Activity Report 2016

Team EX-SITU

Extreme 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. - Interaction, multimedia and robotics
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
5.1.8. - 3D User Interfaces

Other Research Topics and Application Domains:

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

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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 implementation, 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

Michel Beaudouin-Lafon received an ERC Advanced Grant: *ONE – Unified Principles of Interaction*.

Ex-situ had a record of three research papers accepted at ACM/UIST 2016 and eleven research papers accepted at ACM/CHI 2017.

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], Olivier Gladin, 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.

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.

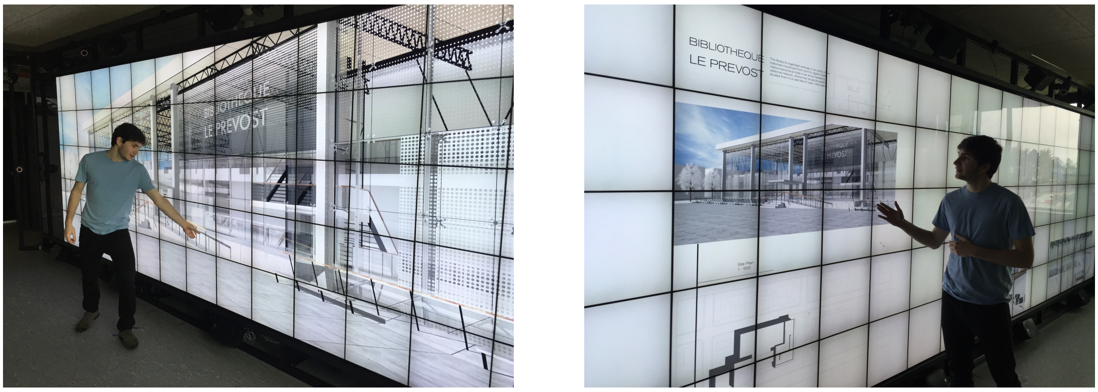
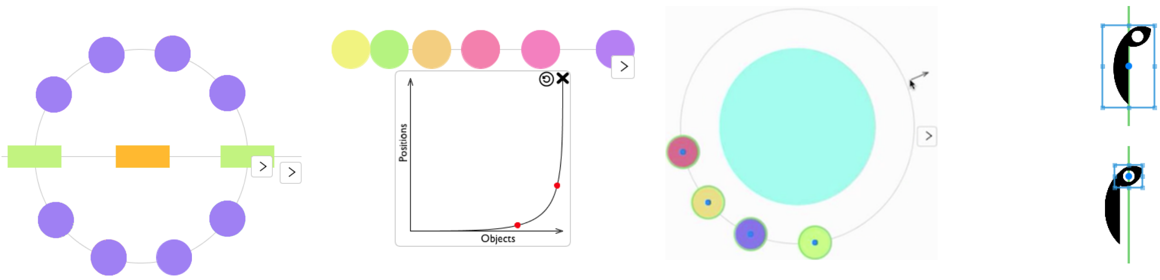


Figure 1. The WILDER platform.

In order to better understand fundamental aspects of interaction, ExSitu studies interaction in extreme situations. We conduct in-depth observational studies and controlled experiments which contribute to theories and frameworks that unify our findings and help us generate new, advanced interaction techniques.

StickyLines – Aligning and distributing graphical objects is a common, but cumbersome task. We studied graphic designers and regular users and identified three key problems with current tools: lack of persistence, unpredictability of the results, and inability to 'tweak' the layout. We created *StickyLines* [14], a tool that reifies guidelines into first-class objects: Users can create precise, predictable and persistent interactive alignment and distribution relationships, and can 'tweak' the alignment in a way that can be maintained for subsequent interactions (Figure 2). We ran a [2x2] within-participant experiment to compare *StickyLines* with standard commands and found that *StickyLines* performed up to 40% faster and required up to 50% fewer actions than traditional alignment and distribution commands for complex layouts. Finally, we gave *StickyLines* to six professional designers and found that not only did they quickly adopt it, they also identified novel uses, including creating complex compound guidelines and using them for both spatial and semantic grouping. This work demonstrate the power of reifying concepts, such as alignment and distribution, into first-class objects that can be directly manipulated and appropriated by end users.



(a) (b) (c) (d)

Figure 2. StickyLines reify alignment and distribution into first-class graphical objects that users can manipulate directly. (a) Circular and horizontal alignments. (b) Non-linear distribution. (c) Ghost guideline. (d) Tweaking an object's bounding box. .

UIST Video Browser – We created an interactive video browser that provides a rapid overview of the 30-second video previews of the ACM UIST conference papers, based on the conference schedule [16]. The web application was made available to the 600+ conference attendees, who could see an overview of upcoming talks, search by topic, and create personalized, shareable video playlists that capture the most interesting or relevant papers. Reifying playlists into first-class objects and applying instrumental interaction concepts helped create a fluid and efficient interface.

In(SITE) – We explored touch-based 3D interaction in the situation where users are immersed in a 3D virtual environment and move in front of a large multi-touch wall-sized display. We designed In(SITE) [20], a bimanual touch-based technique combined with object teleportation features which enables users to perform 3D object manipulation on a large vertical display (Figure 3). This technique was compared with a standard 3D interaction technique. The results showed that participants can reach the same level of performance for completion time and a better precision for fine adjustments with the In(SITE) technique. They also revealed that combining object teleportation with both techniques improves translation tasks in terms of ease of use, fatigue, and user preference.

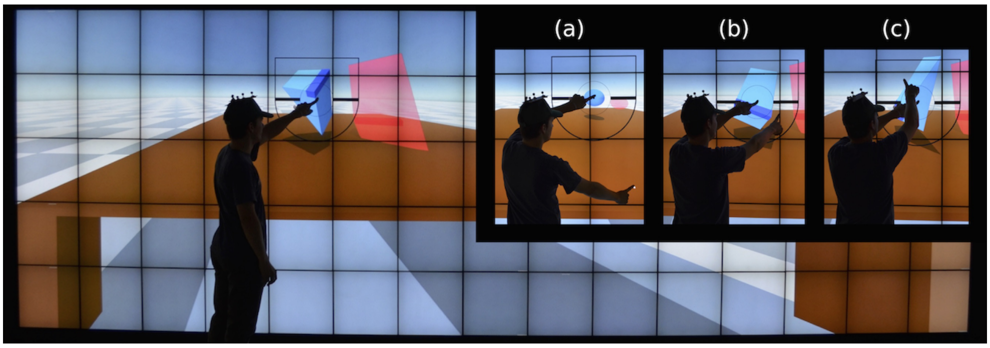


Figure 3. 3D manipulation on a multi-touch wall-sized display combining bimanual interaction and teleportation. The user is performing a xy translation (main pict.), z translation (a), roll rotation (b), and pitch & yaw rotation(c).

In collaboration with Inria Lille (MJOLNER group) and Univ. Strasbourg, we applied our design principles for instrumental interaction to create new interactive tools for the parallelization of programs, a highly specialized task that is currently done by expert developers. Current programming models, languages and tools do not help developers restructure existing programs for more effective execution. At the same time, automatic approaches are overly conservative and imprecise to achieve sufficient performance. We introduced *interactive program restructuring* [28], [11] to bridge the gap between semi-automatic program manipulation and software visualization. First, we extended a state-of-the-art polyhedral model for program representation so that it supports high-level program manipulation. Based on this model, we designed and evaluated a direct manipulation visual interface for program restructuring. This interface provides information about the program that was not immediately accessible in the code and allows to manipulate programs without rewriting code. By providing a visual and textual representation of an automatically computed program optimization that is easily modifiable and reusable by the developer, we create a sort of human-machine partnership where the developer can better take advantage of the power of the machine. An empirical study of developers using this tool showed the value of program manipulation tools based on the instrumental interaction paradigm. This work illustrates how the combination of our conceptual approaches, namely instrumental interaction and human-computer partnership, can benefit extreme users such as developers of parallel programs.

Finally, we reviewed statistical methods for the analysis of user-elicited gestural vocabularies [24]. We showed that measures currently used to assess agreement between participants of a gesture elicitation study are problematic. We discussed the problem of chance agreement and showed how it can bias results. We reviewed chance-corrected agreement coefficients that are routinely used in inter-reliability studies and showed how to apply them to gesture elicitation studies. We also discussed how to compute interval estimates for these coefficients and how to use them for statistical inference.

7.2. Partnerships

Participants: Wendy Mackay, Jessalyn Alvina, Ghita Jalal, Joseph Malloch, Nolwenn Maudet.

ExSitu is interested in designing effective human-computer partnerships, in which expert users control their interaction with technology. Rather than treating the human users as the 'input' to a computer algortithm, we explore human-centered machine learning, where the goal is to use machine learning and other techniques to increase human capabilities. Much of human-computer interaction research focuses on measuring and improving productivity: our specific goal is to create what we call 'co-adaptive sytstems' that are discoverable, appropriable and expressive for the user. *Interactive program restructuring* [28] offers a concrete example, where expert programmers interact with dynamic visualisations of parallel programs to better understand and organize their code. Similarly, tools such as *Color Partner* generate color suggestions based the users input, helping the user guide their discovery of new color possibilities, and *Linkify* helps users create rules to define how visual properties should change under different user contexts (see Jalal's dissertation).

We hosted the 30-person *ERC CREATIV* workshop in Paris, to explore our concepts of *Co-adaptive Systems* (including human-centered machine learning); and *Instrumental Interaction* (including substrates) with prominent researchers from Stanford University, New York University, University of Aarhus, Goldsmiths College, University of Toulouse, IRCAM, University of British Columbia, UC San Diego, and UC Berkeley. Our long-term, admittedly ambitious, goal is to create a unified theory of interaction grounded in how people interact with the world. Our principles of co-adaptive systems and instrumental interaction offer a generative approach for supporting creative activities, from early exploration to implementation. The workshop launched several research projects that are currently in progress or will be published in 2017.

Human-Centred Machine Learning:

We begin by challenging some of the standard assumptions surrounding Machine Learning, clearly one of the most important and successful techniques in contemporary computer science. It involves the statistical inference of models (such as classifiers) from data. However, all too often, the focus is on impersonal algorithms that work autonomously on passively collected data, rather than on dynamic algorithms that progressively reveal their progress to support human users. We collaborated on a workshop at the CHI 2017 conference, entitled "Human-centred Machine Learning" [15] with colleagues from Ircam, Goldsmiths College, and Microsoft Research. We seek a different understanding of the 'human-in-the-loop', where the focus is less on the human user as input to an algorithm, but rather as an algorithm in service of a human user. Examining machine learning from a human-centred perspective includes explicitly recognising human work in the creation of these algorithms, as well as the situated use these algorithms by human work practices. A human-centred understanding of machine learning in human context can lead not only to more usable machine learning tools, but to new ways of framing learning computationally.

Supporting Expressivity:

We helped organize and participated in a workshop at CHI 2017 *Human Computer Interaction meets Computer Music* [27], where we described the results of the MIDWAY Equipe Associé project (with McGill University, Ex-Situ and the *MINT* EP at Inria, Lille.) We presented results of our extensive research with contemporary music composers, in particular our strategy for developing 'co-adaptive instruments'. This involves a paradigm shift, where the goal of the technology is not necessarily the accuracy of a particular result, but rather, the human user's ability to express themselves through the technology.

We also explored the idea of rethinking the use of machine learning to support human-computer partnerships for everyday interaction. We built on gesture-typing, which offers users an efficient, easy-to-learn, and error-tolerant technique for producing typed text on a soft keyboard. Our focus was not on improving recognition accuracy, which we take as a given, but rather on how to make gesture-typed output more expressive.

Experiment 1 demonstrated that users vary word gestures according to instructions (accurately, quickly or creatively) as well as specific characteristics of each word, including length, angle, and letter repetition. We show that users produce highly divergent gestures, with three easily detectable characteristics: curviness, size, and speed. We created the Expressive Keyboard [10] which maps these characteristics to color variations, thus allowing users to control both the content and the color of gesture-typed words (Figure 4). Experiment 2 demonstrates that users can successfully control their gestures to produce the desired colored output, and find it easier to react to visual feedback than explicitly controlling the characteristics of each gesture. Expressive keyboards can map gestural input to any of a variety of output characteristics, such as personalized handwriting and dynamic emoticons, to let users transform gesture variation into expressivity, without sacrificing accuracy.

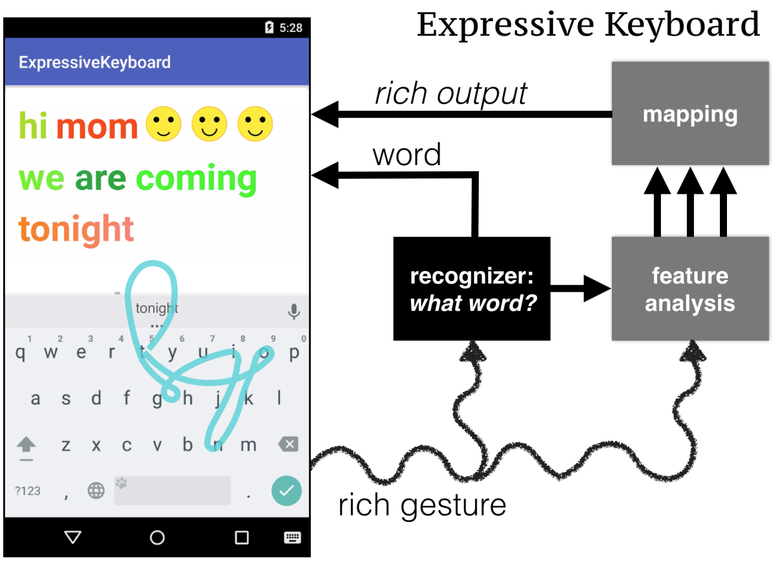


Figure 4. Expressive Keyboards produce accurate words, but also let users control multiple expressive output properties.

7.3. Creativity

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

We explore how concepts of substrate and co-adaptation can change how we design interactive technology for supporting creativity. Co-adaptation is the phenomenon in which users both adapt their behavior to the system's constraints, and appropriate the system for their own needs. We explore these concepts using participatory design studies in creative contexts with expert and non-expert users. We study structuring layouts for graphic designers, sketching movement for choreographers, expressive movements for dancers and further explore expressive gesture of non-experts on mobile devices and possible interactions on hybrid stretchable interfaces. These studies require a multi-disciplinary design team that works closely with users throughout the design process. We create situations that cause users to reflect deeply about their activities in context and work with them to articulate the design problem. The experiments, prototypes and systems that we developed and deployed are illustrated below:

Graphic design: Our studies of the creative design practices of professional graphic designers show that designers appropriate visual properties of existing tools to create their own personal 'instruments'. Unfortunately, most professional design tools make this difficult: At best, they provide only indirect access, through property sheets or dialog boxes, to visual properties, such as color and style, rather treating them as as independent interactive objects. We developed a number of composition tools that demonstrate how to explicitly reify visual properties, using the concept of co-adaptive instruments. Ghita Jalal successfully defended her doctoral dissertation on this topic (see [9]).

We also examined artists' and designers' practices as they manipulate color and create layouts in their projects. We found that artists and designers select colors from personal representations. They manipulate color in the context of its surrounding graphical elements, and combine it with other visual properties such as texture. As they create their layouts, designers establish links among visual properties such as size, position, and layering of graphical elements. They define rules for how these properties change in space, across instances of the same composition, or in time, across related compositions. We also found that designers prefer tools that provide direct access to visual properties.

Choreography: We are interested in designing choreographic support tools because choreographers rarely have access to interactive tools that are designed specifically to support their creative process [13]. In order to design for such a technology, we interviewed six contemporary choreographers about their creative practice. We found that even though each process is unique, choreographers represent their ideas by applying a set of operations onto choreographic objects. Throughout different creative phases, choreographers compose by shifting among various degrees of specificity and vary their focal points from dancers to stage, to interaction, to the whole piece. Based on our findings, we presented a framework for articulating the higher-level patterns that emerge from these complex and idiosyncratic processes. We then articulated the resulting implications for the design of interactive tools to support the choreographic practice.

On generating choreographic ideas, we developed the Choreographer's Workbench, a full-body interactive system that aims to help choreographers explore and design dance movements during the ideation phase by creating a link between past recorded movement ideas and revealing their underlying relationships. The system explores how to increase the discoverability and appropriateness of movement ideas via feedforward visualization of movement characteristics.

We collaborated with the N+1 theater group on the "Grande Vitrine" art and science project, an interactive installation that takes place during the month of Christmas. It consisted of a virtual animated character with whom participants interact and a physical kinetic sculpture whose motions are triggered by participant interaction (Figure 5). The participant were expected to perform full-body movements and figure out the correct one that will help the animated character escape from the virtual screen into the physical motorized display. The installation tested the concept of "shaping" from experimental psychology where the participant is guided to make "successive approximations" in arriving at the correct gesture. It was installed at the theater of Évry, that has a display on the shopping mall in Évry for the entire month of December.

Finally, we collaborated with Simon Fraser University on an interactive installation called still, moving. The installation created a sonic experience that heightens self-awareness of our micro-movements in stillness. Sound created an intimate envelope that nurtures self-reflection and the experience of inward sensations. In still, moving, the audience was equipped with two Myo Armbands that capture their movements as well as their muscular activity. The physiological signals such as muscle tension and subtle accelerations were analyzed and mapped to a sound environment in order to increase perception of the inner self. The design of the relationship between movement and sound was evolving along the interaction, shifting the soundscape from reflective to challenging, guiding the audience in an exploration of novel and gradual relationship to weight and understanding of the complexity of the silent body.

Everyday creativity:

Finally, for non expert users, we developed an inexpensive method for fabricating *Stretchis*, highly stretchable interfaces that combine sensing and displaying capabilities [22]. This method enables designers and casual makers to embed transparent conductors and electroluminescence displays in stretchable PDMS substrates

Figure 5. Passersby interact with the animated Père Noël, first mirrors their behavior and then shapes it.

(Figure 6). We showed how to prototype stretchable user interfaces for a range of application scenarios by using standard design software and screen-printing techniques. Despite the use of inexpensive equipment, our results demonstrate that we can produce durable and highly stretchable sensors and displays that remain functional under strain levels of more than 100%.

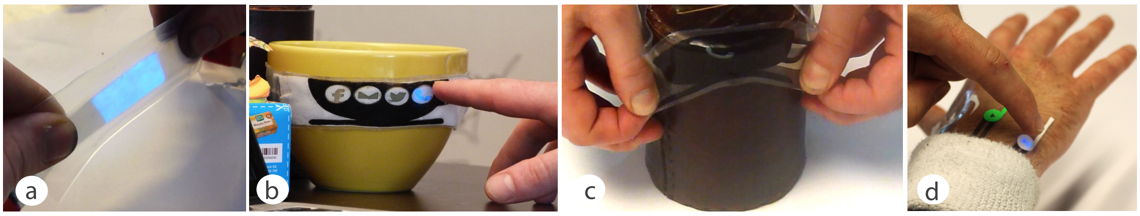


Figure 6. Stretchis are highly stretchable user interfaces that include touch and proximity sensors and electroluminescent displays (a). Stretchis are transparent (b); can be stretched to fit to the geometry of different physical objects (c); and can act as on-skin user interfaces (d).

7.4. 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 studied how wall-sized displays support small groups of users working together on large amounts of data. We conducted observational studies showing that users adopt a range of collaboration styles, from loosely to closely coupled and that shared interaction techniques, in which multiple users perform a command collaboratively, support co-located collaborative work. In order to test the effect of such shared interaction techniques, we operationalize five collaborative situations with increasing levels of coupling in a data manipulation task [18]. The results show the benefits of shared interaction for close collaboration: it encourages collaborative manipulation, it is more efficient and preferred by users, and it reduces physical navigation and fatigue. We also identified the time costs caused by disruption and communication in loose collaboration and analyzed the trade-offs between parallelization and close collaboration. Altogether, these findings can inform the design of shared interaction techniques to support collaboration on wall-sized displays.

We are also interested in how to help teams of novice crafters prototype physical objects. To this end, we conducted a study [12] framed around two all-day design charrettes where novices performed a complete design process: ideation sketching, concept development and presentation, fabrication planning documentation and collaborative fabrication of hand-crafted prototypes. This structure allowed us to control key aspects of the design process while collecting rich data about creative tasks, including sketches on paper, physical models, and videos of collaboration discussions. Participants used a variety of drawing techniques to convey 3D concepts. They also extensively manipulated physical materials, such as paper, foam, and cardboard, both to support concept exploration and communication with design partners. Based on these observations, we proposed design guidelines for CAD tools targeted at novice crafters.

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. 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.

9.1.2. 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.

9.1.3. 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.

9.1.4. 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 was demonstrated at the Fête de la Science in October, 2016, and was shown during the month of December, 2016 in the Evry shopping mall, next to the Agora Theater. It will also be shown in the Curiositas festival in Gif-sur-Yvette in May, 2017.

9.2. National Initiatives

9.2.1. Investissements d'Avenir

9.2.1.1. 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 2016, all ten rooms are operational, and the telepresence network is being deployed.

9.2.2. Institut Universitaire de France

9.2.2.1. 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 [5] illustrate this approach.

9.3. European Initiatives

9.3.1. European Research Council (ERC)

9.3.1.1. Creating Human-Computer Partnerships

Program: ERC Advanced Grant

Project acronym: CREATIV

Project title: Creating Human-Computer Partnerships

Duration: mois année début - mois année fin

Coordinator: 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. A key insight in designing for co-adaptation is that we can encapsulate interactions and treat them as first class objects, called interaction instruments This lets us focus on the specific characteristics of how human users express their intentions, both learning from and controlling the system. By making instruments co-adaptive, we can radically change how people use interactive systems, providing incrementally learnable paths that offer users greater expressive power and mastery of their technology. 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.

9.3.1.2. Unified Principles of Interaction

Program: ERC Advanced Grant

Project acronym: ONE

Project title: Unified Principles of Interaction

Duration: October 2016 - September 2020

Coordinator: Michel Beaudouin-Lafon

Abstract: The goal of ONE is to fundamentally re-think the basic principles and conceptual model of interactive systems to empower users by letting them appropriate their digital environment. The project addresses this challenge through three interleaved strands: empirical studies to better understand interaction in both the physical and digital worlds, theoretical work to create a conceptual model of interaction and interactive systems, and prototype development to test these principles and concepts in the lab and in the field. Drawing inspiration from physics, biology and psychology, the conceptual model combines *substrates* to manage digital information at various levels of abstraction and representation, *instruments* to manipulate substrates, and *environments* to organize substrates and instruments into digital workspaces.

9.4. International Initiatives

9.4.1. Inria Associate Teams Not Involved in an Inria International Labs

9.4.1.1. DECibel

Title: Discover, Express, Create – Interaction Technologies For Creative Collaboration

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (United States) - Electrical and Computer Engineering, Center for Magnetic Resonance Research - Bjoern Hartmann

Start year: 2016

The DECibel associated team includes Inria's ExSitu and the CITRIS Connected Communities Initiative (CCI) at UC Berkeley. ExSitu explores extreme interaction, working with creative professionals and scientists who push the limits of technology to develop novel interactive technologies that offer new strategies for creative exploration. ExSitu's research activities include: developing underlying theory (co-adaptive instruments and substrates), conducting empirical studies (participatory design with creative professionals), and implementing interactive systems (creativity support tools). The CITRIS Connected Communities Initiative investigates collaborative discovery and design through new technologies that enhance education, creative work, and public engagement. It develops interactive tools, techniques and materials for the rapid design and prototyping of novel interactive products, expertise sharing among designers, and citizen science investigations. DECibel will combine the strengths of these two groups to to investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Joanna McGrenere, Professor at University of British Columbia, Vancouver, Canada, visited ExSitu for her entire sabbatical, from September, 2015 to July, 2016.
- Jim Hollan, Professor at University of California at San Diego (UCSD), visited from April to June, 2016.

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. Member of the Organizing Committees

- IHM 2016, *Conférence Francophone d'Interaction Homme-Machine*, Doctoral Consortium Co-Chair: Michel Beaudouin-Lafon, Jury: Wendy Mackay

10.1.2. Scientific Events Selection

10.1.2.1. Chair of Conference Program Committees

- NIME 2016, *New Interfaces for Musical Expression*, Conference Workshop Chair: Joseph Malloch
- ACM/CHI 2016, *Music and HCI*, Conference Workshop Co-Organisers: Wendy Mackay, Joseph Malloch
- ACM/CHI 2016, *Human-Centred Machine Learning*, Conference Workshop Co-Organiser: Wendy Mackay
- ERC CREATIV Workshop *CREATIV*, Conference Workshop Organiser: Wendy Mackay
- MOCO 2016, *International Symposium on Movement and Computing*, Conference Steering Committee member: Sarah Fdili Alaoui

10.1.2.2. Member of the Conference Program Committees

- IEEE VR 2016, *Virtual Reality Conference*: Cédric Fleury
- GI 2016, *Graphics Interface Conference*: Cédric Fleury
- GRAPP 2016, *Conference on Computer Graphics Theory and Applications*: Cédric Fleury
- 3DCVE 2016, *IEEE VR Workshop on Collaborative Virtual Environments*: Cédric Fleury
- CHI 2017, *ACM CHI Conference on Human Factors in Computing Systems*: Michel Beaudouin-Lafon, Wendy Mackay
- CHI 2017, *ACM UIST User Interface Software and Technology*: Wendy Mackay
- MOCO 2016, *International Symposium on Movement and Computing*: Sarah Fdili Alaoui

10.1.2.3. Reviewer

- IJHCS *International Journal on Human-Computer Interaction*: Wendy Mackay
- ACM CSCW 2016 *ACM Conference on Computer-Supported Cooperative Work*: Wendy Mackay
- ACM CHI 2016 *ACM Conference on Human Factors in Computing Systems*: Marianela Ciolfi Felice, Germán Leiva, Oleksandr Zinenko, Ignacio Avellino, Nolwenn Maudet, Joseph Malloch, Theophanis Tsandilas, Michel Beaudouin-Lafon, Wendy Mackay, Sarah Fdili Alaoui
- ACM UIST 2016 *ACM Symposium on User Interface Software and Technology*: Joseph Malloch, Theophanis Tsandilas, Nolwenn Maudet, Ignacio Avellino, Jessalyn Alvina, Cédric Fleury, Michel Beaudouin-Lafon, Wendy Mackay
- UBICOMP 2016, *ACM International Joint Conference on Pervasive and Ubiquitous Computing*: Theophanis Tsandilas
- SIGGRAPH Asia 2016: Theophanis Tsandilas
- ACM MobileHCI 2016, *ACM Conference on Human-Computer Interaction with Mobile Devices and Services*: Jessalyn Alvina
- IEEE 3DUI 2016, *Symposium on 3D User Interfaces*: Cédric Fleury
- IEEE Visualization: Michel Beaudouin-Lafon
- IHM 2016, *Conférence Francophone d'Interaction Homme-Machine*: Cédric Fleury

- WAMCA 2016, *Workshop on Applications for Multi-Core Architectures*: Oleksandr Zinenko
- IMPACT 2016, *International Workshop on Polyhedral Compilation Techniques*: Oleksandr Zinenko
- TEI 2016, *International Conference on Tangible, Embedded and Embodied Interactions*: Sarah Fdili Alaoui
- DIS 2016, *Designing Interactive Systems*: Sarah Fdili Alaoui

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-), Wendy Mackay (2016-)
- 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

- Computers and Graphics: Theophanis Tsandilas
- TVCG, *Transactions on Visualization and Computer Graphics*, IEEE: Cédric Fleury
- UAIS, Universal Access in the Information Society: Michel Beaudouin-Lafon
- JAISE, Journal of Ambient Intelligence and Smart Environments: Michel Beaudouin-Lafon

10.1.4. Invited Talks

- Beyond Lab: Entre L'Homme et la Machine : Le Défi des Nouvelles Interfaces "*Interaction en Grand*", 8 February 2016: Michel Beaudouin-Lafon
- Beyond Lab: Entre L'Homme et la Machine : Le Défi des Nouvelles Interfaces "*Apprentissage Incrémental de Gestes*", 8 February 2016: Wendy Mackay
- Beyond Lab: Entre L'Homme et la Machine : Le Défi des Nouvelles Interfaces "*Movement Connoisseurship for User eXperience in Digital Art and HCI*", 8 February 2016: Sarah Fdili Alaoui
- Beyond Lab: Entre L'Homme et la Machine : Le Défi des Nouvelles Interfaces "*Papier Interactif pour la Créativité*", 8 February 2016: Theophanis Tsandilas
- FAST (Fusing Audio and Semantic Techologies for Intelligent Music Production and Consumption) Workshop Paris "*Creative Musical Expression with Human-Computer Partnerships*", 15 February 2016: Wendy Mackay
- ENS Cachan Semainaire d'Informatique "*Co-Adaptive Instruments. Can we reinvent the graphical user interface*", 2 March 2016: Wendy Mackay
- Café Techno – Inria Alumni & NUMA, "*Quelles interactions avec le monde numérique de demain ?*", March 2016: Michel Beaudouin-Lafon
- Les Outils du Design, ENSCI, "*Instrumental Interaction*", April 2016: Michel Beaudouin-Lafon
- École Thématique Maths-Info-HPC, Saint-Germain-au-Mont-d'Or, "*Polyhedral Code Transformations via Interactive Visualizations*", 10 May 2016: Oleksandr Zinenko
- Journée d'étude Scénariser la danse par le numérique, Université de Strasbourg "*Étude du mouvement expressif dans les interactions incorporée pour la danse*", 18 May 2016: Sarah Fdili Alaoui

- May Residency of the Moving Stories Project, Simon Fraser University "*Embodied Interaction for dance and tools for supporting choreography*", 28 May 2016: Sarah Fdili Alaoui
- ERC CREATIV Workshop "*Creating Human-Computer Partnerships*", 13 June 2016: Wendy Mackay
- ICCC International Conference on Computational Creativity 2016: ERC Comics Invited Address "*Creating CoAdaptive partnerships*", 29 June 2016: Wendy Mackay
- ENS Paris, "*Polyhedral program transformations via interactive visualization*", 1 June 2016: Oleksandr Zinenko
- ARC Raymond Hains, Ecole Européenne Supérieure Beaux Arts de Rennes, "*Construire et déconstruire les logiciels du design*", 11 octobre 2016: Nolwenn Maudet
- Journée MENESR-EHESS: Coding and computer science in our schools: new ways of learning? "*Entre les enfants et les ordinateurs: Human Computer Interaction*", 11 october 2016: Wendy Mackay
- CM Lab, Tokyo Tech, "*Designing Design Tools*", 20 october 2016: Nolwenn Maudet
- Google Japan, Tokyo, Japan, "*Expressive Keyboards: Expressive Keyboards: Enriching Gesture-Typing on Mobile Devices*", 20 October 2016: Jessalyn Alvina
- Rencontre Inria – Industrie Lille "*Interactions avec les objets ! et services numeriques*", 25 November 2016: Wendy Mackay
- TEDx Saclay, "*Dancing in digital*", 30 November 2016: Sarah Fdili Alaoui
- Rencontres Lurs: "*Droit à l'Erreur* ", 25 August 2016: Wendy Mackay
- UniThé ou Café "*Créer des Partenariats Homme-Machine*", 17 November 2016: Wendy Mackay
- Infomuse, Casa Paganini "*Embodied Interaction for dance and tools for supporting choreograph*", 14 Decembre 2016: Sarah Fdili Alaoui

10.1.5. Scientific Expertise

- European Research Council, Panel member for Starting Grants: Michel Beaudouin-Lafon
- CNRS Mission pour l'Interdisciplinarité, Panel member for the call "Sciences Sociales et Cognitives des Comportements Collectifs": Michel Beaudouin-Lafon
- ACM/CHI Best Paper Award Committee "Best Paper Award Committee": Wendy Mackay
- ACM/SIGCHI "Lifetime Service Award Committee": Wendy Mackay

10.1.6. Research Administration

- Computer Science Department, Université Paris-Saclay: Wendy Mackay (member of steering committee)
- CNRS, Conseil Scientifique de l'Institut INS2I: Michel Beaudouin-Lafon (member)
- Telecom ParisTech: Michel Beaudouin-Lafon (member of research committee)
- IRCAM: Michel Beaudouin-Lafon (member of scientific committee)
- "Institut de la Société Numérique", IDEX Laboratory of Université Paris-Saclay: Michel Beaudouin-Lafon (member of steering committee)
- "Conseil de Laboratoire", LRI: Wendy Mackay, Cédric Fleury (members)
- "Conseil Scientifique", LRI: Michel Beaudouin-Lafon (member)
- "Commission Locaux", LRI: Theophanis Tsandilas (member)
- CCSU, "Commission Consultative de Spécialistes de l'Université", Computer Science department: Michel Beaudouin-Lafon, Wendy Mackay (members)
- COERLE "Comité Operationnel d'Evaluation des Risques Légaux et Ethiques", Inria: Wendy Mackay

- CERNI "Comité d'Ethique pour les Recherches Non Interventionnelles", Université Paris-Sud: Wendy Mackay
- "Commission de Développement Technologique", Inria: Theophanis Tsanidlas (member), until April 2016

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

Interaction & HCID Masters: Wendy Mackay, *Career Seminar* 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: Michel Beaudouin-Lafon, Wendy Mackay *Fundamentals of Situated Interaction*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Wendy Mackay, *Design of Interactive Systems*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Wendy Mackay, *Advanced Design of Interactive Systems*, 21 hrs, M1/M2, Univ. Paris-Sud

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

Interaction & HCID Masters: Michel Beaudouin-Lafon & Cédric Fleury, *Groupware and Collaborative Interaction*, 31.5 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*, 21 hrs, M1/M2, Univ. Paris-Sud

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

HCID Masters: Wendy Mackay & Michel Beaudouin-Lafon, *Fundamentals of Situated Interaction*, 21 hrs, M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Programmation des interfaces interactives avancées*, 15 hrs, L3, Univ. Paris-Sud

Polytech 5th year Apprentices: Sarah Fdili Alaoui, *Informatique Graphique et visualisation*, 12 hrs, M2, Univ. Paris-Sud

Polytech 5th year: Cédric Fleury, *Réalité Virtuelle et Interaction*, 48 hrs, M2, Univ. Paris-Sud

Polytech 3st year: Cédric Fleury, *Interaction Homme-Machine*, 18 hrs, M1, Univ. Paris-Sud

Polytech 3st year: Cédric Fleury, *Projet Java-Graphique-IHM*, 24 hrs, M1, Univ. Paris-Sud

Polytech 1st year: Cédric Fleury, *Introduction à l'Informatique*, 71 hrs, L1, Univ. Paris-Sud

M1 Informatique: Theophanis Tsandilas, *Évaluation des Interfaces*, 2 hrs, M1, Univ. Paris-Sud

10.2.2. Supervision

PhD students

PhD: Oleksandr Zinenko, *Interactive Program Restructuring*, Université Paris-Saclay, 25 November 2016. Advisors: Stéphane Huot (Inria Lille) & Cédric Bastoul (Université de Strasbourg)

PhD: Ghita Jalal, *Supporting visual composition with reified interactive properties*, Université Paris-Saclay, 16 December 2016. Advisor: Wendy Mackay

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

PhD in progress: Stacy (Shu-Yuan) Hseuh, *Embodied design for Human-Computer Co-creation*, November 2015. Advisors: Wendy Mackay & Sarah Fdili Alaoui

PhD in progress: Philip Tchernavskij, *Towards Unified Principles of Interaction*, October 2016. Advisor: Michel Beaudouin-Lafon

Masters students

Brennan Jones, University of Calgary, “Physical and virtual avatars for telepresence and remote collaboration”: Ignacio Avellino, Cédric Fleury & Michel Beaudouin-Lafon

Francesco Vitale, Université Paris-Saclay, “Field study of operating systems upgrades”: Joanna McGrenere, Wendy Mackay

Dimitri Belopopsky, Université Paris-Saclay, “La Grande Vitrine des Choses”: Michel Beaudouin-Lafon, Wendy Mackay, Joseph Malloch

Sruthi Coimbatore Viswanathan, Université Paris-Saclay, “Touch Keyboard with Haptic Feedback”: Michel Beaudouin-Lafon

Iva Karabatic, Université Paris-Saclay, “Chord input on a digital whiteboard”: Wendy Mackay, Michel Beaudouin-Lafon

Diana Lipcanu, Université Paris-Saclay, “The Inteaction Musuem”: Wendy Mackay, Michel Beaudouin-Lafon

Isha Van Baar, Université Paris-Saclay, “The Inteaction Musuem”: Wendy Mackay, Michel Beaudouin-Lafon

Nam Giang, Université Paris-Saclay, “Interactive Video Preview Playlist”: Wendy Mackay, Carla Griggio

Midas Nouwens, Université Paris-Saclay, “Communication Appliances to Support Communication for Distributed Families”: Wendy Mackay, Carla Griggio

Pierre Mahe, IRCAM, “EMBRACe Expressive Movement Body fRAmework and Computing”: Sarah Fdili Alaoui

Niels Mourette, IRCAM, “The augmented body from within”: Sarah Fdili Alaoui

Shu-Yuan Hsueh, IRCAM & ENSCII, “Dynamic Guides for Embodied Interactiob”: Wendy Mackay, Sarah Fdili Alaoui

Philip Tchernavskij, University of Aarhus, “Information Substrates for Asymmetrical Collaboration”: Wendy Mackay, Michel Beaudouin-Lafon

10.2.3. Juries

Mathieu Le Goc, Inria Saclay, December 2016 (Advisor: Jean-Daniel Fekete): Michel Beaudouin-Lafon, President.

Alex Goguey, Inria Lille, October 2016 (Advisor: Géry Casiez): Michel Beaudouin-Lafon, reviewer.

Andéol Evain, IRISA, December 2016 (Advisor: Anatole Lécuyer): Michel Beaudouin-Lafon, reviewer.

Emiline Brulé, Télécom Paris, 6 June 2016 (Advisor: Annie Gentes): Wendy Mackay, reviewer.

10.3. Popularization

Organisation d'une Journée d'étude, 15 April 2016 @ ENSCI *La fabrique des outils, concevoir et pratiquer les logiciels de design*: Nolwenn Maudet

BeyondLab, 10 February 2016 *Meet-up sur les nouvelles interfaces*: Sarah Fdili Alaoui, Michel Beaudouin-Lafon, Wendy Mackay, and Theophanis Tsandilas

Inria Rencontres Industrielles 2016, "*Expressive Keyboards: Enriching Gesture-Typing on Mobile Devices*", 25 November 2016: Jessalyn Alvina, Wendy Mackay

Inria Rencontres Industrielles 2016, "*StickyLines: Reifying Alignment and Distribution of Graphical Objects*", 25 November 2016: Michel Beaudouin-Lafon, Wendy Mackay

ACM UIST Demonstration, "*Expressive Keyboards*", Jessalyn Alvina

ACM UIST Demonstration, "*StickyLines*", Marianela Ciolfi

ACM UIST Demonstration, "*Stretchis*", Michael Wessely

ACM UIST Demonstration, "*UIST Video Playlist*", Carla Griggio

ACM "*HCI Pioneers*", Michel Beaudouin-Lafon, Wendy Mackay

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

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