INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team in-situ

Situated Interaction

Futurs

THEME COG

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1. Team

The In Situ project is a collaboration between INRIA Futurs and the Laboratoire de Recherche en Informatique (Laboratory for Computer Science) of Paris-Sud University, within the framework of the PCRI (Pôle Commun de Recherche en Informatique). In-Situ was established in 2002 and includes the following personnel:

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2. Overall Objectives

2.1. Objectives

As computers permeate every aspect of society, the number and variety of computer users has multiplied dramatically as has the quantity and complexity of the data they manage. Computers are now ubiquitous and increasingly diverse, ranging from mobile phones and PDAs to laptops, desktops and wall-sized displays. Computers and telephony have converged to create a new communication medium, providing mobile access to myriad on-line services. This revolution poses major challenges for the design, implementation and deployment of interactive systems. The current failure to address these challenges has resulted in applications that users can no longer understand or control, lowering productivity and increasing frustration.

The focus of the In Situ project is to create innovative interactive systems that truly meet the needs of their users. For us, context is critical: we need to provide designers with tools and methods that actively take context into account. This requires a deeper understanding of the complementary characteristics of humans and computers as well as an analysis of specific situations of use. Our goal is to develop and facilitate the creation of such situated interfaces, which take optimal advantage of context to provide users with the particular tools they need to address the problems at hand.

The desktop metaphor that has driven personal computing for the past 25 years has reached its limits, with no short-term alternative. Our approach both expands today's graphical user interfaces and explores new possibilities, addressing the following goals:

- Flexibility to support end-user customization and programming as well as adaptation to physical context;
- Integration of physical and electronic worlds through the exploration of mixed reality and tangible interfaces;
- Scalability with respect to the quantity of data being managed, through the development of multi-scale interfaces and information visualization techniques;
- Cooperation and collaboration support in order to study new forms of person-to-person mediated communication;
- Integration of varied interaction styles and techniques into a single coherent environment, using appropriate interaction models and architectures.

2.2. Research Themes

In Situ's research is organized according to the following themes:

Interaction paradigms including multi-scale (zoomable) interfaces, interactive information visualization, bimanual interaction, multimedia (video and audio) and tangible interfaces. Our goal is to not only explore these paradigms individually but also to investigate how to integrate them into real-world applications.

Research methods, including participatory design techniques that actively involve users throughout the design process and multidisciplinary design techniques that facilitate communication among researchers from engineering, social science and design disciplines. Our goal is to develop, test and disseminate these methods to both researchers and practitioners in industry.

Engineering tools that enable us to facilitate the design and adoption of effective interaction techniques and paradigms and componentbased architectures to facilitate dynamic management of interactive systems. Our goal is to develop open source toolkits that enable us and our research colleagues to design and implement advanced interactive systems.

Although each theme is articulated separately, we often intermix them in actual projects in order to address real-world problems. We thus apply our own research methods to the design of new interaction techniques, develop our own tools for developing these techniques, and integrate these techniques in the design of

innovative interactive systems. In the long run, we seek to create a new generation of interactive environments as an alternative to the current generation of desktop computers.

3. Scientific Foundations

3.1. Scientific Foundations

In Situ uses a multi-disciplinary research approach, including computer scientists, psychologists and designers. Working together requires an understanding of each other's methods. Much of computer science relies on formal theory, which, like mathematics, is evaluated with respect to its internal consistency. The social sciences are based more on descriptive theory, attempting to explain observed behaviour, without necessarily being able to predict it. The natural sciences seek predictive theory, using quantitative laws and models to not only explain, but also to anticipate and control naturally occurring phenomena. Finally design is based on a corpus of accumulated knowledge, which is captured in design practice rather than scientific facts but is nevertheless very effective.

Combining these approaches is a major challenge. We are exploring an integrative approach that we call generative theory, which builds upon existing knowledge in order to create new categories of artefacts and explore their characteristics. Our goal is to produce prototypes, research methods and software tools that facilitate the design, development and evaluation of interactive systems [2].

4. Application Domains

4.1. Application Domains

In Situ works actively with users from various application domains in order to understand their specific needs. By studying similar problems in different domains, we can begin to generalise our results. Our current application domains include:

- Biological research, in cooperation with the Institut Pasteur;
- Creative industries (music composition), in cooperation with IRCAM (Paris);
- Domestic technologies, in cooperation with France Telecom, Philips, KTH (Sweden), and the Royal College of Art (U.K.);
- Research Archives, in cooperation with the French National Archives and the Bibilothèque Nationale;
- Semantic Web data management, in cooperation with MIT and W3C;
- Desktop and Data Management, in cooperation with INRIA Rocquencourt, Ecole des Mines de Nantes, Université d'Orléans, ILOG S.A., Cosytec S.A., IntuiLab S.A. and CEA.

5. Software

5.1. The Núcleo toolkit

Keywords: *Multimedia, Rapid prototyping, Telecommunications, Toolkit, Video.*

Participant: Nicolas Roussel.

Núcleo, the latest version of VideoSpace [52]), is a software toolkit designed to help HCI and CSCW researchers to explore new uses of images and image streams within interactive systems. Núcleo supports both rapid prototyping and incremental development of video applications and is the basis for most of the video-based systems implemented by In Situ over the past few years, including: a web-based mediaspace, the Well, an informal video communication system,VideoProbe and MirrorSpace (see Fig. 1).

Núcleo provides developers with a set of tools and a C++ class library that makes is easy to integrate image streams within documents and applications. For example, users may display image streams in HTML documents in place of static images. The library makes it easy to create a video link with only a few lines of code, and managing mulitple sources and processing video is only slightly more complex. The source code compiles on Linux and Mac OS X and is freely available under the GNU Lesser General Public License (LGPL). For more information, see http://insitu.lri.fr/~roussel/projects/nucleo/

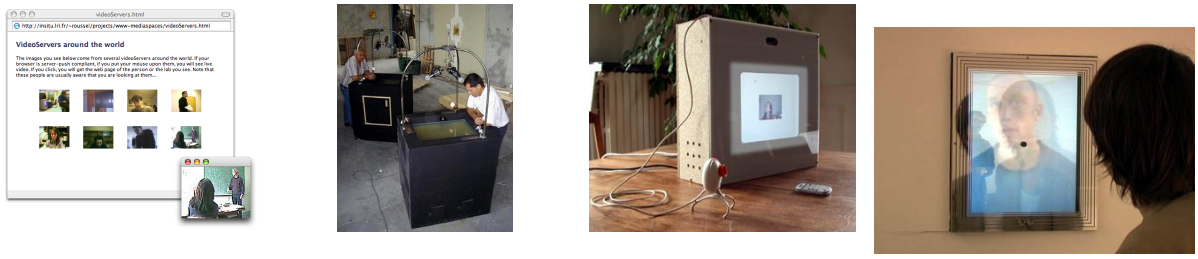

Figure 1. Sample Núcleo applications: a web-based mediaspace [54]; the well, an informal video communication system [53]; VideoProbe [39] and MirrorSpace[10].

5.2. wmtrace

Keywords: *Window management, activity log.*

Participant: Olivier Chapuis [correspondant].

wmtrace [21] includes two tools that help us the study of a user's window management activity. The first tool runs in the background of an X Window session and continuously logs information about windows and how they are being manipulated. The second tool uses a VCR-like interface (see Fig. 2) to replay the resulting logs and analyze the entire session. This tool provides several ways to filter the logs and extract high-level information, including interactive move events and mouse speed. Both tools allow HCI researchers to perform qualitative and quantitative statistical analyses of window management activity.

wmtrace is freely available under the GNU General Public License (GPL) and the CeCILL licence. The log recorder compiles and runs on any X Window system (e.g. Linux or FreeBSD). The log viewer is written in Java, and more or less platform independent. Both software can be downloaded from http://insitu.lri.fr/~chapuis/software/wmtrace/.

5.3. The Metisse window system

Keywords: *OpenGL, Window management, X Window, window system.*

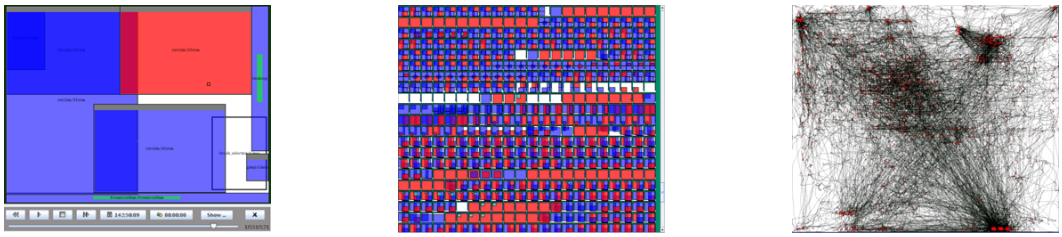

Figure 2. wmtrace: VCR-like interface; session overview; sample plot of mouse trajectories (black) and mouse clicks (red)

Participants: Olivier Chapuis [correspondant], Nicolas Roussel.

Metisse [22] is a window system that facilitates the design, implementation and evaluation of innovative window management techniques. The Metisse architecture is uses a compositing approach, making a clear distinction between rendering and the interactive compositing process. The Metisse server is a modified X server that can render application windows off-screen. The default compositor is a combination of a slightly modified version of a standard X window manager, FVWM, combined with an interactive viewer application called FvwmCompositor.

FvwmCompositor uses OpenGL to display windows. This library offers a rich graphics model well adapted to the exploration of new window management techniques. Texture mapping, for example, makes it possible to transform the window shapes in real-time (Fig. 3, left). Alpha blending makes it easy to create translucent objects and shadows. Scaling, rotation and translation can also be used to position windows in 2D$\frac{1}{2}$ or 3D (Fig. 3, middle and right).

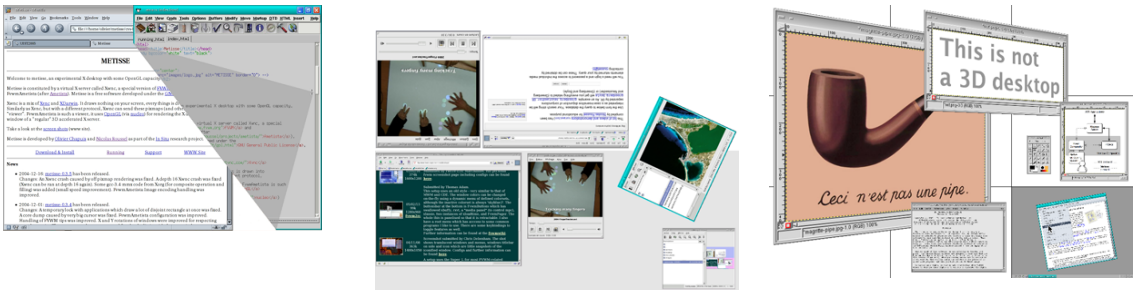

Figure 3. Sample window management techniques implemented with Metisse: extended paper metaphor (left), interactive table configuration that allows to duplicate and rotate windows (middle) and zoomable 3D desktop (right).

Metisse has been used by Mekensleep[1] to develop a multiplayer poker game called *Poker3D*. This application acts as a new compositor and uses the Metisse server to integrate an external chat application and 2D GTK+ interfaces into its OpenGL-based 3D scene (Fig. 4).

Metisse is implemented in C and C++. Its source code compiles on Linux and Mac OS X and is freely available under the GNU General Public License (GPL). We are currently working on the design of a standard

[1] http://www.mekensleep.com/

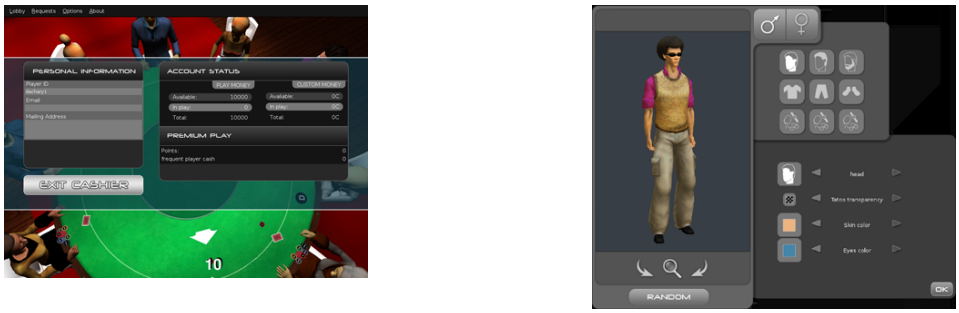

Figure 4. Poker3D as a Metisse compositor: windows containing GTK+ interface elements are rendered by the Metisse server and displayed by Poker3D on top of the 3D scene.

protocol and a client API that will make it easier to implement new compositors. For more information, see http://insitu.lri.fr/metisse/.

5.4. The Zoomable Visual Transformation Machine

Keywords: *Distortion Lenses, Graphical User Interface (GUI) Toolkit, Java, Structured Graphics Editors, Visual Programming Languages, Zoomable User Interface (ZUI).*

Participants: Eric Mounhem, Emmanuel Pietriga [correspondant].

Current Graphical User Interface toolkits like Java/Swing are powerful, generic and portable, but cannot be used for some application classes such as structured graphics editors (e.g. graph editors, development environments for visual programming languages, etc.). Programmers are required to use lower-level APIs such as Java2D which are more expressive but harder to use. The ZVTM is a Zoomable User Interface (ZUI) toolkit implemented in Java, aimed at promoting the development of the HCI aspects of such applications by making their implementation easier, while favoring the rapid integration of novel interaction techniques.

ZVTM provides application programmers with building blocks for implementing complex 2.5D (zoomable) interface components that cannot be handled by traditional WIMP widgets. Featuring off-the-shelf visualization and navigation components that are easy to combine, ZVTM provides a simple yet powerful API and handles low-level operations such as multi-threading, clipping, repaint requests and animation management. The toolkit is based on the metaphor of *universes* that can be observed through smart movable/zoomable cameras. The graphical object model permits management of a large number of complex geometrical shapes. It emphasizes perceptual continuity via an advanced animation module that can animate virtually any on-screen modification. This ranges from camera movements and distortion lens activation, to graphical objects' visual variables modifications. Various temporal pacing functions are available to control the execution of these animations.

Initially developed by Xerox Research Centre Europe and the World Wide Web Consortium (W3C) team at MIT, ZVTM is open-source (LGPL) since early 2002. It is used in both academic and industrial projects such as IsaViz (http://www.w3.org/2001/11/IsaViz/), W3C's visual browser/editor for RDF (Figure 5 - left), RDQLPlus (http://rdqlplus.sourceforge.net/), or ZGRViewer (http://zvtm.sourceforge.net/zgrviewer.html) for viewing large graphs generated by AT&T GraphViz[2] (Figure 5 - middle). The toolkit's development is now supported by INRIA.

More information can be found at http://zvtm.sourceforge.net and [9]

[2] http://www.graphviz.org

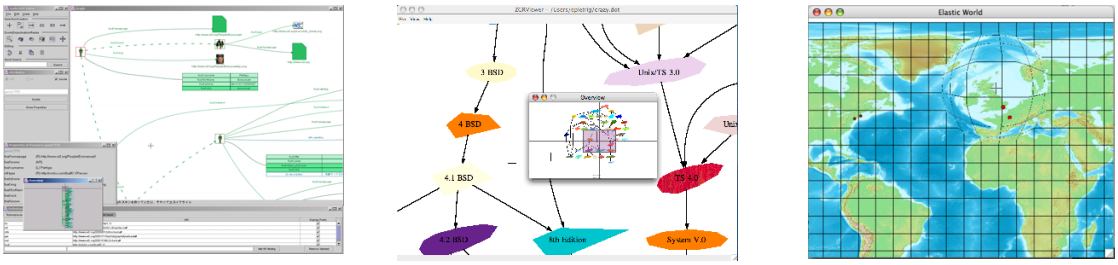

Figure 5. ZVTM used in various applications

5.5. IsaViz - A Visual Authoring Tool for RDF

Keywords: *Java, RDF, Semantic Web, Visual Graph Authoring Tool.*

Participant: Emmanuel Pietriga [correspondant].

IsaViz [49] is a visual authoring tool for RDF [56] designed and distributed by the World Wide Web Consortium (W3C). RDF models are graphs whose textual serializations in RDF/XML or other triple-oriented formats are not user-friendly, partly because they fail to convey the models' graph structure. IsaViz generates editable visual representations as zoomable 2D graphs which are often easier to understand.

IsaViz is also used as a testbed for experimenting with new methods and vocabularies for presenting RDF data. IsaViz features a rendering engine capable of interpreting Graph Stylesheets (GSS [50]). As shown in Figure 6, IsaViz provides a visual debugger for FSL path expressions as part of the undergoing effort to implement a Fresnel interpretor in IsaViz (see section 6.6).

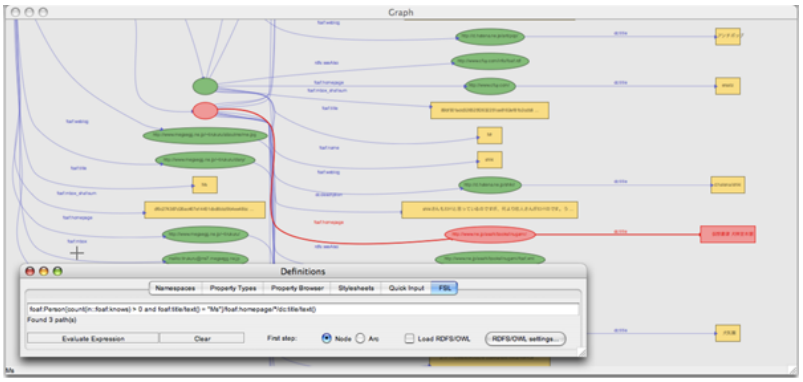

Figure 6. FSL Visual Debugger in IsaViz

5.6. The InfoVis Toolkit

Keywords: *Information Visualization, Java, Toolkit.*

Participant: Jean-Daniel Fekete.

The InfoVis Toolkit is an Interactive Graphics Toolkit written in Java to facilitate the development of Information Visualization applications and components.

The main characteristics of the InfoVis Toolkit are:

Unified data structure The base data structure is a table of columns. Columns contain objects of homogeneous types, such as integers or strings. Trees and Graphs are derived from Tables.

Small memory footprint Using homogeneous columns instead of compound types dramatically improves the memory required to store large tables, trees or graphs, and in general the time to manage them.

Unified set of interactive components Interactive filtering (a.k.a. dynamic queries) can be performed with the same control objects and components regardless of the data structure, simplifying the reuse of existing components and the design of generic ones.

Fast the InfoVis Toolkit can use accelerated graphics provided by Agile2D[3], an implementation of Java2D based on the OpenGL API for hardware accelerated graphics [41]. On machine with hardware acceleration, some visualizations redisplay 100 times faster than with the standard Java2D implementation.

Extensible the InfoVis Toolkit is meant to incorporate new information visualization techniques and is distributed with the full source and a very liberal license. It can be used for student projects, research projects or commercial products.

The InfoVis Toolkit, as of version 0.9, implements nine types of visualization (Fig. 7): Time Series, Scatter Plots, Parallel Coordinates and Matrices for tables, Node-Link diagrams, Icicle trees and Treemaps for trees, Adjacency Matrices and Node-Link diagrams (with several layouts) for graphs.

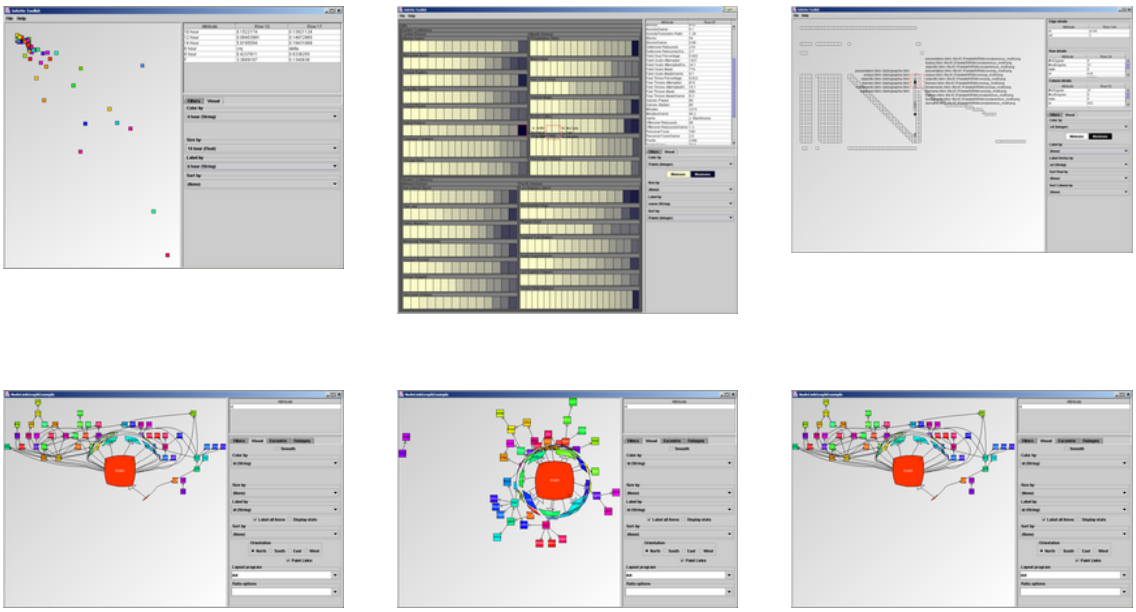

Figure 7. Several visualizations produced using the Infovis Toolkit

The InfoVis toolkit is used for teaching the Information Visualization course (Masters level, Paris-Sud University) and is the basis for several In Situ contracts, e.g., Micromégas (see section 7.3). InfoVis is the foundation for the visualization component of several forthcoming ANR projects that will begin in January.

More information can be found at http://insitu.lri.fr/~fekete/InfovisToolkit or [5] [40]

[3] http://www.cs.umd.edu/hcil/agile2d

5.7. The Hierarchical State Machine Toolkit

Keywords: *Advanced Interaction Techniques, Hierarchical State Machines, Instrumental Interaction, Post-WIMP Interaction, Software Architecture*.

Participant: Renaud Blanch [correspondant].

Programming languages provide little support for programming interactions and traditional toolkits provide little support for creative graphic design, making it difficult to develop interactive programs that support advanced interaction techniques. The Hierarchical State Machine Toolkit (HsmTk) focuses on the development of rich interactions, helping programmers as well as interaction and graphic designers. HsmTk features a new control structure that makes interactions first class objects by extending C++ with hierarchical state machines. The use of Scalable Vector Graphics (SVG) as the graphic language enables graphic designers to specify high-quality interfaces. Together, these features enable a tight coupling between graphic and interaction design by designers and software development by programmers. See http://insitu.lri.fr/~blanch/projects/Hsm/Hsm.html or [20], [12] for more information.

5.8. Tcl Wiki Server

Keywords: *Computer-Supported Cooperative Work, Wiki*.

Participant: Michel Beaudouin-Lafon [correspondant].

A wiki server is a web server that allows authorized visitors to create and edit the pages directly from within their web browser, turning anyone into a potential author. The Tcl Wiki server was created in 1998 with two main goals in mind: simplicity and openness. The simplicity comes from a carefully designed syntax for editing the contents of the pages and a minimal user interface to navigate the site. Every version of every page is archived; concurrent edits are merged when possible and flagged as conflicts otherwise. The openness of the system makes it easy for advanced users to customize the rendering of pages and to create new page types. For example, bibliography pages contain BibTeX entries and format them automatically.

The Tcl Wiki server is written entirely in Tcl and runs on any platform without requiring a Web server. The version running at LRI (Université Paris-Sud) has been in use for the past 5 years and has about 40 active sites. It is available for free at http://wiki.lri.fr/wiki/download.wiki under an Open Source licence.

More information can be found at http://wiki.lri.fr/wiki.

6. New Results

6.1. Tools for Post-WIMP interaction

Keywords: *Advanced Interaction Techniques, Hierarchical State Machines, Instrumental Interaction, Software Architecture*.

Participants: Michel Beaudouin-Lafon [correspondant], Renaud Blanch, Jean-René Courtois, Jean-Daniel Fekete.

The INDIGO project, funded by the national RNTL program, was to design, develop and validate a distributed software architecture for the development of a new generation of interactive systems characterized by the following requirements:

- visualize and interact with complex and dynamic information;
- adapt to a large range of platforms and input devices;
- support real-time cooperative work.

The INDIGO software architecture is based on a high-level communication protocol between Conceptual Objects (CO) servers and Rendering and Interaction (RI) servers. This architecture is similar to that of the popular X Window System, with the important difference that the RI servers implement higher-level models for displaying data and interacting with it than the X Server, and CO servers manage interaction and visualization at a higher level of abstraction than X clients. The project ended in June of 2005. We have finalized the demonstrators, including an RI server that uses Web Services to communicate with the CO server developed by ILOG. Rendering uses the fast SVG (Scalable Vector Graphics) renderer called SVGL developed by the project. An air-traffic control application was developed by CENA using our tools to validate the approach. The INDIGO architecture was presented at the annual IHM conference [20].

6.2. Evaluation and Optimization of Pointing and Interaction Techniques

Keywords: *Fitts' law*, *Interaction Technique*.

Participants: Caroline Appert, Michel Beaudouin-Lafon [correspondant], Renaud Blanch, Olivier Chapuis, Yangzhou Du, Jean-Daniel Fekete, Wendy Mackay.

Graphical user interfaces (GUIs) are based on a small set of interaction techniques, which rely heavily on two elementary actions: pointing a target on the screen, e.g. an icon or button, and navigating to a non-visible part of the information space, e.g. by scrolling or zooming.

We are working on improving pointing and navigation performance in GUIs. Indeed, the performance of pointing on a screen is similar to that of pointing in the physical world, and it should be possible to take advantage of the computing power to get a significant advantage when pointing in an information world. The major theoretical tool to study pointing performance is Fitts' law [43][6], which defines the movement time as an affine function of the index of difficulty (ID), defined as the log of the ratio between target distance and target width. In other words, pointing performance strictly depends on the relative size of the target to the distance to the target. Our approach is based on the concept of *multiscale interface* where objects can be represented at different levels of scale in order to combine an overview of the document and details of its parts [6].

We have developed OrthoZoom Scroller [17], a novel multiscale interaction technique to improve target acquisition in very large one-dimensional spaces. The OrthoZoom Scroller requires only a mouse to perform panning and zooming into a 1D space. Panning is performed along the scrolling dimension while zooming is performed along the orthogonal one. We conducted a controlled experiment to compare OrthoZoom Scroller with the only other multi-scale technique requiring only a mouse, Speed Dependant Automatic Zooming [46]. The results show that OrthoZoom Scroller is about twice as fast as Speed Dependant Automatic Zooming to perform pointing tasks whose index of difficulty is in the 10-30 bits range. We have also developed an application to browse large textual documents to show how OrthoZoom Scroller is usable and useful in situ.

We have also started to explore *perspective pointing and navigation* in the context of the MicroMegas project. Document navigation in standard graphical user interfaces can be described through the metaphor of a user-controlled video-camera flying over a planar surface. While traditional GUIs have exploited only translating and zooming this camera, we have started to explore the design space that opens up when camera tilting is allowed. An ecological optics analysis leads us to the conclusion that the current GUI is similar to a flight simulator that deprives the pilot of one kind of information critically needed to control navigation, namely, prospective visual information [34].

We have shown with a controlled experiment that a perspective visualization of the document improves both performance and user satisfaction. However one problem with perspective viewing is that the visualization scale implodes at some critical viewing distance. We have shown mathematically and empirically that perspective pointing and navigation collapses for targets located too far, when the ID is beyond 15, and we have started to develop techniques to avoid this barrier.

Finally we are continuing our work on *semantic pointing* [4], which takes advantage of the relative scale of motor space to display space in order to facilitate pointing. An improved version of semantic pointing uses not only the cursor position but also its speed and acceleration to control the motor scale. We have also started to

capture and study the actual use of pointing devices *in situ* in order to make our techniques more effective in real contexts of use.

6.3. Information Visualization

Keywords: *Information Visualization, Toolkit.*

Participants: Jean-Daniel Fekete [correspondant], Fabrice Haüy, Nathalie Henry, Jean-Christophe Latsis.

Our research on Information Visualization is organized around three main topics: infrastructure, evaluation and applications.

6.3.1. Infrastructure

Creating new information visualization techniques using traditional GUI toolkits is long and difficult. We have designed a new toolkit that allows us to experiment with new techniques in a much simpler a general way than before: the Infovis Toolkit (see section 5.6).

The InfoVis Toolkit [5] is designed to support the creation, extension and integration of advanced 2D Information Visualization components into interactive Java Swing applications. The InfoVis Toolkit provides specific data structures to achieve a fast action/feedback loop required by dynamic queries. It comes with a large set of components such as range sliders and tailored control panels to control and configure the visualizations. Supported data structures currently include tables, trees and graphs. Supported visualizations include scatter plots, time series, Treemaps, node-link diagrams for trees and graphs and adjacency matrix for graphs. All visualizations can use fisheye lenses and dynamic labeling. The InfoVis Toolkit supports hardware acceleration when used with Agile2D, an OpenGL-based implementation of the Java Graphics API resulting in speedup factors of 10 to 200.

We are currently exploring new techniques for the visualization of large graphs (for constraint-based programs, large social networks, software engineering), time-based data, exploration and management of familiar datasets. We are also exploring new interaction techniques to filter large datasets since existing techniques do not scale well.

See http://insitu.lri.fr/~fekete/InfovisToolkit and [5] [40] for more details.

6.3.2. Evaluation

Evaluation of Information Visualization tools is currently a challenge [42], [51]. Traditional evaluation in HCI has been focusing on measuring performance (speed, error rate) for well specified tasks. In contrast, Information Visualization is about getting insights from data. Measuring the number or quality of insights is difficult and not well understood.

To address this problem, we have been actively working in three different directions: organizing workshop to gather experience and principles from researchers, co-organizing the Information Visualization Contest[4] to establish benchmarks for Information Visualization[5], and developping a framework to help evaluating Information Visualization using the InfoVis Toolkit.

A new collaboration on this topic has also been initiated with brazilian researchers from the Federal University of Rio Grande do Sul and PUC-Rio University (see section 8.3).

6.3.3. Applications

Information Visualization should be validated on real applications. We are currently applying our tools and concepts to three main domains: software engineering, social networks and digital libraries.

In the software engineering domain, we have designed and implemented a set of visualizations to help understand and optimize Constraint Programming languages [44] in the OADymPPaC project. We have also investigated visualizations to help understand test generation systems [47]. We are currently applying the InfoVis Toolkit for profiling programs.

[4] http://www.cs.umd.edu/hcil/iv04contest
[5] http://www.cs.umd.edu/hcil/InfovisRepository

In the social networks domain, we are starting to work on exploratory visualization. Current studies in social networks suppose the user knows the nature of the network he wants to explore and the list of transformations and layouts that best suit his needs. This is usually not true and tools are very weak at helping users understand the nature of their networks and the meaningful transformations they could perform to get insights. This work has begun in 2004 with the arrival of Nathalie Henry in the Project. She is co-advised by Jean-Daniel Fekete and Peter Eades from the University of Sydney and NICTA, Australia.

We have been focusing on the use of the matrix representation to explore large graphs, following-up with our work on using matrices for constraint-based programming. Matrices present challenging problems, both interactively and mathematically. We are designing an interactive system to help users navigate and interact with large matrices. We are also preparing a survey on methods to reorder matrices, whether from graphs of from tabular data.

In the digital Library domain, we are applying information visualization to show the structure and facilitate the navigation in manuscript corpora [45] (see 7.5).

6.4. Home technologies

Keywords: *Multimedia, Telecommunications, Video.*

Participants: Michel Beaudouin-Lafon, Sofiane Gueddana, Jean-Baptiste Labrune, Wendy Mackay [correspondant], Nicolas Masson, Emmanuel Nars, Yann Riche, Nicolas Roussel.

Computers have become smaller and less expensive, enabling us to transfer technology originally designed for the workplace into the home. But home environments provide new challenges, both methodologically and in terms of design. We need new methods of working with users, to find previously unidentified needs and desires, and new measures of effectiveness, since productivity and efficiency are no longer relevant. We have embarked on several new projects this year, studying different groups of people, including families, the elderly and children. We are particularly interested in communication among small, intimate groups, enabling participants to “stay in touch” with each other without explicit action, such as dialing a phone or sending an email message.

The interLiving [7] project identified two key concepts for supporting intra-family communication: Communication Appliances and FamilyNet. Communication appliances are defined as single-function, simple-to-use devices that enable small groups of people to share various types of data (text, images, video, sound), either synchronously or asynchronously. We have begun a new participatory design project, called PeerCare [Yann workshop publication], in which we are working with elderly widows to provide technology that helps them stay in touch, ensuring each others’ safety while avoiding a “Big Brother”style of monitoring. We have also been exploring vision techniques for enhancing interaction with the MirrorSpace [10] and ran an experiment comparing object-tracking and movement tracking that will be published at CHI’06. We are also beginning a new project with France Télécom R&D to design communication appliances and other interactive systems for the home environment (see section 7.1). A third project explores technology for children, both communication appliances and other technologies. Fig. 8 shows the MagicWand, with a video camera and an orientation sensor, that allows children to create multiple, overlapping images of themselves by moving the wand. The Tangicam [25] is a circular frame that allows children to capture video as they look through the frame, and then use the same device as a circular slider to view images on a DiamondTouch desktop.

The other key technology is FamilyNet / Circa which separate network management from the exchange of data. FamilyNet concentrates on non-technical users, using RFID-tagged cards as a tangible interface for manipulating small group membership. Based on public-key encryption, FamilyNet provides a simple, secure method for non-technical users to create and manage groups. We have completed an experiment to test the FamilyNet [35] (as a follow-on to our earlier field studies), and we presented the system at SOUPS’05 [27]. Circa [48] concentrates on the underlying architecture, providing an on-line interface that enables users to easily create and manage small groups and exchange data. Circa also provides tools for developers of communication appliances, allowing them to concentrate on the user interface.

Figure 8. MagicWand, Tangicam recording images, Tangicam displaying and manipulating images.

6.5. Desktop and familiar data management

Participants: Olivier Chapuis, Jean-Daniel Fekete, Matthieu Langet, Nicolas Roussel [correspondant], Aurélien Tabard.

As part of the Micromégas project, we are currently developing new methodologies and tools to better understand how users manage their documents and applications and to design new metaphors or interaction techniques to facilitate these tasks.

wmtrace [21] (section 5.2), for example, was developed to log and analyze the interactions between a user and an X Window system. Metisse [22], [32] (section 5.3) provides a highly tailorable framework for exploring new window management techniques. These two systems are fully compliant with existing X Window protocols for window management, such as ICCCM and EWMH. This makes it possible to use them on a daily basis, with traditional applications such as GIMP, OpenOffice, Mozilla or the GNOME and KDE suites. In addition to wmtrace, we have also developed a set of tools to monitor user interactions with other software components of the Linux and OS X platforms. Interactions with the file system, the printers or Web activity, for example, can be recorded for later analysis. We are currently investigating ways in which these logs could be used to take advantage of the episodic memory of the user to retrieve a particular data or context [33].

Together with Catherine Letondal (from Pasteur Institute), we are exploring ways to enhance the biologists' daily use of the Web for information retrieval and analysis. Biologists typically retrieve gene and protein sequences from Web databases and analyze them using Web application portals. Unfortunately, the Web pages providing data rarely offer links to the tools required for their analysis, and traditional history and bookmarks mechanisms provide insufficient support for frequent revisits [55]. These navigation problems are not specific to biologists but of a more general concern. The human mind operates by association, connecting items into a web of trails [38]. But navigation tools such as web browsers take little advantage of these trails. Observations and interviews of biologists led us to the design of *Pagelinker* [36], a Firefox extension that allows users to create contextual links between Web pages (Fig. 9). We are now exploring further uses of this notion of user-defined contextual links.

6.6. End User Interaction with Semantic Web Data

Keywords: *Information Visualization*, *RDF*, *Semantic Web*, *Structured data representation*.

Participant: Emmanuel Pietriga [correspondant].

The Semantic Web aims at extending the current Web with information that is "given well-defined meaning, better enabling computers and people to work in cooperation" [37]. Software agents are the primary consumers of Semantic Web content. RDF [56], the foundational framework for describing information in the Semantic Web, is thus designed to facilitate machine interpretability of information and does not define a visual

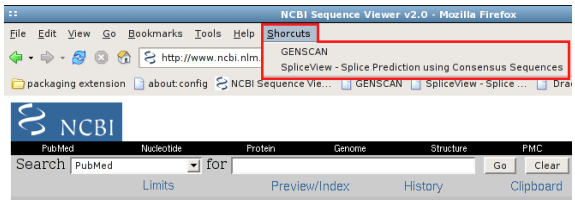

Figure 9. PageLinker.

presentation model since human readability is not one of its stated goals. However, RDF applications are not only about the semantic processing of information. Information coming from the Semantic Web, either directly from RDF repositories or as a result of complex processes, often must be presented to users. We are exploring the problem of displaying RDF data in a user-friendly manner through the development of visualization applications based on state-of-the-art interaction techniques, as well as through the specification of new languages for describing Semantic Web data presentation knowledge.

Recognizing the general need for presenting RDF content to users and wanting to promote the exchange of presentation knowledge across applications, we are developing Fresnel [19] as a application-independent, extensible, vocabulary of core RDF display concepts. The core modules of Fresnel are designed to be relevant accross representation paradigms (node-link diagrams, nested box layouts, table-like layouts, GUIs using specialized widgets, etc.), exploiting the fact that all applications displaying Semantic Web content to users are confronted with the same two issues, independently of the underlying representation paradigm and interface capabilities: selecting what content to show and specifying how to format and style this content. This work is a community-based effort conducted in collaboration with members of projects Simile and Haystack at MIT/W3C (see section 8.3). Two draft specifications, Fresnel[6] and FSL[7] are under development and participants are working on various implementations of these for their own Semantic Web browsers and visualization applications. FSL also serves as the basis of our collaboration with LRI's BioInformatics team on the design of an extended path language for navigating in RDF graphs (XPR, [23]).

One of these applications is IsaViz (see section 5.5), a visual RDF authoring tool representing RDF models as node-link diagrams, based on ZVTM (see section 5.4) and featuring interaction techniques for navigating in large graphs. Initially developed by W3C and Xerox Research Centre Europe, work on IsaViz is now supported by In Situ, as new interaction techniques for visualizing and editing RDF models are being experimented with.

6.7. iMuseum - The Museum of Interaction

Keywords: *Interaction Techniques, Museum, Web.*

Participants: Caroline Appert, Michel Beaudouin-Lafon, Jean-René Courtois, Wendy Mackay [correspondant], Emmanuel Pietriga.

Researchers and designers of interactive systems face a common problem: unlike like other design fields (architecture, industrial design, graphic design), we have no shared repository of interactive systems. We have no easy way of reviewing the history of our field nor analysing 'best practices'. We have no easy way of showing students examples of specific interaction techniques, nor can we easily compare them. Interactive systems are, by their very nature, dynamic and interactive, requiring a dynamic and interactive medium to present them. The Interaction Museum is a project funded byt the Convivio European Network of Excellence that will create an on-line resource aimed at HCI practitioners, teachers and researchers by collecting a wide variety of interaction techniques and systems and making them available to the HCI community. Users will be

[6] http://www.w3.org/2005/04/fresnel-info/manual/
[7] http://www.w3.org/2005/04/fresnel-info/fsl/

able to browse the entries in the museum using various navigation tools, while interactive exhibits will provide predefined thematic paths through the museum.

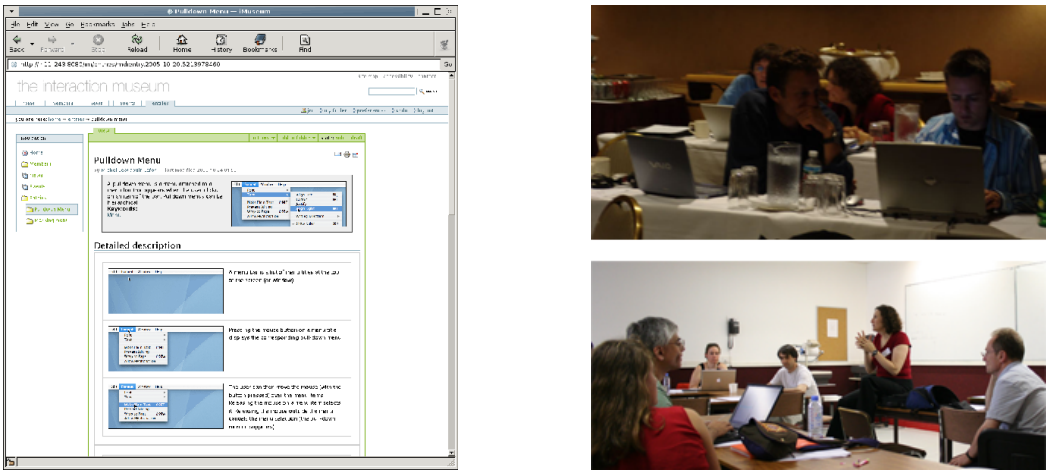

Figure 10. iMuseum Web site

During the first year, we ran two symposia, one in Paris in June and one in Seattle in October, that gathered senior members of the community. In the Paris Symposium, we created a number of scenarii of users of the museum and video prototypes describing how the system could be used for a variety of tasks. In the Seattle Symposium, we had researchers in the field create entries for the museum describing some of their research. In parallel, we developed a first version of the Web server that will be used to browse the museum as well as create and edit entries. The goal is to officially open the museum at the end of the second year, after having collected a significant amount of initial material and streamlined the user interface for navigating the museum and creating entries and exhibits.

7. Contracts and Grants with Industry

7.1. Experimental communication systems for the home environment

Participants: Sofiane Gueddana, Nicolas Roussel [correspondant].

Research project funded by France Télécom R&D, 36 months (2005-2008).

The goal of this project is to design innovative communication systems for the home environment. In this context, we are particularly interested in supporting smooth transitions between alternative forms of communication involving different media combination.

7.2. iMuseum - The Museum of Interaction

Participants: Caroline Appert, Michel Beaudouin-Lafon, Jean-René Courtois, Wendy Mackay [correspondant], Emmanuel Pietriga.

Project funded by the Convivio European Network of Excellence, 24 months (2004-2005).

The Interaction Museum is an on-line resource aimed at HCI practitioners, teachers and researchers that will collect a wide variety of interaction techniques and systems and make them available to the HCI community.

7.3. Micromégas

Participants: Michel Beaudouin-Lafon, Olivier Chapuis, Jean-Daniel Fekete, Matthieu Langet, Wendy Mackay, Nicolas Roussel [correspondant].

Research project funded by the French ACI on *Data Masses*, 36 months (2003-2006). Partners: LMP (Marseille, coordinator), In Situ, MErLIn (INRIA, Rocquencourt) and Institut Pasteur (Paris).

The goal of the Micromégas project is to design and prototype new interactive systems for managing large data sets. The project focuses on multi-scale interaction with familiar data: personal or professional data that users have somehow manipulated (e.g. created, received or downloaded).

7.4. INDIGO (Interactive Distributed Graphical Objects)

Participants: Michel Beaudouin-Lafon [correspondant], Renaud Blanch, Jean-René Courtois, Jean-Daniel Fekete.

Research project funded by national network on software technology (RNTL), 36 months (2001-2005). Partners: LRI / In Situ (coordinator), ILOG (Gentilly), CENA (Toulouse), W3C (Sophia-Antipolis).

The INDIGO project aims at designing and prototyping a new generation of tools to enable the development of highly interactive distributed graphical applications.

7.5. French ACI Archiving and Preservation

Participants: Pascal Costa-Cunha, Jean-Daniel Fekete [correspondant], Fabrice Haüy, Wendy Mackay.

Two contracts aimed at digitizing and supporting manuscripts for literary and historical purposes: “Collaborative annotation for online manuscripts” (ACLAM) and “Archeology of Administrative Knowledge” (Millefeuille). The ACLAM project is led by INRIA with two partners: the French National Library (BnF[8]) and the Institute of Modern Textes (ITEM[9]). The Millefeuille project is led by the French “École nationale des Chartes” with the French Archives, INRIA, Univ. Sorbonne-Paris I and Univ. Paris X, as partners.

8. Other Grants and Activities

8.1. National actions

- Jean-Daniel Fekete is member of the Scientific Committee of the the French ANR for the *Data Masses* program
- Jean-Daniel Fekete is co-responsible of the Working Group: Tools and Formalisms for HCI (ALF) with Eric Lecolinet
- Jean-Daniel Fekete is a member of the directing committee of the French GDR I3

8.2. European actions

- *Convivio*. Members of In Situ involved: Wendy Mackay.

[8] http://www.bnf.fr
[9] http://www.item.ens.fr

8.3. International actions

- *Fresnel: modeling presentation knowledge for the display of Semantic Web data*. This work is a community-based effort initiated in the context of MIT project Simile[10] and involves: INRIA project In Situ, MIT DIG (Decentralized Information Group), MIT project Haystack, MIT Libraries, Freie Universität Berlin, and W3C. Members of In Situ involved: Emmanuel Pietriga. See section 6.6 for more details.
- *EDGE: Evaluation methods, Design Guidelines and Environments for Virtual Reality and Information Visualization Techniques*. This project is a french-brazilian collaboration supported by INRIA and CNPq (36 months, 2005-2008). The partners are MErLIn (INRIA), the CS Institute of the Federal University of Rio Grande do Sul and the CS Department of PUC-Rio University. Members of In Situ involved: Nicolas Roussel (coordinator of the french side) and Jean-Daniel Fekete.
- *Navigation and Visualization of Large Social Networks*. Nathalie Henry is preparing a joint PhD (co-tutelle) with the University of Sidney, Information Visualization Research Group (Australia). Members of In Situ involved: Nathalie Henry and Jean-Daniel Fekete (advisor).
- *Designing Communication Appliances for the Elderly*. Yann Riche is preparing a joint PhD (co-tutelle) with the University of Queensland, Interaction Design Research Laboratory (Australia). Members of In Situ involved: Yann Riche and Wendy Mackay (advisor).
- *Evaluation of Information Visualization*. Jean-Daniel Fekete and Catherine Plaisant of the University of Maryland are gathering resources to improve the evaluation techniques used in the domain of Information Visualization. They have initiated an international contest, taking place every year during the IEEE Symposium on Information Visualization. They gather and maintain the benchmarks and results on an open web site at http://www.cs.umd.edu/hcil/InfovisRepository.

9. Dissemination

9.1. Keynote addresses and Invited Lectures

- University of Aarhus, Denmark, January 2005: Michel Beaudouin-Lafon, Wendy Mackay
- ILOG Corporation, France, February 2005: Wendy Mackay
- Xerox Research Centre Europe, France, March 2005: Wendy Mackay, Emmanuel Pietriga
- OFTA (Observatoire Français des Techniques Avancées), France, June 2005: Wendy Mackay
- Oséo anwar IdF, France, October 2005: Wendy Mackay

9.2. Journal editorial board

- ACM Transactions on Computer-Human Interaction (TOCHI): Wendy Mackay (Associate Editor)
- CSCW Journal: Michel Beaudouin-Lafon (Advisory Board)
- Human Computer Interaction (HCI) Special Issue on Awareness Systems: Wendy Mackay (Co-Editor)
- International Journal of Human-Computer Study (IJHCS): Wendy Mackay (Co-Editor in Chief), Michel Beaudouin-Lafon, Jean-Daniel Fekete (Associate Editors)
- Revue d'Interaction Homme-Machine (RIHM): Michel Beaudouin-Lafon, Wendy Mackay
- Revue Information-Interaction-Intelligence (Revue I3): Michel Beaudouin-Lafon

[10] http://simile.mit.edu

9.3. Journal reviewing

- CSCW Journal: Michel Beaudouin-Lafon
- Human Computer Interaction: Wendy Mackay
- International Journal on Universal Access in the Information Society: Emmanuel Pietriga
- Revue Information-Interaction-Intelligence (Revue I3): Michel Beaudouin-Lafon
- Technique et Science Informatique (TSI): Michel Beaudouin-Lafon
- Information Visualization Journal, Palgrave Macmillan: Jean-Daniel Fekete
- Document Numérique, Hermès, France: Jean-Daniel Fekete

9.4. Conference organization

- ACM CHI 2005, Portland, USA: Wendy Mackay, Michel Beaudouin-Lafon (Associate Chairs)
- ACM Multimedia 2005, Singapore: Nicolas Roussel (Program Committee member)
- ACM UIST 2006, Montreux, Switzerland: Nicolas Roussel (Demonstration Co-Chair)
- Critical Computing Conference 2005, Aarhus, Denmark: Wendy Mackay (Associate Chair)
- ECSCW 2005 (European Conference on Computer-Supported Work), Paris, France: Wendy Mackay, Michel Beaudouin-Lafon (Co-Chairs), Nicolas Roussel (Demonstration and Video Chair)
- IEEE International Conference on Multimedia & Expo 2005, Amsterdam, The Netherlands: Nicolas Roussel (Program Committee member)
- IEEE Symposium on Visual Languages and Human-Centric Computing 2006, Brighton, UK: Emmanuel Pietriga (Program Committee member)
- IEEE Symposium on Visual Languages and Human-Centric Computing 2005, Dallas, USA: Emmanuel Pietriga (Program Committee member)
- UbiMob 2005 (Ubiquité et Mobilité), Nice, France: Wendy Mackay (Co-Chair)
- CRIWG 2005, 11th International Workshop on Groupware, Porto de Galinhas: Nicolas Roussel (Program Committee member)
- CHI 2005 Workshop on Awareness Systems, Portland, USA: Wendy Mackay (Co-Chair)
- Interact 2005 Doctoral Consortium, Rome, Italy: Wendy Mackay (Jury member)
- Interaction Museum Symposium I, Paris, France: Michel Beaudouin-Lafon, Wendy Mackay, Emmanuel Pietriga (co-organizers)
- Interaction Museum Symposium II, Seattle, USA: Michel Beaudouin-Lafon, Wendy Mackay, Emmanuel Pietriga (co-organizers)
- IEEE Symposium on Information Visualization 2005: Jean-Daniel Fekete (Program Committee member)
- Graph Drawing 2005: Jean-Daniel Fekete (Program Committee member)

9.5. Conference reviewing

- ACM CHI 2006, Montreal, Canada: Michel Beaudouin-Lafon, Jean-Daniel Fekete, Wendy Mackay, Nicolas Roussel, Caroline Appert, Renaud Blanch
- ACM CHI 2005, Portland, USA: Michel Beaudouin-Lafon, Wendy Mackay, Renaud Blanch, Jean-Daniel Fekete
- ACM UIST 2005, Seattle, USA: Michel Beaudouin-Lafon, Wendy Mackay, Nicolas Roussel, Emmanuel Pietriga, Jean-Daniel Fekete
- ACM Multimedia 2005, Singapore: Nicolas Roussel
- Critical Computing Conference 2005, Aarhus, Denmark: Wendy Mackay
- ECSCW 2005 (European Conference on Computer-Supported Work), Paris, France: Michel Beaudouin-Lafon, Wendy Mackay, Nicolas Roussel
- IFIP International Conference on Human-Computer Interaction (INTERACT) 2005, Rome, Italy: Michel Beaudouin-Lafon, Wendy Mackay
- IEEE International Conference on Multimedia & Expo 2005, Amsterdam, The Netherlands: Nicolas Roussel
- IEEE Symposium on Visual Languages and Human-Centric Computing 2006, Brighton, UK: Emmanuel Pietriga
- IEEE Symposium on Visual Languages and Human-Centric Computing 2005, Dallas, USA: Emmanuel Pietriga
- Conférence Francophone d'Interaction Homme-Machine (IHM) 2005, Toulouse, France: Michel Beaudouin-Lafon, Renaud Blanch, Jean-Daniel Fekete, Emmanuel Pietriga, Nicolas Roussel
- CRIWG 2005, 11th International Workshop on Groupware, Porto de Galinhas, Brasil: Nicolas Roussel
- International Forum Less Is More, Cambridge, UK: Michel Beaudouin-Lafon
- IEEE Symposium on Information Visualization 2005: Jean-Daniel Fekete
- Graph Drawing 2005: Jean-Daniel Fekete, Nathalie Henry

9.6. Scientific associations

- AFIHM (French speaking HCI asssociation): Michel Beaudouin-Lafon, Jean-Daniel Fekete, Executive Committee members
- ACM: Michel Beaudouin-Lafon member at large of the ACM Council and member of the ACM Publications Board

9.7. Evaluation committees and invited expertise

- RNTL program (ANR, National Research Agency): Michel Beaudouin-Lafon, member of the evaluation committee since 2000
- MDD program (ANR, National Research Agency): Jean-Daniel Fekete, member of the evaluation committee since 2005
- Hasler Foundation, Switzerland: Nicolas Roussel, referee for the 2005 *Man-Machine Interaction* program
- French Cooperation between Brasilian and French Universities (COFECUB): Nicolas Roussel, referee
- LIRMM, Montpellier: Michel Beaudouin-Lafon, member of the evaluation committee
- LIG, Grenoble: Michel Beaudouin-Lafon, member of the evaluation committee
- IRCAM, Paris: Michel Beaudouin-Lafon, member of the scientific committee
- LIP6, Paris: Jean-Daniel Fekete, member of the evaluation committee
- OFTA (Observatoire Français des Techniques Avancées): Wendy Mackay, member of Groupe Informatique Diffuse
- TAICHI FP6 Project, Wales, U.K. (FET-Open Coordination Action): Wendy Mackay, reviewer

9.8. PhD defenses

- Tue Haste Andersen (DIKU, Copenhague), Ph.D. Thesis "Interacting with sound and pre-recorded music: novel interfaces and use patterns": Michel Beaudouin-Lafon, reviewer
- Renaud Blanch (Université Paris-Sud), Ph.D. Thesis "Architecture logicielle et outils pour les interfaces hommes-machines graphiques avancées": Michel Beaudouin-Lafon, adviser
- Jean-Daniel Fekete (INRIA Futurs, Saclay), HDR "Nouvelle génération d'Interfaces Homme-Machine pour mieux agir et mieux comprendre": Michel Beaudouin-Lafon, jury member
- Thomas Riisgaard Hansen, (University of Aarhus, Denmark), Ph.D. mid-term exam : Wendy Mackay
- Roland Parviainen (Luleå University of Technology, Sweden), Ph.D. Thesis "Large scale and mobile group communication systems": Nicolas Roussel, *faculty oponent*
- Zhong-Yi Quck (ESA, Ecole Spéciale d'Architecture in Paris) Diplôme d'Architecture Thesis "Augmented Architecture" : Wendy Mackay, jury member
- Gaëtan Rey (CLIPS-IMAG), Ph.D. Thesis "Contexte et interaction homme-machine : le contexteur": Michel Beaudouin-Lafon, reviewer
- Nguyen-Thong Dang (Ecole Pratique des Hautes Etudes, EuroControl) Ph.D. Thesis: "A Stereoscopic 3D Visualisation Environment for Air Traffic Control, An Analysis of Interaction and a Proposal of New Interaction Techniques": Wendy Mackay, jury member

10. Bibliography

Major publications by the team in recent years

[1] C. APPERT, M. BEAUDOUIN-LAFON, W. MACKAY. *Context Matters: Evaluating Interaction Techniques with the CIS Model*, in "People and Computers XVIII - Design for Life - Proceedings of HCI 2004, Leeds, UK", Springer Verlag, September 2004, p. 279-295, http://insitu.lri.fr/~appert/caro_fichiers/CIS_HCI04.pdf.

[2] M. BEAUDOUIN-LAFON. *Designing interaction, not interfaces*, in "Proc. Conference on Advanced Visual Interfaces, AVI 2004, Gallipoli (Italy)", Invited keynote address, ACM Press, May 2004, p. 15–22, http://doi.acm.org/10.1145/989863.989865.

[3] M. BEAUDOUIN-LAFON, W. MACKAY. *Prototyping Development and Tools*, in "Human Computer Interaction Handbook", JULIE A. JACKO, A. SEARS (editors). , Lawrence Erlbaum Associates, 2002, p. 1006-1031, http://www.isrc.umbc.edu/HCIHandbook/.

[4] R. BLANCH, Y. GUIARD, M. BEAUDOUIN-LAFON. *Semantic Pointing: Improving Target Acquisition with Control-Display Ratio Adaptation*, in "Proceedings of ACM Conference on Human Factors in Computing Systems (CHI2004)", CHI Letters, vol. 6(1), ACM Press, April 2004, p. 519–526, http://doi.acm.org/10.1145/985692.985758.

[5] JEAN-DANIEL. FEKETE. *The InfoVis Toolkit*, in "Proceedings of the 10th IEEE Symposium on Information Visualization (InfoVis 04), Austin, TX", IEEE Press, October 2004, p. 167-174, http://www.lri.fr/~fekete/ps/ivtk-04.pdf.

[6] Y. GUIARD, M. BEAUDOUIN-LAFON. *Target acquisition in multiscale electronic worlds*, in "International Journal of Human Computer Studies (IJHCS), Special Issue "Fitts' law fifty years later: Applications and contributions from human-computer interaction"", vol. 61, n° 6, December 2004, p. 875-905, http://dx.doi.org/10.1016/j.ijhcs.2004.09.005.

[7] H. HUTCHINSON, W. MACKAY, B. WESTERLUND, B. BEDERSON, A. DRUIN, C. PLAISANT, M. BEAUDOUIN-LAFON, S. CONVERSY, H. EVANS, H. HANSEN, N. ROUSSEL, B. EIDERBÄCK, S. LINDQUIST, Y. SUNDBLAD. *Technology Probes: Inspiring Design for and with Families*, in "Proceedings of ACM CHI 2003 Conference on Human Factors in Computing Systems", CHI Letters, vol. 5(1), ACM Press, 2003, p. 17-24, http://doi.acm.org/10.1145/642611.642616.

[8] W. MACKAY, C. LETONDAL, G. POTHIER, K. BØEGH, H. SØRENSEN. *The Missing Link: Augmenting Biology Laboratory Notebooks*, in "Proc. ACM Symposium on User Interface Software and Technology (UIST 2002), Paris, France", CHI Letters, vol. 4(2), ACM Press, October 2002, p. 41-50, http://doi.acm.org/10.1145/571985.571992.

[9] E. PIETRIGA. *A Toolkit for Addressing HCI Issues in Visual Language Environments*, in "IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'05)", September 2005, p. 145-152, http://doi.ieeecomputersociety.org/10.1109/VLHCC.2005.11.

[10] N. ROUSSEL, H. EVANS, H. HANSEN. *Proximity as an interface for video communication*, in "IEEE Multimedia", vol. 11, n° 3, July-September 2004, p. 12-16, http://doi.ieeecomputersociety.org/10.1109/MMUL.2004.15.

Books and Monographs

[11] H. GELLERSEN, K. SCHMIDT, M. BEAUDOUIN-LAFON, W. MACKAY (editors). *Proceedings of the 9th European Conference on Computer-Supported Cooperative Work (ECSCW'05)*, 490 pages, Springer, Paris, France, September 2005.

Doctoral dissertations and Habilitation theses

[12] R. BLANCH. *Architecture logicielle et outils pour les interfaces hommes-machines graphiques avancées*, 174 pages, Thèse de Doctorat, Université Paris-Sud, Orsay (France), Septembre 2005, http://insitu.lri.fr/~blanch/publications/these/.

[13] JEAN-DANIEL. FEKETE. *Nouvelle génération d'Interfaces Homme-Machine pour mieux agir et mieux comprendre*, 122 pages. Rapport de recherche LRI 1411, Présentation des travaux en vue de l'Habilitation à diriger des recherches, Université Paris-Sud, Orsay (France), May 2005, http://insitu.lri.fr/~fekete/ps/hdr.pdf.

Articles in refereed journals and book chapters

[14] M. BEAUDOUIN-LAFON. *Enjeux et perspectives en interaction homme-machine*, in "Paradigmes et enjeux de l'informatique", N. BIDOIT, L. F. DEL CERRO, S. FDIDA, B. VALLÉE (editors). , 2005, p. 197-201.

[15] M. GHONIEM, JEAN-DANIEL. FEKETE, P. CASTAGLIOLA. *Readability of Graphs Using Node-Link and Matrix-Based Representations: Controlled Experiment and Statistical Analysis*, in "Information Visualization Journal", vol. 4, n° 2, 2005, p. 114–135.

[16] C. LETONDAL. *Participatory Programming: Developing programmable bioinformatics tools for end-users*, in "End-User Development", H. LIEBERMAN, F. PATERNO, V. WULF (editors). , chap. 10, Kluwer Academic, 2005.

Publications in Conferences and Workshops

[17] C. APPERT, JEAN-DANIEL. FEKETE. *OrthoZoom Scroller: 1D Multi-Scale Navigation*, in "Proceedings of ACM CHI 2006 Conference on Human Factors and Computing Systems", to appear, ACM Press, April 2006.

[18] O. BEAUDOUX, M. BEAUDOUIN-LAFON. *OpenDPI : A Toolkit for Developing Document-centered Environments*, in "Proc. 7th International Conference on Enterprise Information Systems (ICEIS'2005)", 2005.

[19] C. BIZER, R. LEE, E. PIETRIGA. *Fresnel - A Browser-Independent Presentation Vocabulary for RDF*, in "Second International Workshop on Interaction Design and the Semantic Web", October 2005, http://www.ifi.unizh.ch/ddis/313.0.html.

[20] R. BLANCH, S. CONVERSY, T. BAUDEL, Y. P. ZHAO, Y. JESTIN, M. BEAUDOUIN-LAFON. *INDIGO: une architecture pour la conception d'applications graphiques interactives distribuées*, in "Actes des dix-septièmes journées francophones sur l'Interaction Homme-Machine (IHM 2005)", 2005, p. 139-146, http://insitu.lri.fr/~blanch/publications/ihm2005/.

[21] O. CHAPUIS. *Gestion des fenêtres : enregistrement et visualisation de l'interaction*, in "Proceedings of

IHM 2005, 17ème conférence francophone sur l'Interaction Homme-Machine", ACM Press, International Conference Proceedings Series, Septembre 2005, p. 255-258.

[22] O. CHAPUIS, N. ROUSSEL. *Metisse is not a 3D desktop!*, in "Proceedings of UIST'05, the 18th ACM Symposium on User Interface Software and Technology", ACM Press, October 2005, p. 13-22, http://doi.acm.org/10.1145/1095034.1095038.

[23] S. COHEN-BOULAKIA, C. FROIDEVAUX, E. PIETRIGA. *Selecting Biological Data Sources and Tools with XPR, a Path Language for RDF*, in "Pacific Symposium on Biocomputing (PSB), Maui, Hawaii.", to appear, January 2006, http://helix-web.stanford.edu/psb06/#semantic.

[24] M. GHONIEM, H. CAMBAZARD, JEAN-DANIEL. FEKETE, N. JUSSIEN. *Peeking in Solver Strategies Using Explanations Visualization of Dynamic Graphs for Constraint Programming*, in "Proceedings of the ACM Symposium of Software Visualization (SoftVis'05)", ACM Press, May 2005, p. 27–36, http://doi.acm.org/10.1145/1056018.1056022.

[25] JEAN-BAPTISTE. LABRUNE, W. MACKAY. *Tangicam: Exploring observation tools for children*, in "IDC 2005 (Interaction Design and Children), Boulder, CO, US", 2005.

[26] W. MACKAY, Y. RICHE, JEAN-BAPTISTE. LABRUNE. *Communication Appliances: Shared Awareness for Intimate Social Networks*, in "ACM SIGCHI 2005 Workshop on Awareness Systems: Known results, theory, concepts and future challenges, Portland, OR, US", 2005.

[27] W. MACKAY, M. BEAUDOUIN-LAFON. *FamilyNet: A Tangible Interface for Managing Intimate Social Networks*, in "Proceedings of SOUPS'05, Symposium On Usable Privacy and Security", ACM Press, July 2005, http://cups.cs.cmu.edu/soups/2005/2005posters/24-mackay.pdf.

[28] W. MACKAY, M. BEAUDOUIN-LAFON. *Generative approaches to simplicity in design*, in "International Forum: Less is More - Simple Computing in an Age of Complexity, Cambridge (UK)", april 2005.

[29] E. NARS. *Visualisation multi-échelles pour photos personnelles*, in "Proceedings of IHM 2005, 17ème conférence francophone sur l'Interaction Homme-Machine", ACM Press, International Conference Proceedings Series, Septembre 2005, p. 259-262, http://insitu.lri.fr/~nars/publications/Circa_photos.pdf.

[30] E. PIETRIGA. *A Toolkit for Addressing HCI Issues in Visual Language Environments*, in "IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'05)", September 2005, p. 145-152, http://doi.ieeecomputersociety.org/10.1109/VLHCC.2005.11.

[31] Y. RICHE, W. MACKAY. *PeerCare : Challenging the monitoring approach to care for the elderly*, in "British HCI 2005 Workshop on HCI and the Older Population, Edinburg, UK", 2005.

[32] N. ROUSSEL, O. CHAPUIS. *Metisse : un système de fenêtrage hautement configurable et utilisable au quotidien*, in "Proceedings of IHM 2005, 17ème conférence francophone sur l'Interaction Homme-Machine", ACM Press, International Conference Proceedings Series, Septembre 2005, p. 279-282, http://insitu.lri.fr/~roussel/publications/IHM05-metisse.pdf.

[33] N. ROUSSEL, JEAN-DANIEL. FEKETE, M. LANGET. *Vers l'utilisation de la mémoire épisodique pour la*

gestion de données familières, in "Proceedings of IHM 2005, 17ème conférence francophone sur l'Interaction Homme-Machine", ACM Press, International Conference Proceedings Series, Septembre 2005, p. 247-250, http://insitu.lri.fr/~roussel/publications/IHM05-micromegas.pdf.

Internal Reports

[34] Y. GUIARD, O. CHAPUIS, Y. DU, M. BEAUDOUIN-LAFON. *Navigation 3D pour explorer une vaste surface 2D : les promesses de la vue en perspective*, 28 pages, Rapport de Recherche, n° 1413, LRI, Université Paris-Sud, France, Juin 2005, http://www.lri.fr/Rapports-internes/2005/RR1413.pdf.

Miscellaneous

[35] N. MASSON. *Conception et évaluation des communication appliances*, 76 pages, Rapport de stage de Master, ENST Bretagne, Septembre 2005.

[36] A. TABARD. *Conception d'un navigateur web spécifique pour la bio-informatique*, 67 pages, Rapport de stage de Master, Université Pierre et Marie Curie, Paris 6, Septembre 2005.

Bibliography in notes

[37] T. BERNERS-LEE, J. HENDLER, O. LASSILA. *The Semantic Web*, in "Scientific American", may 2001.

[38] V. BUSH. *As we may think*, in "Atlantic Monthly", vol. 176, n° 1, June 1945, p. 101-108, http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm.

[39] S. CONVERSY, N. ROUSSEL, H. HANSEN, H. EVANS, M. BEAUDOUIN-LAFON, W. MACKAY. *Partager les images de la vie quotidienne et familiale avec videoProbe*, in "Proceedings of IHM 2003, 15ème conférence sur l'Interaction Homme-Machine", ACM Press, International Conference Proceedings Series, Novembre 2003, p. 228-231, http://doi.acm.org/10.1145/1063669.1063704.

[40] JEAN-DANIEL. FEKETE. *La boîte à outils InfoVis*, in "Proceedings of IHM 2004, Namur, Belgium", International Conference Proceedings Series, ACM Press, September 2004, p. 69-76.

[41] JEAN-DANIEL. FEKETE, C. PLAISANT. *Interactive Information Visualization of a Million Items*, in "Proc. IEEE Symposium on Information Visualization 2002 (InfoVis 2002), Boston, USA", IEEE Press, October 2002, p. 117-124.

[42] JEAN-DANIEL. FEKETE, C. PLAISANT. *Les leçons tirées des deux compétitions de visualisation d'information*, in "Proceedings of IHM 2004, Namur, Belgium", International Conference Proceedings Series, ACM Press, September 2004, p. 7-12.

[43] P. FITTS. *The Information Capacity of the Human Motor System in Controlling the Amplitude of Movement*, in "Journal of Experimental Psychology", vol. 47, 1954, p. 381–391.

[44] M. GHONIEM, N. JUSSIEN, JEAN-DANIEL. FEKETE. *VISEXP: visualizing constraint solver dynamics using explanations*, in "Proc. of the 17th International Conference of the Florida Artificial Intelligence Research Society (FLAIRS 2004)", AAAI Press, May 2004.

[45] F. HAÜY. *Navigation au sein d'un corpus de manuscrits*, Rapport de stage de DEA, Technical report, Université Paris-Sud, Orsay, France, September 2004.

[46] T. IGARASHI, K. HINCKLEY. *Speed-dependent automatic zooming for browsing large documents*, in "UIST '00: Proceedings of the 13th annual ACM symposium on User interface software and technology, New York, NY, USA", ACM Press, 2000, p. 139–148.

[47] JEAN-CHRISTOPHE. LATSIS. *Visualisation interactive de graphes pour l'aide au test de programme*, Rapport de stage de DEA, Technical report, Université Paris-Sud, Orsay, France, September 2004.

[48] E. NARS. *A group communication infrastructure*, in "NordiCHI '04: Proceedings of the third Nordic conference on Human-computer interaction", ACM Press, November 2004, p. 429–432, http://doi.acm.org/10.1145/1028014.1028087.

[49] E. PIETRIGA. *IsaViz: a Visual Environment for Browsing and Authoring RDF Models*, May 2002, http://www2002.org/devday.html, WWW 2002 - The 11th World Wide Web Conference (Developer's day), Honolulu, Hawaii, USA.

[50] E. PIETRIGA. *Styling RDF Graphs with GSS*, in "XML.com", December 2003, http://www.xml.com/pub/a/2003/12/03/gss.html.

[51] C. PLAISANT. *The challenge of information visualization evaluation*, in "AVI '04: Proceedings of the working conference on Advanced visual interfaces", ACM Press, 2004, p. 109–116.

[52] N. ROUSSEL. *Exploring new uses of video with videoSpace*, in "Proceedings of EHCI'01, the 8th IFIP International Conference on Engineering for Human-Computer Interaction", MURRAY REED. LITTLE, L. NIGAY (editors). , Lecture Notes in Computer Science, vol. 2254, Springer, 2001, p. 73-90, http://springerlink.com/link.asp?id=mev6gnypq9cvana3.

[53] N. ROUSSEL. *Experiences in the design of the well, a group communication device for teleconviviality*, in "Proceedings of ACM Multimedia 2002", ACM Press, December 2002, p. 146-152, http://doi.acm.org/10.1145/641007.641036.

[54] N. ROUSSEL. *Mediascape: a Web-based Mediaspace*, in "IEEE Multimedia", vol. 6, n° 2, April-June 1999, p. 64-74, http://doi.ieeecomputersociety.org/10.1109/MMUL.1999.10007.

[55] L. TAUSCHER, S. GREENBERG. *How people revisit web pages: empirical findings and implications for the design of history systems*, in "International Journal of Human Computer Studies (IJHCS)", vol. 47, n° 1, 1997, p. 97-137, http://dx.doi.org/10.1006/ijhc.1997.0125.

[56] W3C. *RDF (Resource Description Framework)*, October 2005, http://www.w3.org/RDF/.