



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

Activity Report 2018

Project-Team EX-SITU

Extreme Situated Interaction

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

RESEARCH CENTER
Saclay - Île-de-France

THEME
Interaction and visualization

Table of contents

1. Team, Visitors, External Collaborators	1
2. Overall Objectives	2
3. Research Program	3
4. Application Domains	4
4.1. Creative industries	4
4.2. Scientific research	4
5. Highlights of the Year	4
6. New Software and Platforms	4
6.1.1. WildOS	4
6.1.2. Unity Cluster	5
6.1.3. WILDER	5
7. New Results	6
7.1. Fundamentals of Interaction	6
7.2. Human-Computer Partnerships	8
7.3. Creativity	9
7.4. Collaboration	11
8. Partnerships and Cooperations	12
8.1. Regional Initiatives	12
8.1.1. MoveIT – Modeling the Speed/Accuracy Trade-Off of Human Aimed Movement with the Tools of Information Theory	12
8.1.2. An Augmented-Reality System for Collaborative Physical Modeling and Design	12
8.1.3. Le Plateau des Recherches Infinies	13
8.1.4. Virtual Reality for Interacting with Building Information Model at Paris-Saclay	13
8.2. National Initiatives	13
8.2.1. ANR	13
8.2.2. Investissements d’Avenir	14
8.3. European Initiatives	14
8.3.1. European Research Council (ERC)	14
8.3.1.1. Creating Human-Computer Partnerships	14
8.3.1.2. Unified Principles of Interaction	14
8.3.2. Marie Sklodowska-Curie Actions	15
8.4. International Initiatives	15
8.5. International Research Visitors	16
9. Dissemination	16
9.1. Promoting Scientific Activities	16
9.1.1. Scientific Events Organisation	16
9.1.2. Scientific Events Selection	16
9.1.2.1. Chair of Conference Program Committees	16
9.1.2.2. Member of the Conference Program Committees	16
9.1.2.3. Reviewer	17
9.1.3. Journal	17
9.1.3.1. Member of Editorial Boards	17
9.1.3.2. Reviewer - Reviewing Activities	17
9.1.4. Invited Talks	18
9.1.5. Scientific Expertise	18
9.1.6. Research Administration	19
9.2. Teaching - Supervision - Juries	19
9.2.1. Teaching	19
9.2.2. Supervision	20

9.2.3. Juries	21
9.3. Popularization	21
9.3.1. Articles and contents	21
9.3.2. Interventions	21
10. Bibliography	22

Project-Team EX-SITU

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

Keywords:

Computer Science and Digital Science:

- A5.1. - Human-Computer Interaction
- A5.1.1. - Engineering of interactive systems
- 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
- B5.7. - 3D printing
- B6.3.1. - Web
- B6.3.4. - Social Networks
- B9.2. - Art
- B9.2.1. - Music, sound
- B9.2.4. - Theater
- B9.5. - Sciences

1. Team, Visitors, External Collaborators

Research Scientists

- Wendy Mackay [Team leader, Inria, Senior Researcher, HDR]
- Theophanis Tsandilas [Inria, Researcher]
- Baptiste Caramiaux [CNRS, Researcher]

Faculty Members

- Joanna Mcgreneire [University of British Columbia and Inria Chair, from May 2018 until Jul 2018]
- Michel Beaudouin-Lafon [Univ Paris-Sud, Professor, HDR]
- Sarah Fdili Alaoui [Univ Paris-Sud, Assistant Professor]
- Cédric Fleury [Univ Paris-Sud, Assistant Professor]

Post-Doctoral Fellows

- Jessalyn Alvina [Inria, until May 2018]
- Benjamin Bressolette [Univ Paris-Sud, from Dec 2018]
- John Maccallum [Inria, until Nov 2018]
- Nolwenn Maudet [Inria, until Mar 2018]
- Andrew Webb [Inria]

PhD Students

- Dimitrios Christaras Papageorgiou [Univ Paris-Sud, from Oct 2018]
- Marianela Ciolfi Felice [Univ Paris-Sud]
- Carla Griggio [Inria]
- Per Carl Viktor Gustafsson [Univ Paris-Sud, from Oct 2018]
- Han Han [Univ Paris-Sud, from Oct 2018]
- Shu-Yuan Hsueh [Univ Paris-Sud]

Germán Leiva [Inria]
Jiali Liu [Institut Telecom, until Apr 2018]
Wanyu Liu [Institut Telecom]
Yujiro Okuya [Univ Paris-Sud]
Miguel Renom [Univ Paris-Sud, from Oct 2018]
Jean-Philippe Rivière [Univ Paris-Sud]
Téo Sanchez [Inria, from Sep 2018]
Philip Tchernavskij [Univ Paris-Saclay]
Elizabeth Walton [Univ Paris-Sud, from Nov 2018]
Michael Wessely [Inria]
Yi Zhang [Inria, from Sep 2018]
Yiran Zhang [Univ Paris-Sud]

Technical staff

Romain Di Vozzo [Inria, until May 2018]
Lawrence Fyfe [Inria]
Romain Primet [Inria]
Nicolas Taffin [Inria]

Interns

Kevin Ah Son [Inria, from May 2018 until Jul 2018]
Pratik Aher [Univ Paris-Sud, from Jun 2018 until Jul 2018]
Krishnan Chandran [Univ Paris-Sud, from Jun 2018 until Aug 2018]
Dimitrios Chararas Papageorgiou [Univ Paris-Sud, from Mar 2018 until Sep 2018]
Léo Colombaro [Univ Paris-Sud, from Feb 2018 until Jul 2018]
Wuji Geng [Inria, from Mar 2018 until Aug 2018]
Per Carl Viktor Gustafsson [Inria, from Mar 2018 until Sep 2018]
Jiannan Li [Univ Paris-Sud, from Jun 2018 until Oct 2018]
Jaahnvi Mohan [Univ Paris-Sud, from May 2018 until Aug 2018]
Miguel Renom [Univ Paris-Sud, from Mar 2018 until Aug 2018]
Téo Sanchez [Univ Paris-Sud, from Feb 2018 until Jul 2018]
Swati Swati [Univ Paris-Sud, from May 2018 until Aug 2018]
Tong Xue [Univ Paris-Sud, from Mar 2018 until Sep 2018]
Yi Zhang [Inria, from Mar 2018 until Aug 2018]

Administrative Assistant

Alexandra Merlin [Inria]

Visiting Scientist

Janin Koch [Aalto University, from Oct 2018]

External Collaborator

Midas Nouwens [Aarhus University]

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.

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—artists, 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; game designers; 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

- ANR ELEMENT project was accepted.
- CNRS PEPS project was accepted.
- ERC CREATIV was extended for a year.
- Wanyu Liu, Olivier Rioul, Joanna McGrenere, Wendy Mackay, and Michel Beaudouin- Lafon: Honorable Mention award at ACM CHI 2018 for “BIGFile: Bayesian Information Gain for Fast File Retrieval” [22]

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 an 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 [SED-SAC].

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 with 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.

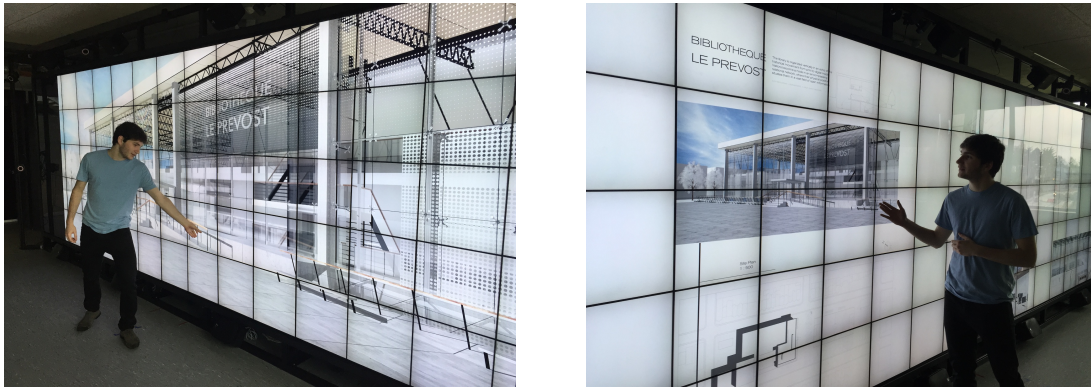


Figure 1. The WILDER platform.

7. New Results

7.1. Fundamentals of Interaction

Participants: Michel Beaudouin-Lafon [correspondant], Wendy Mackay, Cédric Fleury, Theophanis Tsandilas, Dimitrios Christaras Papageorgiou, Han Han, Germán Leiva, Nolwenn Maudet, Yujiro Okuya, Miguel Renom, Philip Tchernavskij, Andrew Webb.

In order to better understand fundamental aspects of interaction, ExSitu conducts 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. Our theoretical work also leads us to deepen or re-analyze existing theories and methodologies in order to gain new insights.

Continuing our long-standing exploration of Fitts' law, we demonstrated the dangers of confounding factors in Fitts'-like experimental designs and recommended how to avoid them [20]. Confounds come from the fact that traditional Fitts'-like experiments use geometric progressions of the two main factors (target distance D and amplitude W) and aggregate data points per $ID = \log(1 + D/W)$. This typically leads to a strong confound between D and ID , whereby an effect attributed to ID may in fact be due solely to D . We showed evidence of published results where this confound led to the misinterpretation of experimental results, and proposed stochastic sampling of D and W as a technique to avoid such problems.

We also reviewed statistical methods for the analysis of user-elicited gestural vocabularies [16] and argued that current statistics for assessing agreement across participants are problematic. First, we showed that raw agreement rates disregard agreement that occurs by chance and do not reliably capture how participants distinguish among referents. Second, we explained why current recommendations on how to interpret agreement scores rely on incorrect assumptions. Third, we demonstrated that significance tests for comparing agreement rates, either within or between participants, yield large Type I error rates ($> 40\%$ for $\alpha = .05$). As alternatives, we presented agreement indices that are routinely used in inter-rater reliability studies. We discussed how to apply them to gesture elicitation studies. We also demonstrated how to use common resampling techniques to support statistical inference with interval estimates. We applied these methods to reanalyze and reinterpret the findings of four gesture elicitation studies. We also participated in an invited formal debate at ACM/CHI 2018 to discuss the issue of replicability in HCI experiments, specifically whether or not the community should adopt the TOP (Transparency and Openness) guidelines for data and code transparency, citation, experiment preregistration and replication of experiments.

In order to explore novel forms of interaction based on the concepts of *interaction instruments* and *interactive substrates*, we conducted several studies and developed prototypes in three main areas:

First, we challenged the notion of application as the main organizing principle of digital environments. Most of our current interactions with the digital world are mediated by applications that impose artificial limits on collaboration among users and distribution across devices, and the constantly changing procedures that disrupt everyday use. These limitations are due partly to the engineering principles of encapsulation and program-data separation, which highlight the needs for appropriate conceptual models of interaction [18]. We proposed new architectural principles [28], [17] that address these issues by considering interactions as first-class objects that can be dynamically created, added to and removed from an interactive system.

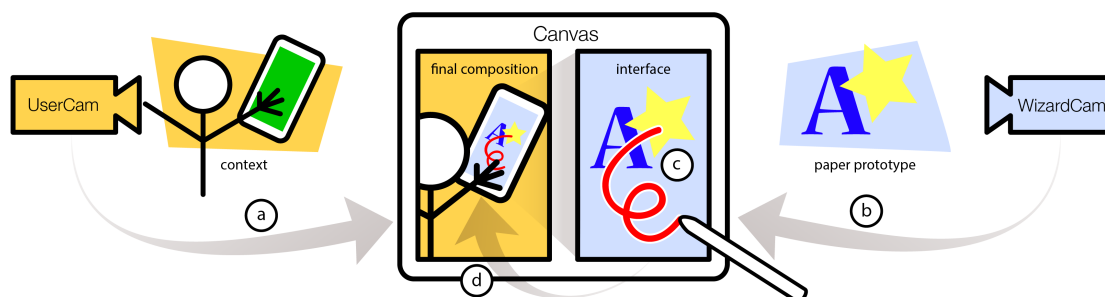


Figure 2. Montage: the UserCam captures the context (a) and the WizardCam captures the paper prototype (b); Both live-stream video to the Canvas, where the designer can add digital sketches (c). Montage replaces the green screen with the interface to create the final composition (d).

Second, we addressed the needs of designers and developers of interactive systems through a series of studies and prototypes. Current prototyping tools do not adequately support the early stages of design, nor the necessary communication between designers and developers. We created and evaluated VideoClipper and Montage [21], two tools that facilitate video prototyping for the early sketching of ideas. VideoClipper facilitates the planning and capturing of video brainstorming ideas and video prototypes, while Montage (fig. 2) uses chroma-keying to create more advanced video prototypes and facilitating their reuse in different contexts. We also created Enact (under submission), a prototyping tool that lets designers and developers work in the same environment to create novel touch-based interaction techniques. Germán Leiva, supervised by Michel Beaudouin-Lafon, successfully defended his Ph.D. thesis *Interactive Prototyping of Interactions: From Throwaway Prototypes to Takeaway Prototyping* [34] on this topic.

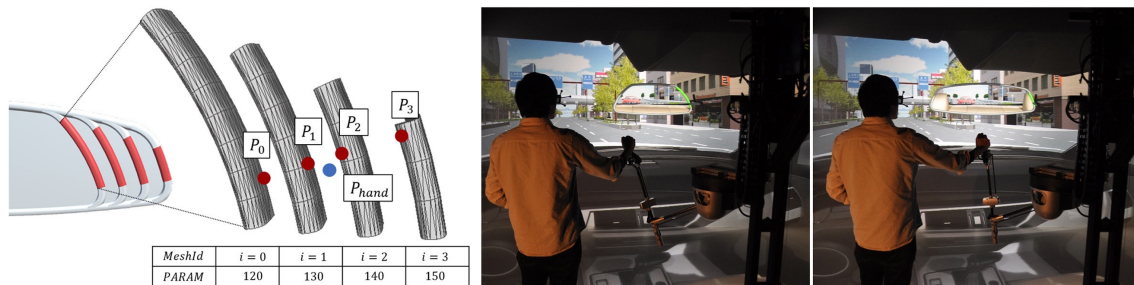


Figure 3. Pre-computed meshes of a rear-view mirror while modifying the right part: the user's hand position (P_{hand}) determines the selected shape (left). A virtual car cockpit where the user modifies the rear-view mirror shape in real time, using haptic force feedback (right).

Third, in the context of Computer Aided Design (CAD), we explored solutions for modifying parametric CAD objects in an immersive virtual reality system. In particular, we developed *ShapeGuide* [14], a technique that lets users modify parameter values by directly pushing or pulling the surface of a CAD object (Figure 3). Including force feedback increases the precision of the users' hand motions in the 3D space. In a controlled experiment, we compared *ShapeGuide* to a standard one-dimensional scroll technique to measure its added value for parametric CAD data modification on a simple industrial object. We also evaluated the effect of force feedback assistance on both techniques. We demonstrated that *ShapeGuide* is significantly faster and more efficient than the scroll technique. In addition, we showed that force feedback assistance enhances the precision of both techniques.

7.2. Human-Computer Partnerships

Participants: Wendy Mackay [correspondant], Baptiste Caramiaux, Téo Sanchez, Marianela Cioffi Felice, Carla Griggio, Shu Yuan Hsueh, Wanyu Liu, John Maccallum, Nolwenn Maudet, Joanna Mcgrenerere, 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, appropriate and expressive for the user.

The *Bayesian Information Gain* (BIG) project uses Bayesian Experimental Design, where the criterion is to maximize the information-theoretic concept of mutual information, also known as information gain (fig. 4-left). The resulting interactive system "runs experiments" on the user in order to maximize the information gain from the user's next input and get to the user's goal more efficiently. *BIGnav* applies BIG to multiscale navigation [7]. Rather than simply executing the navigation commands issued by the user, *BIGnav* interprets them to update its knowledge about the user's intended target, and then computes a new view that maximizes the expected information gain provided by the user's next input. This view is located such that, from the system's perspective, the possible navigation commands are uniformly probable, to the extent possible. *BIGFile* [22] (ACM CHI Honorable Mention award) uses a similar approach for file navigation, with a split interface (fig. 4-right) that combines a classical area where users can navigate the file system as usual and an adaptive area with a set of shortcuts calculated with BIG. *BIGnav* and *BIGFile* create 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 both techniques are significantly faster

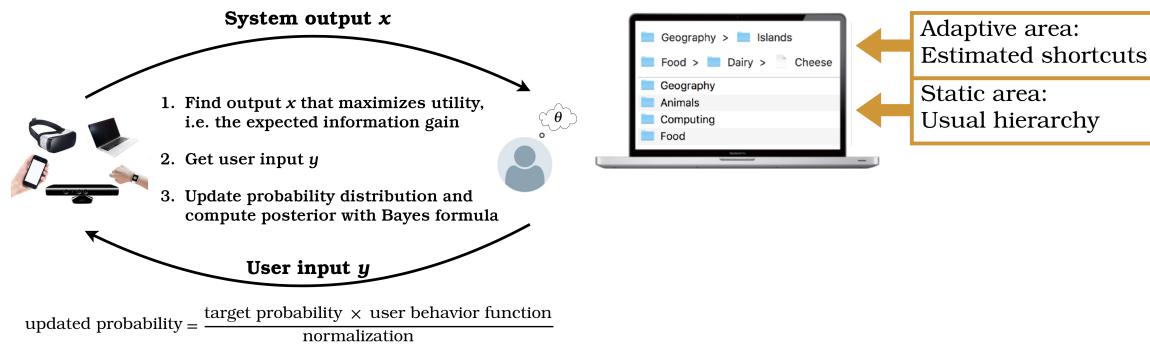


Figure 4. The BIG framework (left) and its application to the BIGFile split-adaptive interface for file navigation (right).

(40% and more) than conventional navigation techniques. Wanyu Liu, supervised by Michel Beaudouin-Lafon, successfully defended her Ph.D. thesis *Information theory as a unified tool for understanding and designing human-computer interaction* [35] on this topic.

In the area of visualization, we studied the common challenge faced by domain experts when identifying and comparing patterns in time series data. While automatic measures exist to compute time series similarity, human intervention is often required to visually inspect these automatically generated results. In collaboration with the ILDA Inria team and Univ. Paris-Descartes, we studied how different visualization techniques affect similarity perception in EEG signals [12], [31]. Our goal was to understand if the time series results returned from automatic similarity measures are perceived in a similar manner, irrespective of the visualization technique; and if what people perceive as similar with each visualization aligns with different automatic measures and their similarity constraints. Overall, our work indicates that the choice of visualization affects which temporal patterns we consider to be similar, i.e., the notion of similarity in a time series is not visualization independent. This demonstrates the need for effective human-computer partnerships in which the computer complements, rather than replaces, human skills and expertise.

We began to explore *human-centred machine learning*, which takes advantage of *active machine learning* to facilitate personalization of an interactive system. We developed a gesture-based recognition system where the user iteratively provides instances and also answers the system's queries. Our results demonstrated the phenomenon of co-adaptation between the human user and the system, which challenges the state of the art in conventional active learning. We further explored interactive reinforcement learning as a way to explore high-dimensional parametric space efficiently [24].

7.3. Creativity

Participants: Sarah Fdili Alaoui [correspondant], Marianela Ciolfi Felice, Carla Griggio, Shu Yuan Hsueh, Germán Leiva, John Maccallum, Wendy Mackay, Baptiste Caramiaux, Nolwenn Maudet, Joanna Mcgrenere, Midas Nouwens, Jean-Philippe Rivière, 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. We follow a multi-disciplinary participatory design approach, working with both expert and non-expert users in diverse creative contexts. We also create situations that cause users to reflect deeply on their activities in situ and collaborate to articulate new design problems.

We identified diverse strategies for recording choreographic fragments and, influenced by the concept of *information substrates*, designed *Knotation* [19], a mobile pen-based tool where choreographers sketch representations of their choreographic ideas and make them interactive (Figure 5). Subsequent studies showed that *Knotation* supports both dance-then-record and record-then-dance strategies. Marianela Ciolfi Felice, supervised by Wendy Mackay and Sarah Fdili Alaoui, successfully defended her Ph.D. thesis *Supporting Expert Creative Practice* on this topic [32].

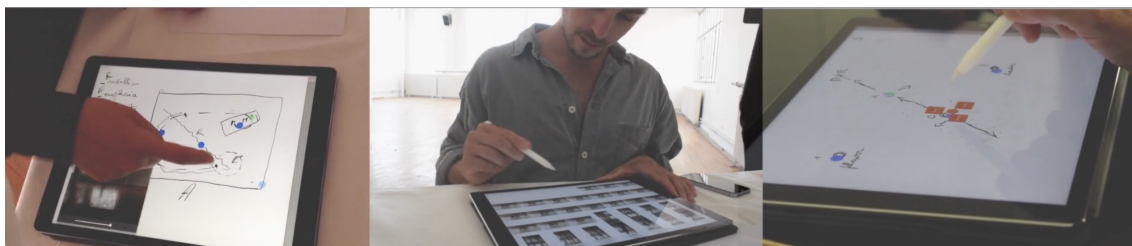


Figure 5. A choreographer uses *Knotation* to specify and interact with the spatial and temporal layout of a piece.

We are also developing a *Choreographer's Workbench*, a full-body interactive system that helps choreographers explore dance movements by linking previously recorded movement ideas and revealing their underlying relationships. The system emphasizes discoverability and appropriation of movement ideas, using feedforward to visualize movement characteristics. We studied how dancers learn complex expressive movements [23], and studied how variability during practice affects learning motor and timing skills [11]. We contributed to soma-based design, i.e. movement-based designs and design practices specifically engaging with aesthetics [13]. We also collaborated with Ircam on a tool that uses reinforcement learning to explore high-dimensional sound spaces [24]. Users enter likes and dislikes to guide navigation within the sound space, shifting from a parameter-based to a reward-based exploration strategy.

We also are interested in how makers transition between physical and digital designs. Makers often create both physical and digital prototypes to explore a design, taking advantage of the subtle feel of physical materials and the precision and power of digital models. We developed *ShapeMe* [25], a novel smart material that captures its own geometry as it is physically cut by an artist or designer. *ShapeMe* includes a software toolkit that lets its users generate customized, embeddable sensors that can accommodate various object shapes. As the designer works on a physical prototype, the toolkit streams the artist's physical changes to its digital counterpart in a 3D CAD environment (Figure 6). We used a rapid, inexpensive and simple-to-manufacture inkjet printing technique to create embedded sensors. We successfully created a linear predictive model of the sensors' lengths, and our empirical tests of *ShapeMe* showed an average accuracy of 2 to 3 mm. We further presented an application scenario for modeling multi-object constructions, such as architectural models, and 3D models consisting of multiple layers stacked one on top of each other.

We also presented *Interactive Tangrami* [29], a method for prototyping interactive physical interfaces from functional paper-folded building blocks (Tangramis). *Interactive Tangrami* can contain various sensor input and visual output capabilities. Our digital design tool lets makers design the shape and interactive behavior of custom user interfaces. The software manages the communication with the paper-folded blocks and streams the interaction data via the Open Sound protocol (OSC) to an application prototyping environment, such as MaxMSP. The building blocks are fabricated digitally with a rapid and inexpensive ink-jet printing method. Our systems allows to prototype physical user interfaces within minutes and without knowledge of the underlying technologies. Finally, we continued our work with Saarland University, TU Berlin and MIT on digitally fabricated *directional screens* [15]. Michael Wessely, supervised by Theophanis Tsandilas and Wendy

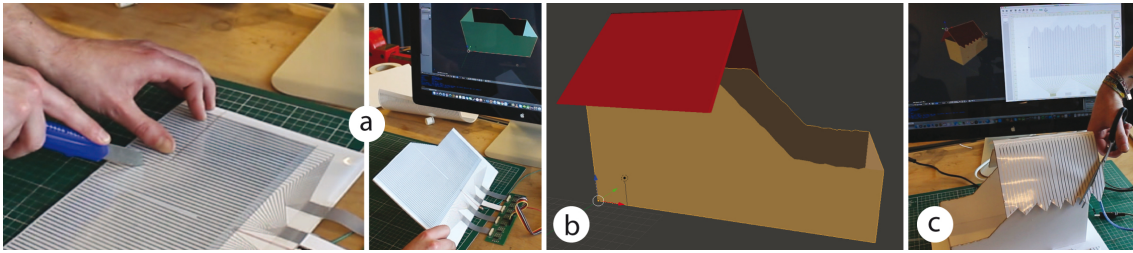


Figure 6. *ShapeMe* is a novel sensing technology that enables physical modeling with shape-aware material: (a) The maker cuts a foamcore piece to reshape the walls of a house model. The updated shape is captured by a grid of length-aware sensors and is communicated to 3D modeling software. (b) The makers digitally create the pieces of the roof and then produce its physical model. (c) The maker explores variations of the roof by cutting its side with scissors, while its shape is continuously captured.

Mackay, successfully defended his Ph.D. thesis *Fabricating Malleable Interaction-Aware Material* [36] on these topics.

7.4. Collaboration

Participants: Cédric Fleury [correspondant], Michel Beaudouin-Lafon, Wendy Mackay, Carla Griggio, Yujiro Okuya.

ExSitu is interested in exploring new ways of supporting collaborative interaction and remote communication. We investigated how large interactive spaces such as wall-sized displays or immersive virtual reality systems can foster collaboration in both co-located and remote situations in the context of Digiscope (<http://digiscope.fr/>). We also conducted in-depth studies to better understand communication through social networks.

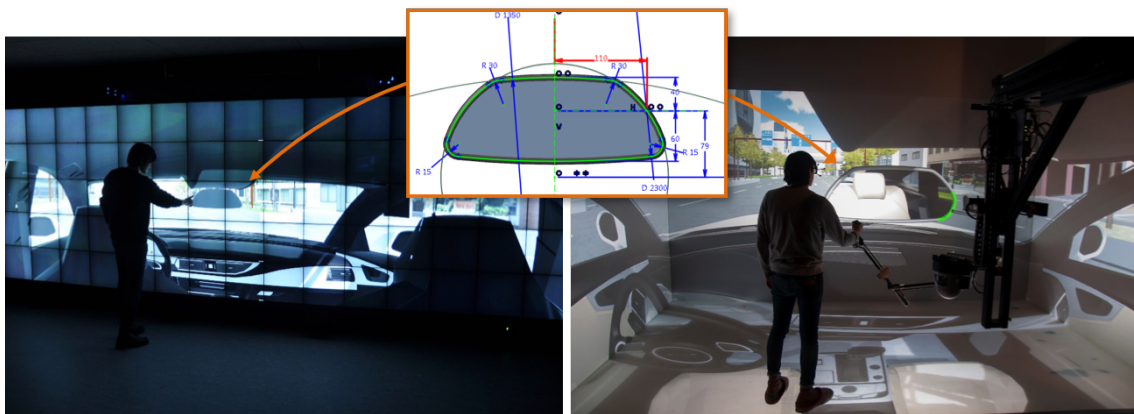


Figure 7. Collaborative CAD data modification between a wall-sized display (left) and a CAVE system (right).

Remote users can have significantly different display and interaction capabilities, such as a wall-size display v.s. an immersive CAVE. We started to explore how such asymmetric interaction capabilities provide

interesting opportunities for new collaboration strategies. In particular, we developed a distributed architecture allowing the collaborative modifications of CAD data across heterogeneous platforms [27] and tested it between the EVE and WILDER platforms of Digiscope (CAVE vs. wall-sized touch display – Figure 7).

Remote collaboration across large interactive spaces also requires telepresence systems which support audio-video communication among users as they move in front of the display or inside of the immersive virtual reality system. We have added 3D audio to improve spatial awareness of remote users [26]: 3D audio lets us position a sound source for each remote participant at the virtual position occupied by this participant in the local space. When using video as well as audio, this lets us position the audio feed so that it is congruent with the position of the video feed.

Finally, we conducted an in-depth study of how users communicate via multiple social network apps that offer almost identical functionality. We studied how and why users distribute their contacts within their app ecosystem. We found that users appropriate the features and technical constraints of their apps to create idiosyncratic “communication places”, each with its own recursively defined membership rules, perceived purposes, and emotional connotations. Users also shift the boundaries of their communication places to accommodate changes in their contacts’ behavior, the dynamics of their relationships, and the restrictions of the technology. We argue that communication apps should support creating multiple “communication places” within the same app, relocating conversations across apps, and accessing functionality from other apps. Carla Griggio, supervised by Wendy Mackay, successfully defended her Ph.D. thesis *Designing for Ecosystems of Communication Apps* [33] on this topic.

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. Wanyu defended her thesis in November 2018 [35] and received an Honorable Mention award for her CHI 2018 paper [22].

8.1.2. *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.

8.1.3. *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 Swati Swati, an intern, for two months over the summer. The project was presented at the Fête de la Science in October, 2018, and will be permanently exhibited in the future Learning Center of Université Paris-Saclay.

8.1.4. *Virtual Reality for Interacting with Building Information Model at Paris-Saclay*

Type: Equipment and human resources

Funding: STIC Paris-Saclay

Duration: 2018-2019

Coordinator: Jean-Marc Vézien (LIMSI-CNRS)

Partners: CNRS, Univ. Paris-Sud

Inria contact: Cédric Fleury

Abstract: The goal of this project is to develop interactive tools for BIM application in virtual reality using a user-centered design approach. The project will use as a case study the interior design of the *Learning Center* building on Paris-Saclay campus.

8.2. National Initiatives

8.2.1. ANR

ELEMENT: Enabling Learnability in Human Movement Interaction

Type: Equipment and human resources

Funding: ANR

Duration: 2019-2022

Coordinator: Baptiste Caramiaux, Sarah Fdili Alaoui, Wendy Mackay

Partners: IRCAM, LIMSI

Inria contact: Baptiste Caramiaux

Abstract: The goal of this project is to foster innovation in multimodal interaction, from non-verbal communication to interaction with digital media/content in creative applications, specifically by addressing two critical issues: the design of learnable gestures and movements; and the development of interaction models that adapt to a variety of user's expertise and facilitate human sensorimotor learning.

8.2.2. Investissements d'Avenir

8.2.2.1. Digiscope - Collaborative Interaction with Complex Data and Computation

Type: EQUIPEX (Equipement d'Excellence)

Duration: 2011-2019

Coordinator: Michel Beaudouin-Lafon

Partners: Université Paris-Saclay (coordinator), Université Paris-Sud, CNRS, CEA, Inria, Institut Mines-Telecom, CentraleSupélec, Université Versailles - Saint-Quentin, ENS Paris-Saclay, 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. 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: June 2013 - May 2019

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.

8.3.2. Marie Skłodowska-Curie Actions

8.3.2.1. Enhancing Motion Interaction through Music Performance

Program: Marie Curie grant

Project acronym: MIM

Project title: Enhancing Motion Interaction

Duration: 2016 - 2018

Coordinator: Baptiste Caramiaux

Abstract: The goal of the project to enhance Human Motion–Computer Interaction by leveraging a multidisciplinary approach across experimental psychology, music technology and computational modelling. Firstly, the project examines skilled activities, in particular music performance, in order to understand fundamental cognitive and psychological aspects of control and expression in human motion. The project involves computational models of motor control and expressive variations built from music performance data collected during psychophysical studies. Secondly, the project broaches the implementation of these models in Digital Musical Instruments (DMI), thus creating a new type of digital instrument based on sensorimotor learning mechanisms. The resulting DMI is then assessed through a user study in which elements of exploration and engagement will be tested over several sessions. Therefore, the project contributes to two main uncharted research areas. Firstly it contributes to the fundamental understanding of sensorimotor learning processes by considering complex human motion, specifically motion in music performance. Secondly, it represents an original application of computational modelling by modelling expressive musical gestures and transferring these models to interactive systems.

8.4. International Initiatives

8.4.1. Inria International Labs

Inria@Silicon Valley

Associate Team involved in the International Lab:

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

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 investigate novel tools and technologies that support Discovery, Expressivity, and Creativity.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Joanne McGrenere, Professor at the University of British Columbia, Canada and Inria Chair, visited for two months, to work with Wendy Mackay, Carla Griggio, Jessalyn Alvina, Yi Zhang and John MacCallum.

8.5.1.1. Internships

Janin Koch, Ph.D. student from Aalto University, Finland, visited for three months to work with Wendy Mackay.

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events Organisation

9.1.1.1. Member of the Organizing Committees

- ACM/ISMIR 2018, International Society for Music Information Retrieval Conference, Music and Technology co-chair: Wendy Mackay
- HAMAC International Research Workshop 2018, Human-Machine Collaboration in Embodied Interaction, main organiser: Baptiste Caramiaux
- UIST 2018, ACM Symposium on User Interface Software and Technology, Publicity Co-Chair: Michael Wessely
- UIST 2018, ACM Symposium on User Interface Software and Technology, Video Preview Co-Chair: Carla Griggio
- UIST 2018, ACM Symposium on User Interface Software and Technology, Doctoral Symposium jury: Wendy Mackay
- CHI 2018 workshop "Rethinking Interaction: From instrumental interaction to human-computer partnerships Toolkits", organizers: Wendy Mackay, Michel Beaudouin-Lafon
- Interaction 2018, Program Co-Chair: Nolwenn Maudet

9.1.2. Scientific Events Selection

9.1.2.1. Chair of Conference Program Committees

- IHM 2018, Conférence Francophone d'Interaction Homme-Machine, Work-in-Progress (TeC) co-chair: Cédric Fleury

9.1.2.2. Member of the Conference Program Committees

- ACM CHI 2019, *ACM CHI Conference on Human Factors in Computing Systems*: Michel Beaudouin-Lafon, Wendy Mackay, Theophanis Tsandilas
- ACM UIST 2018, *ACM Symposium on User Interface Software and Technology*: Michel Beaudouin-Lafon, Wendy Mackay
- ACM UIST 2018 Doctoral Symposium: Wendy Mackay
- ACM UIST 2018 Best Paper Award Committee: Wendy Mackay
- ACM UIST 2018 Student Innovation Awards Committee
- IUI 2018, *ACM IUI Conference on Intelligent User Interfaces*: Wendy Mackay
- IUI 2019, *ACM IUI Conference on Intelligent User Interfaces*: Wendy Mackay
- MOCO 2018, *International Conference on Movement and Computing*: Sarah Fdili Alaoui
- 3DCVE 2018, *IEEE VR Workshop on Collaborative Virtual Environments*: Cédric Fleury
- ACM C&C 2018, *Creativity and Cognition*: Andrew Webb

9.1.2.3. Reviewer

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

9.1.3. Journal

9.1.3.1. Member of 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-)
- PloS ONE: Baptiste Caramiaux (2018-)
- JIPS, *Journal d'Interaction Personne-Système*, AFIHM: Michel Beaudouin-Lafon (2009-)

9.1.3.2. Reviewer - Reviewing Activities

- TOCHI, *Transactions on Computer Human Interaction*, ACM: Baptiste Caramiaux

- CG&A, *Computer Graphics and Applications*, IEEE: Cédric Fleury
- Frontiers in *Robotics and AI*, Virtual Environments section: Cédric Fleury

9.1.4. Invited Talks

- Univ. of California San Diego (UCSD), *Towards Unified Principles of Interaction*, March 2018: Michel Beaudouin-Lafon
- Univ. of California San Diego (UCSD), *Human-Computer Partnerships*, March 2018: Wendy Mackay
- ETH Zürich, *Towards Unified Principles of Interaction*, 11 April 2018: Michel Beaudouin-Lafon
- Université de Zürich, *Human-Computer Partnerships*, 12 April 2018: Wendy Mackay
- Creativity Across Disciplines Symposium, Aarhus University, *Towards a Unified Theory of Interaction*, 5 April 2018: Wendy Mackay
- Workshop on Human-Computer Partnerships, ACM CHI 2018, *Human-in-the-loop? or Human-Computer Partnerships?*, May 2018: Wendy Mackay
- SIG: Transparent Statistics Guidelines, Panel Discussion, ACM CHI 2018, May 2018: Wendy Mackay
- SIFED 2018 : Symposium International Francophone sur l'Écrit et le Document, *Interactions à base d'esquisses sur papier et ordinateur*, 1 June 2018, Tours, France: Theophanis Tsandilas
- DATAIA-JST International Symposium on Data Science and AI, *AI and HCI: Towards Human-Computer Partnerships*, Paris, 11 July 2018: Michel Beaudouin-Lafon
- Science & Research Panel, *Interactive Materials with Printed Electronics*, 2018 Feb14 Paris, 13 July 2018: Micheal Wessely
- Rencontres Jeunes Chercheurs, RJIHM, *Experiment Design in HCI*, July: Wendy Mackay
- Workshop on Human-Computer Collaboration in Embodied Interaction (HAMAC), *Creating Human-Computer Partnerships*, IRCAM, Paris, 8 July 2018: Michel Beaudouin-Lafon
- Inria seminar Unithé ou Café, *Machine Learning and Teaching for Interaction Design*, 13 Septembre 2018: Baptiste Caramiaux
- Visual Computing Conference, Stuttgart, *Human-Computer Partnerships*, 8 October 2018: Wendy Mackay
- ECSS 2018, *European Computer Science Summit, Informatics Europe*, Gothenberg, 11 October 2018: Wendy Mackay
- GOTO Copenhagen, Keynote address, *Human-Computer Partnerships*, November 2018: Wendy Mackay
- Université de Poitiers, Techné Séminaire 1 *Technologie Numérique pour l'Éducation, Designing Interactive Systems*, 15 November 2018: Wendy Mackay
- Université de Poitiers, Techné Séminaire 2 *Technologie Numérique pour l'Éducation, Exploratory Experiment Design*: 15 November 2018: Wendy Mackay

9.1.5. Scientific Expertise

International

- NSERC Evaluation: Wendy Mackay, external expert (2018)
- ACM SIGCHI “Lifetime Service Award” committee member: Michel Beaudouin-Lafon

National

- Agence Nationale de la Recherche (ANR), Appel à projets jeunes chercheuses et jeunes chercheurs: Theophanis Tsandilas, reviewer
- ERC Generator program, Université de Lille: Michel Beaudouin-Lafon, external expert
- CNRS INS2I “Cellule ERC”: Michel Beaudouin-Lafon, member

9.1.6. Research Administration

Information Science and Technology (STIC) Department, Université Paris-Saclay: Michel Beauouin-Lafon (chair since June 2018), Wendy Mackay (member)

Research division, Université Paris-Saclay: Michel Beauouin-Lafon (advisor for Digital Sciences since June 2018)

Digiteo RTRA research network, Université Paris-Saclay: Michel Beauouin-Lafon (director since June 2018)

STIC Doctoral School, Université Paris-Saclay: Michel Beauouin-Lafon (adjunct director of pole 3 until May 2018)

CNRS INS2I, “Conseil Scientifique de l’Institut”: Michel Beauouin-Lafon (member)

Telecom ParisTech, “Comité de la recherche”: Michel Beauouin-Lafon (member)

Pôle Systematic, Working group on Information Systems: Michel Beauouin-Lafon (member of steering committee)

Computer Science Department, Université Paris-Sud: Michel Beauouin-Lafon (vice-President for research)

“Conseil de Laboratoire”, LRI: Wendy Mackay, Cédric Fleury (members)

“Conseil Scientifique”, LRI: Michel Beauouin-Lafon (member)

CCSU, “Commission Consultative de Spécialistes de l’Université”, Université Paris-Sud: Michel Beauouin-Lafon, Wendy Mackay (members)

“Commission Locaux”, LRI: Theophanis Tsandilas (member)

“Commission Scientifique”, Inria: Theophanis Tsandilas (member), since March 2017

“Comité de sélection, Professeur”, Université de Bordeaux: Michel Beauouin-Lafon (president)

“Comité de sélection, Maître de Conférence”, Université Paris-Sud: Wendy Mackay

“Tenure review committee”, University of California, Irvine: Wendy Mackay

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 Beauouin-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 Beauouin-Lafon, *Fundamentals of Human-Computer Interaction*, 21 hrs, M1/M2, Univ. Paris-Sud

Interaction & HCID Masters: Michel Beauouin-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
 Interaction & HCID Masters: Baptiste Caramiaux, *Gestural and Mobile Interaction*, 24 hrs, M1/M2, Univ. Paris-Sud
 Polytech: Sarah Fdili Alaoui, *Graphisme et Visualisation*, 18h, “Apprentis” 5th 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, *Option Réalité Virtuelle*, 56 hrs, 5th year, Univ. Paris-Sud
 Polytech: Cédric Fleury, *Réalité Virtuelle et Interaction*, 48 hrs, “Apprentis” 5th year, Univ. Paris-Sud

9.2.2. Supervision

PhD students

PhD: Wanyu Liu, *Modeling the speed-accuracy trade-off of pointing tasks using the tools of information theory*, 22 November 2018. Advisors: Olivier Rioul (Institut Mines Telecom) & Michel Beaudouin-Lafon
 PhD: Carla Griggio, *Interactive Human-Machine Learning*, Université Paris-Saclay, 11 December 2018. Advisor: Wendy Mackay
 PhD: Germán Leiva, *Interaction-driven Software Development*, Université Paris-Saclay, 12 December 2018. Advisors: Wendy Mackay & Michel Beaudouin-Lafon
 PhD: Michael Wessely, *Sketching and Physical Prototyping for Creative Fabrication Design*, Université Paris-Saclay, 13 December 2018. Advisors: Theophanis Tsandilas & Wendy Mackay
 PhD: Marianela Ciolfi Felice, *Substrates and Co-adaptive Instruments for Creativity*, Université Paris-Saclay, 14 December 2018. Advisors: Wendy Mackay & Sarah Fdili Alaoui
 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: 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 & Baptiste Caramiaux
 PhD in progress: Yiran Zhang, *Telepresence for remote and heterogeneous Collaborative Virtual Environments*, October 2017. Advisors: Patrick Bourdot (LIMSI-CNRS) & Cédric Fleury
 PhD in progress: Téó Sanchez, *Co-Learning in Interactive Systems*, September 2018. Advisors: Baptiste Caramiaux & Wendy Mackay
 PhD in progress: Elizabeth Walton, *Inclusive Design in Embodied Interaction*, November 2018. Advisors: Baptiste Caramiaux, Sarah Fdili Alaoui & Wendy Mackay
 PhD in progress: Miguel Renom, *Theoretical bases of human tool use in digital environments*, October 2018. Advisors: Michel Beaudouin-Lafon & Baptiste Caramiaux

PhD in progress: Dimitrios Christaras Papageorgiou, *Design, implementation and evaluation of a conceptual model of interactive substrates*, October 2018. Advisor: Michel Beaudouin-Lafon

PhD in progress: Han Han, *Participatory design of digital environments based on interaction substrates*, October 2018. Advisor: Michel Beaudouin-Lafon

PhD in progress: Viktor Gustafsson, *Co-adaptive Instruments fo Game Design*, October 2018. Advisor: Wendy Mackay

PhD in progress: Yi Zhang, *Generative Design using Instrumental Interaction, Substrates and Co-adaptive Systems*, October 2018. Advisor: Wendy Mackay

Masters students

Téo Sanchez, ENS, Sorbonne Université, “Gesture Interaction with Active Machine Learners”: Baptiste Caramiaux

Miguel Renom, “Transfer of tool-based skills from physical to digital tools”: Michel Beaudouin-Lafon

Dimitrios Christaras Papageorgiou, “Prototype of an environment based on information substrates and digital instruments”: Michel Beaudouin-Lafon

Tong Xue, “Analysis of information substrates and digital instruments in existing interactive software”: Michel Beaudouin-Lafon

Viktor Gustafsson, “Narrative Substrates for Interactive Video Games”: Wendy Mackay

Yi Zhang, “Situating Breakdowns in Video-Mediated Communication”: Wendy Mackay

Wuji Geng, “Interaction Museum Design”: Wendy Mackay

Krishnan Chandran, “Collocated Collaboration over Augmented Reality Models”: Theophanis Tsandilas and Cédric Fleury

9.2.3. Juries

PhD theses

Emaline Brulé, Télécom ParisTech (advisor: Annie Gentes): Wendy Mackay, reporter

Julien Gori, Télécom ParisTech (advisor: Olivier Rioul): Michel Beaudouin-Lafon, invited

Benjamin Bressolette, Centrale Marseille (advisor: Richard Kronland-Martinet): Michel Beaudouin-Lafon, examiner

Habilitations

- Marcos Serrano, Université de Toulouse, November 2018: Michel Beaudouin-Lafon, reviewer
- Eric Lecolinet, Télécom ParisTech, December 2018: Michel Beaudouin-Lafon, examiner

9.3. Popularization

9.3.1. Articles and contents

- Radio show “Les P’tits Bateaux” on France Inter public radio: Michel Beaudouin-Lafon (interviews in response to children questions on 10 June 2018, 16 September 2018, 7 October 2018)
- Panel at “*La Fabrique de la Danse*”, Centre 104, Paris, 5 Avril 2018: Baptiste Caramiaux (panel member)

9.3.2. Interventions

- Le Plateau des Recherches Infinies: art-science project with photographer Didier Goupy presenting the portraits of 100 researchers of Université Paris-Saclay. Fête de la Science, Gif-sur-Yvette, October 2018
- Workshop on “Rapid Prototyping with Interactive Materials”, Fab14, Toulouse, July 2018: Michael Wessely

- Workshop “*Relational Listening*”, CLOUD/Danslab, Lake Studios, Berlin, 22 July 2018: John MacCallum (co-facilitator).

10. Bibliography

Major publications by the team in recent years

- [1] S. F. ALAOU, J. FRANÇOISE, T. SCHIPHORST, K. STUDD, F. BEVILACQUA. *Seeing, Sensing and Recognizing Laban Movement Qualities*, in "ACM Conference on Human Factors in Computing Systems (CHI)", Denver, United States, May 2017 [DOI : 10.1145/3025453.3025530], <https://hal.inria.fr/hal-01663132>
- [2] J. ALVINA, J. MALLOCH, W. MACKAY. *Expressive Keyboards: Enriching Gesture-Typing on Mobile Devices*, in "Proceedings of the 29th ACM Symposium on User Interface Software and Technology (UIST 2016)", Tokyo, Japan, ACM, October 2016, pp. 583 - 593 [DOI : 10.1145/2984511.2984560], <https://hal.inria.fr/hal-01437054>
- [3] I. AVELLINO, C. FLEURY, W. MACKAY, M. BEAUDOUIN-LAFON. *CamRay: Camera Arrays Support Remote Collaboration on Wall-Sized Displays*, in "Proceedings of the CHI Conference on Human Factors in Computing Systems", Denver, United States, CHI '17, ACM, May 2017, pp. 6718 - 6729 [DOI : 10.1145/3025453.3025604], <https://hal.archives-ouvertes.fr/hal-01544645>
- [4] M. C. CIOLFI FELICE, N. MAUDET, W. E. MACKAY, M. BEAUDOUIN-LAFON. *Beyond Snapping: Persistent, Tweakable Alignment and Distribution with StickyLines*, in "UIST '16 Proceedings of the 29th Annual Symposium on User Interface Software and Technology", Tokyo, Japan, Proceedings of the 29th Annual Symposium on User Interface Software and Technology, October 2016 [DOI : 10.1145/2984511.2984577], <https://hal.archives-ouvertes.fr/hal-01410171>
- [5] C. KLOKMOSE, J. EAGAN, S. BAADER, W. MACKAY, M. BEAUDOUIN-LAFON. *Webstrates: Shareable Dynamic Media*, in "ACM Symposium on User Interface Software and Technology (UIST)", Charlotte, United States, UIST '15 Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology, ACM, November 2015, pp. 280-290 [DOI : 10.1145/2807442.2807446], <https://hal.archives-ouvertes.fr/hal-01242672>
- [6] C. LIU, O. CHAPUIS, M. BEAUDOUIN-LAFON, E. LECOLINET. *Shared Interaction on a Wall-Sized Display in a Data Manipulation Task*, in "Proceedings of the 34th international conference on Human factors in computing systems", San Jose, United States, CHI '16, SigCHI and ACM, May 2016, pp. 1-12 [DOI : 10.1145/2858036.2858039], <https://hal.inria.fr/hal-01275535>
- [7] 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>
- [8] M. NANCEL, E. PIETRIGA, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Mid-air Pointing on Ultra-Walls*, in "ACM Transactions on Computer-Human Interaction", August 2015, vol. 22, n^o 5, pp. 21:1–21:62 [DOI : 10.1145/2766448], <https://hal.inria.fr/hal-01184544>

- [9] T. TSANDILAS, A. BEZERIANOS, T. JACOB. *SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays*, in "Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 3255-3264 [DOI : 10.1145/2702123.2702129], <https://hal.archives-ouvertes.fr/hal-01144312>
- [10] M. WESSELY, T. TSANDILAS, W. E. MACKAY. *Stretchis: Fabricating Highly Stretchable User Interfaces*, in "ACM Symposium on User Interface Software and Technology (UIST)", Tokyo, Japan, October 2016, pp. 697-704 [DOI : 10.1145/2984511.2984521], <https://hal.archives-ouvertes.fr/hal-01412289>

Publications of the year

Articles in International Peer-Reviewed Journals

- [11] B. CARAMIAUX, F. BEVILACQUA, M. M. WANDERLEY, C. PALMER. *Dissociable effects of practice variability on learning motor and timing skills*, in "PLoS ONE", 2018, vol. 13, n^o 3, e0193580 p. [DOI : 10.1371/JOURNAL.PONE.0193580], <https://hal.archives-ouvertes.fr/hal-01726186>
- [12] A. GOGOLOU, T. TSANDILAS, T. PALPANAS, A. BEZERIANOS. *Comparing Similarity Perception in Time Series Visualizations*, in "IEEE Transactions on Visualization and Computer Graphics", October 2018, 11 p. , <https://hal.inria.fr/hal-01845008>
- [13] K. HÖÖK, B. CARAMIAUX, C. ERKUT, J. FORLIZZI, N. HAJINEJAD, M. HALLER, C. C. M. HUMMELS, K. ISBISTER, M. JONSSON, G. KHUT, L. LOKE, D. LOTTRIDGE, P. MARTI, E. MELCER, F. F. MÜLLER, M. GRAVES PETERSEN, T. SCHIPHORST, E. M. SEGURA, A. STÅHL, D. SVANAES, J. THOLANDER, H. TOBIASSON. *Embracing First-Person Perspectives in Soma-Based Design*, in "Informatics", February 2018, vol. 5, n^o 1 [DOI : 10.3390/INFORMATICS5010008], <https://hal.archives-ouvertes.fr/hal-01699005>
- [14] Y. OKUYA, N. LADEVEZE, C. FLEURY, P. BOURDOT. *ShapeGuide: Shape-Based 3D Interaction for Parameter Modification of Native CAD Data*, in "Frontiers in Robotics and AI", November 2018, vol. 5 [DOI : 10.3389/FROBT.2018.00118], <https://hal.inria.fr/hal-01958226>
- [15] M. PIOVARČI, M. WESSELY, M. JAGIELSKI, M. ALEXA, W. MATUSIK, P. DIDYK. *Design and analysis of directional front projection screens*, in "Computers and Graphics", August 2018, vol. 74, pp. 213 - 224 [DOI : 10.1016/J.CAG.2018.05.010], <https://hal.archives-ouvertes.fr/hal-01848680>
- [16] T. TSANDILAS. *Fallacies of Agreement: A Critical Review of Consensus Assessment Methods for Gesture Elicitation*, in "ACM Transactions on Computer-Human Interaction", June 2018, vol. 25, n^o 3, pp. 1-49 [DOI : 10.1145/3182168], <https://hal.archives-ouvertes.fr/hal-01788775>

International Conferences with Proceedings

- [17] A. BASMAN, P. TCHERNAVSKIJ, S. BATES, M. BEAUDOUIN-LAFON. *An anatomy of interaction: co-occurrences and entanglements*, in "Programming'18 Companion - Conference Companion of the 2nd International Conference on Art, Science, and Engineering of Programming", Nice, France, ACM Press, April 2018, pp. 188-196 [DOI : 10.1145/3191697.3214328], <https://hal.archives-ouvertes.fr/hal-01854418>
- [18] M. BEAUDOUIN-LAFON, W. MACKAY. *Rethinking Interaction: From Instrumental Interaction to Human-Computer Partnerships*, in "Extended Abstracts of the 2018 CHI Conference", Montreal QC, Canada, ACM Press, April 2018, CHI 2018 Workshop [DOI : 10.1145/3170427.3170635], <https://hal.archives-ouvertes.fr/hal-01788023>

- [19] M. CIOLFI FELICE, S. FDILI ALAOUI, W. MACKAY. *Knotation: Exploring and Documenting Choreographic Processes*, in "Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems", Montreal QC, Canada, April 2018 [DOI : 10.1145/3173574.3174022], <https://hal.inria.fr/hal-01817569>
- [20] J. GORI, O. RIOUL, Y. GUIARD, M. BEAUDOUIN-LAFON. *The Perils of Confounding Factors: How Fitts' Law Experiments can Lead to False Conclusions*, in "CHI' 18", Montréal, Canada, April 2018 [DOI : 10.1145/3173574.3173770], <https://hal.archives-ouvertes.fr/hal-01690122>
- [21] G. LEIVA, M. BEAUDOUIN-LAFON. *Montage: A Video Prototyping System to Reduce Re-Shooting and Increase Re-Usability*, in "UIST '18", Berlin, Germany, October 2018 [DOI : 10.1145/3242587.3242613], <https://hal.archives-ouvertes.fr/hal-01966544>
- [22] W. LIU, O. RIOUL, J. MCGRENERE, W. MACKAY, M. BEAUDOUIN-LAFON. *BIGFile: Bayesian Information Gain for Fast File Retrieval*, in "Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)", Montreal QC, Canada, ACM Press, April 2018 [DOI : 10.1145/3173574.3173959], <https://hal.archives-ouvertes.fr/hal-01791754>
- [23] J.-P. RIVIÈRE, S. FDILI ALAOUI, B. CARAMIAUX, W. MACKAY. *How Do Dancers Learn To Dance?: A first-person perspective of dance acquisition by expert contemporary dancers*, in "MOCO 2018 - 5th International Conference on Movement and Computing", Gênes, Italy, June 2018, pp. 1-8 [DOI : 10.1145/3212721.3212723], <https://hal.archives-ouvertes.fr/hal-01849604>
- [24] H. SCURTO, F. BEVILACQUA, B. CARAMIAUX. *Perceiving Agent Collaborative Sonic Exploration In Interactive Reinforcement Learning*, in "Proceedings of the 15th Sound and Music Computing Conference (SMC 2018)", Limassol, Cyprus, July 2018, <https://hal.archives-ouvertes.fr/hal-01849074>
- [25] M. WESSELY, T. TSANDILAS, W. MACKAY. *Shape-Aware Material: Interactive Fabrication with ShapeMe*, in "UIST 2018 - 31st ACM Symposium on User Interface Software and Technology", Berlin, Germany, ACM Press, October 2018, vol. 18, pp. 127-139 [DOI : 10.1145/3242587.3242619], <https://hal.archives-ouvertes.fr/hal-01872776>

Conferences without Proceedings

- [26] L. FYFE, O. GLADIN, C. FLEURY, M. BEAUDOUIN-LAFON. *Combining Web Audio Streaming, Motion Capture, and Binaural Audio in a Telepresence System*, in "Web Audio Conference", Berlin, Germany, September 2018, <https://hal.inria.fr/hal-01957843>
- [27] Y. OKUYA, N. LADEVEZE, O. GLADIN, C. FLEURY, P. BOURDOT. *Distributed Architecture for Remote Collaborative Modification of Parametric CAD Data*, in "IEEE VR International Workshop on 3D Collaborative Virtual Environments (3DCVE 2018)", Reutlingen, Germany, March 2018, <https://hal.inria.fr/hal-01849289>
- [28] P. TCHERNAVSKIJ. *Critique of 'files as directories: some thoughts on accessing structured data within files' (1)*, in "Conference Companion of the 2nd International Conference on Art, Science, and Engineering of Programming", Nice, France, ACM Press, April 2018 [DOI : 10.1145/3191697.3214324], <https://hal.archives-ouvertes.fr/hal-01854295>
- [29] M. WESSELY, N. MORENKO, J. STEIMLE, M. SCHMITZ. *Interactive Tangrami: Rapid Prototyping with Modular, Paper-folded Electronics*, in "Symposium on User Interface Software and Technology", Berlin,

Germany, October 2018, pp. 143-145 [DOI : 10.1145/3266037.3271630], <https://hal.archives-ouvertes.fr/hal-01959161>

Research Reports

- [30] C. BARILLOT, I. FIJALKOW, I. QUEINNEC, F. THEOLEYRE, H. TOUZET, M. BEAUDOUIN-LAFON, M.-P. CANI, F. CHAUMETTE, G. CONREUR, V. CORTIER, C. GAVOILLE, G. -. GOGNIAT, J. GOSSA, A. HERZIG, J. KRIVINE, P. LAMARRE, F. LAMNABHI-LAGARRIGUE, A.-C. LETOURNEL, L. SEINTURIER, I. TELLIER, S. TORRES, C. TRUCHET, A. TSOUKIAS, M. VERLEYSSEN. *Prospective Report of the scientific council of the Information Sciences and their interactions Institute of CNRS*, CNRS, December 2018, <https://hal.archives-ouvertes.fr/hal-01956087>
- [31] A. GOGOLOU, T. TSANDILAS, T. PALPANAS, A. BEZERIANOS. *Comparing Time Series Similarity Perception under Different Color Interpolations*, Inria, June 2018, n^o RR-9189, <https://hal.inria.fr/hal-01844994>

References in notes

- [32] M. C. FELICE. *Supporting Expert Creative Practice*, Université Paris-Saclay, Orsay, France, December 2018
- [33] C. GRIGGIO. *Designing for Ecosystems of Communication Apps*, Université Paris-Saclay, Orsay, France, December 2018
- [34] G. LEIVA. *Interactive Prototyping of Interactions: From Throwaway Prototypes to Takeaway Prototyping*, Université Paris-Saclay, Orsay, France, December 2018
- [35] W. LIU. *Information theory as a unified tool for understanding and designing human-computer interaction*, Université Paris-Saclay, Orsay, France, November 2018
- [36] M. WESSELY. *Fabricating Malleable Interaction-Aware Material*, Université Paris-Saclay, Orsay, France, December 2018