



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**

## **Universe of One, Situated Support and Context Aware Application**

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**Introductory Remarks to a L3D Discussion Meeting, Jan 21, 2004**

# Universe of One, Situated Support and Context Aware Application

## ▪ universe of one

- people with disabilities form “a universe of one” → research in personalization, user modeling, and adaptivity/adaptation is of critical importance
- individuals can (and in some cases must) follow very different learning paths → create environments that match individual needs and learning styles

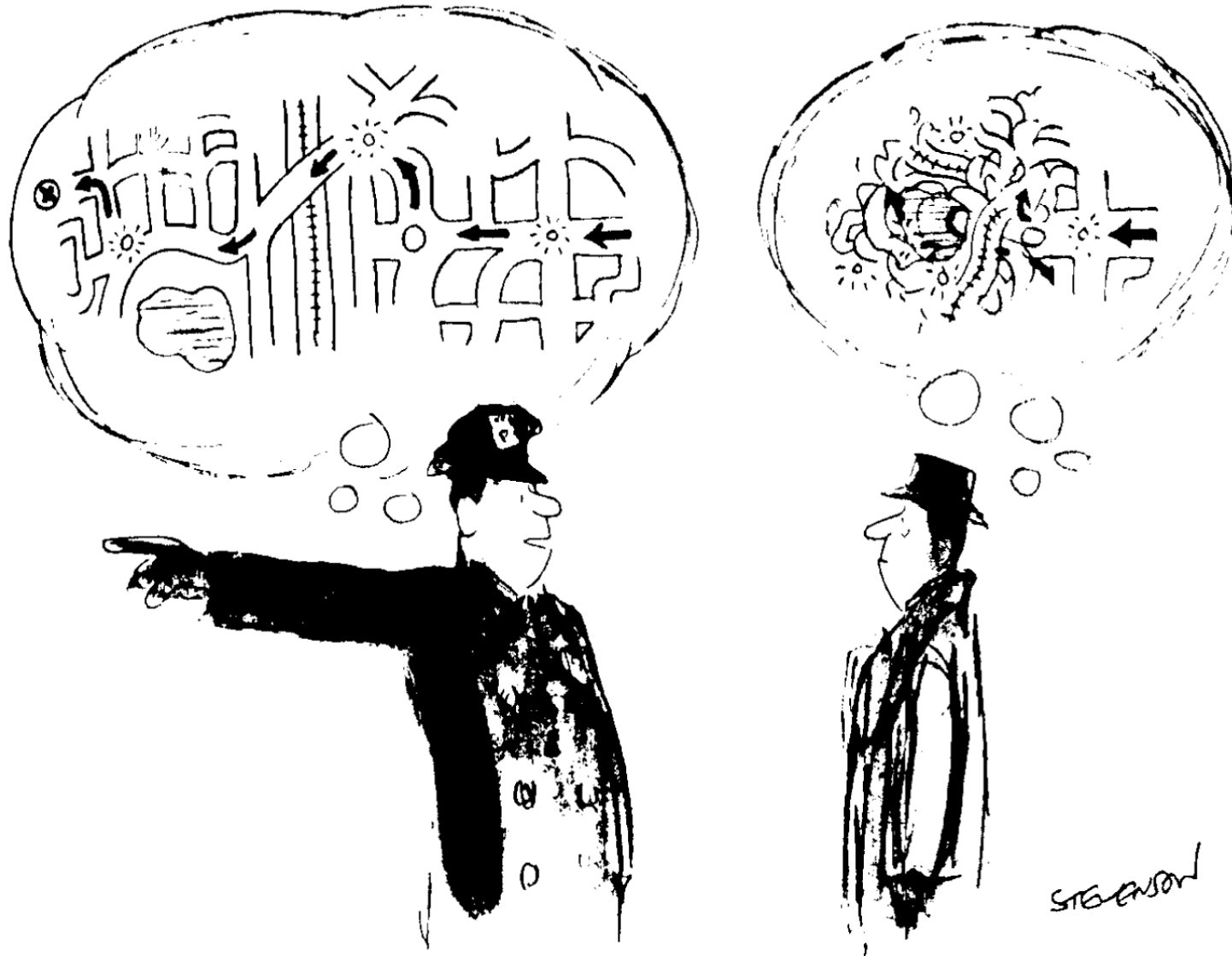
## ▪ situated support

- planning (as it is done at design time) is important → but needs to be complemented by support for situated action at use time

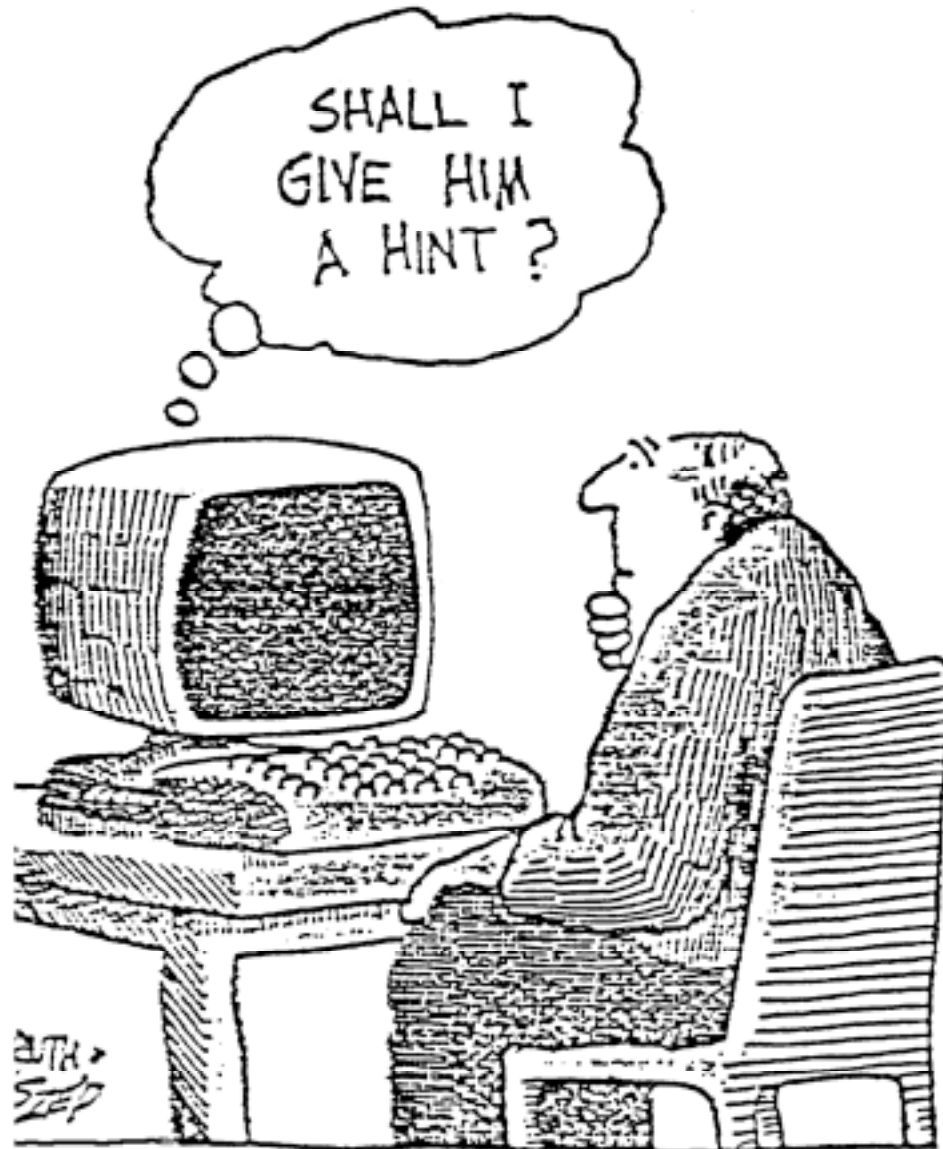
## ▪ context awareness

- is important for **all** applications
- it poses **unique new challenges** for:
  - “universe of one” applications
  - pervasive/ubiquitous application

# Context = Shared Understanding and Background Knowledge



**Context = Information Delivery, Contextualization, and Intrusiveness**



# Exploiting Context Awareness

- **claim:** building *truly context-aware environments* present a greater challenge than
  - location awareness captured by sensors
  - presence awareness in distributed collaborative work (e.g., social network analysis based on email traffic)
  - *it requires shared understanding between humans and their computational environments*
- **context in design** is not a fixed entity sensed by devices, but it is emerging and it is unbounded
- **context-aware computing** (Moran/Duguid, HCI journal, 2001, p 89): *“one goal of context-aware computing is to acquire and utilize information about the context of a device to provide services that are appropriate to the particular people, place, time, events, and so forth”*

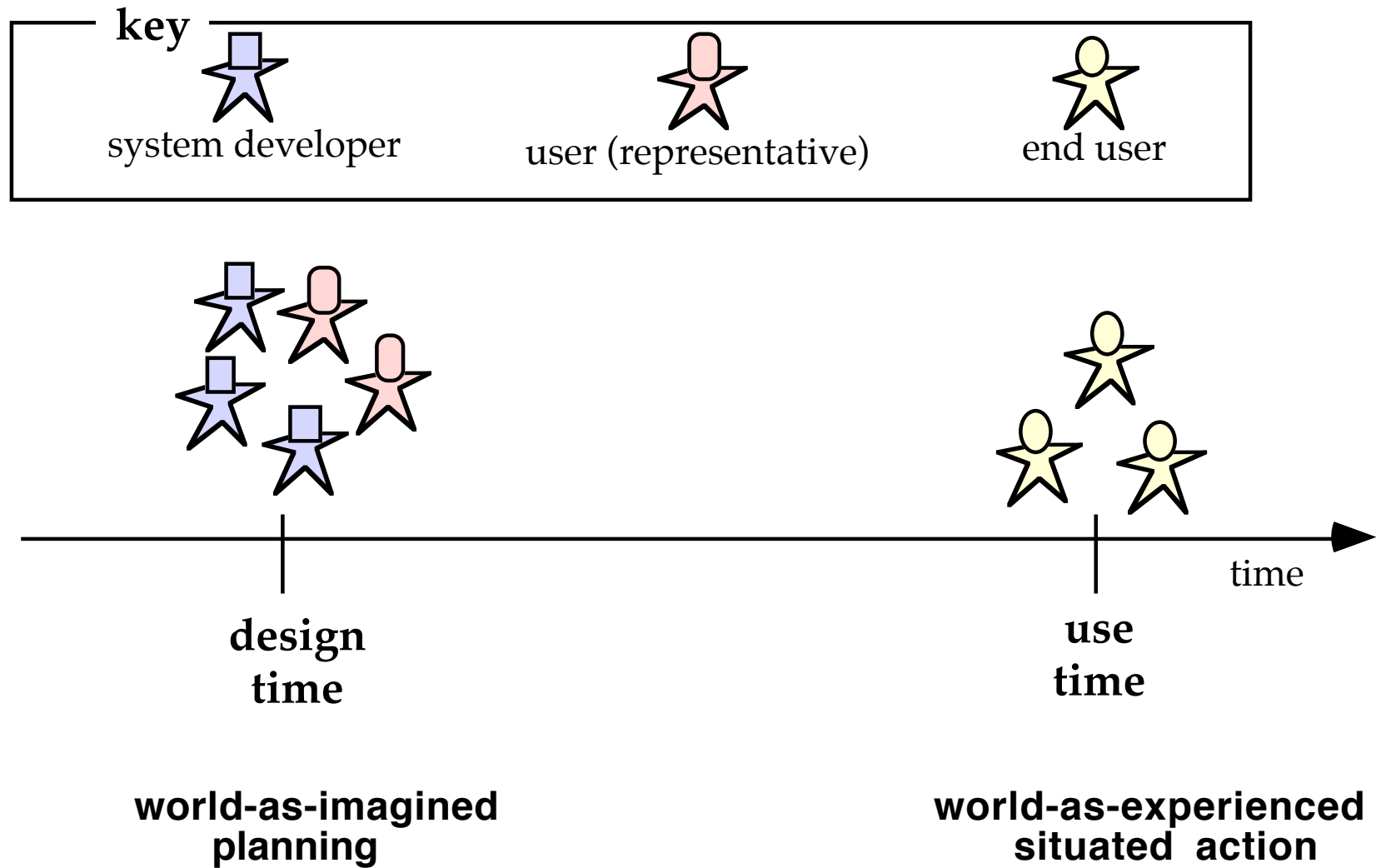
# Global Objectives for Context-Aware Environments

- **identify user goals from low-level interactions**
  
- **increase the resources for interpretation**
  - physical location, interaction, navigation, other users in the environment
  - interactions (e.g., posing a query) with computational artifacts are often part of a larger activity, such as a complex design task, but computer systems do not “understand” the larger activity
  
- **reduce the information overload**: from “*anytime and anywhere*” → “*say the ‘right’ thing at the ‘right’ time in the ‘right’ way*”
  
- **articulate design intent** — in design, a large fraction of context-relevant information cannot be inferred from the environment because the context
  - resides outside the environment
  - is unarticulated
  - exists only in the mind of the designer

# Sensing, Inferring, and Creating Context

- **active badges**
  - represent an early technological development for the location-based services
  - the information provided by active badges can be used to support circumstantial indexing <Bolt, 1984>
- **latent semantic analysis (LSA)** — infer context from statistical similarities in texts
- **social interaction approaches** <Dieberger et al., 2000> — *usage data, recommender systems, social navigation, attention-sensitive alerting, etc.*
- **some relevant publications/meetings:**
  - special issue “**context in design**” of the HCI journal, 1994
  - special issue “**context-aware computing**” of the HCI journal, 2001
  - workshop on “user modeling for context-aware applications”, UM’01, july, Sonthofen, Germany

# Design Time and Use Time





# Design Time and Use Time

- **a fundamental challenge:** how do you write software for millions of users at *design time*, while making it work as if it was designed for each individual user only known at *use time*?
- **print media:** a fixed context for use time is decided at design time
- **computational media:** presentations at use time can take advantage of contextual factors only known at use time (about tasks, users, social systems,.....) in the form of specification sheets and usage data, supporting dynamic forms, dynamic websites, ....
- **evolving the existing systems:** users (acting as designers) can transcend the boundaries of the systems as developed at design time

# A Comparison Between Adaptive and Adaptable Systems

	<b>Adaptive</b>	<b>Adaptable</b>
<b>Definition</b>	dynamic adaptation by the system itself to current task and current user	user changes (with substantial system support) the functionality of the system
<b>Knowledge</b>	contained in the system; projected in different ways	knowledge is extended
<b>Strengths</b>	little (or no) effort by the user; no special knowledge of the user is required	user is in control; system knowledge will fit better; success model exists
<b>Weaknesses</b>	user has difficulty developing a coherent model of the system; loss of control; few (if any) success models exist (except humans)	systems become incompatible; user must do substantial work; complexity is increased (user needs to learn the adaptation component)
<b>Mechanisms Required</b>	models of users, tasks and dialogs; knowledge base of goals and plans; powerful matching capabilities; incremental update of models	layered architecture; human problem-domain communication; "back-talk" from the system; design rationale
<b>Application Domains</b>	active help systems; critiquing systems; differential descriptions; user interface customization	end-user modifiability, tailorability, filtering, design in use

## Some Examples of L3D Research in Context-Awareness

- **active help systems (CHI'85) (A. Lemke)**: identify user goals from low-level interactions
- **critiquing systems and learning on demand (CHI'89-CHI'94) (A. Morch, T. Sumner, ....)**: analyze and infer the task at hand; detect and identify the potential for a design information need; present contextualized information
- **specification components (K. Nakakoji)** — allow and assist users to enrich the description of their tasks, articulate design intent
- **expectation agents (D. Redmiles, A. Girgensohn, and F. Shipman)**: integrate at design time into the systems expectations for use time
- **integrating communication with design artifacts (B. Reeves, E. Arias, H. Eden)**
- **information delivery (Y. Ye)**: exploit partial work products, reduce information overload
- **Mobility-for-All, MAPS, Lifeline, Query-Lens (CLever research team)** — context in pervasive computing environments

# Design Intent

Intention of the Designer



Procedure Written by the Designer

```
to triangle  
  repeat 3 [forward 100 right 60]  
end
```

Feedback from the Environment

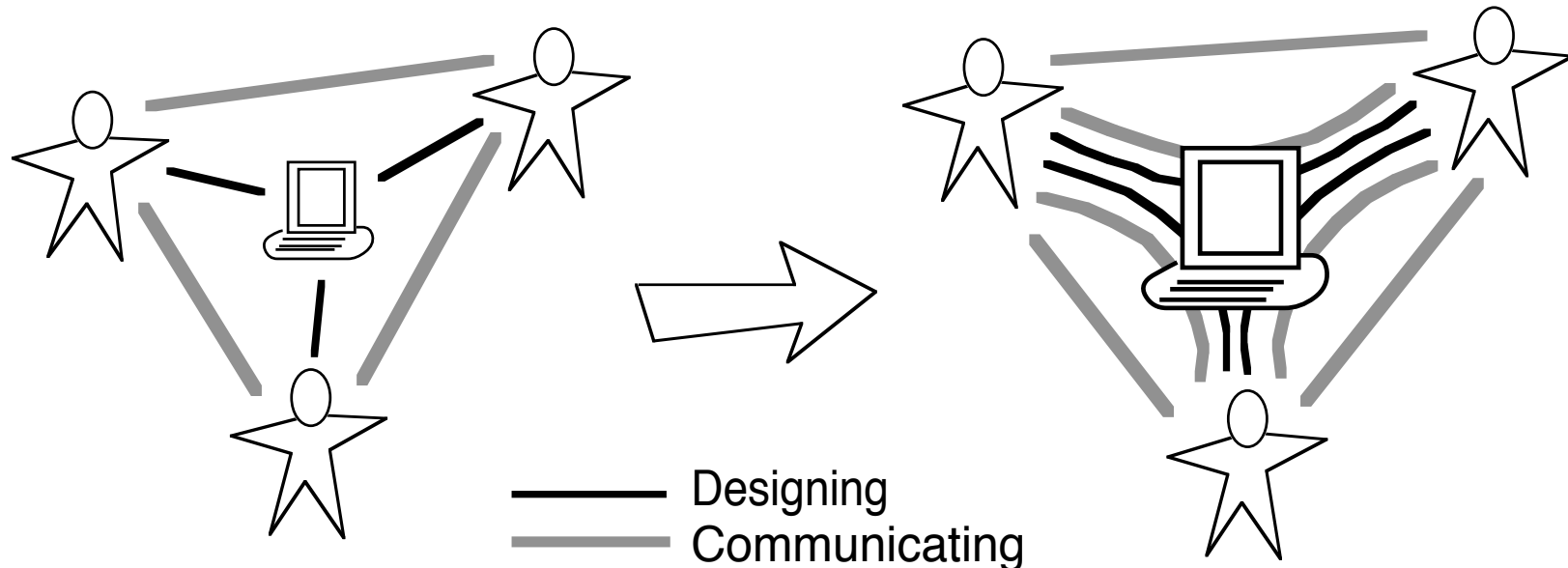


"Intent" Articulated to the system

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# Integrating Communication with Design Artifacts

(e.g. Envisionment and Discovery Collaboratory)



Computer stores  
the artifact

Computer mediates  
design and communication

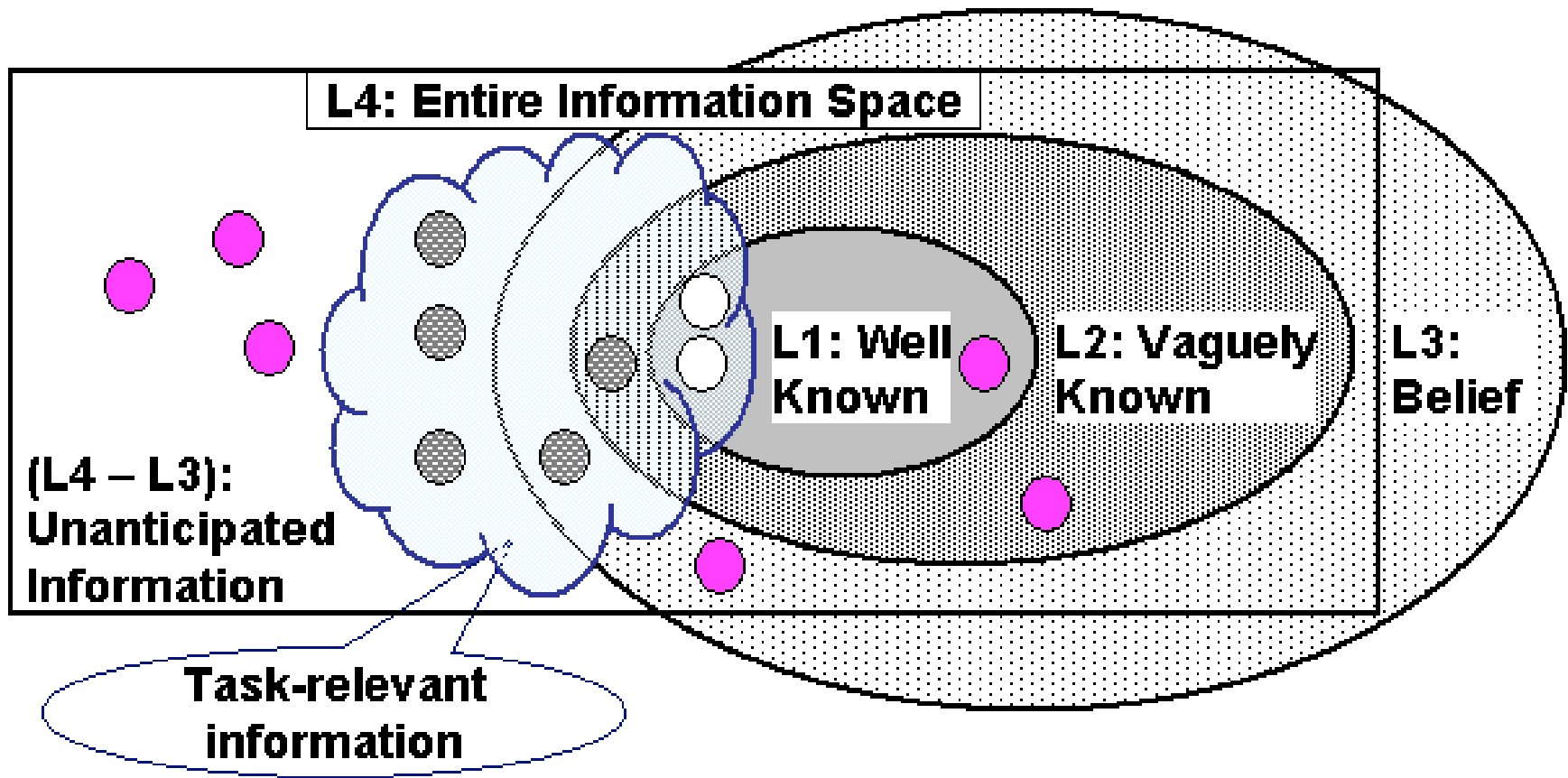
- **challenge:** communication taking place outside of design environments is isolated from artifacts → when designing and communication are both mediated by design environments, then rationale and communication can be integrated with artifacts

# CodeBroker: Personalizing Delivered Information in a Software Reuse Environment

- **thousands of components, constantly evolving**
  - standard Java repository: has grown from 211 classes to more than 2100 classes in 4 years
  - no programmer knows all of them
  
- **information access does not support programmers who do not actively search for reusable components**
  - unaware of the existence of relevant components
  - unable to locate components
  
- **delivering personalized components based on task and user modeling techniques**
  - immediate task → task model
  - current development session → discourse model
  - user's knowledge of components → user model

# The Fundamental Challenge for Information Delivery

## Making Information Relevant to the Task at Hand



# Relationships

- **meta-design:**
  - define the context, not the content
  - question: in which applications is the context defined at design time or does it emerge (particularly in ubiquitous, mobile computing environments)?
  
- **social creativity:** let the users define and share the emerging context
  
- **context: explicitly defined  $\leftrightarrow$  sensed/derived**
  - explicitly defined  $\rightarrow$  specification component, explicit user modeling
  - sensed/derived  $\rightarrow$  usage data, analysis of an emerging work product



# Questions

- explore **specific dimensions** of contexts
  - static  $\leftrightarrow$  dynamic, constantly changing
  - long-term  $\leftrightarrow$  short-term
- **research directions:**
  - smart context-aware machines helping people (CLever)
  - systems that augment people's capability to be context-aware (example: a police person / sales agent / helpdesk person who is aware of a customer's context and are able to provide useful recommendations)
- the **biggest (?)** questions for many developments associated with context-awareness: the role of **privacy**