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

Anatomy is Not Destiny: Creating Eyeglasses for the Mind

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Symposium "*The Future of Assistive Technology in Dementia Care*",
HWK, Delmenhorst, September 6-8, 2022

Background and Acknowledgements

<<University of Colorado>>

Center for Lifelong Learning and Design (L3D)
https://l3d.cs.colorado.edu/wordpress/about/

Research Project: Building cognitive levers (CLever) to help people help themselves
http://l3d.cs.colorado.edu/clever/

Coleman Institute for Cognitive Disabilities
https://www.colemaninstitute.org

National Science Foundation (NSF)
https://www.nsf.gov

Outline

- Framework of our Research

- **Past:** Cognitive Levers (CLever) Research Project (6 Minutes Movie)

- **Present:**
  - Distributed Cognition
  - Beyond the Individual Human Mind → Renaissance Communities
  - Beyond the Unaided Human Mind → Tools for Learning and Tools for Living

- **Future:**
  - Artificial Intelligence
  - **Meta-Design**
  - Design Trade-Offs

- Impact

Why Anatomy does not have to be Destiny?

"The invention of eyeglasses in the twelfth century not only made it possible to improve defective vision but suggested the idea that human beings need not accept as final either the endowments of nature nor the ravages of time.

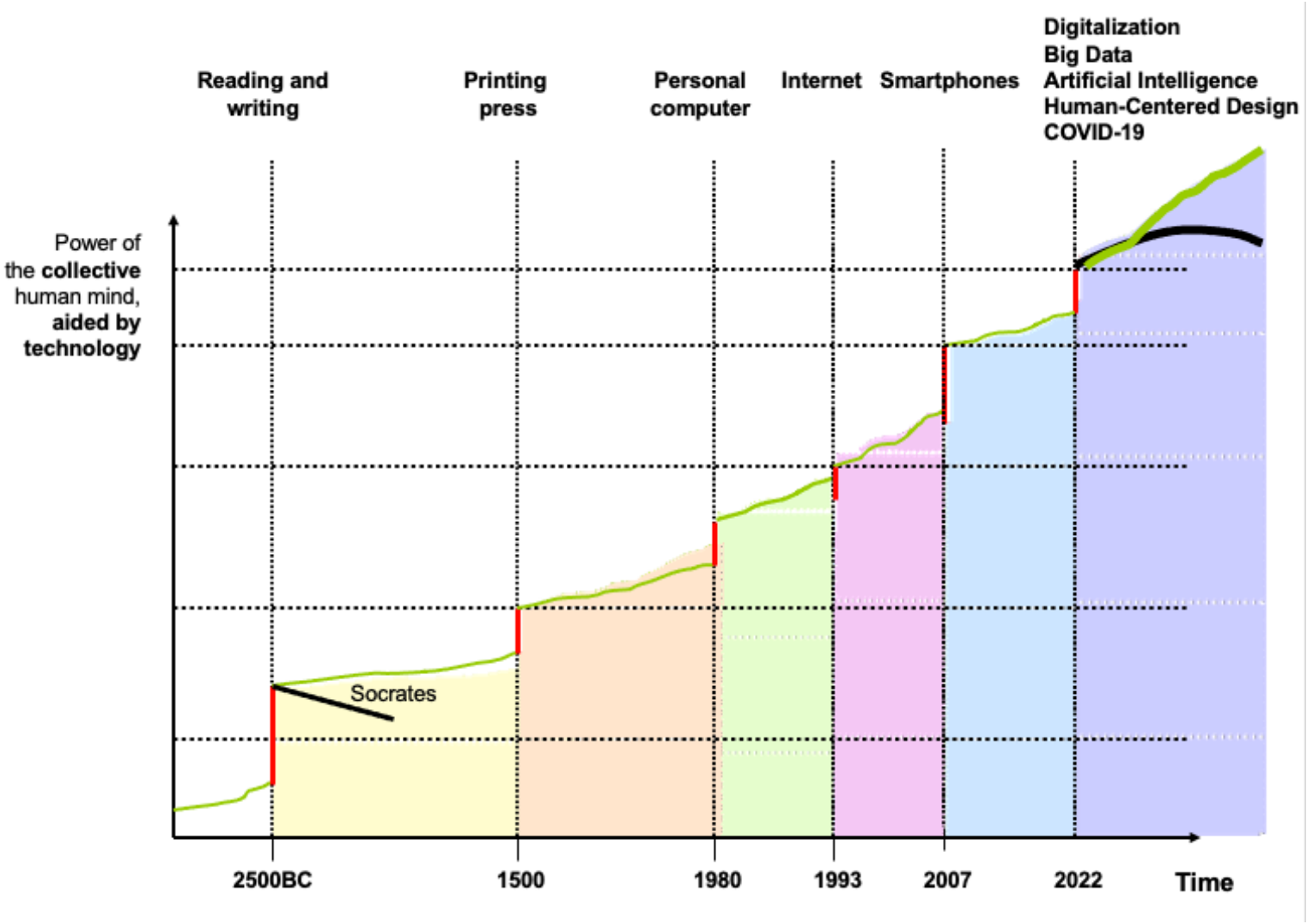
Eyeglasses refuted the belief that anatomy is destiny by putting forward the idea that ***our minds*** *as well as our bodies are improvable!"*

source: Postman, N. (1985) "Amusing Ourselves to Death", p 14

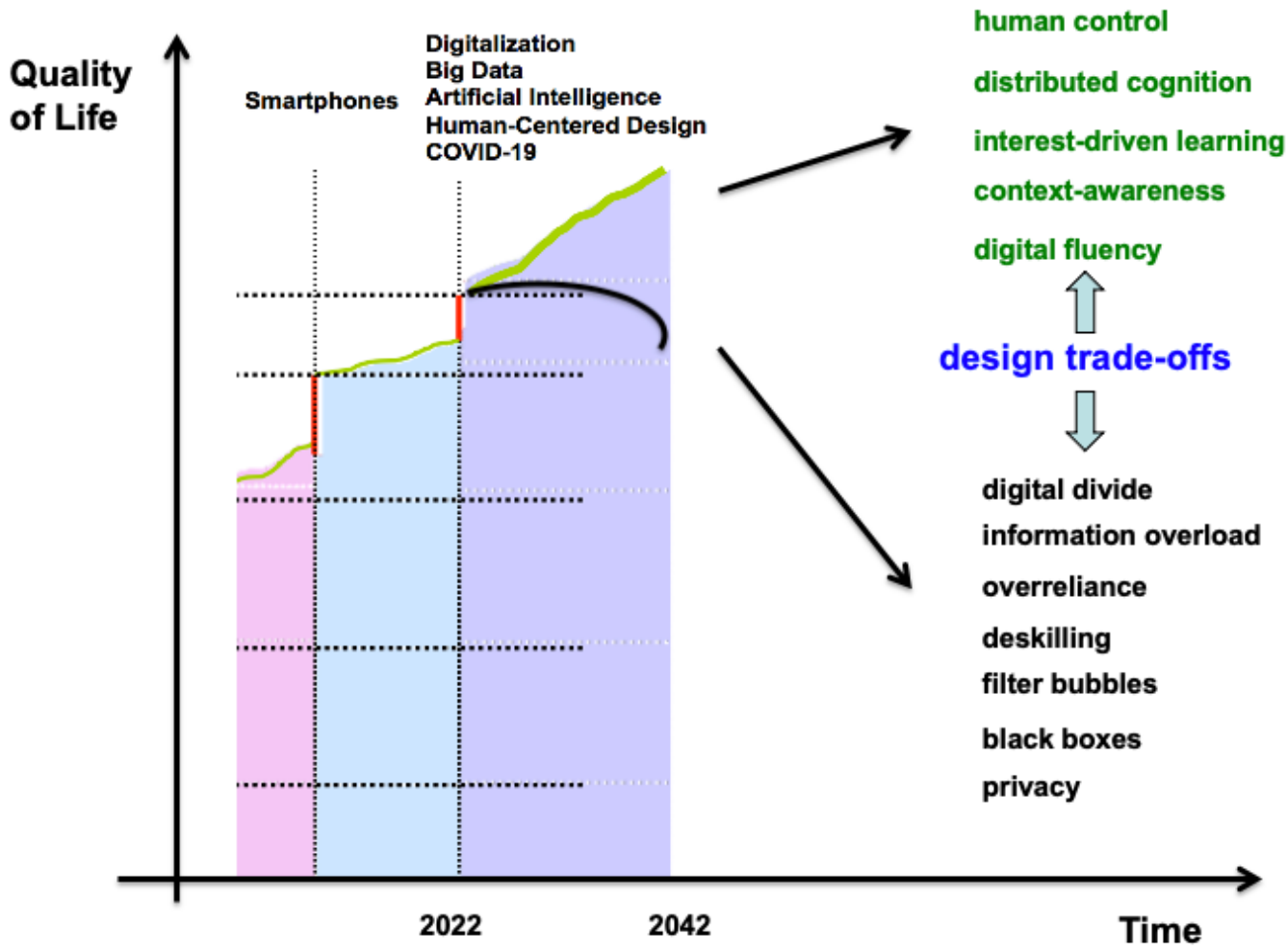
Basic Assumptions of the *"eyeglasses for the mind" erspective for* our Research Objectives

- the assertion that the **cognitive abilities of all of us are limited**
- the development of computational media that provide unique opportunities to "improve our minds" — especially **the minds of people with cognitive disabilities** — represent fundamental research challenges for assistive technologies extending human abilities

Major Technologies for Transcending the Unaided, Individual Human Mind



The Future — Exploring Design Trade-Offs Opportunities and Pitfalls



Fundamental Opportunity

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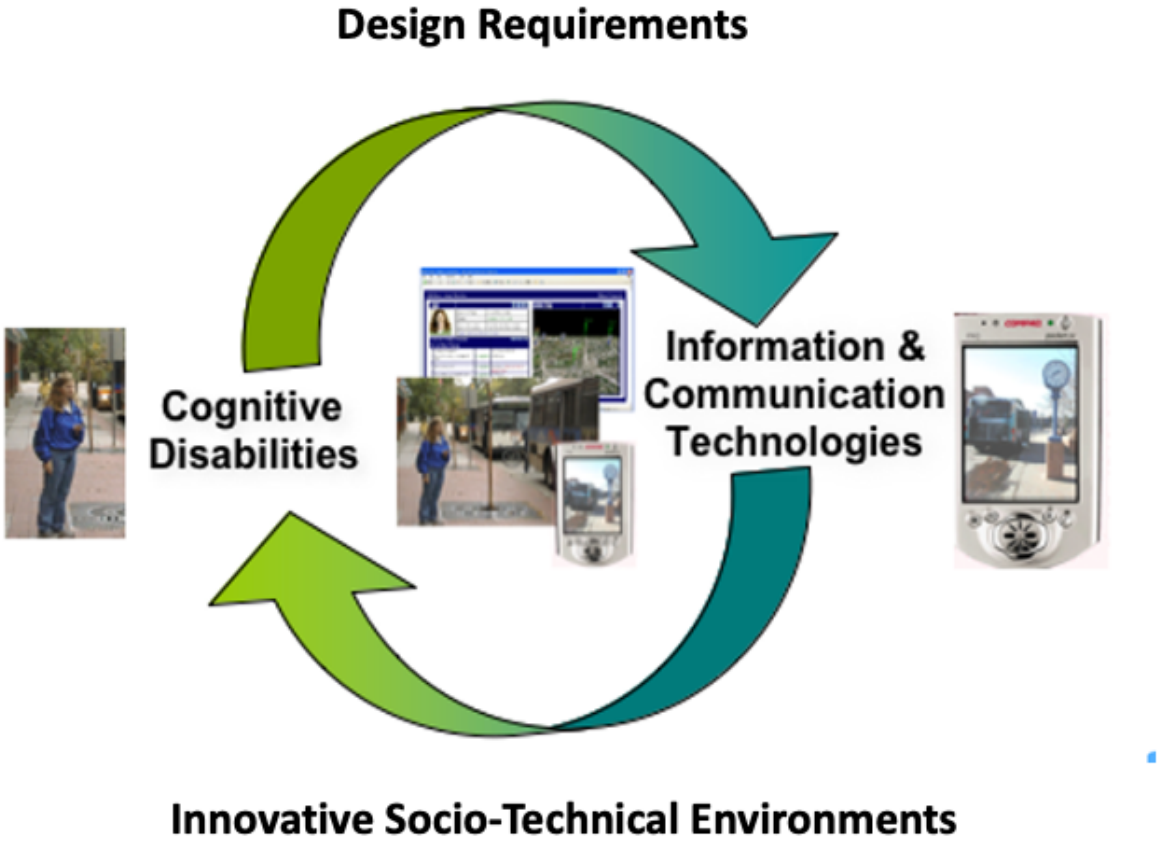
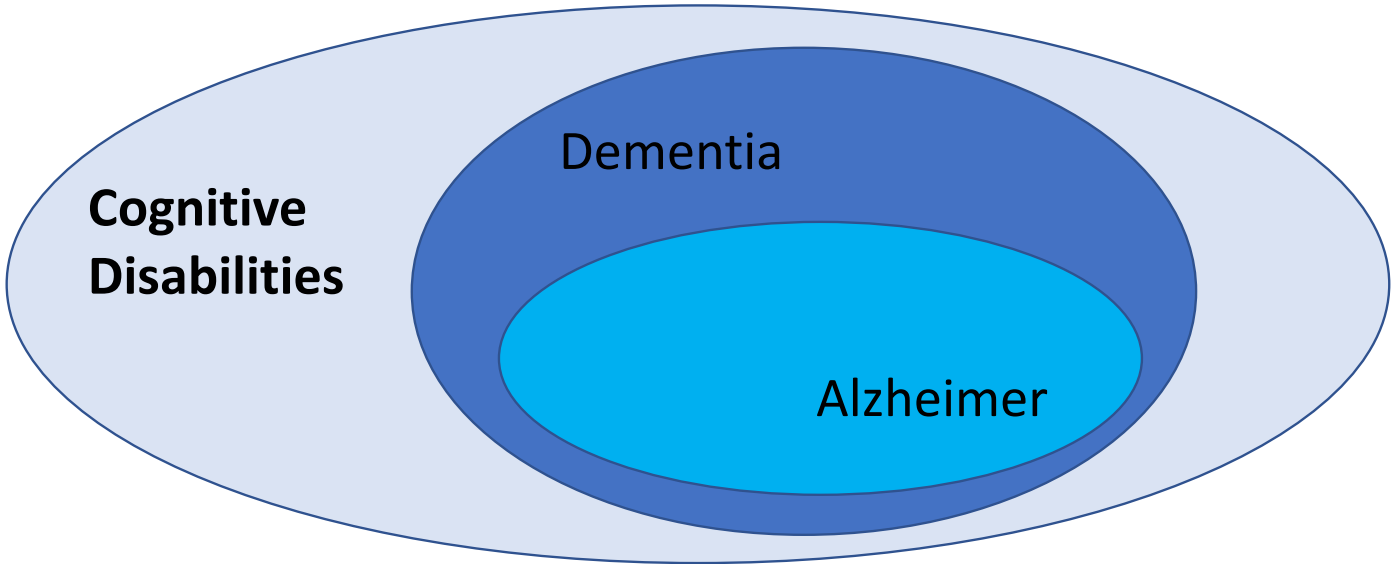
Co-Evolution between Understanding Cognitive Disabilities and Innovative Information & Communication Technologies



Cognitive Disabilities ←→ Dementia



Cognitive Limitations:

- memory loss
- difficulty communicating or finding words
- difficulty reasoning or problem-solving
- difficulty handling complex tasks
- difficulty with planning and organizing
- confusion and disorientation

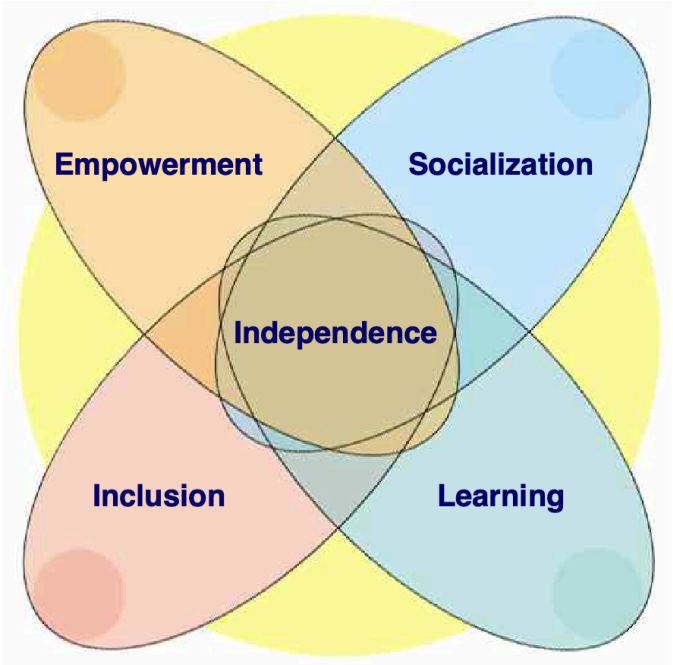
The Past

Cognitive Levers (CLever)

A Research Project of the Center for LifeLong Learning and Design (L3D)

- CLever (2000 - 2008) was supported by the **Coleman Institute at the University of Colorado**

- **objectives of CLever:**



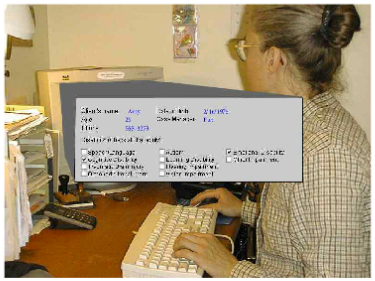
The Story Shown in the Video

<<https://youtu.be/-Zi4dgUx1C4 — 6 minutes>>

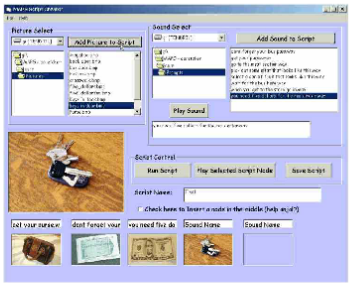
- **focus**
  - socio-technical environments: to assist people with cognitive disabilities, dementia — but also: out-of-town visitors and foreigners, everyone
  - **domain**: use of human-centered public transportation systems
  - **scenario**: a woman with cognitive disabilities (memory problems, no capacity for planning and remembering) and her mother

- **Five Subsystems Shown in the Video**

Web2gether: Community Support Tool

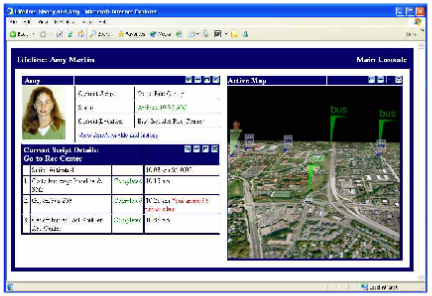


The Evaluation Assistant



Memory Aiding Prompting Systems

Mobility for All



Lifeline: Remote Monitoring System

Selected CLever Projects Shown in the Video

- **Web2gether: Online Community Environment** — supporting the members of a community

- **TEA: The Evaluation Assistant** — matching the needs of individuals to specific technologies (overcome *lack of adoption* and *high level of abandonment*)

- **MAPS: Memory Aiding Prompting Systems** — creating (simple) computer programs (scripts) by end-users (care workers) who have no interest in technology per se
  → **meta-design**

- **Mobility-for-All: Human Centered Public Transportation Systems** — exploiting the power of ubiquitous, mobile, wireless technologies

- **Lifeline: Remote Monitoring —** embedding the technological component in a socio-technical environment (tracking environment, panic button) → activate human support networks when the technology fails

The Present

- Distributed Cognition
- Beyond the Individual Human Mind → Renaissance Communities
- Beyond the Unaided Human Mind → Tools for Learning and Tools for Living

Distributed Cognition

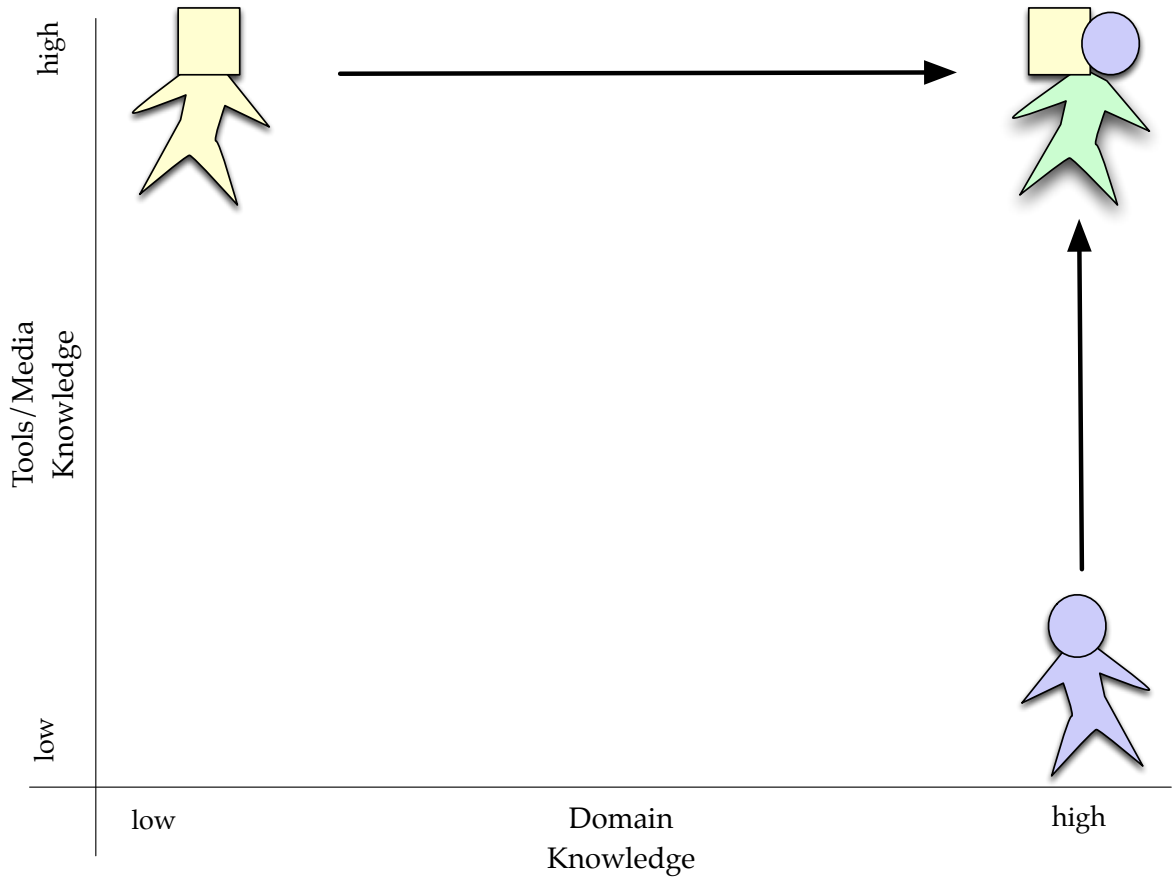
Einstein: "'My pencil and I are smarter than I am."
"

- **claim*:*** distributed intelligence
  - **combines** "knowledge in the head" with "knowledge in the world" → **transcends** the traditional view that human cognition exists solely 'inside' a person's head
  - provides an effective **theoretical framework** for technology for improving cognitive function
  - provides guidelines how artifacts, tools, and **socio-technical environments** can change tasks and empower human beings

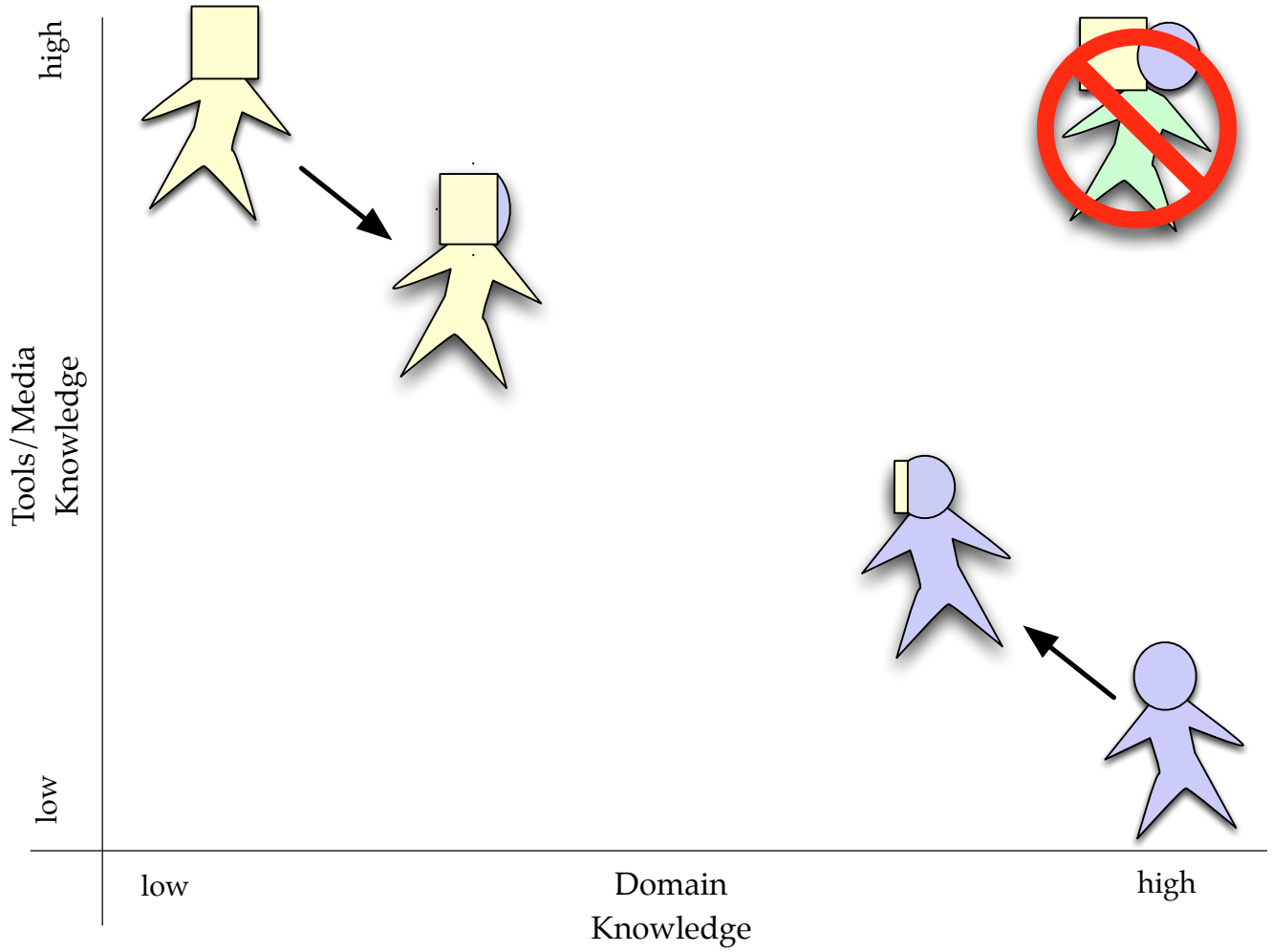
- **forms of distribution**:
  - **human←→ human:** across groups, teams, social networks, communities
  - **human ←→ artifacts:** between ***internal*** (memory, attention, executive function) and ***external*** (artifacts, tools) structures and resources

Renaissance Scholars and Renaissance Communities

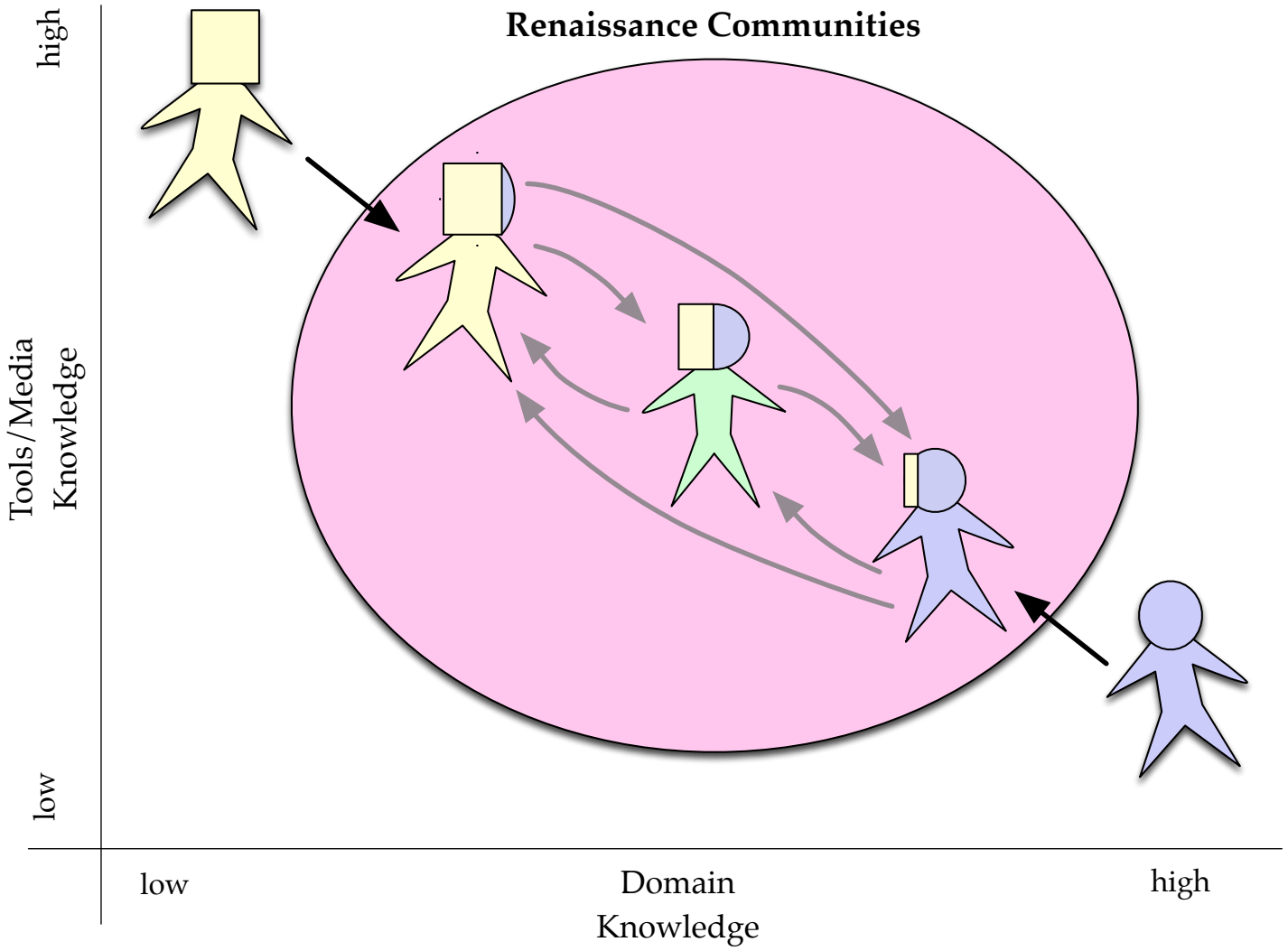
The Renaissance Scholars in the Digital Age —"The Superhuman" Desired but Unrealistic



A Realistic Objective: Learning “something” about the other Domain



Renaissance Communities



Tools for Learning and Tools for Living

- **tools for learning (scaffolding with fading):**
  - *objective*: autonomous performance by people without tools
  - *examples*: training wheels, wizards, external scripts, templates, prompting systems

- **tools for living (doing tasks with tools):**
  - grounded in a distributed intelligence perspective
  - intelligence is mediated by tools for achieving activities that would be error prone, challenging, or impossible to achieve (e.g., microscope, telescope, ...)

- **fundamental questions:**
  - what does it mean to **"learn" in the 21st century** in which powerful tools are available for many intellectual activities?

The Future

- Artificial Intelligence
- **Meta-Design**
- Design Trade-Offs

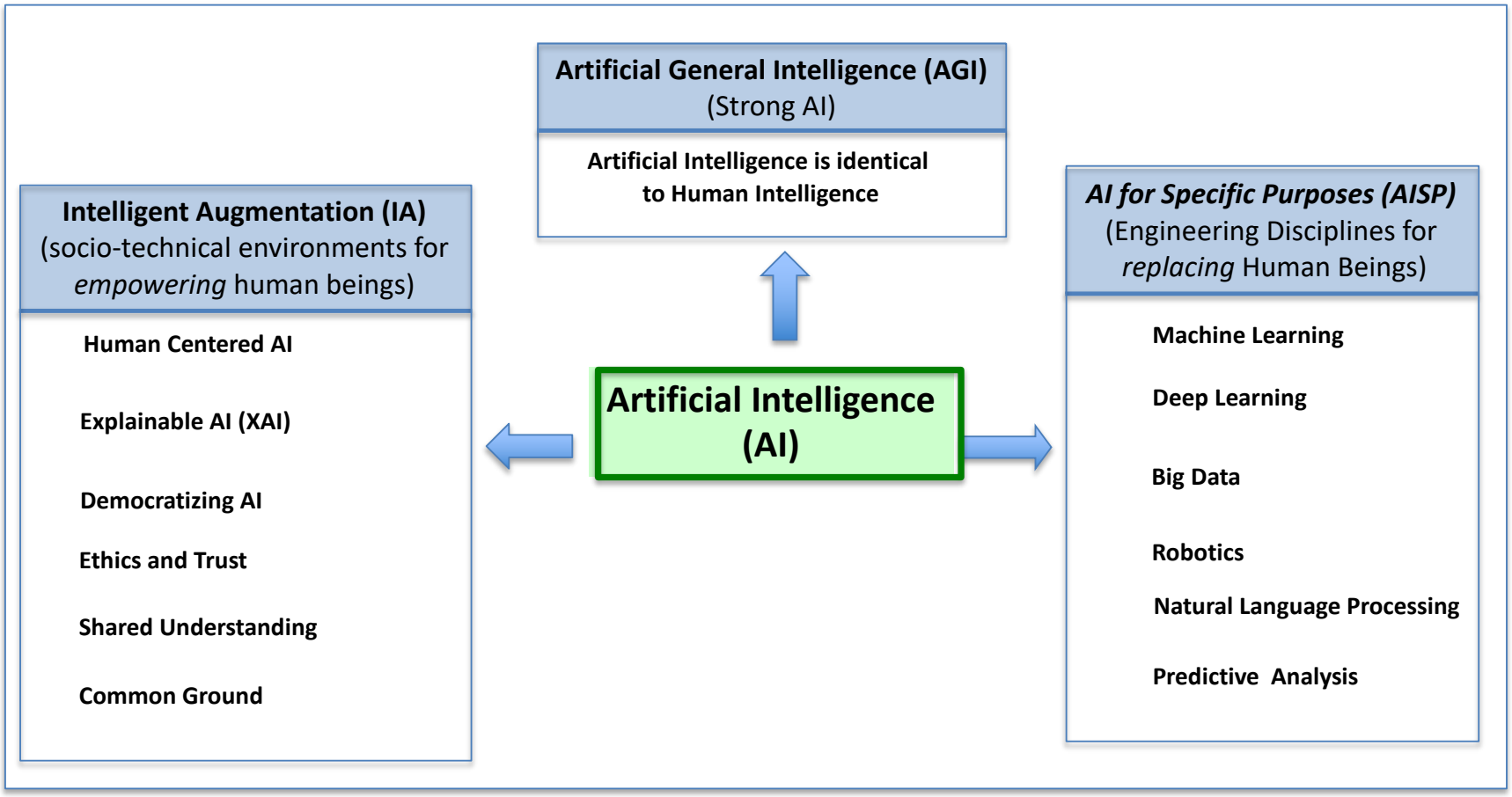
Artificial Intelligence (AI): The Theme of the Year / Decade

- there is **no generally accepted definition for AI** and there is no defined boundary to separate “AI systems” from “non-AI systems”

- AI is credited with **miraculous abilities** to solve all problems and exploit all opportunities of the digital age
  - it is currently being considered world-wide as a “deus ex machina” and promoted by numerous people (including: politicians, industrialists, academics, …….) who did not even know what AI was five years ago
  - but: **AI is at least 50 years old**

- **AI in Dementia Research —** numerous research activities and research papers focused on
    - **(social assistive) robotics** (e.g.: presentation by Prof. Filippo Cavallo “A Novel Cognitive Assessment Scenario in Dementia Using Social Assistive Robots”)
    - **artificial cognitive assistant** (conversational agents)

Differentiating AI Approaches



Meta-Design—Empowering Humans and Communities

- **definition:** design for designers
- **fundamental assumption**: design is not a matter of getting rid of the emergent, but rather of including it and making it an opportunity for more creative and more adequate solutions to problems
- **examples:** Wikipedia, Open Source,
- **support for meta-design:**
  - task-specific languages supporting human problem-domain interaction
  - provide programming environments that protect users from low-level computational drudgery
  - support customization, reuse, and redesign with component-based approaches

- **Design Methodologies**

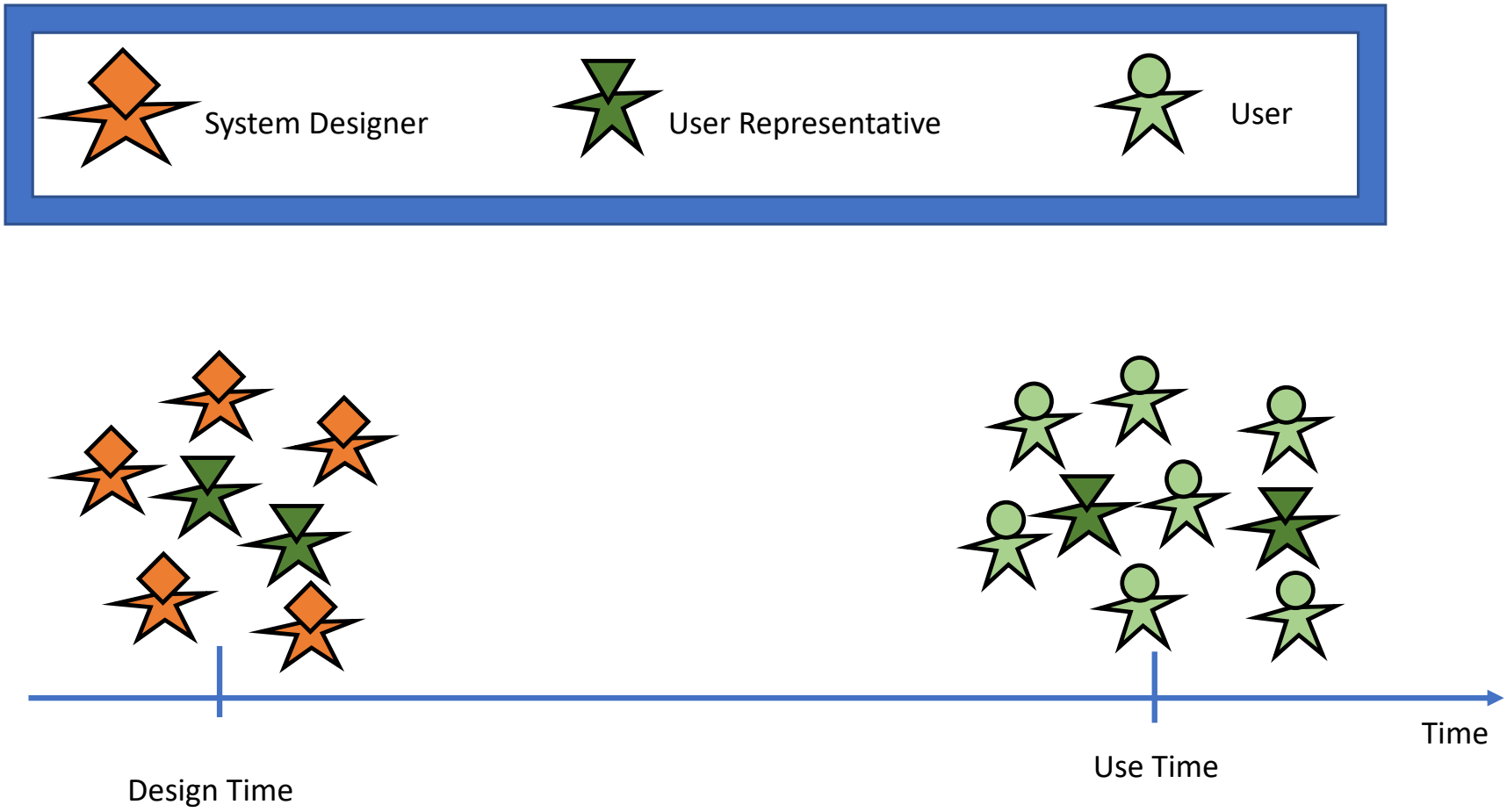
  professionally-dominated design

  → user-centered design

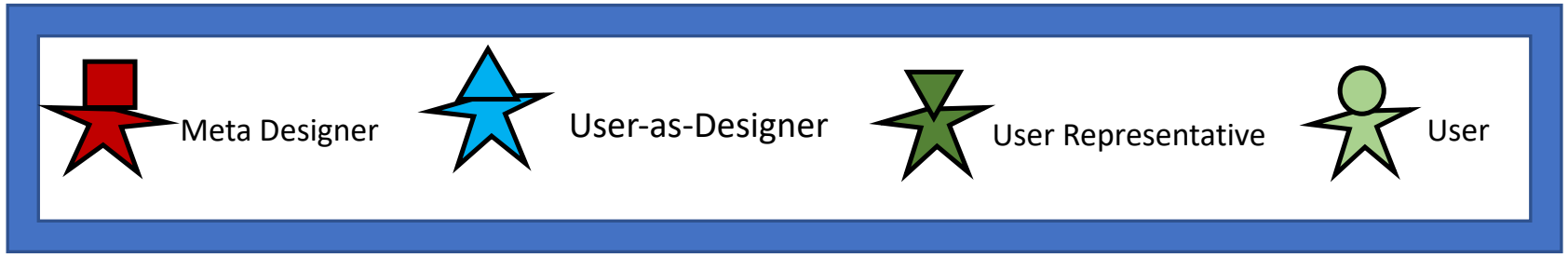
  → participatory design

  → meta-design

Participatory Design



Meta-Design


Meta Designer
User-as-Designer
User Representative
User


Time
Design Time
Use Time

The Ubiquity of Meta-design

- **Wikipedia**
- **Open Source**
- **Social Production** (cultures of participation encouraging and supporting owners of problems in contributing user-generated content in Web 2.0 environments) — **Benkler**
- **Democratizing Innovation** *("Users that innovate can develop exactly what they want rather than relying on manufacturers to act as their (often very imperfect) agents")* — ***von Hippel***
- **Liberterian Paternalism (Nudges:** appropriate mixes between prescriptive and permissive) — **Thaler and Sunstein**
- **Convivial Tools** *("give each person who uses them the greatest opportunity to enrich the environment with the fruits of his or her vision.")* — **Illich**
- **Learning and Teaching** (*new paradigms such as* courses as seeds, community-based learning theories, flipped classrooms) — **Center for Lifelong Learning and Design**

Meta-Design — A fundamental design requirement for The Future of Assistive Technology in Dementia Care

- patients form a **"universe of one"**
  - unexpected **islands** of abilities exist
  - unexpected **deficits** of abilities exist

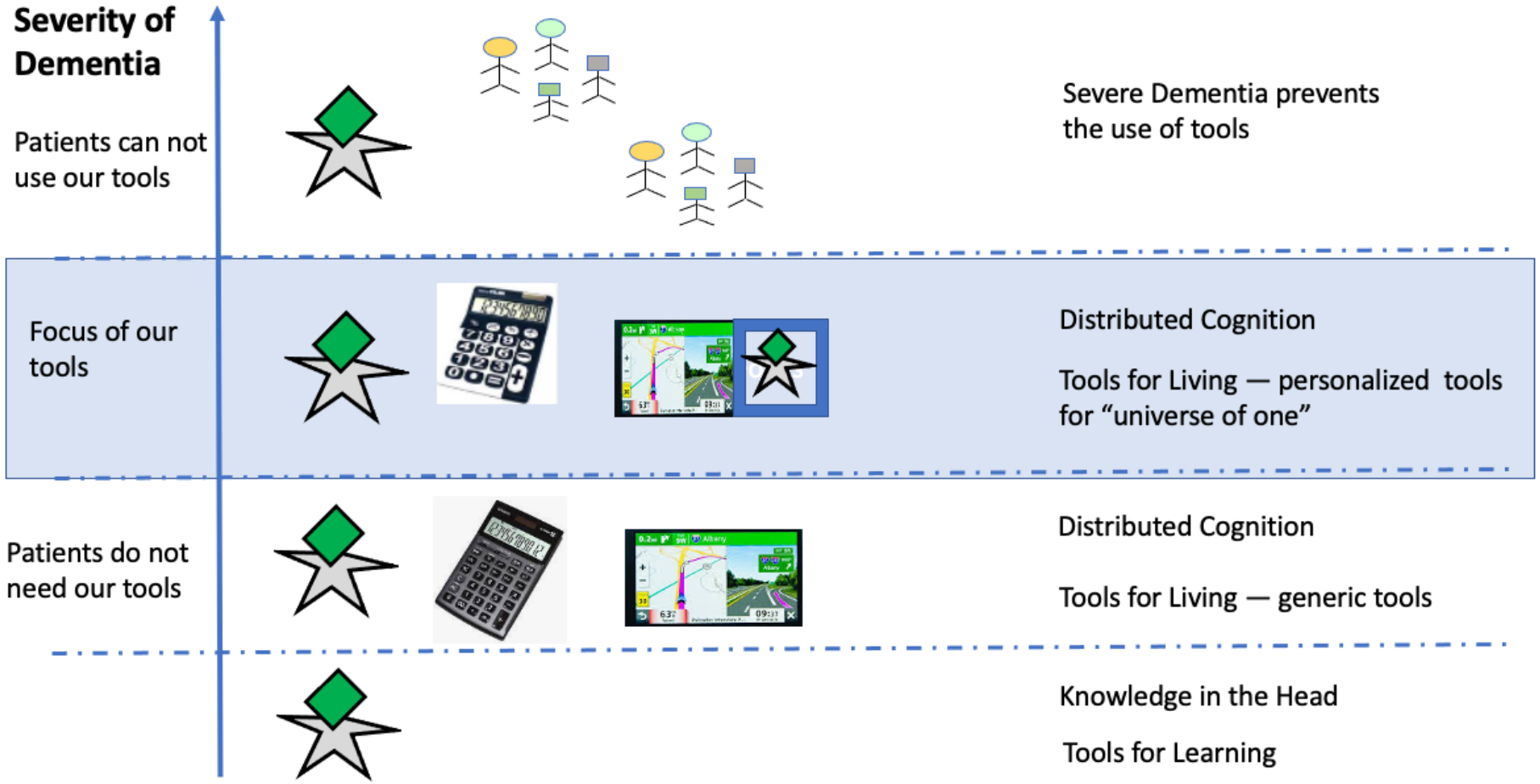
  → research in personalization, user modeling, adaptation, end-user development,

- care workers know the **needs of their patients** better than outsiders

- care workers adapt the assistive technologies to **local needs** — assistive technology systems do not work 'out of the box'

- **challenge:** care workers (not knowledgeable in information technology) must act as end-user developers to tailor, extend, or evolve assistive technologies

Activities of Daily Life: Independence versus Dependence on Tools and Care Workers



Meta-Design in Dementia Care

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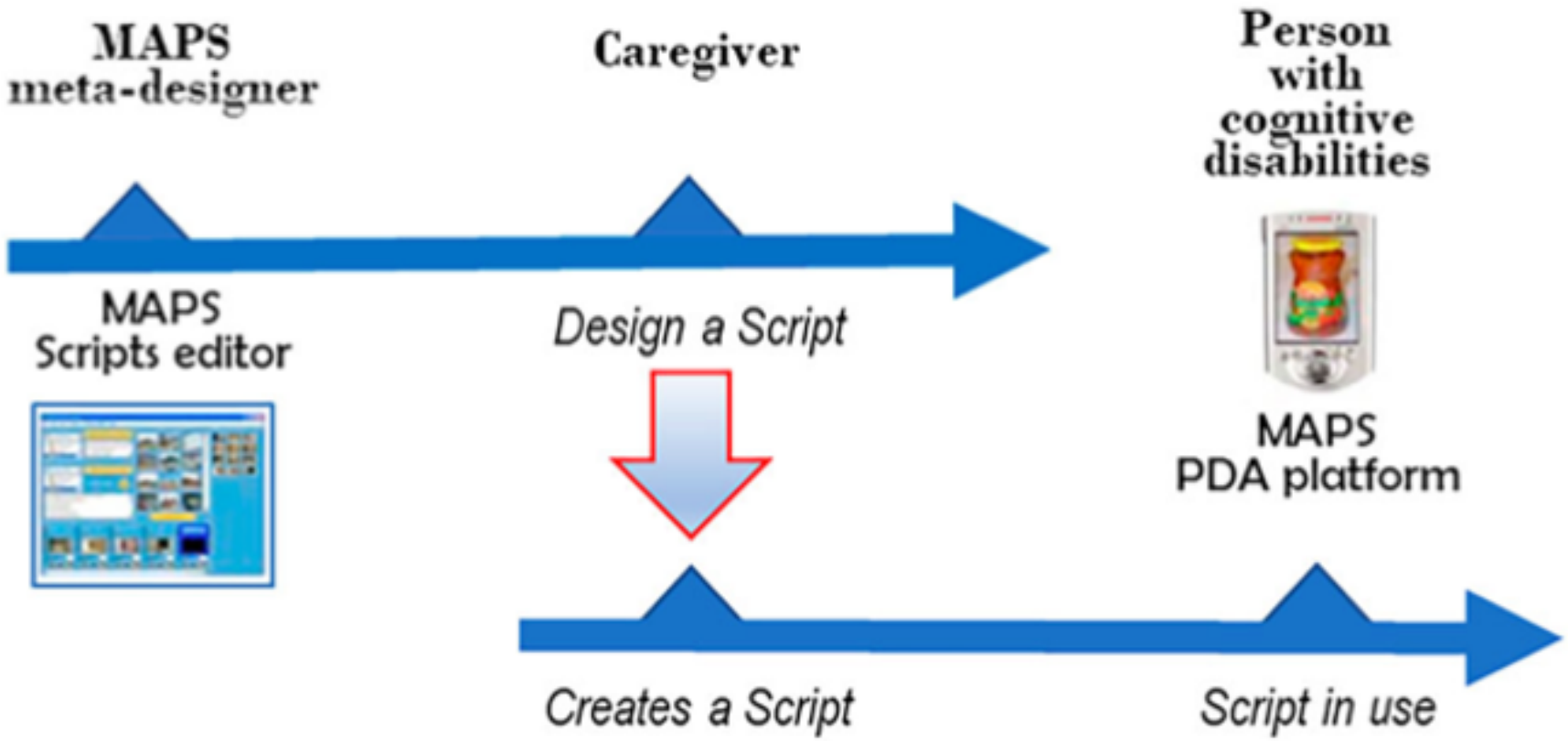
Support care workers to act as designers



Design Trade-Offs

- **claims:**
  - all important technologies are **"Faustian bargains": they give and take away** → technological change always produces winners and loosers

- **example: tracking /sensing of human beings and human actions**
  - **plus**: independence and support (Lifeline in Video)
  - **minus: privacy violations**

- **example: tools for living**
  - **plus**: transcending the unaided human mind (Mobility for All in Video)
  - **minus:over-reliance**

- **example: meta-design**
  - **plus**: independence, control (Memory Aiding Prompting Systems in Video)
  - **minus:** learning requirments, participation overload

- **example: Artificial Intelligence (AI) versus Intelligence Augmentation (IA)**
  - **plus:** IA = care robots helping not replacing, human caregivers
  - **minus:** AI = lack of human socialization

Recommendation: A New Science of Design
—
inspired by and applied to cognitive disabilities

"*For most people, technology makes things **easier**.*
*But for people with disabilities, technology makes things **possible**"*

- **new architectures for socio-technical environments** providing new experiences and opportunities for all stakeholder

- **standard tool sets fail** for people with disabilities because they are lacking the cognitive prerequisites for taking advantage of the tools

- **challenge**: create more than just alterations to existing tools developed for people without disabilities → design tools **explicitly** for people with cognitive disabilities

- **design trade-offs:** explore opportunities and pitfalls and be aware of unintended consequences

- **research methodology — basic research on real problems:** transcend the limitations of basic research (often limited to the ivory tower) and applied research (often limited to short duration of solving well-defined specific problems)

Impact of Socio-Technical Environments for People with Cognitive Disabilities

- will provide people with cognitive disabilities with **new opportunities and a different quality of life**

- will address **major social and economical challenges** (e.g., aging populations)

- have the potential to make **fundamental contributions and identify fundamental research issues** in the world of the 21st century by **"creating eyeglasses for the mind"** for transcending the unaided, individual human mind

Conclusions

- the future is not out there to be discovered — it has to be **invented and designed**

- **where are we?**

  "This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning." —Winston Churchill

Further Information

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