Looking forward

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Our research lies within the field of Human-Computer Interaction (HCI), a discipline concerned with "the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" [1]. HCI is a constantly moving field[1]. Changes in computing technologies extend their possible uses and modify the conditions of existing ones. People also adapt to new technologies and adapt them to their own needs. Different problems and opportunities for HCI thus regularly appear, and among them, it is not always easy to differentiate the *news*, incremental on what we already know, from the real significant *new*. In such a moving field, one needs a bearing, an articulated vision of where one wants to go. Over the recent years, we believe incremental news have unfortunately eclipsed fundamental HCI topics on which a lot of work remains to be done. In what follows, we summarize the essential elements of our vision and the associated long-term goals.

Computers as tools

In the early 1960s, at a time where computers were scarce, expensive, bulky and formal-scheduled machines used for automatic computations, Engelbart saw their potential as personal interactive resources. He saw them as *tools*, as things we would purposefuly use to carry out particular tasks [3]. Others at the same time had a different vision. They saw computers as *partners*, intelligent entities to whom we would delegate tasks. These two visions constitute the roots of today's predominant human-computer interaction paradigms, *use* and *delegation*.

In the delegation approach, partners must be instructed what to do. While early intelligent systems only supported communication at their initiative (*human in the loop*), modern ones operate in a reactive mode by constantly monitoring their environment. They respond to explicit demands or observe people with unobtrusive sensors to guess their intentions and respond implicitly. A lot of effort has been made to support oral, written and non-verbal forms of human-computer communication, and to analyze and predict human behavior. But the inconsistency and ambiguity of human beings make these tasks very difficult. The difficulty is not caused by the lack of models, but by their limited applicability when confronted to the complexity of real-world situations. In the delegation approach, the limiting factor is what the machine understands. The machine is thus the center of interest.

Our focus is on computer users and our work should ultimately benefit them. Our interest is not in solving the difficult problems related to machine understanding. It is not in what machines understand, but in what people can do with them. Instead of intelligent systems, we aim for systems supporting intelligent use. We do not reject the delegation paradigm but clearly favor the one of tool use. We acknowledge that the frontier between the two is getting thinner as they become intertwined. One of our goals will be to explore this frontier to better understand what it takes for an interactive system to be perceived as a tool or a partner, and how the two paradigms can be combined for the best benefit of the user.

Empowering tools

The first computers were designed to process numbers faster than any human could. As performance increased, numbers got used to encode more and more complex data and operations, turning computers into generic information processors. This potential has been used extensively to model the real world and its processes for automation and simulation purposes. A lot of what could be has actually been automated. As Serres once said, we are now "doomed to become inventive, to become intelligent" [4].

We are not interested in the simulation of the real world or the automation of its processes per se. Again, our interest is in what people can do with machines, not in what machines can do by themselves. The ability provided by interactive tools to trigger and control complex transformations in real time can support

[1] For a very brief history of the field, see [2]

intellectual and creative processes in unnatural but powerful ways. The digital world can be made quite different from the real one, and we want to take advantage of this to give people the power to do things impossible otherwise. We are interested in working with people who already use interactive computers in remarkable ways, whether for work or leisure. People who solve particularly difficult problems, create singular things or provide extraordinary performances, for example. These people illustrate what is currently possible with technology. We not only want to see if we can push the limits of what they can do, but also if we can help other people attain similar achievements.

Tools supporting transparent use

Predictive user interfaces based on peripheral unnoticeable sensors are often described as a move towards implicit, transparent interactions. But invisible interfaces can cause great confusion and frustration[2], and what is implicit can be quite ambiguous, especially when coupled with uncertain and inaccurate machine understanding. Literally invisible interfaces can be highly visible in effect when forcing users to explicit their intentions by adapting their behavior so as to match machines' capabilities. In these situations, people become *the tools of their tools*[3], as Thoreau said [5].

We believe technology is most empowering when it is transparent. But the transparent tool is not the one you cannot see, it is the one invisible in effect, the one that does not get into your way but lets you focus on the task. Heidegger used the term *zuhanden* (*ready-to-hand*) to characterize this unobtruded relation to things [6]. Merleau-Ponty posited the primacy of perception in this practical understanding of the world. He described it as an active and constructive process rather than a passive one, and emphasized the role of the body in it [7]. Expanding on this, phenomenologists and situated, embodied and enactive cognitivists have developed converging approaches that place the tight and inextricable perception-action coupling at the root of cognition, even for high-level tasks such as reasoning and problem-solving [8]. Like other HCI researchers [9, 10, 11, 12, 13], we want to draw upon these philosophical and cognitive approaches.

We believe transparency of interaction is not best achieved with tools mimicking human capabilities, but with those taking full advantage of them and fitted to the context and task[4]. Our actions towards the digital world need to be digitized, and the digital world must provide us with proper feedbacks in return. Input and output technologies pose somewhat inevitable constraints while the number, diversity and dynamicity of digital objects call for sophisticated perception-action couplings for increasingly complex tasks. We want to study the means currently available for perception and action in the digital world. Are they suited to modern contexts of use and tasks? Do they take best advantage of our perceptual and control skills, for example? Do they support the right level of coupling for transparent use? Can we improve them or design more suitable ones? As we understand the important role of the body on the human side, we understand the importance of hardware elements on the computer side. Our work will follow a systems approach encompassing these elements and all the software layers above, from device drivers to applications.

But tools also designed for analytic use

Engelbart believed in the coevolution of humans and their tools. He was not just interested in designing a personal computer but also in changing people, to radically improve the way we manage increasing complexity. His NLS system was not designed for beginners, it was difficult to use and required substantial training. Among other factors, this difficulty with initial use was fatal to it: few people were willing to spend the required time to become proficient at it. Later at PARC, Xerox created a system providing untrained non-computer professionals with adequate support for typical office procedures. Since then, the computing industry has mostly focused on the development of similar walk-up-and-use interfaces for novice users, described as "intuitive" and "natural" interfaces by marketing departments.

"Intuitive" and "natural" are usually vague terms for "already learned" and "easily learned" [14]. Systems or techniques that rely on already or easily learned processes can be used rather effectively in a short time. Not only does this serve maketing purposes, but it also suits HCI researchers who favor short initial performance evaluations over longitudinal performance studies [15]. But as a result of this industrial and academic focus on initial performance, we are trapped in a "beginner mode" of interaction with a low performance ceiling [16]. Despite the amount of time we spend using interactive systems, the everyday experience remains close to riding a child's tricycle: easy and enjoyable but far from efficient. People find it acceptable to spend considerable amounts of time learning and practising all sorts of skills. Why not

[2] For a perfect computerless illustration, see the classical "*windowless door*" practical joke.

[3] The original slogan for Microsoft Kinect is interesting from this perspective. "*You are the controller*" was meant to explain Kinect supports controller-free gaming. But if the game does not take advantage of other specificities not found in controller-based systems, it just turns people into imprecise game controllers, i.e. rather inadequate tools for their tool.

[4] The transparency of driving a car, for example, "is not achieved by having a car communicate like a person, but by providing the right coupling between the driver and action in the relevant domain (motion down the road)" [9].

tap into these resources to develop real digital skills, and not just expert ways of using toy tools to achieve ordinary goals? Why not help people ride powerful motorcycles, drive bulldozers or fly planes?

No matter how well designed for it, we must accept that new powerful tools might not support immediate transparent use and require attention. Heidegger used the term *vorhanden* (present-at-hand) to characterize the analytic relation to things that not only occurs when learning about them, but also when handling breakdowns, when they change or need to be adapted, or when teaching others how to use them. Analytic use is unavoidable and its interplay with transparent use is essential to tool accommodation and appropriation [17]. We want to study this interplay. Why and how does the experience of a tool evolve between present-at-hand and ready-to-hand? Can it be helped? How does one design for progressive learnability, how does one facilitate the development of skills? Can we learn from "expert users" on these matters, e.g. understand how they acquired and apply the knowledge and skills contributing to their performance?

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