Wisdom is not the product of schooling but the lifelong attempt to acquire it. - Albert Einstein

Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research

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DLC Course, Spring Semester 2002
February 20, 2002

Core Issues of Human-Computer Interaction (HCI)

- reality is not user-friendly
- the user interface is not the major problem for HCI research
- most users are not interested in computers per se, but in their tasks
- “high-tech scribes” and “complete idiots” are not the primary computer users
- experts (= users who know everything about a domain or a tool) do not exist → complex systems can and will not be completely learned and learning on demand is a necessity
- information is not the scarce resource
Beyond Human-Computer Interaction

• human-computer interaction is more than user interfaces
  Applying the Macintosh style to poorly designed applications and machines
  is like trying to put Bearnaise sauce on a hot-dog! (A. Kay)

• make systems useful and usable
  If ease of use was the only valid criterion, people would
  stick to tricycles and never try bicycles. (D. Engelbart)

• the human mind is limited
  Humans have a bounded rationality. (H. Simon)

• support human problem-domain interaction
  Interfaces get into the way. I don't want to focus my energies on an interface.
  I want to focus on the job. (D. Norman)
Useful versus Usable

• **usable (as main objective):**
  - novices
  - limited functionality
  - low threshold to get started
  - walk-up and use
  - “experts” exist
  - understandable model of the complete system can be developed
  - examples: original MacIntosh, ATMs, VCRs

• **useful (as main objective):**
  - skilled users
  - broad functionality
  - high ceiling for skilled users
  - no “experts” (→ learning on demand is a necessity rather than a luxury)
  - no complete models
  - end-user modifiability, programmability
  - examples: Unix, Symbolics, application programs (e.g., MS-Word, Excel, Mathematica)

• **goal: useful and usable**
Success Stories of Useful and Usable
—
A Large Hardware Store with Knowledgeable Sales Agents

• Empirical Study: McGuckin Hardware in Boulder, Colorado — more than 350,000 different line items

• problem setting and problem solving are intertwined

• queries are articulated incrementally, situations talk back, examples are critical

• to determine the relevance of a found object requires domain knowledge (e.g., “simulation of use” — the plumber story)

• a shared understanding is incrementally achieved between customer and sales agent

• summary: “computer systems have the same functionality as McGuckin, but are operated like K-Mart”
Missing from HCI Research

• a motivation perspective
  - intrinsically motivating computational environments
  - what will make users want to share? (e.g., design rationale: who is the beneficiary and has to do the work?)
  - making information relevant to the task at hand
  - example: good computer games

• a learning perspective
  - life-long learning and learning on demand
  - integration of working and learning
  - example: high-functionality applications (HFAs)

• a change and evolution perspective
  - users change
  - artifacts change tasks, work, organizations
  - media/technology changes
  - organizations change
  - examples: co-adaptive systems, evolutionary design of complex systems, design-in-use
Going BEYOND

- novice → skilled domain worker
  - unit tasks (seconds) → design (days, months, years)
  - laboratory → naturalistic environments
  - static user → supporting transitions and change (e.g., co-adaptivity)

- direct manipulation → programmability, end-user modifiability

- information overload → saying the “right” thing at the “right” time in the “right” way

- system creation → system evolution

- tools → human-centered agents (goal sharing, information delivery)

- solving “given” problems → integration of problem framing and problem solving

- HCI → human problem-domain communication (HPDC)
Distributed Cognition

• **Hollan/Hutchins/Kirsch:**
  “the theory of distributed cognition provides an effective theoretical framework for understanding human-computer interaction and a fertile framework for designing and evaluating digital artifacts.”

• **between:**
  - human beings
  - humans and things (computational artifacts)
  - internal (memory, attention) and external (artifacts, materials) resources
  - different times: reuse, build on the success of others, exploit culture

• **advantage of humans:**
  - shared understanding
  - background knowledge

• **advantage of things** (Illich, p 125):
  “a thing is available at the bidding of the user - or could be - whereas persons formally become a skill resource only when they consent to do so, and they can also restrict time, place, and methods as they choose.”
Distributed Cognition: Media as Extensions of Humans

Einstein: “My pencil and I are more clever than I”
Distributed Cognition: Media as “Information Prosthesis”

cognitive disabilities

cognitive disabilities with greatly enriched tool set
Distributed Cognition: Socio-Technical Environments
Transcending the Limitations of the Individual Human Mind

social + technical environment
Distributed Cognition: Matching Needs and Support

mismatch
(universe of one)

match between user
and tools
Ethnography

- cognition in the wild → data from “beyond the laboratory”
- interviewing
- surveys
- participant observation
- video and auto recording
- automated recording of histories of interaction (in HCI)
- examples:
  - ship navigation
  - airline cockpit automation
  - beyond direct manipulation
Active Representations

- dynamic forms
- dynamic menus
- official airline guide
- history-enriched digital objects ("read and edit wear")
- PAD++: Zoomable Multiscale Interfaces
Conclusions

This is not the end. It is not even the beginning. But it is, perhaps, the end of the beginning. (W. Churchill)

• Past:
  - WIMPs (windows, icons, menus, and pointers)
  - emphasis on interfaces
  - focus on beginners
  - these are major achievements → but: they should not be considered the end, but rather the beginning

• co-evolution of
  “working/design, learning and collaborating” ↔ “new media”

• theory guided design: ethnographic observation and controlled experimentation as a basis for theoretically informed design of digital work material and collaborative workplaces

• the future is not out there to be “discovered” — it has to be invented and designed by human beings