Revisiting the Three HCI Waves: A Preliminary Discussion on Philosophy of Science and Research Paradigms

Conference Paper · October 2016

DOI: 10.1145/3033701.3033740

CITATIONS
3

READS
387

2 authors:

Emanuel Felipe Duarte
University of Campinas
10 PUBLICATIONS **10** CITATIONS

SEE PROFILE

M. Cecilia Calani Baranauskas
University of Campinas
281 PUBLICATIONS **1,120** CITATIONS

SEE PROFILE

Revisiting the Three HCI Waves: A Preliminary Discussion on Philosophy of Science and Research Paradigms

Emanuel Felipe Duarte
Institute of Computing
University of Campinas
emanuel.duarte@ic.unicamp.br

M. Cecília C. Baranauskas
Institute of Computing
University of Campinas
cecilia@ic.unicamp.br

ABSTRACT
Human-Computer Interaction (HCI) is dynamic and interdisciplinary. Diverse areas of knowledge contribute to form and advance the state of the art, but also bring different views about how to do research in HCI. In this paper we aim at promoting discussion and increased awareness on different kinds of research by comparing the three HCI waves with concepts of Philosophy of Science and general research paradigms. We believe this awareness can play an important role in improving the fairness of the peer review process and support researchers in positioning themselves and their investigations.

ACM Classification Keywords
H.5.0. Information Interfaces and Presentation (*e.g.*, HCI): General

Author Keywords
HCI Waves; Philosophy of Science; Research Paradigms.

INTRODUCTION
Human-Computer Interaction (HCI) can be described as a dynamic and interdisciplinary field of inquiry. The research community is composed by scientists from diverse areas of knowledge carrying significantly different backgrounds, such as Industrial Design, Engineering, Computing, Psychology, Linguistics, among others. This plurality favors the synthesis and adaptation of concepts and theories that may seem unrelated to each other in their original fields, but are stitched together to form and continuously evolve the state of the art in HCI. This diversity, however, also brings together many different views of what is (and what should be) HCI research, as well as how can HCI, as a scientific field, progress further.

According to Kuhn's [14] theory about the structure of scientific revolutions, science does not actually progress from a simple accumulation of facts, but instead by successive and overlapping reframing of ideas, a paradigm shift. A paradigm itself, quoting Filstead [9], can be defined as a "*set of interrelated assumptions about the social world which provides a philosophical and conceptual framework for the organized study of that world*". With Filstead's definition in mind, we find it important for researchers to continuously discuss different views about how to do and how to understand research in HCI. The objective, however, should not be to converge into a single universally accepted definition of "proper HCI research", but instead acknowledge and explore the existence of different waves of thought to further understand paradigms in our field, as previously done by Harrison *et al.* [10] and Bødker [4]. We believe this proper awareness can play an important role in a fairer perception of chosen methods and merits in the peer review process, and also support informed decisions on how researchers can better position themselves and their investigations.

In this paper we present a preliminary discussion on how HCI waves recognized in the literature relate to concepts of Philosophy of Science and the Positivist-Postpositivist, Constructivist-Interpretivist and Critical-Ideological research paradigms. The paper is structured as follows: we summarize the three HCI waves, then proceed to briefly discuss Philosophy of Science and research paradigms, which allows us to revisit the HCI waves according to what was discussed. Finally, we present conclusions and directions for ongoing work.

THE THREE HCI WAVES
According to Harrison *et al.* [10], the HCI community has its main roots in two distinctive research fields: first engineering, and later cognitive science. The authors proceed to describe that each of these two fields have directly contributed to their own wave of thought in HCI research. The authors, however, also reported the emergence of a third wave with different roots altogether. Similar analyses also appeared in other studies found in the literature [4, 2, 18, 5], suggesting a fair acceptance of this categorization. The three waves of thought described by the authors are as follows:

- **First-wave HCI**: stems directly from the early engineering roots of HCI. The focus is on human factors and ergonomics, favoring concrete problems and simple performance metrics (*e.g.*, to study whether a pilot can make error-free use of a new and complex airplane control system [20]). Interaction is perceived as a form of "man-machine coupling", which can be improved by solving ergonomic issues and interaction disruptions. This first wave is, in origin, pragmatic and focused on practical results more than on theoretical issues or basis [10];

IHC '16, October 04-07, 2016, São Paulo, Brazil
 ISBN 978-1-4503-5235-2/16/10 $15.00
DOI: http://dx.doi.org/10.1145/3033701.3033740

- **Second-wave HCI**: stems from the so-called cognitive science revolution. There is an increased emphasis on theory, and the focus is on what happens in the human mind in terms of information processing (*e.g.*, to study how the human mind processes information displayed by a machine and communicates back to the machine through a user interface [16]). Interaction is perceived as a metaphor of "mind and computer as coupled information processors" [10]. Bannon [1], considering the first-wave understanding about users too simplistic, proposed instead to understand people as situated actors who possess a set of skills and shared practices based on work experience. Complementing, Bødker [5] argues distributed cognition and activity theory are important theoretical sources for this second wave, and the concept of context also begin to appear into focus; and

- **Third-wave HCI**: brings forth previously under-recognized and marginalized topics such as culture and values, along with a view of the researcher role (*e.g.*, to study how to reintroduce humanities in HCI to stimulate emancipatory/social change-oriented approaches [3]). Interaction is seen as a form of creation of meaning in which both artifact and its context exert mutual influence and are subject to multiple interpretations [10]. Bødker [4] argues this third wave tries to break away from the focus on work-related and "purposeful" interaction, and interaction is characterized by new possibilities from novel technologies, such as pervasive computing, augmented reality, tangible interfaces, among others.

Although these three waves follow a chronological order, the emergence and acceptance of a newer wave does not in fact replace the existing ones. Even though there are significantly different views on how to conduct research between researchers positioned in different waves, we find it important to observe these waves seem to coexist in the same scientific community. In CHI 2016[1], for instance, there are studies which seem to be aligned with first [11, 13] (focus on ergonomics), second [6, 19] (focus on cognitive skills) and third [8, 7] (focus on feminist HCI) waves.

These discussions on waves of thought reported in the literature, among more recent ones [12], can provide useful insights, but perhaps we, as researchers, can also benefit from stepping out of the HCI domain to shed light on the subject. In the next section we seek a more underlying understanding of Philosophy of Science and research paradigms in general.

A BRIEF DISCUSSION ON PHILOSOPHY OF SCIENCE AND RESEARCH PARADIGMS

Ponterotto [17] broadly defines science as a "*systematic quest for knowledge*", and Philosophy of Science, in turn, as the "*conceptual roots undergirding the quest for knowledge*". According to the author, Philosophy of Science incorporates beliefs or assumptions regarding "philosophical anchors", such as: (1) ontology (the nature of being and reality); (2) epistemology (the study of knowledge, acquisition of knowledge, and the relationship between research participant and researcher); (3) methodology (the process and procedures of research). (4) axiology (the role and place of values in the research process); and (5) rhetorical structure (the language and presentation used to report the research).

Synthesizing the paradigmatic schema described by Ponterotto [17] and Lincoln, Lynham and Guba [15], in Table 1 we describe the Positivist-Postpositivist, Constructivist-Interpretivist and Critical-Ideological paradigms according to the five philosophical anchors mentioned in the previous paragraph. It is important to emphasize this paradigmatic schema is one among many available in literature, and it was chosen for being concise, making it adequate for the scope of this paper. A deeper analysis could be made with a more complex schema, but this superficial knowledge on Philosophy of Science and research paradigms in general already allow us to proceed and revisit the three HCI waves previously discussed.

THE THREE HCI WAVES, REVISITED

At a first glance it can be tempting to speculatively try and fit each HCI wave inside a general research paradigm. First-wave HCI seems aligned with Positivist-Postpositivist paradigm. Second and third-wave HCI are more elusive: the former seems aligned to Positivist-Postpositivist or Constructivist-Interpretivist paradigms depending upon the analyzed studies, while the latter with Critical-Ideological or Constructivist-Interpretivist paradigms, also depending upon the analyzed studies. However, these are at best poorly informed and possibly stereotyped categorizations. In the following subsections we try to construct better informed insights regarding the relationship between HCI waves and research paradigms through an analysis of the philosophical anchors described in Table 1.

First-wave HCI, Revisited

Regarding **ontology**, in human factors and ergonomics, the major defining fields of the first wave, there seems to be a notion of the existence of a true reality that may or may not be perfectly apprehended and measured: this reality can be considered the perfect fit between man and machine. With respect to **epistemology**, dualism and objectivism seem to be central points, as the researcher should exert no influence in the perceived man-machine coupling being studied. The **methodology** seems dominated by true experimental methods of inquiry (or quasi-experimental methods, when the only option available), which aim to identify and explain what seems to be universal laws of how man and machine best fit together. In terms of **axiology**, values do not seem to be considered in the research process, as they should not exert any influence on the desired man-machine coupling (even though values may in fact determine what is researched and what is not). Lastly, the **rhetoric** is expected to be objective and emotionally neutral, making use of simple performance metrics. In summary, first-wave HCI seems indeed strongly aligned with the Positivist-Postpositivist paradigm.

Second-wave HCI, Revisited

Considering **ontology**, in cognitive psychology, the major defining field of the second wave, there seems to be no consensus on whether there is a true reality that can only be apprehended and measured imperfectly, or multiple subjective realities: the study of the human mind and mental processes

[1] https://chi2016.acm.org/wp/paper-proceedings/

	Positivism-Postpositivism	Critical-Ideological	Constructivism-Interpretivism
Ontology	There is one true reality: it may or may not be perfectly apprehended, identified and measured (naïve realism *vs*. critical realism).	There is a virtual reality shaped by social, political, cultural, economic, ethnic and gender values (historical realism).	There are multiple (local and specific) constructed realities: reality is subjective and influenced by context (relativism).
Epistemology	Participant and researcher should be independent (dualism), and rigorous procedure should allow bias-free studies (objectivism), even though these may not be perfect.	Interaction between researcher and participant is central, but with the goal of inciting transformation that leads to empowerment and emancipation from oppression.	Reality is socially constructed and, therefore, the interaction between researcher and participant is central to capturing the participant's lived experience.
Methodology	True experimental methods (or quasi, when the only option available) are used to uncover and explain relationships among variables that lead to universal laws.	More naturalistic inquiries often lead to qualitative methods to provide immersion on the participant's world and gain insight on his lived experience.	More naturalistic inquiries often lead to qualitative methods to provide immersion on the participant's world and gain insight on his lived experience.
Axiology	There is no place for values in the research, the researcher should remain emotionally detached.	The researcher values are disclosed, but also hoped and expected to influence the research process and outcome.	The researcher values cannot be completely disconnected from the research process, they should be acknowledged and disclosed.
Rhetoric	Objective and emotionally neutral.	Personal and often passionate.	Often more personal.

Table 1. Research Paradigms and Philosophical Anchors (adapted from [17, 15]).

is multifaceted instead of cohesive. In regard to **epistemology**, dualism and objectivism seem to be central points: the researcher should exert no influence (or at least a negligible level of influence) in the perceived functioning of the human mind, even though it may be impossible to actually divorce both. The **methodology** seems divided by true experimental methods of inquiry (or quasi-experimental methods, when the only option available) and more naturalistic inquiries, but both aiming to identify and explain what seems to be universal laws of how mental processes such as attention, memory, problem solving and creativity operate. In terms of **axiology**, values do not seem to be considered in the research process, as they should exert no direct influence on the desired interpretation of mental processes (even though they may determine what is researched, and may also influence both process and outcome). Lastly, the **rhetoric** is expected to be objective and emotionally neutral, making use of simple performance metrics, but also being possible to make use of more subjective and qualitative observations. In summary, second-wave HCI seems to float between Positivist-Postpositivist and Constructivist-Interpretivist paradigms.

Third-wave HCI, Revisited

With regard to **ontology**, the diversity of lines of thought that form the third wave leaves no room for the understanding of a true reality that can only be apprehended and measured imperfectly. Distinctive views of multiple subjective realities or a virtual reality shaped by social, political, cultural, economic, ethnic and gender values can separately be used to investigate previously under-recognized and marginalized topics. With respect to **epistemology**, the interaction between researcher and participant seems to be central: the researcher actively exerts influence over participants when trying to gain new forms of insight on his lived experience, or even more preeminently when inciting transformations that leads to empowerment and emancipation from some kind of oppression. The **methodology** seems divided by quasi-experimental methods and more naturalistic inquiries, with both aiming not to identify and explain universal laws, but to understand different facets of reality that were previously ignored, or under-recognized and marginalized. In terms of **axiology**, values are acknowledged to be directly influential on the research process and the outcome, and may even be hoped and expected to do so. Lastly, when not objective and neutral, the **rhetoric** can be subjective and may even contain some amount of emotional and values bias. In summary, third-wave HCI seems to float between Critical-Ideological and Constructivist-Interpretivist paradigms, but sometimes also borrows (or inherits) an objective and neutral rhetoric common of the Positivist-Postpositivist paradigm.

CONCLUSIONS

To reflect upon HCI in terms of waves of thought, Philosophy of Science and research paradigms can be beneficial for the HCI community: the acknowledgement of different research paradigms, along with an explicit positioning of the researcher may, for instance, promote a fairer peer review process. This reflection, however, should become a continuous practice inside the research community. In this preliminary discussion it is remarkable how HCI waves are not simply synonyms for general research paradigms, but instead different research paradigms can underlie the same HCI wave. We believe all paradigms can be valid according to context, and their coexistence can also be beneficial to the field. However, as a community, the question we should be asking might

be whether the *status quo* and the strong notion of "proper science", commonly found in academia, has perpetuated inconsistencies among contemporary HCI work with regard to how they reflect their roots in terms of Philosophy of Science.

Ongoing Work: we are further studying how research in HCI continues to flow in terms of waves. We are also studying aspects of Philosophy of Science and research paradigms. By reflecting on these findings we seek to reach a better informed and less stereotyped understanding of research in HCI.

ACKNOWLEDGMENTS

This study was financially supported by CAPES and CNPq (Grant #308618/2014-9). We would like to thank colleagues from the InterHAD research group for helping in the maturing of ideas presented in this paper.

REFERENCES

1. L. Bannon. 1992. From Human Factors to Human Actors: The Role of Psychology and Human-computer Interaction Studies in System Design. In *Design at Work*, Joan Greenbaum and Morten Kyng (Eds.). L. Erlbaum Associates Inc., Hillsdale, NJ, USA, 25–44.
2. L. Bannon. 2011. Reimagining HCI: Toward a More Human-centered Perspective. *interactions* 18, 4 (July 2011), 50–57. DOI: http://dx.doi.org/10.1145/1978822.1978833
3. J. Bardzell and S. Bardzell. 2015. Humanistic HCI. *Synthesis Lectures on Human-Centered Informatics* 8, 4 (2015), 1–185. DOI: http://dx.doi.org/10.2200/S00664ED1V01Y201508HCI031
4. S. Bødker. 2006. When Second Wave HCI Meets Third Wave Challenges. In *Proceedings of the 4th Nordic Conference on Human-computer Interaction: Changing Roles (NordiCHI '06)*. ACM, New York, NY, USA, 1–8. DOI:http://dx.doi.org/10.1145/1182475.1182476
5. S. Bødker. 2015. Third-wave HCI, 10 Years Later—participation and Sharing. *interactions* 22, 5 (Aug. 2015), 24–31. DOI:http://dx.doi.org/10.1145/2804405
6. J. W. Bonny, L. M. Castaneda, and T. Swanson. 2016. Using an International Gaming Tournament to Study Individual Differences in MOBA Expertise and Cognitive Skills. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3473–3484. DOI: http://dx.doi.org/10.1145/2858036.2858190
7. C. D'Ignazio, A. Hope, B. Michelson, R. Churchill, and E. Zuckerman. 2016. A Feminist HCI Approach to Designing Postpartum Technologies: "When I First Saw a Breast Pump I Was Wondering if It Was a Joke". In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2612–2622. DOI: http://dx.doi.org/10.1145/2858036.2858460
8. C. Fiesler, S. Morrison, and A. S. Bruckman. 2016. An Archive of Their Own: A Case Study of Feminist HCI and Values in Design. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2574–2585. DOI: http://dx.doi.org/10.1145/2858036.2858409
9. W. J Filstead. 1979. *Qualitative and Quantitative Methods in Evaluation Research*. SAGE Publications, Inc, Beverly Hills, CA, USA, Chapter Qualitative Methods: A Needed Perspective in Evaluation Research, 33–48.
10. S. Harrison, D. Tatar, and P. Sengers. 2007. The three paradigms of HCI. In *Alt. Chi. Session at the SIGCHI Conference on Human Factors in Computing Systems*. ACM, San Jose, CA, USA, 1–18.
11. S. Jang, L. H. Kim, K. Tanner, H. Ishii, and S. Follmer. 2016. Haptic Edge Display for Mobile Tactile Interaction. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 3706–3716. DOI: http://dx.doi.org/10.1145/2858036.2858264
12. Gustavo Kira. 2016. *Trajetórias no Design de Interação de Terceira Onda: Participações, Seus Rastros, Suas Viradas*. Master's thesis. Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brazil.
13. R. Konrad, E. A. Cooper, and G. Wetzstein. 2016. Novel Optical Configurations for Virtual Reality: Evaluating User Preference and Performance with Focus-tunable and Monovision Near-eye Displays. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 1211–1220. DOI: http://dx.doi.org/10.1145/2858036.2858140
14. T. S. Kuhn. 1970. *The Structure of Scientific Revolutions*. University of Chicago Press, Chicago, IL, USA.
15. Y. S. Lincoln and E. G. Guba. 2000. *Handbook of Qualitative Research* (second ed.). SAGE Publications, Inc, Thousand Oaks, CA, USA, Chapter Paradigmatic Controversies, Contradictions, and Emerging Confluences, 163–188.
16. D. A. Norman. 2002. *The Design of Everyday Things*. Basic Books, New York, NY, USA.
17. J. G. Ponterotto. 2005. Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of counseling psychology* 52, 2 (2005), 126–136.
18. Yvonne Rogers. 2012. HCI Theory: Classical, Modern, and Contemporary. *Synthesis Lectures on Human-Centered Informatics* 5, 2 (2012), 1–129. DOI: http://dx.doi.org/10.2200/S00418ED1V01Y201205HCI014
19. J. Tiab and K. Hornbæk. 2016. Understanding Affordance, System State, and Feedback in Shape-Changing Buttons. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, New York, NY, USA, 2752–2763. DOI: http://dx.doi.org/10.1145/2858036.2858350
20. E. L. Wiener. 1989. *Human factors of advanced technology (glass cockpit) transport aircraft*. Technical Report. NASA.