**Team: Ingénierie de l'Interaction Homme-Machine (IIHM)**
**Engineering Human-Computer Interaction**
**Scientific leader: Joëlle Coutaz**
**Evaluation 2005–2009**
**Reporting Period: 1 January 2005 to 30 September 2009**

**Web site:** http://iihm.imag.fr/en
**Parent Organizations:** Université Grenoble 1 (UJF), Université Grenoble 2 (UPMF), Grenoble INP, CNRS

# Contents

# 1 General presentation

### Scientific and Technological Project

The IIHM research group is primarily concerned with the software aspects of Human-Computer Interaction (HCI). Its scientific project is to elaborate new concepts, theories, models and software tools for designing, implementing, and evaluating novel interaction techniques in the areas of multimodal and mixed reality interaction, collaborative and mobile interaction, as well as for User Interface (UI) plasticity. IIHM has made fundamental contributions to software architecture modeling for interactive systems, as well as to the understanding and rapid prototyping of multimodal, mixed reality and plastic, migratory, distributed UIs. Its current research activities fall within the area of HCI for Ambient Intelligence. Ambient Intelligence seeks to provide humans with the right services, at the right time and place, using the appropriate interaction techniques and resources. As a result, over the last few years, our research has shifted from the control of interactive systems and applications confined to a single workstation to that of a dynamic computational aura where the boundary between the physical and the digital worlds is progressively disappearing, where everything is highly dynamic, mobile, and adaptive.

### History of the team

IIHM was created twenty years ago (in September 1989) as the HCI research team of the UMR LGI (Laboratoire de Génie Informatique), with the research objective of developing concepts, software architecture models and tools for understanding and facilitating the implementation of Graphical User Interfaces. With the reorganization of the Grenoble laboratories in 1995, IIHM acted as one of the key founders of the UMR CLIPS-IMAG (Communication Langagière et Interaction Personne Système) with the creation of a new research area in multimodal user interfaces and Augmented Reality systems. IIHM joined LIG at its creation in 2007 as an opportunity to extend its research studies to ambient intelligence.

# 2 Team Composition

| *Permanent Researchers* | | | | |
|---|---|---|---|---|
| Name | First name | Function | Institution | Arrival date |
| Bérard | François | Associate Professor | GINP | Jan 01 |
| Blanch | Renaud | Associate Professor | UJF | Sep 06 |
| Calvary | Gaëlle | Associate Professor | UJF | Jan 00 |
| Coutaz | Joëlle | Full Professor | UJF | Sep 73 |
| Dupuy-Chessa | Sophie | Associate Professor | UPMF | Sep 02 (since September 2008, 50% IIHM, 50% SIGMA) |
| Laurillau | Yann | Associate Professor | UPMF | Sep 07 |
| Nigay | Laurence | Full Professor | UJF | Sep 94 |

| *Post-docs, engineers and visitors* | | | | |
|---|---|---|---|---|
| Name | First name | Function and % of time | Institution | Arrival date |
| Balme | Lionel | Post-doc | UJF | Sep 08 |
| Pusch | Andreas | Post-doc | UJF | Oct 08 |
| Serna | Audrey | Post-doc | UJF | Oct 08 |
| Sprague | David | Visitor | Univ. of Victoria | Apr 08 |
| Vincent | Thomas | Expert engineer | UJF | Mar 08 |

| *Doctoral Students* | | | | |
|---|---|---|---|---|
| Name | University | Supervisors | Funding (sources and dates) | Date of first registration |
| Avouac P.-A. | UJF | L. Nigay (50%), P. Lalanda (ADELE) | Contract ADELE (LIG) | Sep 08 |
| Camara F. | UJF | G. Calvary (80%), R. Demumieux (FT R&D) | FT R&D Dec 08–Dec 11 | Dec 08 |
| Clay A. | Bordeaux 1 | L. Nigay (30%), M. Delest & N. Couture (Bordeaux 1) | Contract ESTIA (Biarritz) | Sep 06 |
| | | | | *continued on next page* |

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| *Doctoral Students* | | | | |
|---|---|---|---|---|
| Name | University | Supervisors | Funding (sources and dates) | Date of first registration |
| Fontaine E. | UJF | J. Coutaz (50%), A. Demeure (PRIMA) | ANR/2I contract Oct 08–Sep 11 | Sep 08 |
| Gabillon Y. | UJF | G. Calvary (50%), H. Fiorino (MAGMA) | Region grant Sep 07–Oct 10 | Sep 07 |
| Gauffre G. | Toulouse 1 | L. Nigay (25%), E. Dubois & R. Bastide (Toulouse 1) | Contract IRIT (Toulouse) | Sep 06 |
| Godet-Bar G. | UJF | S. Dupuy-Chessa (50%), D. Rieu (SIGMA) | MENRT Sep 06–Oct 09 | Sep 06 |
| Jourde F. | UJF | L. Nigay, Y. Laurillau | BDI-DGA grant Oct 07–Sep 10 | Sep 07 |
| Martin C. | UJF | G. Calvary (50%), H. Fiorino (MAGMA) | MENRT Sep 08–Sep 11 | Sep 08 |
| Perez-Medina J. | UJF | S. Dupuy-Chessa (50%), D. Rieu (SIGMA) | Foreign scholarship Oct 05–Oct 09 | Sep 06 |
| Scoditti A. | UJF | R. Blanch., J. Coutaz | FUI contract Feb 08–Feb 11 | Sep 07 |
| Serrano M. | UJF | L. Nigay | European contract Sep 07–Aug 10 | Jan 08 |

| *Habilitation Theses defended during period* | | | | |
|---|---|---|---|---|
| Name | First name | Defense date | University | Current position |
| Calvary | Gaëlle | 9 nov. 2007 | UJF | Associate Professor |

**Past team members**

| *Past doctoral students (Oct. 2005–Jun. 2009)* | | | | | |
|---|---|---|---|---|---|
| Name | Date of first registration | Date of departure | University | Supervisor | Current position |
| G. Bailly | Oct 05 | May 09 | UJF | L. Nigay, É. Lecolinet (Télécom Paris) | Post-doc Télécom Paris-Tech |
| L. Balme | Oct 03 | Jun 08 | UJF | J. Coutaz | Expert Eng., UJF |
| N. Barralon | Oct 02 | Dec 06 | UJF | J. Coutaz | Dev. R&D, Object Direct (Grenoble) |
| J. Bouchet | Oct 03 | Dec 06 | UJF | L. Nigay | EADS R&D |
| O. Dâassi | Oct 02 | Jan 07 | UJF | G. Calvary | Ass. Prof. Gabes (Tunisie) |
| C. Coutrix | Oct 05 | May 09 | UJF | L. Nigay | Post-doc Finland (European project CALLAS) |
| A. Demeure | Oct 03 | Oct 07 | UJF | G. Calvary | Ass. Prof., UJF |
| V. Ganneau | Oct 05 | Jan 09 | UJF | G. Calvary | Engineer, Haploid (Paris) |
| A. Gorayeb | Oct 02 | Oct 07 | UJF | V. Rialle (TIMC), J. Coutaz | USA |
| M. Horchani | Oct 04 | Dec 07 | UJF | L. Nigay, F. Panaget (FT R&D) | Ass. Prof. Ecole Navale de Brest |
| J. Letessier | Oct 03 | Mar 07 | GINP | F. Bérard, J. Crowley (PRIMA) | Start-up CEO |
| B. Mansoux | Oct 03 | Abandonned | UJF | L. Nigay, J. Troccaz (TIMC) | Unknown |
| V.-T. Nguyen | Sep 03 | Dec 08 | GINP | E. Castelli (MICA), G. Calvary | Researcher at MICA (Hanoï) |
| G. Rey | Oct 01 | Aug 05 | UJF | J. Coutaz | Ass. Prof. Nice |
| J.-S. Sottet | Sep 05 | Oct 08 | UJF | G. Calvary | Post-Doc Nantes |

| *Past post-doctoral researchers, engineers and visitors* | | | | | |
|---|---|---|---|---|---|
| Name | First name | Function | Date of arrival | Date of departure | Home Institution (if appropriate) |
| Alvaro | Xavier | Expert Engineer | Oct 05 | Mar 08 | |
| Andersson | Simon | Expert Engineer | Jul 06 | Apr 08 | |
| Barralon | Nicolas | Post-doc | Dec 06 | Aug 07 | UJF |
| Dronne | Mayalene | Expert Engineer | Dec 08 | Feb 09 | |
| Juras | David | Expert Engineer | Mar 07 | Dec 08 | |
| Moran | Alberto | Visitor | Oct 07 | Oct 07 | UABC (Mexique) |
| Ortega | Michael | Post-doc | Apr 07 | Jan 09 | GINP |
| McBryan | Tony | Visitor | Jan 09 | Jan 09 | Univ. of Glasgow (UK) |
| Petit | Mathieu | Visitor | Jan 08 | Jan 08 | Ecole Navale, Brest |
| Serrano | Marcos | Expert Engineer | Sep 05 | Aug 07 | |
| Vanderdonckt | Jean | Visiting Prof. | May 06 | Jun 06 | Univ. catholique de Louvain (B) |

### Evolution of the team

IIHM was created twenty years ago with one permanent Faculty and one doctoral student. By the end of 2005, the group included five permanent Faculty members and fourteen doctoral students. During the past four years (2005–2009), IIHM has continued to grow steadily to reach seven permanent Faculty members (all of them academic personnel), twelve doctoral students (plus 3 theses defended between January 2009 and May 2009), three post-docs and one engineer recruited on temporary contracts.

# 3 Research Themes

In our previous report (2001–2005), IIHM presented four research themes: *Multimodal Interaction*, *Mixed Reality Interaction*, *Novel Interaction Techniques*, and *User Interface Plasticity*. During this reporting period (2005–2009), we have added a new theme: *Interaction for Handheld Devices and Mobility* which, together with our earlier themes, extends our research interest to Human-Computer Interaction for Ambient Intelligence. Over the years, we have devised a method that serves as a systematic structured framework for each of the themes developed in the group.

(1) We start from the conceptual analysis of new problems (such as that of UI multimodality and UI plasticity) which, in turn, leads into the definition of taxonomies and problem spaces. Taxonomies and problem spaces serve as reference vocabulary for new concepts and provide researchers with a systematic structure for comparing the state of the art and for identifying new directions for research. We consider that conceptual analysis is the necessary step towards a good understanding of new problems and effective sharing with the research community.

(2) Then, notations, languages (meta-models), and models are proposed for the key concepts and issues identified in Step 1. These are either related to the analysis and design phases of interactive systems, or to the implementation phase, or both. For example, a full range of computational meta-models related by transformations and mappings have been defined to express multiple perspectives on interactive systems.

(3) In Step 3, we propose development processes that indicate when and how to use the concepts and models developed in previous steps. For example, we have devised Symphony a development method that brings together main-stream software engineering practices and models (such as UML use cases and activity diagrams) with those of HCI (such as task models) by establishing explicit links between them.

(4) Finally, IIHM develops the effective tools that support the methods, concepts, models, and processes elaborated in the previous steps. We are interested in tools that support the design phases as well as the run time and evaluation phases of interactive systems.

## 3.1 Multimodal Interaction

**List of participants**

Permanent researchers: S. Dupuy-Chessa, Y. Laurillau, L. Nigay.

Doctoral students: J. Bouchet (Th. defended [13]), M. Horchani (Th. defended [10]), A. Gorayeb (Th. defended [9]), A. Clay (3rd year), F. Jourde (2nd year), M. Serrano (1st year).

**Scientific issues and positioning of the team**

This theme is one of the foundational research areas of the group, and still remains a key area in our research activity. The domain of multimodal interaction has become increasingly complex. The diversity of sensors and actuators coupled with robust recognition and synthesis algorithms, as well as the availability of affordable devices such as webcams and game devices (e.g., the Nintendo Wii mote), have opened the way to a wide spectrum of new forms of interaction. Beyond desktop UIs, multimodal interaction has a key role to play in mobile and tabletop systems as well as in UI plasticity (see our other themes). In addition, because of the growing number of personal mobile and embedded devices, multimodal UI's and multi-user UI's are converging into a novel area. In order to harness the complexity due to this diversity, IIHM aims at improving the genericity of the concepts, models, methods, and tools for building multimodal user interfaces. With this goal in mind, the group places particular emphasis on engineering multimodal interaction to facilitate the development of usable multimodal user interfaces, and on the exploration of multi-user interaction in relation with multimodality.

*Engineering multimodal interaction.* We have defined a conceptual component-based approach to the development of multimodal interaction along three axes: genericity, data-flow levels and specification levels. This conceptual model has been implemented as an open-source software framework called OpenInterface. More than fifteen multimodal systems for augmented tables, mobile devices and desktop, have been prototyped using our OpenInterface Interactive Development Environment suite tool (OIDE), as part of industrial projects as well as research demonstrators. However, it has been observed that software designers are unable to reuse the knowledge developed by HCI experts unless there is some support for knowledge reuse. Design patterns, which propose solutions to recurring problems in given contexts, offer an appropriate option to this issue. We are initiating this work with the MSTIC Project funded by UJF.

*Multi-user multi-modal interaction.* While much work has been done on multimodality for single-user applications, we have investigated multimodal interaction in the context of collaborative work on mobile devices, augmented tables and desktops. We have studied notations for specifying and capturing the relevant dimensions of multimodal collaborative interaction and in particular the degree of coupling between users in the light of fusion between interaction modalities [44]. This work is the subject of industrial transfer with Bertin Technologies (PEA FH-PA project with the French Department of Defense, DGA).

**Major results**

3 Theses defended: J. Bouchet [13], M. Horchani [10], A. Gorayeb [9]. The OI (OpenInterface) component model [45, 75], the OI framework [46], and the OIDE development environment [17, 45, 56, 118] as well as dialogic strategies for output multimodalities [57, 58] and the use of multimodal output for Mixed Reality [72, 82]. Over the last fifteen years, the IIHM group has pioneered the research in multimodal interaction. In particular, we have provided a number of reference models including the CARE properties (which are highly referenced today), a generic fusion mechanism as well as the PAC-Amodeus software architecture model which still serve for a number of tools developed in European projects such as the ITEA EMODE project [2005–2008], the OI STREP FP VI project [2006–2009]. We are proud to be the coordinator of the OI European project. Our participation to 4 international projects on multimodal interaction as well as our international publications on this topic indicate that IIHM is a key player in this area.

**Perspectives**

Multi-user multi-modal interaction, which has just started in our group, is an original line of research that needs to be pursued. It will be combined with our research on Mixed Reality interactive surfaces (see next sub-section). Examples of application domains will include "Open enterprise" (one of the leading societal challenges of the LIG scientific project) as well as industrial co-design in cooperation with G-SCOP lab (Grenoble), specialized in the study of design processes.

## 3.2 Mixed Reality Interaction

**List of participants**

Permanent researchers: F. Bérard, S. Dupuy-Chessa, L. Nigay.

Doctoral students: C. Coutrix (Th. defended [2]), J. Letessier (Th. defended [11]), G. Gauffre (3rd year), G. Godet-Bar (3rd year), J. Perez-Medina (3rd year).

**Scientific issues and positioning of the team**

Mixed Reality (MR) interactive systems seek to merge the physical and the digital worlds so that users can take advantage of the two worlds in a smooth and seamless manner. MR is a promising avenue to improve efficiency and ease of learning. However, there is still no clear and unified understanding of this interaction paradigm. Our efforts in this domain cover the steps of our research approach, from concepts and methods, to effective tools and evaluation.

*Concepts for designing and prototyping mixed objects.* To address the challenge of designing mixed systems, we have defined a new interaction model for mixed reality systems called Mixed Interaction Model (MIM) [39, 67]. MIM extends and generalizes previous models related to the design of mixed reality systems. It introduces a new way of thinking about interaction design with mixed systems in terms of [physical-digital] mixed objects that take part in the interaction with the user. We conducted conceptual and experimental evaluations of our model before developing the OP toolkit [2, 115], by considering existing conceptual validation frameworks as well as by designing and prototyping several mixed systems in collaboration with design actors.

*Rationalizing the development process of MR systems.* The knowledge and know-how of HCI scientists and interaction engineers used for designing MR systems is not well understood. We address this issue by proposing a software engineering method called Symphony that brings together the process used for designing Mixed Reality interaction with the process used for developing the business core portion of the system [22, 43, 55, 70]. The main contributions of Symphony are three-fold: 1) a process that manages and reenforces the collaboration between HCI and SE specialists; 2) a system structure that makes explicit the production of these specialists using two sorts of conceptual components: Interactional Objects and Business Objects; 3) a framework that facilitates the coupling between Interactional Objects and Business Objects.

*Tools for prototyping MR systems.* Our group was among the pioneers in the implementation of interactive surfaces. In particular, the MagicTable was one of the very first multi-point surface prototypes using computer vision. This initial research was then extended in the ANR Digitable project whose goal was to develop software and interaction techniques for touch-based interaction on large surfaces. This project has received the Noblanc prize for best project at the STIC 2006 conference. Based on the MIM interaction model, the OP toolkit supports the rapid prototyping of mixed objects and embeds various existing technical toolkits including the Phidgets, AR toolkit and Interface-Z.

*Empirical work on evaluating users benefits of mixed interaction.* We study MR systems in the context of an augmented table or wall as well as on mobile devices. Our goal is to better understand the properties of the mixed interaction that contribute to the success of the technique according to criteria including human performance and user’s experience.

**Major results**

2 Theses defended: C. Coutrix [2], J. Letessier [11]. The Mixed Interaction Model as a new way of thinking about Mixed Reality objects and its related OP toolkit for rapid prototyping [2, 39, 67]. Most notably, GML, a toolkit that supports the development of multi-point interaction for large surfaces using computer vision tracking techniques. These have been licensed and have served as the foundation for the creation of a start-up in 2008 (i.e. HiLabs, http://www.hilabs.net/).

**Perspectives**

Design process methodology is a difficult area that requires long-term research to demonstrate its benefits. We have elicited the principles of our method Symphony for the development process of MR systems. The next step is to use and test Symphony against real world application domains such as Maritime surveillance, and robotics systems (in cooperation with Thales, PY Automation, and Gostai, members of the UsiXML ITEA2 project, 2009–2012). Our tools for augmented interactive surfaces (e.g., the GML toolkit) will be improved to facilitate the development of augmented reality and multimodal collaborative interaction with multiple surfaces. The OP toolkit will be extended to support other technical mixed-reality toolkits (e.g., the Arduino toolkit) and will further be evaluated by considering designers as users of the OP toolkit.

## 3.3 New Interaction Techniques

**List of participants**

Permanent researchers: F. Bérard, R. Blanch, L. Nigay.

Doctoral students: G. Bailly (Th. defended [1]), A. Scoditti (2nd year).

**Scientific issues and positioning of the team**

This theme focuses on interaction techniques that improve Graphical User Interface (GUI) interaction. Although GUI is in common use in commercial products, there is still much to learn from theories in cognitive psychology. In particular, we are interested in techniques that support tasks that are central to HCI. These include pointing, selecting, and navigating within large information spaces.

*Beyond the Menu.* Menus are used for exploring and selecting commands in graphical user interfaces. They are widespread and used by a wide variety of users, resulting in a large diversity of menu techniques. Although each menu technique has been motivated in the literature on a case per case basis, it is currently difficult to have a clear understanding of the possibilities for designing new menu techniques, or to grasp the advances of each individual technique, or even to compare existing menus. In this context, we have proposed MenUA, a design space for reasoning about menus [1]. MenUA is based on a list of usability and applicability criteria such as speed and accuracy, adequacy and memorization performances, that define a coherent framework for exploring design alternatives and for making informed design choices.

Stemming from MenUA, we have designed, developed and evaluated four menu techniques: Wave menus [49], Flower menus [34], Leaf menus [33] and Multi-Touch Menus [86]. Wave menus improve the novice mode of Marking menus by improving navigation within hierarchies of commands. Flower menus increase the menu breadth of Marking menus while supporting a good learning curve in the expert mode. Leaf menus are linear menus enriched with stroke shortcuts to facilitate the selection of commands on small handheld touch-screen devices. Finally, Multi-Touch Menus exploit the recent capabilities of multi-touch surfaces so that users can explore and select commands using the five fingers of the hand.

*Beyond the Desktop.* The other focus of our work on new interaction techniques is on improving navigation and selection in various desktop contexts. Zoomable Treemaps [18] facilitates the exploration of large data sets such as the hierarchical classification of web sites provided by the Open Directory Project (ODP) (694,986 categories distributed on 13 levels). The set of new interaction techniques they provide make use of the specific structure of the treemaps to facilitate the manipulation of the visual rendering.

Pointing to a specific target on the desktop is another fundamental task that deserves attention. With AirMice [31] we provide a way to point on the desktop using the fingers and to smoothly switch from 2D to 3D input with the hand on a traditional desktop computer. We also have shown that, contrary to expectation, the 2D mouse can be a more efficient device for 3D placement than traditional 3D input devices [28]. In addition, we have investigated the use of two concurrent input channels to perform a pointing task. The first channel is the traditional mouse input device whereas the second one is the eye gaze position. The Rake Cursor [27] interaction technique combines a grid of cursors controlled by the mouse and the selection of the active cursor by the gaze. We have shown that rake cursor pointing drastically outperforms mouse-only pointing and also significantly outperforms the state of the art of pointing techniques mixing gaze and mouse input.

**Major results**

1 Thesis defended: G. Bailly [1]. A diversity of menu techniques (wave menu, leaf menu, flower menu, multi-touch menu) all derived from a conceptual design space (MenUA) [1, 49, 34, 33, 86]; the Zoomable Treemaps for navigating in very large hierarchical information spaces [18] (a study that started at ENST-GET while R. Blanch was a post-doct); the Rake cursor [27] and AirMice [31] for pointing tasks; interestingly, the superiority of the 2D mouse over 3D devices for the placement of 3D objects.

**Perspectives**

We will continue to create novel GUI-based interaction techniques to improve efficiency, comfort, and pleasure for generic HCI tasks (e.g., pointing, selecting, navigating within large information spaces). These will be studied for the conventional workstation, for large interactive surfaces as well as for small devices. We will develop tools for facilitating the prototyping and benchmarking of new menu techniques. Our next challenge is to integrate 3D (both for input and output) into our design space and to address the co-existence of 2D with 3D.

## 3.4 Interaction for Small Handheld Devices and Mobility

**List of participants**

Permanent researchers: R. Blanch, G. Calvary, J. Coutaz, L. Nigay.

Doctoral students: G. Bailly (Th. defended [1]), V. Ganneau (Th. defended [3]), A. Scodittti ($2^{nd}$ year), M. Serrano ($1^{st}$ year).

**Scientific issues and positioning of the team**

Handheld devices are increasingly common, but the research on interaction techniques for mobile devices is still very preliminary. The objective of IIHM is to contribute to the emergence of a more solid foundation through the development of rapid prototyping tools complemented with empirical studies. In addition to improving conventional GUI techniques (e.g., menu-based selection), our focus is on the exploration of 3D instrumental gesture as well as on mixed reality and multimodality on smart phones.

*Tools for rapid prototyping UIs on handheld devices.* We are conducting two complementary lines of actions at two levels of abstraction: (1) The development of a toolkit, the NOMAD Toolkit, that allows the implementation of new forms of interaction techniques for high-end Linux-based phones equipped with a variety of sensors and actuators. These interaction techniques will include 3D instrumental gestures combined with 2D and 3D rendering. The architecture of the NOMAD toolkit relies on a clear distinction between scene graph description and behaviour description. This is an ongoing work conducted within the FUI NOMAD project. (2) At a higher level of abstraction, ICARE is an environment that allows developers to assemble software components according to the CARE properties and to generate a multimodal UI accordingly for the target hand-held device [13]. The key result is that ICARE, which enables rapid prototyping, is able to cooperate with ACIDU, a tool developed by FT R&D, that automatically captures usage data in realistic mobile situations [73].

*Tools for capturing the use of hand-held devices.* In addition to ACIDU developed by FT R&D, we have developed EMMA (Embedded Manager for Mobile Adaptation) [3, 42] to gather data in real life settings. EMMA learns key contexts of use and provides the end-user with on the fly relevant adaptation. The process is based on an embedded Bayesian user model that runs on a Windows Mobile Smartphone. Adaptation can be controlled by the end-user. Field studies have been conducted to measure the acceptability and the added value of adaptation on mobile devices. In addition, EMMA can serve as a designer's partner to probe the key contexts of use, thus saving design efforts and time.

*Empirical work.* Our empirical work consists in experimentally testing multiple forms of interaction techniques for the mobile phone. The goal is to better understand the properties of interaction techniques according to a set of criteria (e.g., speed and error rate, time to learn). We have explored menu techniques that enable the mobile user to interact with one finger (i.e. the thumb), such as the Leaf Menu [33] and the Wave menus on iPhone. The key properties of these techniques include an expert mode that does not rely on the keyboard (hotkeys), a precise interaction with one finger and an efficient management of the small size of the screen. We are exploring other forms of interaction including 3D gestures using accelerometers and speech commands. We also study MR systems on mobile phones using the phone camera and various sensors (location and orientation of the mobile users).

**Major results**

Novel menus for the mobile phone [1, 30, 33] and mixed reality techniques based on mobile phone camera [73]; ICARE for prototyping and evaluating multimodal UI on mobile phones [13]; EMMA [42], a software probe for automatically identifying key contexts of use of hand held devices; A model of dialogic strategies in multimodal interaction that supports system feedback adaptation to user's requests [10, 57, 58].

**Perspectives**

Our work on mobile devices will continue to draw from the conceptual results developed in the themes "Multimodal interaction", "Mixed Reality interaction", and "New interaction techniques" with particular attention devoted to the constraints imposed by the small size screen of handheld devices as well as to mobility which, in turn, leads into the challenging issue of eye-free interaction. Another challenge is the development of the NOMAD toolkit that will enable the prototyping of novel, robust, and efficient 2D-3D user interfaces on mobile phones where latency and flexibility are key.

## 3.5 User Interface Plasticity

**List of participants**

Permanent researchers: G. Calvary, J. Coutaz, L. Nigay.

Doctoral students: L. Balme (Th. defended [4]), N. Barralon (Th. defended [12]), O. Dâassi (Th. defended [7]), A. Demeure (Th. defended [8]), V. Ganneau (Th. defended [3]), V.-T. Nguyen (Th. defended), G. Rey (Th. defended [14]), J.-S. Sottet (Th. defended [5]), Y. Gabillon (2$^{nd}$ year), C. Martin (2$^{nd}$ year), P.-A. Avouac (1$^{st}$ year), F. Camara (1$^{st}$ year), E. Fontaine (1$^{st}$ year).

**Scientific issues and positioning of the team**

Our research group has initiated this theme ten years ago with the publication of a research agenda at Interact 99. Since then, we have reached a leading position in this area. The challenge of UI plasticity is to support UI adaptation to the context of use while preserving human-centered values: adaptation to a wide diversity and unpredictable changes of users, platforms, and physical and social environments. In conformity with our research methodology, we have started by defining the "UI plasticity problem space" that now serves as a reference in the scientific community (paper published in 2003, ranked, at the time of this writing, 2nd in the top ten references of Elsevier "Interacting With Computer" journal —W3C standardization is in progress).

The problem space of plastic UI is complex: it covers UI re-molding, which consists in reshaping all (or parts) of a particular UI to fit the constraints imposed by the context of use. It also includes UI re-distribution (i.e. migration) of all (or parts) of a UI across the resources that are currently available. UI plasticity may affect all of the levels of abstraction of an interactive system, from the cosmetic surface level re-arrangements to deep re-organizations at the functional core and task levels. When appropriate, UI re-molding may be concerned by all aspects of the CARE properties, from synergistic-complementary multimodality (as in "put-that there") and post-WIMP UI's, to mono-modal GUI. Re-molding and re-distribution should be able to operate at any level of granularity from the interactor level to the whole UI while guaranteeing state recovery at the user's action level. Because we are living in a highly heterogeneous world, we need to support multiple technological spaces simultaneously such that a particular UI may be a mix of, say, Tcl/Tk, Swing, and XUL. And all of this, should be deployed dynamically under the appropriate human control by the way of a meta-UI.

Based on the requirements of our problem space, we have then established a set of principles for the development of plastic UI's, and we have implemented several prospective tools according to these principles. One of our driving principles is to blur the distinction between the development stage and the runtime phase (UIs cannot be systematically predefined at design time) and to support the cooperation between close adaptiveness (i.e. adaptation expressed within the code) and open adaptiveness (i.e. adaptation performed by a middleware dedicated to UI plasticity). Consequently, at run time, an interactive system is a set of graphs of models that expresses different aspects of the system at multiple levels of abstraction (e.g., task level, Abstract UI, Concrete UI, pieces of code). The models developed at design-time, which convey high-level design decision, are still available at runtime for performing rational deep adaptation. In addition, for portions of a UI that cannot be generated by the way of transformations (e.g., post-WIMP interaction techniques whose interaction nuances are too complex to be expressed with high-level languages), specific hand-coded components can be retrieved and assembled dynamically with the code obtained from models transformation.

**Major results**

The "UI plasticity" problem space, concepts, software principles, and UI quality reasoning [12, 19, 20, 37, 38, 40, 50, 51, 54, 61, 62, 77, 117, 119, 121]. An operational model of the notion of context [14, 20]. The Comet software architecture model for developing plastic widgets and the Comet development environment for prototyping plastic UI's in terms of Comet widgets [8, 41, 68]. The Mara MDE development environment for the development of conventional GUI plastic UI's [5, 61]. Ethylene, a component model for plastic UI along with a run time middleware that supports the dynamic assembly of components developed in different technologies, ranging from high-level descriptions to executable code [4]. A semantic network to dynamically recruit models and/or executable code [69]. EMMA, a probe that automatically gathers application usage on mobile phones [3, 42].

**Perspectives**

Our perspectives on UI plasticity is to address three complementary challenges: (1) Conceptual challenge: dynamic user interface composition as the result of dynamic compositions (not simply re-composition) of business services to comply with changes of user's intent. Until now, UI adaptation has been studied for predefined functional cores, not for functional cores that construct themselves on the fly. (2) Methodology challenge: we will test our method Symphony against the development process of plastic UI's. (3) Technical challenge: integration of our current exploratory tools into a unique, flexible and extensible development environment that will blur the distinction between the design phases, the run-time and the evaluation phases and that will be able to support all forms of plastic UI's.

# 4 Application domains and social, economic or interdisciplinary impact

HCI has an impact on nearly every social and economic domain where informatics is used. As exemplified by the iPhone and the Wii mote, the potential for innovation is high. The diversity of applications and potentials is a good motivation for the group to strive for generality. We test the generality of our concepts, tools and methods with application domains and scenarios defined by our industrial partners (e.g., Orange labs, ST Ericsson, Myriad group, Thales).

- For multimodal interaction, our typical application domains include: games, military aircraft cockpits, command post for controlling drones, multimodal dialogues for mobile phones.
- Mixed Reality interaction has been applied to archeology, computer-assisted surgery, games, photo album browsing, and more generally to the navigation within large information spaces.
- Novel interaction techniques have been applied to interactive visualization for desktops, table-tops, and handheld devices.
- UI plasticity has been tested with web-based services (such as administrative services for the citizen), maritime surveillance systems, meteorology, and photo album browsing.

Other forms of impact of our results are difficult to evaluate or may reveal themselves in the long run. For example, according to Arno Gourdol, a former master student in our group, and more recently Chief software architect of the Apple MacIntosh Finder for OS X, the OS X finder has been designed using the PAC architectural model, devised by our group and published in 1987.

# 5 Contracts and grants

| Source of funding | Projects Acronym (in bold, on going projects) | Funding for IIHM (euros) |
|---|---|---|
| European projects | SIMILAR (FP6, NoE), **OI (FP 6, STREP)**, MOSAIC (regional program ICT-Asia), E-MODE (ITEA2), **UsiXML (ITEA2)** | 965 813 |
| ANR | **CARE**, **CONTINUUM**, DIGITABLE, **MyCitizSpace**, VERBATIM, NAVGRAPHE | 649 191 |
| FUI | **NOMAD** | 724 762 |
| French Defense Agency | INTUITION, **Partage d'Autorité** | 348 000 |
| Contracts with Industry | **FT R&D**, Thales | 181 000 |
| Internal Funding | MAPPING, COCOVI, **BQR INP**, **K-IHM** | 39 900 |
| | **Total funding (euros)** | **2 908 665** |

## 5.1 External contracts and grants (Industry, European, National)

**European projects**

1. **OI** (OpenInterface, IST-FP6-35182 STREP 2006–2009, http://www.oi-project.org/). Project partners: UJF (F), Univ. of Glasgow (UK), UCL (B), Fraunhofer (D), France Télécom (F), TXT solutions (I), Arcadia design (I), PhonoClick (T), Immersion (F), Multitel (B). Coordinator and scientific leader of the project: L. Nigay. The project has provided an open source platform for the rapid development of multimodal user interfaces as a central tool for an iterative user-centred design process.

2. **MOSAIC** (Mobile Search and Annotation using Images in Context, Regional programme ICT-Asia, 2006–2008). Project partners: IPAL (Singapore) NTU (Taiwan), NII (Japan), MICA (Vietnam), LIRIS (Lyon), LIG (MRIM and IIHM). Scientific leader for the novel interaction techniques work package: L. Nigay. The project has developed a novel mobile search and annotation framework as well as new interaction techniques using images in context.

3. **E-MODE** (Enabling MOdel Transformation-based Cost Efficient Adaptive Multimodal User Interfaces, ITEA2 if04046 2005–2008, http://int.emode-projekt.de/). 24 partners distributed over 6 countries. Partners for France: Thales (coordinator, F), CEA, ENSTB, FT R&D, Intuilab, LIP6-UPMC, Lyria. Scientific leader for UJF: J. Coutaz. The project has promoted Model-Driven Engineering for the adaptation of multimodal user interfaces to the context of use.

4. **UsiXML** (User Interface extensible Mark-up Language, ITEA2 08026, 2009–2012). 28 partners distributed over 7 countries. Partners for France: Thales (coordinator), Institut Telecom Bretagne, LIP6-UPMC, UJF, PY Automation, Gostai. Scientific leader for UJF: G. Calvary. The project is a follow-up of E-MODE with the goal to define, validate

and standardize an open user interface description language to increase productivity and reusability as well as to improve usability and accessibility of industrial applications by supporting multiple devices, users, natural languages, modalities, and platforms.

**ANR and FUI projects**

1. **CARE** (Cultural experience: Augmented Reality & Emotion, ANR programme Audiovisuel et Multimédia 2007, 2007–2010, http://careproject.fr/). 7 Partners: ESTIA, Immersion (Coordinator), IRIT, LIMSI, MetaPages, LIG (UJF), UTT. Scientific leader for UJF: L. Nigay. The project aims at integrating, adapting and developing augmented reality related tools and generic interaction techniques to enhance the emotion produced in cultural performances. The professions related to dance (Ballet of Biarritz) and pictorial art (Museum of Toulouse) are used as application domains.

2. **CONTINUUM** (Continuity of Services in Ubiquitous and Mobile computing, ANR programme Réseaux du futur et services, 2009–2012, http://continuum.unice.fr/). 7 partners: I3S (Univ. Nice, coordinator), LIG (UJF), Suez Environnement, Lyonnaise des eaux, Gemalto, Ludotic, Mobilgov. Scientific leader for UJF: F. Jouanot (Hadas research group of LIG). The project addresses the problem of service continuity within the long-term vision of ambient intelligence. A core problem is to achieve software adaptation to a variety of resources in dynamic and heterogeneous environments with an appropriate balance between system autonomy and human control. The professions related to water management are used as a business application domain.

3. **DIGITABLE** (ANR "software networks", 2005–2008, http://digitable.imag.fr). 5 Partners: FT R&D Lannion (coordinator), LIMSI, ENSAM, LIG (UJF), Institut Telecom Bretagne. Scientific leader for UJF: F. Bérard. The project has developed new interaction techniques and optimized algorithms for robust finger tracking on table-top multi-user interactive surfaces.

4. **MyCitizSpace** (ANR programme RNTL 2007 "Réseaux d'information et de connaissances", 2007–2010, http://genibeans.com/cgi-bin/twiki/view/MyCitizSpace/PresentationDuProjet). 7 Partners: Altemis, Délégation Régionale du travail, de l'emploi et de la formation professionnelle d'Île de France, Genigraph, INRIA Rocquencourt, IRIT (coordinator), Région Midi-Pyrénées, LIG (UJF). Scientific leader for UJF: G. Calvary. The project aims at improving the accessibility of administrative services for citizens using a diversity of devices ranging from workstations to smart phones.

5. **NOMAD** (Navigation sur Objets Mobiles et Accès 3D, FUI 07 293 0685, Pôle de compétitivité Minalogic, 2007–2010, http://iihm.imag.fr/contract/nomad/). 5 partners: CEA Leti, Calao System, MOVEA, Purple Labs (coordinator), STMicroelectronics, UJF. Scientific leader for UJF: R. Blanch and J. Coutaz. The project aims at developing new concepts and 3D interaction techniques for mobile devices equipped with actuators and sensors.

6. **VERBATIM** (Formal Verification and Test of Multimodal Interfaces, ANR programme RNRT, 2003–2007, http://iihm.imag.fr/nigay/VERBATIM/). 7 partners: Academic/Research: LIG-IIHM, LIG-VASCO, ONERA, LISI-ENSMA Industrial: CLEARSY, FT R&D (Coordinator), SILICOMP/AQL. The project addresses the problem of formal verification and test of multimodal interaction (including the CARE properties) using B and Lustre. Application domain: a mobile Mixed Reality system.

7. **NAVGRAPHE** (Navigation in Huge Graphs, ACI Masse de Données – Massive Data, 2003–2006, http://acimd.labri.fr/03FICHES/NAVGRAPHE.htm). 8 partners: LaBRI-Bordeaux (Coordinator), LIG-IIHM, LIRMM-Montpellier, IRIN-Nantes, LRI-Paris, CBiB-Bordeaux, IGM-Paris, Laboratoire de Sciences Cognitives-Bordeaux. The project studied the problem of real time navigation in huge graphs. In particular, LIG-IIHM in collaboration with LaBRI (Tulip toolkit) and the bio-informatics partners studied the exploration of RNA structures.

**French Defense Agency (Direction Générale des Armées-DGA)**

1. **INTUITION** (Multimodal interaction for military aircraft cockpits – PEA-DGA – Long Term Research Project - French defense procurement agency, 2003–2006). 4 Partners: THALES (Coordinator), LIMSI-Paris, IRIT-Toulouse, LIG-IIHM. The project focused on the design and implementation of multimodal user interfaces. We defined a design process and developed tools that are dedicated to several phases of our design process. In particular IIHM developed ICARE, a component-based development environment (whose concepts and principles have served as the foundations for the OI European framework —cf. section on multimodal interaction). In the INTUITION project, our main application domain was military and we focused on the design and development of multimodal interaction for military aircraft cockpits in FACET, a real-time simulator of the French military aircraft RAFALE.

2. **PARTAGE D’AUTORITÉ** (Multimodal and Collaborative Interaction – Military drones – PEA-DGA – Long Term Research Project - French defense procurement agency, 2008–2011). 5 partners: BERTIN (Coordinator), Py Automation, SAGEM, EADS and LIG-IIHM. The key research challenge is to explore multimodal and collaborative interaction. LIG-IIHM focuses on notations for specifying such interfaces. The application domain is a command post for controlling a group of military drones.

**CNRS**

PEPS CNRS (Exploratory project SHS-ST2I, 2008–2009): Technological simulation and artistic materialization.

**Contracts with industry**

1. **FT R&D** Issy-les-Moulineaux (2005–2006). Mobile Augmented Reality.
2. **FT R&D** Lannion (2005–2006). PACR. Usage and Multimodality on Mobile Phones.
3. **FT R&D** Lannion (2004–2007). Multimodal Dialogue.
4. **FT R&D** Lannion (2007–2009). Plasticity and Mobility.
5. **FT R&D** Orange Labs Lannion (2009–2012). Plasticity beyond usability.
6. **THALES** (2005–2006). Multimodal Interaction.

## 5.2 Research Networks (European, National, Regional, Local)

**SIMILAR** (IST-FP6-507609, Network of Excellence, dec. 2003–dec. 2007) served as an integrated task force on multimodal user interfaces that respond efficiently to speech, gestures, vision, haptics and direct brain connections by merging into a single research group 34 European laboratories in Human-Computer Interaction (HCI) and Signal Processing.

**GdR I3 (Information, Interaction, Intelligence)**. (1) Creation (in 2004) and co-chairing (by G. Calvary) of the working group CESAME on the design and evaluation of ambient user interfaces. (2) Creation and co-chairing (by L. Nigay) of the working group Ubiquity and Mobility along with the creation of the UbiMob conference whose proceedings are published in the ACM Digital Library. (3) Member of the *“Comité directeur”* of GdR I3 (L. Nigay until 2007, G. Calvary currently).

**Cluster Isle** (regional funding). (1) Member of the project “Presence: communicating environments and objects, HCI and usage” (2005–2008). (2) Member of the project “Web Intelligence” (2005–2008).

**Pluri-Formation Programme (PPF) on Multimodal Interaction** (national funding) brings together local research groups from INRIA Rhône-Alpes, UJF and GINP, to design and develop various forms of multimodal systems (2005–2009).

**Institut Carnot LSI** (http://www.carnot-lsi.com/). Our group is a member of Institut Carnot LSI (Logiciel et Systèmes Intelligents) which includes 500 researchers and engineers specialized in the development of software and hardware solutions for embedded systems, transportation, security, domotics, and medical application.

## 5.3 Internal Funding

**MAPPING** (Modèles, Agents et Perception pour la Plasticité des Interfaces Homme-Machine Nouvelle Génération, 2005–2007, IMAG funding). Partners: research groups from LIG (PRIMA, IIHM, MAGMA, ADELE). The project brings together several skills in computer science to address the whole adaptation process: both the perception and adaptation parts.

**COCOVI** (Conception Collaborative et Validation pour les Systèmes interactifs post-WIMP, 2006–2007, IMAG funding). Partners: research groups from LIG (IIHM, ADELE, SIGMA, VASCO). The project aims at proposing a process and tool supports for the development of post-WIMP interfaces. It is based on the use of software engineering techniques (design patterns, testing, MDE,. . . ) for engineering HCI.

***Vers une ingénierie collaborative intégrant pratiques et modèles des SI et de l’IHM*** (2006–2007, BQR GINP funding). Partners: research groups from LIG (IIHM, SIGMA). The project aims at improving information systems by taking into account the design of user interfaces in the development process.

**K-IHM** (*Capitalisation de connaissances en IHM*, 2009–2010, MSTI UJF funding). Partners: research groups from LIG (IIHM, SIGMA). The project aims at capitalizing HCI design knowledge into design patterns and at proposing a tool support for facilitating the use of patterns.

# 6 Principal International Collaborations

**McGill University, Canada**. F. Bérard has spent one year (2008) as a scientific visitor at the “Center for Intelligent Machine” of McGill University (Montréal, Canada). He was hosted by Jeremy R. Cooperstock and cooperated with the group on basic research on input for 3D worlds. This work resulted in a publication ([28]) and the cooperation is still on ongoing.

**Université catholique de Louvain (UCL), Belgique**. J. Vanderdonckt from UCL has spent 2 months in our research group (2006). This cooperation has resulted in 2 joint publications in conferences and journals as well as in the creation of the UsiXML ITEA2 project (2009–2012). In addition, B. Collignon, a PhD at UCL (J. Vanderdonckt supervisor), has spent 6 months in our group with a grant from the Belgium “First Europe” programme (2005–2006).

**Université de Liège (ULG), Belgique**. Jean-François Vandamme, a PhD at UCL (J. Piater advisor), has spent 6 months in our group with a grant from the Belgium “First Europe” programme (2005).

**University of Glasgow (UK)**. Tonny McBrian, PhD at the University of Glasgow (Phil Gray advisor), has spent 3 weeks in our group with a grant from the UK (jan. 2009).

**Universidad Autónoma de Baja California (UABC), Mexico**. Alberto Moran has spent 1 month in our group with a grant from UABC academic mobility (Oct. 2007).

# 7 Visibility, Scientific and Public Prominence

## 7.1 Contribution to the Scientific Community

### Managment of Scientific Organisations

- IFIP WG2.7-13.4 (Engineering HCI). G. Calvary, general secretary.
- GdR I3. L. Nigay (until 2007), then G. Calvary, members of “*Comité Directeur*”.
- CNRS and MESR. Working group on Ambient Intelligence. J. Coutaz co-chair, since 2008.
- Campus Innovation. PILSI project (Grenoble). Working group on Ambient Intelligence. J. Coutaz chair, since 2008.

### Administration of Professional Societies

- AFIHM (*Association Francophone d’Interaction Homme-Machine*). G. Calvary, co-chair of the administrative council; R. Blanch, secretary of the administrative council; L. Nigay, chair of the AFIHM committee for scientific publications and conferences.

### Editorial Boards

- Interacting With Computers, Elsevier. J. Coutaz, 2003–2008
- Journal Human Computer Interaction Series, Springer, G. Calvary, since 2002.
- Journal of Multimodal Interfaces, Springer. J. Coutaz and L. Nigay, since 2007.
- *Revue de l’Interaction Homme-Machine* (RIHM). J. Coutaz and L. Nigay, until 2007.
- *Journal d’Interaction Personne-Système*. G. Calvary and L. Nigay, since 2008.

### Organisation of Conferences and Workshops

- IHM2009: IIHM organizes IHM 2009 in Grenoble (Oct. 09), 20 years after its creation by J. Coutaz (J. Coutaz , P. Palanque from IRIT general chairs, G. Calvary and S. Dupuy-Chessa organization chairs).
- *Rencontres Jeunes Chercheurs en Interaction Homme-Machine*, 2006. S. Dupuy-Chessa.
- *Rencontres Jeunes Chercheurs en Interaction Homme-Machine*, 2008. R. Blanch.

**Program committee members**

- G. Calvary. Co-chair of CADUI06 (Computer-Aided Design of User Interfaces); co-chair EICS09 (Engineering Interactive Computing Systems). Co-chair of Ergo-IA09. Program committee member of EIS 07, DSVIS 08, and regular program committee of TAMODIA.
- S. Dupuy-Chessa. Program committee member of IADIS Multi Conference on Computer Science and Information Systems, Interfaces and Human-Computer Interaction area (2007 and 2008), INFORSID 2008), 5$^{th}$ Int. Workshop on Model-Based Methodologies for Pervasive and Embedded Software MOMPES 2008 within ETAPS 2008, IDM 2009, UbiMob 2009, Interact 2009.
- L. Nigay. British Society HCI 2006, paper chair and technical chair; Program committee member for AVI (2004, 06, 08), INTERACT (2005, 07, 09), DSVIS (2005, 06, 08).

**International expertise**

- J. Coutaz. Expert for the European Commission: projects evaluation in FP6 (IST, Software & Service Architectures and Infrastructures) and in FP7 (ICT, Software & Service Architectures and Infrastructures).
- J. Coutaz. Expert for EPSRC (UK) and for FWO (B).
- S. Dupuy-Chessa. Projects selection for COFECUB (*comité français d'évaluation de la cooperation universitaire et scientifique avec le Brésil*), 2008.

**National expertise**

- AERES. L. Nigay: laboratories evaluation expert.
- ANR. J. Coutaz: rapporteur for the call on audiovisual and multimedia (2006), evaluator for *"programme blanc"*; L. Nigay: Evaluation Committee for the calls "Conception and Simulation", "Software Technologies", "Audiovisual and Multimedia".
- DGA. L. Nigay: member of the commission for the "Cognitive ergonomics and Human Factor Engineering" qualification, and member of the evaluation committee "Human Factors".
- INRIA. G. Calvary: CR recruitment for INRIA Futur (2007); L. Nigay: Projects evaluation (2008).
- OST/STIC. J. Coutaz expert of the working group in charge of defining bibliographic indicators (2007–2008).
- SNRI *(Stratégie Nationale de Recherche et d'Innovation)*. J. Coutaz, member of the experts of the working group "Quality of Life of the Citizen", 2008.
- Specialists Commissions, Selection committees for faculty recruitment: G. Calvary (Univ. Toulouse and INSA de Lyon, in 2009). S. Dupuy-Chessa (UPMF since 2009, UJF in 2007 and 2008; IUTA-Lyon1 in 2009). L. Nigay (UJF in 2007 and 2008).
- "Young researcher" award, *La Recherche magazine*, 2008. L. Nigay, jury members. S. Dupuy-Chessa evaluation of projects.

## 7.2 Prizes and Awards

**Personal Awards**

- J. Coutaz: elected to the "CHI academy" for "leadership in the profession in Computer Human Interaction", April 2007 (http://sigchi.org/documents/awards/).
- J. Coutaz: nominated "Honorary Degree of Doctor of Science" of University of Glasgow (Honoris Causa), july 2007.
- L. Nigay: Junior Member of *Institut Universitaire de France* (2005–2009).
- L. Nigay: Gold Medal of University Joseph Fourier (2005).

**Best Paper Awards**

- Sottet, J.S., Calvary, G., Favre, J.M. Towards Model-Driven Engineering of Plastic User Interfaces, Workshop on Model Driven Development of Advanced User Interfaces (MDDAUI'05) held in conjunction with the ACM/IEEE 8$^{th}$ International Conference on Model Driven Engineering Languages and Systems (MoDELS'05), October 2005, Half Moon Resort, Montego Bay, Jamaica. Award: one of the two best papers.

**Other Awards**

- ANR project DigiTable, Noblanc prize "Best project", STIC 2006 conference.

**Communication in public media**

- 14-16 november 2008: *"Au-delà du clavier-souris-écran"* Beyond WIMP, location *"Place aux Sciences"* downtown Grenoble, 3 day demonstration. 13682 participants. L. Nigay. M. Serrano, D. Juras and M. Ortega.
- 2006 International Workshop on scientific movies – J.-P. Mirouze Realizator (CNRS-Images & Flight Movies France 5) L. Nigay - Innovative Interaction Techniques
  http://www.cnrs.fr/cnrs-images/rendez-vous/difftv/emergence/DP_EmergenceNouveauMonde.pdf
  On TV France 5: 11 and 19 October 2006.

# 8 Software Publication

**GML**

Type: library/toolbox

Problem addressed: rapid development of innovative interactive systems.

Provides multi-platform video input, image processing, computer vision, and hardware optimized graphical rendering from a high-level programming language (Tcl).

Released as OpenSource software (http://iihm.imag.fr/projects/gml/) and with a commercial licence to the HiLabs startup.

*Dépot APP* (version 0.13.0) Feb 2008.

**OpenInterface** (joint effort of the OpenInterface partners)

Type: Environment

Problem addressed: Rapid development of multimodal interaction

http://www.oi-project.org https://forge.openinterface.org/

# 9 Educational Activities

## 9.1 Supervision of Educational Programs

F. Bérard was in charge of the "Virtual Reality Center" of Ensimag prior to 2006. Since 2006, he has been responsible for international student exchange program for Ensimag.

S. Dupuy-Chessa was director of Continuing Education for the Informatics Department of IUT2 (Institut Universitaire de Technologies) (2002–2008). From 2006 to 2008, she was in charge of projects tutoring for the professional License degree SIL (Computing Systems and Software). She has been director of studies for the second year (100 students) at IUT2 from 2007 to 2008; Since June 2008, she is director of studies for 50 students (*"groupes décalés"*).

G. Calvary has been responsible for the Professional Master's program in Informatics Applied to the Management of Enterprises (M2P-MIAGE) from 2003 to 2007. In addition, she has been responsible for two years of the M2P-MIAGE projects tutoring.

L. Nigay is in charge of Professional Master's program in Software Engineering (M2P-GI) since 2005. She has also created a new M2P-GI for alternate education (2007). Since 2006, she is responsible of a complete module on multimodal interaction at the University of Eindhoven (TU/e).

### 9.2 Teaching

| Name | Position | Year | Number of hours to teach | Academic Programmes | University |
|---|---|---|---|---|---|
| Bérard François | Ass. Prof. | 2005–2007 (CRCT in 2008) | 776 h eqTD i.e. 221 h/year | Engineering Degree, M1, M2 | GINP |
| Blanch Renaud | Ass. Prof. | 2006–2008 (recruited in 2006) | 192 h eqTD/ year (as newly recruited, he was supposed to teach 144 eqTD/year) | L3, M1 | UJF |
| Calvary Gaëlle | Ass. Prof. | 2005–2008 | 960 h eqTD i.e. 240 h/year | M2-P, M2-R, M1, L3 | UJF, CIES, UPMF, Univ. Nice, Univ. Brest |
| Coutaz Joëlle | Prof. | 2005–2008 | 856 h eqTD i.e. 214 h/year | M2-P, M2-R, M1 | UJF |
| Dupuy-Chessa Sophie | Ass. Prof. | 2005–2008 | 840 h eqTD i.e. 210 h/year | L1, L2, L3 | UPMF |
| Laurillau Yann | Ass. Prof. | 2007–2008 (recruited in 2007) | 600h eqTD i.e. 300h/year | L1, L2, L3 | UPMF, Univ. Chambéry |
| Nigay Laurence | Prof. | 2005–2008 (IUF member) | 320 h eqTD i.e. 80 h/year | M2-P | UJF, Univ. of Eindhoven |

## 10 Industrialization, patents and technology transfer

### 10.1 Creation of Startups

After his PhD, Julien Letessier has created HiLabs (incorporated in october 2008, http://www.hilabs.net/). HiLabs designs, develops, markets, and sells products and interactive systems that aim at improving the accessibility of digital services.

### 10.2 Software Licenses

GML has been licensed to HiLabs in 2008.

## 11 Self-Assessment

STRENGTH: visibility, openness to pluri-disciplinarity and to collaboration with the industry, productive doctoral formation, and clear governance - IIHM is a dynamic, highly visible research group that is actively engaged in both the national and international scientific communities devoted to Engineering for Human-Computer Interaction (HCI). We are known for our pioneering contributions in software architecture for interactive systems, multimodal interaction, multi-point interactive surfaces, and user interface plasticity. As demonstrated by our numerous projects as well as by the innovative nature of our current research themes and teaching activities in HCI, the group is particularly opened to novel ideas and to stimulating collaborations with both academic community and with industry. We are convinced that novelty and progress emerge by bringing together multiple sources of knowledge, while maintaining a good balance between concepts and experiments. In particular, we draw from collaboration with experts in ergonomics, cognitive and social sciences to create operational technologies. Furthermore, when relevant, we elaborate new technical solutions from advanced results developed in other specialties of Computer Science such as Software Engineering (MDE, SOA), Artificial Intelligence (reasoning and planning under uncertainty), and computer vision (object tracking). This is highlighted by the collaboration that IIHM maintains with several other teams of the LIG (e.g., ADELE, PRIMA, MAGMA, SIGMA). Moreover the group is quite attentive to the requirements of industry which provides our research agenda with hard, real world problems. This is confirmed by the numerous projects that the team performs with industrial partners.

From the scientific production point of view, our papers are published in the major international conferences of the domain including CHI, INTERACT, ICMI and AVI. Publications in journals still need to be improved further, even though there has been a very significant increase from the previous four year period.

Since 2005, IIHM has maintained an average of thirteen to fourteen PhD students and three to four PhD defenses each year. Among our thirteen most recent doctoral students (2005–2009), three (23%) have been hired as associate professors (Univ. Nice, Univ. Grenoble, Univ. Gabes), three (23%) are currently post-doctoral researchers (defense in 2008 and 2009), five (38%) have chosen to work as project managers in industry or as expert engineers in academic environments, one has left for the US, and notably, one (J. Letessier) has created a new enterprise commercialising an innovative new technology based on his doctoral research on interactive surfaces (HiLabs incorporated in October 2008). One student, however, has abandoned his doctoral research (for a total of three over the 20 years of existence of IIHM).

The governance of the team is based on the principles of the "reasonable person", on scientific mutual respect, and encourages initiatives and hard work. Each team member is the scientific leader and representative of a research theme of the group: F. Bérard for mixed reality, R. Blanch for novel interaction techniques, G. Calvary for plasticity, S. Dupuy-Chessa for methodology, L. Nigay for multimodality. The leader, J. Coutaz, coordinates relations between the themes so that altogether, they coherently cover significant issues for the future of HCI (currently, within the perspective of ambient intelligence). Every new permanent team member gets the financial support from the team that is necessary to start a new theme as well as new contracts (travel, students gratification, equipment). Every student is enrolled within a research contract and is offered to attend reference conferences in the field (even if no publication) to get acquainted with the mechanisms of research. The team, including students and contractual engineers, meets once a month at the "lunch *équipe*" where both scientific and everyday life topics are discussed. The financial figures are checked by the team members on a regular basis (every 3 or 4 months depending on the availability of our administrative assistant).

THREATS: lack of a permanent engineer - All of the team members are academic faculty obliged to devote "continuous partial attention" to teaching, administration, and research. The recruitment of a permanent engineer would help to capitalize and solidify our technical know-how. This is necessary to allow our group to maintain its leading position in international scientific competition and to be responsive to opportunities for challenging issues.

OPPORTUNITIES: ambient intelligence - Novel opportunities are offered by research initiatives on "Ambient Intelligence" planned for both the national and local levels. Our research agenda on "HCI for Ambient Intelligence" is perfectly aligned with these initiatives. Current opportunities also include cooperative research with industry, as private entrepreneurs now recognize that the user interface is a differentiator for their business.

## 12 Perspectives for the research team

IIHM will carry on its research agenda within the perspective of Ambient Intelligence (AmI). IIHM has been deeply involved in this main theme of the laboratory from the beginning. With its experience and research themes, IIHM is ideally suited to respond to the challenges raised by AmI. Indeed the themes novel interaction techniques, multimodal interaction and mixed reality interaction will pursue its basic research for a variety of interaction devices ranging from handhelds to home appliances and large interactive surfaces. Moreover UI adaptation has to draw upon novel interaction techniques for a large diversity of devices. Depending on resource availability and human behaviour, UI adaptation must be able to choose the appropriate modalities whether they be conventional or mixed reality interaction techniques, it must adapt to the user's needs, affect and emotion. In this context, we anticipate even more links between the theme UI plasticity and the other themes of the team.

With regards to method and tool support, the long-term and challenging goal is to provide a flexible and extensible environment (a tool suite) that will blur the distinction between the design phases, the run-time and evaluation phases of the development process, that will support the dynamic composition of services and devices, from single users to collaborative situations, as well as all forms of multimodal, plastic UI's, all of this under appropriate human control. A new challenge, then, needs to be addressed: to provide users with the means to understand, control, and even build and debug their own interactive spaces. This new line of research that we call meta-UI [66] will contribute to the "End-User Software Engineering" promising research area (e.g., Dagstuhl Seminar on EUSE, Feb 2007). As a first step towards this challenging goal, we plan to define a coherent catalogue of tools and interaction techniques. Moreover the future recruitment of an engineer, part time in the team, will help us to capitalize and organize the various developed tools of the team. This catalogue will also serve as a showcase of the team.

Applications for our research will include four of the leading initiatives of LIG: "Open Enterprise", "Smart Buildings", "Creativity and Knowledge" and MarveLIG.

In the perspective of a well-managed transition, L. Nigay will assume the role of responsible for the IIHM group starting on 1st September 2009. J. Coutaz will remain a member of IIHM in preparation of her retirement by 2011.

With regards to everyday life of the team and to better manage the larger size of the team, we plan to organize more frequent meetings (than once a month "lunch equipe"), with frequent presentations from the doctoral students and a lunch per week between the permanent Faculty members.

# 13 Publications

## Doctoral Dissertations and Habilitations Thesis [TH]

**2009**

[1] G. Bailly. *Techniques de menus : Caractérisation, Conception et Evaluation*. PhD thesis, 2009. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier. 280 pages.

[2] C. Coutrix. *Interfaces de Réalité Mixte : Conception et Prototypage*. PhD thesis, 2009. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier. 394 pages.

[3] V. Ganneau. *Modèle utilisateur pour la plasticité des interfaces homme-machine en mobilité*. PhD thesis, 2009. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier. 272 pages.

**2008**

[4] L. Balme. *Interfaces homme-machine plastiques : Une approche par composants dynamiques*. PhD thesis, 2008. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier.

[5] J.-S. Sottet. *Méga-IHM : malléabilité des Interfaces Homme-Machine dirigées par les modèles*. PhD thesis, 2008. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier.

**2007**

[6] G. Calvary. *Plasticité des Interfaces Homme-Machine*. PhD thesis, 2007. Thèse Habilitation à Diriger des Recherches préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier.

[7] O. Daassi. *Les COMETts : une nouvelle génération d'Interacteurs pour la Plasticité des Interfaces Homme-Machine.* PhD thesis, 2007. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier. 134 pages.

[8] A. Demeure. *Modèles et outils pour la conception et l'exécution d'Interfaces Homme-Machine Plastiques*. PhD thesis, 2007.

[9] A. Gorayeb. *ECOVIP : Espace de Communication Visiophonique pour personnes âgées - conception, réalisation et évaluation participatives*. PhD thesis, 2007. Thèse de doctorat Informatique préparée au Laboratoire TIMC (Co-encadrement V. Rialle, J. Coutaz), Université Joseph Fourier.

[10] M. Horchani. *Vers une communication humain-machine naturelle: stratégies de dialogue et de présentation multimodales*. PhD thesis, 2007. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier. 303 pages.

[11] J. Letessier. *Vision pour l'interaction : une approche centrée utilisateur, orientée service*. PhD thesis, 2007. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier.

**2006**

[12] N. Barralon. *Couplage de Ressources d'Interaction en Informatique Ambiante*. PhD thesis, 2006. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier.170 pages.

[13] J. Bouchet. *Ingénierie de l'Interaction Multimodale en Entrée, Approche à composants ICARE*. PhD thesis, 2006. Thèse de doctorat Informatique préparée au Laboratoire de Communication Langagière et Interaction Personne-Système (CLIPS), Université Joseph Fourier. 297 pages.

**2005**

[14] G. Rey. *Contexte en Interaction Homme-Machine : le contexteur*. PhD thesis, 2005. Thèse de doctorat Informatique préparée au Laboratoire d'Informatique de Grenoble (LIG), Université Joseph Fourier,186 pages.

## International peer reviewed journal [ACL]

**2009**

[15] T.-J. Chin, Y. You, C. Coutrix, J.-H. Lim, J. P. Chevallet, and L. Nigay. Mobile phone-based mixed reality: the Snap2Play game. *The Visual Computer, Springer-Verlag Publ., ISSN 0178-2789 (Print) 1432-2315 (Online)*, 25(1):25–37, 2009.

**2008**

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**2007**

[17] A. Benoît, L. Bonnaud, A. Caplier, Y. Damousis, F. Jourde, J.-Y. L. Lawson, L. Nigay, M. Serrano, and D. Tzoradas. Multimodal signal processing and interaction for a driving simulator : component-based architecture. *Journal on Multimodal User Interface, Springer Publ.*, 1(1):49–58, 2007.

[18] R. Blanch and Éric Lecolinet. Browsing zoomable treemaps: Structure-aware multi-scale navigation techniques. *IEEE Transactions on Visualization and Computer Graphics (Proceedings of InfoVis 2007)*, 13(6):1248–1253, 2007.

[19] J.-S. Sottet, G. Calvary, J. Coutaz, J.-M. Favre, J. Vanderdonckt, A. Stanciulescu, and S. Lepreux. A language perspective on the development of plastic multimodal user interfaces. *Journal of Multimodal User Interfaces*, 1(2), 2007.

**2005**

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## National peer-reviewed journal [ACLN]

**2007**

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[22] G. Godet-Bar, D. Juras, S. Dupuy-Chessa, and D. Rieu. Vers une méthode de conception de systèmes mixtes : Principes et mise en œuvre. *RSTI - ISI. Interaction homme-machine dans les SI*, 12:39–66, 2007.

**2006**

[23] C. Daassi, L. Nigay, and M.-C. Fauvet. A taxonomy of temporal data visualization techniques. *Revue Information Interaction Intelligence*, 5(2):41–63, 2006. Paru en 2006 pour un Volume en 2005.

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**2005**

[25] N. Barralon. Couplage de ressources d'interaction : des bases pour l'analyse. *Revue d'Interaction Homme-Machine (RIHM)*, 6(2):31–61, 2005.

[26] G. Calvary, O. Daassi, J. Coutaz, and A. Demeure. Des widgets aux comets pour la plasticité des systèmes interactifs. *Revue d'Interaction Homme-Machine (RIHM)*, 6(1):33–53, 2005. ISSN 1289-2963.

## International peer-reviewed conferences with proceedings [ACTI]

**2009**

[27] R. Blanch and M. Ortega. Rake cursor: Improving pointing performance with concurrent input channels. In *Proceedings of the 27th international conference on Human factors in computing systems (CHI 2009)*, pages 1415–1418, 2009.

[28] F. Bérard, J. Ip, M. Benovoy, D. El-Shimy, J. R. Blum, and J. R. Cooperstock. Did "minority report" get it wrong? superiority of the mouse over 3D input in a 3D placement task. In *Conference Proceedings of INTERACT '09, the Twelfth IFIP TC13 International Conference on Human-Computer Interaction, Springer LNCS (Lecture Notes in Computer Science)*, 2009.

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[34] G. Bailly, Éric Lecolinet, and L. Nigay. Flower menus: A new type of marking menus with large menu breadth, within groups and efficient expert mode memorization. In *Proceedings of the Working Conference on Advanced Visual interfaces (AVI '08)*, pages 15–22. ACM, 2008.

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## National peer-reviewed conferences with proceedings [ACTN]

### 2009


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| | 2005 | 2006 | 2007 | 2008 | 2009 | **Total** |
|---|---|---|---|---|---|---|
| ACL - International peer reviewed journal | 1 | 0 | 3 | 1 | 1 | **6** |
| ACLN - National peer reviewed journal | 2 | 2 | 2 | 0 | 0 | **6** |
| INV - Invited conferences, seminars and tutorials | 1 | 4 | 5 | 4 | 2 | **16** |
| ACTI - International peer-reviewed conferences with proceedings | 11 | 11 | 14 | 15 | 7 | **58** |
| ACTN - National peer-reviewed conferences with proceedings | 5 | 4 | 7 | 11 | 1 | **28** |
| COM - Oral communications, without proceedings, in international or national events (e.g. tutorials, courses in summer schools, . . . ) | 1 | 1 | 1 | 1 | 1 | **5** |
| AFF- Posters in international or national conferences and workshops | 7 | 10 | 1 | 8 | 0 | **26** |
| OS – Scientific books and book chapters | 0 | 1 | 2 | 3 | 3 | **9** |
| OV –Scientific popularization | 0 | 1 | 0 | 0 | 1 | **2** |
| DO – Book or Proceedings editing | 0 | 1 | 1 | 1 | 0 | **3** |
| TH –Doctoral Dissertations and Habilitations Theses | 1 | 2 | 6 | 2 | 3 | **14** |
| **Total** | 29 | 37 | 42 | 46 | 19 | **173** |