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

Context-Aware Systems

The 'Right' Information, at the 'Right' Time, in the 'Right' Place, in the 'Right' Way, to the 'Right' Person

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Center for LifeLong Learning & Design (L^3D)

Presentation, L3D Meeting, February 1, 2012

Overview

- Motivating Examples
- Context and Context-Awareness
- Problems Addressed by Context-Aware Systems
- Exploring Particular Aspects of Context-Aware Systems
- L3D's Research in Context Aware Systems
- Implications and Future Research

The Basic Challenge

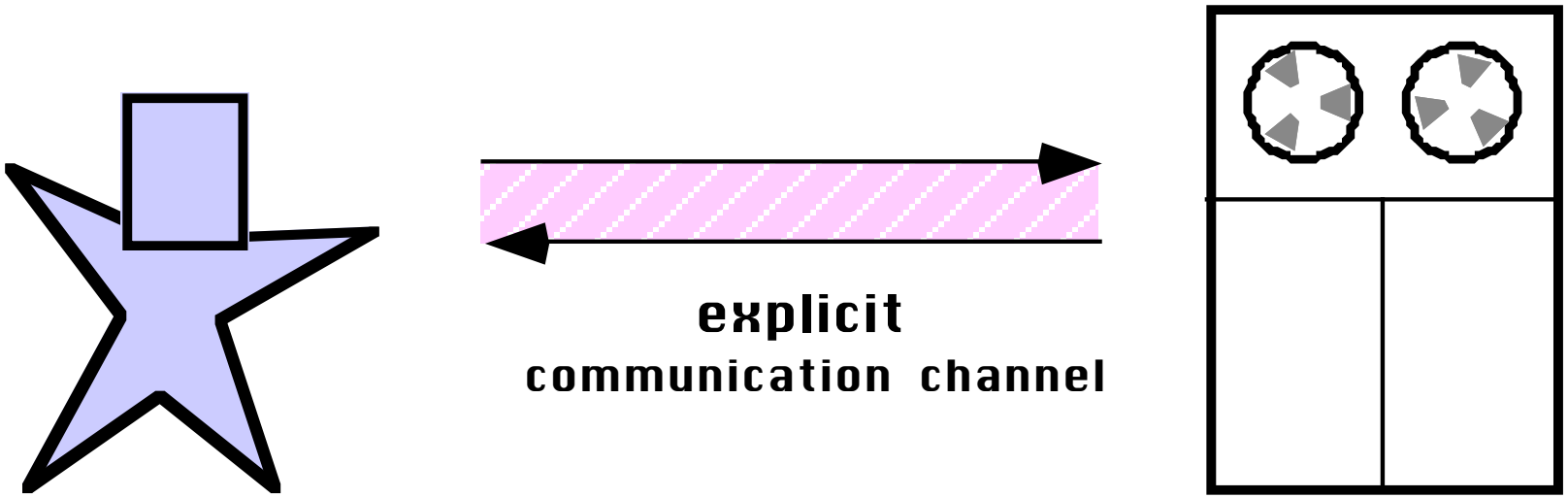
"the interaction between people and computers requires essentially the same interpretive work that characterizes interaction between people, but with ***fundamentally different resources*** *available to the participants*

Suchman, L. A. (1987) *Plans and Situated Actions,* Cambridge University Press,

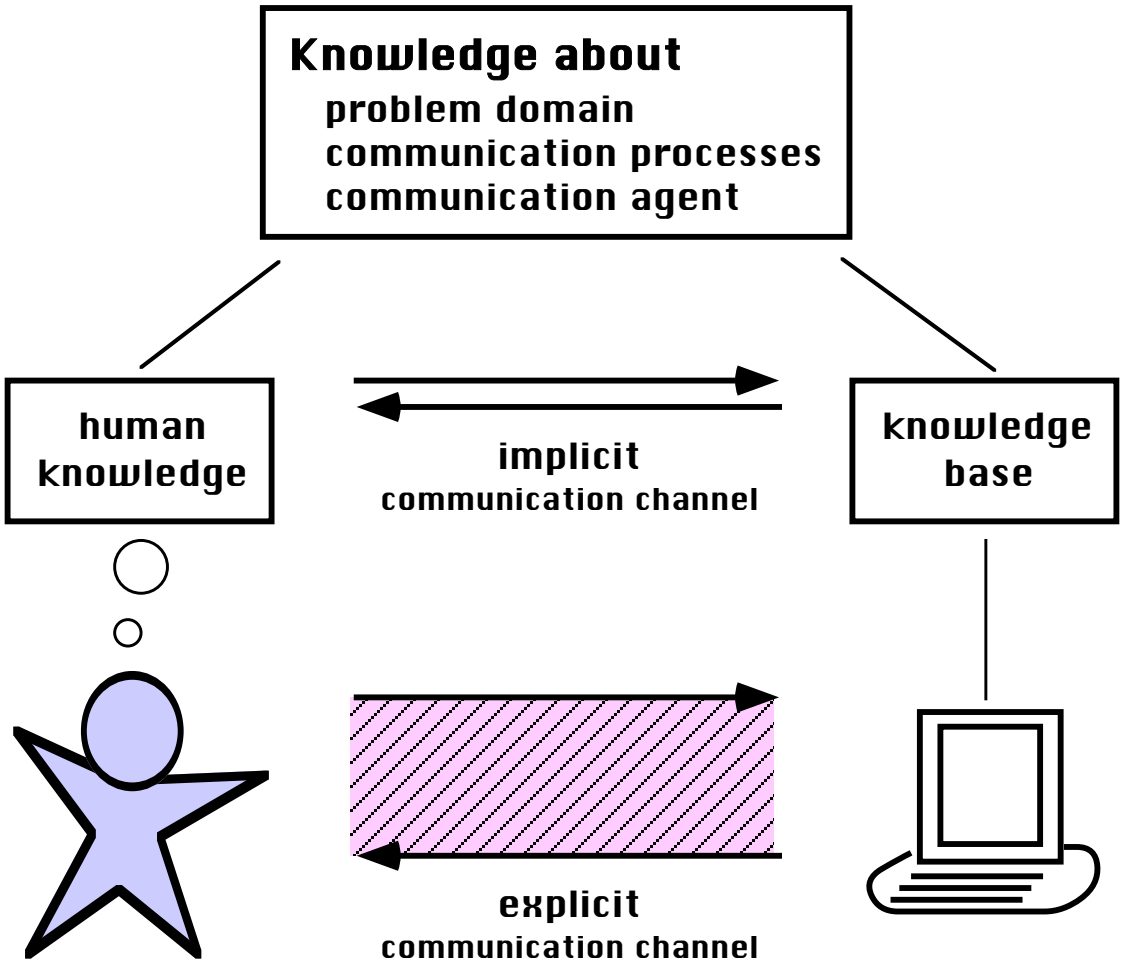
- a major research objective of human-centered computing (HCC):
  to create a **synergy** between human and computational resources with socio-technical environments

The ‘Old’ Days — The Human-Computer Dyad:

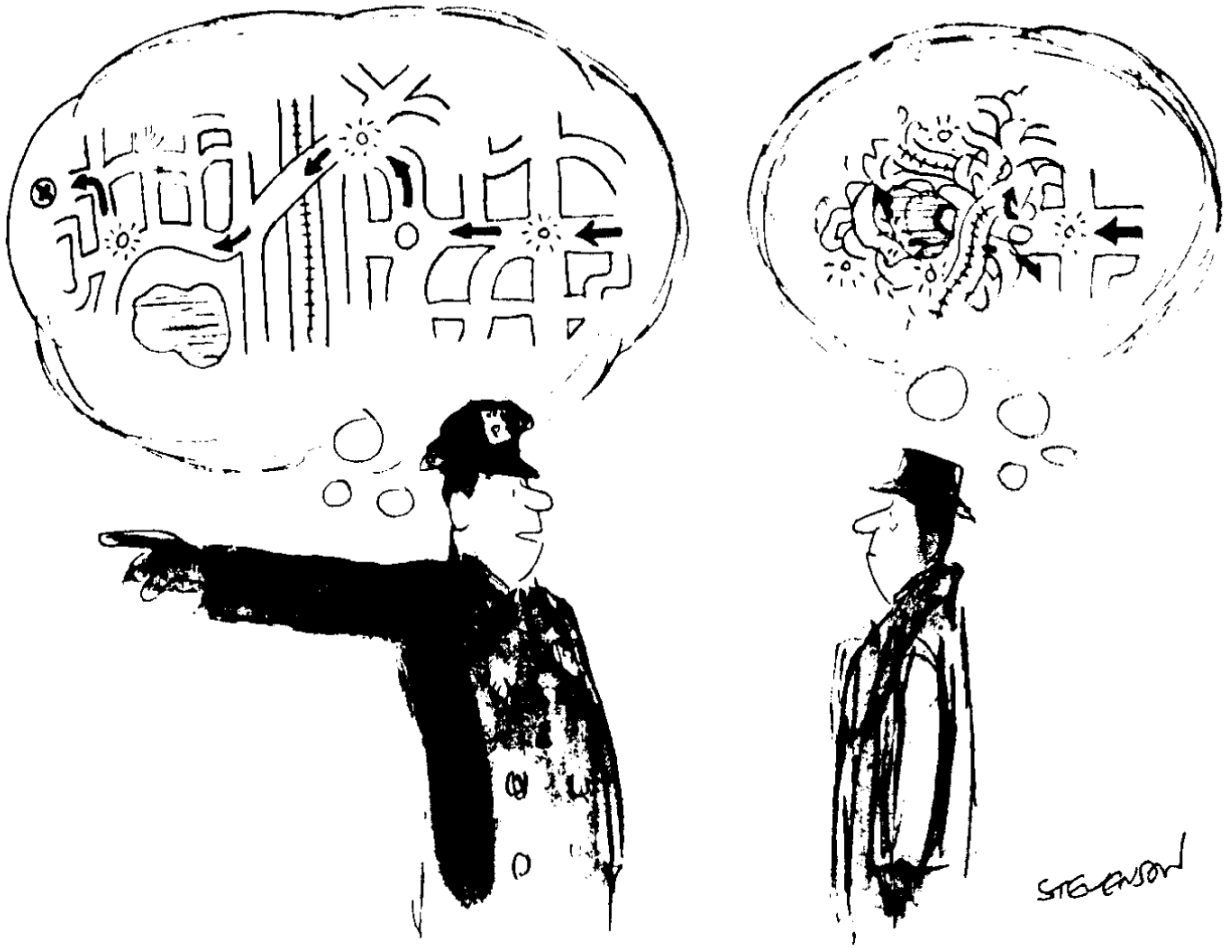
Human and Computer connected by a narrow explicit communication channel



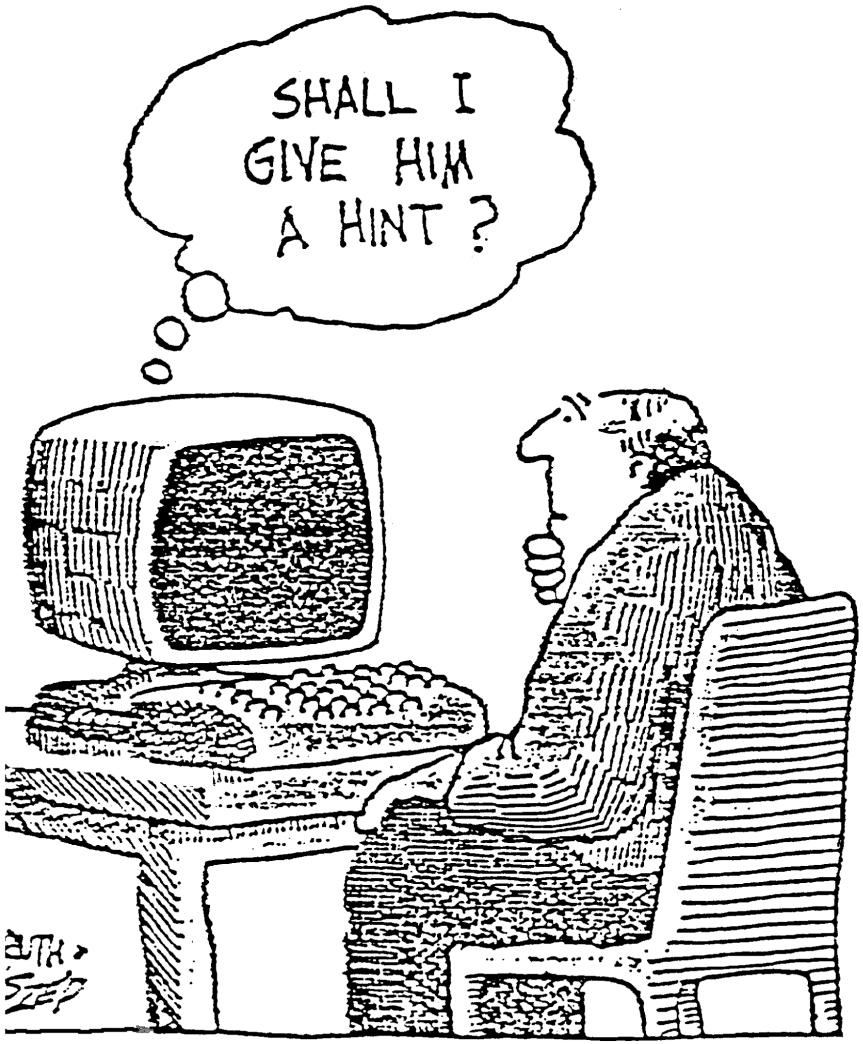
Knowledge-Based HCC:
Broader Explicit and Additional Implicit Communication Channel



Understandability, Learnability and Common Ground

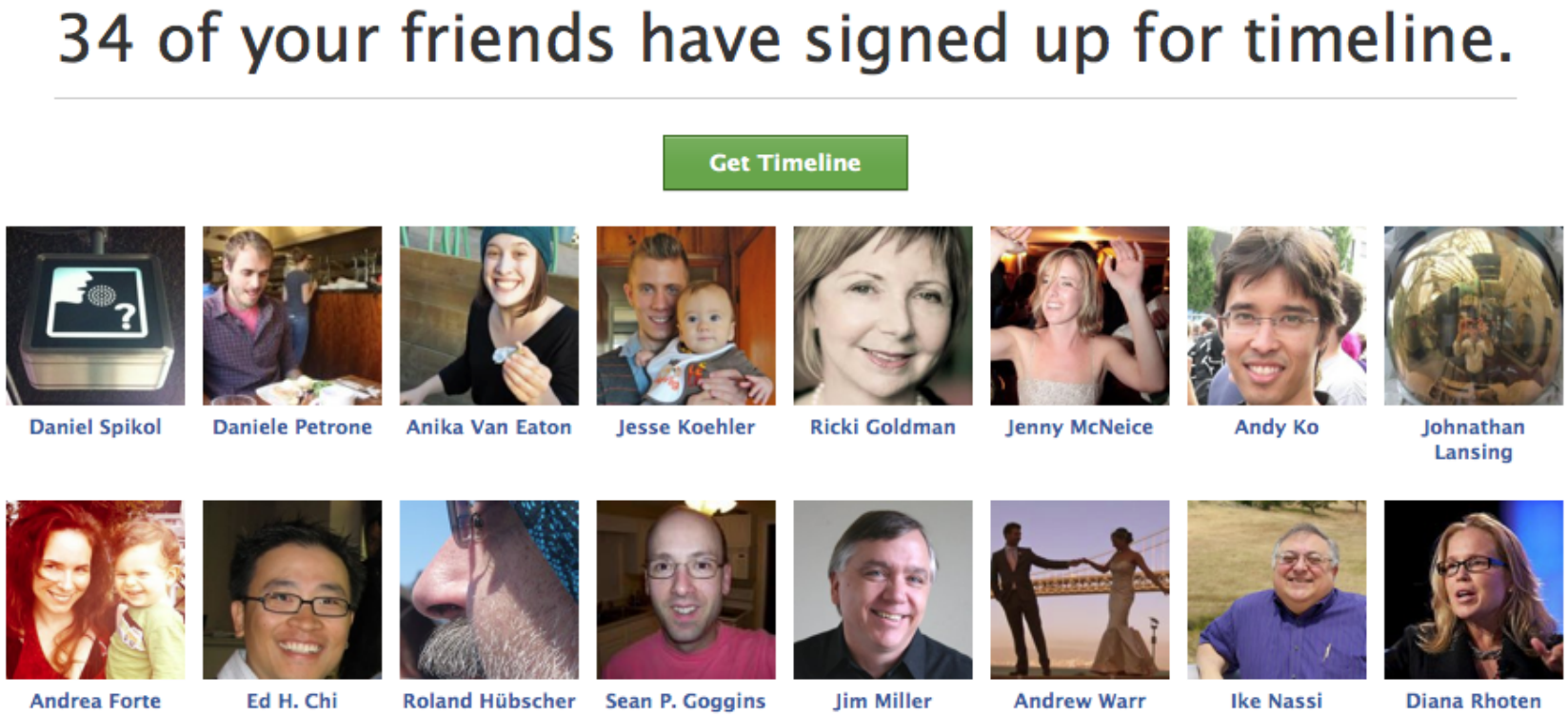


Information Delivery and Intrusiveness: Inferring from Gestures and Behavior



Context Awareness in Todays World?

Timeline = Share and highlight your most memorable posts, photos and life events on your timeline



Context

- **determining factors:**
  - the people involved (including their background knowledge and their intentions)
  - the objective of the interaction (including the task to be carried out)
  - the time and place where the interactions take place

- **challenges**
  - how to obtain information relevant for the context
  - how to represent context information
  - how to use context information

Problems Addressed by Context-Aware Systems

- **information overload and human attention**
  - *"What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate efficiently among the overabundance of information sources that might consume it."* — Herbert Simon
  - *see also: Simon's example of the U.S. State Department's misanalysis of printing bottlenecks*

- unarticulated **design intent**

- providing information "to anyone, at any time and at any place" → **the five 'Rights'**

The 'Right' Information, at the 'Right' Time, in the 'Right' Place, in the 'Right' Way to the 'Right' Person

<<'right' is in quotes because in most cases there is no simple 'right' or 'wrong'>>

- ***the 'right' information*** — requires task modeling (and can be inferred from partial constructions in design, from interests derived from previous actions (e.g.: books bought, movies watched) or described via specification components)

- ***the 'right' time*** — addresses intrusiveness of information delivery (e.g.: when to notify a user about the arrival of a e-mail message, when to critique a user about a problematic design decision); it requires to balance the costs of intrusive interruptions against the loss of context-sensitivity of deferred alerts

- ***the 'right' place*** — takes location-based information into account

……..in the ‘Right’ Way to the ‘Right’ Person

- ***the ‘right’ way*** — differentiates between multi-model representations; e.g.: by using multimedia channels to exploit different sensory channels is especially critical for users who may suffer from some disability

- ***the ‘right’ person*** — requires user modeling; e.g.: as it is exploited in recommender systems and in intelligent tutoring systems

Exploring Particular Aspects of Context

- ***Location-based information systems*** — have focused on a narrow notion of context: how to capture location automatically by hardware and software sensors

- ***Recommender systems*** — have explored techniques for recommending various products or services to individual users based on the knowledge of users' tastes and preferences as well as users' past activities (such as: previous purchases, previous articles read, previous search commands issued)

Exploring Particular Aspects of Context

- ***Ambient Intelligence research*** — has analyzed environments with many embedded devices where these devices can recognize the situational context of users and exploit the additional information for personalization and customization

- **L3D's research** — focused on *design activities* and *high-functionality environments*, specifically exploring *unique aspects of context aware systems* such as:
  - articulating *design intent* with *specification components* (examples: specification component in kitchen design (Kumiyo Nakakoji), drawing an equilateral triangle)
  - critiquing systems (generic, specific, and interpretive)
  - information access and delivery (example: passive and active help systems)
  - intrusiveness (spelling correctors, notifications, passive versus active systems)
  - synergy between adaptive and adaptable components (example: sliders (Tammy Sumner), Auto-Correct in MS-Word)

Drawing an Equilateral Triangle

Intention of the Designer

Procedure Written by the Designer

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

Creating More Context by Articulating Design Intentions

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

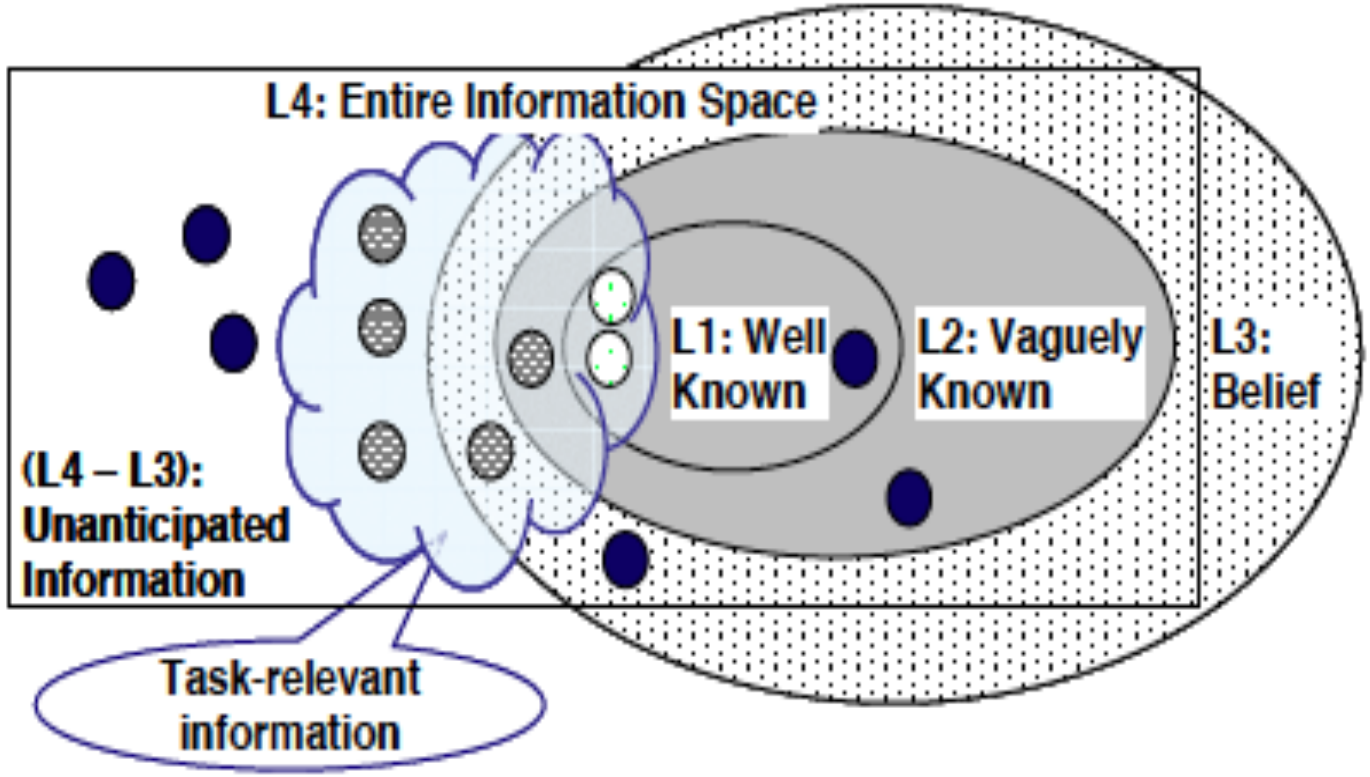
```
closed figure
```

L3D Research in Context-Aware Systems

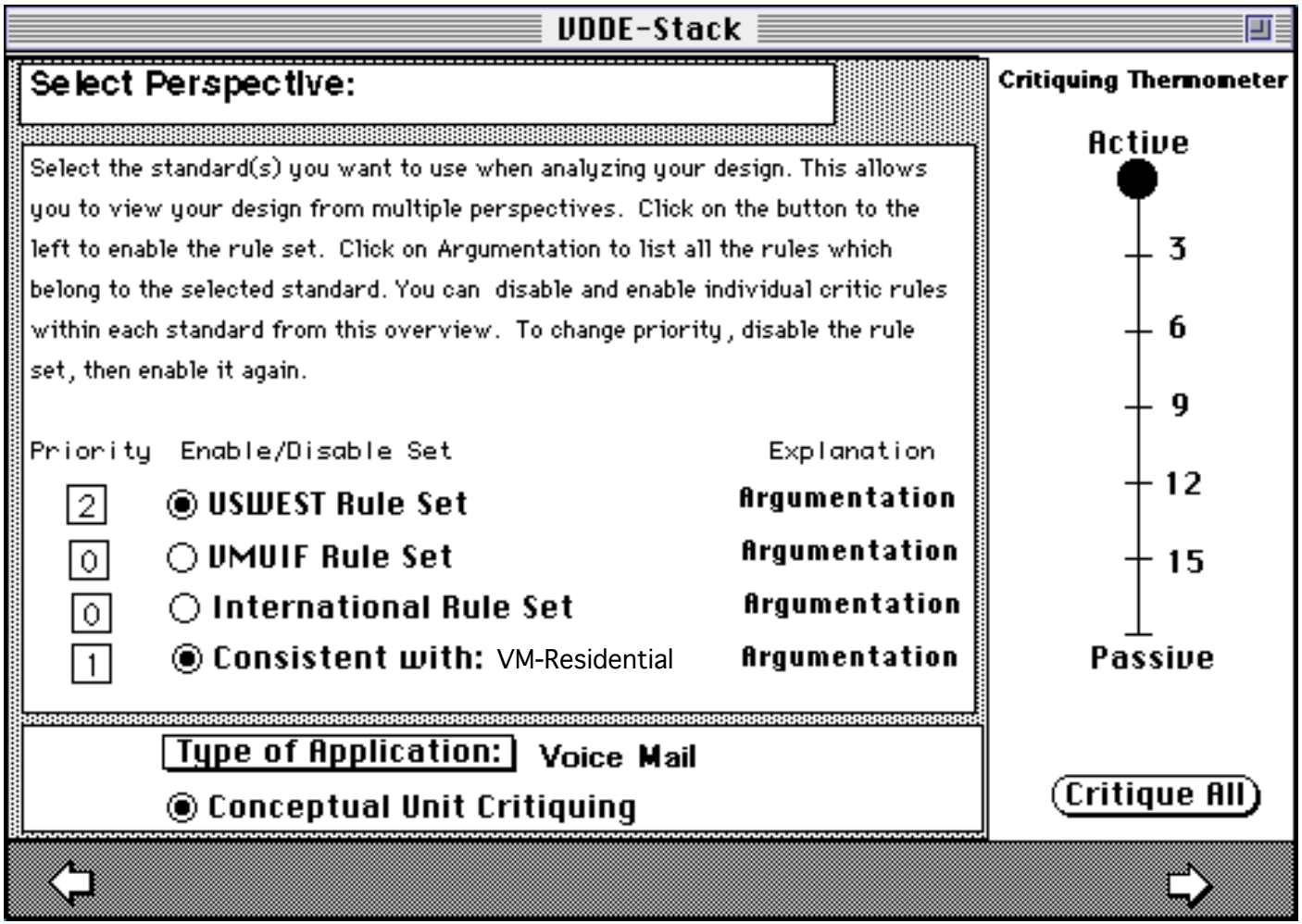
Information Sharing: Access ("Pull") and / or Delivery ("Push")

	access ("pull")	delivery ("push")
examples	browsing, search engines, bookmarks, passive help systems	Microsoft's "Tip of the Day", broadcast systems, critiquing, active help systems, agent-based systems
strengths	non-intrusive, user controlled	serendipity, creating awareness for relevant information, rule-enforcement
weaknesses	task relevant knowledge may remain hidden because users can not specify it in a query	intrusiveness, too much decontextualized information
major system design challenges	supporting users in expressing queries, better indexing and searching algorithms	context awareness (intent recognition, task models, user models, relevance to the task-at-hand)

Computing User- and Task-Relevant Information Delivery in a High-Functionality Environment (HFE)



Adaptation Mechanism to Control Different Critiquing Rule Sets and Different Intervention Strategies (Tammy Sumner)



A Comparison between Adaptive and Adaptable Systems

	Adaptive	Adaptable
Definition	dynamic adaptation by the system itself to current task and current user	user changes the functionality of the system
Knowledge	contained in the system; projected in different ways	knowledge is extended
Strengths	little (or no) effort by the user; no special knowledge of the user is required	user is in control; user knows her/his task best;
Weaknesses	user has difficulty developing a coherent model of the system; loss of control	systems become incompatible; user must do substantial work; complexity is increased (user needs to learn the adaptation component)
Mechanisms Required	models of users, tasks, and dialogs; incremental update of models	support for meta-design
Application Domains	active help systems, critiquing systems, recommender systems	end-user modifiability, tailorability, definition of filters, design in use

Design Trade-Offs for Context-Aware Systems

- filter bubbles and group think
- making information relevant to the task at hand versus serendipity
- intrusivenes
- remembering and forgetting
  - Bell, G., & Gemmell, J. (2009) *Total Recall*
  - Mayer-Schönberger, V. (2009) *Delete — the Virtue of Forgetting in the Digital Age*
  - Bannon, L. J. (2006) "Forgetting as a Feature, Not a Bug: The Duality of Memory and Implications for Ubiquitous Computing," in *CoDesign*
- privacy
- control

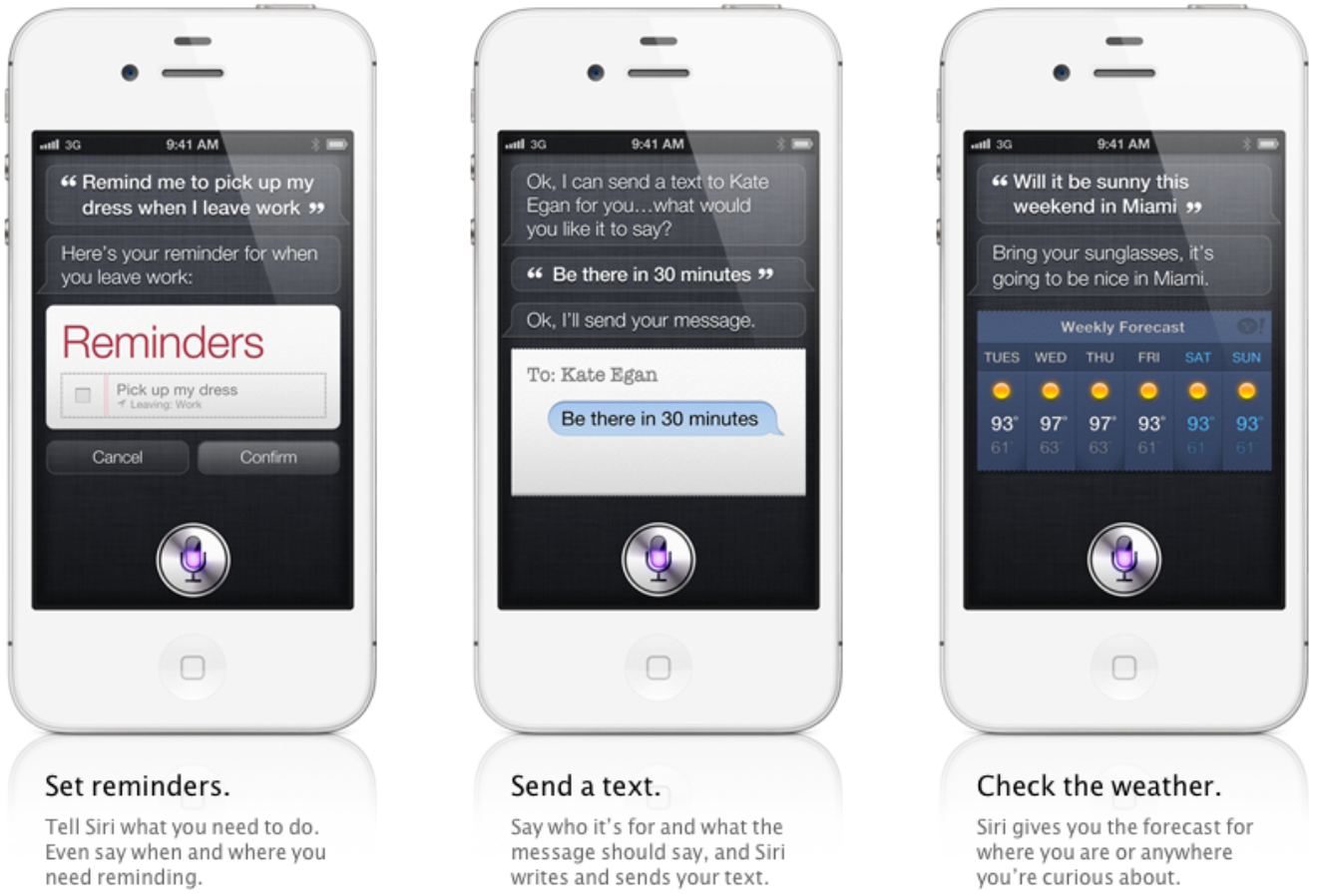
Filter Bubbles

- **source:** E. Pariser. (2011). *Beware online "filter bubbles" (TED Talk)*. http://www.ted.com/talks/eli_pariser_beware_online_filter_bubbles.html

- **the design trade-off:**
  - no person can afford to pay attention to more than a very small fraction of new things produced ("demassification")
  - a culture can not survive long unless all of its members paid attention to at least a few of the same things ("massification")

Context-Awareness: Apps on the I-Phone

- local traffic reporting + **Siri (intelligent assistant) + ……..**



Context-Awareness and Human-Centered Computing

- Human-Centered Computing should serve the benefit of users

- the design of context-aware systems must take into account the importance and influence of social contexts to make the technical systems desirable, usable, useful, meaningful at a personal and social level

- **basic message of this presentation:**

create a **generic conceptual/theoretical framework** for context aware systems based on the **lessons learned** with L3D's research efforts over the last two decades