When Second Wave HCI meets Third Wave Challenges

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ABSTRACT

This paper surveys the current status of second generation HCI theory, faced with the challenges brought to HCI by the so-called third wave. In the third wave, the use context and application types are broadened, and intermixed, relative to the focus of the second wave on work. Technology spreads from the workplace to our homes and everyday lives and culture. Using these challenges the paper specifically addresses the topics of multiplicity, context, boundaries, experience and participation in order to discuss where second wave theory and conceptions can still be positioned to make a contribution as part of the maturing of our handling of the challenges brought on by the third wave.

Author Keywords

Multiplicity, context, boundaries, experience, participation

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The desktop computer has been part of our work-life for a while. Even so many work situations do not consist solely of work at the desktop. Many other artefacts are used in changing configurations with and around the computer. Most user interface design has failed to recognize this, and accordingly we are still stuck with the idea that new design should replace existing artefacts, rather than exist together with them.

Mobile technology makes it possible to work in many places, and current mobile technologies often seem to assume that as long as the individual user has access to all her personal documents on her laptop, she can work independently of place. This assumes that everybody would always want to carry along every document one has ever produced

or received. And on top, many work settings are not about individual documents but presupposes a network-oriented shared use of documents and services across physical place. Furthermore, while moving about, and e.g. working from home, we face a blurring of the boundaries between work and other parts of life, as well as an ongoing reconfiguration of work and non-work technologies. How do we deal with changing configurations of the interfaces in particular such that cross between work and non-work? How do experiences with non-work technology influence work, and how do we deal with those experiences in design of workplace technology?

In choosing the title "When second wave HCI meets third wave challenges" I have indicated that these questions and challenges can, will, and must be addressed in the transition from the second generation HCI, that Bannon [1] identified in his "from human factors to human actors" paper, to the third generation or wave, that one might identify as a break with the second wave, theoretically and technologically[1].

In the second wave, focus was on groups working with a collection of applications. Theory focused on work settings and interaction within well-established communities of practice. Situated action, distributed cognition and activity theory were important sources of theoretical reflection, and concepts like context came into focus of analysis and design of human-computer interaction. Rigid guidelines, formal methods, and systematic testing were mostly abandoned for proactive methods such as a variety of participatory design workshops, prototyping and contextual inquiries (contextual inquiry [10] as well as a number of other qualitative approaches to studying use as it happens).

Meanwhile, in the third wave, the use context and application types are broadened, and intermixed. Computers are increasingly being used in the private and public spheres. Technology spreads from the workplace to our homes and everyday lives and culture [5]. New elements of human life are included in the human-computer interaction such as culture, emotion and experience [32], and the focus of the third wave, to some extent, seems to be defined in terms of what the second wave is not: non-work, non-purposeful,

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[1] I appreciate the discussions of this phenomenon with a large group of colleagues from the University of Aarhus.

non-rational, etc. Conceptually and theoretically, the third wave HCI focuses on the cultural level (e.g. through aesthetics [5, 7, 32, 34], expansion of the cognitive to the emotional [32], or a pragmatic/cultural-historical focus on experience [29]. Methodologically, the third wave has partly moved away from a commitment to users towards a more exploratory take-it-or-leave-it approach [24] where designers seek inspiration from use, e.g. through cultural probes. There are some exceptions to this, not least [7].

New technologies servicing these developments have appeared; pervasive technologies, augmented reality, small interfaces, tangible interfaces, etc. seem to be changing the nature of human-computer interaction in ways that we don't quite understand. We witness the creation of ad-hoc configurations of large and small user interfaces. The new interfaces are moveable and used in changing locations and contexts; different tasks are done through a combination of specialized technologies, whereas the PC idea was to gather as much functionality as possible in one computer. Many new modalities, e.g. gestures, are proposed. However, they are most often presented in theoretical isolation, and as an isolated technical solution.

At this point in time, where the third wave seems to be breaking away from the second wave, I attempt to look at the relationship in a different way. The second wave has left many problems behind that have not yet been solved. These may to some extent be seen in a new light with what we know about the third wave. Furthermore, there are ways in which the third wave could probably benefit from a more direct confrontation with the theories and methods of the second generation. It is in this space that I try to place this current discussion. As part of this discussion it is sometimes relevant to return, as well, to the first generation of HCI, because of the impact that this generation had, or did not have, on the second wave.

In order to proceed the discussion we look more specifically into some elements of this discussion. I have already indicated where some of the weaknesses of the second wave might be found, and where the second wave needs more development still. It is those latter parts that I will focus on in the following. In particular, I look into some examples before returning to the general discussion. Specifically, I look at *multitudes of hardware and applications*, *context and use across contexts and communities*, and *use beyond work. Emotions and experience-based design* are addressed as well as *reflexivity*. Finally, I discuss participation and the possible continuation of "from human factors to human actors".

MULTIPLICITY OF INTERACTION
The desktop computer has been part of our work-life for a while. When one looks at the HCI textbooks, one is tempted to think that HCI has always been about gathering applications on the computer desktop. Even so, we know from many studies that work is rarely work at the desktop only. Many other artefacts are used in changing configurations

with and around the computer, as we shall return to in a moment.

The Xerox STAR [35] in many ways was the predecessor of what we know today as the PC desktop and WIMP interface. As the first what-you-see-is-what-you-get commercial office interface it introduced windows, icons, menus and pointing/the mouse as pointing device into the commercial setting. In my recent work I have been revisiting the STAR design [15], and in doing so, it became evident that STAR was the result of a detailed and serious design effort, and not something that came about because it was "natural". E.g. as part of the design process several sets of icons were tested for ease of remembering and recognition. The STAR was based on a small number of design principles that were carried through, even though it was not easy in all instances. As a consequence, many of the elements that we take for granted and find "natural" today were results of choices that were little predictable.

Much of the design from Star was taken over by Windows and Mac, but essential elements were not, e.g. the relationship between documents and applications: In STAR the document came first, and the functionality was attached to the document. In the predecessors, applications made the world go round. In [15] I give examples of how the current PC platform has reduced the multiplicity of devices and interaction possibilities relative to how e.g. STAR dealt with them. In addition this is a reduction to how people work at the real life desktop:

In a study of tax officers [31] and their use of their physical desktop, it was essential that this use break with the assumptions of the PC desktop in a number of ways: Most strikingly, our analysis showed that the physical desktop spaces were used in various ways other than just as random piles and documents on the desktop. Throughout the taxation process, each document had a location on the desktop. Other resources had locations in a similar manner, the calculator for instance. This was exactly where the electronic information differed, because it was brought up on the computer screen in windows. The physical desktop offered functional spaces that were used to separate and structure the taxation process: last year's documents at the back of the desk, etc. Not all documents stayed in one location. Some were moved around as the taxation process took place, and spatial mobility was in this way essential. The relationship between documents were created and maintained in this process: The history of the case as such was maintained because the separation and ordering of year was maintained when the material was laid out on the desk, and repackaged into the file. We investigated a set-up that could be created by somebody, shared by the whole group of tax officers, and adapted to their individual needs (by themselves or by somebody else). This was pointed out to be very different from the support for the individual to produce a personal desktop look and feel that would last over time, which WIMP provides today.

The taxation case was analysed using activity theory and distributed cognition as theoretical frameworks. It illustrated one important element of what I call multiple interaction, namely the work that the human user does to make multiple objects and mediators work together. In our work with ship bridges and wastewater plants, we have seen similar ways in which users apply multiple instruments across vast physical spaces, and not only at the desktop [6, 9, 12]. In this type of case, the work carried out by the human user is not only what distributed cognition sees as the cognitive work to transform representations, it is to a very large degree physical transportation and transformation as well, what [9] calls zooming with the feet.

The wastewater plant turns wastewater into clean water. As analysed in [6] it is the plant manager, together with a small group of workers, who are concerned with the overview and optimisation of the wastewater process. In the wastewater plant, there are many examples of juxtaposed mediators, most of them rather mundane – a bucket on a stick, a test tube, and some chemicals are used to test the sludge. What ties these mediators together as they are spread over the vast physical space of the plant, is the movement of the human users through daily rounds and routines, as well as in problem-solving situations [37].

In these and other case analyses we have worked with various kinds of multi-mediation. [21] introduces the concept of *webs-of-technology* in an effort to embrace the understanding that we never design single, monolithic devices or systems but technology that must be seen and used in relation to many other devices, applications and systems. Webs-of-technology are used to describe ubiquitous interaction as a process of negotiation between the users and the technology, focussing on the availability of technology and interpretability of services.

[12] proposed a way of combining the basic figures of thought from activity theory with those of semiotics. Through this model we gave a rather more detailed account of both instrumental and communicative aspects *and* their interrelation, than what has been seen before in semiotic or activity theoretical HCI. We analyse co-occurring mediators, rather than one at the time. Examples of this are juxtaposed mediators, and situations where language mediation is heavily intertwined in the instrumental mediation. Through the analysis of different kinds of objects – immediate and ultimate objects, and the way the division of work influences what are the objects of activity of particular human beings, we have come a step further in understanding how human beings mediate their engagement with objects that are not just singular. Furthermore, the historical development of the mediators, and of the division of work embedding these, are important factors in understanding such mediation. Levels and chains of mediations are two ways in which multiple mediation of these multiple objects happen. On the boundary between the second and the third wave, Bertelsen [5] uses Wartofsky's notion of primary, secondary and tertiary artefacts, to add layers of understanding and development to the perspective of multi-mediation.

The challenge in the third wave is exactly to encompass multiple mediators, and in particular other than PC-based ones. In actual facts the PC seems to be merely a parenthesis if we look at the development from the STAR to the second generation HCI. The recognition of multiplicity can in some ways be traced back to first generation HCI, in particular to the exploratory early stages. Nonetheless, all that can be said about multiple mediation in the second generation HCI has not yet been said. In the UUID project [16] we are currently working to understand ubiquitous interaction from the perspective that any kind of use is constituted as use of configurations of mediators, that can be chained, juxtaposed, etc. and may substitute for one another depending on the situations and e.g. the level of operationalisation [14]. While these mediators all consist of physical as well as logical elements [4], it is not the border between the physical and the logical as such that is interesting, it is as much the action possibilities or affordances offered by a certain configuration for a certain purpose.

Most user interface design approaches seem to have failed to recognize that there are several mediators and that experiences come from a mixture of sources. Accordingly we are stuck with the idea that new design should replace existing mediators, rather than exist together with them. However, in order to provide methods to achieve this, we need to work towards understanding how mediators in webs or configurations can be isolated, analysed and replaced into the configuration.

CONTEXT AND CHANGING USE CONTEXTS

Context has in many ways been the most central second wave concept. Yet it has in many ways been a concept that many talked about but most failed to define in a way that has been useful to HCI. Engeström's triangles [25] have largely been used to enumerate dimensions of context. However, there always seem to be another layer or new dimension of context, and in that respect, attempts to make "complete" analyses of context have largely failed, at the same time as the dynamics or dialectics of the original approach are often largely ignored.

A somewhat different approach to understanding this phenomenon has been taken by Star [36], through her notion of boundary objects, and by Brown & Duguid [22]. In both cases the attempts have been to create objects and artefacts that are sufficiently self-contained to travel across contexts of use. Unfortunately none of these discussions have led very far beyond pointing to some issues, and to what I see as a general over-exploitation of the concept of boundary objects. However, that way of thinking resonates well with much of the design thinking regarding mobile technology: Mobile technology makes it possible to work many places, and current mobile technologies often seem to be designed based on the assumption that as long as the individual user has access to all her personal documents on her laptop, she

can work independently of place. Nonetheless, many work settings are not about individual documents but presupposes a network-oriented shared use of documents and services across physical place:

In our work with construction and energy area managers [17] we have seen how their work can be characterized as highly non-routine with a corresponding high degree of flexibility needed to be able to respond to changes in plans as they occur. Area managers supervise construction and maintenance of public buildings such as schools. They collaborate with janitors and institution managers who are permanently located in the buildings, whereas they themselves travel there only for meetings. Ad hoc meetings on site with carpenters, bricklayers, roofers and other contractors as well as janitors and institution managers are often needed to keep a project on track and coordinate the different efforts. The regular inspection visits offer more time to plan and prepare from the office as do a number of the scheduled meetings. During these meetings it is often necessary to refer to shared material such as blueprints, architect drawings, timelines, contractor bids, most of which belong in the project portfolio. Common to the shared materials is that none of them are available electronically on site. They are normally kept in doublet copies on site (owned by the locals) and in the remote office of the area managers.

Not surprisingly, a great deal of effort goes into 'checking information out' of the various computer applications and other information repositories at the office in preparation for meetings. This requires a certain amount of anticipation of possible needs and meetings during the day. Similarly 'checking information into' the computer applications and institution and project portfolios upon the area managers' return from site demands work since it is important to recall which changes have been made, and e.g. which pictures taken during the day goes with which project. The area managers move through very different work settings characterised not only by the physical location, but also by the difference in the character of the work tasks, the individual carrying out the task, and the resources; people and tools at hand (computerized and otherwise).

Thinking mobility and self-containment of mediators and documents first does not comply well with the networked thinking of e.g. the area managers. They don't own documents. They work with many types of documents that are shared with the institutions that they service, and to a large extent it would be preferable if all information and documents were available to every area manager whenever he was in the office, or at a particular site. Accordingly, this perspective on context is much more in line with Weiser's programmatic paper [39] where he looks at e.g. pads and screens as something that does not belong to and travel *with* the human user, but something that is there to be used in situations in particular locations. Bardram et al. [3] have developed the use of such interaction possibilities as large screen and other resources in the environment in activity-

based computing, a perspective that specifically aims to address how users may make the most out of such resources in the environment as screens, printers etc., when carrying mobile devises.

Bertelsen & Nielsen [8] proposes the use of contextual units as ways of delimiting context for analysis and design. These are dynamic ways of delimiting what we are designing for, yet they are somewhat underdeveloped. Accordingly, context remains a challenge in third wave, partly because the second wave has not completed its achievements. However, the third wave specifically emphasizes the general context of culture and human being, in particular e.g. our being in non-work situations such as in the home, in our engagement with the arts, and with leisure activities.

With its focus on the home, on leisure, etc. the third wave specifically seems to want to separate these types of activities from work, which the focus in the second wave were. The third wave seems to insist that non-work is special and detached from purposefulness. While the third wave may make a lot of sense, in order to provide a clear-cut focus for analysis and design, the second wave may find the negation of all it stands for somewhat confusing and insist that it still has a contribution to make, by elevating the focus from work to life, instead of negating work.

Let us look at an example from recent empirical work:

In a public organization that is undergoing major organizational change, a caseworker works in three locations, using two-three network platforms. In order to transfer documents across these sites and platforms, she uses her personal hot-mail account, because web-mail is the only resource she knows that can be accessed from all platforms, and hence supports transportation of documents across platforms.

From the second-generation theory, this raises questions of how do we deal with configurations of mediators that cross between work and human life in general? How do experiences with non-work technology influence work, and how do we deal with those experiences in design of work-place technology? In line with some of my earlier work (e.g. [13]) it seems that, while moving about, and e.g. working from home, we face a blurring of the boundaries between work and others parts of life, as well as an ongoing reconfiguration of work and non-work technologies. Certain technologies truly are used equally in work and outside, e.g. web-browsers, which help us retrieve scientific papers, as well as train schedules and give us access to e.g. web-banking. Other technologies such as email and cellular phones, people seem to reconfigure differently – some use one mail client and account for all mail, while other juggle several accounts and mail systems. Some have one cell-phone while others draw clear boundaries between when they use a private phone and when they use a work phone. Some use the same forms of interaction for both, others don't.

If one looks as boundaries as resources [17] it is clear that the boundaries are not drawn once and for all, and hence,

by having as research focus *only* on the non-work, we miss the opportunity to understand the resources that exist on the boundaries, and hence to develop technology and interaction accordingly. As a matter of fact, work is a place where technologies get introduced, and explicit training takes place, an element that is often missed in the discussion of the home. As discussed in [22] one faces the lack of training instruments when introducing non-work technologies, and hence it may be necessary to train a large number of users to be front runners when opening e.g. a new subway ticket system.

This leads us back to context. The concept draws attention to the connection between a particular mediator and its surroundings, including other mediators, and to e.g. people's experience with such other mediators. However the boundary discussion points out that at the same time as we try to delimit a context we should also look out for the resources and work that goes on, on the boundaries of particular contexts.

EXPERIENCE AND REFLEXIVITY

Emotions and experiences are keywords in the third wave. They are a result of the negation and discussion of rationality and purposefulness in the second wave, the focus on non-work, and motivation.

Emotion in relation to design and to HCI has been promoted e.g. by Norman [32] as the next wave from traditional cognition, more or less short-circuiting the second generation HCI. However, Norman seems to be stuck in his cognitivist paradigm, which means that he just sees emotions as add-ons to cognition, as discussed in [18]. Boehner et al. [18] tackle the topic of emotion from a social, interactionist point of view, arguing that meaning in emotion is generated by the interaction of people, and accordingly emotion is understood and often modified by interaction with others rather than through individually generated experience.

McCarthy and Wright [29] choose a pragmatist view rooted in second generation HCI. Their emphasis is on felt experience bridging between the individual and the collective or cultural levels. To [29], felt experience consists of a number of steps that includes anticipation of the experience as well as reflection and recapitulation of it. They give several examples of how multiple technologies mediate such experience, and point out that felt experience occurs on the boundaries between one-self and others.

While experience may seem to be a different perspective on human-computer interaction that than of the second generation, [20, 23] point towards an element of experience that is close to home of second generation HCI, namely that of reflexivity. In much of ubiquitous computing it seems to be an assumption that the computing and hence the interaction can simply be made to disappear, once and for all, from

the attention of the human user. The IST project Palcom[2] has made an effort of explaining how learning and understanding are essential prerequisites of making computer interfaces disappear from the attention of the user (see also [9]). And, as discussed in [4], [14] takes the view that understanding and disappearing go hand in hand – the breakdowns that make the disappeared mediator re-appear are, and must also be, the foundation for learning and reflection. Chalmers [23] uses Heidegger's hermeneutic cycle to provide a similar discussion.

Because experience and reflexivity go hand in hand with ubiquity, learning is closely attached to the reconfiguration of configurations of mediators. Such reconfiguration has to do both with

- a dimension of what activity theory would call operationalisation [14] – the dimension that allows the user to form repertoires of operations through which the instruments are handled on the one hand, and to consciously reflect on dealing with the components on the other (see [2, 4, 20, 23, 31]).

- a dimension of wholes and parts described by Palcom as *"Besides the need to be able to construct collections with emergent behaviour from existing ambient components and devices, it is also desirable to be able to de-construct assemblies[3]."* When it comes to interaction possibilities, it is important e.g. to de-construct the ubiquitous setting, when there is a malfunction in the configuration.

Re-configurability in the hands of networks of human users leads the way back to a topic that seems to be somewhat forgotten as a research theme, tailorability, not as individual adaptation of technology, but as adaptation and further development through interaction and cooperation among people [38, 27, 28].

HUMAN ACTORS–PARTICIPATION REVISITED

To the second wave, human actors have meant taking users seriously, specifically users as workers with a particular practice in a particular setting. In the Scandinavian tradition in particular, we have emphasized the active engagement of these users in design. At some level such active user participation is now taken for granted in many design settings. As pointed out in [11] this taken-for-grantedness of participatory methods leads to a lack of reflection or reflexivity on behalf of designers as regards their own ways of working. For that reason alone, second generation methods such as participatory design should definitely be ready to take on new methodological challenges. In addition, the multiplicity, context, and transparency/reflexivity discussions challenge the focus with which many second generation

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[2] www.ist-palcom.org

[3] ibid.

methods replace one mediator with another. This calls for change.

A few rebels who are profiling the third wave, have responded, primarily to the transparency discussion, by emphasizing a total, art-focussed breakdown [26] without much commitment to the actual users of the technology [24]. The question is how the third wave could develop a productive, reflexive practice that makes more than artistic statements to provoke us?

First of all, the human actor needs to step out of the role as worker in a particular practice, and participate in design as a person who brings her entire life to the design. Yet, the second wave insists on a commitment from the designers to users to ensure that design truly benefits users. In my perspective, the notion of felt life [29] seems like a serious starting point in that direction.

Secondly, Bødker & Christiansen [13] argue that many of the questions that we need to deal with as designers of the new multiple, experience-oriented technology are still so open that we need to make technological experiments in order to understand which questions to ask. This leads to an approach that is quite similar to that of Boehner et al. [19]. It gives a new role to prototyping: design–prototyping need to play a role not only to investigate transparency and operationalisation of interaction, but controlled reflexivity as well. It is important, however, that we do not just "dump" technology on people–we need to examine carefully the questions to ask and have respect for the answers we get.

Thirdly, and least developed, is the challenge coming from re-configurability (of wholes and parts of configurations) and tailorability. Mørch et al. [30] address the most recent developments in this area, and conclude (in my interpretation) that the challenges lie within tailoring new components that come from outside the context of the immediate configuration of mediators (such as other areas of life), combining different levels of tailoring and integrating with existing mediators and configurations, and supporting cooperation between different users in the reconfiguration process. In other words, tailorability research is ready to face the challenges of the third wave, in cooperation with the rest of second wave HCI. Accordingly, we need to challenge tailoring by moving away from end user programming in isolation and towards configurations with multitudes of physical devices etc.

HEADING TOWARDS THE REAL THIRD WAVE?
I have provided a collage of concepts, solutions and discussions, sketching what is essentially the boundary work needed for second wave HCI to face the rebellious thoughts from the third wave.

I have emphasized that the second wave should not be abandoned. However, it does indeed need to transcend its conceptions of multiplicity, context and reconfiguration.

The second and the third wave seem to be stuck on either side of the divide between work on the one hand and leisure, arts, and home on the other; between rationality on the hand and emotion on the other. While development on either side may lead towards a true third wave, I don't believe that we get there until we embrace people's whole lives and transcend the dichotomies between work, rationality, etc. and their negations.

I am concerned with the possible lack of serious commitment of designers to users. To some extent, this is tied to the artistic, cultural focus of many of the specific projects of the third wave. As I have pointed out, this leads to a situation where mediators either make us break down or act transparently, but where our ability as human beings to learn and cooperate in communities of practice is largely ignored. A reverse "keep it simple stupid", that may essentially prevent third wave technologies from becoming true parts of everyday life.

The emerging third wave seems strongly tied to a kind of consumerism that differs from the underlying co-determination framework of the Scandinavian societies. My young colleagues often bring up issues of how one may do participatory design in the context of the home and of consumer products. A way of proceeding that would truly break with consumerism, would be to move the co-determination framework outside the "factory gates." I imagine making use of people's experiences of cooperating and learning, hence supporting them in making informed choices that would radically form their lived lives with technology. I imagine that researchers provide re-configurable alternatives, through design-prototyping, where the questions asked have been carefully examined and the answers digested in cooperation with users. Perhaps, this way we could strike the balance differently between individual and individualized choice on the one hand, and one size fits all on the other? We could perhaps make more out of the cooperation and learning possibilities within and across communities?

Based on the Scandinavian tradition, exactly Scandinavian research may have a chance of doing such projects. Where exactly, they would take us, is an open and interesting question.

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