Mutual Configuration: Exploring the Dynamic Interplay of Human-Computer Interaction as a Socio-Technical System

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Abstract

Computers and humans are composed of different material (biology vs. hardware and software) but share many similarities at higher levels of abstraction. For example, thought and behavior can be simulated by computational processes. Alan Turing's Universal Computer first proposed in 1936 was designed based on insights of how a human computer went about computing, by reading, writing, remembering, and following rules. The underlying computer-user framework was influenced by mathematicians and engineers. In this workshop position paper, we focus on the use and historical development of the concept of "end user" and the evolution of two seminal computer-user frameworks, the Universal Computer and the framework proposed by Lucy Suchman 50 years later to analyse human-computer communication. Our analyses highlight at a high level the reciprocal nature of computer use over time, and we argue: on the one hand, machines are becoming more like people and on the other, people are coming to define themselves more as virtual machines. We highlight similarities and differences of the two frameworks and suggest some implications for end-user development and human communication. Our argument is twofold. First, the computer should primarily be a tool for human use, and not the other way around. Second, we must develop a conceptual framework for human-computer communication that considers how data from domain-expert computers users may in the long run lead to end-user conformity, thus approximating the behaviour of machines.

Keywords

end-user, computer user model, HCI evolution, mutual configuration, socio-technical system

1. Introduction: Sociotechnical systems and artificial intelligence

We explore the concept of mutual configuration in human-computer interaction (HCI) in this paper, focusing on how computers and humans shape each other over time. This reciprocal relationship is becoming increasingly complex as AI systems become more sophisticated. The conceptualization of the duality of humans and computers goes back to the notion of socio-technical system (STS) systems. The STS concept in the context of information systems (Trist, 1981) has been an influential source for describing, analyzing, and thinking about the relationships between systems and people. Scandinavian

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researchers were early adopters of STS thinking outside of UK, applying socio-technical perspectives in the first Scandinavian participatory design (PD) projects. Kristen Nygaard provided a conceptual foundation for PD with the notion of multiple perspectives (Nygaard & Sørgaard, 1985). In the PD community, this led to the concept of mutual learning (Bratteteig, 1997), which means that system developers must learn from the end users their professional language and end users must learn from systems developers their (informatics) language to be able to articulate their needs into requirements specifications.

A socio-technical system represents a shared perspective where social and technical elements are intertwined in a reciprocal manner. On the one hand, the work activities are conditioned and shaped by technical possibilities and constraints, and, on the other hand, the technical system is shaped by human activities, user abilities, and team goals. This reciprocal process engages users at multiple levels of participation in a complex system that may potentially consist of more than two perspectives . Woolgar (1990) and others in the social sciences used the term "configuring the user." This phrase illustrates that the computer "talks back" to us what we intend it to do. In a similar manner researchers in workplace learning used the term "co-configuration" (e.g., Engeström 2004). The term was originally developed by scholars in management science to mean an emerging type of work that generates new forms for learning. Characteristic for co-configuration is that it consists of "customer-intelligent" products and service combinations, supporting continuous mutual exchange between customers and developers over a long time (Victor & Boynton, 1998). In an educational setting with artificial intelligence (AI) based writing aids, some researchers have begun observing a somewhat disturbing phenomenon, namely that these systems do not sufficiently encourage students to pursue novelty and instead lead to conformity (Kukich, 2000). With the latest AI tools, tools based on large language models (LLMs) and generative AI, mutual configuration has reached a new level. On the one hand, users can configure these systems by pre-prompting, data training and algorithm tuning. On the other hand, as humans interact and engage with AI systems, the algorithms and models powering these technologies constantly learn from our actions, thereby adjusting their capabilities to better suit our needs in future versions of the AI models. This constant interplay between human input, AI-driven responses, and adjustment fosters a reciprocal shaping that drives mutual configuration to new and unforeseen possibilities, some that will be good, and others that we should avoid.

To approach the phenomenon in a preconceptual manner, i.e., enabling us in the next round to formulate research questions and hypotheses, we use the term *mutual configuration.* Mutual configuration means the mutual shaping of humans and computers during computer use. In this position paper we address the question in what ways the concept of end-user has developed over time in terms of mutual configuration connected with two seminal computer-user frameworks.

In parallel to the development of the end-user concept, there has been a steady stream of literature about what the computer can possibly do, and not do (Dreyfus, 1992). By using language, thinking and naming the computer as a partner in various human activities, the end user is configured in relation to this.

2. Human-computer communication frameworks

We use two seminal computer user frameworks to guide our discussion. The Universal Computer/Turing Machine, which conceptualized the computer as a human performing calculations, and Suchman's framework, which conceptualizes the situated nature of human computer interaction and the importance of social factors, involving two or more humans interacting within their environment, which includes but not exclusively computers. Turing had the human operator in mind when he suggested the Universal Computer by modelling the computing machine on a person doing arithmetic operations with pen and paper (Turing, 1936; 1950). Suchman criticized the later and refined human information processing model of the computer (Suchman, 1987). Today's AI systems are even more versatile and have extended their reach to everyone, not just mathematicians, engineers, computer scientists, and photocopiers. Therefore, developers aim to create a new and tighter relationship between humans and computers, which requires some serious discussions in terms of long-term effects. We provide some steppingstones toward that end.

2.1. Turing's framework of the Universal Computer

A computer in the 1930s was the name of a human being doing computation such as a loan officer or bank teller calculating interests in a bank. Turing used this framework of a "human computer" to describe how a professional specialist operated to propose a new method of automated calculation, which later became the basic principles behind the Universal Computer, later named Turing Machine (Turing, 1936). Human computers (e.g. bank tellers) wrote, read and used exact "programs" or calculating procedures for performing handheld computation with pencils, papers, and knowledge of basic arithmetic. When for example computing 255.15 with 34.12, Turing observed that the human computer read the numbers one by one, wrote numbers back on the paper and performed operations both horizontally and vertically. Turing discovered that it was possible to describe the process by using a horizontal strip (a tape) with numbers (and more generally symbols) upon which the program could read and write the numbers as an automated typewriter. Turing's framework had an unlimited amount of tape and the means of going back and forth along the tape to fetch symbols. The physical version of his framework required a finite tape.

Turing's Universal Computer is relevant to set the stage for discussing the question on the use and historical development of the concept of end user. The Turing machine modelled the image of the human user doing computing, or said in Turing's own words, *"We may compare a man in the process of computing a real number to a machine which…"* (Turing, 1936, p. 231). The comparison of a human doing calculations with a machine is rather direct, in the same way a human reads and writes, the computer reads and writes. Furthermore, Turing takes the comparison to a higher level when he says that the human is *"in a state of mind"* while doing the calculation, which is also the way he describes the process of computer calculations (Turing, 1936), pointing forward to the 1950 paper where he asks, *"can machines think?"* (Turing, 1950. p. 433). On that basis we can claim that human-computer communication with a Turing machine is a process of mutual configuration of human and computer at a very low level of input-output exchange where the end user is a domain expert (bank teller, logician, or mathematician). The concept of the end user that emerged with Turing's seminal work is a person doing calculations like a human operator. With today's retrospective eyes, these tasks have gradually been replaced by computers.

The Turing machine can simulate the logic of any computational process and is a versatile platform for human-computer configuration. However, even the smallest thing to create with a Turing machine would take a very long time, referred to as the Turing tar pit (Perlis, 1982), which contrasts systems that one can modify with fewer options, such as specialized tools like a coffee cup or a wristwatch. However, some systems that are easy to modify may not allow for much variation, referred to as over-specialized systems (Hutchins, Hollan & Norman, 1985; Fischer & Lemke, 1988). This capacity for boundless flexibility in terms of configurability sets the Universal Turing machine apart from specialized systems for domain-expert users (Costabile et al., 2003). However, complexity of operating a Turing machine leads to a problem of balancing between algorithmic computability, domain-specific tasks, and physical machines.

By adopting the perspective that not only computer systems and algorithms evolve but also domain-specific tasks and human-computer interaction (Grudin, 2017), we can begin to ask questions such as, are the machine becoming more like a partner, straw man (e.g. Big Tech companies), an information processor, a learner in training, a consumer, a client, someone who is entertained – or all of this? By calling the computer a "learning partner," for example, the end-user will be seen as a learner, or novice in the relation to an expert. This brings us into the second seminal framework of the computer user, Lucy Suchman's ethnographically inspired framework s(Suchman, 1987).

2.2. Suchman's framework of computer-human interaction

Lucy Suchman created a framework to describe and analyze human-computer communication. The framework has been influential in the HCI community, partly as a critique of a cognitive approach to HCI and partly by providing a social foundation for HCI research, adopting ethnographic, ethnomethodological, and critical approaches to HCI and AI research (e.g., Bratteteig, 1997; Star & Strauss, 1999). This framework was used empirically to describe and analyze office workers using a photocopy machine. The core message of Suchman's research is that instead of following predefined plans to guide action, actional guidance emerges in situated action, or in her own words, "That term [Situated Actions] underscores the view that every course of action depends in essential ways on its material and social circumstances." (Suchman, 1987, p. 70). The framework makes explicit and visible different types of signals, data, and information pertaining to the situated use of machines based on a theoretical framework obtained from from pragmatist philosophy, social psychology, and ethnomethodology (Dittrich, 2023). Thus, the concept of the end user that emerges from Suchman's research is the interactions among two or more conversational partners, where the computer is one of them.

The conceptual framework Suchman constructed is meant for application in empirical research. It is a protocol for observation and analysis described in a transcription table with four columns, two related to the user and two to the machine. The table is shown in Figure 1. Suchman used the protocol for analyzing human-computer communication. The four columns are what is not (1) and is (2) available to the machine, what the machine shows to users (3), and the design rationale for the respective step (4). The format extended the analysis format used in ethnomethodology adapted to human-computer interaction and inspired the interaction analysis method developed (Jordan & Henderson, 1995). A key finding is that many of the actions (including verbal interactions) issued by humans are not available to the machine, implying these actions are situated (material or social) contrary to prevalent cognitive models of HCI, which were narrowly focused because the machine is *"...tracking the user's actions through a very small keyhole"* (Suchman, 2007, p. 11).

THE USER		THE MACHINE	
I	II	III	IV
Actions not available to the machine	Actions available to the machine	Effects available to the user	Rationale

Figure 1: Suchman's (1987) framework of interactions with a an advanced (AI-based) photocopy machine in terms of user actions and effects (output) of the machine. Rationale refers to designers' assumptions regarding intentions and consequences of user actions.

Suchman wanted to capture the shared understanding that emerges in the conversation between humans and the expert support system (i.e., embedded in the photocopier). By shared understanding it means the transitory intermediate products (understandings) developed in a conversation, which is more than the sum of what any one of the actors contribute and know on their own. Some form of shared understanding is at play when two or more actors communicate, but what about when a human interacts with a computer? The idea that the computer understands or creates an effect that is like or at least comparable with human understanding was new at the time. The title of the 2nd version of her book (Suchman, 2007) foregrounds a future where it makes sense to distinguish whether machines are becoming more like people, or whether people are defining themselves more as machines.

3. Conversational machines and artificial humans in future frameworks

AI systems have been on the research agenda since the 1950s. However, as Hobbes (1946) wrote – both corporations and governments may be viewed as Artificially Intelligent machines or entities, and things that are made by corporations are owned by somebody. Applying Hobbes's social contract theory to modern AI systems and Big Tech companies presents an interesting perspective. Users surrender their data (a form of individual freedom) to Big Tech companies in exchange for the advantages these technologies offer: access, convenience, personalization, connectivity, some power, and more. These companies, in turn, gain an enormous amount of power, knowledge, and control from possessing and processing this data, much like Hobbes's Leviathan.

Before the computer, and the telephone, we used many kinds of tools to support our activities. We listened, talked, discussed, thought, and analyzed. Most of these mediated activities arouse feelings of joy, excitement, sadness, and wonder. However, we also see today that computers are becoming more like partners rather than merely tools (Grudin, 2017). As we progress further into areas of complex human-computer interaction mediated by AI, conversational user interfaces (CUIs) and digital personas, require that the traditional concept of the "end user" demands re-evaluation. Are we now in a time where the border between computer and human gradually blurs, and to talk about the computer configuring the user starts to make sense, instead of or in addition to the more common notion of the user configuring the computer. CUIs, with advancements in natural language processing, allow machines to interpret and respond to human communication beyond simple commands, understanding nuances of context and emotion. Meanwhile, digital personas present an image of autonomy, which will attract human users by giving them means of exploring alternative identities, suggesting an interaction more akin to communication between two (artificial) humans rather than between a human and a tool.

These advancements signify a shift in the dynamic balance of control between end users and computers, from the human to the computer, a drift that we believe should be the cause of some concern. Now, it becomes imperative to revisit multiple frameworks for understanding the reciprocal nature of human-computer interaction, including and going beyond the two frameworks we have presented, considering real, pressing issues of ethics, social responsibility, and the socio-technical implications of evolving technologies and human-computer relationships. We suggest that a path toward that end lies in identifying the strengths and shortcomings of previous frameworks while taking advantage of the potentials that two very different type of intelligent entities, humans and computers, together offer.

Based on the ideas presented in this workshop position paper, the list of open issues for discussion at the workshop could include:

- The reciprocal nature of human-computer interaction:
    - In what ways are AI systems shaping human behavior and thought processes, and how can we devise a new framework to better understand and guide the evolving relationships between humans and computers?
- Regarding the role of the end user:
    - As AI becomes more sophisticated, how should we redefine the concept of the "end user"?
    - What protections need to be in place for users as the line between human (as a behavioral machine) and computer (approaching partner) blurs?
- Sociotechnical systems and AI:
    - How does the integration of AI into sociotechnical systems affect social structures and relationships?
    - What role do AI systems play in reinforcing or challenging existing social hierarchies and norms?
- Balancing benefits and risks of advanced AI with the use of EUD techniques:
    - How can we foster an environment in which the advantages of AI can be maximized while mitigating risks?

- What mechanisms can be set up to weigh the benefits against the potential harms of sophisticated AI systems with end-user development techniques?

References

[1] T. Bratteteig, Mutual Learning. Enabling cooperation in systems design, Proc IRIS. Vol. 20 (1997) 1-20.

[2] M.-F. Costabile, D. Fogli, C. Letondal, P. Mussio, A. Piccinno, Domain-Expert Users and their Needs of Software Development, HCI 2003 End User Development Session, June 2003, Crete, Greece.

[3] J. Dittrich, Re-re-reading Lucy Suchman's Plans and Situated actions, Blogpost in fordes/User Research, Design Methods, Education, Jun 30 (2023), URL: https://www.fordes.de/posts/rerereading_suchman_plansActions.html#fn:scription.

[4] H. Dreyfus, What Computers Still Can't Do. A Critique of Artificial Reason, The MIT Press, Cambridge, 1992.

[5] Y. Engeström, New forms of learning in co-configuration work, Journal of Workplace Learning 16.1-2 (2004) 11–21.

[6] J. Grudin, From Tool to Partner: The Evolution of Human-Computer Interaction, Morgan & Claypool, 2017.

[7] T. Hobbes, Leviathan, Basil Blackwell, 1946.

[8] E. L. Hutchins, J. D. Hollan, D. A. Norman, Direct Manipulation Interfaces, Human–Computer Interaction 1.4 (1985) 311-338.

[9] K. Kukich, Beyond automated essay scoring, IEEE Intelligent Systems 15.5 (2000) 22-27.

[10] K. Nygaard, P. Sørgaard, The Perspective Concept in Informatics, in: G. Bjerknes et al. (Eds.), Computers and Democracy, Avebury, Aldershot, UK, 1987, pp. 371–393.

[11] A. J. Perlis, Special Feature: Epigrams on programming, SIGPLAN Not. 17, 9 (Sept. 1982), 7–13.

[12] S. L. Star, A. Strauss, Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work, Computer Supported Cooperative Work 8 (1999) 9–30.

[13] L.Suchman, Plans and Situated Actions: The Problem of Human-Machine Communication, Cambridge University Press, New York, 1987.

[14] L. Suchman, Human-Machine Reconfigurations, Cambridge University Press, New York, 2007.

[15] E. Trist, The Evolution of Socio-technical Systems: A conceptual framework and an action research program, Ontario Ministry of Labour, Ontario Quality of Working Life Centre, 1981.

[16] A. M. Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, Proceedings of the London Mathematical Society, 2 (1936) 230-265.

[17] A. M. Turing, Computing Machinery and Intelligence, Mind, Volume LIX, Issue 236 (1950), pp. 433–460.

[18] B. Victor, B., A.C. Boynton, Invented here: Maximizing your organization's internal growth and profitability. Harvard Business School Press, Boston, 1998.
[19] S. Woolgar, Configuring the User: The Case of Usability Trials, The Sociological Review 38.1 suppl (1990), 58–99.