INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team in-situ

Interaction Située

Futurs

THEME COG

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1. Team

In Situ is a collaborative project between INRIA (unité Futurs) and the Laboratoire de Recherche en Informatique of the University Paris-Sud within the framework of the PCRI (Pôle Commun de Recherche en Informatique).

Head of project-team
Wendy Mackay [DR, INRIA]

Research scientists
Michel Beaudouin-Lafon [Professor, Université Paris-Sud]
Olivier Chapuis [CR, CNRS]
Jean-Daniel Fekete [CR1, INRIA]
Emmanuel Pietriga [CR2, INRIA]
Nicolas Roussel [Assistant Professor, Université Paris-Sud]

Administrative assistant
Gina Grisvard [TR, INRIA]

Project Staff
Jean-René Courtois [Ingénieur d'Etudes CDD, Université Paris-Sud]
Fabrice Haüy [Ingénieur expert, INRIA]
Mathieu Langet [Ingénieur d'études CDD, CNRS]
Jean-Christophe Latsis [Ingénieur Expert, INRIA]

Ph. D. students
Olivier Beaudoux [ESEO Teacher, Angers]
Renaud Blanch [ATER, Université Paris-Sud]
Caroline Appert [Allocataire de recherche MENRT, Université Paris-Sud]
Pascal Costa-Cunha [Allocataire de recherche MENRT, INRIA]
Emmanuel Nars [Allocataire de recherche MENRT, Université Paris-Sud]
Jérôme Lard [Thalès Research & Technology, CIFRE]
Jean-Baptiste Labrune [Allocataire de recherche MENRT, INRIA]
Nathalie Henry [Allocataire de recherche MENRT, INRIA]
Yann Riche [Allocataire de recherche MENRT, INRIA]
Michaël Guérin [2Minutes, CIFRE]

Research scientists (partner)
Catherine Letondal [Ingénieur, Institut Pasteur]
Yves Guiard [DR CNRS, Université de la Méditerranée]

2. Overall Objectives

In Situ is a collaborative project between INRIA (unité Futurs) and the Laboratoire de Recherche en Informatique of the University Paris-Sud within the framework of the PCRI (Pôle Commun de Recherche en Informatique).

The In Situ project addresses the problem of how to create effective interactive systems, considering the role of context, both human and technical, as fundamental to the problem. Creating *situated interfaces*, i.e. interfaces that are adapted (or adaptable) to their contexts of use, takes advantage of the complementary features of humans and computers.

Our research is organized in three main themes:

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.

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 that implement, e.g. interaction techniques, may be added, removed or substituted dynamically.

However these themes are often intermixed in actual projects, which we see as indispensable in order to address real-world problems. More specifically, the In Situ project develops novel interaction techniques, new tools (in the form of toolkits) to develop these techniques and new methods to enhance the design process of interactive systems. 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.

3. Scientific Foundations

The In Situ project addresses the problem of how to create effective interactive systems, considering the role of context, both human and technical, as fundamental to the problem. Creating situated interfaces, i.e. interfaces that are adapted (or adaptable) to their contexts of use, takes advantage of the complementary features of humans and computers.

The research is organized along three main themes: new interaction paradigms, participatory design and engineering of interactive systems. However these themes are often intermixed in actual projects, which we see as indispensable in order to address real-world problems. More specifically, the In Situ project develops novel interaction techniques, new tools (in the form of toolkits) to develop these techniques and new methods to enhance the design process of interactive systems. 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.

Our group is multi-disciplinary, 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[21].

4. Application Domains

There are several potential application domains for In Situ. To validate our goals, we have selected domains with the following features:

- multiple validation criteria: increasing productivity, security or comfort;
- diverse users: professionals, specialists or non-professionals;
- diverse environments: classical desktops, non-standard (e.g. airplane cockpits) or mobile.

We have selected the following application domains:

Air traffic control in cooperation with the French Research Center of Air-Traffic Control (CENA) and EuroControl;

Biology and health in cooperation with Institut Pasteur;

Telecommunications and multimedia for families in cooperation with the University of Maryland, USA, the CID-KTH in Sweden (see the Interliving project), the Royal College of Art in London, England and France Telecom R&D, Thomson Multimedia and Philips.

Software Engineering in cooperation with INRIA Rocquencourt, École des Mines de Nantes, Universitée of Orleans, ILOG S.A., Cosytec S.A., IntuiLab S.A. and CEA.

5. Software

5.1. The Núcleo toolkit

Keywords: *C++*, *Toolkit*, *Video*.

Participant: Nicolas Roussel.

Núcleo (previously called VideoSpace) [57] is a software toolkit designed to facilitate the use of image streams to support such new forms of human-computer interaction and computer-supported collaborative activities. The motivation for this toolkit is the desire to focus on the *uses* of video, rather than the *technologies* it requires. In this perspective, it is not focused on performance or reliability issues, but rather on the ability to support rapid prototyping and incremental development of video applications. This approach contrasts with many of the research themes usually associated to video in the Multimedia or Network communities such as compression, transport or synchronization. Núcleo is not aimed at these topics. It is rather intended to help HCI and CSCW researchers who want to explore new uses of the images.

Núcleo is designed after Alan Kay's famous saying: "simple things should be simple, complex things should be possible". It provides users and developers with a set of basic tools and a C++ class library that make it easy to integrate image streams within existing or new documents and applications. The tools, for example, allow users to display image streams in HTML documents in place of ordinary static images (see Fig. 1) or to embed these streams into existing X Window applications. Creating a video link with the library requires only a few lines of code; managing multiple sources and including video processing is not much more complicated. Since the image streams managed by Núcleo often involve live video of people, the toolkit also provides a flexible mechanism that allows users to monitor and control access to their own image.

Source code for Núcleo 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/.

5.2. The Ametista toolkit and the Metisse Desktop

Keywords: *OpenGL*, *VNC*, *Window management*, *X Window system*, *application redirection*.

Participants: Olivier Chapuis [correspondant], Nicolas Roussel.

Ametista [59][58] is a mini-toolkit designed to facilitate the exploration of new window management techniques. The current implementation supports three types of windows, that can be freely mixed: *pseudo-windows* that are randomly-colored rectangles; *placeholders* that display a fixed image or a video stream and live windows of X Window applications, through a redirection mechanism. Pseudo-windows can be used for low-fidelity prototyping in the early stages of the exploration of a new window management technique. Placeholders help getting a better idea of the envisioned technique by displaying snapshots or movies of real applications. Finally, live X windows can be used for high-fidelity prototyping and evaluation of the technique.

Ametista uses OpenGL to display windows. This library offers a rich graphics model well adapted to the exploration of new window management techniques. Alpha blending, for example, makes it easy to

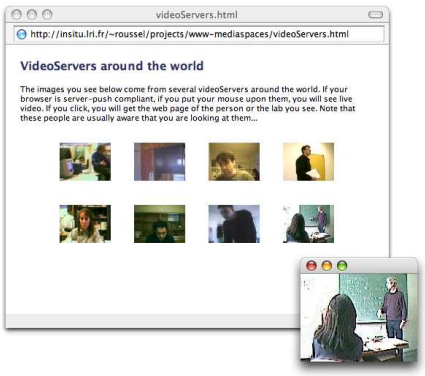

Figure 1. Custom client application and sample HTML document showing video images captured and transmitted in real-time by a Núcleo application

create translucent objects and shadows. Scaling, rotation and translation can also be used with a perspective projection to position windows in 2D$\frac{1}{2}$ or 3D (see Fig. 2, left and middle). Ametista makes an extensive use of texture mapping. Textures are used to display fixed images and video streams in placeholders as well as the content of X windows. They also make it possible to transform the window shapes in real-time (see Fig. 2, right).

Source code for Ametista 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/ametista/.

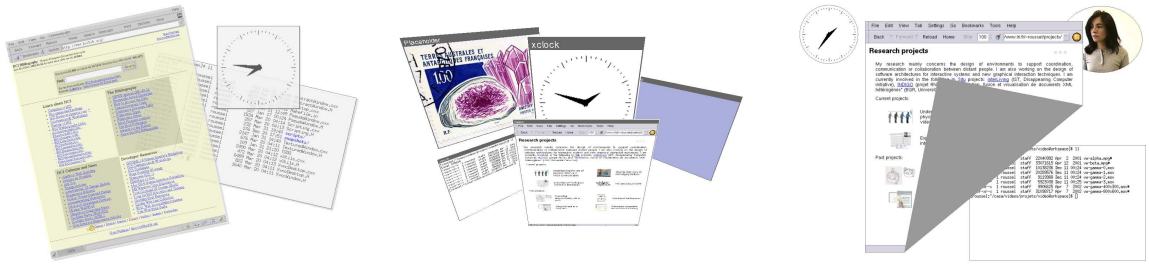

Figure 2. Examples of window image transformations achieved by using Ametista

Metisse is an experimental desktop that combines a virtual X server, a modified version of the FVWM window manager, and an FVWM module based on Ametista. Metisse can be used as a replacement for standard X desktop environments such as GNOME or KDE (see Fig. 3), allowing new window management techniques developed for Ametista to be used “for real”, on a daily basis.

Source code for Metisse compiles on Linux and Mac OS X and is freely available under the GNU General Public License (GPL). For more information, see http://insitu.lri.fr/~chapuis/metisse/.

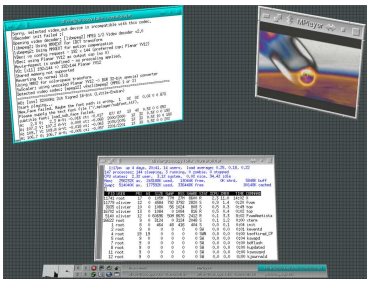

Figure 3. The Metisse desktop

5.3. The Zoomable Visual Transformation Machine

Keywords: *Graphical User Interface (GUI)*, *Java*, *Toolkit*, *Zoomable*.

Participant: Emmanuel Pietriga.

Current Graphical User Interface toolkits like Swing (Java) are powerful, generic and portable, but cannot be used for some application classes such as graph editors or development environments for visual programming languages. Programmers are required to use lower-level APIs such as Java2D which are more expressive but harder to use. The ZVTM[1] is a Zoomable User Interface (ZUI) toolkit implemented in Java, designed to ease the task of creating complex visual editors. It allows the programmer to focus on his task by providing a simple yet powerful API and handling 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. It can handle large amounts of complex geometrical shapes through its own graphical object model and puts the emphasis on perceptual continuity by providing an advanced animation module that can be used to animate virtually any on-screen modification, from camera movements or distortion lens activation to graphical objects' visual variables modifications using various temporal schemes.

The ZVTM is an open framework for experimenting with novel interaction techniques and their application to advanced visual editors, as shown in Figure 4. Implemented techniques include 2.5D user interfaces, superimposed translucent layers, distortion lenses, rate-based scrolling and speed-dependent automatic zooming. The addition of new techniques such as semantic pointing are planned as future work in the context of the research activity centered on advanced interaction techniques for the Semantic Web. 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 industial projects such as IsaViz (http://www.w3.org/2001/11/IsaViz/), W3C's visual browser/editor for RDF, Prawn [46] or RDQLPlus http://rdqlplus.sourceforge.net/. The toolkit's development is now supported by INRIA.

5.4. The InfoVis Toolkit

Keywords: *Information Visualization*, *Java*, *Toolkit*.

Participant: Jean-Daniel Fekete.

The InfoVis Toolkit is a Interactive Graphics Toolkit written in Java to ease 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.

[1] http://zvtm.sourceforge.net/

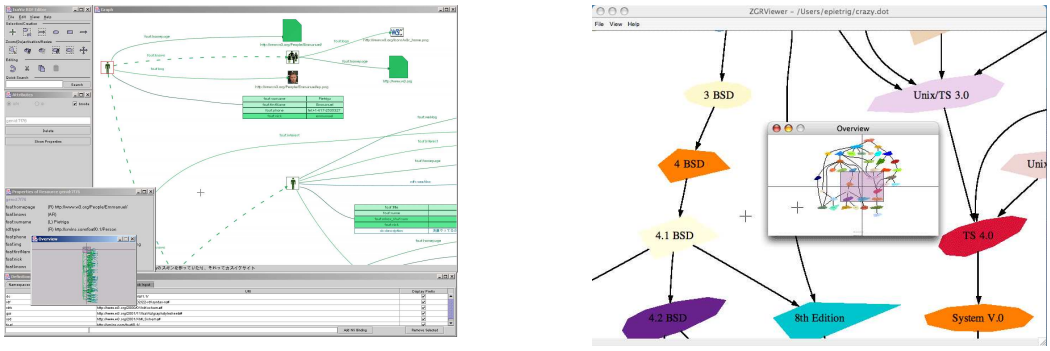

Figure 4. ZVTM in Action

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[2], an implementation of Java2D based on the OpenGL API for hardware accelerated graphics [50]. 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 0.7, implements eight types of visualization (Fig. 5): Time Series and Scatter Plots, Parallel Coordinates for tables, Node-Link diagrams, Icicle trees and Treemaps for trees, Adjacency Matrices and Node-Link diagrams (with several layouts) for graphs.

The toolkit is used for teaching Information Visualization (Masters at University of Paris-Sud). It is also used in several contracts of the group such as OADymPPaC, Micromegas (see section 7.3), ViPP 5.5 and ACLAM 7.4.

More information can be found at http://insitu.lri.fr/~fekete/InfovisToolkit or [28][27]

5.5. The Visual Perl Profiler

Keywords: *Information Visualization*, *Perl*, *Profiling*.

Participants: Jean-Daniel Fekete [correspondant], Jean-Christophe Latsis.

Industrial software development is difficult to optimize because it relies on a large number of software layers, developped by several companies using different methodologies and quality standards. The Visual Perl Profiler (ViPP) is a visualization system designed to explore visually the trace of a Perl program to understand its dynamic behavior.

ViPP extracts all its data from a profile produced by a Perl program and shows four views 6: the tree of all packages used in the program, the tree of function calls during the program execution, its aggregated version for more global inspection, and the function call graph as an adjacency matrix. All these visualization can be

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

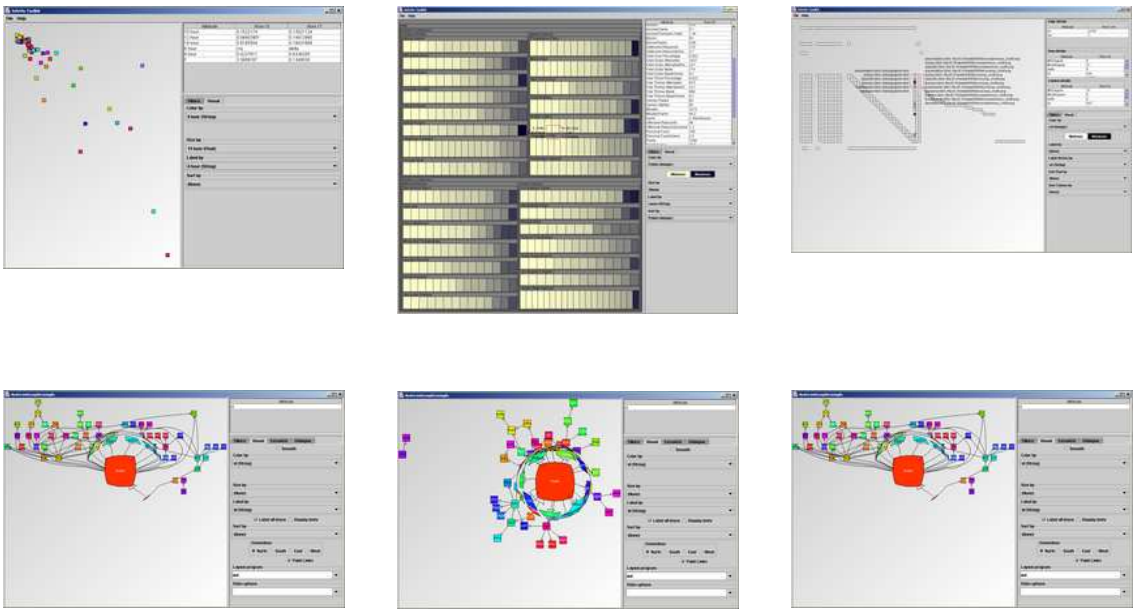

Figure 5. Several visualizations produced using the Infovis Toolkit

tailored to focus on several metrics. On the bottom view of the figure, the coloring depends on the time spent on each function. Ten small function calls take almost 10% of the time, which is unexpected and should be further explored.

ViPP is an example of program execution visualization developped quickly and effectively using the InfoVis Toolkit. It builds on the results of the OADymPPaC project (7.1) and is a starting point for designing generic trace visualizations for different categories of languages.

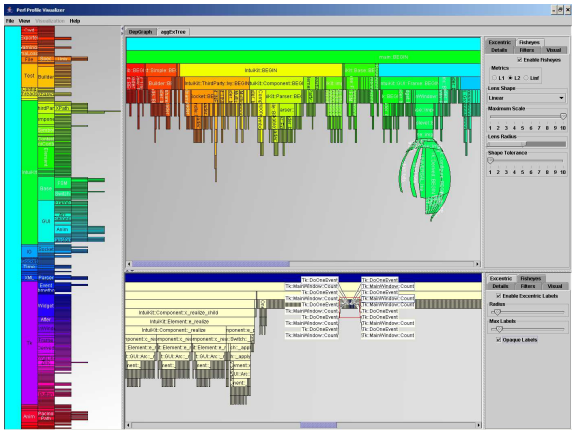

Figure 6. The Visual Perl Profiler showing the package tree on the left, the execution tree on the bottom and the aggregated execution tree on top.

ViPP is distributed with the InfoVis Toolkit at http://ivtk.sourceforge.net.

6. New Results

6.1. Tools for Post-WIMP interaction

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

Graphical user interfaces have not changed much since the creation of the Desktop metaphor twenty years ago. Compared with the growth of the computing power of desktop computers, desktop interfaces have been remarkably stable[21]. Interactive applications do not take advantage of new interaction paradigms or interaction techniques. All too often, novel interaction techniques are developed as prototypes and tested individually, while their adoption in real application requires studying their integration with other techniques. We are exploring new programming environment and systems able to quickly integrate new techniques and interaction paradigms as they are discovered. Our activity focuses on creating a new software architecture that will enable new interactive applications to profit from richer graphics and novel interaction paradigms without changing the non-interactive part of the application. We are coordinating the RNTL Indigo project with ILOG, the W3C and the CENA in Toulouse to create new mechanisms based on technologies standardized by the W3C for the infrastructure and from our experience in toolkits for the separation of application and their interaction and presentation. We have also just started to work on an "Interaction Museum", funded by the European Network of Excellence Convivio, to gather existing as well as future interaction techniques so as to make them more readily available to practitioners, researchers and students. This will complement our work on software tools and architectures by exposing the developers of interactive applications to novel techniques, therefore easing the transfer of research results to industry.

6.2. Evaluation and Optimization of Pointing and Interaction Techniques

Participants: Yves Guiard [correspondant], Michel Beaudouin-Lafon, Wendy Mackay, Renaud Blanch, Caroline Appert.

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 [51][13], 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.

We have explored a technique called *target expansion*[33] which grows the size of the target when the cursor is near it, and showed that the index of the difficulty of the task is that of the expanded target, even when expansion occurs when the cursor has traveled 90% of the distance to the target. However taking advantage of this property proves to be difficult because it requires a proper anticipation by the system of the target to be expanded. Indeed, expanding the wrong target impairs performance and goes against our primary goal.

We have developed two techniques that look for more promising. The first one is *semantic pointing* [22]. Semantic pointing uses two independent sizes for each potential target presented to the user: one size in motor space adapted to its importance for the manipulation, and one size in visual space adapted to the amount of information it conveys. This decoupling between visual and motor size is achieved by changing the control-to-display ratio according to cursor distance to nearby targets.

A target with a small visual size and a large motor size will display little information but will be easy to select, which makes it appropriate for, e.g., buttons or links in a Web Page. A target with a large visual size and a small motor size will display more information but will be hard to select, which is appropriate for non-interactive informative labels, for example. A controlled experiment has confirmed that the index of difficulty that best predicts pointing time is the one that uses the motor size rather than the visual size. A prototype application shows how this technique applies to standard GUIs, e.g. scrollbars, dialog boxes, menus and web pages.

The second technique is called *vector pointing*[34]. It can be seen as an extreme version of semantic pointing where the cursor jumps "empty" space and moves from target to target with very little mouse motion. We have shown with a control experiment that Fitts' law does not apply. Indeed, the pointing time of a single target with semantic pointing is constant! In a real application, the performance of vector pointing depends on the accuracy of the prediction of the target being aimed by the user and the influence of distractors. Work is ongoing to develop an application for testing vector pointing in a real setting.

We have also persued our work on multiscale navigation[17], i.e. navigation of an information world that can be zoomed in or out at any scale (also called Zoomable User Interface or ZUI). Following up on our work that showed that Fitts' law applies to tasks with an extremely high level of difficulty (30 or more, i.e. a ratio of 2^{30} between target size and target distance) we have developed a theoretical model to explain this result[33]. The model shows an effect of view size on multiscale navigation, which we successfully tested in a controlled experiment. We will continue this work in the context of the Micromegas project (see section 7.3) where we will develop ZUIs and study novel navigation techniques.

The complexity of an interaction technique for a given task, *i.e.* a given interaction sequence, measures the cost of the actions relative to the size of the task when using this interaction technique. The work on pointing and navigation studies the limit performance of human subjects in such tasks. However it is often difficult to observe such performance when the technique is used in the context of a real application. In order to better understand how interaction techniques behave in context, we are developing a model and associated tool to describe interaction techniques and predict their comparative performance for multiple tasks representative of different interaction contexts. The model, called CIS[20] (Complexity of Interaction Sequences) introduces the notion of complexity for interaction techniques. We have successfully tested the model by evaluating 3 interaction techniques (fixed palettes, bimanual palettes and toolglasses) and shown that the most efficient technique depends on the interaction context, confirming the results of one of our earlier studies [55]. We intend to develop CIS in several directions like improving predictions precision and automating the identification of best and worst contexts for an interaction technique.

6.3. Interactive paper

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

Most computer software for managing on-line documents assumes that all user interaction takes place via a keyboard, mouse and screen and that documents exist only in their on-line form. Yet users often write by hand and annotate printed documents, forcing them to juggle on-line and off-line versions. We are exploring the concept of "interactive paper", with the goal of better integrating physical and computer documents and allow users to take advantage of the best aspects of each.

We have been working for several years with research biologists at the Pasteur Institute, observing their use of laboratory notebooks[36] [47][53]. For both practical and legal reasons, lab notebooks must exist in a physical format, even though a large percentage of the information they contain may come from a computer. From a user's perspective, some information is best entered by hand as ink on paper, e.g. making annotations or quick sketches, whereas other information is best entered on a computer, e.g. generating a graph of the results of an experiment. We have collaboratively designed several prototypes that help biologists do both, maintaining a physical notebook while simultaneously generating an interactive, on-line version.

This year, we began working with a new technology, the Anoto pen[23], which allows us to capture the strokes as the user writes on ordinary paper. This provides an extremely light-weight method of obtaining a

copy of the hand-written parts of the notebook, which we can then provide a variety of on-line services. We developed a working prototype in collaboration with several biologists and plan to test it with them in 2004. Of particular interest is investigating how best to let the biologists create their own personal annotation systems, which they can then use to create personalized indexes, facilitate searching, and provide links to both physical and on-line objects.

In the past two months, we began two new projects in a related area, which involves working with historical manuscripts. For historians, the physical characteristics of these manuscripts are often as important as the information they contain. They need to interact with the actual physical object (often without touching it) while simultaneously entering information into a computer, for subsequent analysis. We are interested in exploring new techniques for linking physical and on-line documents, as well as providing novel methods of visualizing their contents. We are also working with archivists, who are interested in identifying and visualizing the evolution of related documents over time. We ran an initial workshop with historians and archivists in November, and will continue collaborating closely with them next year.

6.4. Information Visualization

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.

6.4.1. 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 5.4).

The InfoVis Toolkit[28] 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 [28][27] for more details.

6.4.2. Evaluation

Evaluation of Information Visualization tools is currently a challenge [29] [56]. 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[3] to establish benchmarks for Information Visualization[4], and developping a framework to help evaluating Information Visualization using the InfoVis Toolkit.

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

6.4.3. 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[32] in the OADymPPaC project (see 7.1). We have also investigated visualizations to help understand test generation systems[43]. We are currently applying the InfoVis Toolkit for profiling programs, such as Perl (see 5.5).

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 just begun 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.

In the digital Library domain, we are applying information visualization to show the structure and facilitate the navigation in manuscript corpora[41] (see 7.4).

6.5. Software support for group communication

Participants: Nicolas Roussel [correspondant], Emmanuel Nars.

Over the recent years, technology has played an increasing role in distant communication between people. The growing number of computer systems, combined with the increase of network speed allows us to exchange a variety of data such as text, sound, images or video, in both a synchronous or asynchronous way. However, many of the tools and protocols we use were initially designed for one-to-one communication and quickly show their limits when used for group communication. As an example, gathering pictures of a wedding from various sources via email, ftp or http and making them available on the Internet can be really cumbersome.

In the context of this work, we are mostly interested in group-based communication between close-knit groups of people. The close-knit relationships to which we refer are close to the concept of *intimate social network*. Knowing someone, working with that person or being part of the same family does not necessarily imply that kind of intimate relationship. Although intimate social networks are omnipresent in our daily life, they are very poorly supported by current communication systems.

We are currently developing Circa[38][37], a software infrastructure to support communication within intimate social networks. Circa was designed with two goals in mind: offering users a way to share and exchange data with small groups that they can easily create and manage and providing developers with tools allowing their applications to benefit from this infrastructure.

We are also exploring ways to combine Circa with other software infrastructures developed by colleagues from PUC-Rio University (Rio de Janeiro, Brazil). Common interests include support for user mobility as well as context-aware services, from both a user and a system perspective (i.e. services that depend on the user activity or on the computing resources available).

6.6. Interaction and design: using proximity as an interface to video-mediated communication

Participants: Nicolas Roussel, Helen Evans, Heiko Hansen.

One of the advantages of video over audio for mediated communication is the ability to transmit non-verbal information. Physical proximity between people is a language for non-verbal communication that we all employ everyday, although we are barely aware of it. Yet, existing systems for video-mediated communication fail to fully take into account these proxemics aspects of communication.

The MirrorSpace project[18][39] aims at creating an original personal video communication system that takes physical proximity into account. Whereas existing systems aim at creating a single shared space corresponding to a particular interpersonal distance, the goal of MirrorSpace is instead to create a continuum

of space that will allow a variety of interpersonal relationships to be expressed. Our work focuses on the understanding of how people's interactions can trigger smooth transitions between situations as extreme as general awareness of remote activity where anonymity is preserved to intimate situations where people can look into the eyes of a remote person.

MirrorSpace units (see Fig. 7) combine a digital camera, a flat screen and a proximity sensor. As we aim to support intimate forms of communication, it felt important to us that people could actually look into each other's eyes and possibly merge their portraits into one, so the camera was placed right in the middle of the screen. This setup allows participants to come very close to the camera while still being able to see the remote people and interact with them.

Figure 7. MirrorSpace installation at Mains d'Oeuvres

The proximity sensor that measures the distance to the closest object or person in front of it. This distance is used by MirrorSpace software to alter the remote images displayed, and possibly the local one. A blur filter is applied on the images to visually express a distance computed from the local and remote sensor values. Blurring distant objects and people in MirrorSpace allows one to perceive their movement or passing with a minimum involvement. It also offers a simple way of initiating or avoiding a change to a more engaged form of communication by simply moving closer or further away.

This work started as part of the interLiving project (IST/FET, Disappearing Computer initiative, 2000-2003). MirrorSpace was first exhibited in a public setting in February 2003, at *Jeune Création*, a contemporary art exhibition in Paris. It was then exhibited at *Mains d'Oeuvres* (Saint-Ouen) (May 2003), *Pas vu, pas pris* (July 2003) and at the Interactive Design exhibit in the Pompidou Center (Paris December 2003 - February 2004). It was also featured in two national newspapers : *Libération* (20 February, 2003) and *Les Echos* (15 December, 2004). See http://insitu.lri.fr/~roussel/projects/mirrorSpace/ for more details.

7. Contracts and Grants with Industry

7.1. French RNTL project OADymPPaC

Participant: Jean-Daniel Fekete.

The OADymPPaC project aims at providing tools for the dynamic analysis and debugging of constraint-based programs. It is funded by the RNTL French network. Partners include INRIA (from the Rocquencourt Contraintes project and Futurs IN-SITU project), Ecole des Mines de Nantes, University of Orleans, IRISA in Rennes, the ILOG company and the Cosytec company. The project started in 2000 and will end in 2004

Our role in the project is to provide tools for visualizing dynamically the execution of constraint-based programs. We have designed several tools to read a generic trace produced by constraint-based programs and translate it into generic and specific visualization components. Our current work is focused on visualizing large dynamic graphs that are built and maintained by constraint solvers. Two graphs are important: the

constraint/variable graph available on all solvers and the graph of "explanations" produced by recent solvers such as PaLM [52]. We designed the Infovis Toolkit[28] to help building appropriate tools for this project.

Instead of focusing on node-link diagrams for representing graphs, we are exploring the use of adjacency matrices to achieve higher graph density and real-time performances. We have investigated three directions: readability of adjacency matrices compared to node-link diagrams[30][31], clustering techniques to help aggregating large graphs and interaction techniques to explore the evolution of large graphs[32].

7.2. French RNTL project INDIGO

Participants: Michel Beaudouin-Lafon, Renaud Blanch, Jean-René Courtois, Jean-Daniel Fekete, Nicolas Roussel.

The goal of the INDIGO project is 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 more and more complex and dynamic information;
- adapt to a more and more divers set of platforms (mobile phone, PDA, PC, immersive VR, etc.) and input devices;
- support cooperative work, in particular real-time sharing and editing of information across multiple sites.

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 will implement higher-level models for displaying data and interacting with it than the X Server, and CO servers will therefore manage interaction and visualization at a higher level of abstraction than X clients. This has several advantages, including the following: a higher-level protocol requires less bandwidth, novel interaction techniques can be added to the IR servers transparently, CO servers can use multiple RI servers simultaneously to support collaborative work, and CO servers are independent from the end-user platform.

The partners of the project are In Situ (coordinator, RI server, protocol), the French company ILOG (CO server, protocol), the W3C (protocol) and CENA (requirements and sample applications), the French research center for air traffic control. In order to foster the adoption of the INDIGO architecture, the protocol will be publicly available and submitted to the W3C, and reference implementations of the servers will be available under an open source license.

Over the last 12 months, we have developed a second-generation RI server that uses Web Services to communicate with the CO server developed by ILOG. Rendering uses the fast SVG (Scalable Vector Graphics) rendered called SVGL, originally developed at LRI and now developed at CENA, and interaction is based on the instrumental interaction model [44] and implemented with Hierarchical State Machines [45]. The last phase of the project will develop of a full-scale demo application in the context of air traffic control.

7.3. French ACI on Data Masses project Micromegas

Participants: Yves Guiard, Nicolas Roussel, Wendy Mackay, Michel Beaudouin-Lafon, Olivier Chapuis, Jean-Daniel Fekete, Mathieu Langet.

Over the twenty years that elapsed since the Xerox Star, the first personal computer with a graphical user interface ever commercialized, the amount of information stored on our computers has been subject to a thousand-fold increase. The mass of electronic data we have nowadays at our disposal in both our professional and personal lives is such that the risk of being overwhelmed with information – even with the information we have stored ourselves – has become a serious concern.

Micromegas involves four teams that share their experience in the fields of human movement and cognition, human-computer interaction, information visualization, and multi-modal interaction: LMP in Marseille, In Situ and MerLIn at INRIA, and Institut Pasteur in Paris. One essential feature of our approach is an emphasis

on multi-scale interaction. Complexity, we believe, cannot be mastered by the human unless it can be tackled hierarchically: the information contained in a huge set of files or an electronic world atlas cannot be retrieved and utilized unless one can easily manipulate the level of granularity at which one wishes to interact with the data, from the most global level (a view of the subsuming folders, a general view of the planet) to the most local (the contents of a file, a detailed city map). The cognitive capabilities of humans, however, are too limited to encompass such a scope, and hence the challenge is to understand how they spontaneously vary the scale factor and, in the context of computerized information, to help them do so.

Micromegas deliberately focuses on the case of *familiar* data – both professional and personal – that have been stored by the users themselves, who not only save their own production but also collect external data. Thus, we are more concerned with personal hard disks than the Web. Still, we are facing huge data bases (on the order of several tens of gigabytes) whose size, which keeps on growing exponentially, makes the multi-scale approach compulsory.

The project is organized in three sub-projects, designed to foster collaboration between the participants and structure the research effort.

Sub-project 1 addresses the fundamental aspects of multiscale navigation. Through an experimental approach, it applies the principles of the ecological approach to visual perception from psychologist J.J. Gibson to design and evaluate novel navigation techniques for multiscale information worlds.

Sub-project 2 addresses visualization techniques. Many visualization techniques have been developed over the years, however few address the actual presentation of large data sets. In many cases, data is aggregated before being presented to the user. Such aggregation essentially supports a hierarchical view of the data, while we are interested in richer representations that support multiscale navigation, transformation between views, and efficient use of the display surface.

Sub-project 3 consists of two case studies. The first one covers management of personal file systems, a task facing almost every computer user and not well supported by current desktop interfaces. The second study covers the management of experimental data by biologists at the Institut Pasteur. Rather than focusing on the data used and produced by an experiment, it addresses the wider picture of sense-making that is part of the scientific process of designing, running and analyzing series of experiments.

The expected results of the project include fundamental results on multiscale visualization and navigation, practical tools to create multiscale interfaces, guidelines and recommendations to design multiscale applications, prototype systems for file management and laboratory notebooks, and, in general, a deeper understanding of how humans can take advantage of and interact with multiscale information worlds.

7.4. French ACI Archiving and Preservation

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

Manuscripts are special kinds of documents not well supported in the digital world. When considered as images, they cannot be used for full-text searching or indexing. When transcribed and used as textual documents, they loose all their graphic features. These features can be ever more important than the textual content. For example, laboratory notebooks contain more than text: formulas (mathematical, biological, chemical), references to experimental objects, photographs or results of printouts of various machines. Historical manuscripts can contain ornamented letters, diacritical marks, hard-to-read text portions or schemas. Literary manuscripts can be very complex graphically and convey an intimate relationship with the author lost in the textual form.

We are working on two contracts aimed at digitizing and supporting manuscripts for literary and historical purposes: “Collaborative annotation for online manuscripts” (ACLAM) and “Publishing ancient Ethiopian manuscripts” (Ethiopia). The ACLAM project is led by INRIA with two partners: the French National Library (BnF[5]) and the Institute of Modern Textes (ITEM[6]). The Ethiopia project is led by the French National Archives with INRIA, the Ethiopian ministry of culture and the British National Library as partners.

[5] http://www.bnf.fr
[6] http://www.item.ens.fr

For both projects, we will provide our expertise on augmented documents [54] and manuscripts [48][49].

For the ACLAM project, we have already designed a conceptual framework to structure manuscrit corpora into meaningful layers[24][14]. Based on this design, we have started to design and implement tools to help researchers in litterature and librarians. These tools include:

- an image viewer for reading manuscrits using Fisheyes lenses (http://www.lri.fr/~fekete/manuscript,
- a visual exploration system for finding concordances between transcribed manuscript folios http://www.lri.fr/~fekete/concordance/,
- an graphic editor to describe the structure of a manuscript corpora,
- a collaborative Web site to gather and enrich material around manuscript corpora.

To validate these tools and concepts, we have selected three corpora: the drafts manuscript of the "Trois comptes´´ of Gustave Flaubert; one of the "cahiers" of Marcel Proust and of of the "cahiers" of Paul Varéry. These corpora are being digitized by the National French Library (BnF) and are already transcribed by ITEM. These corpora will populate our collaborative Web site and researchers will enrich the digitized pages with navigation maps, encoded transcriptions and various studies related to the collections.

8. Other Grants and Activities

8.1. National actions

- Michel Beaudouin-Lafon is co-chair of the CNRS Thematic Network of Human-Computer Interaction (RTP16) representing around 200 researchers
- CNRS STIC: Action Spécifique "Plasticité des Interfaces": Michel Beaudouin-Lafon
- 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 committe of the French GDR I3
- Nicolas Roussel is co-chair of the HCI Working Group of Num@tec Automotive, a research consortium that brings together academic researchers from CEA, CNRS, INRIA, INRETS and Ecole des Mines de Paris with major players of the French automotive industry (both manufacturers and suppliers)

8.2. European actions

- UID-Net: Catherine Letondal
- Convivio: Wendy Mackay
- 6th Framework Multi-modal program reviewer: Wendy Mackay

9. Dissemination

9.1. Academic service

9.1.1. Journal editorial board

- International Journal of Human-Computer Study (formerly International Journal of Man-Machine Study, founded in 1968): Wendy Mackay (co-editor in Chief), Jean-Daniel Fekete (editor)
- ACM Transactions on Computer-Human Interaction (TOCHI): Wendy Mackay (associate Chair)
- Revue de l'Interaction Homme-Machine (RIHM): Michel Beaudouin-Lafon, Wendy Mackay

9.1.2. Journal reviewing

- Revue I3: Michel Beaudouin-Lafon (member of the board)
- Revue TSI: Michel Beaudouin-Lafon (member of the board)
- CSCW Journal: Michel Beaudouin-Lafon (member of the advisory board)
- HCI Journal: Nicolas Roussel
- Software Practice and Experience (SPE): Jean-Daniel Fekete
- IEEE Transactions on Graphics and Visualization: Jean-Daniel Fekete
- Document Numérique, Hermès, France: Jean-Daniel Fekete
- Pervasive Computing: Wendy Mackay
- ACM/Transactions on Computer-Human Interaction: Wendy Mackay
- IEEE Software: Wendy Mackay

9.1.3. Keynotes and Invited Lectures

- International Conference on Advanced Visual Interfaces (AVI '04), Gallipoli, Italy, May 2004 : Michel Beaudouin-Lafon, opening keynote speaker[21]
- Interaction Homme-Machine Conference, (IHM 2004), France: Jean-Daniel Fekete, Invited Lecture[29]
- General Seminar of the "Institut des Textes et Manuscrits Modernes" (ITEM, France): Jean-Daniel Fekete
- Unversity of British Columbia Distringuished Lecture Series, Canada: Wendy Mackay
- Oregon Research Institute Distringuished Lecture Series, USA: Wendy Mackay
- Philips Human-Computer Interaction Conference, Netherlands: Wendy Mackay

9.1.4. Conference organization

- ECSCW 05 : Wendy Mackay and Michel Beaudouin-Lafon, Chairs
- ACM CHI 2005: Wendy Mackay, Beaudouin-Lafon (Associate Chair)
- ACM UIST 2004: Michel Beaudouin-Lafon (Associate Chair)
- ACM AVI'04: Wendy Mackay (Associate Chair)
- ACM CHI 2003-2004: Michel Beaudouin-Lafon (Associate Chair for 2004)
- IHM 2004: Michel Beaudouin-Lafon (vice-chair), Jean-Daniel Fekete (proceedings chair)
- Graphics Interface 2004: Jean-Daniel Fekete
- IEEE Symposium on Information Visualization 2004: Jean-Daniel Fekete is co-chair of the Infovis 2004 Contest. He launched this new submission category in 2003.
- IEEE Symposium on Information Visualization 2004: Workshop on Information Visualization Software Infrastructures (http://vw.indiana.edu/ivsi2004/): Jean-Daniel Fekete
- IEEE International Conference on Multimedia & Expo 2005: Nicolas Roussel
- ACM Multimedia 2004: Nicolas Roussel
- ETP04, ACM Multimedia 2004 Workshop on Effective Telepresence: Nicolas Roussel

9.1.5. Conference reviewing

- ACM CHI 2005: Jean-Daniel Fekete, Wendy Mackay, Nicolas Roussel, Michel Beaudouin-Lafon
- ACM IUI 2004: Jean-Daniel Fekete
- ACM DIS'04: Wendy Mackay
- AVI'04: Wendy Mackay
- ACM DUX 2003: Wendy Mackay
- ACM UIST 2004: Michel Beaudouin-Lafon, Wendy Mackay, Nicolas Roussel
- ACM Multimedia 2004: Nicolas Roussel
- IHM 2004: Michel Beaudouin-Lafon, Jean-Daniel Fekete, Wendy Mackay
- Infovis 2004: Jean-Daniel Fekete

9.1.6. Scientific associations

- AFIHM (French speaking HCI asssociation): Michel Beaudouin-Lafon, Jean-Daniel Fekete, Executive Committee members
- ACM: Michel Beaudouin-Lafon member at large of ACM Council and member of ACM Publications Board
- ASTI (Association des Sciences et Technologies de l'Information): Michel Beaudouin-Lafon, member of the executive committee.
- GDR I3: Jean-Daniel Fekete (Head of WG 2.2)

9.1.7. PhD defenses

- Pierre Dragicevic (Ecole des Mines de Nantes), PhD Thesis "Multi-device Interaction´´, Michel Beaudouin-Lafon, Jury member Jean-Daniel Fekete, adviser and Jury member
- Christophe Bouthier (LORIA, Nancy), Ph.D. thesis, "Mise en contexte de la conscience de groupe : Adaptation et visualisation" : Michel Beaudouin-Lafon, reviewer
- René Chalon (ICTT, Lyon), Ph.D. thesis, "Réalité mixte et travail collaboratif : IRVO, un modèle d'interaction homme-machine" : Michel Beaudouin-Lafon, jury member.

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