History & Theories in Human-Computer Interaction

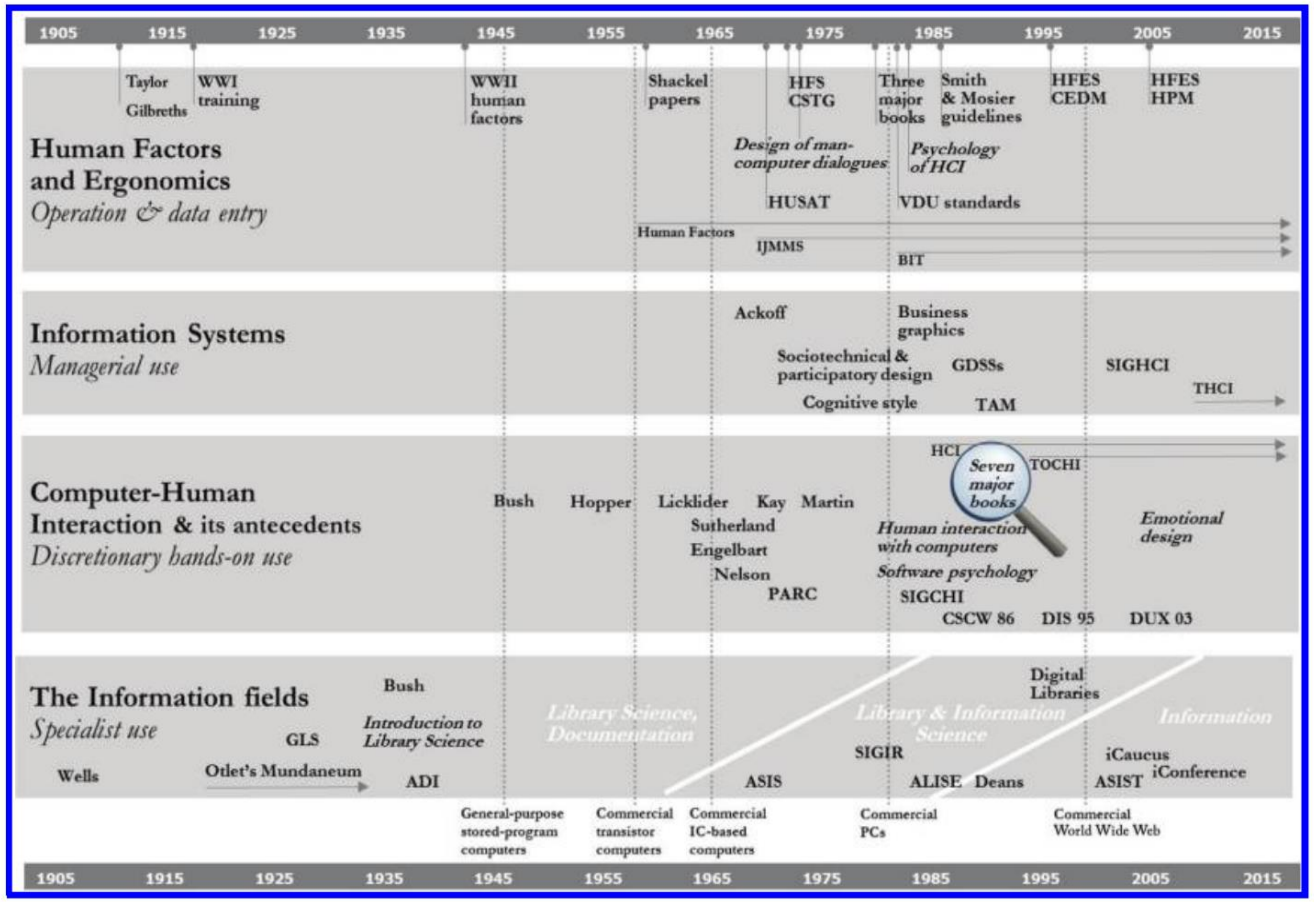


Figure 7.1: Fields with major HCI threads. Left edges of items align with the dates that articles or books were published, organizations or conference series initiated, and so on. Details are in the text.

Grudin, J. (2022). *From tool to partner: The evolution of human-computer interaction*. Springer Nature.

Definitions

From: https://dl.acm.org/doi/pdf/10.1145/2594128
Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.

Definitions

Human-Computer Interaction (HCI) is a multidisciplinary field that focuses on the study, design, and evaluation of the interactions between humans (users) and computers (or more broadly, machines). The history of HCI is intertwined with the evolution of computers and encompasses various research areas including computer science, cognitive psychology, ergonomics, and design.
Here's a brief history of Human-Computer Interaction:

1.1940s-1950s: The Beginning

1. Computers, primarily large mainframes, were used mostly for scientific calculations. Interaction was done using punched cards.

2.1960s: Graphical and Direct Interaction

1. **Sketchpad**: Invented by Ivan Sutherland in 1963, this was one of the first graphical computer interfaces.
2. **Mouse**: Douglas Engelbart, in the late 1960s, invented the computer mouse, fundamentally changing the way users interacted with computers. He also showcased a demo of collaborative real-time editing, hypertext, and video conferencing in 1968, which is famously known as "The Mother of All Demos."

3.1970s: Personal Computing and WIMP Interfaces

1. The idea of a personal computer started to gain traction.
2. Development of WIMP interfaces (Window, Icon, Menu, Pointing device). This became a foundational aspect of HCI.

4.1980s: Birth of HCI as a Field and Desktop Metaphor

1. Apple Macintosh, released in 1984, popularized the GUI (Graphical User Interface) for the masses.
2. Xerox PARC played a crucial role in refining and inventing GUI elements.
3. Universities started offering HCI courses, and the term "User Experience" (UX) began to emerge.
4. The CHI (Conference on Human Factors in Computing Systems) conference was established, marking the formalization of HCI as a research field.

5.1990s: Web and Mobile Interaction

1. The World Wide Web was born, changing the dynamics of HCI from localized software to globally distributed applications.
2. The Palm Pilot, released in the mid-90s, was an early example of a popular mobile user interface.

6.2000s: Ubiquitous Computing and Multitouch Interfaces

1. Devices began to be embedded in everyday objects (Ubiquitous Computing).
2. Apple introduced the iPhone in 2007, revolutionizing touch interfaces and mobile computing.
3. Social media platforms like Facebook and Twitter shifted HCI considerations towards social interactions and group dynamics.

7.2010s: Natural User Interfaces and Immersive Experiences

1. Gesture-based systems like Microsoft Kinect.
2. Voice assistants such as Apple's Siri, Amazon's Alexa, and Google Assistant.
3. Virtual Reality (VR) and Augmented Reality (AR) began to gain mainstream traction.

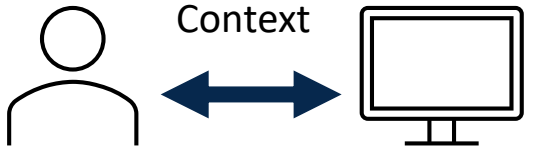
8.2020s and Beyond: AI, Ambient Interaction, and Ethics

1. Machine learning and AI became integral to user experiences, influencing recommendations, personalization, and interaction dynamics.
2. A growing emphasis on ethical considerations in HCI, focusing on privacy, inclusivity, and avoiding biases.
3. The concept of ambient interaction, where interactions become seamless with our environment, reducing the need for traditional interfaces.

Through the years, HCI has grown from simple command-line interactions to a complex field that seeks to understand and improve the overall user experience, considering accessibility, usability, aesthetics, and emotional connections. As technology continues to evolve, so too will HCI, as it adapts to new paradigms and user needs.

- ChatGPT

Distributed Cognition

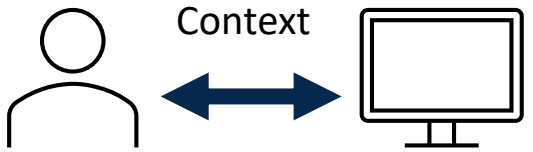


Main Concepts:

- The theory of distributed cognition, like any cognitive theory, seeks to understand the organization of cognitive systems
- What is a cognitive process?
  - “A cognitive process is delimited by the functional relationships among the elements that participate in it, rather than by the spatial colocation of the elements”
- Three elements of cognitive processes:
  - Cognitive processes may be distributed across the members of a social group
  - Cognitive processes may involve coordination between internal and external (material or environmental) structure
  - Processes may be distributed through time in such a way that the products of earlier events can transform the nature of later events
- Central Hypothesis:
  - Cognitive and computational properties of systems can be accounted for in terms of the organization and propagation of constraints.
  - Integrated framework for research that combines ethnographic observation and controlled experimentation as a basis for theoretically informed design of digital work materials and collaborative workplaces
- We continue with “human computer symbiosis” and try to define tasks that involve coordination amongst multiple cognitive systems.

- Distributed cognition: toward a new foundation for human-computer interaction research. ACM Transactions on Computer-Human Interaction (TOCHI), 7(2), 174-196.

Direct manipulation



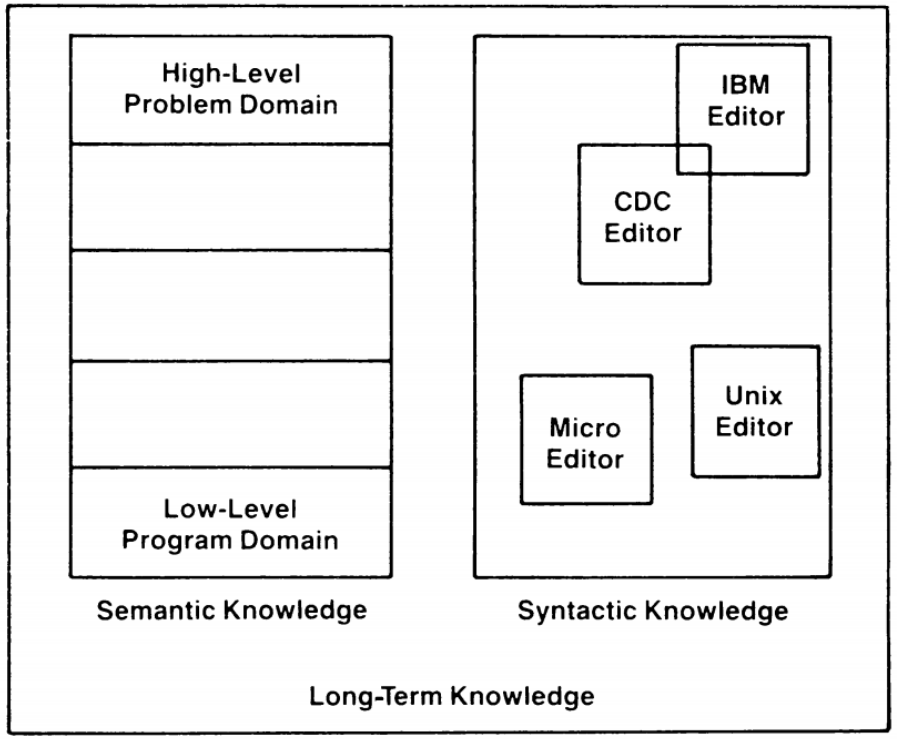


Figure 5. The semantic knowledge in long-term memory goes from high-level problem domain concepts down to numerous low-level program domain details. Semantic knowledge is well-structured, relatively stable, and meaningfully acquired. Syntactic knowledge is arbitrary, relatively volatile unless frequently rehearsed, and acquired by rote memorization. There is usually little overlap between the syntax of different text editors, but they often share semantic concepts about inserting, deleting, and changing lines of text.

- The central ideas seemed to be visibility of the object of interest; rapid, reversible, incremental actions; and replacement of complex command language syntax by direct manipulation of the object of interest-hence the term "direct manipulation. “

-Ben Shneiderman, University of Maryland, 1983

- The best way to describe a direct manipulation interface is by example. The term direct manipulation was coined by Shneiderman (1974, 1982, 1983) to refer to systems having the following properties:
  - 1. Continuous representation of the object of interest.
  - 2. Physical actions or labeled button presses instead of complex syntax.
  - 3. Rapid incremental reversible operations whose impact on the object of interest is immediately visible. (Shneiderman, 1982, p. 251)

-Edwin L. Hutchins, James D. Hollan, and Donald A. Norman, 1985

- Direct manipulation interfaces. Human–computer interaction, 1(4), 311-338.
- Direct manipulation: A step beyond programming languages. Paper presented at the Proceedings of the Joint Conference on Easier and More Productive Use of Computer Systems.(Part-II): Human Interface and the User Interface-Volume 1981.

Theory-Gulf of Execution & Evaluation (Semantic & Articulatory Distance)

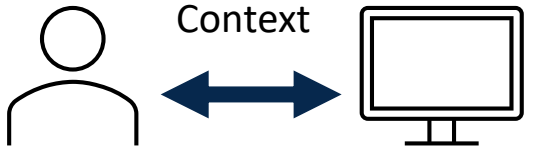


Figure 3. **The gulfs of execution and evaluation. Each gulf is unidirectional: The gulf of execution goes from goals to system state; the gulf of evaluation goes from system state to goals.**

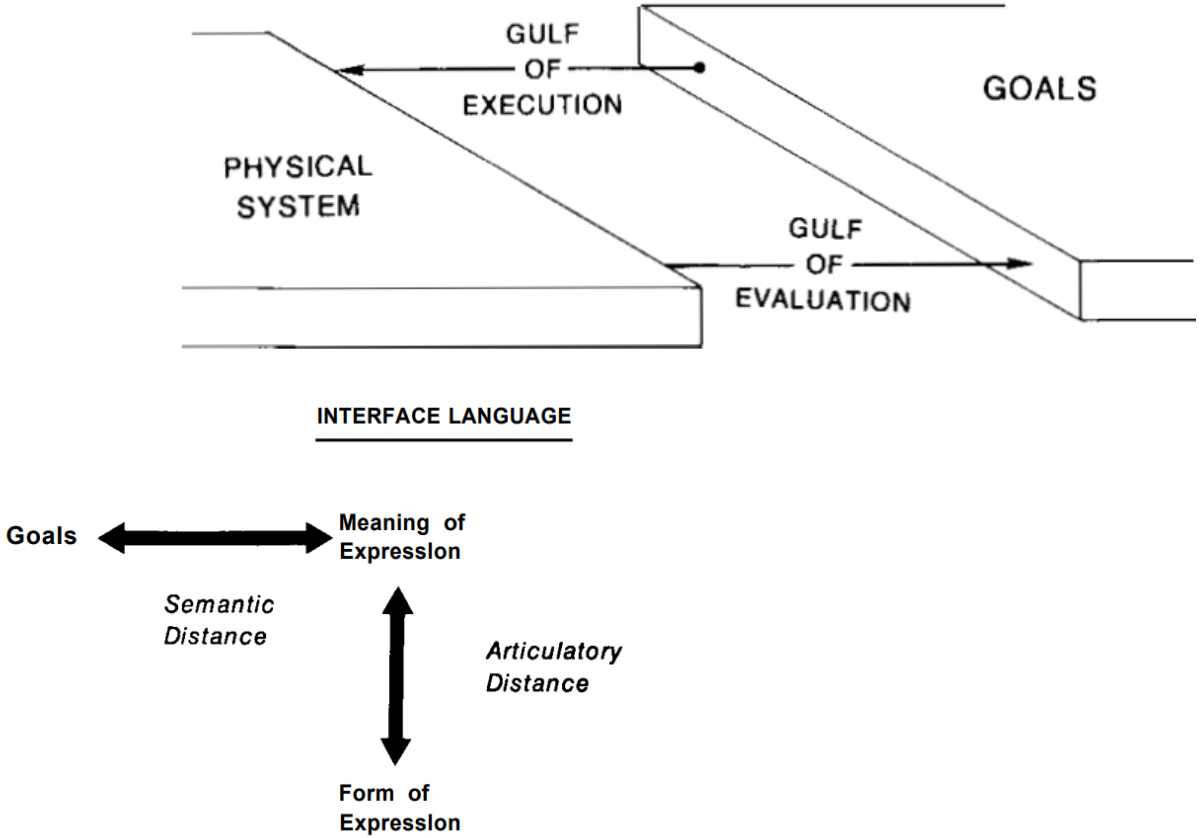
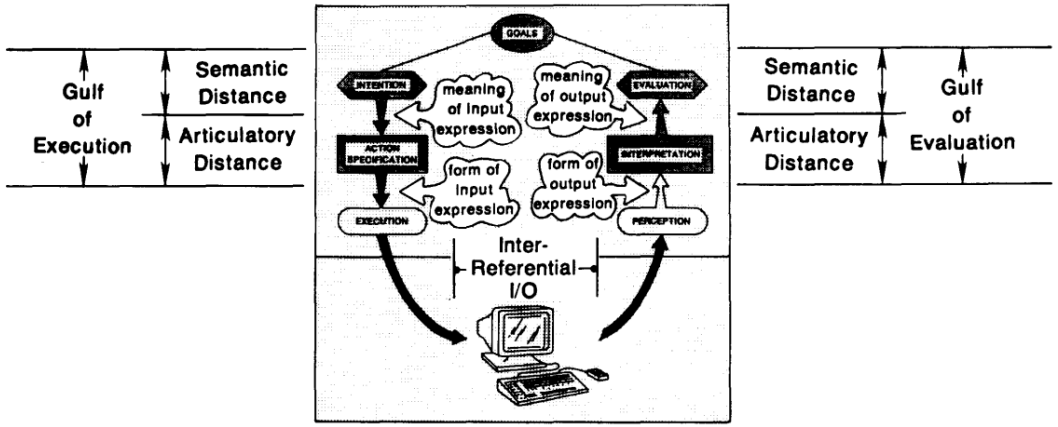
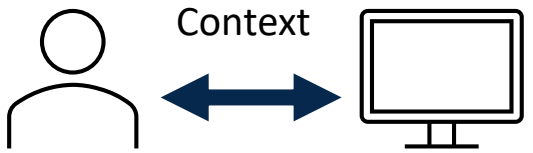


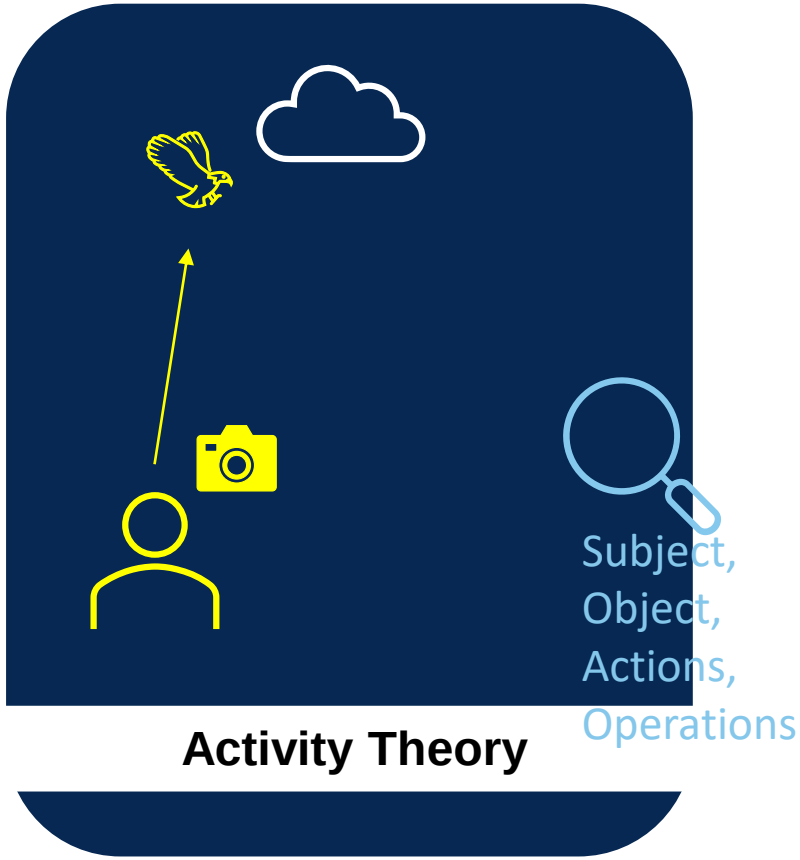
Figure 6. **Forming an intention is the activity that spans semantic distance in the gulf of execution. The intention specifies the meaning of the input expression that is to satisfy the user's goal. Forming an action specification is the activity that spans articulatory distance in the gulf of execution. The action specification prescribes the form of an input expression having the desired meaning. The form of the input expression is executed by the user on the machine interface and the form of the output expression appears on the machine interface, to be perceived by the user. When some part of the form of a previous output expression is incorporated in the form of a new input expression, the input and output are said to be inter-referential. Interpretation is the activity that spans articulatory distance in the gulf of evaluation. Interpretation determines the meaning of the output expression from the form of the output expression. Evaluation is the activity that spans semantic distance in the gulf of evaluation. Evaluation assesses the relationship between the meaning of the output expression and the user's goal.**

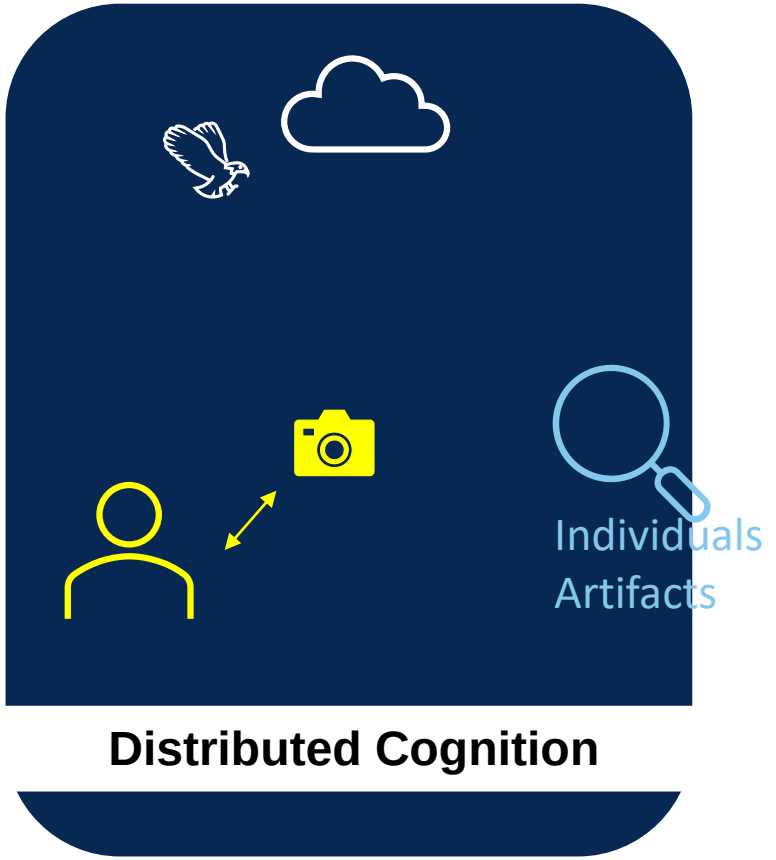


- Hutchins, E. L., Hollan, J. D., & Norman, D. A. (1985). Direct manipulation interfaces. Human–computer interaction, 1(4), 311-338.

Context



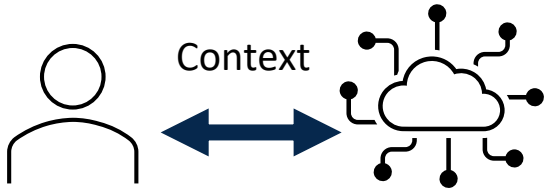




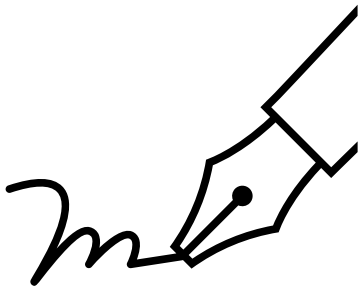
Evolving nature, e.g., shoemaker novice (Dourish, 2004)

- Nardi, B. A. (1996). Studying context: A comparison of activity theory, situated action models, and distributed cognition. Context and consciousness: Activity theory and human-computer interaction, 69102, 35-52.
- Dourish, P. (2004). What we talk about when we talk about context. Personal and Ubiquitous Computing, 8(1), 19-30. https://doi.org/10.1007/s00779-003-0253-8

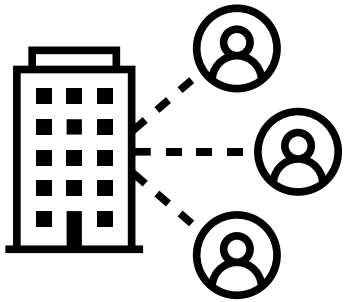
Ubiquitous Computing



To develop novel uses, often focusing on implicit user input to minimize the intrusion of technology into everyday life. The objective of this application-centered research is to understand how everyday tasks can be better supported, and how they are altered by the introduction of ubiquitous technologies.

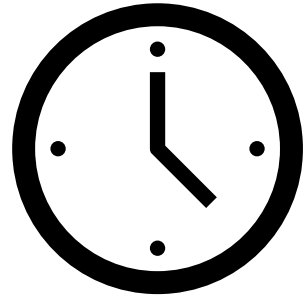


Natural interfaces



Context-aware applications

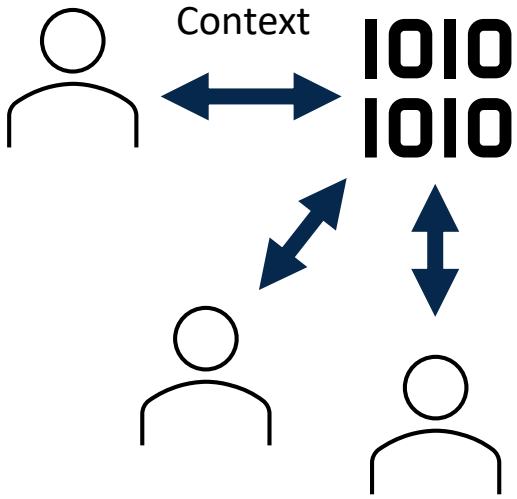
Automated capture and access



7*24 continuous interaction

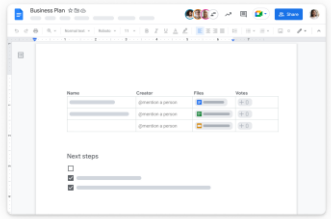
- Abowd, G. D., & Mynatt, E. D. (2000). Charting past, present, and future research in ubiquitous computing. ACM Transactions on Computer-Human Interaction (TOCHI), 7(1), 29-58.

Awareness, Groupware



Ethnographically-informed

- Coexistence awareness
  - Media spaces
  - Collaborative virtual environments
- Cooperation awareness
  - Shared workspaces
  - Group editors



Technology-oriented

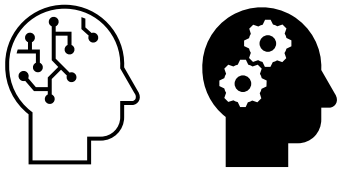
- Base technology
  - Awareness information environments
  - Sensing technology
  - Awareness information presentation
- Modeling awareness
  - Spatial model
    focus, nimbus, medium, aura
  - Future awareness model

A → B

Awareness: a **user**'s internal knowing and understanding of **a situation** including **other users** and the **environment** that is gained through subtle practices of **capturing and interpreting information**; and this awareness information partly exists in the **environment** and is partly provided by awareness **technology**.

- Gross, T. (2013). Supporting Effortless Coordination: 25 Years of Awareness Research. Computer Supported Cooperative Work (CSCW), 22(4-6), 425-474. https://doi.org/10.1007/s10606-013-9190-x

AI opportunities and challenges



Human-Centered AI **Opportunities**:

(i) automation and human agency,

(ii) system uncertainty and user confidence,

(iii) system's objective complexity and a user's perceived complexity

Challenges:

Unclear expectations of AI (existing and future),

Communication between user-centered and technology-driven approaches

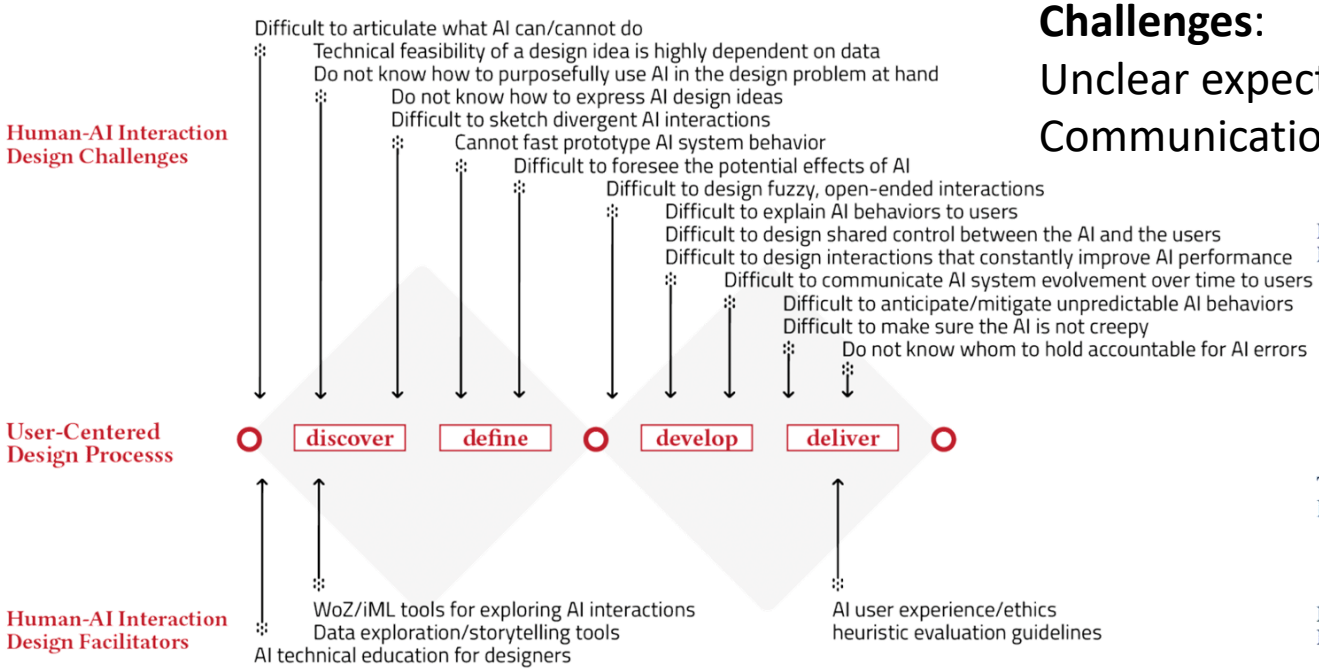


Figure 1: Mapping the human-AI interaction design challenges in the literature [58, 13, 26, 53] onto a user-centered design process (Double Diamond [10])

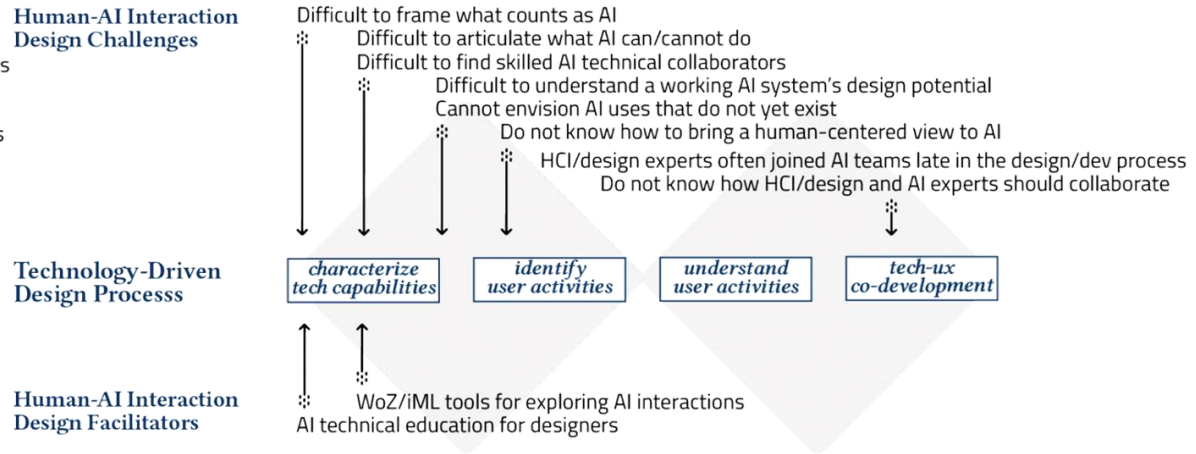


Figure 2: Mapping UX design challenges of AI in prior research on a technology-driven design innovation process [41, 5]

- Jiang, J., Karran, A. J., Coursaris, C. K., Léger, P. M., & Beringer, J. (2022). A situation awareness perspective on human-AI interaction: Tensions and opportunities. International Journal of Human–Computer Interaction, 1-18.
- Yang, Q., Steinfeld, A., Rosé, C., & Zimmerman, J. (2020, April). Re-examining whether, why, and how human-AI interaction is uniquely difficult to design. In Proceedings of the 2020 chi conference on human factors in computing systems(pp. 1-13).

October 17th, 2023