Changing Work and Business Practices. In N. Patel (Ed.), Evolutionary and Adaptive Information Systems: IDEA group publishing.

Dittrich, Y., Mørch, A., & Wulf, V. (2003, September 14-18, 2003). Tailoring Co-operation. Paper presented at the Workshop at the ECSCW2003, Helsinki.

Dolonen, J., Chen, W., & Mørch, A. (2003). Integrating Software Agents with FLE3. Paper presented at the CSCL 2003, Bergen, Norway.

Engels, G., & Sauer, S. (2002). Object-oriented Modeling of Multimedia Applications. In S. K. Chang (Ed.), Handbook of Software Engineering and Knowledge Engineering (Vol. 2, pp. 21-53). Singapore: World Scientific.

Engels, G., Sauer, S., & Neu, B. (2003, October 2003). Integrating Software Engineering and User-centred Design for Multimedia Software Developments. Paper presented at the IEEE Symposia on Human-Centric Computing Languages and Environments (HCC'03), Auckland, New Zealand.

Eriksson, J., Warren, P., & Lindeberg, O. (2003, 9-12 august 2003). An Adaptable Architecture for Continuous Development. User roles reflected in the architecture. Paper presented at the IRIS 26, Porvoo, Finland.

Esteban, O., Chatty, S., & Palanque, P. (1995a, 9-14 July 1995). Different approaches in visual interactive software construction. Paper presented at the HCI International conference, Yokoohama, Japan.

Esteban, O., Chatty, S., & Palanque, P. (1995b, 27-29 March 1995). Visual construction of Interactive Software. Paper presented at the IFIP conference on Visual Database, Lausanne, Switzerland.

Esteban, O., Chatty, S., & Palanque, P. (1995c, 27-29 June 1995). Whizz'Ed: a Visual Environment for building Highly Interactive Software. Paper presented at the IFIP Human-Computer Interaction conference, Interact'95, Lillehammer, Norway.

Fogli, D., Fresta, G., Mussio, P., & Salvi, D. (2003, September 2003). Documents in Visual Reasoning: from paper-based to electronic ones. Paper presented at the DMS 03, Miami, FL.

Fogli, D., Piccinno, A., & Salvi, D. (2003, September 2003). Software Shaping Workshops: What Users See Is What Users Need. Paper presented at the DMS 03, Miami, FL.

Jacomi, M., & al., e. (1997). A Making-Movies Metaphor for Structuring Software Components in Highly Interactive Application. Paper presented at the HCI 97.

Jondahl, S., & Mørch, A. (2002). Simulating Pedagogical Agents in a Virtual Learning Environment. (short paper + web proceedings, URL: newmedia.colorado.edu/cscl/211.pdf). Paper presented at the CSCL 2002, Boulder, Colorado.

Kahler, H. (2001). Supporting Collaborative Tailoring. Unpublished PhD, Roskilde University.

Klann, M., Eisenhauer, M., Oppermann, R., & Wulf, V. (2003, 2003/6). Shared initiative: Cross-fertilisation between system adaptivity and adaptability. Paper presented at the UAHCII 2003, Crete.

Leblanc, F. (1999). Programmation visuelle pour la description du comportement d'un robot autonome. Unpublished Master, INP Toulouse.

Lindeberg, O., Eriksson, J., & Dittrich, Y. (2002). Using Metaobject Protocol to Implement Tailoring. Possibilities and Problems. Paper presented at the 6th World Conference on Integrated Design & Process Technology.

Lohmann, M., Sauer, S., & Schattkowsky, T. (2003, October 2003). ProGUM-Web: Tool Support for Model-Based Development of Web Applications. Paper pre-

sented at the 6th International Conference on the Unified Modeling Language (UML 2003), San Francisco, CA, USA.

Marucci, L., Paternò, F., & Santoro, C. (2003). Multiple and Cross-Platform User Interfaces: Engineering and Application Frameworks: Wiley and Sons.

Mørch, A. (2003). Component-Based Design and Software Readymades: Toward Artful Integration. Paper submitted to Book on EUD. In: Kluwer Academic Publishers.

Mørch, A., Dolonen, J., Åsand, H.-R., & Svanæs, D. (2003). Participatory Design of Workplace Learning Scenarios: InterMedia, University of Oslo.

Mørch, A. I. (2002). Evolutionary Growth and Control in User Tailorable Systems. In N. Patel (Ed.), Adaptive Evolutionary Information Systems (pp. 30-58): Idea Group Publishing.

Mori, G., Paternò, F., & Santoro, C. (2002). CTTE: Support for Developing and Analysing Task Models for Interactive System Design. IEEE Transactions on Software Engineering, 28(8), 797-813.

Mori, G., Paternò, F., & Santoro, C. (2003). Tool Support for Designing Nomadic Applications. Paper presented at the ACM IUI'03, Miami.

Paganelli, L., & Paternò, F. (2003). A Tool for Creating Design Models from Web Site Code. International Journal of Software Engineering and Knowledge Engineering, 13(2), 169-189.

Palanque, P., & Bastide, R. (2003, June 2003). User-Centered Point of View to End-User Development. Paper presented at the Universal Access for Human-Computer Interaction, UAHCI 2003, Heracklion, Crete.

Peyton Jones, S., Blackwell, A., & Burnett, M. (2003). A user-centred approach to functions in Excel. Paper presented at the International Conference on Functional Programming.

Sauer, S., & Engels, G. (2001, September 2001). UML-based Behavior Specification of Interactive Multimedia Applications. Paper presented at the IEEE Symposia on Human-Centric Computing Languages and Environments (HCC'01), Stresa, Italy.

Schattkowsky, T., & Lohmann, M. (2002, September/October 2002). Rapid Development of Modular Dynamic Web Sites using UML. Paper presented at the 5th International Conference on the Unified Modeling Language (UML 2002), Dresden, Germany.

Stevens, G., & Wulf, V. (2002). Elektronische Archive in virtuellen Organisationen - Flexibilisierte Zugriffskontrolle mittels komponentenbasierter Anpassbarkeit. Informatik Spektrum, 25(1), 12-21.

Stiemerling, O., & Cremers, A. B. (2000). The EVOLVE Project: Component-Based Tailorability for CSCW Applications. AI & Society, 14, 120-141.

Whitley, K. N., & Blackwell, A. F. (2001). Visual programming in the wild: A survey of LabVIEW programmers. Journal of Visual Languages and Computing, 12(4), 435-472.

Won, M. (2003). Supporting End-User Development of Component-Based Software by Checking Semantic Integrity. Paper presented at the ASERC Workshop on Software Testing, Banff, Canada.