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Université Paris-Sud (Paris 11)

Activity Report 2012

Project-Team IN-SITU

Situated interaction

IN COLLABORATION WITH: Laboratoire de recherche en informatique (LRI)

RESEARCH CENTER
Saclay - Île-de-France

THEME
Interaction and Visualization

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Project-Team IN-SITU

Keywords: Augmented Reality, Interaction, Interactive Computing, Perception, Visualization

Creation of the Project-Team: July 01, 2002 .

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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 are often difficult to understand or control, lowering productivity and increasing frustration. User interfaces have not kept pace with the rapid progress in other aspects in computing: The desktop metaphor that has driven personal computing for the past 25 years has reached its limits, with no short-term alternative.

The time has come for a new generation of interactive systems. 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. Our approach both expands today's graphical user interfaces and explores new possibilities, addressing the following goals:

- *Flexibility* to support end-user customisation 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 visualisation 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.

The overall goal of In Situ is to develop situated interfaces, i.e. interfaces that are adapted (or adaptable) to their contexts of use by taking advantage of complementary aspects of humans and computers. Our very ambitious longterm goal is to move beyond the current generation of desktop environments and envision the next generation of interactive environments. The specific objective for the next four years is to create one or more prototype interactive environments that begin to explore what this next generation of interactive systems might look like.

Our proposed research strategy is to develop case studies and development tools, in parallel. The case studies will allow us to study specific users, in particular application domains, and explore innovative interaction approaches in real-world contexts. The development tools, consisting of architectures and toolkits, will allow us to create a development environment for creating novel types of interaction and facilitate the creation of innovative applications. We have identified four research themes, each with separate deliverables, to achieve this objective: Interaction and Visualization Paradigms, Mediated Communication, Research Methods and Engineering of Interactive Systems.

2.2. Research Themes

INSITU addresses three major research themes:

Interaction and visualization paradigms focuses on the trade-off between power and simplicity in interactive systems, both in terms of interaction and in managing and visualizing data. Rather than accepting one or the other, our objective is to shift the trade-off curve, creating systems that provide more power while retaining simplicity. We are currently investigating 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 focuses on how multi-disciplinary teams can create effective interactive systems that take context into account. Our objective is to create new research methods that include users throughout the design process, to test these methods in real-world settings and to disseminate these methods to researchers and designers. We are currently investigating 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.

Engineering of interactive systems focuses on creating effective tools for building interactive systems. Our objective is to generate libraries, exploratory toolkits and platforms that enable us to quickly implement and work with new concepts, while also enabling researchers within and outside of INSITU to benefit from our research. We are currently investigating tools that facilitate the design and adoption of effective interaction techniques and paradigms and component-based 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 we articulate each theme separately, we often intermix them within actual projects. We also work across disciplines, providing us with research breadth, and at the same time, seek to obtain depth in particular projects. We 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, which we test in real-world settings. Our long-term goal is to create a new generation of interactive environments that provide a compelling alternative to the current generation of desktop computers.

2.3. Highlights of the Year

- INSITU had 4 full papers and 2 notes accepted at the most prestigious conference in our field, ACM CHI 2012, including a Best Paper Award and an Honorable Mention Award.
- Wendy Mackay was awarded a five-year Advanced Grant by the European Research Council (ERC).
- Ilaria Liccardi was awarded a three-year Marie Curie grant by the European Research Council, to work with Wendy Mackay and Prof. H. Abelson at M.I.T.

BEST PAPERS AWARDS :

[24] **Using Rhythmic Patterns as an Input Method in CHI '12: Proceedings of the SIGCHI Conference on Human Factors and Computing Systems**. E. GHOMI, G. FAURE, S. HUOT, O. CHAPUIS, M. BEAUDOUIN-LAFON.

[25] **Evaluating the Benefits of Real-time Feedback in Mobile Augmented Reality with Hand-held Devices in CHI'12 - 30th International Conference on Human Factors in Computing Systems - 2012**. C. LIU, S. HUOT, J. DIEHL, W. E. MACKAY, M. BEAUDOUIN-LAFON.

[29] **An Investigation into the Use of Tactile Instructions in Snowboarding. in MobileHCI '12: Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services**. D. SPELMEZAN.

3. Scientific Foundations

3.1. Multi-disciplinary Research

INSITU 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 [40].

4. Application Domains

4.1. Research Domains

INSITU works on general problems of interaction in multi-surface environments as well as on challenges associated with specific research groups. The former requires a combination of controlled experiments and field studies; the latter involves participatory design with users. We are currently working with highly creative people, particularly designers and music composers, to explore interaction techniques and technologies that support the earliest phases of the design process. We are also working with research scientists, particularly neuroscientists and astrophysicists, in our explorations of interaction in multisurface environments, and with doctors and nurses to support crisis management situations.

5. Software

5.1. jBricks

Participants: Stéphane Huot, Emmanuel Pietriga [correspondant], Mathieu Nancel, Romain Primet.

jBricks (Figure 1) is a Java toolkit that integrates a high-quality 2D graphics rendering engine based on ZVTM (section 5.2) and a versatile input configuration module (based on ICon [45] and FlowStates 5.4) into a coherent framework, enabling the exploratory prototyping of interaction techniques and rapid development of post-WIMP applications running on cluster-driven interactive visualization platforms such as wall-sized displays. The goal of this framework is to ease the development, testing and debugging of interactive visualization applications. It also offers an environment for the rapid prototyping of novel interaction techniques and their evaluation through controlled experiments.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See E. Pietriga, S. Huot, M. Nancel, R. Primet, Rapid Development of User Interfaces on Cluster-Driven Wall Displays with jBricks, EICS '11: Proceedings of the 3rd ACM SIGCHI symposium on Engineering interactive computing systems, pages 185-190, June 2011
- OS/Middleware: Java (Linux, Mac OS X, Windows)
- Required library or software: several, managed through Maven
- Programming language: Java

5.2. The Zoomable Visual Transformation Machine

Participants: Caroline Appert, Rodrigo de Almeida, Olivier Chapuis, Arjit Gupta, Emmanuel Pietriga [correspondant], Mathieu Nancel, Romain Primet.

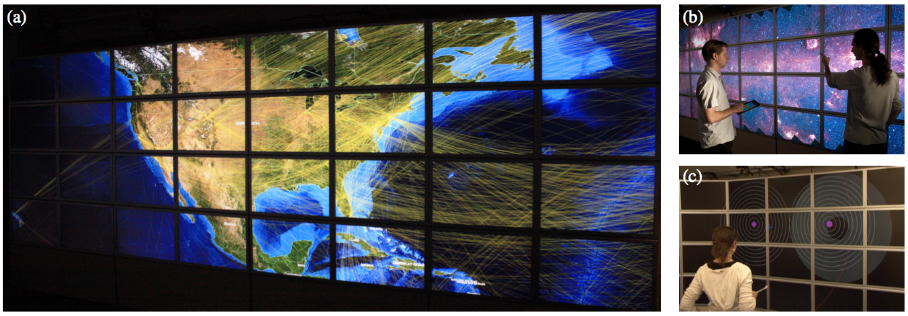

Figure 1. jBricks applications running on the WILD platform (32 tiles for a total resolution of 20 480 × 6 400 pixels). (a) Zoomed-in visualization of the North-American part of the world-wide air traffic network (1 200 airports, 5 700 connections) overlaid on NASA's Blue Marble Next Generation images (86 400 × 43 200 pixels) augmented with country borders ESRI shapefiles. (b) Panning and zooming in Spitzer's Infrared Milky Way (396 032 × 12 000 pixels). (c) Controlled laboratory experiment for the evaluation of mid-air multi-scale navigation techniques.

ZVTM provides application programmers with building blocks for implementing complex multi-scale interface components that cannot be handled by traditional WIMP widgets. Featuring off-the-shelf visualisation 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 activation of distortion lenses to modification of the visual variables of graphical objects. Various temporal pacing functions are available to control the execution of these animations. ZVTM is now one of the core components of our jBricks toolkit for wall-sized displays (Section 5.1), and current development activities around the toolkit focus on making applications run transparently on cluster-driven ultra-high-resolution wall-sized displays such as that of the WILD visualization platform. The toolkit is also used to develop advanced visualization components for the ALMA observatory's operations monitoring and control software [26].

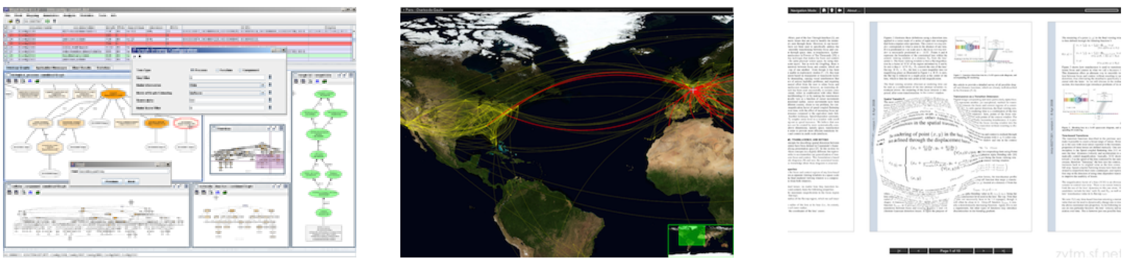

Figure 2. ZVTM used in various applications

Initially developed by Xerox Research Centre Europe and the World Wide Web Consortium (W3C) team at MIT, ZVTM has been available as open-source software under the GNU Lesser General Public License (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, Blast2GO (Figure 2 - left) (http://www.blast2go.org/), or ZGRViewer (http://zvtm.sourceforge.net/zgrviewer.html) for viewing large graphs generated by AT&T GraphViz [1] (Figure 2 - right). The development of the toolkit is now supported by Inria. More information can be found at http://zvtm.sourceforge.net and [52] and [51].

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See Pietriga, A Toolkit for Addressing HCI Issues in Visual Language Environments, IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC '05), pages 145-152, September 2005
- License: LGPL
- Type of human computer interaction: Graphique
- OS/Middleware: Java (Linux, Mac OS X, Windows)
- Required library or software: several, managed through Maven
- Programming language: Java

5.3. The SwingStates Toolkit

Participants: Caroline Appert [correspondant], Michel Beaudouin-Lafon.

SwingStates [37] is a library that adds state machines and a graphical canvas to the Java Swing user interface toolkit. It was motivated by the lack of widely disseminated toolkits that support advanced interaction techniques and the observation that HCI research toolkits are little used outside the lab. By extending the popular Java Swing toolkit rather than starting from scratch, the goal is to facilitate the dissemination and adoption of SwingStates by practitioners.

SwingStates uses *state machines* to specify interaction. It provides programmers with a natural syntax to specify state machines and reduces the potential for an explosion of the number of states by allowing multiple state machines to work together or separately. SwingStates can be used to add new interaction techniques to existing Swing widgets, e.g. to select buttons and checkboxes by crossing rather than clicking. It can also be used with the SwingStates canvas (see below) and to control high-level dialogues.

SwingStates also provides a powerful *canvas widget*. The canvas can contain any Java2D shape, including geometric shapes, images, text strings and even Swing widgets. Shapes can be manipulated individually or collectively, through *tags*. An intensive use of polymorphism allows to apply almost any command to a tag: the command is then applied to all objects with this tag. Tags are also used in conjunction with state machines, to specify transitions that occur only on objects with a given tag. For example, pie menus can be implemented by creating a canvas in the overlay layer of any Swing application (Figure 3).

SwingStates tightly integrates state machines, the Java language and the Swing toolkit to provide programmers with a natural and powerful extension to their natural programming environment. SwingStates is available at http://swingstates.sf.net under the GNU Lesser General Public License (LGPL).

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See C. Appert and M. Beaudouin-Lafon (2008) SwingStates: Adding State Machines to Java and the Swing Toolkit. Software: Practice and Experience, 38(11):1149 - 1182.
- OS/Middleware: Mac OS X, Linux, Windows
- Required library or software: Java virtual machine
- Programming language: Java

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

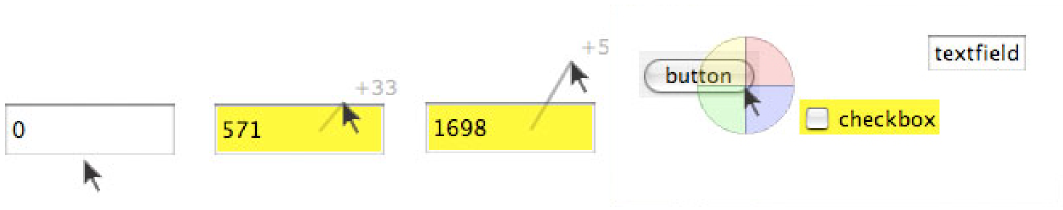

Figure 3. A numeric text field whose value can be set by a joystick-like interaction (left) and a semi-transparent menu to change the background color of Swing widgets (right)

5.4. The FlowStates Toolkit

Participants: Caroline Appert [correspondant], Michel Beaudouin-Lafon, Stéphane Huot.

FlowStates [38], is a new toolkit to program advanced interaction techniques which require non standard input (e.g., two different mice that act independently, a joystick, a tablet, etc.). It is built on top of two existing toolkits: SwingStates [37] and ICon [45].

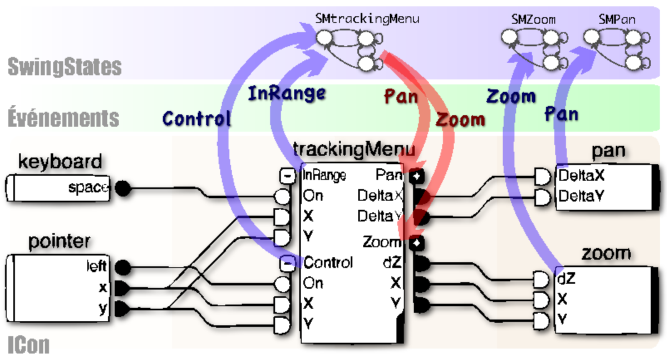

Figure 4. State machines and data flow in FlowStates

With FlowStates the developer can program interaction logic using state machines like SwingStates does but does not restrict the set of possible input channels to Java AWT standard input (a single couple <mouse, keyboard>). The state machines just have to define the virtual input events that are required to trigger their transitions so that FlowStates turns these machines into ICon devices which can be plugged to any physical input channels (Figure 4). An ICon device is a data flow building block that has input and output slots in order to be connected to other devices in the simple graphical environment provided by ICon. State machines can also send out events which appear as output slots in the data flow model.

With FlowStates we showed how two models for programming interaction (state machines and data flow) can be fully integrated to offer a huge power of expression. The explicit decision to not set strict limits between the roles of each model makes this hybrid approach highly flexible, the developer setting himself the limit between the two according to his needs and habits.

FlowStates is available at http://www.lri.fr/~appert/FlowStates/.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See C. Appert, S. Huot, P. Dragicevic and M. Beaudouin-Lafon (2009) FlowStates: Prototypage d'applications interactives avec des flots de données et des machines à états. In Proceedings of IHM 2009. ACM, pages 119-128.
- OS/Middleware: Mac OS X, Linux, Windows
- Required library or software: ICon, Java virtual machine
- Programming language: Java

5.5. TouchStone

Participants: Caroline Appert [correspondant], Michel Beaudouin-Lafon, Wendy Mackay.

TouchStone [8] is a platform for designing, running and analyzing the results of controlled experiments (Figure 5). While it focuses on experiments comparing interaction techniques, it can be used in a wide variety of contexts.

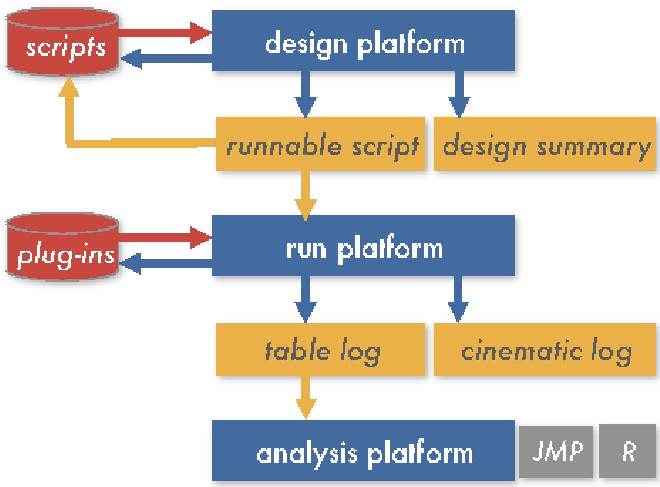

Figure 5. The architecture of the Touchstone platform

With the *Touchstone design platform*, a user specifies the factors and the measures of the experiment, the blocking and counterbalancing of trials, and assess the time it will take to run the experiment. Multiple designs can be explored in parallel to assess the various trade-offs. The output of the design platform is an XML file that can be used as input for the run platform.

The *Touchstone run platform* provides a framework to implement and run an experiment and to collect experimental data. It uses a flexible plug-in architecture to manage a variety of input devices and interaction techniques. The runs of the experiment are controlled by an XML script that can be produced by the design platform.

The analysis platform currently consists of data analysis tools such as JMP, R or Excel. Log data produced by the run platform can be directly loaded into any of these tools. In a future version, analysis sketches will be derived from the experimental design to assist with the analysis.

Touchstone has been used heavily at INSITU over the past three years for the many experiments that we design and run. It has also been used for teaching for the first time in 2011. Students used it to design various experiments during tutorial classes in Master 2 Interaction ("Introduction to HCI" module).

Touchstone is available at http://code.google.com/p/touchstone-platforms/ under a BSD License.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See W. Mackay, C. Appert, M. Beaudouin-Lafon, O. Chapuis, Y. Du, JD. Fekete and Y. Guiard (2007) TouchStone: Exploratory Design of Experiments. In Proceedings of ACM CHI 2007 Conference on Human Factors and Computing Systems. ACM, pages 1425-1434.
- OS/Middleware: Mac OS X, Linux, Windows
- Required library or software: Java virtual machine
- Programming language: Java

5.6. Metisse

Participant: Olivier Chapuis [correspondant].

Metisse [43] is a window system that facilitates the design, implementation and evaluation of innovative window management techniques. The system is based on a compositing approach, making a clear distinction between the rendering and the interactive compositing processes. The Metisse server is a modified X server that supports both input and output redirection. The default compositor is a combination of a slightly modified version of FVWM, a standard window manager, with an interactive viewer application called *FvwmCompositor*.

FvwmCompositor uses OpenGL to display windows, which 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 (Figure 6, 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 (Figure 6, middle and right). Input redirection makes it still possible to interact with applications no matter the visual transformations applied to the windows. It also makes it possible to adapt, reconfigure or re-combine existing graphical interfaces [54]. This year we used again Metisse to implement novel desktop interaction techniques [4].

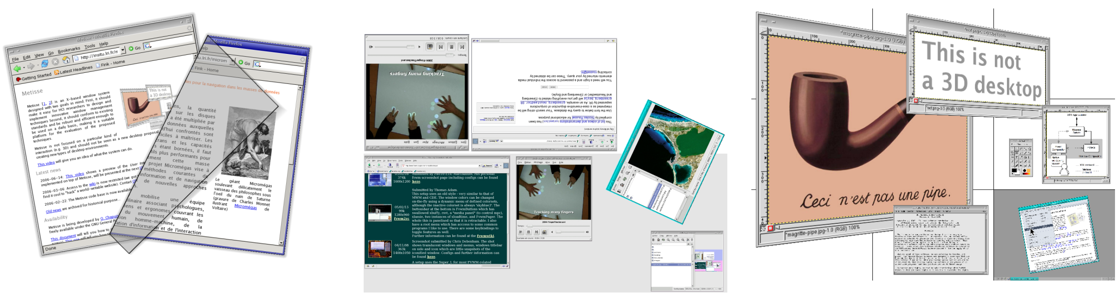

Figure 6. Sample window management techniques implemented with Metisse: extended paper metaphor (left), interactive table configuration that allows to duplicate and rotate windows (middle) and zoomable 3D desktop (right).

- Web: http://insitu.lri.fr/metisse/
- ACM: H.5.2 [User Interfaces]: Windowing systems
- Software benefit: see [43], [54], [44], [47] and [4].
- License: GPL
- Type of human computer interaction: Graphique

- OS/Middleware: X Window et Mac OS X
- Required library or software: OpenGL via nucleo [2] and some usual C/C++ libraries
- Programming language: * C/C++

5.7. Wmtrace

Participant: Olivier Chapuis [correspondant].

Wmtrace [42] includes two tools that help us study an individual 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 uses a VCR-like interface (Figure 7) 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.

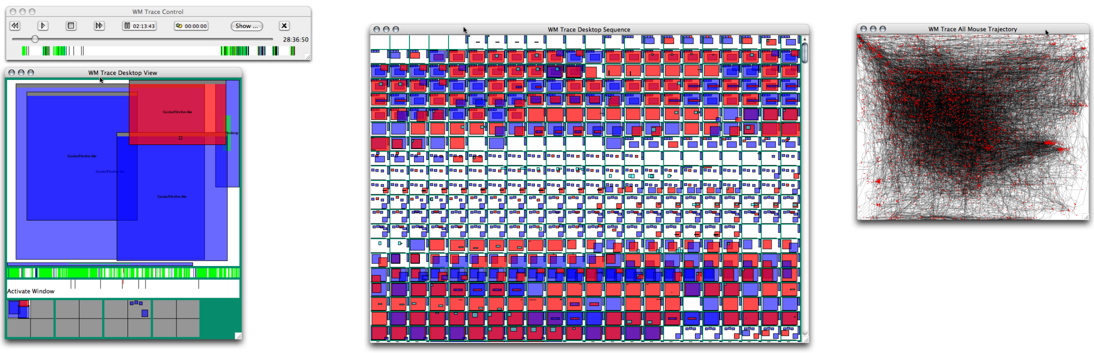

Figure 7. VCR-like interface, session overview and sample plots of mouse trajectories (black) and mouse clicks (red)

- Web: http://insitu.lri.fr/~chapuis/software/wmtrace/.
- ACM: H.5.2 [User Interfaces]: Windowing systems
- Software benefit: see [42], [47], [41].
- License: GPL
- Type of human computer interaction: Deamon and Graphique
- OS/Middleware: X Window (deamon) and Java (VCR interface)
- Required library or software: all X libraries (daemon) and Java (VCR interface)
- Programming language: * C and Java

5.8. The Substance Middleware

Participants: Michel Beaudouin-Lafon [correspondant], Clemens Klokmose, Tony Gjerlufsen, James Eagan, Clement Pillias.

[2] http://interaction.lille.inria.fr/~roussel/projects/nucleo/index.html

Substance is a middleware based on a novel programming paradigm called *data-oriented programming* and was designed to facilitate the development of multi-surface interactive applications [48]. Such applications are distributed by nature as they involve a varying number of display and interaction surfaces that are controlled by different computers. For example, our WILD room includes a 32-monitor display wall driven by 16 computers plus a front-end, a multi-touch table, various mobile devices such as iPodTouch and iPads, and the laptops that the users of the room may bring with them. We want to support seamless interaction techniques across these surfaces, such as the pick-and-drop technique pioneered by Rekimoto [53].

Data-oriented programming consists of attaching functionality to a tree data structure through *facets* attached to the individual nodes of the tree. Facets can be added and removed dynamically, and notified of changes in the tree. Substance supports two powerful ways to share nodes and facets: mounting, where access to the shared tree is managed through remotely, and replication, where the shared tree is replicated at each site and synchronized.

Figure 8. The Canvas (left) and SubstanceGrise (right) applications developed with Substance. (©CNRS-Phototheque - Cyril FRESILLON for SubstanceGrise).

Substance has been used to create two full-scale applications (Figure 8): a generalized Canvas that can display and manage graphics, PDF files, image files and other content (through an extensible content manager) across surfaces spanning multiple displays and computers; SubstanceGrise, which uses multiple instances of the Anatomist/BrainVISA application to display coordinated 3D imagery of many brains in parallel on the WILD wall and control from a physical model of the brain.

Substance is available at http://substance-env.sourceforge.net/ under a GNU GPL 3.0 licence.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See T. Gjerlufsen, C. Klokmose, J. Eagan, C. Pillias and M. Beaudouin-Lafon (2011) Shared Substance: Developing Flexible Multi-Surface Applications. In CHI '11: Proceedings of the 29th international conference on Human factors in computing systems. ACM, pages 3383-3392.
- OS/Middleware: Mac OS X, Linux
- Required library or software: several, managed by Python install
- Programming language: Python

5.9. Scotty

Participants: Michel Beaudouin-Lafon [correspondant], James Eagan, Wendy Mackay.

The goal of Scotty is to support *malleable interfaces*, i.e. interfaces that can be modified at run-time in ways not anticipated by the designers [46]. Scotty is a toolkit that allows a programmer to extend an existing Mac OS X application without access to its source code. Scotty provides the following abstractions: hooks to alter the appearance of windows and widgets, event funnels to alter their behavior, glass sheets to overlay graphics and add new interaction methods, dynamic code loading and object proxies to redefine and extend existing objects. Scotty also provides a higher-level interface based on instrumental interaction [39]. Scotty currently runs on Mac OS X for applications written with the Cocoa user interface framework.

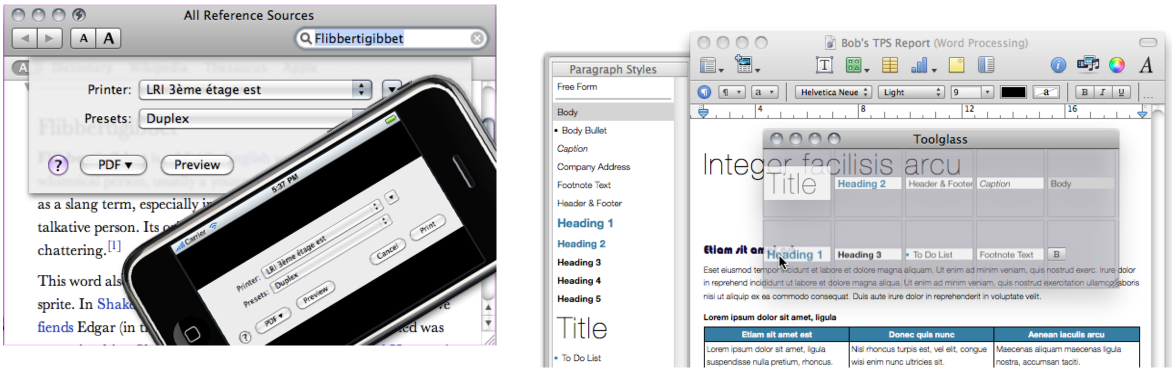

Figure 9. Using Scotty to teleport a window of a Mac OS X application onto an iPhone (left) and to create a toolglass in the Pages word processor (right).

Scotty has been used to create a number of extensions (Figure 9). *Scribbler* is a generic extension that uses glass sheets to allow handwritten annotations of any Cocoa window. *Teleportation* is another generic extension that can teleport and resize the content of any Cocoa window onto another computer, including an iPhone or iPad. The user can interact with the teleported content as if it was on the original computer. It was used to create a content provider for the Substance Canvas (see above), making it possible to display any application running on a laptop onto the WILD wall display and/or table. When vector-based content is available, e.g., for text, Scotty provides smooth rescaling without the typical pixelation apparent when enlarging bitmap images. Finally *Stylesheet* is an extension to the Pages word processor that provides a semi-transparent toolglass for specifying the styles of paragraphs.

Scotty is available at http://insitu.lri.fr/Projects/Scotty under a GNU GPL 3.0 licence.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: See J. Eagan, W. Mackay and M. Beaudouin-Lafon (2011) Cracking the Cocoa Nut: User Interface Programming at Runtime. In UIST 2011: Proceedings of the 24th ACM Symposium on User Interface Software and Technology. ACM, pages 225-234.
- OS/Middleware: Mac OS X
- Required library or software: none
- Programming language: Objective-C, Python

6. New Results

6.1. Interaction Techniques

Participants: Caroline Appert, Michel Beaudouin-Lafon, David Bonnet, Anastasia Bezerianos, Olivier Chapuis, Emilien Ghomi, Stéphane Huot, Can Liu, Wendy Mackay [correspondant], Mathieu Nancel, Cyprien Pindat, Emmanuel Pietriga, Theophanis Tsandilas, Julie Wagner.

We explore interaction techniques in a variety of contexts, including individual interaction techniques on mobile devices, the desktop, and very large wall-sized displays, using one or both hands. We also explore interaction with physical objects and across multiple devices, to create mixed or augmented reality systems. This year, we explored interaction techniques based on time (*EWE* and *Dwell-and-Spring*), bimanual interaction on mobile devices (*Bipad*) and interaction on very large wall displays (*Jelly Lenses*, *Looking-Around-Bezels*). We also developed interactive paper systems to support early, creative design (*Pen-based Mobile Assistants*, *Paper Tonnetz*, *Paper Substrates*). We also explored augmented reality systems, using tactile feedback (*TactileSnowboard Instructions*) and tangible interaction (*Mobile AR*, *Combinatorix*) to support learning.

EWE – Although basic interaction techniques, such as multiple clicks or spring-loaded widgets, take advantage of the temporal dimension, more advanced uses of rhythmic patterns have received little attention in HCI. Using temporal structures to convey information can be particularly useful in situations where the visual channel is overloaded or even not available. We introduce Rhythmic Interaction [24] which uses rhythm as an input technique (Figure 10). Two experiments demonstrate that (i) rhythmic patterns can be efficiently reproduced by novice users and recognized by computer algorithms, and (ii) rhythmic patterns can be memorized as efficiently as traditional shortcuts when associated with visual commands. Overall, these results demonstrate the potential of Rhythmic Interaction and richer repertoire of interaction techniques. (*Best Paper award, CHI'12*)

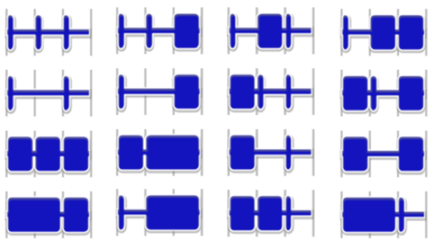

Figure 10. We defined 16 three-beat patterns: Each rectangle represents a tap, the thin gray lines show beats.

Dwell-and-Spring – Direct manipulation interfaces consist of incremental actions that should be reversible The challenge is how to provide users with an effective "undo". Actions such as manipulating geometrical shapes in a vector graphics editor, navigating a document using a scrollbar, or moving and resizing windows on the desktop rarely offer an undo mechanism. Users must manually revert to the previous state by recreating a similar sequence of direct manipulation actions, with a high level of associated motor and cognitive costs. We need a consistent mechanism that supports undo in multiple contexts. *Dwell-and-Spring* [19] uses a spring metaphor that lets users undo a variety of direct manipulations of the interface. A spring widget pops up whenever the user dwells during a press-drag-release interaction, giving her the opportunity to either cancel the current manipulation (Figure 11) or undo the last one. The technique is generic and can easily be implemented on top of existing applications to complement the traditional undo command. A controlled experiment demonstrated that users can easily discover the technique and adopt it quickly when it is discovered.

BiPad – Although bimanual interaction is common on large tabletops, it is rare on hand-held devices. We take advantage of the advanced multitouch input capabilities available on today's tablets to introduce new bimanual interactio techniques, under a variety of mobility conditions. We found that, when users hold a tablet, the primary function of the non-dominant hand is to provide support, which limits its potential movement. We studied how users "naturally" hold multi-touch tablets to identify comfortable holds, and then developed a set of 10 two-handed interaction techniques that accounts for the need to support the device while interacting with it. We introduced the *BiTouch* design space that extends Guiard's "Kinematic Chain Theory" [49] to account for the *support function* in bimanual interaction. We also designed and implemented

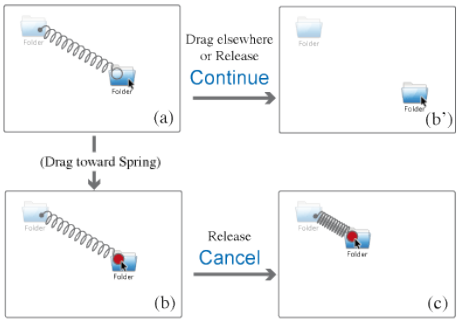

Figure 11. Cancel scenario: The user dwells while dragging an icon (a), which pops up a spring. She either (b) catches the spring's handle and releases the mouse button to cancel the current drag and drop, causing the spring to shrink smoothly (c) and returning the cursor and icon to their original locations, or she continues dragging the spring's handle any direction (b').

the *BiPad* toolkit and set of interactions, which enables us to implement bimanual interaction on multitouch tablets (Figure 12). Finally, a controlled experiment demonstrated the benefits and trade-offs among specific techniques and offered insights for designing bimanual interaction on hand-held devices [31].

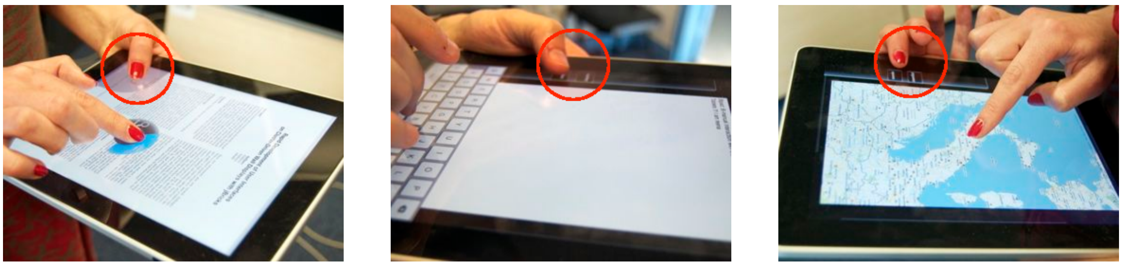

Figure 12. Bimanual interaction on a multitouch tablet with BiPad: (left) navigating in a document; (center) switching to uppercase while typing on a virtual keyboard; (right) zooming a map. The non-dominant hand is holding the device and could perform 'tapa', 'gestures' or 'chords' in order to augment dominant hand's interactions.

Jelly Lenses – Focus+context lens-based techniques smoothly integrate two levels of detail using spatial distortion to connect the magnified region and the context. Distortion guarantees visual continuity, but causes problems of interpretation and focus targeting, partly due to the fact that most techniques are based on statically-defined, regular lens shapes, that result in far-from-optimal magnification and distortion (Figure 13 left and center). JellyLenses [27] dynamically adapt to the shape of the objects of interest, providing detail-in-context visualizations of higher relevance by optimizing what regions fall into the focus, context and spatially-distorted transition regions (Figure 13-right). A multi-scale visual search task experiment demonstrated that JellyLenses consistently perform better than regular fisheye lenses.

Looking behind Bezels – Using tiled monitors to build wall-sized displays has multiple advantages: higher pixel density, simpler setup and easier calibration. However, the resulting display walls suffer from the visual discontinuity caused by the bezels that frame each monitor. To avoid introducing distortion, the image has to

Figure 13. Magnifying the Lido in Venice. (left) a small fisheye magnifies one part of the island (Adriatic sea to Laguna Veneta), but requires extensive navigation to the whole island in detail; (center) a large fisheye magnifies a bigger part of the island, but severely distorts almost the entire image, hiding other islands; (right) a JellyLens automatically adapts its shape to the region of interest, with as much relevant information in the focus as (b) while better preserving context: surrounding islands are almost untouched from (a).

be rendered as if some pixels were drawn behind the bezels. In turn, this raises the issue that a non-negligible part of the rendered image, that might contain important information, is visually occluded. We drew upon the analogy to french windows that is often used to describe this approach, and make the display really behave as if the visualization were observed through a french window [21]. We designed and evaluated two interaction techniques that let users reveal content hidden behind bezels. One enables users to offset the entire image through explicit touch gestures. The other adopts a more implicit approach: it makes the grid formed by bezels act like a true french window using head tracking to simulate motion parallax, adapting to users' physical movements in front of the display. The two techniques work for both single- and multiple-user contexts.

Pen-based Mobile Assistants – Digital pen technology allows easy transfer of pen data from paper to the computer. However, linking handwritten content with the digital world remains difficult as it requires the translation of unstructured and highly personal vocabularies into data structured so as to be understood and processed by a computer. Automatic recognition can help, but is not always reliable: it require active cooperation between users and recognition algorithms. We examined [30] the use of portable touch-screen devices in connection with pen and paper to help users direct and refine the interpretation of their strokes on paper. We explored four bimanual interaction techniques that combine touch and pen-writing, where user attention is divided between the original strokes on paper and their interpretation by the electronic device. We demonstrated these techniques through a mobile interface for writing music (Figure 14) that complements the automatic recognition with interactive user-driven interpretation. An experiment evaluated the four techniques and provided insights as to their strengths and limitations.

Paper Tonnetz – Tonnetz are space-based musical representations that lay out individual pitches in a regular structure. We investigated how properties of Tonnetz can be applied in the composition process, including how to represent pitch based on chords or scales and lay them out in a two-dimensional space (Figure 15). *PaperTonnetz*[20] is a tool that lets musicians explore and compose music with Tonnetz representations by making gestures on interactive paper, creating replayable patterns that represent pitch sequences and/or chords. An initial test in a public setting demonstrated significant differences between novice and experienced musicians and led to a revised version that explicitly supports discovering, improvising and assembling musical sequences in a Tonnetz.

Paper Substrates – Our goal is to design novel interactive paper interfaces that support the creative process. We ran a series of participatory design sessions with music composers to explore the concept of "paper substrates"

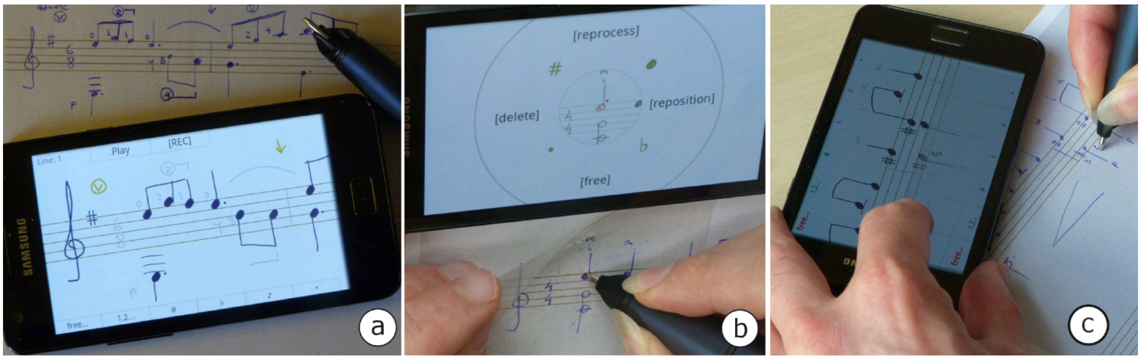

Figure 14. Writing music with a pen and a smartphone. (a) Handwritten score translated by the device. (b) Correcting the recognition of a note over a plastic sheet. (c) Guiding the interpretation of strokes with the left hand.

[23]. Substrates are ordinary pieces of paper, printed with an Anoto dot pattern, that suppport a variety of advanced forms of interaction (Figure 15). Each substrate is strongly typed, such as a musical score or a graph, which faciliates interpretation by the computer. The composers were able to create, manipulate and combine layers of data, rearranging them in time and space as an integral part of the creative process. Moreover, the substrates approach fully supported an iterative process in which templates can evolve and be reused, resulting in highly personal and powerful interfaces. We found that paper substrates take on different roles, serving as data containers, data filters, and selectors. The design sessions resulted in several pen interactions and tangible manipulations of paper components to support these roles: drawing and modifying specialized data over formatted paper, exploring variations by superimposing handwritten data, defining programmable modules, aligning movable substrates, linking them together, overlaying them, and archiving them into physical folders.

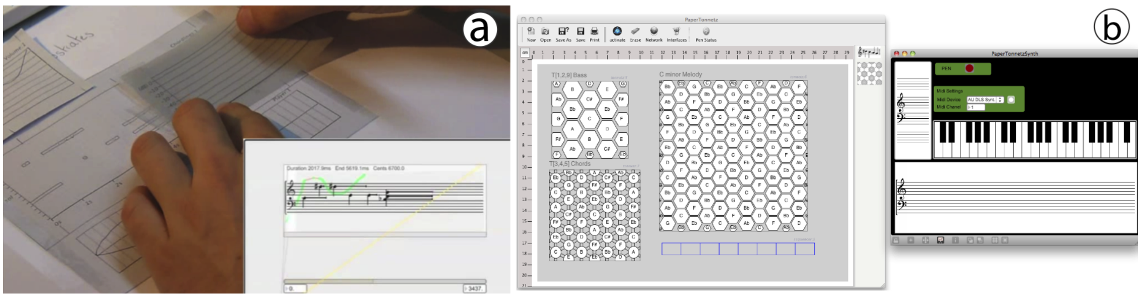

Figure 15. Paper-based interfaces for musical creation. (a) Paper substrates are interactive paper components for working with musical data. (b) PaperTonnetz main interface representing the virtual page with three Tonnetz and one sequencer (left). The Max/MSP patch to play and visualize created sequences (right).

Tactile Snowboard Instructions – Beginnning snowboarders have difficulty getting instructions and feedback on their performance if they are separated spatially from their coach. Snowboarders can learn correct technique by wearing a system with actuators (vibration motors) attached to the thighs and shoulders, which reminds them to shift their weight and to turn their upper body in the correct direction (Figure 16). A field study with amateur snowboarders demonstrated that these "tactile instructions" are effective for learning basic turns and offered recommendations for incorporating tactile instructions into sports training. *Best Paper award, Mobile HCI'12*

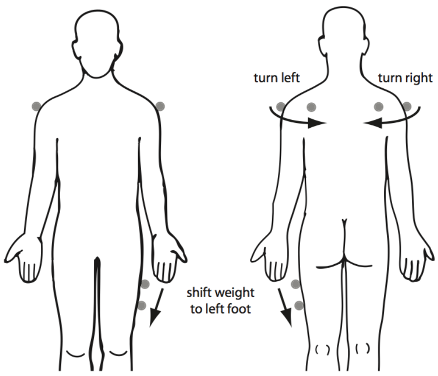

Figure 16. Two vibration motors are placed at each shoulder and laterally at the thigh that points forward during the ride. Arrows illustrate the direction of the stimuli on the skin, labels show the corresponding messages.

Mobile AR – We examined how new capabilities of hand-held devices, specifically higher resolution screens, camera and localization, can be used to create mobile *Augmented Reality (AR)* to help users learn and manage their interactions with everyday physical objects, such as door codes and home appliances. We explored AR-based mobile note-taking [50] to provide real-time on-screen feedback of physical objects that the user must manipulate, such as entering a door code. Here, the user uses the device to identify the required values of sliders and buttons (Figure 17). A controlled experiment showed that mobile AR improved both speed and accuracy over traditional text or picture-based instructions. We also demonstrated that adding real-time feedback in the AR layer that shows the user's actions with respect to the physical controls further increases performance [25]. (*Honorable Mention award, CHI 2012*)

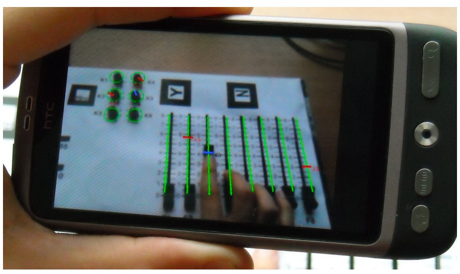

Figure 17. Mobile augmented reality for setting physical controls. Required values are displayed in red and turn blue when set correctly.

Combinatorix – We developed Combinatorix [28], a mixed tabletop system to help groups of students work collaboratively to solve probability problems. Users combine tangible objects in different orders and watch the effects of various constraints on the problem space (Figure 18). A second screen displays an abstract representation, such as a probability tree, to show how their actions influenced the total number of combinations.

We followed an iterative participatory design process with college students taking a combinatorics class and demonstrated the benefits of using a tangible approach to facilitate learning abstract concepts.

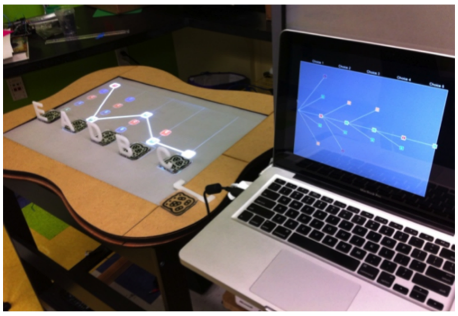

Figure 18. Combinatorix uses tangible objects on an interactive tabletop to control the tabletop display and associated screen, to help users explore and understand complex problems in combinatorial statistics.

6.2. Research Methods

Participants: Caroline Appert, Michel Beaudouin-Lafon, Anastasia Bezerianos, Olivier Chapuis, Jérémie Garcia, Stéphane Huot, Ilaria Liccardi, Wendy Mackay [correspondant], Emmanuel Pietriga.

Human-Computer Interaction is a multi-disciplinary field, with elements of computer science, software engineering, experimental psychology and anthropology. More recently, designers have joined the CHI community, offering an important perspective, but also a different fundamental research paradigm, which differs from the value systems of engineering and the natural sciences. We explored the paradigm of *Research through Design* [34], which we differentiate from traditional epistemologies in the human sciences. We distinguish design from research-through-design: the end goal is not to produce an artifact, but rather to frame an alternative future and uncover unmet human needs, desires, emotions, and aspirations. We identified three research perspectives that have been adopted within the HCI community: *Projection* explores possible future states, *Place* specifies the context in which design artifacts presented to gather data, and *Point-of-View* identifies the philosophical perspective imposed by researchers. Our goal is to understand what it means to conduct research through design and how to value research-through-design contributions.

In addition to exploring general questions about research paradigms, we also explore more focused questions that apply new research methods to the design of multi-surface environments. Large interactive surfaces (like the WILD platform) are interesting collaborative settings that allow viewing of large amounts of visual information. Before we are ready to use these platforms in real visual analysis situations, where people can place themselves at different positions around the display, we must first understand how the perception of visual information is affected by perspective distortion introduced by varying viewing distances and angles. A deeper understanding of such distortion effects can help visualization researchers design effective visualizations for these spaces and implement interaction techniques to aid in extreme distortion situations. We conducted [16] two studies on the perception of visual variables that encode information, such as Angle, Area, and Length, and found that perception is impacted differently at different locations on the screen, depending on the vertical and horizontal positioning of this information. The visual variable of Length was the most accurately perceived across the display. Our second study examined the effect of perception when participants can move freely in such situations, compared to when they have a static viewpoint, and found that a far but static viewpoint was as accurate but less time consuming than one that included free motion. But we observed that in free motion participants often chose non-optimal walking strategies that can increased perception errors, thus we provide precise recommendations on where and how to move in such environments. This work is a first step towards understanding and predicting the impact of large display environments to people's understanding and tasks.

Annotations play an important role in visual analysis and record-keeping. We discuss the use of annotations on visualization dashboards citeelias:hal-00719221, collections of linked visualizations, focusing on business intelligence analysis through a user centered design process from expert analysts in this domain. The first contribution bridges the gap between expert analyst needs and designers, when it comes to visualization annotations. The second offers a novel approach to annotating of visualizations, "context aware annotations": We annotate data queries directly, rather than image/chart locations. Annotations are present irrespective of the visual data representations users select (different charts, numeric tabular views of their data, etc). We focus particularly on novel annotation aspects made possible by this approach, such as multi-visualization annotations, annotation transparency across charts and data hierarchy levels, and the possibility of recommending to users annotations done to similar data to enable annotation re-use. We also consider new challenges that arise from such our approach, such as what happens to annotations when the underlying data is changed, and provide recommendations and design solutions.

6.3. Engineering of interactive systems

Participants: Caroline Appert, Michel Beaudouin-Lafon [correspondant], Olivier Chapuis, Stéphane Huot, Wendy Mackay, Emmanuel Pietriga, Clément Pillias, Romain Primet.

INSITU continues to develop and apply toolkits to explore and implement interactive systems. Most of the projects listed in the *Interaction Techniques* section either build upon existing toolkits, e.g., *Jelly Lenses* to improve management of focus+context on a wall-sized display, or created new ones, e.g., *BiPad* to create various bimanual interaction techniques for hand-held tablets.

INSITU's primary testbed for exploring multi-surface interaction is the WILD Room [15] (Wall-sized Interaction with Large Datasets), a multisurface environment featuring a wall-sized display, a multitouch table, and various mobile devices. Our goal is to explore the next generation of interactive systems by distributing interaction across these diverse computing devices, enabling multiple users to easily and seamlessly create, share, and manipulate digital content. Our research strategy is to design an extreme environment that pushes the limits of technology – both hardware and software. To ground the design process, we work with extreme users – scientists whose daily work both inspires and stress-tests the environment as they seek to understand exceptionally large and complex datasets. The WILD room, and the soon-to-be-built WILDER room are part of *DigiScope*, a 22.5 Meuro "Equipement d'Excellence" project led by INSITU.

INSITU's collaboration with the ALMA radio-telescope on the design and implementation of user interfaces for operations monitoring and control continued this year [26], and was eventually transferred to Inria Chile in July (see Section 7.4.2). The ALMA radio-telescope, currently under construction in northern Chile, is a very advanced instrument that presents numerous challenges. From a software perspective, one critical issue is the design of graphical user interfaces for operations monitoring and control that scale to the complexity of the system and to the massive amounts of data users are faced with. Early experience operating the telescope with only a few antennas showed that conventional, WIMP-based user interfaces are not adequate in this context. They consume too much screen real-estate, require many unnecessary interactions to access relevant information, and fail to provide operators and astronomers with a clear mental map of the instrument. They increase extraneous cognitive load, impeding tasks that call for quick diagnosis and action. To address this challenge, the ALMA software division adopted a user-centered design approach in collaboration with members of INSIUT. For the last two years, astronomers, operators, software engineers and human-computer interaction researchers from INSITU have been working on the design of better user interfaces based on state-of-the-art visualization techniques. This eventually led to the joint development of those interface components using various software toolkits, some of them developed at INSITU (Section 5.2).

7. Partnerships and Cooperations

7.1. Regional Initiatives

DigiPods (2012-2015) – The *Distant Collaborative Interaction Between Heterogeneous Visualization Platforms* project is funded by the "Équipement mi-lourd SESAME 2012" program of the Région Île-de-France. 6 academic partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, Inria, CNRS, CEA, Institut Telecom ParisTech with an overall budget of 1.9 Meuros, including 850 keuros public funding from Région Île-de-France. Stéphane Huot: coordinator and principal investigator for the whole project. The goal is to equipe Digiscope platforms (see below) with high-end input and interaction devices/systems. These interaction facilities should be: (i) specific to each kind of platform (e.g., haptic devices for immersive rooms, multitouch devices for high-resolution visualization walls); or (ii) generic for all platforms, in order to allow collaboration between heterogeneous platforms. The latter will be the more innovative, providing users with a personal and configurable interaction space, similar on every platform of the project. Designed for studying distant collaborative interaction, these systems will also serve as a testbed for exploring and addressing the challenges of configurability and adaptability for the end-user.

7.2. National Initiatives

Digiscope - Collaborative Interaction with Complex Data and Computation (2011-2020) http://digiscope.fr. "Equipment of Excellence" project funded by the "Invesissements d'Avenir" program of the French government. 10 academic partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Telecom ParisTech, Ecole Centrale Paris, Université Versailles - Saint-Quentin, ENS Cachan, Maison de la Simulation. Overall budget: 22.5 Meuros, including 6.7 Meuros public funding from ANR. Michel Beaudouin-Lafon: coordinator and principal investigator for the whole project. The goal of the project is to create nine high-end interactive rooms interconnected by high-speed networks and audio-video facilities to study remote collaboration across interactive visualization environments. The equipment will be open to outside users and targets four main application areas: scientific discovery, product lifetime management, decision support for crisis management, and education and training. In Situ will contribute the existing WILD room, a second room called WILDER funded by the project, and its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems.

MDGest - Interacting with Multi-Dimensional Gestures (2011-2014). In Situ is the only academic partner. Funded by the French National Research Agency (ANR), Programme JCJC (Junior researchers): 88 Keuros. Caroline Appert (coordinator) and Theophanis Tsandilas. This project investigates new interactions for small devices equipped with a touchscreen. Complementing the standard point-and-click interaction paradigm, the MDGest project explores an alternative way of interacting with a user interface: tracing gestures with the finger. According to previous work, this form of interaction has several benefits, as it is faster and more natural for certain contexts of use. The originality of the approach lies in considering new gesture characteristics (dimensions) to avoid complex shapes that can be hard for users to memorize and activate. Dimensions of interest include drawing speed (local or global), movement direction, device orientation or inclination, and distinctive drawing patterns in a movement.

DRAO – Adrian Bosseau (Inria, Sophia Antipolis) submitted a successful ANR grant with members from INSITU Fanis Tsandilas (Inria) and Wendy Mackay, and Prof. Maneesh Agrawala (Berkeley), called DRAO, to create interactive graphics tools to support sketching. The kickoff meeting was held in Nov. 2012 and included interviews with designers from Toyota.

7.3. European Initiatives

VCoRE – Visual COmputing Runtime Environment. Inria ADT (Technology Transfer Initiative), two academic partners: Inria (Grenoble, Lille, Rennes, Saclay, Sophia Antipolis) and IGD Fraunhofer Institute (Darmstadt, Germany). Stéphane Huot: coordinator and principal investigator for INSITU / Inria Saclay–Île-de-France, Romain Primet: investigator for INSITU / SED / Inria Saclay–Île-de-France. The VCoRE project aims to share resources and to develop a new software framework for advanced Mixed/Augmented/Virtual Reality and Visualization platforms. The advantages of this shared framework will be (i) to provide engineers and researchers with unified and flexible development tools to support research projects; (ii) to ease the development and porting of applications on heterogeneous immersive and visualization platforms, while still making the most of their capabilities (specific hardware, computing power, interaction devices, etc.). All the partners are conducting research projects on such platforms and have a strong background in computer graphics, human-computer interaction, software engineering, real-time simulation, parallel computing, etc. In VCoRE, INSITU will contribute with its expertise in HCI and software engineering, thanks to the knowledge gained from the WILD project. In concrete terms, several of the software tools and methods for designing and programming interaction developed at INSITU will be improved and integrated into VCoRE as the framework interaction management tools (FlowStates, WILDInputServer).

7.4. International Initiatives

BayScope – Prof. Bjorn Hartman (Berkeley), Michel Beaudouin-Lafon and Wendy Mackay submitted a successful NSF CNIC grant “Architectures and Interaction Paradigms for Multi-surface Environments” to support travel between France and Berkeley in conjunction with the BayScope project, the goal of which is to link our work on DigiScope within France to our partners in the SIRIUS Equipe Associé, in California, specifically at Berkeley and at U.C. San Diego.

7.4.1. Inria Associate Teams

SIRIUS – INSITU has an Equipe Associée called *SIRIUS: Situated Interaction Research at Inria, UCSD and Stanford* with U.C. San Diego and Stanford University. The creation of Inria Silicon Valley, and the move of Prof. Bjoern Hartmann to Berkeley, has meant that we’ve included Berkeley in the research group. The primary area of collaboration has been in the context of our DigiScope project and interaction with wall-sized displays, which led to the creation of BayScope at Berkeley and collabortions on the 75-screen wall at UCSD. We have also collaborated on design process and interactive paper with Stanford.

The SIRIUS Associate Team includes INSITU, (head: W. Mackay), the HCI group at Stanford, (head: Prof. Scott Klemmer), and the DCOG-HCI group at UCSD (head: Prof. Jim Hollan). Arvind Satyanarayan completed his undergraduate degree at UCSD and started a Ph.D. at Stanford in the fall of 2011, with three visits to INSITU in 2012 to work on the Multimedia Interactive Schedule project for CHI’13. Bjorn Hartman completed his Ph.D. at Stanford and joined the UC Berkeley faculty in 2011, and is continuing to collaborate on the HydraScope project. Lora Oehlberg completed her Ph.D. at Berkeley in October, 2011 and began an Inria-Silicon Valley post-doc at INSITU. Daniel Strazzula completed his Masters at Stanford and began a Ph.D. on a CORDI grant at INSITU. Melody Kim, an undergraduate at UCSD, visited INSITU in the fall quarter. Both are working with A. Satyanarayan on the Multimedia Interactive Schedule. W. Mackay worked on Combinatorix [28] with B. Schneider (Stanford Ph.D. student). W. Mackay and F. Tsandilas had several meetings with A. Bosseau as part of the ANR DRAO project, which includes Prof. Maneesh Agrawala from Berkeley). W. Mackay and M. Beaudouin-Lafon visited UCSD (J. Hollan and N. Weibel). W. Mackay, M. Beaudouin-Lafon, A. Satyanarayan and J. Hollan attended the Dagstuhl HCI seminar in Germany. SIRIUS helped sponsor two international workshops, one at Berkeley and one in Orsay, France on interaction in multi-surface environments.

7.4.2. Participation In International Programs

CIRIC Chili – Emmanuel Pietriga joined Inria Chile in July 2012 and is now heading the Massive Data project, continuing the close collaboration with ALMA 6.3 and starting new industrial transfer projects related to the visualization of massive datasets and to the engineering of interactive systems.

7.5. International Research Visitors

7.5.1. Internships

Jéronimo Barbosa, Master student, “Linking digital tabletops with physical paper for creative interactions”, Universidade Federal de Pernambuco (CIn/UFPE), Recife, Brazil. May 2012 - October 2012, Inria International Internships Program. Supervision: Theophanis Tsandilas, Anastasia Bezerianos.

Melody Kim, “Interaction with large displays”, Undergraduate student, University of California, San Diego, USA. UCSD. Supervision: Wendy Mackay.

Arvind Satyanarayan, “Interaction with large displays”, PhD student, Stanford University, Computer Science Dpt. (HCI and Visualization group), Stanford, USA. Sirius associate team. Supervision: Wendy Mackay, Michel Beaudouin-Lafon.

7.5.2. Visits to International Teams

Wendy Mackay and Michel Beaudouin-Lafon completed their two-year sabbatical at Stanford University in June, 2012, where they collaborated closely with the Stanford HCI group (Prof.s S. Klemmer and S. Card) and the Berkeley Institute of Design (BID) (Prof. B. Hartmann). D. Strazzula, who completed his Master’s degree at Stanford, returned to U. Paris on an Inria Cordi Ph.D. grant and L. Oehlberg, who completed her Ph.D. at Berkeley, joined INSITU as a Post-Doctoral Fellow. Julie Wagner (Ph.D., INSITU) and Emilien Ghomi (Ph.D., INSITU), and Stéphane Huot (MC, INSITU) visited W. Mackay and M. Beaudouin-Lafon at Stanford, in April and in May. W. Mackay visited Prof. Marcelo Wanderley at McGill University in Canada.

8. Dissemination

8.1. Scientific Animation

8.1.1. Keynote addresses and Invited Lectures

Michel Beaudouin-Lafon: “Instrumental Interaction in Multisurface Environments”, Adobe Research, San Francisco, USA, January 2012.

Michel Beaudouin-Lafon: “Instrumental Interaction in Multisurface Environments”, CMU Silicon Valley, San Jose, USA, February 2012.

Michel Beaudouin-Lafon: “BayScope: Multisurface Interaction With Large Displays ”, Inria Silicon Valley workshop, Berkeley, USA, February 2012.

Michel Beaudouin-Lafon & Wendy Mackay: “Co-adaptive Instruments and Multisurface Environments”, University of California, Irvine, USA, April 2012.

Michel Beaudouin-Lafon & Wendy Mackay: “Co-adaptive Instruments and Multisurface Environments”, University of California, San Diego, USA, April 2012.

Michel Beaudouin-Lafon: “Of Tools and Instruments”, Dagstuhl Seminar on Interaction Beyond the Desktop, August 2012.

Michel Beaudouin-Lafon: “Du Geste à l’Instrument”, FITG, Lille, November 2012.

Michel Beaudouin-Lafon: “DataSense - Interaction and Visualization”, Launch of Labex Digicosme, Ecole Polytechnique, Palaiseau, France, September 2012.

Wendy Mackay:“Medical Applications and Paper Substrates”, Workshop on Cognitive Aids, Berkeley, California, USA, May, 2012.

Wendy Mackay: “Asking Research Questions”, Seminar, Stanford University, March 2012.

Wendy Mackay:“Supporting multi-surface interaction in Medical Emergencies”, Inria Silicon Valley Workshop, Workshop on Cognitive Aids, Berkeley, California, USA, 2012.

Wendy Mackay: “Co-Adaptative Paper”, Dagstuhl Seminar on Interaction Beyond the Desktop, August 2012.

Wendy Mackay:“Creative Composition with Interactive Paper from creative expression to generative power”, Invited Seminar, Massachusetts Institute of Technology, Massachusetts, USA, October 2012.

Wendy Mackay:“Creative Composition with Interactive Paper from creative expression to generative power”, Invited Seminar, McGill University, Montreal Canada, October 2012.

Jérémie Garcia: “Interactive Paper for Musical Composition”, Seminar Les Nouveaux Espaces de la Notation Musicale – GRAME, Lyon, France, April 2012

Stéphane Huot: “Designing Advanced Interaction for High-Resolution Visualization Platforms”, 6th Seminar of Institut Farman – ENS Cachan, Cachan, France, November 2012

Emmanuel Pietriga: “Interfaces graphiques innovantes pour la visualisation de masses de données et le contrôle de systèmes complexes”, SIGCHI Local Chapter, Toulouse, France, June 2012

Cyprien Pindat: “JellyLens: Content-Aware Adaptive Lenses”, VISU 2012 seminar, Paris, France, September 2012

Theophanis Tsandilas: “Interpreting Strokes on Paper with a Mobile Assistant”, Forum sur l’interaction Tactile et Gestuelle, Tourcoing, France, November 2012

Theophanis Tsandilas: “Supporting Music Composition with Paper and Computers”, Inria Sophia Antipolis, France, November 2012

8.1.2. Journal editorial board

Communications of the ACM (CACM), ACM: Wendy Mackay (Member of Editorial Board)

Transactions on Computer-Human Interaction (TOCHI), ACM: Michel Beaudouin-Lafon (Associate Editor)

International Journal of Human-Computer Studies (IJHCS), Elsevier: Michel Beaudouin-Lafon (Member of the Advisory Board)

International Journal on Semantic Web and Information Systems (IJSWIS): Emmanuel Pietriga (Editorial board, special issue on Visualisation of and Interaction with Semantic Web Data)

Journal of Computer-Supported Cooperative Work (JCSCW), Springer: Michel Beaudouin-Lafon (Member of the Advisory Board)

Journal of Visual Languages and Computing (JVLC), Elsevier: Emmanuel Pietriga (Guest Editor)

8.1.3. Journal reviewing

Transactions on Computer-Human Interaction (TOCHI), ACM: Caroline Appert, Olivier Chapuis, Wendy Mackay, Emmanuel Pietriga

Transactions on Visualization and Computer Graphics (TVCG): Anastasia Bezerianos

International Journal of Human-Computer Studies (IJHCS), Elsevier: Caroline Appert, Anastasia Bezerianos

Human-Computer Interaction (HCI), Taylor & Francis: Michel Beaudouin-Lafon, Olivier Chapuis

Software: Practice and Experience, Wiley: Emmanuel Pietriga

8.1.4. Conference organization

ACM CHI 2013 Program Committee Meeting - ACM Conference on Human Factors in Computing Systems: Wendy Mackay (General Chair), Michel Beaudouin-Lafon (Technical Program Committee Co-Chair)

ACM CHI 2012 - ACM Conference on Human Factors in Computing Systems: Caroline Appert (Program Committee member), Olivier Chapuis (Program Committee member), Emmanuel Pietriga (Program Committee member)

ACM ECRC 2012 - First ACM European Computer Research Congress: Michel Beaudouin-Lafon (Organizing Committee member)

ACM UIST 2012 - ACM Symposium on User Interface Software and Technology: Caroline Appert (Program Committee member)

ACM NordiCHI 2012 - Nordic forum for human-computer interaction research: Emmanuel Pietriga (Program Committee member)

IEEE VL/HCC 2012 - IEEE Symposium on Visual Languages and Human Centric Computing: Emmanuel Pietriga (Program Committee member)

IEEE Symposium on Visual Languages and Human Centric Computing: Emmanuel Pietriga (Steering Committee member, chair since September 2011)

IEEE PacificVis 2012 - Pacific Visualization Symposium: Anastasia Bezerianos (Program Committee member)

ACM WWW 2012 (Tutorials) - ACM World Wide Web: Emmanuel Pietriga (Program Committee member)

ACM CHI 2012 Panel “RepliCHI”: Wendy Mackay (Panelist and Co-Organizer)

SIGRAD 2012 - Eurographics Nordic forum for computer graphics and visualization

8.1.5. Conference reviewing

ACM CHI 2012: Caroline Appert, Michel Beaudouin-Lafon, Anastasia Bezerianos, Olivier Chapuis, Jérémie Garcia, Stéphane Huot, Wendy Mackay, Mathieu Nancel, Emmanuel Pietriga, Daniel Spelmezan, Theophanis Tsandilas

ACM UIST 2012: Michel Beaudouin-Lafon, David Bonnet, Olivier Chapuis, Stéphane Huot, Wendy Mackay, Mathieu Nancel, Emmanuel Pietriga, Theophanis Tsandilas, Julie Wagner

ACM CSCW 2012 - ACM Conference on Computer Supported Cooperative Work: Emmanuel Pietriga

ACM EICS 2012 - ACM Symposium on Engineering Interactive Computing Systems: Emmanuel Pietriga

ACM MobileHCI 2012 - ACM Conference on Human Computer Interaction with Mobile Devices and Services: Olivier Chapuis, Stéphane Huot, Daniel Spelmezan

ACM NordiCHI 2012: David Bonnet, Olivier Chapuis, Can Liu, Mathieu Nancel

ACM DIS 2012 - ACM Conference on Designing Interactive Systems: Michel Beaudouin-Lafon, Mathieu Nancel

TEI 2012 - Conference on Tangible Embedded and Embodied Interaction: Caroline Appert

IUI 2012 - International Conference on Intelligent User Interfaces: Michel Beaudouin-Lafon, Stéphane Huot

IEEE InfoVis 2012 - IEEE Information Visualization Conference: Anastasia Bezerianos, Emmanuel Pietriga

IEEE PacificVis 2012 - IEEE Pacific Visualization Symposium: Anastasia Bezerianos, Mathieu Nancel

IEEE VAST 2012 - Visual Analytics Software and Technology: Anastasia Bezerianos, Emmanuel Pietriga

IEEE SciVis 2012 - Visual Analytics Software and Technology: Emmanuel Pietriga

Ergo’IHM 2012: Stéphane Huot

8.1.6. Scientific associations

ACM: Michel Beaudouin-Lafon member of the ACM Europe Council (since 2009)

ACM SIGCHI Paris Local Chapter: Anastasia Bezerianos (Vice Chair), Julie Wagner (Seminars Co-Organizer, Webmaster)

AFIHM (French speaking HCI asssociation): Michel Beaudouin-Lafon member of the Scientific Board (CPPMS), Stéphane Huot member of the Scientific Board (CPPMS) since 2012

ACM SIGCHI: Wendy Mackay, member of CHI Conference Management Committee (since 2011)

8.1.7. Evaluation committees and invited expertise

European Research Council (ERC): Michel Beaudouin-Lafon (SYNERGY Grants panel member)

Steering Committee for ANR CONTINT, National Research Agency, member: Michel Beaudouin-Lafon

ALLISTENE (Alliance des Sciences et Technologies du Numérique) working group on Knowledge, Content and Interaction, members: Wendy Mackay, Michel Beaudouin-Lafon

IRCAM (Paris) Scientific Committee, member: Michel Beaudouin-Lafon

TELECOM ParisTech Research Committee, member: Michel Beaudouin-Lafon

CIGREF Scientific Council, member: Michel Beaudouin-Lafon

Expert reviewer for NSERC (Canada): Michel Beaudouin-Lafon

Expert reviewer for ANR: Caroline Appert, Olivier Chapuis, Stéphane Huot, Emmanuel Pietriga, Wendy Mackay

Univ. Paris-Sud hiring committee, Commission Consultative des Spécialistes de l'Université 27ème section (computer science), members: Michel Beaudouin-Lafon, Stéphane Huot, Wendy Mackay

Univ. Paris-Sud hiring committee, Comité de Sélection 27ème section (computer science), members: Michel Beaudouin-Lafon

Univ. Paul Sabatier (Toulouse) hiring committee, Comité de Sélection 27ème section (computer science), members: Caroline Appert, Stéphane Huot

8.1.8. Awards

Wendy Mackay: European Research Council Advanced Grant

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

Master : Caroline Appert (Lecturer), "Evaluation of interactive systems", 50h, ICT Labs Masters in Computer Science - Human-Computer Interaction and Design Specialty (M1), Université Paris-Sud, France

Master : Caroline Appert, "Internships coordination", 5h, Research Masters in Computer Science - Interaction Specialty (M2), Université Paris-Sud, France

Master : Michel Beaudouin-Lafon, "General Master coordination", 10h, ICT Labs Masters in Computer Science - HCID Specialty (M1), Université Paris-Sud, France

Master : Michel Beaudouin-Lafon, "General Master coordination", 10h, Research Masters in Computer Science - Interaction Specialty (M2), Université Paris-Sud, France

Master : Michel Beaudouin-Lafon (Lecturer), "Fundamentals of Human-Computer Interaction", 25h, Research Masters in Computer Science - HCI Specialty (M2) & ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty(M1), Université Paris-Sud, France

Master : Michel Beaudouin-Lafon (Lecturer), "Groupware and Collaborative Interaction", 20h, Research Masters in Computer Science - Interaction Specialty (M2), Université Paris-Sud, France

Master : Michel Beaudouin-Lafon (Lecturer), "Human-Computer Interaction project", 15h, ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty (M1), Université Paris-Sud, France

Master : Anastasia Bezerianos (Lecturer), “General Master coordination”, 10h, Masters in Computer Science - ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty (M1), Université Paris-Sud, France

Master : Anastasia Bezerianos (Lecturer), “General Master coordination”, 10h, Research Masters in Computer Science - Interaction Specialty (M2), Université Paris-Sud, France

Master : Anastasia Bezerianos (Lecturer), “Programming of Interactive Systems”, 24h, ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty (M1), Masters in Computer Science - M1 Classic & MIAGE, Université Paris-Sud, France

Master : Anastasia Bezerianos (Lecturer), “Mixed Reality and Tangible Interaction”, 12h, Research Masters in Computer Science - Interaction Specialty (M2), Université Paris-Sud, France

Master : Anastasia Bezerianos (Lecturer), “Design and Evaluation of Interactive Systems”, 24h, ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty (M1), Université Paris-Sud, France

Licence : Anastasia Bezerianos (Lecturer), “Développement Logiciel”, 10h, Licence Mention Informatique (L2), Université Paris-Sud, France

3eme année : Anastasia Bezerianos (Lecturer), “Interaction Homme-Machine”, Polytech Paris-Sud, France

Master : David Bonnet (Teaching Assistant), “Fundamentals of Human-Computer Interaction”, 25h, Research Masters in Computer Science - HCI Specialty (M2) & ICT Labs Masters in Computer Science - Human-Computer Interaction and Design specialty (M1), Université Paris-Sud, France

Licence : David Bonnet (Teaching Assistant), “Développement Logiciel”, 40h, Licence 2 Mention Informatique, Université Paris-Sud, France

Licence : Jérémie Garcia (Teaching Assistant), “Développement Logiciel”, 33h, Licence 2 Mention Informatique, Université Paris-Sud, France

Master : David Bonnet (Teaching Assistant), “Programming of Interactive Systems”, 26h, Masters in Computer Science - HCID Specialty (M1), M1 Classic, MIAGE, Université Paris-Sud, France

Licence : Jérémie Garcia (Teaching Assistant), “Vie Artificielle”, 32h, Licence 2 Mention Informatique, Université Paris-Sud, France

Undergraduate and Master: Wendy Mackay (Lecturer) “CS.377 Prototyping Interactive Systems”, 40h, Computer Science, Stanford University, USA.

Undergraduate and Master: Wendy Mackay (Lecturer) “CS.294h Design of Interactive Systems”, 40h, Computer Science, Stanford University, USA.

Master : Wendy Mackay (Lecturer) “Design and Evaluation of Interactive Systems” 24h, ICT Labs Masters in Computer Science - HCID Specialty (M1), Université Paris-Sud, France

Master : Wendy Mackay (Lecturer) “Design and Evaluation of Interactive Systems” 24h, Research Masters in Computer Science - HCID Specialty (M1), Université Paris-Sud, France

Master : Wendy Mackay (Lecturer) “Design and Evaluation of Interactive Systems” 24h, Professional Masters in Computer Science - HCID Specialty (M1), Université Paris-Sud, France

Master : Wendy Mackay (Lecturer) “Fondements de la Recherche” 24h, Research Masters in Computer Science - all three specialties (M2), Université Paris-Sud, France

Master : Mathieu Nancel (Teaching Assistant), “Programming of Interactive Systems”, 29h, Masters in Computer Science - M1 Classic & MIAGE, Université Paris-Sud, France

Licence : Mathieu Nancel (Teaching Assistant), “Ceritificat Informatique et Internet”, 3h (tutoring), Licence Mention Informatique (L1), Université Paris-Sud, France

3eme année : Mathieu Nancel (Teaching Assistant), “Bases de données”, 20h, Polytech Paris-Sud, France

3eme année : Mathieu Nancel (Teaching Assistant), “Interaction Homme-Machine”, 24h, Polytech Paris-Sud, France

Master : Theophanis Tsandilas (Guest Lecturer), “Introduction to Human-Computer Interaction”, 4.5h, DMKM Erasmus Mundus (M2), Polytech’Nantes, France

Master Thesis Supervision: Anastasia Bezerianos, Olivier Chapuis, “Navigating large information spaces on wall displays using mobile devices”, student: Stelios Frantzeskakis, Université Paris-Sud, France

Master Thesis Supervision: Theophanis Tsandilas, Anastasia Bezerianos, “Linking digital tabletops with physical paper for creative interactions”, student: Jéronimo Barbosa, Universidade Federal de Pernambuco (CIn/UFPE), Recife, Brazil

Master Thesis Supervision: Olivier Chapuis, Carolien Appert “Focus+Context Navigation and Interaction on Graphical Tablets”, student: Lei Chen, Telecom Brest, France

8.2.2. Supervision

HDR: Emmanuel Pietriga, “Languages and Interaction Techniques for the Visualization and Manipulation of Massive Datasets”, Université Paris-Sud, June 8th, 2012.

Ph.D.: Mathieu Nancel, “Designing and Combining Interaction Techniques in Large Display Environments”, Université Paris-Sud, December 5th, 2012, Michel Beaudouin-Lafon and Emmannuel Pietriga.

Ph.D.: Julie Wagner, “A Body-centric Framework for Generating and Evaluating Novel Interaction Techniques”, Université Paris-Sud, December 6th, 2012, Wendy Mackay and Stéphane Huot.

Ph.D.: Émilien Ghomi, “Studying expert practices as a basis for designing expressive interaction techniques”, Université Paris-Sud, December 17th, 2012, Michel Beaudouin-Lafon and Stéphane Huot.

Ph.D.: Micheline Elias, “Semantic Information Retrieval and Visualization in Business Intelligence Dashboards”, École Centrale de Paris, October 14th, 2012, Anastasia Bezerianos and Marie-Aude Aufaure (École Centrale de Paris)

Ph.D. in progress: David Bonnet, “Gesture-based interactions and instrumental interaction”, started in September 2011, Michel Beaudouin-Lafon and Caroline Appert

Ph.D. in progress: Jérémie Garcia, “Supporting creative activities with interactive paper”, started in September 2010, Wendy Mackay and Theophanis Tsandilas

Ph.D. in progress: Cyprien Pindat, “Multi-dimensional exploration of complex multi-scale data”, started in September 2010, Claude Puech, Olivier Chapuis and Emmanuel Pietriga

Ph.D. in progress: Can Liu, “Collaborative Multiscale Navigation and Interaction”, started in September 2012, Michel Beaudouin-Lafon, Olivier Chapuis and Eric Lecolinet (Télécom ParisTech)

Ph.D. in progress: Daniel Strazzulla, “Multimedia Communication”, started in September 2012, Wendy Mackay

8.2.3. Juries

Sarah Alaoui (LIMSI, Univ. Paris-Sud, Orsay): Michel Beaudouin-Lafon (president), December 2012.

Jérôme Azé (LRI, Univ. Paris-Sud, Orsay - Habilitation): Michel Beaudouin-Lafon (president), November 2012.

Géry Casiez (LIFL, Univ. Lille 1, Lille - Habilitation): Michel Beaudouin-Lafon, (reviewer), November 2012.

Mathias Baglioni (Télécom ParisTech, Paris): Stéphane Huot (examiner), April 2012.

Aurélie Cohé (Univ. Bordeaux 1, Bordeaux): Caroline Appert (examiner), December 2012.

Micheline Elias (PhD, École Centrale de Paris, October 14th, 2012): Anastasia Bezerianos (advisor).

Mathieu Nancel (Ph.D., Université Paris-Sud, December 5th, 2012), Michel Beaudouin-Lafon (director) and Emmanuel Pietriga (advisor).

Emmanuel Pietriga (HDR, Université Paris-Sud, June 8th, 2012), Wendy Mackay (jury).

Julie Wagner (Ph.D., Université Paris-Sud, December 6th, 2012), Wendy Mackay (director) and Stéphane Huot (advisor).

Émilien Ghomi (Ph.D., Université Paris-Sud, December 17th, 2012), Michel Beaudouin-Lafon (director) and Stéphane Huot (advisor).

8.3. Popularization

- Wendy Mackay: “Les Dossiers de la Recherche, Entretien avec Wendy Mackay : Les tablettes seront de plus en plus interactives”, *La Recherche*, June 2012
- Michel Beaudouin-Lafon, Romain Primet: “La Plateforme WILD”, Presentation of WILD to High School students, November 2012.
- Michel Beaudouin-Lafon, Romain Primet: “WILD: An interactive platform for visualizing high-resolution data” Delegation from Chile (government and academia), November 2012.
- Wendy Mackay, Romain Primet: “WILD: une plateforme de visualisation interactive haute résolution” Presentation of WILD to HEC students, December 2012.
- Emmanuel Pietriga, Roman Primet: "La Plateforme WILD", Presentation of WILD to visitors from the French Ministry of Research and Inria’s Administration Council, April 2012.
- Roman Primet: Presentation of WILD to industrial visitors of LRI, Visite des Industriels, Fête de la Science, October 2012.
- Theophanis Tsandilas, Julie Wagner, and Émilien Ghomi: Presentations for "Who is interaction design?", Centre Pompidou, Future en Seine, June 2012.

9. Bibliography

Major publications by the team in recent years

[1] C. Appert, S. Huot, P. Dragicevic, M. Beaudouin-Lafon. *FlowStates: Prototypage d’applications interactives avec des flots de données et des machines à états*, in ""Proceedings of IHM 2009", "ACM, Octobre 2009, p. 119-128, Best Paper Award, http://doi.acm.org/10.1145/1629826.1629845.

[2] M. Beaudouin-Lafon, O. Chapuis, J. Eagan, T. Gjerlufsen, S. Huot, C. Klokmose, W. Mackay, M. Nancel, E. Pietriga, C. Pillias, R. Primet, J. Wagner. *Multi-surface Interaction in the WILD Room*, in "Computer", 2012, vol. 45, n^{o} 4, p. 48–56, http://dx.doi.org/10.1109/MC.2012.110.

[3] O. Chapuis, J.-B. Labrune, E. Pietriga. *DynaSpot: speed-dependent area cursor*, in "CHI ’09: Proceedings of the 27th international conference on Human factors in computing systems", ACM, 2009, p. 1391–1400, Notable Mention Award, http://doi.acm.org/10.1145/1518701.1518911, http://hal.archives-ouvertes.fr/inria-00373678.

[4] O. Chapuis, N. Roussel. *UIMarks: Quick Graphical Interaction with Specific Targets*, in "UIST ’10: Proceedings of the 23rd annual ACM symposium on User interface software and technology", ACM, October 2010, p. 173–182, http://doi.acm.org/10.1145/1866029.1866057, http://hal.archives-ouvertes.fr/inria-00533398.

[5] J. EAGAN, W. MACKAY, M. BEAUDOUIN-LAFON. *Cracking the Cocoa Nut: User Interface Programming at Runtime*, in "UIST 2011: Proceedings of the 24th ACM Symposium on User Interface Software and Technology", ACM, 2011, p. 225–234, Notable Mention Award, http://doi.acm.org/10.1145/2047196.2047226.

[6] E. GHOMI, G. FAURE, S. HUOT, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Using Rhythmic Patterns as an Input Method*, in "CHI '12: Proceedings of the 30th international conference on Human factors in computing systems", ACM, 2012, p. 1253–1262, Best Paper Award, http://doi.acm.org/10.1145/2207676.2208579.

[7] S. HUOT, O. CHAPUIS, P. DRAGICEVIC. *TorusDesktop: pointing via the backdoor is sometimes shorter*, in "Proceedings of the 2011 annual conference on Human factors in computing systems", New York, NY, USA, CHI '11, ACM, 2011, p. 829–838, http://doi.acm.org/10.1145/1978942.1979064.

[8] W. MACKAY, C. APPERT, M. BEAUDOUIN-LAFON, O. CHAPUIS, Y. DU, J.-D. FEKETE, Y. GUIARD. *TouchStone: Exploratory Design of Experiments*, in "Proceedings of ACM CHI 2007 Conference on Human Factors and Computing Systems", ACM Press, April 2007, p. 1425-1434, http://doi.acm.org/10.1145/1240624.1240840, http://hal.archives-ouvertes.fr/inria-00538384.

[9] M. NANCEL, J. WAGNER, E. PIETRIGA, O. CHAPUIS, W. MACKAY. *Mid-air pan-and-zoom on wall-sized displays*, in "Proceedings of the 2011 annual conference on Human factors in computing systems", New York, NY, USA, CHI '11, ACM, 2011, p. 177–186, Best Paper Award, http://doi.acm.org/10.1145/1978942.1978969.

[10] T. TSANDILAS, C. LETONDAL, W. MACKAY. *Musink: Composing Music through Augmented Drawing*, in "CHI '09: Proceedings of the SIGCHI conference on Human factors in computing systems", ACM, 2009, p. 819–828, Best Paper Award, http://doi.acm.org/10.1145/1518701.1518827.

Publications of the year

Doctoral Dissertations and Habilitation Theses

[11] É. GHOMI. *Designing expressive interaction techniques for novices inspired by expert activities: the case of musical practice*, Univ Paris-Sud, Orsay, France, Décembre 2012, Décembre 2012.

[12] M. NANCEL. *Designing and Combining Interaction Techniques in Large Display Environments*, Univ Paris-Sud, Orsay, France, Décembre 2012, Décembre 2012, http://tel.archives-ouvertes.fr/tel-00772458/.

[13] E. PIETRIGA. *Langages et techniques d'interaction pour la visualisation et la manipulation de masses de données*, Université Paris Sud - Paris XI, June 2012, Habilitation à Diriger des Recherches, http://hal.inria.fr/tel-00709533.

[14] J. WAGNER. *A Body-centric Framework for Generating and Evaluating Novel Interaction Techniques*, Univ Paris-Sud, Orsay, France, Décembre 2012, Décembre 2012, http://tel.archives-ouvertes.fr/tel-00772138.

Articles in International Peer-Reviewed Journals

[15] M. BEAUDOUIN-LAFON, O. CHAPUIS, J. EAGAN, T. GJERLUFSEN, S. HUOT, C. KLOKMOSE, W. E. MACKAY, M. NANCEL, E. PIETRIGA, C. PILLIAS, R. PRIMET, J. WAGNER. *Multisurface Interaction in the WILD Room*, in "IEEE COMPUTER", April 2012, vol. 45, n^o 4, p. 48-56 [*DOI :* 10.1109/MC.2012.110], http://hal.inria.fr/hal-00687825.

[16] A. BEZERIANOS, P. ISENBERG. *Perception of Visual Variables on Tiled Wall-Sized Displays for Information Visualization Applications*, in "IEEE Transactions on Visualization and Computer Graphics", 2012, vol. 18, n° 12, To appear, http://hal.inria.fr/hal-00719203.

[17] N. BOUKHELIFA, A. BEZERIANOS, T. ISENBERG, J.-D. FEKETE. *Evaluating Sketchiness as a Visual Variable for the Depiction of Qualitative Uncertainty*, in "IEEE Transactions on Visualization and Computer Graphics (Proceedings Scientific Visualization / Information Visualization 2012)", December 2012, vol. 18, n° 12, http://hal.inria.fr/hal-00717441.

[18] S. ZHAI, PER OLA. KRISTENSSON, C. APPERT, TUE HASTE. ANDERSEN, X. CAO. *Foundational Issues in Touch-Screen Stroke Gesture Design - An Integrative Review*, in "Foundations and Trends in Human-Computer Interaction", 2012, vol. 5, n° 2, p. 97-205, http://dx.doi.org/10.1561/1100000012, http://hal.inria.fr/hal-00765046.

International Conferences with Proceedings

[19] C. APPERT, O. CHAPUIS, E. PIETRIGA. *Dwell-and-Spring: Undo for Direct Manipulation*, in "CHI '12: Proceedings of the SIGCHI Conference on Human Factors and Computing Systems", Austin, United States, May 2012, p. 1957–1966 [*DOI :* 10.1145/2207676.2208339], http://hal.inria.fr/hal-00663638.

[20] L. BIGO, J. GARCIA, A. SPICHER, W. E. MACKAY. *PaperTonnetz: Music Composition with Interactive Paper*, in "Sound and Music Computing", Copenhague, Denmark, July 2012, http://hal.inria.fr/hal-00718334.

[21] R. A. DE ALMEIDA, C. PILLIAS, E. PIETRIGA, P. CUBAUD. *Looking behind Bezels: French Windows for Wall Displays*, in "AVI - 11th working conference on Advanced visual interfaces - 2012", Capri, Italy, ACM (editor), May 2012, p. 124-131 [*DOI :* 10.1145/2254556.2254581], http://hal.inria.fr/hal-00701753.

[22] M. ELIAS, A. BEZERIANOS. *Annotating BI Visualization Dashboards: Needs and Challenges*, in "CHI - the ACM annual conference on Human Factors in Computing Systems", Austin, United States, ACM, 2012, p. 1641–1650 [*DOI :* 10.1145/2207676.2208288], http://hal.inria.fr/hal-00719221.

[23] J. GARCIA, T. TSANDILAS, C. AGON, W. MACKAY. *Interactive Paper Substrates to Support Musical Creation*, in "SIGCHI Conference on Human Factors in Computing Systems", Austin, Texas, United States, May 2012, http://hal.inria.fr/hal-00664334.

[24] *Best Paper*
E. GHOMI, G. FAURE, S. HUOT, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Using Rhythmic Patterns as an Input Method*, in "CHI '12: Proceedings of the SIGCHI Conference on Human Factors and Computing Systems", Austin, United States, May 2012, p. 1253–1262, Best Paper Award [*DOI :* 10.1145/2207676.2208579], http://hal.inria.fr/hal-00663973.

[25] *Best Paper*
C. LIU, S. HUOT, J. DIEHL, W. E. MACKAY, M. BEAUDOUIN-LAFON. *Evaluating the Benefits of Real-time Feedback in Mobile Augmented Reality with Hand-held Devices*, in "CHI'12 - 30th International Conference on Human Factors in Computing Systems - 2012", Austin, United States, ACM Press, May 2012, p. 2973–2976, Notable Mention Award, http://hal.inria.fr/hal-00663974.

[26] E. PIETRIGA, P. CUBAUD, J. SCHWARZ, R. PRIMET, M. SCHILLING, D. BARKATS, E. BARRIOS, B. VILA VILARO. *Interaction design challenges and solutions for ALMA operations monitoring and control*, in "SPIE Astronomical Telescopes and Instrumentation", Amsterdam, Netherlands, SPIE (editor), SPIE, July 2012, vol. 8451 [*DOI :* 10.1117/12.925180], http://hal.inria.fr/hal-00735792.

[27] C. PINDAT, E. PIETRIGA, O. CHAPUIS, C. PUECH. *JellyLens: Content-Aware Adaptive Lenses*, in "UIST - 25th Symposium on User Interface Software and Technology - 2012", Cambridge, MA, United States, ACM, October 2012, p. 261-270 [*DOI :* 10.1145/2380116.2380150], http://hal.inria.fr/hal-00721574.

[28] B. SCHNEIDER, P. BLIKSTEIN, W. MACKAY. *Combinatorix: a Tangible User Interface that Supports Colaborative Learning of Probabilities*, in "ITS '12: Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces", ACM, 2012, p. 129-132, http://doi.acm.org/10.1145/2396636.2396656.

[29] *Best Paper*
D. SPELMEZAN. *An Investigation into the Use of Tactile Instructions in Snowboarding.*, in "MobileHCI '12: Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services", United States, September 2012, p. 417–426, Best Paper Award, http://hal.inria.fr/hal-00744527.

[30] T. TSANDILAS. *Interpreting Strokes on Paper with a Mobile Assistant*, in "UIST - 25th Symposium on User Interface Software and Technology - 2012", Cambridge, MA, United States, ACM, October 2012, p. 299-308, http://hal.inria.fr/hal-00722810.

[31] J. WAGNER, S. HUOT, W. MACKAY. *BiTouch and BiPad: Designing Bimanual Interaction for Hand-held Tablets*, in "CHI'12 - 30th International Conference on Human Factors in Computing Systems - 2012", Austin, United States, ACM Press, May 2012, http://hal.inria.fr/hal-00663972.

[32] J. WAGNER, W. E. MACKAY, S. HUOT. *Left-over Windows Cause Window Clutter... But What Causes Left-over Windows?*, in "Ergo'IHM 2012 - 24th French Speaking Conference on Human-Computer Interaction", Biarritz, France, International Conference Proceedings Series, ACM, October 2012, p. 47–50, http://hal.inria.fr/hal-00776301.

Conferences without Proceedings

[33] F. F. FILHO, B. CLEARY, W. MACKAY, P. L. DE GEUS. *Using the web to explore scientific knowledge and extend the desktop information space*, in "CSCW 2012 Extended Abstracts", 2012, 4 pages.

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