

Chapter 1

Introduction: New Directions in Third Wave HCI



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Abstract *New Directions in 3rd Wave Human-Computer Interaction* explores the diverse interdisciplinary inquiries comprising the forefront of developments in the field of HCI. This wide ranging collection aims at understanding the design, methods and applications of emerging forms of interaction with new technologies and the rich varieties of human knowledge and experiences. All chapters are structured around two major themes presented in two volumes: Volume 1– Technologies, and Volume 2 – Methodologies.

1.1 Waves, Paradigms, and Cultures

New Directions in 3rd Wave Human-Computer Interaction explores the diverse interdisciplinary inquiries comprising the forefront of developments in the field of HCI. This wide ranging collection aims at understanding the design, methods and applications of emerging forms of interaction with new technologies and the rich varieties of human knowledge and experiences. All chapters are structured around two major themes presented in two volumes: Volume 1– Technologies, and Volume 2 – Methodologies.

These two volumes address the widespread notion that the field of HCI can historically be divided into three ‘waves’ of approaches and application areas. Although there is a consensus on the presence of different ‘waves’, the definition and understanding of what constitutes these is far from set. Bødker (2015) following Bannon (1986), for example, has defined the sequence and conceptualization of the waves as follows:

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- 1st Wave – based on model-driven cognitive science and human factors methods and focusing on strict, formal guidelines grounded in systematic study and testing.
- 2nd Wave – initiated as an extension of the human-technology nexus to include collaborative, mediated, and distributed applications within work settings, involving a higher degree of participation from users of systems.
- 3rd Wave – triggered by the expanding context of HCI far beyond the workplace, an expansion resulting from the increasingly pervasive and ubiquitous essence of computation in everyday life. The 3rd wave places a stronger emphasis on human values, meaning-making, situated knowledge, and experiences.

Grudin (2005) considers the divergent foci on “computer operation, information systems management, and discretionary use” (46) to be the defining features of the three waves of HCI. Grudin emphasizes that these three strands of HCI have not converged and remain relatively autonomous today, and the three frames of inquiry are defined by two research cultures reinforced by differences in scholarly production and activity. A particularly interesting aspect of Grudin’s account is that these three kinds of HCI research run in parallel historical developments. The first wave, for Grudin, is grounded in engineering psychology and has been initiated with the human-machine interface. Although such machines were not necessarily in the first instance computational, the consideration of Human Factors can be traced back to its earliest origins in Taylor’s scientific management of the early twentieth century. Grudin distinguishes compulsory (e.g. work and war) and discretionary (e.g. home and leisure) use as a critical difference that defines second- and third wave HCI research approaches. HCI oriented toward discretionary uses begins, in his account, with general purpose computers circa 1945, while information management-focused HCI begins in the mid 1970s with sociotechnical and participatory design approaches. Once founded, all three strands of HCI continue to progress in parallel through new developments discussed in journals, academic societies, and conferences which operate in relative cultural isolation from each other to the present day.

Harrison et al. (2007) formulate a third understanding of the three waves defined as a difference of ‘paradigms’ in the Kuhnian sense. For these authors, the first wave centered on engineering and human factors (i.e. human-machine “coupling”) and was essentially atheoretic and entirely oriented toward pragmatic design enhancements and solutions, such as helping pilots effectively utilize cockpit instrument panels of increasing complexity. The second wave of HCI was grounded in cognitive science disciplines, where human-computer interaction is understood in terms of information transfer and efficiency of communication between a mind-as-information-processor, and an interface communication with that mind. The third wave is characterized by a growing interest in design that takes into account the full ‘messy’ context of socially situated and embodied action, which introduces humanistic and social science considerations into design research. These once marginal research agendas have moved toward more central positions in HCI discourse, prompting the notion of a third paradigm. “Participatory design, value-sensitive design, user experience design, ethnomethodology, embodied interaction, interaction design, and critical design” (2) as a grouping are brought together under the

heading of the “phenomenological matrix” due to the highlighting of the embodied and socially situated interactor where more than simply efficiency of operation or information transfer is at stake.

While the conceptualization of the historical waves of HCI differ significantly in the details, at a more global level there is a commonality in the sense of a gradual and considerable expansion of HCI’s concerns, methodologies, and application areas. The earliest HCI work was strongly based on the concept of human-machine coupling, which expanded to workplace collaboration as computers came into mainstream professional use. Today, HCI can connect to increasingly more sides of human experience because now there is an app for every almost any aspect of daily life. Despite this clear sense of a commonly understood trajectory in the expansion of HCI’s domains of research and application, there are some tensions to be noted as to how one understands this historical progression. Do the new waves replace the old, or update them? Can one combine waves through hybrid research agendas? Are they complementary to each other? Which wave is ‘the right one’ today? What is meant by a ‘wave’ in the first place? What fourth wave might be on the horizon? These two volumes allow us to explore such general disciplinary questions while also focusing in depth on particular aspects of methodologies and technologies to better understand the range of practices associated with third wave HCI today.

1.2 Are the Waves ‘Paradigms?’

In one of the articles noted above that inspired this project, the three waves of HCI are understood as Kuhnian paradigms (Harrison et al. 2007). As compelling as this appears in terms of a general disciplinary taxonomy, careful consideration reveals some conceptual matters of potentially problematic nature. One of the most apparent issues to note is that the three paradigms of physics described by Kuhn (e.g. Aristotle, Newton, Einstein) unfold over thousands of years, whereas HCI paradigm formation seems to emerge and develop within a very short timeframe. Such fast speed of progression triggers new paradigmatic shifts in a matter of decades, producing a historical development several orders of magnitude faster than the sciences studied by Kuhn.

A key aspect of Kuhn’s paradigm theory relates to the idea of incommensurability between paradigms, and the alterations between normal and extraordinary science. The way scientists in the Greek-, Enlightenment-, and contemporary periods understand phenomena (such as force, substance, motion, and acceleration for example) are incommensurate because of the difference in the conceptual and terminological frameworks that describe the underlying phenomena in question. Such frameworks seem to not be translatable into each other. Moreover, paradigm shifts are ‘revolutions’ in which normal science – which Kuhn conceptualizes as a form of mundane puzzle solving – is shaken up by extraordinary science, which takes up new research agendas in relation to anomalies that have turned up within normal science:

In a given scientific field, long periods of conservative, tradition-bound normal science are punctured by an occasional crisis and, still less frequently, by a revolution. Normal science is highly regimented work under a paradigm. It aims to extend and articulate the paradigm, not to test it, for the paradigm *defines* the research tradition, the scientific life, of a particular discipline and its practitioners.

During a crisis period the usual conservative strictures relax somewhat, and truly innovative ideas and practices may emerge as serious alternatives. The repeated failures of the normal scientists to handle the crisis situation, together with the emergence of a promising new approach, may trigger a revolution.

[T]wo competing paradigms are “incommensurable,” meaning, roughly, that they cannot be measured against the same standard....[I]n the more radical passages of *Structure*, he spoke of paradigm changes as akin to Gestalt perceptual switches, religious conversions, and political revolutions, comparisons he later dropped (Nickles 2002, loc 77, emphasis in original).

In order to more accurately appropriate the notion of paradigms into HCI discourses, we can distinguish between ‘hard’ and ‘soft’ understandings of paradigms. A ‘hard’ notion focuses on common dynamics of generational change and upheaval, revolution, accounting for anomalies, emergence of new exemplars and methods to take up unsolved puzzles. Such ‘hard’ essentialization of a paradigm creates discourses that are incommensurate with each other, where epochal and historical progressions in a discipline confine researchers to ‘living in different worlds.’ This scenario seems to be a poor fit with the three waves of HCI, not least because the waves conduct inquiry into very different phenomena, as opposed to studying the same or similar problems through differing and incompatible conceptual frameworks. As the contributions to these two volumes show, many practitioners develop hybrid approaches and technologies bridging across the discursive terrains of the various waves.

We believe that a ‘softer’ conception of paradigms is better situated to fit the domains of HCI discourse. A ‘soft’ understanding emphasizes communities of inquiry and shared exemplars, held together by a fuzzier logic of ‘family resemblances.’ The three waves under this paradigmatic model approximates families of related approaches, examples, puzzles, problems and solutions. Nersessian (2002) applies Eleanor Rosch’s theories of concept formation to Kuhn’s notion of paradigms to articulate the discourse and practices of research communities:

Most of Kuhn’s work after writing *Structure* centered on issues of what he called the scientific “lexicon,” specifically, on how the language of a scientific community is acquired and how language changes relates to incommensurability.

What one acquires in learning a conceptual structure are not sets of defining characteristics and specifiable rules for the concepts that participate in the problem exemplars comprised by the paradigm. Rather, one acquires sets of “family resemblances” that include both similarities and differences amongst instances.

[R]esearch on categorization in cognitive psychology begun in the early 1970s by the psychologist Eleanor Rosch and her collaborators provides a cognitive underpinning for many of Kuhn’s intuitive insights about concept representation and acquisition.

[R]ather than representing concepts by sets of defining criteria, humans represent both natural and artificial concepts by a prototypical example. Category membership is determined by similarity and dissimilarity to the features of the prototype.

Further, concepts show graded structures. That is, some instances of a given concept are better examples of the concept than other instances. (loc 2622).

Nersessian's approach seems to form a better match for the situation of paradigms in contemporary HCI fields. Understood in this 'softer' manner of graded category membership and family resemblance, the difference between HCI discourses and practices takes on a more recognizable outline. These two volumes can thus be understood as a way of organizing the family resemblances of third wave HCI across rich application and methodological domains – at once highly different from each other, yet recognizably belonging together in their distinctive differences from first and second wave approaches.

1.3 Theoretic Integration

In preparing for a CHI 2015 panel on transdisciplinary design [...], I was asked if a fourth wave is coming. My best answer is that HCI is in the middle of a chaos of multiplicity in terms of technologies, use situations, methods, and concepts. Hopefully something lies beyond that horizon, but for now, I'll leave it to others to identify it (Bødker 2015).

While it is not the direct goal of these volumes to point the way to a fourth wave, it is possible to see some paths emerging for what this might look like – especially if we note the global commonalities in the distinctions between the waves, and take a softer or fuzzier family resemblance stance toward category membership of such vast research terrains. Niklas Luhmann's systems theory could serve as a basis for a more integrationist positioning amongst the divergent academic cultures and exemplary problem-types of contemporary HCI.

Luhmann's systems theory transcends Mind-Body dualisms (and by extension, traditional subjective/objective dichotomies) by introducing a third term – Communication – into the conceptual mix. Appropriating Varela and Maturana's concept of autopoiesis, Luhmann understood (1) Mind, (2) Body, and (3) Communication as separate and distinctive autopoietic systems in structural couplings to each other and to their environments. Two minds in close physical proximity, for instance, are operationally closed to each other – this is demonstrated by the absence of telepathic effects. A third autopoietic system – that of Communication – is needed in order to achieve information transfer between them. For Luhmann, minds don't communicate, only communication communicates (this is a function of its being an operationally closed, autopoietic system). He considered his theory to be a 'super theory' because it included itself in itself, as a theory of making distinctions generally, conceiving of communication, cognition, and bodies as systems that are always making self-other distinctions between their own operational closure and their environments.

Luhmann's systems conception aligns strongly with the three waves of human-computer interaction as he understands technologies to be in the environment of living systems. Within such conceptualization, the first wave of ergonomics-oriented approaches corresponds to structural couplings of technology to the Body, while second wave information processing models address the cognitive capacities of Mind. The third wave's central focus on meaning-making completes the mapping to Communication as its own autopoietic process. We will ground this somewhat abstract discussion in a concrete example by referring to Veronika Tzankova's current research in interactive sports technologies. Her research involves the development of new technical systems for horse riders to improve their overall performance in this contact sport. The successful operation of such systems involves considerations at several levels that closely correspond to the three waves associated with HCI. First, the system requires to be physically constructed which engages technical and ergonomic concerns – such as physical design of the equipment, posture of rider, and kinesiological characteristics of the horse. This level corresponds to problem conceptualization characteristic of first wave HCI. Second, the design of the system should take into account cognitivist considerations – e.g. not distracting the rider through misallocation of limited attentional resources – problematics essential to second wave HCI. Last, the system should effectively communicate to the rider by providing feedback that makes sense – facilitating interspecies communication between technology, horse, and rider through embodied interactions. This level of 'meaning making' is a distinct theme of third wave HCI. A system such as this – especially coming from a sports context where all three levels are vital to the safety and security of the sportsperson engaged – exemplifies the growing necessity of a research agenda that integrates all three HCI waves through discursive and practical variations based upon Luhmann's three autopoietic systems categories of Body, Mind, and Communication.

It is not just that Luhmann's theory logically maps to the typologies of the three HCI waves as explicated by others, but rather actually provides the only model available amongst the major theorists for imagining a possible convergence of all HCI discourses and practices. Instead of academic tribes of subspecialists narrowly concerned with their own local and preferred exemplars and problem-solution spaces, the Mind-Body-Communication matrix could point to a fourth wave of 'integrationist' agendas that at this point we can offer as a speculative gesture on our part. This goes somewhat further than Bødker's discussion "When second wave HCI meets third wave challenges" (2006) by suggesting that even first wave HCI might have potential for reintegration with the new domains and methods presented by the third wave.

While not usually grouped together as a set of related intellectual movements, systems theory shares a common origin with phenomenology and pragmatism in the development of new concepts in an attempt of transgressing Enlightenment binary positions. Just as thinkers like Husserl, Merleau-Ponty, James, and Dewey sought a way out of the traditional Empiricism vs. Idealism philosophical impasses, Bertalanffy's original formulation of general systems theory served as a way of moving beyond Determinism and Vitalism as explanatory frameworks for under-

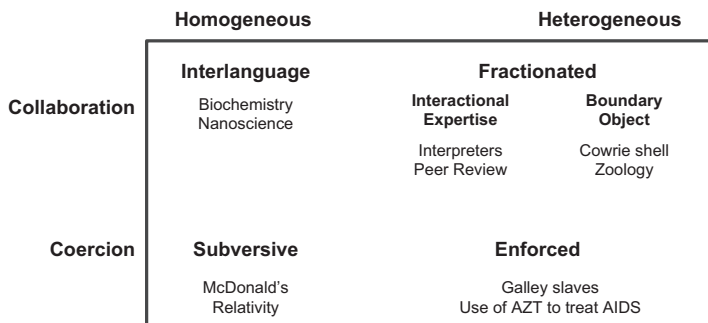


Fig. 1.1 Collins et al. general model of trading zones (as presented in Gorman 2010: Fig. 2.1)

standing organized wholes of self-interacting elements. Taken together, phenomenology, systems theory, and pragmatism can be understood broadly as ‘third way’ approaches that move beyond reductive-causal concepts on the one side, and ideal-spiritual explanations on the other, within an all-encompassing consideration of subjective, objective, and praxeological phenomena.

1.4 Trading Zones and Interactional Expertise

The third wave has generated perhaps the greatest expansion in the disciplinary interactions of HCI with other fields, and can be broadly understood as a trading zone with humanist and social science theories:

Two groups can agree on rules of exchange even if they ascribe utterly different significance to the objects being exchanged; they may even disagree on the meaning of the exchange process itself. Nonetheless, the trading partners can hammer out a local coordination, despite vast global differences. In an even more sophisticated way, cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons, through semi-specific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection (Galison 1997, 783)

A trading zone can gradually become a new area of expertise, facilitated by interactional expertise and involving negotiations over boundary objects (objects represented in different ways by different participants). (Gorman 2010)

Third wave HCI has proposed in a sense a ‘double condition’ of negotiating trading zone inquiry with other areas of HCI research, together with scholarly domains far beyond HCI. Collins et al. (2010) have modelled trading zone inquiry into quadrants defined by the axes Homogeneity-Heterogeneity and Collaboration-Coercion as follows (Fig. 1.1):

Interlanguage trading zones operate by developing new cultural tools, subversive trading zones operate by imposing one culture on another, while enforced trading zones operate with almost no cultural interchange. The final type of trading zone, which occupies the top

right-hand area of the table, involves fractions of cultures as the medium of interchange. There are two kinds of fractionated trading zones: boundary object trading zones, which are mediated by material culture largely in the absence of linguistic interchange, and interactional expertise trading zones, which are mediated by language largely in the absence of the material (loc 169).

HCI clearly has both sides covered in the Fractionated quadrant, being a research practice typically organized around the development of new technical designs, while also being a subject of academic discourse. Where the material culture aspect is perhaps most foregrounded is in the appropriation of forms such as artworks, critique, or various communications media, where content and connotation considerations may take on as much interest as usability. Since third wave HCI has as an orienting feature a concern with meaning making, entertainment, aesthetic experiences, culture forming, style trends, or rhetorical arguments, for instance, can take on an increasing role in investigations and research output. Considering these volumes as a whole in relation to the general model of trading zones, third wave HCI seems ‘squarely’ (no pun intended!) in the Collaboration-Heterogeneous quadrant. Our framing of Luhmann’s ‘super theory’ as a method for integrating all HCI waves could in trading zone terms be understood as a convergence toward the top left Interlanguage quadrant. This quadrant is also understood as the end-phase of trading zone development:

Thus biochemistry, though it grew up as a trading zone, is now just a new homogenous cultural location in which trades happen. When they reach their end points, all the examples in the left-hand areas slip off the table in the westerly direction, as it were (loc 210).

It will remain to be seen of course whether HCI continues along its current path of increasing divergence and plurality of approaches, or whether new lines of convergence may start to draw the different strands together. Regardless of the course of development, the understanding of future trends necessarily depends on our thorough understanding of current affairs. Thus, the objective of *New Directions in 3rd Wave HCI* is to position present and emerging trends shaping the field of human-computer interaction both in terms of (1) technological dynamics (Volume I), and (2) systemic practices of study (Volume 2). As most individuals interact with technology routinely for extensive periods of time (File and Ryan 2014), it is important to understand the experiential dimension of HCI as a source of knowledge and design.

To address these issues, *Volume 1 – Technologies* focuses on the conceptualization and documentation of contemporary third wave HCI. It presents key developments at the leading edge of human computer interactions by providing reflective insights on the theoretic and practical conceptualization, valuation, and development of contemporary technologies. By doing so, this compilation of essays serves as a resource for understanding human-computer interaction through a multiplicity of interdisciplinary perspectives that can facilitate the systematic epistemological shaping (and reshaping) of technological design and production practices. The combination of perspectives from the humanities and social sciences emphasize the importance of human and experiential dimensions within HCI and contribute to the

better conceptualization of the challenges and opportunities that arise as a result of the rapid development and impact of technological progress. Transcending the task-orientedness characteristic of earlier HCI research, *Volume 1: Technologies* covers areas related to artificial intelligence, machine learning, metacreation, 3D printing, critical making, sensorial computing, physical computing, the internet of things, virtual reality, multimodal display, sonification and language technologies, within a frame of experiential inquiry. Drawing on the vast interdisciplinary expertise of the contributors, this volume investigates the experiential and expressive dimension essential to the positive progress of the field of HCI.

Designed to introduce the central themes of research design approaches, *Volume 2 – Methodologies* focuses on latest practices and conceptualizations of the systematic study of HCI. The volume introduces new methodological approaches – often situated in practical case-studies – that integrate human and experiential inquiry within the study of human-computer interactions. Its objective is to identify and address methodological challenges specific to third wave HCI and to propose research approaches embedded within phenomenological, experiential, and expressive modes of investigation. We also hope that the systematization of ‘third wave’ approaches to the study of HCI can serve further as a platform that invites ideas and ‘ways of knowing’ from different epistemological domains into ongoing design practices and applications. This volume integrates diverse research methods, ideas, and perspectives with the aim to highlight and integrate relevant – but often segregated – expertise from the arts, design, social sciences, and the humanities. The application of methodological approaches specific to the particularities of third wave HCI is essential to the development of new, effective, usable *and meaningful* technologies. *Volume 2: Methodologies* covers methodological approaches grounded in autoethnography, empathy-based design, crowdsourcing, psychometrics, user engagement, speculative design, peripheral practices, somatics, embodied cognition and transdisciplinarity. In addition to facilitating inquiry into the design of new technologies, this survey of approaches aims to encourage researchers and designers of technology to critically examine the gamut of processes involved in the production of contemporary technologies.

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