IN PARTNERSHIP WITH:
Université Paris-Sud (Paris 11)

Activity Report 2017

Project-Team EX-SITU

Extreme Situated Interacton

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

RESEARCH CENTER
Saclay - Île-de-France

THEME
Interaction and visualization

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Project-Team EX-SITU

Creation of the Team: 2015 January 01, updated into Project-Team: 2017 July 01

Keywords:

Computer Science and Digital Science:

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A5.1.2. - Evaluation of interactive systems
A5.1.5. - Body-based interfaces
A5.1.6. - Tangible interfaces
A5.1.7. - Multimodal interfaces

Other Research Topics and Application Domains:

B2.8. - Sports, performance, motor skills
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B6.3.4. - Social Networks
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1. Personnel

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Theophanis Tsandilas [Inria, Researcher]

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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

5.1.1. Awards

- Wendy Mackay: Doctor Honoris Causa, Aarhus University (Denmark), September 2017
- Wanyu Liu: “1er Prix Doctorants ED STIC” of Université Paris-Saclay, November 2017, for “BIGNav: Information Theory meets Human-Computer Interaction”

BEST PAPER AWARD:

[20]
W. LIU, R. LUCAS D'OLIVEIRA, M. BEAUDOUIN-LAFON, O. RIOUL. *BIGnav: Bayesian Information Gain for Guiding Multiscale Navigation*, in "ACM CHI 2017 - International conference of Human-Computer Interaction", Denver, United States, May 2017, pp. 5869-5880 [*DOI :* 10.1145/3025453.3025524], https://hal.inria.fr/hal-01677122

6. New Software and Platforms

6.1. Platforms

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.

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

6.1.3. WILDER

Participants: Michel Beaudouin-Lafon [correspondant], Cédric Fleury, Olivier Gladin.

WILDER (Figure 1) is our second experimental ultra-high-resolution interactive environment, which follows the WILD platform developed in 2009. 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.

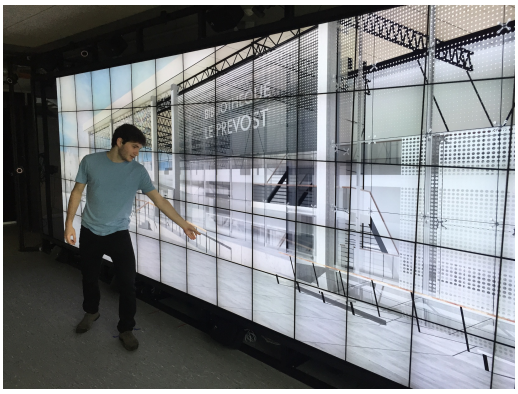
WILDER was inaugurated in June, 2015. It is one of the ten platforms of the Digiscope Equipment of Excellence and, in combination with WILD and the other Digiscope rooms, provides a unique experimental environment for collaborative interaction.

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: Michel Beaudouin-Lafon [correspondant], Marianela Ciolfi Felice, Sarah Fdili Alaoui, Cédric Fleury, Carla Griggio, Wanyu Liu, Wendy Mackay, Nolwenn Maudet, Philip Tchernavskij, Theophanis Tsandilas.



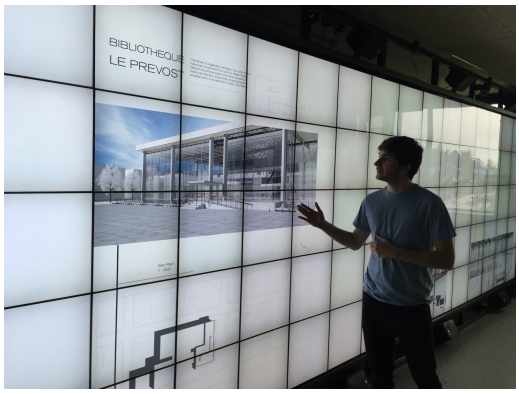


Figure 1. The WILDER platform.

In order to better understand fundamental aspects of interaction, ExSitu studies interaction under 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.

On the theoretical side, in collaboration with Telecom ParisTech, we are bringing the tools and concepts from Information Theory to HCI. We conducted an information-theoretic analysis of human performance for command selection [21]. While a number of studies have focused on improving rapid command selection through novel interaction techniques, new interface design and innovative devices, user performance in this context has received little attention. We ran a controlled experiment to test the theory that the transmitted information from the user to the computer levels off as difficulty increases. Our reasoning is based on basic information-theoretic concepts such as entropy, mutual information and Fano's inequality. The important result is the bell-shaped behavior of the throughput as a function of command entropy, which shows that there is an optimal level of difficulty for a given input technique.

We also used the information-theoretic concept of mutual information, also known as information gain, in our BIG (Bayesian Information Gain) framework. We created *BIGnav* [20], a new multiscale navigation technique based on Bayesian Experimental Design where the criterion is to maximize the expected information gain from the next user input. In a controlled experiment, *BIGnav* was up to 40% faster than the standard pan-and-zoom technique. *BIGnav* creates a form of human-computer partnership (see below) where the computer challenges the user in order to maximize the amount of information extracted from the user's input. This work received a Best Paper Award at ACM CHI 2017, and the first prize for doctoral research from the Paris-Saclay doctoral school in computer science.

Finally, we continued our long-standing line of work on Fitts' law, with a novel analysis of minimal, as opposed to average, movement time in human aimed movement [18]. We showed that both metrics have a lot of support from theoretical and empirical perspectives and gave two examples, one in a controlled experiment and the other in a field study of pointing, where making the minimum versus average distinction is fruitful.

On the empirical side, we conducted two observational studies to better understand how people interact with technology. The first study [23] targeted expert graphic designers and their use of advanced computer tools. Traditional graphic design tools emphasize the grid for structuring layout. Interviews with professional graphic designers revealed that they use surprisingly sophisticated structures that go beyond the grid, which we call *graphical substrates*. These structures are not well supported by existing tools, so we developed two technology probes to explore how to embed graphical substrates into tools. *Contextify* lets designers tailor layouts according to each reader's intention and context, while *Linkify* lets designers create dynamic layouts based on relationships among content properties. We tested the probes with professional graphic designers,

who all identified novel uses in their current projects. We incorporated their suggestions into *StyleBlocks*, a prototype that reifies CSS declarations into interactive graphical substrates. This work demonstrates that graphical substrates offer an untapped design space for tools that can help graphic designers generate personal layout structures.

The second study [30] targeted the operating system upgrade process that most users regularly have to go through to keep their system up to date. While current research has focused primarily on the security aspect of upgrades, we investigated the user's perspective of upgrading software. We found that users delay major upgrades by an average of 80 days, and an extensive field study revealed that very few participants prepare for upgrades (e.g., by backing up files), and over half had negative reactions to the upgrade process and other changes (e.g., bugs, lost settings, unwanted features). During the upgrade process, waiting times were too long, feedback was confusing or misleading, and few had clear mental models of what was happening. Moreover, users almost never mentioned security as a concern or reason for upgrading, while interviews with technical staff responsible for one organization's upgrades focused only on security and licensing, not user interface changes. This work shows that upgrades should be handled differently, offering users more control and decoupling security updates from the introduction of new features or the update of existing features.

These two sets of studies support our strong commitment to re-inventing interactive systems by identifying fundamental principles of interaction that unify, rather than separate, interaction styles in order to support the diversity of uses and users [33]. For example, most of our interactions with the digital world are mediated by apps: desktop, web, or mobile applications. Apps impose artificial limitations on collaboration among users, distribution across devices, and the changing procedures that constantly occur in real work. These limitations are partially due to the engineering principles of encapsulation and program-data separation, calling for new architectural principles [29]. Shareable dynamic media, which we have explored in our earlier work on Webstrates[5], provides an interesting approach as it blurs the limits between apps and documents and supports collaboration, distribution and flexibility as fundamental features [28]. In connection with these issues, we ran a workshop at the ACM CHI 2017 conference on HCI toolkits [37] where we discussed challenges and opportunities to develop new methods and approaches to design, evaluate, disseminate and share toolkits, as well as the technical, methodological and enabling role of toolkits for HCI research.

7.2. Human-Computer Partnerships

Participants: Wendy Mackay [correspondant], Jessalyn Alvina, Marianela Ciolfi Felice, Carla Griggio, Shu Yuan Hsueh, Wanyu Liu, John Maccallum, Nolwenn Maudet, Joanna Mcgrenere, Midas Nouwens, Andrew Webb.

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 algorithm, 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 systems' that are discoverable, appropriable and expressive for the user. Jessalyn Alvina, under the supervision of Wendy Mackay, successfully defended her thesis, *Increasing The Expressive Power of Gesture-based Interaction on Mobile Devices* [38], on this topic.

We are interested in helping users create their own custom gesture-based commands for mobile devices. This raises two competing requirements: gestures must be both personally memorable for the user, while reliably recognizable by the system. We created two dynamic guides [22], *Fieldward* and *Pathward*, which use progressive feedforward to interactively visualize the "negative space" of unused gestures. The Pathward technique suggests four possible completions to the current gesture, whereas the Fieldward technique uses color gradients to reveal optimal directions for creating recognizable gestures (Figure 2). We ran a two-part experiment in which 27 participants each created 42 personal gesture shortcuts on a smartphone, using *Pathward*, *Fieldward* or *No Feedforward*. The Fieldward technique best supported the most common user strategy, i.e. to create a memorable gesture first and then adapt it to be recognized by the system. Users preferred the Fieldward technique to Pathward or No Feedforward, and remembered gestures more easily

when using the technique. Dynamic guides can help developers design novel gesture vocabularies and support users as they design custom gestures for mobile applications.

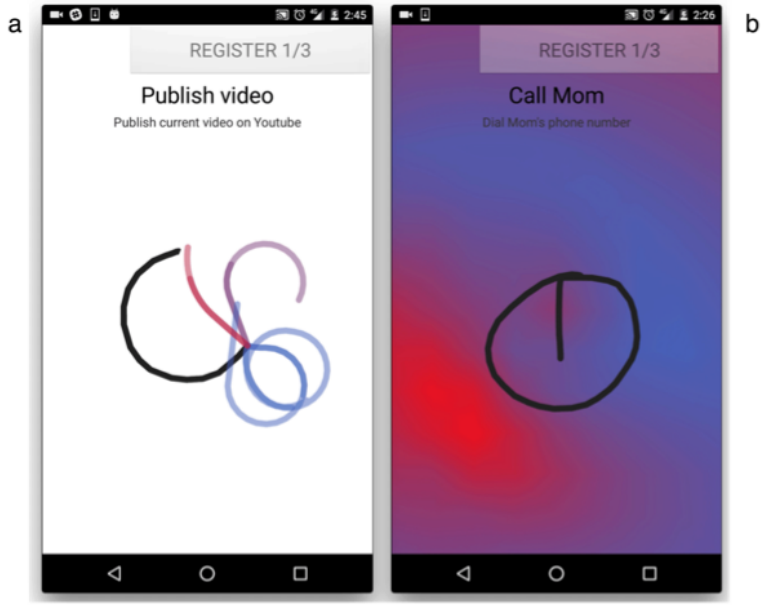


Figure 2. The Pathward (a) & Fieldward (b) dynamic guides help users create their own easy-to-remember gesture commands that are also recognizable by the system.

We are also interested in letting users use simple gestures to generate commands on a mobile device. *CommandBoard* [14] offers a simple, efficient and incrementally learnable technique for issuing gesture commands from a soft keyboard. We transform the area above the keyboard into a command-gesture input space that lets users draw unique command gestures or type command names followed by execute (Fig 3). Novices who pause see an in-context dynamic guide, whereas experts simply draw. Our studies show that *CommandBoard*'s inline gesture shortcuts are significantly faster (almost double) than markdown symbols and significantly preferred by users. We demonstrate additional techniques for more complex commands, and discuss trade-offs with respect to the user's knowledge and motor skills, as well as the size and structure of the command space. We filed a patent for the *CommandBoard* technique.

In the context of an art-science project with the *n+1* theater group and the Théâtre de l'Agora d'Evry, we created an interactive installation that was exhibited at Fête de la Science, at the Agora d'Evry for an entire month, and at the Festival Curiositas. We were interested in understanding what makes public art installations interactive, so that they are engaging both for the individual user and the surrounding public. More specifically, we experimented with the principle of 'shaping' from behavioral psychology to create a human-computer partnership: an animated Santa character mirrors the exact movements of the user, but also offers different types of reinforcing or punishing feedback that in turn shapes the user's behavior (Figure 4). From the user's perspective, the user is always in control. Yet, from the system's perspective, the user moves through successive approximations to a specific desired behavior. Thus, we explore the dynamic nature of shared control between users and technology.

Finally, with *BIGnav* [20], we experimented with a different kind of partnership. *BIGnav* is a new multi-scale navigation technique based on Bayesian Experimental Design where the criterion is to maximize the

Figure 3. CommandBoard creates a new command gesture input space above a soft keyboard. Users can: a) type 'happy' and use a dynamic guide to style it as bold; b) type 'brightn', draw an execute gesture and adjust the brightness slider; c) type 'sans', choose 'sans mono' and draw an execute gesture to change the font; d) type 'color', select yellow in the marking menu to change the brush color.

Figure 4. The interactive Christmas window: the Santa character mimics the movements of the user in front of the window, but also uses reinforcement feedback to shape the movements of the user.

information-theoretic concept of mutual information, also known as information gain. Rather than simply executing user navigation commands, *BIGnav* interprets user input to update its knowledge about the user's intended target. It then navigates to a new view that maximizes the information gain provided by the user's expected subsequent input. *BIGnav* creates a novel form of human-computer partnership, where the computer challenges the user in order to extract more information from the user's input, making interaction more efficient. We showed that *BIGnav* is significantly faster than conventional pan and zoom and requires fewer commands for distant targets, especially in non-uniform information spaces. We also applied *BIGnav* to a realistic application and showed that users can navigate to highly probable points of interest on a map with only a few steps.

7.3. Creativity

Participants: Sarah Fdili Alaoui [correspondant], Marianela Ciolfi Felice, Carla Griggio, Shu Yuan Hsueh, Ghita Jalal, Germán Leiva, John Maccallum, Wendy Mackay, Nolwenn Maudet, Joanna Mcgrenere, Midas Nouwens, Jean-Philippe Riviere, Nicolas Taffin, Philip Tchernavskij, Theophanis Tsandilas, Andrew Webb, Michael Wessely.

ExSitu is interested in understanding the work practices of creative professionals, particularly artists, designers, and scientists, who push the limits of interactive technology. Nolwenn Maudet, under the supervision of Wendy Mackay and Michel Beaudouin-Lafon, successfully defended her thesis, *Designing Design Tools* [40], on this topic. Her research includes observational studies of graphic designers and developers ([24] described in the *Collaboration* section below), as well as the creation of variety of creativity support tools to support professional designers [23] (described in the *Fundamentals of Interaction* section above).

We designed and evaluated computational models of movement's expressive qualities as defined in the framework of Laban Efforts [13] for dancer and movement practitioners. We included experts in Laban Movement Analysis (LMA) in our design process, in order to select a set of suitable multimodal sensors as well as to compute features that closely correlate to the definitions of Efforts in LMA. Evaluation of our model showed that multimodal data combining positional, dynamic and physiological information allows for a better characterization of Laban Efforts. Inspired by movement practices and dance, we designed an interactive sound installation that supports kinesthetic awareness of a participant's micro-movements [17] and discussed perspectives of such an installation from somatic practices and embodied cognition [16]. We discussed [25] the ethical and aesthetic implications of the appropriation of biomedical sensors in artistic practices, in particular dance. We also traced the history and new perspective of HCI in Dance and body based practices [11].

In collaboration with Inria Lille, we developed a versioning and annotation system for supporting collaborative, iterative design of mapping layers for digital musical instruments (DMIs) [31]. We also collaborated with Saarland University, TU Berlin and MIT to digitally fabricate Directional screens, devices and surfaces that maximize perceived image quality (e.g., resolution, brightness, and color reproduction) for large audiences [27]. Finally, Michael Wessely participated in the *MIT Summer School for Computational Fabrication and Smart Matter* and was then invited by its organizers to co-author an article [35] that presents and discusses the results of the summer school.

7.4. Collaboration

Participants: Cédric Fleury [correspondant], Ignacio Avellino Martinez, Michel Beaudouin-Lafon, Marianela Ciolfi Felice, Carla Griggio, Germán Leiva, Can Liu, Wendy Mackay, Nolwenn Maudet, Joanna Mcgrenere, Midas Nouwens, Yujiro Okuya.

ExSitu is interested in exploring new ways of supporting collaborative interaction, especially within and across large interactive spaces such as those of the Digiscope network (http://digiscope.fr/). Multi-touch wall-sized displays afford collaborative exploration of large datasets and re-organization of digital content. However, standard touch interactions, such as dragging to move content, do not scale well to large surfaces and were not designed to support collaboration, such as passing objects around. We created *CoReach* [19], a set of collaborative gestures that combine input from multiple users in order to manipulate content, facilitate data

exchange and support communication. *Throw-and-catch* (Figure 5) lets users send digital objects to each other, *Preview* lets one user show content to another, and *SharedClipboard* lets users gather content. We conducted an observational study to inform the design of *CoReach*, and a controlled study showing that it reduced physical fatigue and facilitated collaboration when compared with traditional multi-touch gestures. A final study assessed the value of also allowing input through a handheld tablet to manipulate content from a distance.

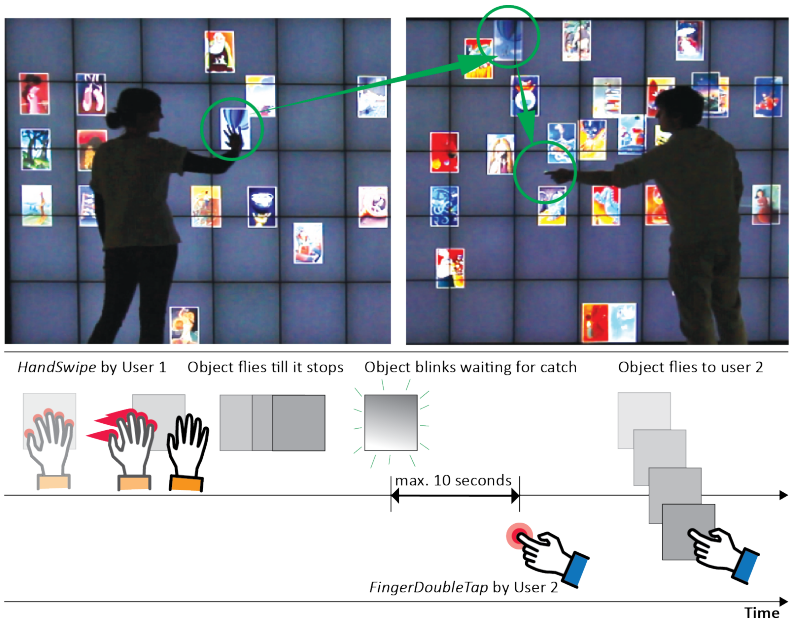


Figure 5. One of the three CoReach gestures: sending an object to the partner.

We also studied remote collaboration across wall-sized displays, where the challenge is to support audio-video communication among users as they move in front of the display. We created *CamRay* [15], a platform that uses camera arrays embedded in wall-sized displays (Figure 6) to capture video of users and present it on remote displays according to the users' positions. We investigated two settings: in *Follow-Remote*, the position of the video window follows the position of the remote user; in *Follow-Local*, the video window always appears in front of the local user. A controlled experiment showed that with *Follow-Remote*, participants were faster, used more deictic instructions, interpreted them more accurately, and used fewer words. However, some participants preferred the virtual face-to-face created by *Follow-Local* when checking for their partners' understanding. An ideal system should therefore combine both modes, in a way that does not hinder the collaborative process. Ignacio Avellino, under the supervision of Michel Beaudouin-Lafon and Cédric Fleury, successfully defended his thesis *Supporting Collaborative Practices Across Wall-Sized Displays with Video-Mediated Communication* [39] on this topic.

We are also interested in the collaboration between between professional interaction designers and software developers when they create novel interactive systems [24]. Although designers and developers have different skills and training, they need to collaborate closely to create interactive systems. Our studies highlighted the mismatches among their processes, tools and representations: We found that current practices create unnecessary rework and cause discrepancies between the original design and the implementation. We identified three types of design breakdowns: omitting critical details, ignoring edge cases, and disregarding technical limitations. In a follow-up study, we found that early involvement of the developer helped mitigate potential design

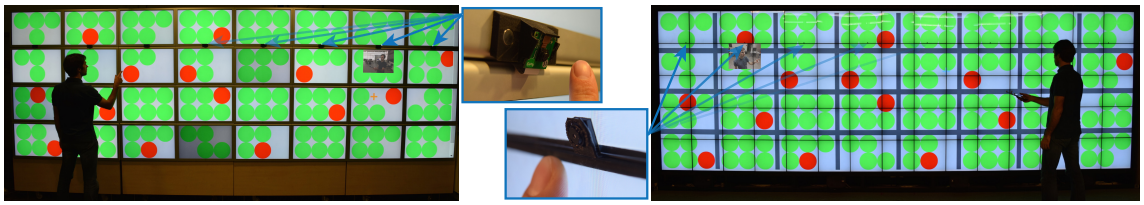


Figure 6. CamRay: the video cameras embedded in the wall-sized display (middle), and the two wall-sized displays (left, right) showing the video feed from the partner.

breakdowns but new ones emerged as the project unfolded. Finally, we ran a participatory design session and found that the designer/developer pairs had difficulty representing and communicating pre-existing interactions. This work will inform our future work on tools for designers and developers of interactive systems, in the context of our overal theoretical framework.

We also studied the use of social networks, with an indepth study of how users communicate via multiple apps that offer almost identical functionality [26] We studied how and why users distribute their contacts within their app ecosystem. We found that the contacts in an app affect a user's conversations with other contacts, their communication patterns in the app, and the quality of their social relationships. Users appropriate the features and technical constraints of their apps to create idiosyncratic communication places, each with its own re- cursively defined membership rules, perceived purposes, and emotional connotations. Users also shift the boundaries of their communication places to accommodate changes in their contacts' behaviour, the dynamics of their relationships, and the restrictions of the technology. We argue that communi- cation apps should support creating multiple communication places within the same app, relocating conversations across apps, and accessing functionality from other apps.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. 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.

8.1.2. 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.

8.1.3. An Augmented-Reality System for Collaborative Physical Modeling and Design

Type: Equipment

Funding: STIC Paris-Saclay

Duration: 2017-2018

Coordinator: Theophanis Tsandilas

Partners: Univ. Paris-Sud, Inria

Inria contact: Theophanis Tsandilas

Abstract: The goal of the project is to develop an augmented-reality system to support collaboration over 3D models and enhance digital-fabrication approaches. It is a collaboration with the AVIZ group and provides funding (8k) for equipment.

8.1.4. Le Plateau des Recherches Infinies

Type: Equipment and subcontracting

Funding: Learning Center Paris-Saclay

Duration: 2017-2018

Coordinator: Michel Beaudouin-Lafon

Partners: Univ. Paris-Sud

Inria contact: Michel Beaudouin-Lafon

Abstract: The goal of this project (30k) is to create an interactive installation presenting the portraits of a hundred researchers from Université Paris-Saclay. It is a collaboration with portrait photographer Didier Goupy. The installation is designed to be exhibited in various sites of Université Paris-Saclay until it is permanently installed in the Learning Center of Université Paris-Saclay. This project supported Shubhangi Gupta, an intern, for two months over the summer.

8.2. National Initiatives

8.2.1. Investissements d'Avenir

8.2.1.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2021

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 2017, all ten rooms and the telepresence network are operational. The project was successfully evaluated by an international jury in June, 2017.

8.3. European Initiatives

8.3.1. European Research Council (ERC)

8.3.1.1. 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.

8.3.1.2. 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.

8.4. International Initiatives

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

8.4.1.1. 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

See also: https://www.inria.fr/en/associate-team/decibel

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.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Mobile Life research team (KTH, Sweden) 20 researchers visited ExSitu in January, 2017.
- Susanne Bødker (Aarhus University, Denmark) visited ExSitu in April, 2017.
- Joanna McGrenere (University of British Columbia, Canada) Inria Chair, visited ExSitu in June-July, 2017.

8.5.1.1. Internships

- Alessandro Silacci, Haute Ecole d'Ingenierie et d'Architecture de Fribourg (Suisse), "Cross-Surface Expressive Gesture Interactions in Collaboration Scenarios": Michel Beaudouin-Lafon
- Shubhangi Gupta, "Design and Prototyping of Web Interface to the 'Plateau des Recherches Infinies' Installation": Michel Beaudouin-Lafon
- Alexander Eiselmayer, University of Zurich, "Touchstone II": Wendy Mackay and Michel Beaudouin-Lafon

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events Organisation

9.1.1.1. Member of the Organizing Committees

- ACM CHI 2017, *Video-Previews* Chair: Carla Griggio
- ACM CHI 2018, *ACM Conference on Human Factors in Computing*, Web Co-Chair: Ignacio Avellino

9.1.2. Scientific Events Selection

9.1.2.1. Chair of Conference Program Committees

- ACM CHI 2017, *Late-Breaking Work* Co-Chair: Theophanis Tsandilas
- ACM/ISMIR 2018, *Music and Technology* Co-Chair: Wendy Mackay

9.1.2.2. Member of the Conference Program Committees

- ACM CHI 2018, *ACM CHI Conference on Human Factors in Computing Systems*: Michel Beaudouin-Lafon, Wendy Mackay, Theophanis Tsandilas
- ACM CHI 2017, *ACM CHI Conference on Human Factors in Computing Systems*: Michel Beaudouin-Lafon, Wendy Mackay
- ACM UIST 2017, *ACM Symposium on User Interface Software and Technology*: Michel Beaudouin-Lafon, Wendy Mackay
- IUI 2018, *ACM IUI Conference on Intelligent User Interfaces*: Wendy Mackay
- MOCO 2017, *International Conference on Movement and Computing*: Sarah Fdili Alaoui
- EuroVR 2017, *European Virtual Reality Conference*: Cédric Fleury
- ACM C&C 2017, *Creativity and Cognition*: Andrew Webb

9.1.2.3. Reviewer

- ACM CHI 2017-18, *ACM CHI Conference on Human Factors in Computing Systems*: Andrew Webb, Carla Griggio, Nolwenn Maudet, Wanyu Liu, Sarah Fdili Alaoui, Cédric Fleury, Theophanis Tsandilas, Michael Wessely, Ignacio Avellino
- ACM UIST 2017 *ACM Symposium on User Interface Software and Technology*: Andrew Webb, Marianela Ciolfi Felice, Theophanis Tsandilas, Michael Wessely, Wanyu Liu, Nolwenn Maudet, Sarah Fdili Alaoui, Cédric Fleury
- ACM DIS 2017, *ACM Conference on Designing Interactive Systems*: Nolwenn Maudet, Sarah Fdili Alaoui, Wendy Mackay
- ACM ISS 2017, *ACM International Conference on Interactive Surfaces and Spaces*: Ignacio Avellino, Philip Tchernavskij
- IEEE InfoVis 2017: Theophanis Tsandilas
- IEEE VR 2018, *Virtual Reality Conference*: Cédric Fleury
- IEEE 3DUI 2017, *Symposium on 3D User Interfaces*: Cédric Fleury
- GI 2017, *Graphics Interface Conference*: Theophanis Tsandilas
- Interaction 18: Carla Griggio, Germán Leiva
- ACM C&C 2017, *Creativity and Cognition*: Sarah Fdili Alaoui
- Mobile HCI '17 Late Breaking, *19th International Conference on Human-Computer Interaction with Mobile Devices and Services*: Germán Leiva, Philip Tchernavskij
- IHM 2017, *Conférence Francophone d'Interaction Homme-Machine*: Theophanis Tsandilas, Cédric Fleury
- Salon des Refusés 2017, workshop at <PROGRAMMING> 2017, *The International Conference on the Art, Science, and Engineering of Programming*: Philip Tchernavskij

9.1.3. Journal

9.1.3.1. Member of the Editorial Boards

- Editor for the Human-Computer Interaction area of the ACM Books Series (published with Morgan & Claypool Publishers): Michel Beaudouin-Lafon (2013-)
- CACM, *Communications of the ACM Web Editorial Board*, ACM: Wendy Mackay (2008-)
- ACM, *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-)

9.1.3.2. Reviewer - Reviewing Activities

- IJHCS, *International Journal of Human-Computer Studies*, Elsevier: Theophanis Tsandilas
- TVCG, *Transactions on Visualization and Computer Graphics*, IEEE: Cédric Fleury
- MTI, *Journal of Multimodal Technologies and Interaction*, MDPI: Sarah Fdili Alaoui
- JHT, *Journal Human Technology, special issue "the Human–Technology Choreographies: Body, movement, and space in expressive interactions"*, EBSCO Publishing: Sarah Fdili Alaoui
- JEP, *Journal of Experimental Psychology*: Michel Beaudouin-Lafon

9.1.4. Invited Talks

- Ecole Normale Supérieur de Lyon, Cultures numériques, éducation aux médias et à l'information, "*Créer des Partenariats Humaine-Machine*", 09 January 2017: Wendy Mackay
- Lyon Culture Numériques Table Ronde, "*Créer des Partenariats Humaine-Machine*", 11 January 2017: Wendy Mackay
- Invited conference, World Information Architecture Day (WIAD), Lyon, "*Interfaces du futur : Unifier pour diversifier*", 18 février 2017: Michel Beaudouin-Lafon
- Invited seminar, CIRMMT (Montreal, Canada), "*Crafting movement in Digital Art and Human Computer Interaction*", 22 March 2017: Sarah Fdili Alaoui
- Colloquim d'Informatique UPMC Sorbonne Universités, Paris, "*Interfaces Homme-Machine : Unifier les principes pour diversifier l'interaction*", 28 February 2017: Michel Beaudouin-Lafon
- Inria 50 years, ERC 10 years, "*ERC CREATIV : Créer des Partenariats Humain-Machine*", 13 March 2017: Wendy Mackay
- IFIP TC13 & TC14 Open symposium (Paris) *Crafting movement in Digital Art and Human Computer Interaction*, 22 March 2017: Sarah Fdili Alaoui
- Wellesley College (Wellesley, MA, USA), "*Towards a Unified Theory of Interaction*", 20 April 2017: Wendy Mackay & Michel Beaudouin-Lafon
- Massachusetts Institute of Technology (Cambridge, MA, USA), "*Towards a Unified Theory of Interaction*", 20 April 2017: Wendy Mackay
- 10Pines (Buenos Aires, Argentina), "*Design and Development of Interactive Systems*", 20 April 2017: Germán Leiva
- 10Pines (Buenos Aires, Argentina), "*Designing cross-application instruments for supporting user appropriation*", 20 April 2017: Carla Griggio
- Participatory Design Workshop, Olin College (Needham, MA, USA), "*Apps for Activists?*", 21 April 2017: Wendy Mackay
- CITEP UBA (Buenos Aires, Argentina) "*Introduction to HCI*", 25 April October 2017: Germán Leiva
- CITEP UBA (Buenos Aires, Argentina) "*Designing cross-application instruments for supporting user appropriation*", 25 April October 2017: Carla Griggio
- Atelier Unibail-Rodamco, "*Créer des Partenariats Humain-Machine*", 02 May 2017: Wendy Mackay
- CHI Stories, Invited Address, ACM CHI'17, "*Creating the First Interactive Video*", 09 May 2017: Wendy Mackay
- Invited Address, University of British Columbia, "*Towards Unified Principles of Interaction*", 09 May 2017: Wendy Mackay

- Dagstuhl Seminar, "*Computational Interactivity*", 5 - 8 June 2017: Wanyu Liu (http://www.dagstuhl.de/en/program/calendar/semhp/?semnr=17232)
- Colloque 10 ans de l'ERC, Université Paris-Saclay, "ONE: Unified Principles of Interaction", 9 June 2017: Michel Beaudouin-Lafon
- ERC CREATIVE Workshop, "*Towards a Unified Theory of Interaction*", 13 June 2017: Wendy Mackay
- University of British Columbia (Canada), "*Towards Unified Principles of Interaction*", 15 June 2017: Michel Beaudouin-Lafon
- Rencontres Jeunes Cherchers, Interaction Homme-Machine, "*Ethics and Experimental Protocols*", 04 July 2017: Wendy Mackay
- Participatory Information Technology group, Aarhus University, "*Untangling Interactive Systems*", 14 September 2017: Philip Tchernavskij
- Honoris Causa Invited Address, Aarhus University (Denmark), "*Human-Computer Partnerships*", 14 September 2017: Wendy Mackay
- Aarhus University (Denmark), "*Towards Unified Principles of Interaction*", 14 September 2017: Michel Beaudouin-Lafon
- Opening Keynote, 12th Biannual Conference of the Italian SIGCHI Chapter (CHItaly 17), "*Towards Unified Principles of Interaction*", 19 September 2017: Michel Beaudouin-Lafon
- Journées sur la Dynamique Interactionnelle du Geste DIG, CNRS, *Applying Laban Movement Analysis to craft movement in Digital Art and Human Computer Interaction*, 22 septembre 2017: Sarah Fdili Alaoui
- Journée LTCI , "*Bayesian Information Gain for Multiscale Navigation*", 10 October 2017: Wanyu Liu
- Les object communicants dans l'écologie des enfants de 0 à 12 ans, MENESR-EHESS, "*Entre les enfants et les ordinateurs: Human Computer Interaction*", 11 October 2017: Wendy Mackay
- ETH Zurich and University of Zurich, "*Understanding and Designing Interaction from an Information-Theoretic Perspective*", 24 November 2017: Wanyu Liu
- Inria 50 Years Celebration, Robotics panel, 8 November 2017: Wendy Mackay
- Remise des Prix Doctorants, "*Bayesian Information Gain for Multiscale Navigation*", 30 November 2017: Wanyu Liu
- Colloque "Corps et Mobiles", Sorbonne Nouvelle, *Radical Choreographic Object*, 4-5 December 2017: Sarah Fdili Alaoui
- Meeting on Global Research Network, Casa Paganini Infomuse, Genova, 2017: Sarah Fdili Alaoui

9.1.5. 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
- CNRS INS2I, member of "Cellule ERC": Michel Beaudouin-Lafon
- ACM "Policy Award" committee member: Michel Beaudouin-Lafon
- ACM SIGCHI "Lifetime Service Award" committee member: Wendy Mackay

9.1.6. Research Administration

- CNRS INS2I, "Conseil Scientifique de l'Institut": Michel Beaudouin-Lafon (member)
- Telecom ParisTech "Comité de la recherche": Michel Beaudouin-Lafon (member)
- IRCAM Scientific Committee: Michel Beaudouin-Lafon (member)

- "Institut de la Société Numérique", IDEX Laboratory of Université Paris-Saclay: Michel Beaudouin-Lafon (member of steering committee)
- Pôle Systematic, Working group on Information Systems: Michel Beaudouin-Lafon (member of steering committee)
- Département STIC, Université Paris-Saclay: Wendy Mackay (member)
- "Conseil de Laboratoire", LRI: Wendy Mackay, Cédric Fleury (members)
- "Conseil Scientifique", LRI: Michel Beaudouin-Lafon (member)
- 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
- CCSU, "Commission Consultative de Spécialistes de l'Université", Université Paris-Sud: Michel Beaudouin-Lafon, Wendy Mackay (members)
- "Commission de Qualification pour Promotion et Changement, Professeur", Télécom Paris-Tech: Wendy Mackay (member)
- "Comité de sélection, Professeur", Université Paris-Sud: Wendy Mackay (member)
- "Comité de sélection, Maître de Conférences", Université Paris-Sud: Michel Beaudouin-Lafon (member)
- "Commission Locaux", LRI: Theophanis Tsandilas (member)
- "Commission Scientifique", Inria: Theophanis Tsanidlas (member), since March 2017
- "User board" of the European project Wholodance: Sarah Fdili Alaoui, since June 2017

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Licence : Sarah Fdili Alaoui, *Programmation des interfaces interactives avancées*, 22.5h, L3, Univ. Paris-Sud

International Masters: Theophanis Tsandilas, *Probabilities and Statistics*, 32h, M1, Univ. Paris-Saclay

HCID Masters: Sarah Fdili Alaoui, *Business Development Labs*, 30h, M1, Univ. Paris-Sud

HCID Masters: Sarah Fdili Alaoui, *Innovation & Entrepreneurship thesis*, 3h, M2, Univ. Paris-Sud

HCID Masters: Sarah Fdili Alaoui, *Design Project*, 36h, M1 et M2, Univ. Paris-Sud

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

Interaction & HCID Masters: Sarah Fdili Alaoui, *Stage en entreprise*, 2h, M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Creative Design*, 27h, M1 et M2, Univ. Paris-Sud

Interaction & HCID Masters: Sarah Fdili Alaoui, *Digital Fabrication*, 13,5h, M1 et 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 & Cédric Fleury, *Groupware and Collaborative Interaction*, 31.5 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Wendy Mackay, *Career Seminar* 6 hrs, 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

Polytech: Sarah Fdili Alaoui, *Graphisme et Visualisation*, 18h, "Apprentis" 5th year, Univ. Paris-Sud

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

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

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

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

9.2.2. Supervision

PhD students

PhD: Ignacio Avellino, *Supporting Collaborative Practices Across Wall-Sized Displays with Video-Mediated Communication*, Université Paris-Saclay, 12 December 2017. Advisors: Michel Beaudouin-Lafon & Cédric Fleury

PhD: Jessalyn Alvina, *Increasing The Expressive Power of Gesture-based Interaction on Mobile Devices*, Université Paris-Saclay, 13 December 2017. Advisor: Wendy Mackay

PhD: Nolwenn Maudet, *Designing Design Tools*, Université Paris-Saclay, 11 December 2017. Advisors: Wendy Mackay & Michel Beaudouin-Lafon

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) Hsueh, *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

PhD in progress: Jean-Philippe Rivière, *Embodied Design for Human-Computer Partnership in Learning Contexts*, October 2017. Advisors: Wendy Mackay & Sarah Fdili Alaoui

Masters students

Jiali Liu, Telecom ParisTech, "Cross-Surface Interaction": Michel Beaudouin-Lafon & Philip Tchernavskij

Linghua Lai, Univ. Paris-Saclay, "VideoBoard: Video for Interaction Design": Wendy Mackay & Germán Leiva

Chengcheng Qu, Univ. Paris-Saclay, "Animated Emojis: Creating Dynamic Expressions with Expressive Keyboards": Wendy Mackay & Jessalyn Alvina

Jean-Philippe Rivière, Univ. Toulouse, "MoveOn: Understanding and Supporting Dance Skill Acquisition through Multimodal Interactive Technology": Wendy Mackay & Sarah Fdili Alaoui

9.2.3. Juries

PhD theses:

- Andrew Bluff, University of Technology Sydney (advisor: Andrew Johnston): Sarah Fdili Alaoui.
- Bart Potsma, LIMSI-CNRS, April 2017 (advisor: Brian Katz): Michel Beaudouin-Lafon, president.
- Samuel Delalez, Université Paris-Saclay, November 2017 (advisor: Christophe d'Alessandro): Wendy Mackay, president
- Maxime Guillon, LIG, November 2017 (advisor: Laurence Nigay): Michel Beaudouin-Lafon, reviewer.
- Hèlene Unaninski, Université de Toulouse, December 2017 (advisor: Stéphane Conversy): Wendy Mackay, reviewer

Habilitations:

- Caroline Appert, LRI, juin 2017: Michel Beaudouin-Lafon, examiner.
- Gilles Bailly, ISIR, octobre 2017: Michel Beaudouin-Lafon, examiner.
- Jean-Julien Aucouturier, IRCAM, novembre 2017: Michel Beaudouin-Lafon, president.

9.3. Popularization

- Interviews on France Culture, LCI, TV5 Monde on the standardization of the AZERTY and BEPO keyboards, June-July 2017, Michel Beaudouin-Lafon
- ACM UIST 17 Demonstration, "*CommandBoard: Creating a General-Purpose Command Gesture Input Space for Soft Keyboard*", Jessalyn Alvina, Carla Griggio, Xiaojun Bi, Wendy Mackay
- Interview à France Culture, 22 Février 2017 @ France Culture *Machines au croisement du design et du numérique*: Nolwenn Maudet
- Demonstration at CEA Digital Days: Data Intelligence, CEA List, "*StickyLines*", March 2017, Marianela Ciolfi Felice & Wendy Mackay
- Demonstration at CEA Digital Days: Data Intelligence, CEA List, "*Expressive Keyboard*", March 2017, Jessalyn Alvina & Wendy Mackay
- ACM SCF 2017 Poster Demonstration *Stretchis: Fabricating Highly Stretchable User Interfaces*: Michael Wessely
- Colloque l'Université Paris-Saclay fête les 10 ans de l'ERC, "*ONE - Unified Principles of Interaction*", 9 June 2017: Michel Beaudouin-Lafon (presentation) and Philip Tchernavskij (poster)
- Presentation of the performance *Radical Choreographic Object*, April 2017 in Theatre de Villeneuve tolosane, September 2017 in Centre de développement Choregraphique, October 2017 in Centre Bellegarde, November 2017 in Le 104 and December 2017 in Centre Bellegarde: Sarah Fdili Alaoui
- Presentation of the Performance *SKIN*, April 2017 in Scene 44 Pole Media, La friche de la belle, May 2017 in festival Curiositas, November 2017 in Attention Travaux, Culture en Essonnes: Sarah Fdili Alaoui
- Scaling up for the Internet of Things, Workshop at Inria Silicon Valley, Berkeley, CA, USA: Wendy Mackay & Theophanis Tsandilas
- Intersections in Music, Movement, and Technology, 17–19 August 2017 *Workshop held at UC Berkeley*: John MacCallum (co-facilitator).
- Relational Listening, 8 July 2017 *Workshop presented at the Conference of Dance and Somatic Practices*: John MacCallum (co-facilitator).
- Relational Listening, 1–30 April 2017 *Workshop*: John MacCallum (co-facilitator).
- Relational Listening, 26 February 2017 *Workshop held at CLOUD/Danslab*: John MacCallum (co-facilitator).

10. Bibliography

Major publications by the team in recent years

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