Future of Human-Building Interaction

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Abstract

In 2030, we will have a different interactive experience with our built environments, at home, at work, and even in public urban spaces. This is attributed to advancements in sensing and actuation systems that can integrate into the building infrastructures, in symbiosis with the new environmental concerns that call for new life, work, and mobility styles. This change, whether gradual or sudden, evident or seamless, can have a remarkable impact on our everyday experiences, and thus entails efforts to envision possible scenarios and plan for them.

We believe that buildings, as they would embody our digital and physical interactive daily experiences, should be designed and nurtured in a dialogue with their users at the individual as well as social levels. This implies a responsibility of the HCI community to intervene and involve the user in the Human-Building Interaction (HBI) design practice.

We propose bringing together expertise from the fields of human-computer interaction, building and urban architecture, and social sciences, and provide them with an occasion for collaboratively creating and sharing "images" of HBI by 2030. The goal is to uncover research opportunities and challenges that will emerge through discussions and multi-faceted debates about the topics proposed.

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Human-Building Interaction; Home Automation; Smart Home; Interactive Architecture

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Background
Human-Building Interaction
In order to sketch out the scope of what we refer to as Human-Building Interaction (HBI), it is essential, and arguably enough, to clarify the very concept of "building". Hillier in his *"Space is the Machine"* argues that it is too much of simplification if we explain building with a function, as being essentially shelter. He suggests considering the phenomenon of the building that is normally multifunctional, and at its core consists of three interconnected aspects: physical, spatial, and social. Briefly speaking, a building is a construction of physical elements that creates and protects a space. Each of these two aspects, the physical and the spatial, carry a social value: the former by the shaping and decoration of elements (with functional or cultural significance), and the latter by providing spatial patterning of activities and relationships [7].

Designing HBI, in that perspective, consists of providing interactive opportunities for the occupants to shape the physical, spatial, and social impacts of their built environment. Some of the examples from the daily routines are: to change the room temperature or light that is to change the building's physical impact; to telework from home that is to change the social impact of both the home and the office; and to rearrange the furniture that is to reconfigure the room's space and to allow for new inter-personal interaction patterns.[1]

The reason why we believe that HBI and particularly its evolution should be a topic of proactive consideration in the CHI community is not that buildings are becoming essentially computers.The primary reason is rather the fact that our everyday interactive experiences are increasingly enriched by computing power and dominated by the techniques that HCI researchers develop. This can be seen as an emerging "real" interaction skill (referring to Reality-Based Interaction) to manipulate and receive feedback about our built environment. In other words, we propose discussing the human interaction with buildings "in" future, and not buildings "of" future. The latter is mainly the target of domains such as Smart Home [11], Robotic Home [1], and Ubiquitous Domestic Environment [17], and can be seen as a subset of the former.

The Evolution of HBI
There is evidence showing that recognisable buildings have been created for as long as at least three hundred thousand years; and strikingly even in the earliest and simplest forms they were interactive and multifunctional [6]. Interaction with the building has been always subject of creative design (Figure 1 shows an example from Persian architecture). However, in recent years, as we move towards the ubiquitous era [21], HBI undergoes a remarkable shift. "Responsive Places" allow users to dynamically reconfigure the room's physical space for example through gesture interaction in CityHome project [10]. Smart buildings sense user data and, in interaction with them, learn how to provide the

[1]The term Human-Building Interaction has been recently used by the building performance research community, referring mostly to how occupants' manage their indoor comfort in a balance with energy consumption issue [9]. We, however, tend to have a broader user-centric look, as described in this proposal.

Figure 1: The distinct knockers for men and women, making different sounds and letting know the person inside the gender of the person at the door. (Photo courtesy of Paul Keller, Flickr)

optimal subjective comfort (thermal, visual, acoustic) while minimizing energy consumption. Ambient awareness tools are developed to change the occupants' behavior, for example towards using the stairwell instead of elevator [18]. Georgia Tech smart floor [14] and embedded displays [12] are examples of embedded interactive technologies, which seek to make the fabric of the built environment more interactive. Proximity sensing models have been developed to detect the context in mixed-reality environments [16], and techniques are created to react to different contextual cues [5]. These are supported by the advancement of telecommunication infrastructures that allow for seamless and flexible connectivity of smart devices [20] .

In addition to the technological developments, in the current building and urban architecture sustainability debates, the continual evolution of building is widely recognised [2], and the user is given a key role in its appropriation and renovation. This concept is apparent in the notions of Open City [19] and Reversible Infrastructure [15].

Why HBI should be discussed in CHI
In the interest of clarity, this sections recalls the premises that induce our suggestion to discuss HBI as a distinct topic of interest within the academic field of HCI:

Premise I (Feasibility of Transition). With technological advancement in sensing systems, computer vision algorithms, data mining methods, actuating systems, and means of displaying information, more complex forms of how buildings can serve us are feasible. These new services are offered often through the styles of interaction that are normally developed and studied in the HCI community.

Premise II (Demand for Transition). As environmental concerns call for new ways of utilizing buildings, and thus, new life, work, and mobility styles (e.g. teleworking, densification, etc.).

we will have different expectations from buildings (e.g. adaptability to the context of use, energy awareness and efficiency, etc.).

Premise III (Significance of Architecture). Buildings, even in the most primitive and unelaborated state, hold multifaceted significance in our everyday short and long-term experiences.

Conclusion. There will be a foundational transition in how we interact with buildings, towards the interaction styles that are usually studied and designed by the HCI research community.

The existing works on HBI, however, have been limited to efforts to making the technology as invisible as possible [13], or considered as part of the discussions on topics such as Smart Home (for example in CHI'15 [11]), interaction in architectural spaces, (for example in CHI'14 [4]), or interaction with technologies at home (for example in CHI'13 [3]).

The workshop that we propose aims to set the stage for launching a new research track that is abstracted from what the buildings of future can provide, and focused on the question of how they should be offered, taking into consideration the inherent properties of building. We suggest the need to broaden considerations of HBI in different abstraction levels: developing innovative design instances, constructing intermediate-level bodies of knowledge (e.g design heuristics, strong concepts [8]), and contributing to the generalized understanding of human interaction with the built environment.

Goals of the workshop

- To bring people with divers backgrounds together, and discuss ongoing studies on HBI.
- To imagine concrete scenarios such as teleworking, building as a medium for cooperation, energy consumption visualization, etc. and to generate ideas about the techniques that can be most appropriate in those scenarios. The scenarios will be prepared by the organisers, or elicited from the position papers.
- To identify the position of HBI among related notions such as Smart Home, Smart City, Ambient Intelligence, etc., and to discuss the HBI capacity to become an independent design space and topic of interest within HCI.

Organisers

- **Hamed Alavi (main contact person)** is post-doctorate researcher at the Human-IST research center (http://human-ist.unifr.ch), in University of Fribourg, and at the Swiss Institute of Technology (EPFL). With a design-oriented approach, his work has been focused on exploring the spatial configuration of displayed information and its impact on the user's behavior. The main product of his doctoral work is an ambient visualization system designed to support the social construct of the classroom; it has been adopted in several schools worldwide.
- **Denis Lalanne** is Professor at the University of Fribourg and heading the Human-IST research center dedicated to research and teaching in HCI, combining expertise in computer science, psychology and sociology. He also participates to the smartlivinglab (.ch) project in which his team is in charge of designing novel Human-Building Interaction technologies. His personal fields of expertise are multimodal interaction and information visualization.
- **Julien Nembrini** is senior lecturer at the University of Fribourg and collaborates to the smartlivinglab(.ch). He is an experienced building physics engineer with activities in Switzerland and Germany; and holds a math degree and a PhD in swarm robotics. His principal fields of expertise are building performance simulation, performative parametric design and building data mining.
- **Elizabeth Churchill**, currently a Director of User Experience at Google, is an applied social scientist. She has been working in the areas of human computer interaction, computer mediated communication, mobile/ubiquitous computing and social media for 20

years. Her first interactive installations in buildings were in 2000, and her current research focuses on secure infrastructures for mobile, distributed and embedded computing - of which the Internet of Things is a subset.

- **David Kirk** is Reader in Cultural Computing at Open Lab, Newcastle University. He has a background in psychology, ergonomics and HCI. His work increasingly adopts methods from a research-through-design tradition and has focused largely on exploring the design and development of technologies for domestic spaces. He has published on reactive architecture, and has extensive experience of organising CHI workshops.
- **Wendy Moncur's** work focuses on the design of technology to support being human in a Digital Age. Her work is grounded in HCI, informed by knowledge from other disciplines including anthropology, sociology, psychology and design. She has explored digital aspects of a range of life transitions - becoming an adult, becoming a parent, relationship breakup, retiring and dying - all of which tend to play out in the built environment of the home.

Website

Hosted by University of Fribourg, and in the format of a blog, a website will contain pre-workshop notifications and news as well as the generated material during the workshop. After the workshop, it will remain as the main reference point, and a hub for prospective networking and collaboration.
http://human-ist.unifr.ch/HBI2016

Pre-Workshop Plans

Based on the previous similar workshops' mailing lists and through our professional networks including the smartliviglab (.ch) project, we will perform a focused mailing with the aim to build a new HBI community. Other larger diffusion modes will be considered as well as the website.

Workshop Structure

This is a full-day workshop starting in the morning with an introduction and position paper presentations. At the end of the morning, participants, in small teams with diverse backgrounds, create a concept map of all of the subjects that appeared in the presentations. The goal of this part is to make a common understanding of what topics fall in the domain of HBI, and how they are connected to each other.

In the afternoon, we ask the participants to rearrange the teams, and to choose one specific lens for their team; examples are "interaction design", "architectural spaces and technology", or "social psychology". Then we propose concrete (future) situations such as:

- The coworking places in 2030, and how the building can support its social dynamics
- Indoor experience when every physical surface is potentially a display (low or high-resolution)
- Teleworking when a seamless mix of virtual and physical worlds is feasible (with advancement in holographic systems)

For each scenario, the teams create storyboards that highlight the opportunities and questions related to their assigned perspective. In the last part of the workshop, we try to build on the previous discussions and collect arguments

for and against the suggestion that HBI can/should form a new research track within CHI. Finally, we wrap-up with discussing the possibilities for the continuation of that scientific conversation.

Post-Workshop Plans

The open access journal MDPI has already accepted to publish a selection of best workshop articles in a special issue. In addition, we discuss other follow-up possibilities during the workshop: a forum, a wiki, a book or a special issue in an international journal. We are confident that this workshop will facilitate future collaboration and continuing discussions on this emerging research field.

Call for Participation

Human-Building Interaction (HBI) addresses the physical, spatial, and social design opportunities and challenges that emerge as built environments become increasingly interactive. This workshop will focus on creating a vision for HBI for 2030. We invite experts in HCI, architecture, and/or the social sciences to help us create this vision.

The workshop will include short presentations followed by vision and scenario development in interdisciplinary teams. Topics could cover home design, urban environment design, and design for management of personal/group privacy across contexts and/or design for energy awareness. The goal is to uncover design opportunities, to consider the implications of increasing environment, interactivity, and to form a community focused on HBI.

Participant selection will be based on submission and acceptance of a 3-page position paper in the CHI Work-in-Progress format. Position papers should include the authors' views on HBI as an emerging field, and should detail their personal interest in and expert perspective on HBI.

Submissions will be reviewed by at least two peer reviewers. At least one author of each accepted position paper must register for and attend the workshop, and must also attend at least one day of the CHI 2016 conference.

Three types of submission are invited:

- **Conceptual contributions**, envisioning the evolution of HBI (ideally in specific use situations)
- **Design and evaluation of technologies**, to enhance human interaction with buildings
- **Data acquisition and user modeling**, applied to HBI-related opportunities and challenges

Position papers should be sent to futurehbiCHI2016@gmail.com
Workshop web page: http://human-ist.unifr.ch/HBI2016

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