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

Gerhard Fischer, Hal Eden, Hiroaki Ogata, and Eric Scharff
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paper: Hollan, J., Hutchins, E., & Kirsch, D. (2001) "Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research." In J. M. Carroll (Ed.) Human-Computer Interaction in the New Millennium, ACM Press, New York, pp. 75-94.

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 <u>and</u> 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."

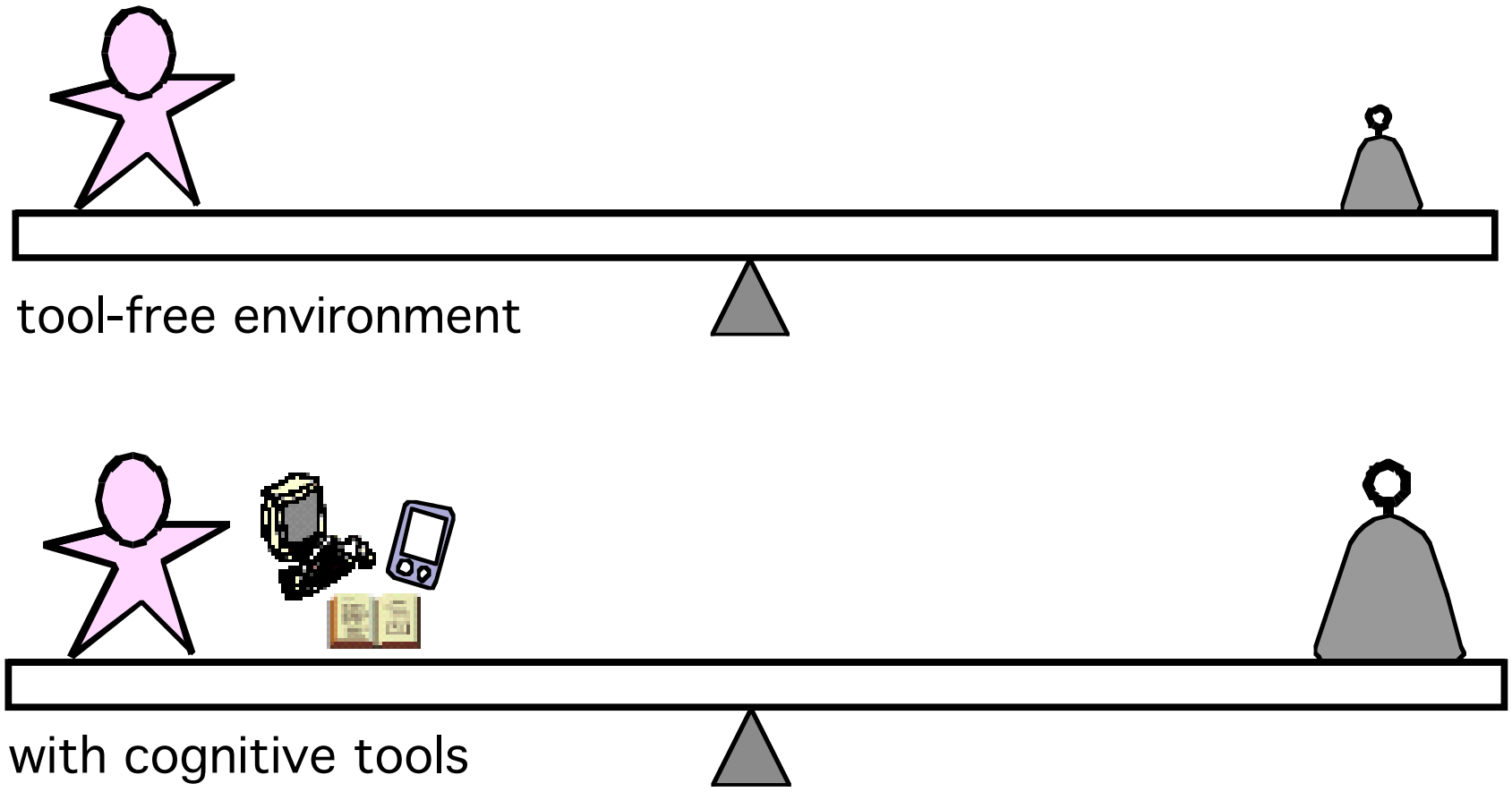
- **between:**
  - human beings
  - humans and things (computational artifacts)
  - internal (memory, attention) and external (artifacts, materials) resources
  - different times: reuse, build on the success of others, exploit culture

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

- **advantage of things** (Illich, p 125)**:** → the "Nobel Prize Winner" fallacy

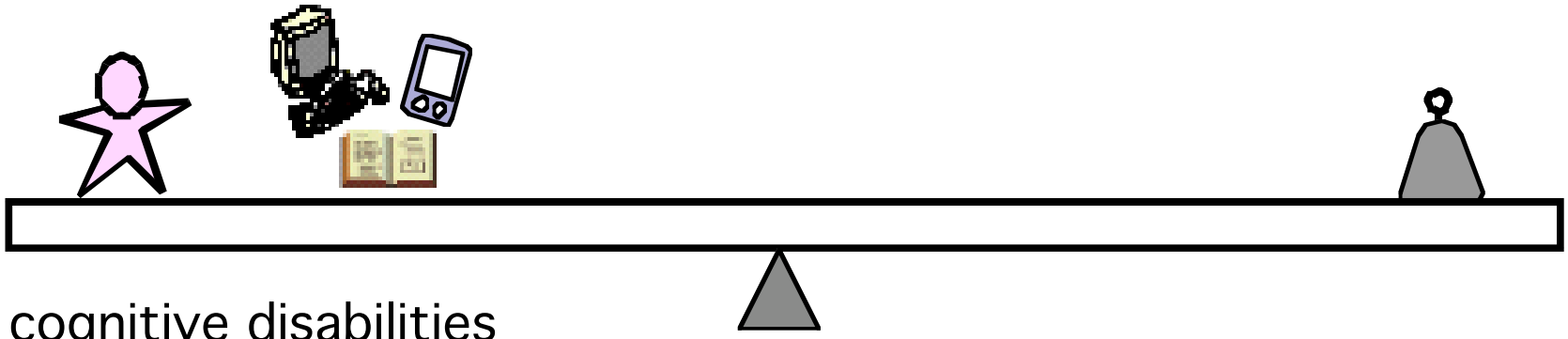
  "a thing is available at the bidding of the user - or could be - whereas persons formally become a skill resource only when they consent to do so, and they can also restrict time, place, and methods as they choose."

Distributed Cognition: Media as Extensions of Humans

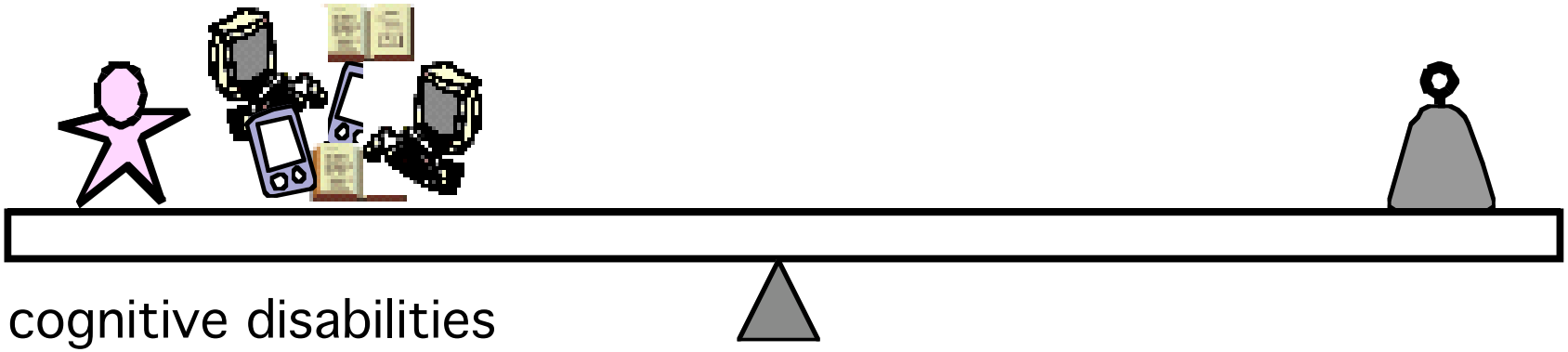


Einstein: "My pencil and I are more clever than I"

Distributed Cognition: Media as "Information Prosthesis"



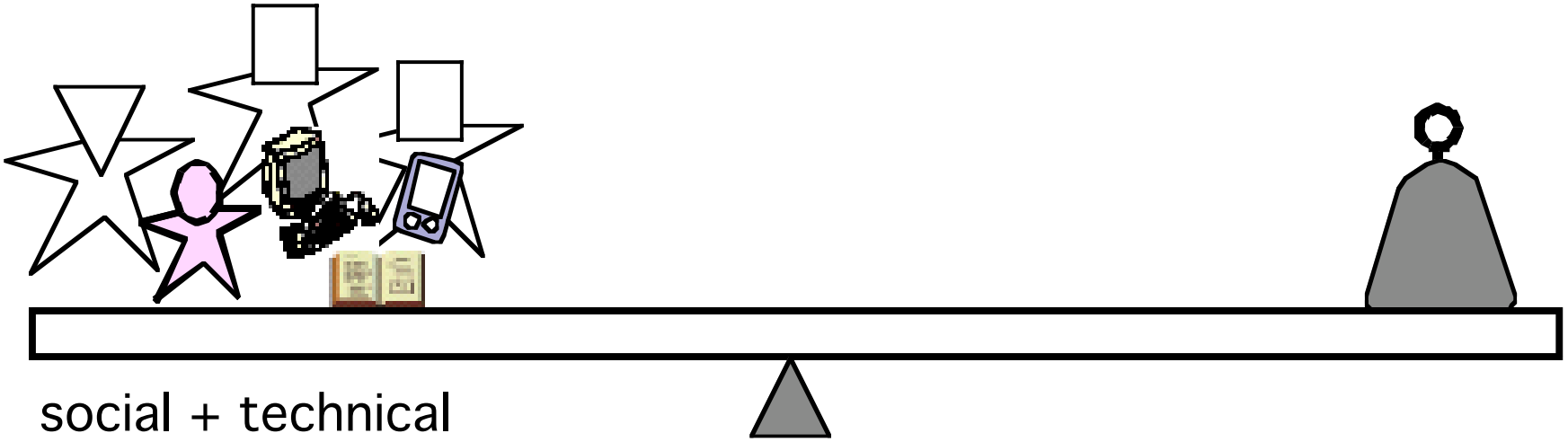
cognitive disabilities



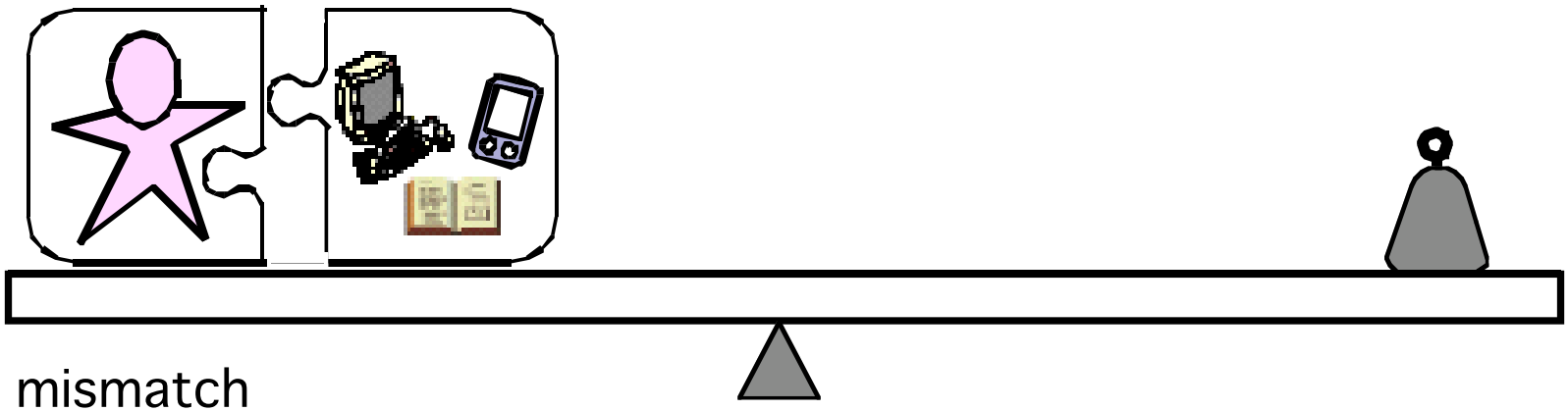
cognitive disabilities
with greatly enriched
tool set

Distributed Cognition: Socio-Technical Environments

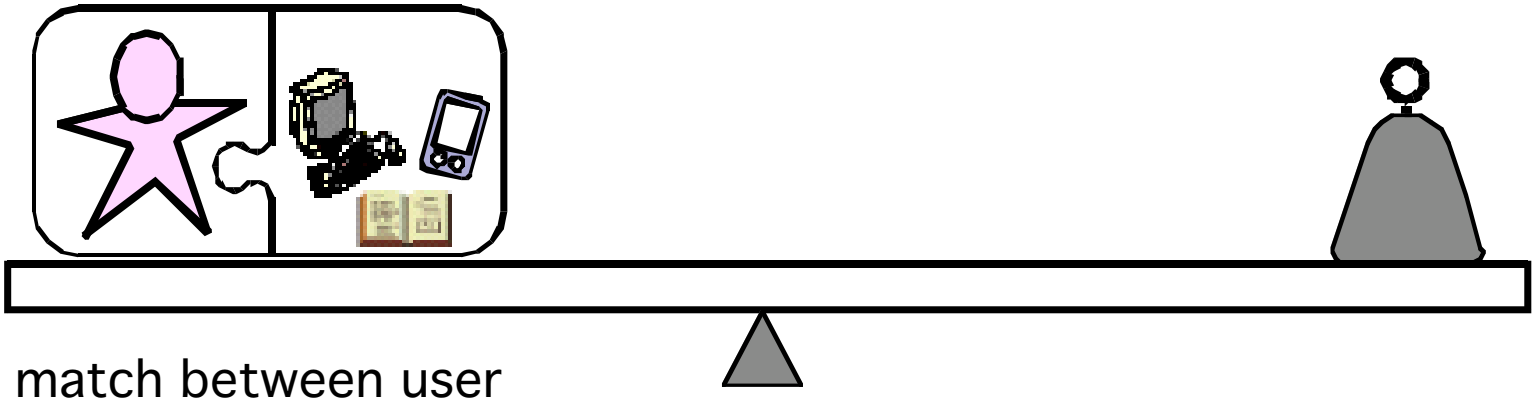
Transcending the Limitations of the Individual Human Mind



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