



Center for  
**LifeLong  
Learning  
& Design**

University of Colorado at Boulder

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

## Transcending the Individual Human Mind

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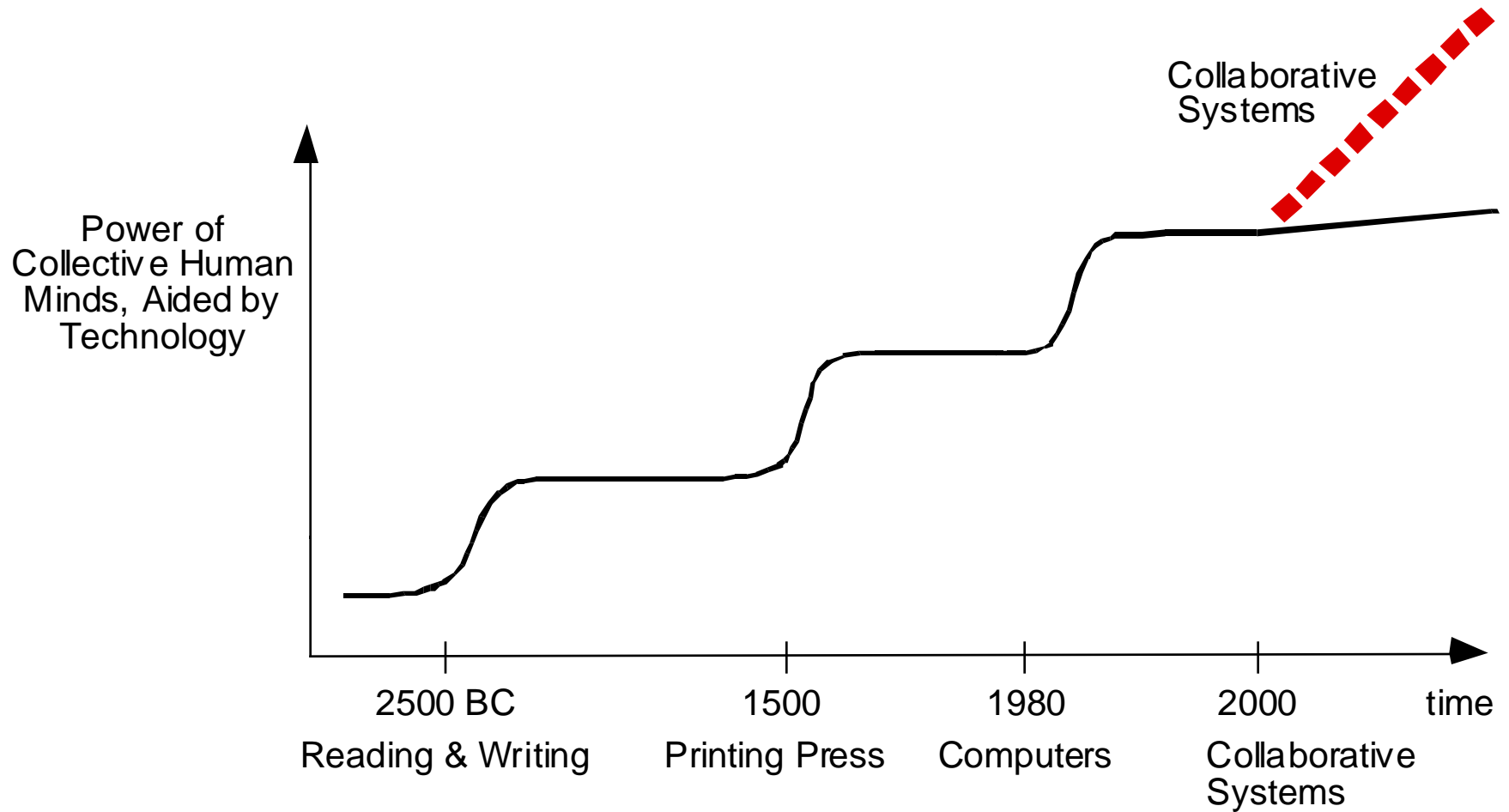
# Overview

- the aided, collective human mind
- a conceptual framework for collaborative design
  - symmetry of ignorance
  - social creativity
  - meta-design
- example: the Envisionment and Discovery Collaboratory (EDC)
- conclusions

**Thinking, Learning and Working —The “Wrong” Image?**  
**“The Thinker” by Auguste Rodin (1840-1917)**



# The Aided, Collective Human Mind — Exploiting the Social



# A Conceptual Framework for Collaborative Design

- symmetry of ignorance (or: asymmetry of knowledge)
- social creativity
- meta-design

# “Symmetry of Ignorance”

*“The strength of the wolf is in the pack,  
and the strength of the pack is in the wolf.”*  
Rudyard Kipling

- **the Renaissance scholar does not exist anymore** — the individual human mind is limited
- **distinct domain of human knowledge exist** (C. P. Snow) → of critical importance: mutual appreciation, efforts to understand each other, increase in socially shared cognition and practice, exploit the “symmetry of ignorance” (Horst Rittel) for mutual learning
- create **boundary objects** (*shared* objects to “talk about” and to “think with”)

## “A Group has No Head” — The Need for and Importance of Externalizations in Collaborative Design

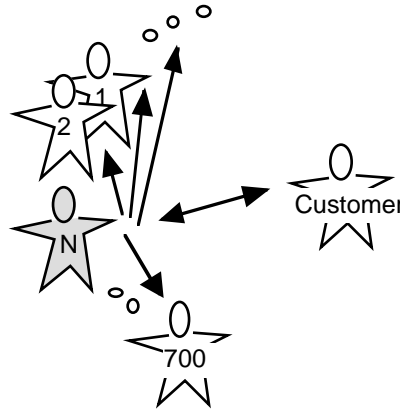
- **claim:** the heart of intelligent human performance is not the individual human mind but **groups of minds in interaction with each other and minds in interaction with tools and artifacts** (distributed cognition)
- **observation:** the individual human mind and external artifacts often function well together, because the required knowledge which an individual needs is distributed between her/his head and the world (examples: a folder system of e-mail messages, a file system, ..... )
- **because a group has no head** → externalizations are critically more important for organizational learning than for individual learning

# Social Creativity

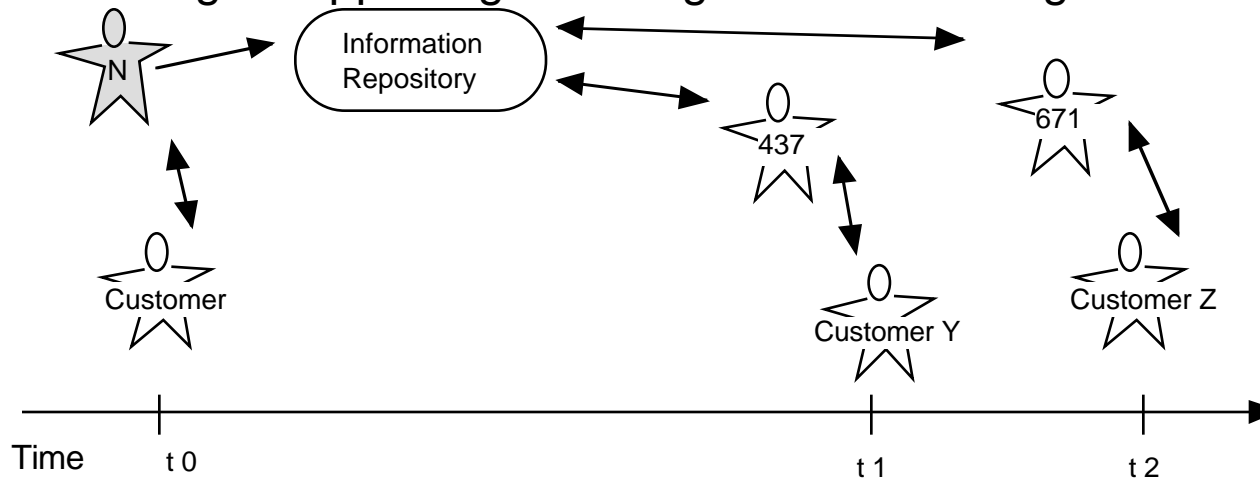
- **social creativity: requires designers not consumers**
- **designers create externalization** which
  - talk back to them and to others
  - can be analyzed, criticized, and incrementally improved
  - can serve as boundary objects
- of critical importance: **motivational aspects**
  - what will make humans want to become designers/active contributors over time?
  - what will make humans want to share? → requires: culture change, organizational memories
  - *“who is the beneficiary and who has to do the work?”* (J. Grudin) → organizational rewards

## Example: 1200 Help Desk People

- broadcasting leads to information overflow of decontextualized information



- the challenge: supporting the integration of working and learning



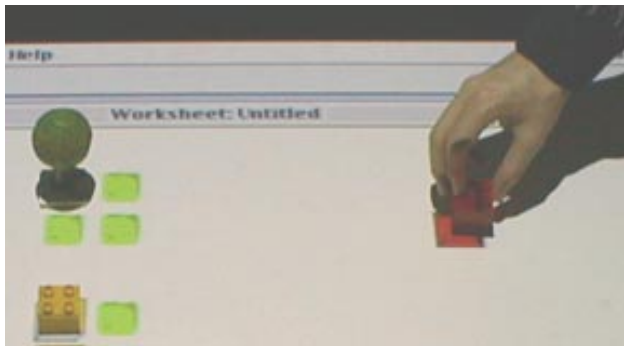
# Meta-Design

- **meta-design** = how to create new media which allows other humans to act as designers and be creative
- **concepts of meta-design:**
  - convivial tools
  - underdesigned systems
  - human problem-domain interaction (“task to the forefront”)
  - critiquing
  - learning on demand
  - open, evolvable systems
- **impact of meta-design**
  - *“if you give a fish to a human, you will feed him for a day — if you give someone a fishing rod, you will feed him for life” (Chinese Proverb)*
  - can be extended to: *“if we can provide someone with the knowledge, the know-how, and the tools for making a fishing rod, we can feed the whole community”*

# The Envisionment and Discovery Collaboratory (EDC)



# The Envisionment and Discovery Collaboratory



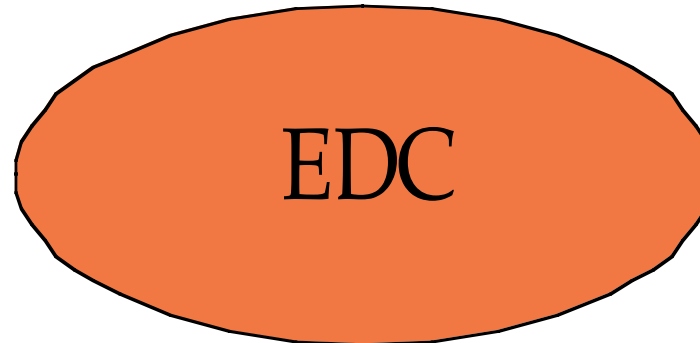
# The Envisionment and Discovery Collaboratory (EDC)

<http://www.cs.colorado.edu/~l3d/systems/EDC>

- **creating shared understanding through collaborative design**
  - symmetry of ignorance, mutual competence, and breakdowns as sources of opportunity
- **integration of physical and computational environments**
  - hardware: electronic whiteboards, crickets
  - software: AgentSheets, Dynasites
  - beyond the screen: immersive environments
- **support for reflection-in-action**
  - action space: AgentSheets, Visual AgenTalk
  - reflection space: Dynasites
  - critics and usage data, preferences linking the two spaces
- **support for boundary objects** which facilitate shared understanding between different communities of practice
- **open system** — seeding, evolutionary growth, reseeded (SER) process model

# The Architecture of the Envisionment and Discovery Collaboratory

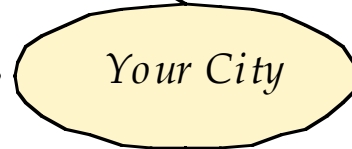
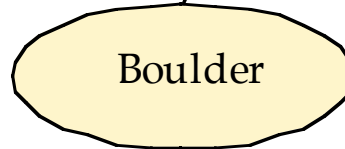
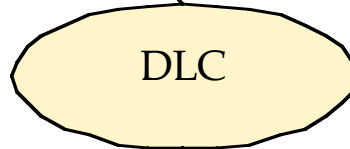
Domain-  
Independent  
Architecture



Application  
Domains



Specific  
Applications



# Characterization and Research Activities in the Action Space

Level	Technology Used	Research Problems
<b>Hardware</b>	Touch-sensitive SMART Board 360; computationally enriched physical objects	recognize the physical construction; turn physical objects into computational entities
<b>Software and End-User Modifiability</b>	AgentSheets simulation environment and Visual AgenTalk	extend domain models, visualize outcomes, create and utilize critics
<b>Linkage to the Reflection Space</b>	critics	recognize breakdowns, contextualize information

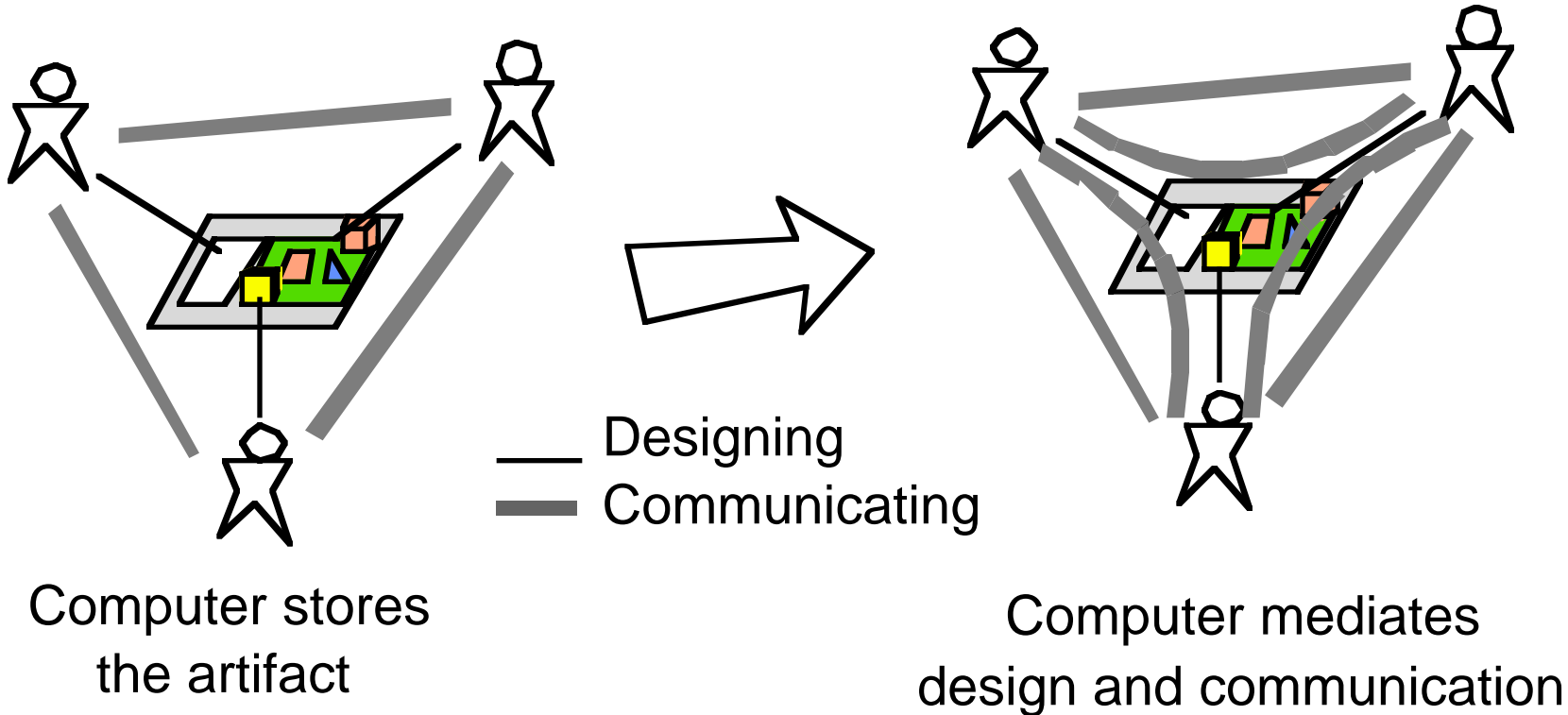
# Characterization and Research Activities in the Reflection Space

<b>Level</b>	<b>Technology Used</b>	<b>Research Problems</b>
<b>Hardware</b>	rear-projection white-board SMART Board 720	multi-model interaction techniques
<b>Software and End-user Modifiability</b>	Dynasites — a substrate for dynamic, evolvable, Web-based information spaces	encourage user participation and evolution of information over time
<b>Linkage to the Action Space</b>	priority specification, maps, previous constructions, questionnaires	make the linkage mechanisms end-user modifiable

# The Strength and Weaknesses of Physical Media

Strengths of Physical Media	Weaknesses of Physical Media
direct, naive manipulability	models are passive; incapable of changing representation without intervention by users
intuitive understanding	behavior cannot be associated with physical objects
tactile interaction	no support for simulation and critiquing
mediation of communication and social interaction	feedback on the consequences of a decision is not provided
relative high fidelity to reality	fidelity to reality is limited due to problems such as scaling
looking provides valuable information	no support for management of large amounts of information

# Embedding Communication in Design Activities



# Meta-Design Aspects in the EDC: Closed versus Open Systems

- **user control:**
  - end-user modifiability (modification and programming by users)
  - conviviality (independence of high-tech scribes)
  - ownership (putting owner of problems in charge)
  
- **example for a closed system: SimCity** — too much crime
  - solution supported: build more police stations (fight crime)
  - solution *not* supported: increase social services, improve education (prevent crime)
  
- **important goal of EDC:** create end-user modifiable versions of SimCity
  - background knowledge can never be completely articulated
  - the world changes

## Closed versus Open Systems: SimCity™ versus EDC

<b>Issue</b>	<b>SimCity™</b>	<b>Research Problems of Open Systems Explored in the EDC</b>
<b>user-directedness, openness of systems</b>	rich construction mechanisms, simulation is a “black” box	rich construction + end-user modification of model and behavior
<b>contextualized information</b>	no support for task-based indexing or reflection-in-action	linking of action and reflections with user-defined critics
<b>engagement / motivation</b>	game engaging but limited in modeling users’ own situations	owners of problems are in charge, and engage in self-directed activities
<b>collaboration</b>	multi-user version restricted to mayoral decisions and voting	ability to share argumentation and simulation components

# Boundary Objects

*“If a lion could speak would we understand him?” — Wittgenstein*

- **boundary objects serve**
  - to communicate and coordinate the perspectives of communities of practice brought together for some purpose
  - the interaction between users and (computational) environments
- perform a **brokering role** involving translation, coordination and alignment between the perspectives of specific communities of practice
- **boundary objects support new civic discourses:** one of the major roles for new media and new technologies is not to deliver predigested information to individuals, but to provide the opportunity and resources for social debate and discussion

## Limitations of the Current EDC and New Research

Features of EDC	Selected Limitations	New Research
<b>Multi-Modal Interaction</b> <ul style="list-style-type: none"> <li>• SMART Boards enable some intuitive interactions</li> <li>• interaction with physical objects</li> <li>• video-taped design sessions capturing the discussions about the design activities</li> </ul>	<ul style="list-style-type: none"> <li>• SMART Boards respond only to sequential input; no support for concurrent interaction</li> <li>• users needs to explicitly change modes using palette</li> <li>• conversation around the design is not integrated into the computational system</li> </ul>	<ul style="list-style-type: none"> <li>• incorporate new generations of hardware and software</li> <li>• physical objects with embedded computation (e.g., crickets) do not require moded interactions</li> <li>• link informal discussion and the design artifact</li> </ul>
<b>Contextualized Information</b> <ul style="list-style-type: none"> <li>• prototypical critics developed for Urban-Planning<sub>EDC</sub></li> <li>• prototypical I-balls developed for Learning-Spaces<sub>EDC</sub></li> </ul>	<ul style="list-style-type: none"> <li>• isolated examples – no general-purpose mechanism for developing critics</li> <li>• only a prototype used for proof-of-concept</li> </ul>	<ul style="list-style-type: none"> <li>• create better mechanisms and data structures to link critics to evolving design argumentation</li> <li>• make prototype fully functional</li> </ul>
<b>Open Systems</b> <ul style="list-style-type: none"> <li>• end-user programming using Visual AgentTalk</li> </ul>	<ul style="list-style-type: none"> <li>• insufficient support (e.g., domain models too limited) for modifications</li> </ul>	<ul style="list-style-type: none"> <li>• develop general-purpose mechanisms for end-user modifications and support for the SER model</li> </ul>