Activity Report 2015

Team EX-SITU

Extreme Situated Interaction

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Saclay - Île-de-France

THEME
Interaction and visualization

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Team EX-SITU

Creation of the Team: 2015 January 01

Keywords:

Computer Science and Digital Science:

5.1. - Human-Computer Interaction
5.1.1. - Engineering of interactive systems
5.1.2. - Evaluation of interactive systems
5.1.5. - Body-based interfaces
5.1.6. - Tangible interfaces
5.1.7. - Multimodal interfaces

Other Research Topics and Application Domains:

1.3. - Neuroscience and cognitive science
9.2.1. - Music, sound
9.5.1. - Psychology

1. Members

Research Scientists

Wendy Mackay [Team leader, Inria, Principal Research Scientist, DR0, HdR]
Theophanis Tsandilas [Inria, Research Scientist, CR1]

Faculty Members

Michel Beaudouin-Lafon [Univ. Paris-Sud, Professor, HdR]
Sarah Fdili Alaoui [Univ. Paris-Sud, Assistant Professor, from Oct 2015]
Cédric Fleury [Univ. Paris-Sud, Assistant Professor]

Engineers

Olivier Gladin [Engineer SED, Inria]
Rémi Hellequin [Engineer (IR), CNRS-Digiscope]
Amani Kooli [Engineer (IE), CNRS-Digiscope]
Monireh Sanaei [Engineer (IJD), Inria, until Jan 2015]
Jonathan Thorpe [Engineer (IR), CNRS-Digiscope]

PhD Students

Jessalyn Alvina [Inria]
Ignacio Avellino Martinez [Inria]
Marianela Ciolfi Felice [Univ. Paris-Sud]
Carla Griggio [Inria, from May 2015]
Ghita Jalal [Inria]
German Leiva [Inria, from May 2015]
Can Liu [Inria]
Wanyu Liu [Institut Mines Telecom, from Oct 2015]
Nolwenn Maudet [Univ. Paris-Sud]
Yujiro Okuya [Univ. Paris-Sud, from Oct 2015]
Marc-Emmanuel Perrin [Institut Mines Telecom, from Oct 2015]
Daniel Strazzulla [Inria, until May 2015]
Michael Wessely [Inria, from Nov 2015]
Oleksandr Zinenko [Inria]

Post-Doctoral Fellow
Joseph Malloch [Inria]

Visiting Scientists
Ana Bernardos [Universidad Politécnica de Madrid, from Sep 2015 until Dec 2015]
Joanna Mcgrenere [University of British Columbia, from Aug 2015]

Administrative Assistant
Alexandra Merlin [Inria]

Others
Jean-Baptiste Louvet [Inria, Intern, from Apr 2015 until Sep 2015]
Thibault Raffaillac [Inria, from Mar 2015 until Sep 2015]
Niyati Roy Chowdhury [Inria, intern, until Sep 2015]
Panagiota Tziova [Inria, Intern, from Apr 2015 until Sep 2015]
Xu Yuebai [Inria, Intern, from May 2015 until Aug 2015]

2. Overall Objectives

2.1. Overall Objectives

Interactive devices are everywhere: we wear them on our wrists and belts; we consult them from purses and pockets; we read them on the sofa and on the metro; we rely on them to control cars and appliances; and soon we will interact with them on living room walls and billboards in the city. Over the past 30 years, we have witnessed tremendous advances in both hardware and networking technology, which have revolutionized all aspects of our lives, not only business and industry, but also health, education and entertainment. Yet the ways in which we interact with these technologies remains mired in the 1980s. The graphical user interface (GUI), revolutionary at the time, has been pushed far past its limits. Originally designed to help secretaries perform administrative tasks in a work setting, the GUI is now applied to every kind of device, for every kind of setting. While this may make sense for novice users, it forces expert users to use frustratingly inefficient and idiosyncratic tools that are neither powerful nor incrementally learnable.

ExSitu explores the limits of interaction — how extreme users interact with technology in extreme situations. Rather than beginning with novice users and adding complexity, we begin with expert users who already face extreme interaction requirements. We are particularly interested in creative professionals, artists and designers who rewrite the rules as they create new works, and scientists who seek to understand complex phenomena through creative exploration of large quantities of data. Studying these advanced users today will not only help us to anticipate the routine tasks of tomorrow, but to advance our understanding of interaction itself. We seek to create effective human-computer partnerships, in which expert users control their interaction with technology. Our goal is to advance our understanding of interaction as a phenomenon, with a corresponding paradigm shift in how we design, implement and use interactive systems. We have already made significant progress through our work on instrumental interaction and co-adaptive systems, and we hope to extend these into a foundation for the design of all interactive technology — to create a *physics of interaction*.

3. Research Program

3.1. Research Program

We characterize Extreme Situated Interaction as follows:

Extreme users. We study extreme users who make extreme demands on current technology. We know that human beings take advantage of the laws of physics to find creative new uses for physical objects. However, this level of adaptability is severely limited when manipulating digital objects. Even so, we find that creative professionals—artistists, designers and scientists—often adapt interactive technology in novel and unexpected ways and find creative solutions. By studying these users, we hope to not only address the specific problems they face, but also to identify the underlying principles that will help us to reinvent virtual tools. We seek to shift the paradigm of interactive software, to establish the laws of interaction that significantly empower users and allow them to control their digital environment.

Extreme situations. We develop extreme environments that push the limits of today's technology. We take as given that future developments will solve "practical" problems such as cost, reliability and performance and concentrate our efforts on interaction in and with such environments. This has been a successful strategy in the past: Personal computers only became prevalent after the invention of the desktop graphical user interface. Smartphones and tablets only became commercially successful after Apple cracked the problem of a usable touch-based interface for the iPhone and the iPad. Although wearable technologies, such as watches and glasses, are finally beginning to take off, we do not believe that they will create the major disruptions already caused by personal computers, smartphones and tablets. Instead, we believe that future disruptive technologies will include fully interactive paper and large interactive displays.

Our extensive experience with the Digiscope WILD and WILDER platforms places us in a unique position to understand the principles of distributed interaction that extreme environments call for. We expect to integrate, at a fundamental level, the collaborative capabilities that such environments afford. Indeed almost all of our activities in both the digital and the physical world take place within a complex web of human relationships. Current systems only support, at best, passive sharing of information, e.g., through the distribution of independent copies. Our goal is to support active collaboration, in which multiple users are actively engaged in the lifecycle of digital artifacts.

Extreme design. We explore novel approaches to the design of interactive systems, with particular emphasis on extreme users in extreme environments. Our goal is to empower creative professionals, allowing them to act as both designers and developers throughout the design process. Extreme design affects every stage, from requirements definition, to early prototyping and design exploration, to implmentation, to adaptation and appropriation by end users. We hope to push the limits of participatory design to actively support creativity at all stages of the design lifecycle.

Extreme design does not stop with purely digital artifacts. The advent of digital fabrication tools and FabLabs has significantly lowered the cost of making physical objects interactive. Creative professionals now create hybrid interactive objects that can be tuned to the user's needs. Integrating the design of physical objects into the software design process raises new challenges, with new methods and skills to support this form of extreme prototyping.

Our overall approach is to identify a small number of specific projects, organized around four themes: *Creativity, Augmentation, Collaboration* and *Infrastructure*. Specific projects may address multiple themes, and different members of the group work together to advance these different topics.

4. Application Domains

4.1. Creative industries

We work closely with creative professionals in the arts and in design, including music composers, musicians, and sound engineers; painters and illustrators; dancers and choreographers; theater groups; graphic and industrial designers; and architects.

4.2. Scientific research

We work with creative professionals in the sciences and engineering, including neuroscientists and doctors; programmers and statisticians; chemists and astrophysicists; and researchers in fluid mechanics.

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Michel Beaudouin-Lafon received the ACM SIGCHI Lifetime Service Award, which "goes to individuals who have contributed to the growth and success of SIGCHI in a variety of capacities. This award is for extended services to the community at large over a number of years" (http://www.sigchi.org/about/awards/2015-sigchi-awards).

Jérémie Garcia received the "Prix Jeune Chercheur Science et Musique", a best thesis award organized by IRISA (Rennes) and sponsored by the Association Française d'Informatique Musicale for his thesis *""Le papier interactif pour la composition musicale"*, supervised by Wendy Mackay, Theophannis Tsandilas and Carlos Agon (IRCAM) (http://jsm.irisa.fr/index.php/prix-jc.

Nolwenn Maudet received the "Prix Spécial du Jury du premier concours EDUCNUM Opération Vie privée", organized by CNIL (national commission for informatics and freedom), for her project *Data Fiction* with Thomas Thibault. This online game is designed to help teenagers better understand how their personal data can be exposed online and how to protect it.

ExSitu received three paper awards. One paper, *Webstrates* [18] received a best paper award at UIST 2015. Two other papers, *Color Portraits* [17] and *SketchSliders* [20], received Honorable Mention awards at CHI 2015 (at most 5% of CHI submissions receive an Honorable Mention).

BEST PAPER AWARD:

[18]
C. KLOKMOSE, J. EAGAN, S. BAADER, W. MACKAY, M. BEAUDOUIN-LAFON. *Webstrates: Shareable Dynamic Media*, in "28th Annual ACM Symposium on User Interface Software and Technology (UIST'15)", Charlotte, United States, ACM, November 2015, pp. 280-290 [*DOI :* 10.1145/2807442.2807446], https://hal.archives-ouvertes.fr/hal-01242672

6. New Software and Platforms

6.1. New Software

6.1.1. WildOS

Participant: Michel Beaudouin-Lafon [correspondant].

WildOS is middleware designed to support applications that run in an interactive room, such as our WILD and WILDER rooms, with various interaction resources, including a tiled wall display, a motion tracking system, interactive tabletops, tablets, smartphones and custom-made or 3d printed interactive devices. The conceptual model of WildOS is a *platform*, such as the WILD or WILDER room, that can be described as a set of devices on which one or more applications can be run.

WildOS consists of a server running on a machine that has network access to all the machines involved in the platform, and a set of clients running on the various interaction resources, such as a display cluster or a tablet. Once *WildOS* is running, applications can be started and stopped and devices can be added to or removed from the platform.

WildOS relies on Web technologies, most notably Javascript and node.js, as well as node-webkit and HTML5. This makes it inherently portable (it is currently tested on Mac OS X and Linux). While applications can be developed only with these Web technologies, it is also possible to bridge to existing applications developed in other environments if they provide sufficient access for remote control. Sample applications include a web browser, an image viewer, a window manager, and the BrainTwister application developed in collaboration with neuroanatomists at NeuroSpin.

WildOS is used for several research projects at ExSitu and by other partners of the Digiscope project. It was also deployed on several of Google's interactive rooms in Mountain View, Dublin and Paris. It is available under on Open Source licence at https://bitbucket.org/mblinsitu/wildos.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: helps development of multisurface applications.
- OS/Middleware: Crossplatform
- Required library or software: node.js, node-webkit
- Programming language: Javascript

6.1.2. Unity Cluster

Participants: Cédric Fleury [correspondant], Jean-Baptiste Louvet.

Unity Cluster is middleware to distribute any Unity 3D (https://unity3d.com/) application on a cluster of computers that run in interactive rooms, such as our WILD and WILDER rooms, or immersive CAVES (Computer-Augmented Virtual Environments). Users can interact the the application with various interaction resources.

Unity Cluster provides an easy solution for running existing Unity 3D applications on any display that requires a rendering cluster with several computers. *Unity Cluster* is based on a master-slave architecture: The master computer runs the main application and the physical simulation as well as manages the input; the slave computers receive updates from the master and render small parts of the 3D scene. *Unity Cluster* manages data distribution and synchronization among the computers to obtain a consistent image on the entire wall-sized display surface.

Unity Cluster can also deform the displayed images according to the user's position in order to match the viewing frustum defined by the user's head and the four corners of the screens. This respects the motion parallax of the 3D scene, giving users a better sense of depth.

Unity Cluster is composed of a set of C Sharp scripts that manage the network connection, data distribution, and the deformation of the viewing frustum. In order to distribute an existing application on the rendering cluster, all scripts must be embedded into a Unity package that is included in an existing Unity project.

- ACM: C.2.4 [Distributed Systems]: Distributed applications, I.3.7 [3D Graphics and Realism]: Virtual reality
- Software benefit: adapts existing Unity 3D application to a rendering cluster of an interactive room.
- OS/Middleware: Crossplatform
- Required library or software: Unity 3D
- Programming language: C Sharp

6.2. Platforms

6.2.1. WILDER

Participants: Michel Beaudouin-Lafon [correspondant], Cédric Fleury, Olivier Gladin, Rémi Hellequin, Stéphane Huot, Amani Kooli, Monireh Sanaei, Gabriel Tezier, Jonathan Thorpe.

WILDER (Figure 1) is our second experimental ultra-high-resolution interactive environment, which follows the WILD platform developed in 2009 [2]. It features a wall-sized display with seventy-five 20" LCD screens, i.e. a 5m50 x 1m80 (18' x 6') wall displaying 14 400 x 4 800 = 69 million pixels, powered by a 10-computer cluster and two front-end computers. The platform also features a camera-based motion tracking system that lets users interact with the wall, as well as the surrounding space, with various mobile devices. The display uses a multitouch frame (the largest of its kind in the world) to make the entire wall touch sensitive.

WILDER was inaugurated in June, 2015. It is one of the ten platforms of the Digiscope Equipment of Excellence and, in combination with WILD and the other Digiscope rooms, provides a unique experimental environment for collaborative interaction.

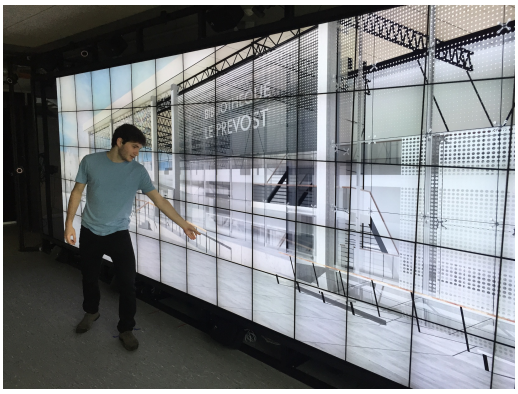
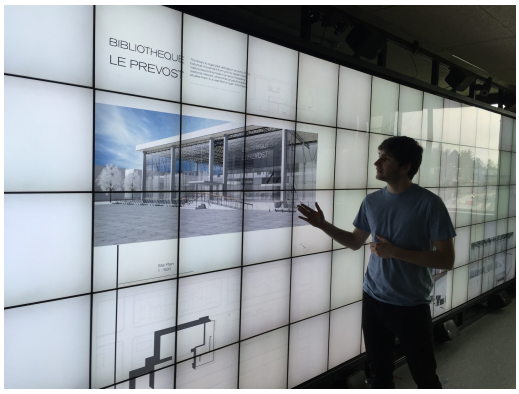

Figure 1. The WILDER platform.

In addition to using WILD and WILDER for our research, we have also developed software architectures and toolkits, such as WildOS and Unity Cluster, that enable developers to run applications on these multi-device, cluster-based systems.

7. New Results

7.1. Fundamentals of Interaction

Participants: Sarah Fdili Alaoui, Michel Beaudouin-Lafon, Cédric Fleury, Wendy Mackay, Theophanis Tsandilas.

In order to better understand fundamental aspects of interaction, ExSitu studies interaction in extreme situations. We conduct indepth observational studies and controlled experiments which contribute to theories and frameworks that unify our findings and help us generate new, advanced interaction techniques. Although we continue to explore the theory of Instrumental Interaction in the context of multi-surface environments [23], we are also extending it into a wider framework we call *information substrates*. This has resulted in several prototypes, such as Webstrates [18]. We also continue to study elementary interaction tasks in large-scale environments, such as pointing [11] and object manipulation [15].

Information substrates – "Instrumental interaction" argues that, since our interaction with the physical world is often mediated by tools, or instruments, we should do the same in the digital world. Our work on multisurface environments has demonstrated the value of this model, for example, to support distributed interfaces in which the user controls the content of a wall-sized display using handheld devices [23]. Instrumental interaction does not, however, describe the "objects of interest" that instruments interact with, nor does it explain how an object becomes an instrument, nor how users appropriate them in unexpected ways (the principle of "co-adaptation").

"Information substrates" embrace a wider scope than instrumental interaction: both objects and instruments are "substrates" that hold information and behavior, and can be combined in arbitrary ways. What makes an object an instrument is defined not by what it is but by how the user uses it. We started to explore this concept wiyh Webstrates [23], a web-based environment in which content and tools are embedded in the same information substrate—in this case the Document Object Model (DOM) (Figure 7).

Our work on information substrates has influenced other projects in the group. For example, our work on tools to help programmers parallelize and optimize their code [22] uses coordinated views of the code: a traditional text view and a graphical polyhedric visualization (Figure 2). These two substrates afford different types of manipulation by the user, but share the same underlying information, i.e. the algorithm being designed. The SketchSliders technique [20], described in the following section, provides users with an easily customizable approach to control complex visual displays. SketchSliders act as a substrate for creating slider instruments, which are independent from but tightly coupled with the visual display they control. By letting users define their own sliders, we solve the long-standing problem of combining power and simplicity. Finally, the ColorLab prototypes [17], described in the following section, provide artists and graphic designers with substrates that offer novel ways to interact with and display color relationships.

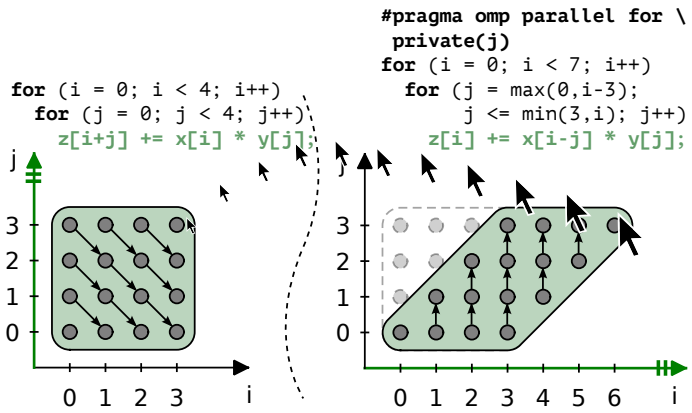

Figure 2. Performing a skew transformation to parallelize polynomial multiplication. The code is automatically transformed from its original form (left) to the skewed one (right).

Interaction in the large – ExSitu and its predecessor InSitu have a long history of studying the most fundamental action in visual environments: pointing. We recently published an extensive 64-page journal article [11] on our studies of pointing on large, wall-sized displays. In such environments, users must be able to point from a distance, typically up to a few meters from the screen, with great accuracy. Existing techniques are ill-suited for this task, due to the combination of the high index of difficulty and the constraint that users must be able to move around in the room while pointing.

We have designed and tested a number of techniques, including dual-mode techniques that combine coarse pointing with direct techniques, such as ray-casting or using the orientation of the head, and fine pointing with relative techniques, such as using a hand-held touchpad 3. Rather than proposing the "ultimate" pointing technique for such environments, we provide a set of criteria, a set of techniques derived from those criteria, and a calibration technique for optimizing the transfer functions used by relative pointing techniques under extreme conditions.

In collaboration with the Inria REVES group in Sophia Antipolis, we proposed a framework for analyzing 3D object manipulation in immersive environments [15]. We decomposed 3D object manipulation into the component movements, taking into account both physical constraints and mechanics. We then fabricated five physical devices that simulate these movements in a measurable way under experimental conditions. We implemented the devices in an immersive environment and conducted an experiment to evaluate direct finger-based against ray-based object manipulation. We identified the compromises required when designing devices that (i) are reproducible in both real and virtual settings, and (ii) can be used in experiments to measure user performance.

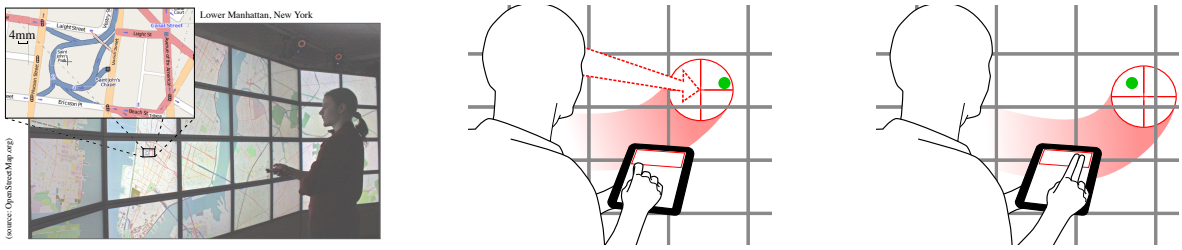

Figure 3. The challenge of pointing on a wall from a distance on a ultra-high resolution wall-sized display (left). Two of the pointing techniques that we evaluated: coarse pointing using the orientation of the head (center) vs. a two-finger swipe (right). In both cases, a one-finger swipe controls precise pointing.

7.2. Creativity

Participants: Sarah Fdili Alaoui, Michel Beaudouin-Lafon, Ghita Jalal, Wendy Mackay, Joseph Malloch, Nolwenn Maudet, Theophanis Tsandilas.

ExSitu is interested in understanding the work practices of creative professionals, particularly artists, designers, and scientists, who push the limits of interactive technology. This year, we conducted studies and created tools for a variety of such users. Based on contextual interviews with artists, designers and scientists, we created the *Color Portraits* design space [17] to characterize color manipulation activities, which influenced the design of a set of color manipulation tools (*Color Lab*). We designed *BricoSketch* [21] to enable professional illustrators to work at different levels of detail on paper. We studied how makers *remix* each others' designs by analyzing metadata from over 175,000 digital designs from Thingiverse [19]. We created *SketchSliders* [20] to help scientists explore their data by sketching and manipulating free-form interactive controllers. Finally, we studied the meaning and use of the term *evaluation* within the NIME (New Interfaces for Musical Expression) community [14].

Our studies of these "extreme users" allows us to obtain empirical grounding for the theoretical concepts of instrumental interaction, information substrates and co-adaptive systems. We expect to transfer what we learn to the design of creative tools, first for expert users, then for non-specialists and non-professional users.

Color Portraits – We conducted contextual interviews with 16 participants, who provided detailed examples of how they used color to create 69 different artistic or technical artifacts [17]. Based on results from these interviews, we created the Color Portraits design space to help identify color manipulation requirements that are poorly addressed by today's color manipulation tools. We then developed a set of novel color-manipulation tools that test the generative power of the design space. We presented these to users as probes. Our observations of how users interacted with the color probes provide implications for the design of more advanced tools.

BricoSketch – We conducted interviews with four professional illustrators and investigated how they use technology and paper in their creative process [21]. We also studied the evolution of the work of one of these illustrators for a period of two years. In interaction with this artist, we designed BricoSketch. BricoSketch enables illustrators to interactively create partial views of their drawings. Such views can be transposed and rescaled. Artists can then use them to create variations of their illustrations or add details with higher drawing precision. Our implementation is based on interactive paper technology that allows for above-the-surface interaction and supports traditional drawing tools such as common pens and pencils.

Remixing Designs – We investigated [19] how makers remix digital designs for physical objects on "Thingiverse", a well-established online 3D-printing maker community. We collected metadata from over 175,000 digital designs and analyzed the *remixing graph* – links between sources and remixes that primarily exhibit a tree-like inheritance structure. We also used this data to identify particularly influential and surprising

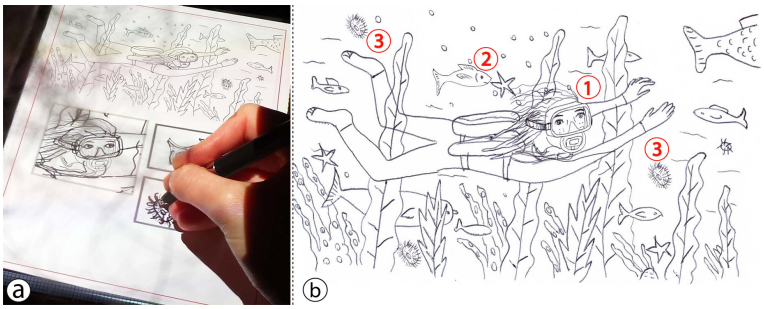

Figure 4. An artist drawing on paper with BricoSketch. (a) The artist has created three views on paper to draw parts of the illustration with higher detail: (1) the head of the diver, (2) a fish, and (3) an urchin. (b) The final composition after blending the partial views together.

"Things", which we further examined via qualitative case studies. We concluded with specific suggestions for online design repositories and design software so as to provide better support for remixing, and thus build stronger online maker communities.

SketchSliders – We developed SketchSliders [20], range sliders that users can freely sketch on a mobile device to parametrize and customize their data exploration on a wall display. With a small combination of sketches and gestures, users can create complex interactive controllers, such as slider branches and data transformation sliders 5. In addition to their natural custom shape, the sketched sliders can also be enhanced by interaction aids such as slider cursors, markers and distribution visualizations. We evaluated the sketching interface with six visualization experts and found that SketchSliders accommodate a wide range of exploration strategies, as well as help users focus and customize their visual explorations.

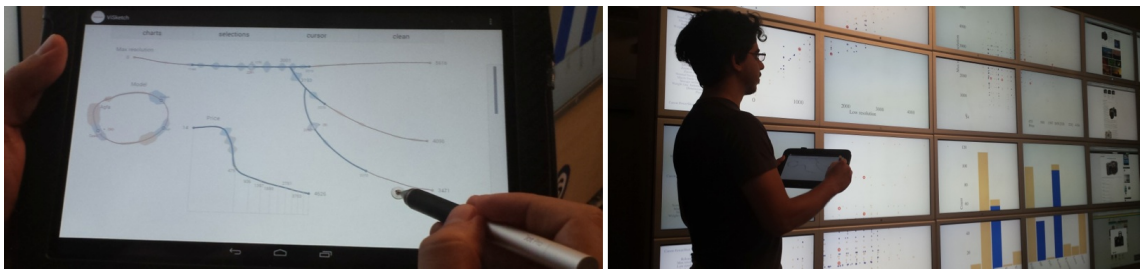

Figure 5. SketchSliders let users directly sketch viusalization controllers to explore multidimensional datasets.

Evaluation for NIME – We explored the use of evaluation techniques and terminology within the past three years of the New Interfaces for Music Expression (NIME) conference [14]. We categorized each paper that mentioned evaluation according to five criteria: a) targets and stakeholders considered, b) goals set, c) criteria used, d) methods used, and e) duration of evaluation. Results suggest that the NIME community does not share a common culture with respect to evaluation, with little consistency regarding use of the term. This paper raises the issue of evaluation within NIME community, with the goal of using it more consistently and effectively in the future.

7.3. Collaboration

Participants: Michel Beaudouin-Lafon, Cédric Fleury, Wendy Mackay, Can Liu, Ignacio Avellino Martinez.

ExSitu is interested in exploring new ways to support collaborative interaction, especially within and across large interactive spaces such as those of the Digiscope network (http://digiscope.fr/). We started to investigate how to support telepresence among large, heterogeneous interactive spaces [24], [25]. In particular, we studied how accurately a user can interpret deictic gestures in a video feed of a remote user [12]. These deictic gestures are important for conveying non-verbal cues for communication between remote users. We also created *Webstrates* [18], an environment for exploring shareable dynamic media and the concept of *information substrate*.

Telepresence among large, heterogeneous interactive spaces – Large interactive spaces are powerful tools that can help scientific, industrial and business users to collaborate on large and complex data sets. In order to reach their full potential, these spaces must not only support local collaboration, but also collaboration with remote users, who may have significantly different display and interaction capabilities, such as a wall-display connected to an immersive CAVE.

We explain why supporting telepresence across large interactive spaces is critical for remote collaboration [24]. We have also started to explore how such asymmetric interaction capabilities provide interesting opportunities for new collaboration strategies in large interactive spaces [25].

Accuracy of deictic gestures for telepresence – In the context of telepresence on large wall-sized displays, we investigated how accurately a user can interpret the video feed of a remote user showing a shared object on the display, by looking at it or by looking and pointing at it (Figure 6) [12]. We also analyzed how sensitive distance and angle errors are to the relative position between the remote viewer and the video feed. We showed that users can accurately determine the target, that eye gaze alone is more accurate than when combined with the hand, and that the relative position between the viewer and the video feed has little effect on accuracy. These findings can inform the design of future telepresence systems for wall-sized displays.

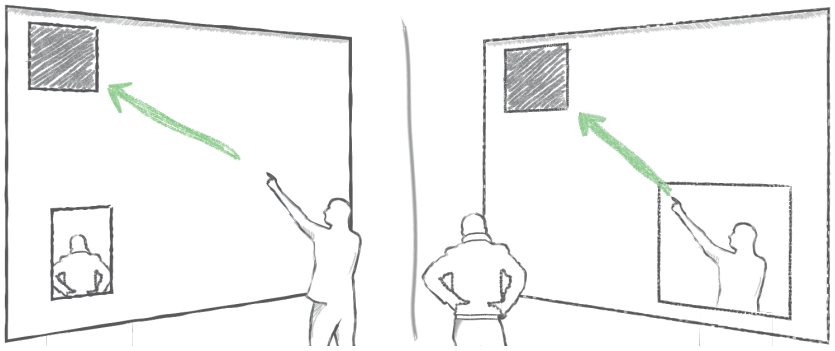

Figure 6. Users working on shared objects using two remote wall-sized displays : a user (left) shows a shared object by pointing at it and the remote user (right) can see which object is being shown through the video feed.

Webstrates – In collaboration with Université of Aarhus (Denmark) and Institut Mines Telecom, we created Webstrates [18], a system inspired by Alan Kay's early vision of interactive dynamic media. Webstrates is based on web technology: web pages served by the Webstrates server can be shared in real time among multiple users, on any web-enabled device. By using transclusion, a webstrate page can include other Webstrates. Webstrates can also include code, making them dynamic and interactive. A Webstrate that can act on another, transcluded Webstrate, is similar to an editor on a classical desktop environment. However the distinction between content and tools, documents and applications is blurred, e.g. content can be used as a tool, and tools

can be shared like regular content. We implemented two case studies to illustrate Webstrates (Figure 7). We authored the article collaboratively, using functionally and visually different editors that we could personalize and extend at run-time. We also used Webstrates to orchestrate a presentation, using multiple devices to control the presentation, to let the audience participate and the session chair organize the session. We demonstrated the simplicity and generative power of Webstrates with three additional prototypes and evaluated them from a systems perspective. Webstrates runs in our WildOS middleware on the WILD and WILDER rooms, and is used for some of our projects on telepresence.

Figure 7. Sample uses of Webstrates: (a) Collaborative document authoring with different editors personalized at run-time; (b) Multiple devices used to sketch a figure (tablet 1), see it in a print preview (tablet 2), and adjust it in a graphics editor (laptop). (c) Distributed talk controlled remotely by a speaker with a separate interface for audience participation.

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

MultiHub (Microsoft donation, 2015-2016) – ExSitu was one of the ten academic institutions world wide awarded a hardware and monetary grant by Microsoft Research as part of its request for proposal to expand the potential applications of the Surface Hub across all aspects of society (http://research.microsoft.com/en-us/projects/surface-hub/). The goal of the MultiHub project is to enable interaction in the large, where groups of experts can interact with rich content and complex data while collaborating both locally and remotely in interactive, multi-surface environments. ExSitu was awarded two 55" Surface Hubs and $19,000 in cash.

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. DigiPods – Remote Collaborative Interaction among Heterogeneous Visualization Platforms

Type: CESAME equipment grant

Funding: Région Île-de-France

Duration: 2012-2015

Coordinator: Stéphane Huot

Partners: Digiteo/FCS Campus Paris-Saclay, Univ. Paris-Sud, Inria, CNRS, CEA, Telecom Paris-Tech

Abstract: The goal is to design new interactive equipment and devices for collaborative interaction in immersive and high-resolution visualization platforms, connected through a high-end telepresence infrastructure. Beyond the usual interactive devices of such platforms (motion capture, interactive surfaces, haptic devices, audio and video systems), we are creating new devices to facilitate co-located or remote interaction and collaboration: telepresence robots and Digicarts, mobile hubs that gather interaction and communication devices. This equipment will be used by Human-Computer Interaction researchers to explore the visualization and manipulation of large datasets, interaction in virtual reality, and remote collaboration among heterogeneous platforms. Researchers and professionals in other fields will also be able to use DigiPods to explore and manipulate complex datasets.

9.1.2. DigiCarts – Remote Collaborative Interaction Devices for Heterogeneos Visualization Platforms

Type: Post-doctoral fellowship

Funding: Digiteo research network

Duration: 2013-2015

Coordinator: Stéphane Huot

Partners: Univ. Paris-Sud, Inria, CNRS, CEA, Telecom ParisTech

Abstract: This grant complements the DigiPods project with funding for a 18-month post-doctoral position focused on the design, implementation and evaluation of the DigiCart devices. This project funded Joe Malloch, a post-doctoral fellow who received his Ph.D. from McGill University.

9.1.3. DigiZoom – Multiscale navigation: from mobile devices to collaborative wall-sized displays

Type: Ph.D. grant

Funding: Digiteo network

Duration: 2012-2015

Coordinator: Olivier Chapuis

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Abstract: The goal of the project was to study multiscale navigation on a variety of devices, with an emphasis on large wall-sized displays in the context of the Digiscope project. This requires to properly operationalize the relevant factors in the various tasks that we seek to study. This work led to an award-winning publication at ACM CHI'14 [6], which introduces an abstract classification task to compare the performance of interaction techniques for navigating and manipulating content. This project funded Can Liu, a joint PhD student between the VIA group at Institut Mines-Telecom and InSitu who defended her thesis [10] in december, 2015.

9.1.4. MultiVis – Novel Interaction Models for Multi-surface Visualization

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: James Eagan (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to design, evaluate, and implement novel interaction models that help users appropriate multiple computational surfaces in the sense-making process. Our initial approach is to operationalize and extend the instrumental interaction model to specifically accommodate the specific needs of the sense-making process for information visualization. This project funds Marc-Emmanuel Perrin, a joint PhD student between the VIA group at Institut Mines-Telecom and ExSitu.

9.1.5. MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2015-2018

Coordinator: Olivier Rioul (Institut Mines Telecom)

Partners: Univ. Paris-Sud, Inria, CNRS, Institut Mines-Telecom

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project is to conduct fundamental studies of aimed movements based on information theory. The project studies the interaction phenomena involved in pointing, in order to discover novel, more effective pointing techniques. This project funds Wanyu Liu, a joint Ph.D. student between the COMELEC and VIA groups at Institut Mines Telecom and ExSitu.

9.1.6. SensoMotorCVE – Sensor-motor Interface for Collaborative Virtual Environments with Heterogeneous Devices: Application to Industrial Design

Type: Ph.D. grant

Funding: DigiCosme Labex

Duration: 2014-2017

Coordinator: Patrick Bourdot (LIMSI-CNRS)

Partners: Univ. Paris-Sud, Inria, CNRS

Inria contact: Cédric Fleury

Abstract: In the context of collaborative virtual environments, the goal of this project is to develop a sensorimotor interface model for CAD data manipulation that supports heterogeneous interactive systems such as wall-sized displays or immersive virtual reality rooms. This project funds Yujiro Okuya, a joint Ph.D. student between the VENISE group at LIMSI and ExSitu.

9.1.7. La Grande Vitrine des Choses

Type: Art-science grant

Funding: IDEX Paris-Saclay

Duration: 2015-2016

Coordinators: Michel Beaudouin-Lafon & Wendy Mackay

Partners: Univ. Paris-Sud, Inria, CNRS, Theater group $n + 1$

Abstract: Art-science project funded by "La Diagonale Paris-Saclay" to create, in collaboration with the theather group "n+1", an interactive store front in the form of an advent calendar, where users must discover which gestures to perform in order make an animated character open the next window. This installation raises the question of who is controlling whom: Participants think that their gestures directly control the character, but the system actually uses shaping techniques from experimental psychology that encourage users to make successive approximations to the correct gesture. The installation will be active during the month of December, 2016 in the Evry shopping mall, next to the Agora Theater. A prototype will also be shown during the Fête de la Science on the Plateau de Saclay in October, 2016.

9.2. National Initiatives

9.2.1. ANR

9.2.1.1. DRAO – Dessin Réaliste Assisté par Ordinateur

Type: Jeunes Chercheuses - Jeunes Chercheurs

Duration: 2012-2015

Coordinator: Adrien Bousseau (Inria Sophia Antipolis)

Partners: Inria Saclay, Inria Sophia Antipolis

ExSitu contacts: Theophanis Tsandilas, Wendy Mackay

Abstract: The goal of the project was to facilitate and accelerate drawing for amateurs as well as for expert designers and illustrators (https://www-sop.inria.fr/members/Adrien.Bousseau/drao). The project explored the following research directions: (1) understanding how professionals draw, (2) automating parts of the drawing process, and (3) teaching people to draw.

9.2.2. Investissements d'Avenir

9.2.2.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2020

Coordinator: Michel Beaudouin-Lafon

Partners: FCS Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, 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

Abstract: The goal of the project is to create ten high-end interactive rooms interconnected by high-speed networks and audio-video facilities to support 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. Digiscope includes the existing WILD room, and funded the WILDER room. ExSitu contributes its expertise in the design and evaluation of advanced interaction techniques and the development of distributed software architectures for interactive systems. At the end of 2015, nine of the ten rooms are operational, and the telepresence network is being developed.

9.2.3. Institut Universitaire de France

9.2.3.1. The Instrumental Paradigm

Type: IUF senior fellowship

Duration: 2011-2016

Principal investigator: Michel Beaudouin-Lafon

Abstract: Tools or instruments are a natural way to interact with the real world, and can serve as a powerful metaphor to interact with on-line information. An instrument reifies interaction: it turns an interaction into a meaningful object for users, designers and developers. We envision a future where large, monolithic and closed applications are replaced by a rich ecology of instruments and information containers that can interoperate, giving users the power to shape their own environments. Our work on multisurface interaction [2] and Webstrates [18] illustrate this approach.

9.3. European Initiatives

9.3.1. CREATIV

Type: IDEAS

Instrument: ERC Advanced Grant

Duration: June 2013 - May 2018

Coordinator: Wendy Mackay

Partner: Inria (France)

Inria contact: Wendy Mackay

Abstract: CREATIV explores how the concept of co-adaptation can revolutionize the design and use of interactive software. Co-adaptation is the parallel phenomenon in which users both adapt their behavior to the system's constraints, learning its power and idiosyncrasies, and appropriate the system for their own needs, often using it in ways unintended by the system designer. The initial goal of the CREATIV project is to fundamentally improve the learning and expressive capabilities of advanced users of creative software, offering significantly enhanced methods for expressing and exploring their ideas. The ultimate goal is to radically transform interactive systems for everyone by creating a powerful and flexible partnership between human users and interactive technology.

9.3.2. Collaborations with Major European Organizations

EIT Digital Master School, European Institute of Technology. Coordinator: M. Beaudouin-Lafon. Partners: KTH (Sweden), U. Paris-Sud (France), U. Aalto (Finland), Technical University Berlin (Germany), Technical University Twente (Netherlands), U. College London (UK), U. Trento (Italy). InSitu participates in the Human-Computer Interaction and Design (HCID) major of the EIT Digital European Master School. Paris-Sud is one the sites for the first year of this Master Program, and host one of the specialties for second-year students. Students in this program receive a double degree after studying in two countries. https://www.dep-informatique.u-psud.fr/en/formation/lmd/M1_HCID.

9.4. International Initiatives

9.4.1. Inria Associate Teams not involved in an Inria International Labs

The MidWay Equipe Associée, *Musical Interaction Design Workbench And technologY*, was created in collaboration with the Input Devices and Music Interaction Technology (IDML) at the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT) at McGill University. The Principle investigator from Inria, Stéphane Huot, was promoted to a Research Director position at Inria Lille, so the projet is now based there, but members of ExSitu have continued to collaborate on the project. The NIME paper on evaluation is a first result from this collaboration [14].

9.4.2. Inria International Partners

9.4.2.1. Informal International Partners

We are collaborating with Clemens Klokmose from University of Aarhus, Denmark, on our exploration of information substrates. This resulted in Webstrates [18], which received a best paper award at ACM UIST'15.

We are working with Shumin Zhai from Google in Mountain View, California, on our project on "expressive keyboards", which allows users to produce expressive output from "shapewriting" on soft keyboards.

We are working with Professor Bjoern Hartmann from U.C. Berkeley and will be starting an Inria Equipe Associée, called DECIBel, in 2016.

We are working with Professor Jürgen Steimele from the Max Planck Institute for Informatics and Saarland University on paper electronics and have recently recruited one of his students as a Ph.D. candidate, Michael Wesseley.

We are working with Marco Gilles, Rebbecca Fiebrink and Atau Tanaka of Goldsmith's college in London, U.K. on Human-Centred Machine Learning, and will run a workshop together in 2016.

We are working with Kim Halkov and Peter Dalsgaard from Aarhus University, on blended interaction spaces.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Joanna McGrenere, Professor at the University of British Columbia, Canada, from August 2015.
- Ana Bernardos, Universidad Politécnica de Madrid, Spain, from September to December 2015.

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific events organisation

10.1.1.1. Member of the organizing committees

- Paper Electronics Workshop, February 2015: Wendy Mackay (organizer)
- MIDWAY Workshop, May 2015: Michel Beaudouin-Lafon, Wendy Mackay, Joe Malloch (co-organizers)
- MOCO 2015, *International Workhshop on Movement and Computing*: Sarah Fdili Alaoui (organizing committee)
- Workshop on *Supporting Creative Design Processes in Blended Interaction Spaces* at ACM Creativity and Cognition 2015: Wendy Mackay (organizing committee)

10.1.2. Scientific events selection

10.1.2.1. Member of the conference program committees

- ACM CHI 2015, *ACM Conference on Human Factors in Computing*: Wendy Mackay, Theophanis Tsandilas
- ACM UIST 2015, *ACM Symposium on User Interface Software and Technology*: Michel Beaudouin-Lafon, Wendy Mackay
- NIME 2015, *New interfaces for Musical Expression*: Theophanis Tsandilas, Sarah Fdili Alaoui
- CMIS 2015, *Workshop on Collaboration Meets Interactive Surfaces*: Theophanis Tsandilas
- IHM 2015, *Conférence Francophone d'Interaction Homme-Machine*: Theophanis Tsandilas
- GRAPP 2015, *Conference on Computer Graphics Theory and Applications*: Cédric Fleury
- 3DCVE 2015, *IEEE VR Workshop on Collaborative Virtual Environments*: Cédric Fleury
- MOCO 2015, *International Workhshop on Movement and Computing*: Michel Beaudouin-Lafon, Sarah Fdili Alaoui

10.1.2.2. Reviewer

- ACM CHI 2016 *ACM Conference on Human Factors in Computing*: Michel Beaudouin-Lafon, Cédric Fleury, Sarah Fdili Alaoui, Joseph Malloch, Ignacio Avellino, Ghita Jalal, Nolwenn Maudet, Carla Griggio, Germán Leiva, Jessalyn Alvina, Sarah Alaoui, Joseph Malloch, Alex Zinenko
- ACM UIST 2015 *ACM Symposium on User Interface Software and Technology*: Theophanis Tsandilas, Cédric Fleury, Ignacio Avellino
- ACM TEI 2016 *ACM Conference on Tangible Embodied Interaction*: Sarah Fdili Alaoui
- IEEE InfoVis 2015, *IEEE Information Visualization Conference*: Theophanis Tsandilas
- GI 2015, *Graphics Interface Conference*: Theophanis Tsandilas
- UBICOMP 2015, *ACM International Joint Conference on Pervasive and Ubiquitous Computing*: Michel Beaudouin-Lafon
- IHM 2015, *Conférence Francophone d'Interaction Homme-Machine*: Cédric Fleury

10.1.3. Journal

10.1.3.1. Member of the editorial boards

- Editor for the Human-Computer Interaction area of the new ACM Books Series (published with Morgan & Claypool Publishers): Michel Beaudouin-Lafon (2013-)
- CACM, *Communications of the ACM Web Editorial Board*, ACM: Wendy Mackay (2008-)
- CACM *Communications of the ACM New Publications Board*, ACM: Wendy Mackay (2015-)
- TOCHI, *Transactions on Computer Human Interaction*, ACM: Michel Beaudouin-Lafon (2009-)
- JIPS, *Journal d'Interaction Personne-Système*, AFIHM: Michel Beaudouin-Lafon (2009-)
- IJHCS, *International Journal of Human-Computer Study*, Elsevier: Michel Beaudouin-Lafon (Member of the Advisory Board, 2009-)
- JCSCW, *Journal of Computer Supported Cooperative Work*, Springer: Michel Beaudouin-Lafon (Member of the Advisory Board, 2010-)

10.1.3.2. Reviewer - Reviewing activities

- Transactions on Visualization and Computer Graphics (TVCG): Theophanis Tsandilas
- Transactions on Computer-Human Interaction (TOCHI): Wendy Mackay
- Ubiquitous Computing (UbiComp'15): Wendy Mackay
- International Journal of Human-Machine Studies (IJHMS): Wendy Mackay

10.1.4. Invited talks

- Keynote address at ACM/TEI'15 (Tangible, Embedded and Embodied Interaction) *Interactive Paper: Tangible Computing from the Digital Desk to Music Composition* 19 January 2015: Wendy Mackay
- Keynote address at LTM21C (Learning and Teaching Music in the Twenty-First Century: The Contribution of Science and Technology) *Supporting Creative Expression with Co-Adaptive Human-Computer Partnerships* 5 November 2015: Wendy Mackay
- Keynote address at Paper Electronics Workshop *Interactive Paper: A Whirlwind Tour of Tangible Computing from the Digital Desk to Music Composition* 20 February 2015: Wendy Mackay
- Research Seminar at University of Munich Interactive Paper: Tangible Computing from the Digital Desk to Music Composition 8 July 2015: Wendy Mackay
- Research Seminar at KTH, Sweden *Interactive Paper: Tangible Computing from the Digital Desk to Music Composition* 30 January 2015: Wendy Mackay
- Microsoft Faculty Summit *Dynachord* July 08 2015: Jianqiao Li
- GT Interco3D @ IHM 2015, "*Perception spatiale dans des systèmes de téléprésence adaptés à des murs d'images*", 27 October 2015: Cédric Fleury
- Microsoft Research - Devices and Networking Summit - 11-13 May 2015, Paris - panel The Next Big Hurdle, "*The myth of perfection*": Michel Beaudouin-Lafon
- NCRS-CNRS Korean-French workshop - 30 June 2015, "*Human-Computer Interaction*": Michel Beaudouin-Lafon
- CNRS workshop "Sciences Sociales et Cognitives du Comportement" - 16 July 2015, "*Interaction Humain-Machine et Sciences du Comportement*": Michel Beaudouin-Lafon
- TedX Leuven, "*Instrumented Bodies: Designing Interfaces for Digital Performance*", 20 February 2015: Joseph Malloch
- Centre National de la Danse, "*Rencontre entre notateurs*", 2 December 2015: Sarah Fdili Alaoui
- Inria Lille, "*Interaction Beyond Computation*", 16 October 2015: Michel Beaudouin-Lafon

- Inria Lille, "*Sketch-based interaction for creative exploration*", 11 March 2015: Theophanis Tsandilas
- Journées Scientifiques Inria, InriART,"*Supporting Computer-Aided Composition with Interaction on Paper*", 17 Juin 2015: Theophanis Tsandilas
- Université Paris Sud, "*la journée Sciences du Mouvement FEDEV*", 27 Novembre 2015: Sarah Fdili Alaoui
- Inria Lille, "*Designing Interfaces for Digital Performance*", 15 July 2015: Joseph Malloch
- Inria Lille, "*Interactive Systems for Music and Dance Performance*", 7 December 2015: Joseph Malloch

10.1.5. Leadership within the scientific community

- Digiscope "Equipement d'Excellence": Michel Beaudouin-Lafon (Scientific director)
- Doctoral School in Computer Science (EDSTIC), Université Paris-Saclay: Michel Beaudouin-Lafon (co-director, Data, Knowledge, Learning & Interaction section)
- DigiCosme "Laboratoire d'Excellence": Michel Beaudouin-Lafon (chair of theme Interaction-Visualization and member of scientific committee)

10.1.6. Scientific expertise

- European Research Council (ERC), Avanced Grants Expert Panel: Michel Beaudouin-Lafon (external expert)
- FWF (Austrian Science Fund): Wendy Mackay (external expert)
- Sapere Aude Starting Grant, Danish Council for Independent Research, International Advisory Board: Wendy Mackay (external expert)
- Agence Nationale de la Recherche (ANR), appel à projets génériques "IHM, Contenus, Connaissances, Big Data, simulation, HPC": Cédric Fleury (reviewer), Theophanis Tsandilas (reviewer)
- CNRS Mission pour l'Interdisciplinarité, Action "Sciences Sociales et Cognitives des Comportements Collectifs": Michel Beaudouin-Lafon (committee member)

10.1.7. Research administration

- Computer Science Department ("GT-STIC"), Université Paris-Saclay: Michel Beaudouin-Lafon (member of steering committee)
- "Institut de la Société Numérique", IDEX Laboratory of Université Paris-Saclay: Michel Beaudouin-Lafon (member of steering committee)
- Telecom ParisTech: Michel Beaudouin-Lafon (member of research committee)
- IRCAM: Michel Beaudouin-Lafon (member of scientific committee)
- "Conseil de Laboratoire", LRI: Wendy Mackay, Cédric Fleury (members)
- "Conseil Scientifique", LRI: Michel Beaudouin-Lafon (member)
- CCSU, "Commission Consultative de Spécialistes de l'Université", Computer Science department: Michel Beaudouin-Lafon, Wendy Mackay (members)

10.1.8. Professional service

- ACM SIGCHI Conference Management Committee: Wendy Mackay (member)
- ACM SIGCHI Lifetime Service Award Committee: Wendy Mackay (member)
- ACM nominating committee: Michel Beaudouin-Lafon (member)
- ACM Europe Council: Michel Beaudouin-Lafon (member)
- EUACM Steering Committee, policy office of ACM Europe Council: Michel Beaudouin-Lafon (member)

- AFIHM Working Group on Ethics: Wendy Mackay (chair)

10.2. Teaching - Supervision - Juries

10.2.1. Teaching administration

Interaction Specialty, Master in Computer Science, Univ. Paris-Sud & Université Paris-Saclay: Michel Beaudouin-Lafon (chair), Cédric Fleury (internships)

HCID Masters (EIT Digital European Master in Human-Computer Interaction and Design), Univ. Paris-Sud: Michel Beaudouin-Lafon (chair)

10.2.2. Teaching

Interaction & HCID Masters: Wendy Mackay, *Formation à la Recherche* 21 hrs, M2, Univ. Paris-Sud

Interaction & HCID Masters: Michel Beaudouin-Lafon, *Fundamentals of Human-Computer Interaction*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui & Theophanis Tsandilas, *Programming of Interactive Systems*, 21 hrs, M1, Univ. Paris-Sud

Interaction & HCID Masters: Wendy Mackay, *Design of Interactive Systems*, 42 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Wendy Mackay, *Business Development Lab* 21 hrs, M1, Univ. Paris-Sud

Interaction & HCID Masters: Joseph Malloch *Digital Fabrication*, 10 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Michel Beaudouin-Lafon & Cédric Fleury, *Groupware and Collaborative Interaction*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Creative Design*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Design Project*, 15 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Gesture and Mobile Interaction*, 4 hrs, M1/M2, Univ. Paris-Sud

Polytech Fifth year: Cédric Fleury, *Réalité Virtuelle et Interaction*, 48 hrs, M2, Univ. Paris-Sud

Polytech Fifth year: Sarah Fdili Alaoui, *Informatique Graphique et visualisation*, 42 hrs, M2, Univ. Paris-Sud

Polytech Third year: Cédric Fleury, *Projet Java-Graphique-IHM*, 24 hrs, M1, Univ. Paris-Sud

Polytech First year: Cédric Fleury, *Introduction à l'Informatique*, 64 hrs, L1, Univ. Paris-Sud

10.2.3. Supervision

PhD students

PhD: Can Liu, *Collaborative Multiscale Navigation and Interaction*, Université Paris-Saclay, defended on 17 December 2015 [10]. Advisors: Michel Beaudouin-Lafon, Olivier Chapuis (LRI & Inria ILDA), Eric Lecolinet (Telecom ParisTech)

PhD in progress: Ghita Jalal, *Co-Adaptive Systems*, September 2013, Wendy Mackay

PhD in progress: Oleksandr Zinenko, *Interactive Code Restructuring*, September 2013. Advisors: Stéphane Huot (Inria Lille) & Cédric Bastoul (Université de Strasbourg)

PhD in progress: Ignacio Avellino, *Remote Collaboration in Large Interactive Spaces*, September 2014. Advisors: Michel Beaudouin-Lafon & Cédric Fleury

PhD in progress: Jessalyn Alvina, *Mobile Co-Adaptive Instruments*, September 2014. Advisor: Wendy Mackay

PhD in progress: Nolwenn Maudet, *Substrates and Co-Adaptive Instruments*, September 2014. Advisors: Wendy Mackay & Michel Beaudouin-Lafon

PhD in progress: Marc-Emmanuel Perrin, *Novel Interaction Models for Multi-surface Visualization*, September 2014. Advisors: Michel Beaudouin-Lafon & James Eagan (Télécom ParisTech)

PhD in progress: Marianela Ciolfi Felice, *Substrates and Co-adaptive Instruments for Creativity*, September 2015. Advisors: Wendy Mackay & Sarah Fdili Alaoui

PhD in progress: Carla Griggio, *Interactive Human-Machine Learning*, September 2015. Advisor: Wendy Mackay

PhD in progress: Germán Leiva, *Interaction-driven Software Development*, September 2015. Advisor: Michel Beaudouin-Lafon

PhD in progress: Wanyu Liu, *Modeling the speed-accuracy trade-off of pointing tasks using the tools of information theory*, October 2015. Advisors: Olivier Rioul (Institut Mines Telecom) & Michel Beaudouin-Lafon

PhD in progress: Yujiro Okuya, *Sensorimotor interface for Collaborative Virtual Environments based on heterogeneous interactive devices: application to industrial design*, October 2015. Advisors: Patrick Bourdot (LIMSI-CNRS) & Cédric Fleury

PhD in progress: Michael Wessely, *Sketching and Physical Prototyping for Creative Fabrication Design*, November 2015. Advisors: Theophanis Tsandilas & Wendy Mackay

Masters students

Jean-Baptiste Louvet, Insa Rouen, "Touch-based Interaction Technique for 3D Manipulation on Wall-sized Displays": Cédric Fleury

Niyati Roy Chowdhury, Univ. Paris-Sud, "Brain on the wall: An observational study with a novel brain image analysis tool, BrainTwister": Wendy Mackay & Michel Beaudouin-Lafon

Panagiota Tziova, Univ. Paris-Sud, "Bad Hacks and Good tricks: How professional designers appropriate creativity tools": Wendy Mackay

Xu Yuebai, Univ. Paris-Sud, "Interactive Brain Visualization": Michel Beaudouin-Lafon & Wendy Mackay

Maxence Bobin, Univ. Paris-Sud "Internet of Things for stroke rehabilitation in a home-based context": Wendy Mackay (reviewer)

10.2.4. Juries

PhD committee of Carl Unanader-Sharin (KTH Royal Institute of Technology, January 2015, Stockholm, advisor: K. Hook): Wendy Mackay (Opponent examiner)

PhD committee of Jérémie Boy (Inria University Paris-Sud, May 2015, advisors: Françoise Detienne and Jean-Daniel Fekete): Wendy Mackay (President)

PhD committee of Olivier Perrotin (LIMSI, Sept 2015, advisor: Ch. d'Alessandro): Michel Beaudouin-Lafon (President).

PhD committee of Jonathan Aceituno (Inria Lille, Octobre 2015, advisor: Nicolas Roussel): Michel Beaudouin-Lafon (Reviewer).

PhD committee of William Delamare (LIG Grenoble, Nov. 2015, advisor: Laurence Nigay): Michel Beaudouin-Lafon (President).

PhD committee of Quentin Roy (Telecom ParisTech, Dec. 2015, advisor: Y. Guiard & E. Lecolinet): Michel Beaudouin-Lafon (President).

PhD committee of Weiya Chen (LIMSI, Dec. 2015, advisor: P. Bourdot): Michel Beaudouin-Lafon (President).

Hiring Committee for Professor position, Univ. Paris-Sud: Wendy Mackay (member)

Hiring Committee for Assistant Professor position, Univ. Paris-Sud: Wendy Mackay (member)

10.3. Popularization

BD Interactive: 2101 Sciences et science-fiction, Chromatiques (Web documentaire) April 2015: Wendy Mackay (interview) http://www.chroma-tv.com

Journée d'étude robots/travail/intelligence : La Chaire des Bernadins -– L'Humain au défi du numérique, FING, 8 Oct 2015 *Table Ronde: Les robots : substitution ou complément ?*: Wendy Mackay (panel member)

Lindau, Film on the Attractivity of Research in France, Ministère de Recherche, June 2015: Wendy Mackay (interview)

Ableton Loop Summit, 1 November 2015 *Panel: New Instruments and Evolving Performance Practices*: Joseph Malloch (panel member)

Fête de la Science, LRI, 9 October 2015, *Wilder*: Olivier Gladin, Rémi Hellequin, Amani Kooli, and Jonathan Thorpe

11. Bibliography

Major publications by the team in recent years

[1] I. AVELLINO, C. FLEURY, M. BEAUDOUIN-LAFON. *Accuracy of Deictic Gestures to Support Telepresence on Wall-sized Displays*, in "CHI '15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM (editor), ACM Conference on Human Factors in Computing Systems (CHI), April 2015, pp. 2392-2396 [*DOI :* 10.1145/2702123.2702448], https://hal.archives-ouvertes.fr/hal-01242676

[2] 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. *Multi-surface Interaction in the WILD Room*, in "IEEE Computer", 2012, vol. 45, n^{o} 4, pp. 48–56, http://dx.doi.org/10.1109/MC.2012.110

[3] E. GHOMI, S. HUOT, O. BAU, M. BEAUDOUIN-LAFON, W. E. MACKAY. *Arpège: Learning Multitouch Chord Gestures Vocabularies*, in "Interactive Tabletops and Surfaces (ITS '13)", St Andrews, United Kingdom, ACM (editor), ACM, October 2013, http://hal.inria.fr/hal-00870173

[4] G. JALAL, N. MAUDET, W. E. MACKAY. *Color Portraits: From Color Picking to Interacting with Color*, in "Proceedings of the ACM International Conference on Human Factors in Computing Systems, 2015", Seoul, South Korea, May 2015 [*DOI :* 10.1145/2702123.2702173], https://hal.archives-ouvertes.fr/hal-01226494

[5] C. KLOKMOSE, J. EAGAN, S. BAADER, W. MACKAY, M. BEAUDOUIN-LAFON. *Webstrates: Shareable Dynamic Media*, in "ACM Symposium on User Interface Software and Technology (UIST)", Charlotte, United States, ACM (editor), UIST '15 Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology, November 2015, pp. 280-290 [*DOI :* 10.1145/2807442.2807446], https://hal.archives-ouvertes.fr/hal-01242672

[6] C. LIU, O. CHAPUIS, M. BEAUDOUIN-LAFON, É. LECOLINET, W. E. MACKAY. *Effects of Display Size and Navigation Type on a Classification Task*, in "CHI '14", Toronto, Canada, CHI '14, ACM, April 2014, pp. 4147-4156 [*DOI :* 10.1145/2556288.2557020], https://hal.archives-ouvertes.fr/hal-00957269

[7] M. NANCEL, E. PIETRIGA, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Mid-air Pointing on Ultra-Walls*, in "ACM Transactions on Computer-Human Interaction", August 2015, vol. 22, n^{o} 5, pp. 21:1–21:62 [*DOI :* 10.1145/2766448], https://hal.inria.fr/hal-01184544

[8] T. TSANDILAS, A. BEZERIANOS, T. JACOB. *SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays*, in "Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 3255-3264 [*DOI :* 10.1145/2702123.2702129], https://hal.archives-ouvertes.fr/hal-01144312

[9] T. TSANDILAS, G. MAGDALINI, S. HUOT. *BricoSketch: Mixing Paper and Computer Drawing Tools in Professional Illustration*, in "International Conference on Interactive Tabletops and Surfaces (ITS'15)", Funchal, Portugal, November 2015, pp. 127-136 [*DOI :* 10.1145/2817721.2817729], https://hal.archives-ouvertes.fr/hal-01207358

Publications of the year

Doctoral Dissertations and Habilitation Theses

[10] C. LIU. *Embodied Interaction for Data Manipulation Tasks on Wall-sized Displays*, Université Paris-Saclay, December 2015, https://tel.archives-ouvertes.fr/tel-01264670

Articles in International Peer-Reviewed Journals

[11] M. NANCEL, E. PIETRIGA, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Mid-air Pointing on Ultra-Walls*, in "ACM Transactions on Computer-Human Interaction", August 2015, vol. 22, n^{o} 5, pp. 21:1–21:62 [*DOI :* 10.1145/2766448], https://hal.inria.fr/hal-01184544

International Conferences with Proceedings

[12] I. AVELLINO, C. FLEURY, M. BEAUDOUIN-LAFON. *Accuracy of Deictic Gestures to Support Telepresence on Wall-sized Displays*, in "CHI '15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 2392-2396 [*DOI :* 10.1145/2702123.2702448], https://hal.archives-ouvertes.fr/hal-01242676

[13] L. BAGNÈRES, O. ZINENKO, S. HUOT, C. BASTOUL. *Opening Polyhedral Compiler's Black Box*, in "CGO 2016 - 14th Annual IEEE/ACM International Symposium on Code Generation and Optimization", Barcelona, Spain, March 2016, https://hal.inria.fr/hal-01253322

[14] J. BARBOSA, J. MALLOCH, M. M. WANDERLEY, S. HUOT. *What does " Evaluation " mean for the NIME community?*, in "NIME 2015 - 15th International Conference on New Interfaces for Musical Expression", Baton Rouge, United States, Louisiana State University, May 2015, pp. 156-161, https://hal.inria.fr/hal-01158080

[15] E. CHAPOULIE, T. TSANDILAS, L. OEHLBERG, W. E. MACKAY, G. DRETTAKIS. *Finger-Based Manipulation in Immersive Spaces and the Real World*, in "IEEE Symposium on 3D User Interfaces (3DUI)", Arles, France, IEEE (editor), March 2015, 8 p. , https://hal.inria.fr/hal-01114629

[16] P. DALSGAARD, K. HALSKOV, W. MACKAY, N. MAIDEN, J.-B. MARTENS. *Supporting Creative Design Processes in Blended Interaction Spaces*, in "Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition (C&C '15)", Glasgow, United Kingdom, ACM, June 2015, pp. 395-396 [*DOI :* 10.1145/2757226.2767184], https://hal.inria.fr/hal-01263191

[17] G. JALAL, N. MAUDET, W. E. MACKAY. *Color Portraits: From Color Picking to Interacting with Color*, in "Proceedings of the ACM International Conference on Human Factors in Computing Systems, 2015", Seoul, South Korea, May 2015 [*DOI :* 10.1145/2702123.2702173], https://hal.archives-ouvertes.fr/hal-01226494

[18] *Best Paper*
C. KLOKMOSE, J. EAGAN, S. BAADER, W. MACKAY, M. BEAUDOUIN-LAFON. *Webstrates: Shareable Dynamic Media*, in "28th Annual ACM Symposium on User Interface Software and Technology (UIST'15)", Charlotte, United States, ACM, November 2015, pp. 280-290 [*DOI :* 10.1145/2807442.2807446], https://hal.archives-ouvertes.fr/hal-01242672.

[19] L. OEHLBERG, W. WILLETT, W. E. MACKAY. *Patterns of Physical Design Remixing in Online Maker Communities*, in "CHI 2015 - Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 639-648 [*DOI :* 10.1145/2702123.2702175], https://hal.inria.fr/hal-01263171

[20] T. TSANDILAS, A. BEZERIANOS, T. JACOB. *SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays*, in "Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 3255-3264 [*DOI :* 10.1145/2702123.2702129], https://hal.archives-ouvertes.fr/hal-01144312

[21] T. TSANDILAS, G. MAGDALINI, S. HUOT. *BricoSketch: Mixing Paper and Computer Drawing Tools in Professional Illustration*, in "International Conference on Interactive Tabletops and Surfaces (ITS'15)", Funchal, Portugal, November 2015, pp. 127-136 [*DOI :* 10.1145/2817721.2817729], https://hal.archives-ouvertes.fr/hal-01207358

[22] O. ZINENKO, C. BASTOUL, S. HUOT. *Manipulating Visualization, Not Codes*, in "International Workshop on Polyhedral Compilation Techniques (IMPACT)", Amsterdam, Netherlands, January 2015, 8 p. , https://hal.inria.fr/hal-01100974

Other Publications

[23] M. BEAUDOUIN-LAFON. *Instrumental Interaction in Multisurface Environments*, January 2015, Position paper for the TEI 2015 workshop on Interactive Infrastructures, https://hal.archives-ouvertes.fr/hal-01242669

[24] C. FLEURY, I. AVELLINO, M. BEAUDOUIN-LAFON, W. E. MACKAY. *Telepresence systems for Large Interactive Spaces*, April 2015, Workshop on Everyday Telepresence: Emerging Practices and Future Research Directions, ACM conference on Human Factors in Computing Systems (CHI 2015), https://hal.inria.fr/hal-01242304

[25] C. FLEURY, N. FEREY, J.-M. VÉZIEN, P. BOURDOT. *Remote Collaboration across Heterogeneous Large Interactive Spaces*, March 2015, Workshop on Collaborative Virtual Environments (3DCVE), IEEE Virtual Reality conference (VR 2015) [*DOI :* 10.1109/3DCVE.2015.7153591], https://hal.inria.fr/hal-01242306