Interaction Research and Design across Times in HCI

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ABSTRACT

Human-Computer Interaction as a discipline has witnessed a steady growth over the last decades and experienced an evolution of different foci of interaction research and interaction design. Interaction research in HCI has been studying the interaction between users and computers to derive user requirements and needs, developing systems, and evaluating the interaction between users and computers with new concepts and systems. Interaction design in HCI has—in a desigernly way—crafted and demonstrated concepts and systems. Insightful works have analysed and charted those evolutions separately. This paper brings interaction research and interaction design together and characterises their evolution across times in a systematic manner based on standardised criteria.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods.

KEYWORDS

Interaction Research, Interaction Design, HCI Discipline

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1 INTRODUCTION

Human-Computer Interaction (HCI) is an interdisciplinary field where actors with diverse backgrounds research the interaction between users and computers to understand the requirements and needs of users before concepts and systems are built, design and develop concepts and systems, and evaluate the interaction between users and computers. In other words: 'human-computer interaction (HCI) is the study of the interaction between people (user) and computers' [46, p. 45]; and it is situated at the 'intersection between the social and behavioural sciences on the one hand, and computer and information technology on the other. It is concerned with understanding how people use devices and systems that incorporate or embed computation, and how such devices and systems can be more useful and usable.' [7, p. 1]. The decades since its emergence have witnessed tremendous growth in academia and industry, as well as an evolution of topics in HCI. Several authors have presented insightful discussions of this evolution and identified trends in foci, and topics, and waves of how users are seen, how interaction is defined, and how technology has evolved [2, 5, 18, 21, 22, 28, 29]. Thereby, the analyses looked more at interaction research than interaction design.

Interaction research in HCI, as the above quote regarding the intersection demonstrates, primarily focuses on the empirical and the technical side of HCI, with the empirical side playing a central role [40]. The empirical research performs investigations and experiments towards a better understanding of users and their interaction with computers.

Interaction design is a 'process that is arranged within existing resource constraints to create, shape, and decide all use-oriented qualities (structural, functional, ethical, and aesthetic) of a digital artefact' [38, p. 5]. Interaction design borrows from many disciplines, mainly various design disciplines, and has a solid connection to HCI.

Many discussions contribute to a better understanding of interaction research and interaction design [6, 8, 36, 37]. While those discussions help to understand interaction research and interaction design *per se*, an analysis of interaction research and interaction design across times and through the different foci in HCI is missing.

This paper's contribution is the analysis and characterisation of interaction research and interaction design across times and trends in foci in HCI. It aims to evoke a more holistic view of interaction research and interaction design. The paper will introduce the different foci in HCI and discuss interaction research and interaction design in each of them. It will also look into user experience as another important more recent focus.

2 RELATED WORK

This papers benefits from insightful previous work on interaction research and interaction design and different foci in HCI across times.

2.1 Interaction Research and Interaction Design

Three types of research have been identified in HCI, which apply well to interaction research: (1) research as simple search; (2) research as gathering specific information; (3) and research as 'investigation or experimentation aimed at the discovery and interpretation of facts and revision of accepted theories or laws in light of new facts' whereby 'conducting experiments is a central activity in a lot of HCI research' [40, p. 122]. In HCI, a theory often refers to some hypothesis or assumptions formulated before conducting an empirical study. Laws predict individual phenomena or relationships between phenomena; they are scarce in HCI. When HCI research is seen as *problem-solving*, two more types of research can be identified: empirical research that studies the interaction of users with technology, but also conceptual research that explains this interaction and phenomena involved, and constructive research that aims to understand the building of interactive systems [43].

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Interaction design can be seen as a process, but this is not as clearly defined and strictly carried through as a process in research or engineering. Instead, it leaves much freedom to the designer interacting with the stakeholders involved in the design. Design is oriented towards the future, aiming to develop new ideas and concepts that ultimately materialise in models, prototypes, and systems. Authors use different terms to describe the results of the interaction design: some talk about digital artefacts, some talk about systems or interactive systems, and some talk about applications [38]. This paper uses diverse terms, but always has interaction between the user and the system in mind in the sense that one communicates with the other, influencing the other and likely receiving something back.

Comparing interaction research to interaction design, we see that research is typically incremental and aims at small but thorough contributions and additions to the existing body of knowledge [40]. Design, at least from an ideal perspective, aims at radical innovations and significant changes.

2.2 HCI Across Times

Various foci have been identified in insightful publications that offer different perspective on the evolution of the field [2, 5, 18, 21, 22, 28, 29]. Some works go back quite early and identify different *levels of interfaces,* such as the interface as hardware in the 1950s, the interface as software in the 1960s and 1970s, the interface as terminal in the 1970s–1990s, the interface as dialogue starting in the 1980s, and the interface as work setting starting in the 1990s [28]. Many authors characterise the evolution of HCI since the 1980s as starting with human factors and a strong focus on single users and single-user scenarios and applications and cognitive science, continuing with computer-supported cooperative work and a new focus on users interacting with each other via computer technology and behavioural and social sciences and distributed cognition, moving on to ubiquitous computing and inclusion of the users' environment and their interaction in and with the environment and the diverse hardware and software it contains [2, 5, 21, 22, 29]. More recently, some authors have examined the changing relationship between users, their tools, and their environment. For instance, entanglement with digital technology has been identified [18], but other theories have also been identified to characterise more recent interaction and coupling between users and their tools [53].

3 INTERACTION RESEARCH AND INTERACTION DESIGN ACROSS TIMES

This section characterises the evolution of foci on interaction research and interaction design on the dimensions dominant hardware and software, primary perspective on users, and on interaction as well as its interaction research, interaction design, and predominant paradigm.

3.1 Classical HCI

In the early days of HCI, great inventions in *software and hardware* have fascinated people in the field and beyond. Already in the beginning of the 1960s, Ivan Sutherland had developed and presented SketchPad—a graphic application that allowed users to develop their graphics with the software interactively. Sutherland characterised the move to interactive systems with the metaphor of moving from writing letters to communicating with computers [26, 51]. At the end of the 1960s, Douglas Engelbart presented his NLS system, which featured not only excellent text processing functionality but also the classical computer mouse, which was invented as part of the NLS system and has been in use until today [15].

Users were also in focus, but primarily as human factors with their perceptual and cognitive factors [29]. User modelling and modelling of tasks played an important role [28]. Early visionaries—particularly Brian Shackel—had already addressed users' needs and ergonomics in the 1950s [48].

At the same time, interactive systems—and with them a focus on *interaction*—emerged that were based on a metaphor of windows, icons, menus, and pointing devices (WIMP). Users could use their keyboard and mouse to interact with the system and to get immediate results on their computer screens [52].

The *interaction research* at that time focused on human factors and ergonomics to find an ideal fit between the users and their perceptual-cognitive capabilities and the computers with their hardware and software capabilities. The so-called *interface ergonomics* included both the hardware and the software interface. The goal was to optimise hardware and software controls, dials and metres, etc. [46]. Usability engineering became prominent with clear procedures and methods on how to measure the effectiveness and efficiency of the interaction and satisfaction of users. Those methods included usability testing, as well as observations, questionnaires, interviews, and focus groups and were, in general, applied in usability laboratories rather than in the field [42].

The *interaction design* at that time also intensely focused on ergonomics and often included anthropometrics to understand better the measures of human uses and to adapt the devices to the human body [11]. Since many of the systems, in both hardware and software, were in practice still quite error-prone, there was a strong methodological focus on learning from errors and deriving principles to avoid errors in new designs [31, 55]. In some cases, researchers and designers seemed to have a hierarchical relationship. For instance, Gould and Lewis presented three principles (i.e., early focus on users and tasks, empirical measurement, and iterative design). They reported on a study in which they had the implicit assumption that all designers should apply their principles, but many designers did not apply them [20].

Overall, *usability* was the dominant paradigm of the time. Usability defined the extent to which a user can reach the goal with an existing system in an existing environment. More precisely, usability measures effectiveness in the sense of how well the user reaches the goal, efficiency in the sense of the user's effort to reach the goal, and satisfaction in the sense of a positive overall impression and a lack of discomfort during this interaction with the system [35].

3.2 Computer-Supported Cooperative Work: Beyond the Individual User

Computer-Supported Cooperative Work (CSCW) leverages on *hardware* with networked personal computers and workstations as the backbone for cooperative applications. Those cooperative systems or groupware systems allow users to cooperate across time and

space. Groupware systems are 'computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment.' [13, p. 40]. Cooperative systems support either asynchronous cooperation, where the users work together at different times, or synchronous cooperation, where the users work simultaneously. Synchronous cooperative systems can be developed from scratch as so-called collaboration-aware systems. Alternatively, they can be developed as so-called collaboration-transparent systems, where specific software layers are used to share and distribute single-user applications between networked computers [12].

Cooperative systems primarily aim to support small groups of *users* who cooperate intensely with each other, typically ranging from three to 15 persons (e.g., cooperatively editing a document in real-time). Systems specifically supporting dyads—that is, two persons—are an exception. Groups with more than 15 members are also supported, but primarily feature loose cooperation and turn-taking where only one or few persons are active, and the others are passively following (e.g., an online lecture where mostly only the teacher is presenting, or some individual members of the audience ask a question) [24].

The cooperative *interaction* that takes place in the groups ranges from (1) pure coexistence, where the members are present in the system at the same time, do not directly interact with each other, but are aware of each other's presence (e.g., in lists that show online users and their online status), to (2) communication, where the members of a group exchange messages with each other, to (3) coordination, where the members of a group orchestrate their individual activities and manage mutual dependencies in their tasks, to (4) consensus, where the members of a group exchange positions and arguments and try to find solutions that all members accept, and finally to (5) collaboration, which, in the context of CSCW refers to close and tight cooperation typically performed at the same time and with intense exchange with each other [23, 24].

Interaction research in CSCW focuses on a better understanding of social actors and their social interaction in the context where it occurs. Ethnography has been a very prominent method in CSCW for social investigation. The researcher goes into the field and stays there for an extended period to get a first-hand experience of the situation, the actors in this situation, and the social interactions taking place. Classical ethnographic studies in CSCW were the study of the actors in the control room of the Bakerloo Line of the London Underground [33, 34] and the study of the social interaction in radar suites of the London Air Traffic Control Centre [4, 32]. For those studies, in Europe, several prominent researchers in CSCW have established and practised a particular approach, which they refer to as ethnomethodologically informed ethnography. This approach warrants 'probativeness' or 'faithfulness to the phenomena' with a 'renewed and unprejudiced (and difficult) look at the phenomena that have frequently become obscured beneath layers of theoretical abstraction and speculation.' [44, p. 209].

Interaction design in CSCW has also leveraged ethnography with some rather specific flavours, such as concurrent ethnography (where the design process starts while an ethnographic study is still running); and quick and dirty ethnography (where a quick and lightweight ethnographic study is performed and its results are used as design input) [44]. Since the design of cooperative systems typically affects not only single users but the social interaction of many actors, it is essential to involve users throughout the design process. For this reason, participatory design is very prominent in its interaction design. Participatory design has been defined as 'working directly with users (and other stakeholders) in the design of social systems, including computer systems that are part of human work.' Methods used during a participatory design process range from developing early mock-ups with users to prototyping together. Some authors have characterised the design process of cooperative systems in which many stakeholders are involved as one where, at times, designers will need to listen to all stakeholders, but ultimately, in order to get some of their own ideas into production, will need to seduce the stakeholders since the designers here have no formal authority [1]. Another central design aspect is the modelling of all dimensions of the cooperative system to be built (e.g., the users' tasks, the overall organisation) [27]. Overall, cooperative systems are very heterogeneous, ranging from communication systems such as email applications and audio and video conferencing systems to collaboration tools such as shared editors. Therefore, the design approach needs to be adapted specifically to the respective scenario and cooperative system that is to be designed [3].

A fundamental paradigm of CSCW—across scenarios and cooperative systems—was situated action. The term *situated action* was coined by Lucy Suchman as an outcome of her ethnographic studies in which she found that in practice, the acting persons and team members often needed to adapt to changing circumstances in their environment and in their shared cooperative endeavour. Despite the value of planning and having scripts that represent sequences of action, it would be risky to assume that reality always functions according to plan [50]. As the ethnographers above, Suchman was also influenced by ethnomethodology, especially Garfinkel [19]. In that tradition, she wanted to understand how social interaction is possible in the world and, to some extent, shapes the world, as opposed to developing abstract theories.

3.3 Ubiquitous Computing: Beyond the Computer and the Desktop

Ubiquitous Computing (UbiComp) started in the Xerox PARC laboratory under the guidance of Mark Weiser at the beginning of the 1990s. UbiComp means that computing technology is available to users anywhere and anytime and in very diverse forms of *hardware and software*. Mark Weiser described ubiquitous computing and its goal as follows [56, p. 75]:

> The goal is to achieve the most effective kind of technology, that which is essentially invisible to the user. [. . .] To bring computers to this point while retaining their power will require radically new kinds of computers of all sizes and shapes to be available to each person. I call this future world "Ubiquitous Computing" (UbiComp).

UbiComp was a great vision and a success in developing radically new hardware and software. Several of them are the precursors of many of today's consumer electronics, and therefore worth mentioning here. For instance, the Xerox PARCTab was a palm-sized handheld mobile device that could be used with a pen or buttons.

It featured applications for communication (e.g., email) and for collaboration (e.g., shared drawings or text). It could also be a remote control for other appliances [54]. The Xerox Pads were foot-sized devices that looked similar to today's tablets and could be used with a pen. The applications were similar to those of the palm-sized devices, except that their use was more convenient due to the larger screen [56]. The Liveboard was a yard-sized device similar to today's smartboards. It could be used either with a keyboard and a mouse, or with special pens.

The motivation behind UbiComp was to support *users* in diverse usage situations. For instance, the PARCTab could be used in different modes depending on the user's capabilities and situation. A two-handed person with both hands available for interaction with the device could hold the device in one hand and the pen in the other. A one-handed person could hold the device in one hand and interact with it with the three buttons on one side of the device since the device nicely fits into one hand of an adult person. Depending on the person's handedness, the screen could be rotated by 180 degrees so the device could be held, and the buttons could be pressed either with the left hand or with the right hand.

The UbiComp environment featured smooth and seamless *interaction* between users and the different devices and among the devices. For instance, the palm-sized devices could be used for voting, and the results of all participants' votes were then shared on the Liveboard. The Liveboard featured a *walk-up* interaction—that is, it aimed to allow users who come near the board and immediate interaction without much effort for starting up and configuration, etc.

A lot of *interaction research* was aimed at informing the development of the concept and prototypes of the UbiComp environment. The whole technology of hardware and software were masterpieces of research and engineering. Overall, interaction research in UbiComp there was often a strong integration of methods from research and engineering towards developing and integrating new materials and processes. The processes of the development of the hardware and software was iterative. For instance, the pads were developed in three different generations and featured a specifically developed operating system. Overall, the interaction research approach had many facets. Indeed, the hardware and software had been designed and developed with a strong focus on users and user needs. Equally important, though, the whole UbiComp environment was a great demonstration of what is possible using bleeding-edge hardware and software and pushing this base technology to its limits and beyond.

The *interaction design* of the UbiComp environment was visionary and thoughtful. A central vision was the notion of *Calm Technology,* which was presented by Weiser and Brown as follows [58, p. 79]:

> The most potentially interesting, challenging, profound change implied by ubiquitous computing era is a focus on calm. [. . .] Calmness is a new challenge that UC brings to computing. [. . .] But when computers are all around, so that we want to compute while doing something else and have more time to be more fully human, we must radically rethink goals, context and technology of computer and all the other technology crowding into our lives. Calmness is a fundamental challenge for all technological design of next fifty years.

Indeed, up until today, we are surrounded by technology (e.g., laptops, tablets, smartphones, smartwatches) that is not calm and sometimes notifies us adequately, but sometimes also disrupts us in inappropriate moments. Despite the tremendous technological advancements in each device developed at PARC at that time, the interaction design brought it together smoothly, which is fascinating to this day. John Seely Brown, who was the Director of PARC at that time, wrote in the epilogue of a publication by Weiser, Gold and himself about Mark Weiser, who passed away only a few weeks before that article was published [59, p. 695]:

> Mark Weiser . . . leaves behind many great legacies, ubiquitous computing being the one most known to the world. As this brief essay describes, his vision of ubiquitous computing transcends the issues raised by technology and searches for ways to redefine how we relate to each other, particularly in situations where computing and its various interfaces become transparent to our actions. Creating transparent computing is as much a study in phenomenology as it is of user and community interface design. For Mark, sharp boundaries between the social and the technical, between the artistic and the scientific, and between work and play never existed. He sought to create a technological world that honoured the human and social spirit. We will all miss his constant drive to challenge current conceptions of computer science, human-computer interaction, and today's computer-mediated workscapes.

The *phenomenology* mentioned by Brown is a very central, critical, and foundational notion and methodological approach for UbiComp. Phenomenology tries to understand how human beings are in the world—what Husserls calls the *Lebenswelt* or life-world—and perceive and experience the world. Thereby, consciousness and previous experiences play an essential role. They allow us to perceive the objects that we are seeing in our environment and the reflection on this perception [39]. Heidegger studied under Husserl and developed his own *hermeneutic phenomenology,* in which he reflected on our being in a world that has been there before us, how we interact in this world, and how we use tools in this world. Heidegger offers an excellent analysis and distinction of the status of tools and the type of interaction with tools. Tools can be ready-at-hand, *zuhanden*, or present-at-hand, *vorhanden* [10]. In the first mode, the tools are working, and the users typically know the tools very well and fluently interact with them and hardly need to focus on them (e.g., when we ride a bicycle, we do not want to focus on the bicycle, but rather on the traffic around us). In the second mode, when the tools are present-at-hand, the users are focusing on the tools. This might be the case when a tool needs to be configured or a tool has broken down (e.g., when we change gears on a bicycle or need to repair a tyre of the bicycle). Those modes play an important role, even in today's technology. For instance, it makes a massive difference if we are programming our smart environment or simply using our smart environment.

3.4 User Experience: Beyond Pure Productivity

The trend towards user experience and a focus on user experience design has drastically increased. From the *hardware and software* perspective, users are 'facing new, multiple, experience-oriented technologies across life and work' [5, p. 26]. Today, we talk more of computing than of computers. A prominent example that underlines this trend is that several years ago, the company formerly known as *Apple Computers Inc.* decided to remove *Computers* from their official company name. Computers are still around in the form of desktop computers or laptops, but in many countries and sectors, more digital devices have been bought than computers. The sales figures of Apple, for instance, show for the financial year 2023 that the lion's share of sales was on the iPhone (52% of total sales), followed by services (22%) and the group of wearables, home, and accessories (10%), whereas the figures for Macs (8%) and iPads (3%) were considerably lower [17]. An anonymous reviewer of this paper corroborated this finding and provided a valuable comment that Apple discarded much of its usability research and seems to replace usability research with surface design.

User experience targets a very broad audience. *Users* can refer to children as young as two or three years old using their Tonies to play their favourite music or fairy tales simply by putting some figures on their Toniebox. Users can also mean teenagers who play online games on their smartphones. Elderly users benefit from Internet connections with others for socialising.

For those reasons, the *interaction* should be easy, intuitive, and fun. The user experience in the interaction refers to [49, p. 13]:

> how people feel about a product and their pleasure and satisfaction when using it, looking at it, holding it, and opening or closing it. It includes their overall impression of how good it is to use, right down to the sensual effect small details have on them, such as how smoothly a switch rotates or the sound of a click and the touch of a button when pressing it.

Interaction research on user experience has produced remarkable insights methods into a better understanding of user experience and how to design for it. The interaction-centred framework of experience characterises the interaction of a user with a system as well as the potentially evoked experiences. The interactions of a user with the system can be fluent where the user easily and smoothly interacts with the system and does not focus on the system. It can be cognitive in cases where the user needs to focus on the system because it is not performing as expected. Finally, it can be expressive in the sense that the user makes changes to the system. The resulting experiences also have three different types. Experience refers to the constant stream of impressions that the users have of their tools, their interaction with the tools, and their environment. *An* experience is a typically short period that makes an impression on the user, stays in the memory, and is likely to be told to others. Co-experiences are moments that are shared with others and that leave an impression [16].

User experience design is *interaction design* for user experience rather than experience—that is, designers can create stimuli that eventually lead to the intended experience on the users' side [49]. Some propositions have been suggested for successful interaction design of user experience. For instance, the relationship and interaction between users and technology should be seen from the perspective of the experience and felt emotional quality. The pragmatist approach towards experience helps to understand and conceptualise the users' actions and meaning making of their technology and environment. Pragmatism helps us understand aesthetics' vital role in the everyday experience of interaction with technology [41].

Pragmatism is a philosophical school of thought, which has—like many philosophical traditions—several actors with their perspectives that emphasise different aspects and, to some extent, use different terminology. As far as user experience is concerned, John Dewey's position towards pragmatism is prominent. In this form of pragmatism, the relationship between an individual and an object is at the centre of the analysis. The point of departure here is the personal experience of the individual. This experience is not only intellectual but also sensory and emotional and emerges during the interaction of the individual with the objects in the environment. The experience here is something special, something to be remembered, rather than experience as a continual flow of perception of the world. Some languages, such as German, denote those two phenomena in specific terms. The German word *Erlebnis* refers to an experience, and the German word de *Erfahrung* refers to the ongoing stream of perceptions [36].

4 SUMMARY

Table 1 summarises the four foci, with their hardware and software, users, interaction, interaction research, and interaction design, and paradigm.

5 CONCLUSIONS

Human-computer interaction as a discipline has seen various trends of foci over the last decades. As pointed out in this paper, those foci have been identified in different threads of related work before. This paper contributes a systematic analysis and compilation of four central foci based on the criteria of hardware and software, perspective on users and interaction, and, most importantly, interaction research and interaction design, and the central paradigm.

The four foci have been put into subsections and might appear distinct. However, in reality, the boundaries of those trends are not always clear-cut. Instead, trends might evolve fluently into other trends and remain and exist in parallel. In addition, it is important to note that newer trends are not necessarily better; instead, they represent different foci over time.

This paper has some limitations. It—with the space restrictions given—needed to simplify and could not discuss regional differences between continents (e.g., between Europe and the US [29]) neither between individual countries (e.g., typically Scandinavian approaches [9, 29]).

Also, recently generative AI tools are on the rise and influence many areas of our professional and private lives. The use of tools to support creativity in interaction design in human-computer interaction and beyond has become a prominent topic and would fill a paper on its own [45]. Generative AI has recently also been used for interaction research; for instance, for generating synthetic research data [30]).

Table 1: Four foci with hardware and software, users, interaction, interaction research, interaction design, and paradigms.

	Classical HCI	Computer-Supported Cooperative Work	Ubiquitous Computing	User Experience
Hardware and Software	Mainframes and PCs; NLS with Mouse [15]; SketchPad [51]	Networked PCs and workstations; groupware systems [13]	Hardware in diverse sizes and shapes with connected software [56]	Diverse forms of computing, from computers to consumer electronics [5]
Users	Mostly professional users, single-users and cognitive science [29]	Small groups and behavioural and social science, distributed cognition [24]	Users with diverse needs in diverse usage situations [14]	Broad audience of different ages and backgrounds
Interaction	Transition from batch processing to interactive systems [52]	Cooperative interaction [23]	Smooth and seamless interaction among users, devices, and between them [57]	Hardware and software and interaction with it as part of the overall impression [49]
Interaction Research	Focus on human factors; fit between users and systems; methods such as usability engineering, lab studies [42]	Focus on social interaction and social actors [33, 34]; methods such as field studies with ethnomethodologically-informed ethnography [44]	Focus on making and using; technology-push with methods of hardware research and engineering [54]	Focus on understanding experience through fluent, cognitive, expressive interaction [16]; with methods for sampling experiences [25]
Interaction Design	Focus on ergonomics and anthropometrics; design principles and methods [31, 55]	Focus on stakeholders and their needs; methods such as participatory design and prototyping with stakeholders [44]	Focus on calm technology as a central interaction concept; methods for integrating technology into the users' environment [58] and allowing users to configure their environments [47]	Focus on design for experience, including felt emotional quality; with methods for compositional, sensual, emotional, and spatio-temporal experience [41]
Central paradigm	Usability [35]	Situated action [50]	Phenomenology [59]	Pragmatism [41]

Finally, it is essential to note that the evolution of trends is continuing. Recently, important impulses have come from interaction research, and even more so from interaction design. They have great potential to influence the future evolution of HCI, and might even trigger some new trends in the future. When we look at interaction design as an open-ended endeavour that addresses weakly defined situations [38]—as opposed to problem-solving of typically clearly and narrowly defined problems—then issues such as values and ideals, as well as society, politics, and nature, need to be taken into consideration [36].

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