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

Meta-Design: A Framework for the Future of End User Development (EUD)

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Presentation, "EUD-Net" Symposium,
October, 6 and 7, 2003 — Fraunhofer, Birlinghoven

Thanks

- to the **organizers of the Symposium** and the **members of the Network of Excellence** for inviting me

- to the **members of the Center for LifeLong Learning and Design (L3D)** who have helped me over the years to explore issues surrounding EUD and meta-design in PhD theses, prototype developments, papers, ...— **including Alexander Repenning ("Agentsheets")**

- to many **collaborators** for trying to understand, articulate, and evolve the concept of meta-design — **including Elisa Giaccardi ("Interactive Art")**

- to the **National Science Foundation** and the **Coleman Institute** for supporting our work on meta-design

Overview

- Core Message

- Cultures and Media

- Meta-Design

- Consumers and Designers

- Transforming Application Areas

- Research Challenges

- Conclusions

Core Message

- EUD is **more than a technical problem**

- **claim:** providing tools, environments, and substrates for EUD **is necessary, but not sufficient**

- EUD should be conceptualized as **meta-design** creating **new mindsets**, new **sources of creativity**, **cultures changes**, and **innovative societies** by providing new insights into
  - learning and working
  - communicating
  - design and design communities
  - collaboration
  - co-creation

End User Development (EUD)

- **definition by EUD-Net:** "EUD is a set of activities or techniques that allow people, who are non-professional developers, at some point to create or modify a software artifact"

- **EUD**
  - EUD = EUP and EUM (end-user programming and end-user modifiability
  - features of EUD environments
  - markets for EUD (Microsoft, IBM, SAP, BEA)
  - technologies for EUD

- **meta-design**
  - mindsets and cultures
  - new media
  - social capital, motivation, interests
  - division of labor
  - making people ("domain experts", "owner of problems") independent of "high-tech scribes"

EUD: Beyond Binary Choices

- **Turing Tar Pit:** *"Beware of the Turing Tar Pit, in which everything is possible, but nothing of interest is easy."* — **Alan Perlis**

  - why are current interactive programming environments, such as Logo, Smalltalk, Squeak, ToonTalk, Agentsheets, …… not sufficient for supporting meta-design?

  - level of representation is still too far removed from the conceptual world of the domain workers

  - emphasize objective computability → the challenge: subjective computability

- **The Inverse of the Turing Tar Pit:** *"Beware of the over-specialized systems, where operations are easy, but little of interest is possible."*

  - domain-specific tools (such as SimCity) provide extensive support for certain problem contexts

    the ability to extend these environments is limited — even minor incremental changes are often impossible in these systems

Cultures and Media

- **claim: cultures** are substantially defined by their media and tools for thinking, working, learning, and collaborating (most prominent example: oral → literal socities)

- **fundamental challenge for computational media:** to contribute to the invention and design of cultures in which humans can express themselves and engage in **personally meaningful activities**

- **new media change**
  - the structure and contents of our interests
  - the nature of our cognitive and collaborative tools
  - the social environment in which thoughts originate and evolve, and mindsets develop

- **empirical observation:** a large number of new media are designed from the perspective of seeing and treating humans primarily as **consumers**

# Empowering Users to Act as Designer: A Brief History of our Research Efforts in End-User Development

- Fischer, G. and A. C. Lemke (1988). "Construction Kits and Design Environments: Steps Toward **Human Problem-Domain Communication**." Human-Computer Interaction 3(3): 179-222.

- Fischer, G., & Girgensohn, A. (1990) "**End-User Modifiability** in Design Environments." CHI'90 Proceedings

- MacLean, A., K. Carter, et al. (1990). "**User-Tailorable Systems**: Pressing the Issues with Buttons". CHI'90 Proceedings

- Girgensohn, A. (1992) "**End-User Modifiability** in Knowledge-Based Design Environments, Ph.D. Dissertation, University of Colorado at Boulder.

- Fischer, G. (1993). "Shared Knowledge in Cooperative Problem-Solving Systems - Integrating **Adaptive and Adaptable** Components", in Adaptive User Interfaces - Principles and Practice. M. Schneider-Hufschmidt, et al (eds)

- Oppermann, R., Ed. (1994). "**Adaptive** User Support". Hillsdale, New Jersey, Lawrence Erlbaum.

- Eisenberg, M., & Fischer, G. (1994) "**Programmable Design Environments**: Integrating End-User Programming with Domain-Oriented Assistance." CHI'94
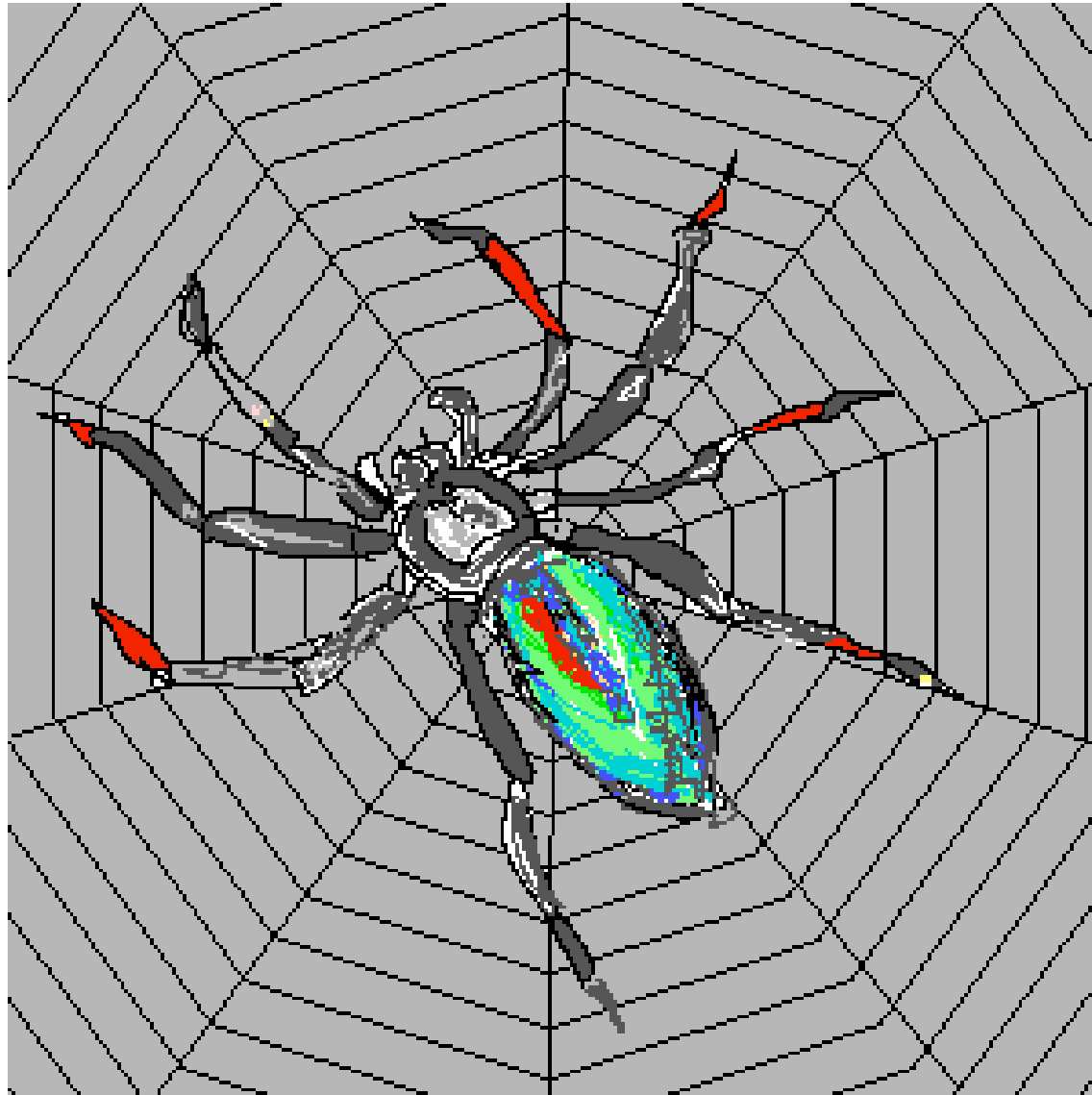
Human Problem Domain Interaction — Pinball Construction Kit
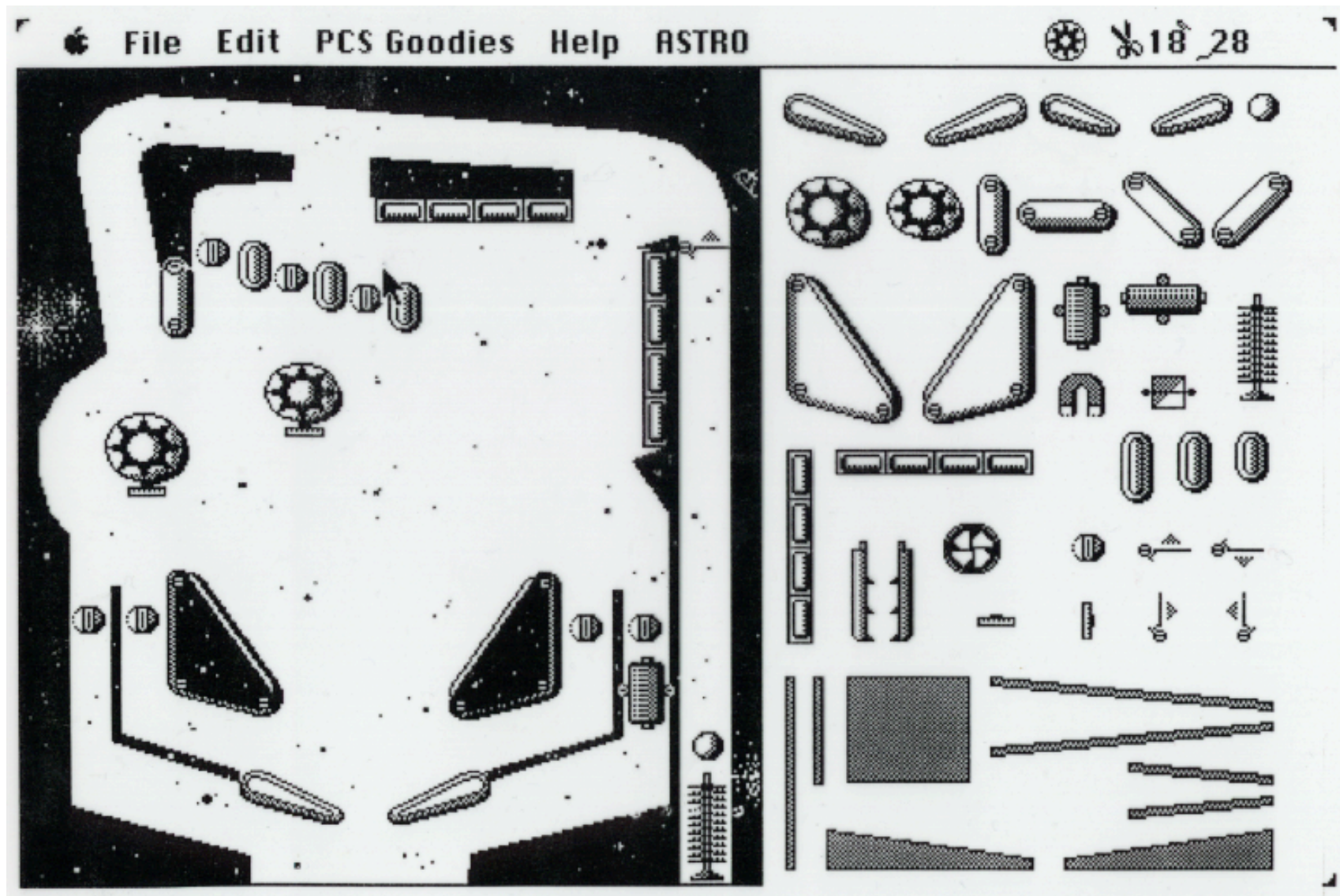
Human Problem Domain Interaction — Music Construction Kit
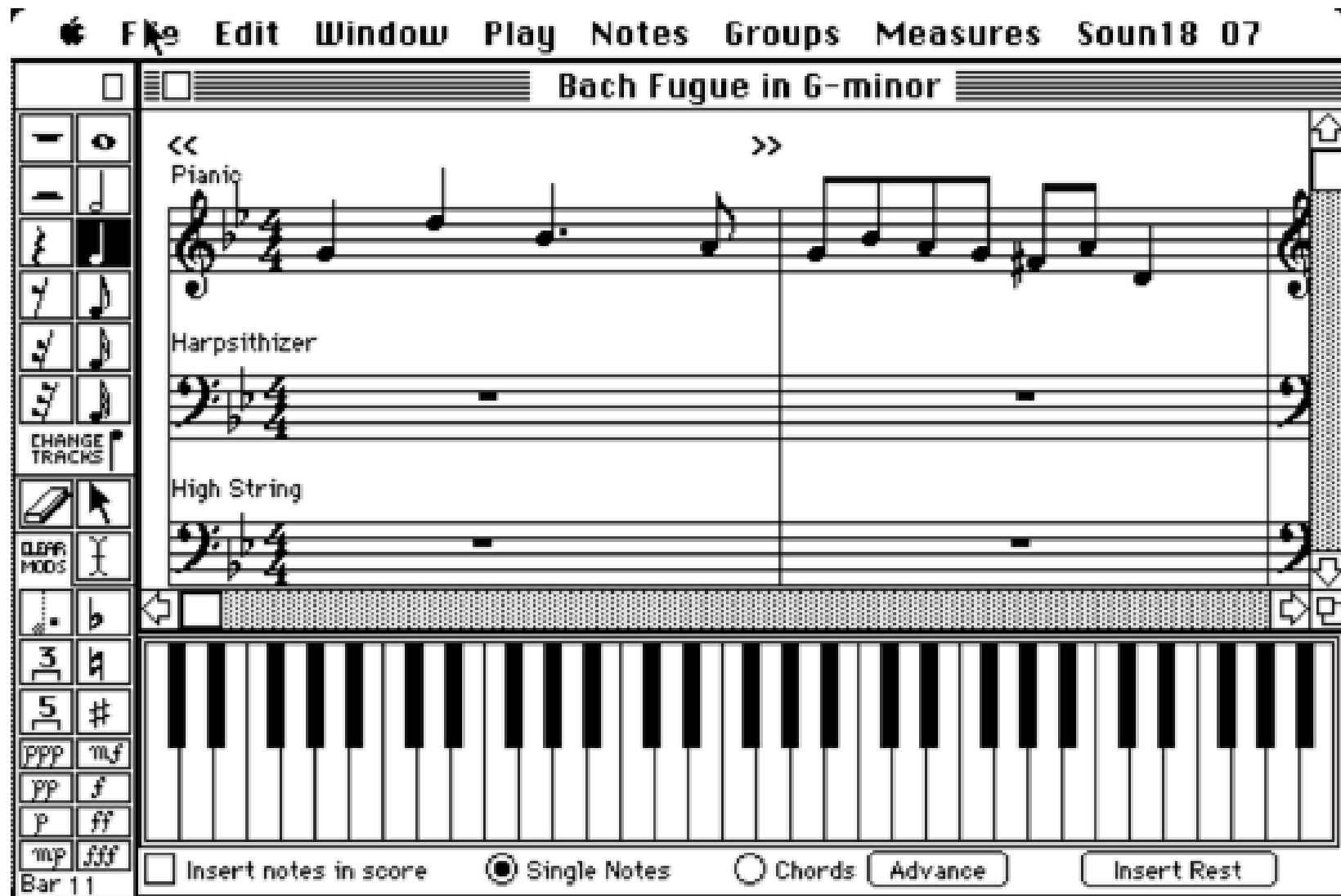
SchemePaint (M. Eisenberg): a programmable application
combining direct manipulation with interactive programming

History of our Research Efforts in EUD — Continued

- Repenning, A.: **"Agentsheets"** → http://www.agentsheets.com/

- DiGiano, C. and M. Eisenberg (1995). "**Self-disclosing Design Tools**: A Gentle Introduction to End-User Programming", Proceedings of DIS'95 Symposium

- Eisenberg, M. (1997). "**End-User Programming**", Handbook of Human-Computer Interaction.

- Fischer, G. (1998) "Complex Systems: **Why Do They Need to Evolve** and How Can Evolution Be Supported"

- Fischer, G., et. al. (2001) **"Seeding, Evolutionary Growth and Reseeding (SER):** The Incremental Development of Collaborative Design Environments."

- Fischer, G. (2002) "**Beyond 'Couch Potatoes'**: From Consumers to Designers and Active Contributors", in FirstMonday

Current Major Research Projects

	"enTWIne: Social Creativity and Meta-Design in Lifelong Learning Communities**"**

- supported by the National Science Foundation, Directorate of Education and Human Resources, August, 2001 to July, 2004
- http://www.cs.colorado.edu/~l3d/entwine/

	"CLever: Cognitive Levers — Helping People Help Themselves**"**

- supported by the Coleman Initiative, August 2000 – July 2004
- http://www.cs.colorado.edu/~l3d/clever/index.html

Meta-Design — How We Think About It

- "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)

- **meta-design** extends this to:

  "if we can provide the knowledge, the know-how, and the tools for making fishing rods, we can feed the whole community"

Meta-Design

- **meta-design**
  - new media that allow users to act as designers and be creative
  - the creation of context rather than content
  - puts the tools rather than the object of design in your hands
  - does not define a product, but the conditions for a process of interaction

- **why meta-design?**
  - design for diversity (for "a universe of one" → CLever Project)
  - design as a process is tightly coupled to use and continues during the use of the system
  - addresses and overcome problems of closed systems
  - prerequisite for social creativity and innovation
  - transcends a "consumer mindset"

Concepts and Objectives of Meta-Design

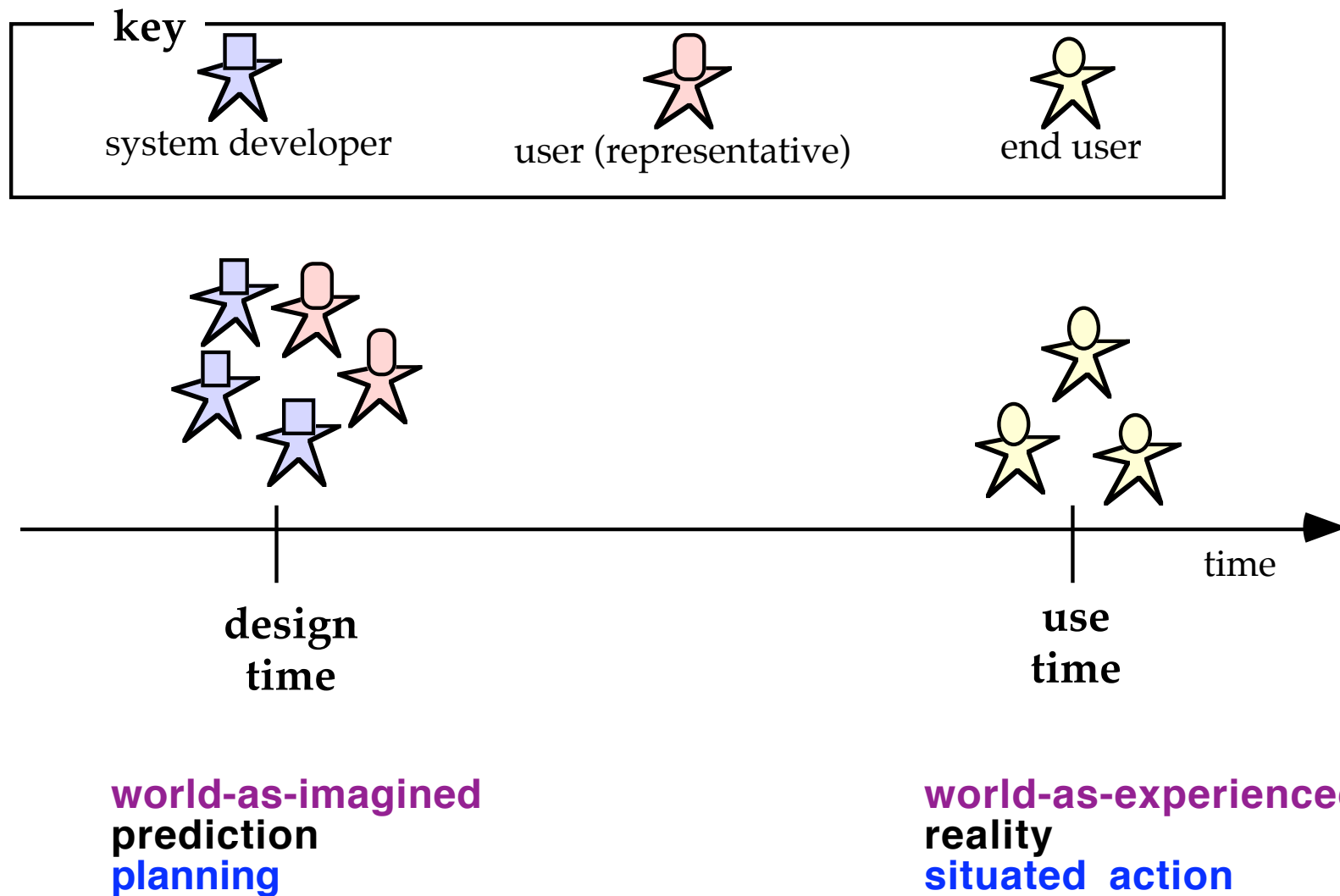| Concept	Implications
convivial tools	allow users to invest the world with **their** meaning and to use tools for a purpose they have chosen
domain-orientation	bring task to the forefront; provide time on task; support **human problem-domain interaction**
open, evolvable systems	put **owners of problems in charge**; in open systems, extension is an essential part of use
unself-conscious cultures of design	coping with **ill-defined problems** (C. Alexander)
underdesigned systems	create seeds and constructs for **design elaboration** at use time (example: American constitution)
emergent behavior	create models which are **suggestive** rather than definitive
collaborative work practices	support **design communities** and the emergence of power users

Traditional Design versus Meta-Design

for more details see: Elisa Giaccardi "Principles of Metadesign", PhD Thesis

Traditional Design	Meta-design
guidelines and rules	exceptions and negotiations
representation	construction
content	context
object	process
certainty	contingency
resolution	emergence
top-down	bottom-up
autonomous mind	distributed mind
creation	co-creation
complete designs	extensible designs
specific solutions	solutions spaces
art	interactive art

Design Time and Use Time

key

system developer   user (representative)   end user

design time

use time

time

world-as-imagined
prediction
planning

world-as-experienced
reality
situated action

Computational Media
—
Extending Design Opportunities 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,.....)
  - examples: specification sheets and usage data, supporting dynamic forms, dynamic websites, user and task specific maps and traffic schedules....

- **evolving the existing systems**: users (acting as designers) can transcend at use time the boundaries of the systems as developed at design time

Comparing Self-conscious and Unself-conscious Cultures of Design

	self-conscious	unself-conscious
definition	an explicit, externalized description of a design exists (theoretical knowledge)	process of slow adaptation and error reduction; situated
original association	professionally-dominated design	primitive societies, handmade things
examples	seeding and reseeding designed cities: Brasilia, Canberra, Abudja	evolutionary growth naturally grown cities: London, Paris
strengths	activities can be delegated; division of labor becomes possible	many small improvements → artifacts well suited to their function; coping with ill-defined, unarticulated problems
weaknesses	many artifacts are ill-suited to the job expected of them	no general theories exist or can be studied (because the activity is not externalized)
requirements	externalized descriptions must exist—issue: how adequate are these externalized descriptions?	owner of problems must be involved because they have relevant, unarticulated knowledge

Meta-Design: Beyond Professionally-Dominated, User-Centered Design and Participatory Design

- **professionally-dominated design**
  - works at best for people with the same interests and background knowledge

- **user-centered design:**
  - analyze the needs of the users
  - understand the conceptual worlds of the users

- **participatory design**
  - involve users more deeply in the process as co-designers by empowering them to propose and generate design alternatives
  - focus on system development at design time by bringing developers and users together to envision the contexts of use

- **meta-design:**
  - create design opportunities at use time
  - requires co-creation

What Do Meta-Designers Do?

- use their own creativity to create socio-technical environments in which other people can be creative

- create the technical and social conditions for broad participation in design activities which are as important as creating the artifact itself

Meta-Design Concepts (in Microsoft Word)
—
Users as Co-Developers

- can *tailor* and *customize* the system by setting different parameters as their personal preferences

- can *extend* and *evolve* existing information structures (e.g., menus, spelling dictionaries, auto-correct tables, …)

- can write *macros* to create new operations (an example of "programming by example" or "programming by demonstration")

- can create *programs in VisualBasic* to extend the functionality of the system

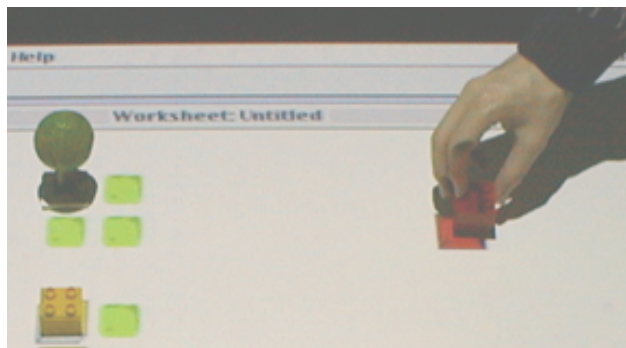- can *share* the user-defined extensions

A Macro for Unwrapping Text
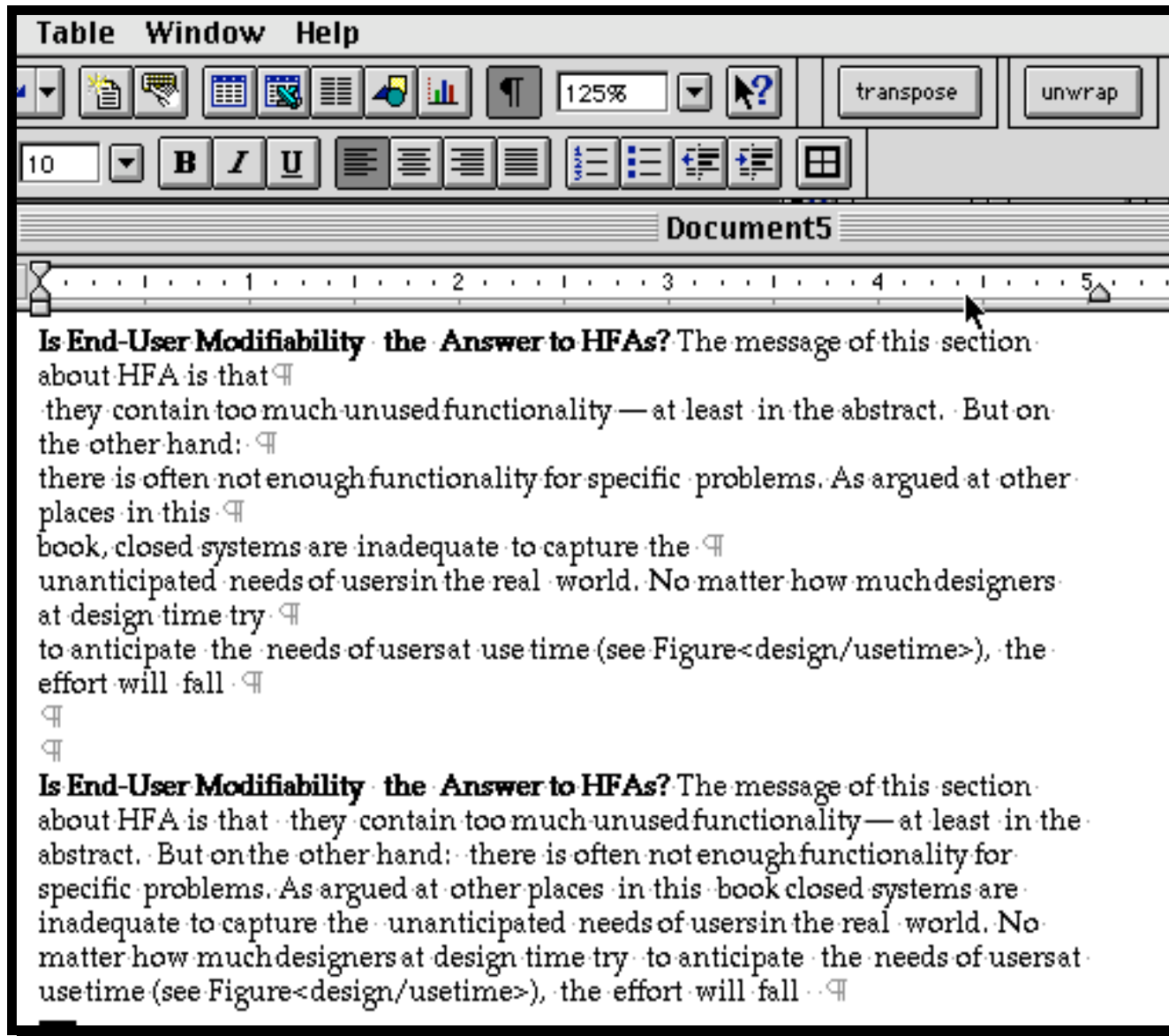
Example: The Envisionment and Discovery Collaboratory

The Envisionment and Discovery Collaboratory

EDC$_{pitaboard}$: The Participate-In-The-Action (PITA) Board

based on: DGT electronic chessboard, NL; http://www.dgtprojects.com/

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

- **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, because:
  - background knowledge can never be completely articulated
  - the world changes

- **user control:**
  - end-user modifiability
  - conviviality (independence of high-tech scribes)
  - ownership (putting owners of problems in charge)

Consumer and Designers — Beyond Binary Choices

- **claims:**
  - there is nothing wrong being a consumer (watching a tennis match, listening to a concert, ...)
  - the same person wants to be a consumer in some situations and in others a designer
  - consumer / designer is not an attribute of a person, but of a context
    consumer / designer ≠ f{person} → f{context}

- **problems:**
  - someone wants to be a designer but is forced to be a consumer → *personally meaningful activities*
  - someone wants to be a consumer but is forced to be a designer → *personally irrelevant activities*

Consumer and Designers — A Continuum

Consumer <--->Designer

passive consumer

      active consumer

            end-user
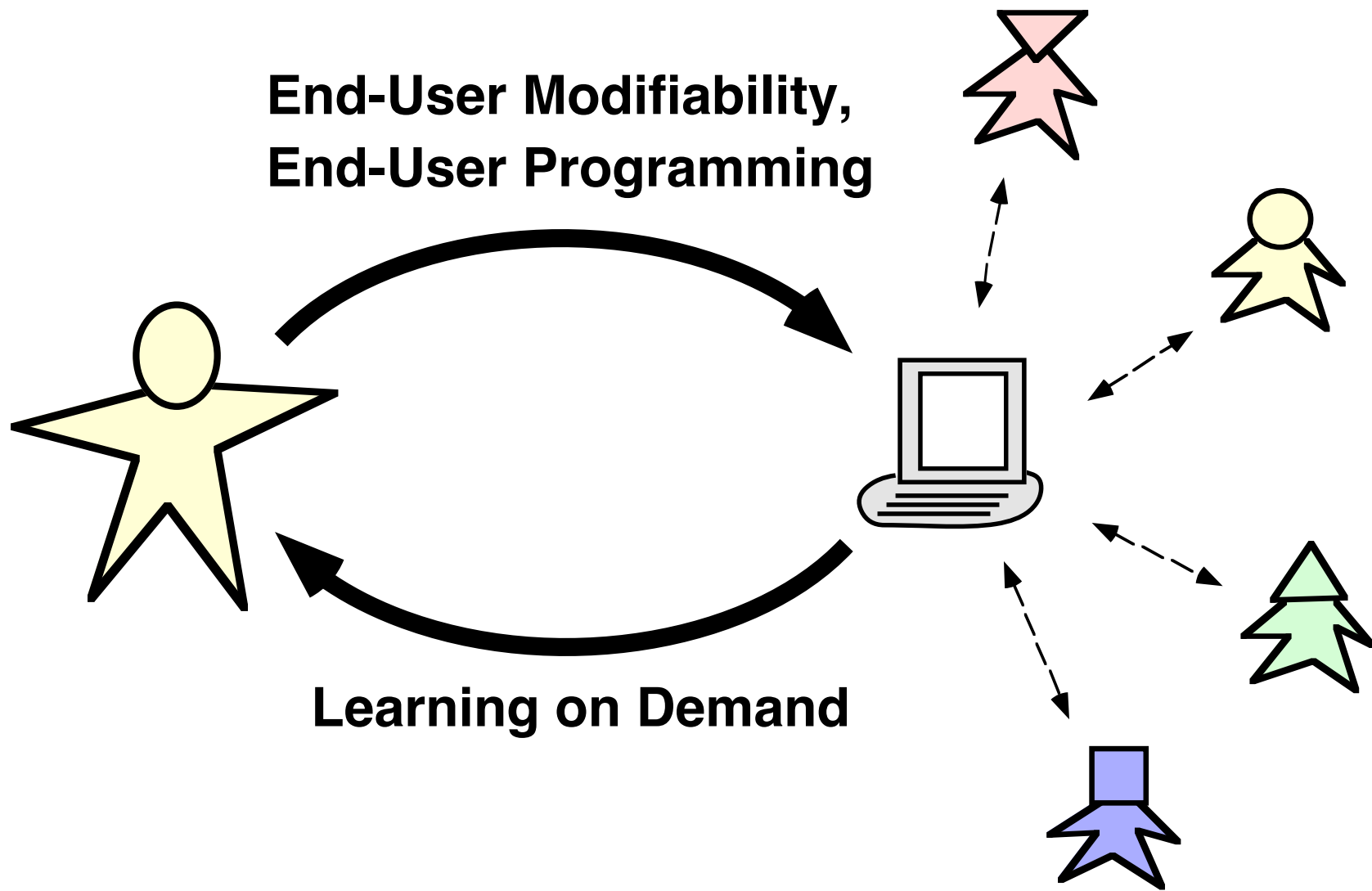
                user

                    power users, local developers

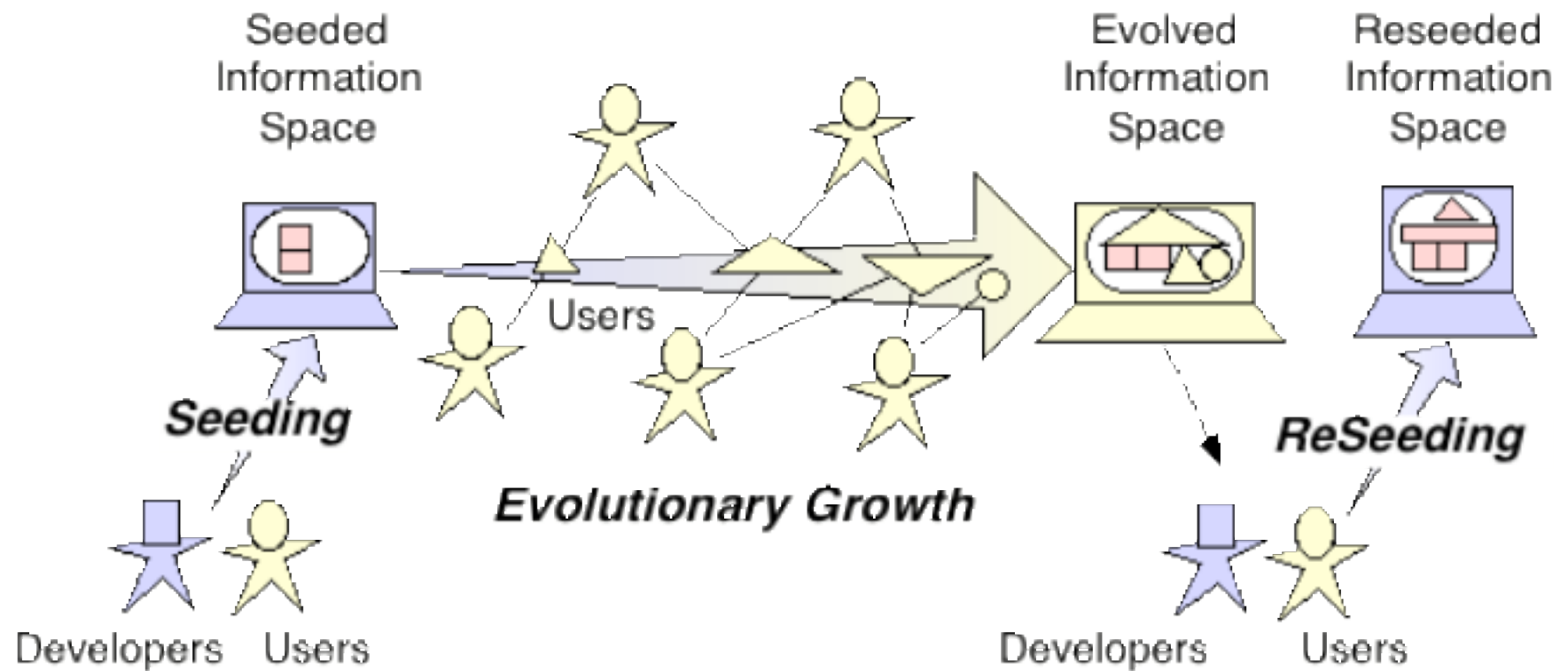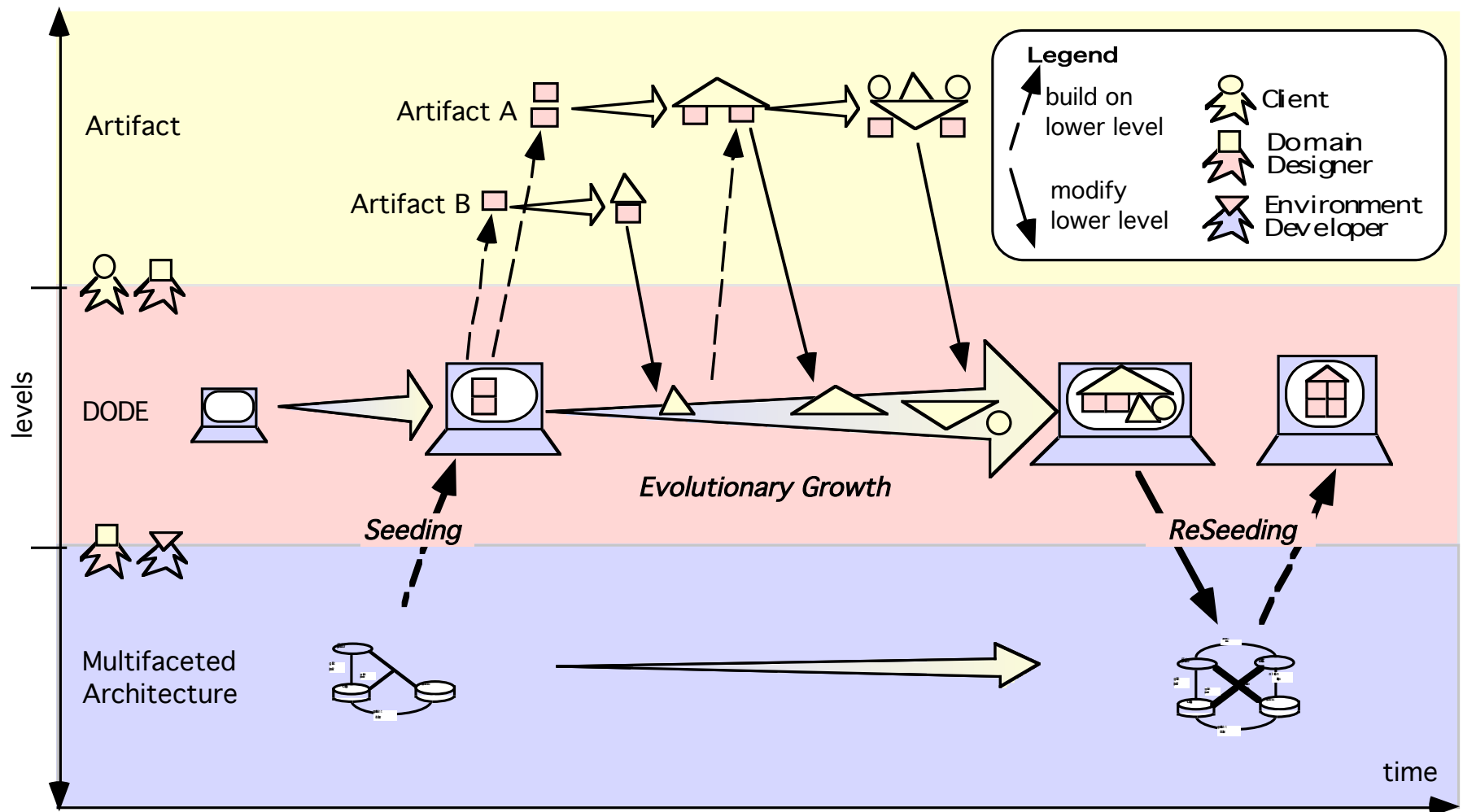   domain designer

                            meta-designer

Duality between Learning and Contributing

**End-User Modifiability,
End-User Programming**

Learning on Demand

The Seeding, Evolutionary Growth, Reseeding (SER) Model
Supporting Meta-Design

- **at design time:**
  - development of an initial system that can change over time (seed)
  - underdesign: creating design options for users

- **at use time:**
  - support for "unself-conscious culture of design": users will experience breakdowns by recognizing "bad fit" at use time
  - end-user modifications allow users to address limitations they experience
  - evolutionary growth through incremental modifications

- **reseeding:**
  - significant reconceptualization of the system
  - account for incremental modifications, mitigate conflicts between changes, and establish an enhanced system

The Seeding, Evolutionary Growth, Reseeding (SER) Model

The SER Model Applied to Domain-Oriented Design Environments

Artifact

Artifact A

Artifact B

Legend

build on lower level

modify lower level

Client

Domain Designer

Environment Developer

levels

DODE

Evolutionary Growth

Seeding

ReSeeding

Multifaceted Architecture

time

Motivational Aspects and Meta-Design

- **what will make humans want to become designers/active contributors over time?**
  - serious working and learning does not have to be unpleasant but can be personally meaningful, empowering, engaging, and fun
  - "programming is not hard, but it is boring"

- **what will make humans want to share?** → requires: mindset change, culture change, community knowledge bases, social capital

- **who is the beneficiary and who has to do the work?** → organizational rewards

Utility = Value / Effort

- **increase in value: motivation and rewards for a "design culture"**
  - feeling in control (i.e., independent from "high-tech scribes")
  - being able to solve or contribute to the solution of a problem
  - mastering a tool in greater depth
  - making an ego-satisfying contribution to a group
  - enjoying the feeling of good citizenship to a community ("social capital")

- **decrease in effort:**
  - meta-design is hard
  - extending meta-design to design for design communities

- **examples:**
  - oral → literate society: high value, very large effort
  - paper-based literacy → digital literacy: ?????? ,???????
  - individual → social: ?????? ,???????

The Role of Power Users in Meta-Design

- end-user development features themselves add considerably **more functionality** to complex systems

- empirical analyses clearly show that not too many users of these complex systems are willing to engage in this **additional learning effort**

- Gantt and Nardi (1992): have observed the emergence of **"power users"** who are technically inclined to perform system modifications that other end-users are unable or unwilling to perform

- **"power users"** ("gardeners", "local developers", "super users", domain-expert-users"):
  - domain experts knowledgeable about EUD
  - computer science experts knowledgeable about the domain

Meta-Design: Transforming Application Areas

- **design:** customization, personalization, tailorability, end-user development, design for diversity

- **architectural design:** underdesign, support for "unself-conscious culture of design"

- **teaching and learning:** teachers as facilitator, learning communities, courses-as-seeds

- **informed participation:** beyond access, social creativity

Meta-Design: Transforming Application Areas — Continued

- **open source:** a success model of decentralized, collaborative, evolutionary development (Eric Scharff, PhD thesis)

- **living organizational memories:** livingOM (Jonathan Ostwald), Web2Gether (Rogerio dePaula)

- **digital libraries:** community digital library (Michael Wright and Tamara Sumner)

- **interactive art:** collaboration, co-creation, puts the tools rather than the object of design in the hands of users (Elisa Giaccardi)
    - examples: http://www.sito.org/ — **Gridcosm, HyGrid**

The Potential Mismatch Problem in Teaching and Learning

Teacher	Student	Example
authority ("sage on the stage")	dependent, passive	lecture without questions, drill
motivator and facilitator	interested	lecture with questions, guided discussion
delegator	involved	group projects, seminar
coach/critic ("guide on the side")	self-directed, discovery-oriented	self-directed study group, apprenticeship, dissertation

- **major mismatches:**
  - dependent, passive learners take courses with non-directive teachers, and
  - self-directed, discovery-oriented active learners take courses with directive, authoritarian teachers

- **lessons learned:** meta-designers can create **possibilities** for participation and involvement, but they **can not enforce** participation and involvement

Research Challenges for End-User Development

- my core message: EUD is **more than a technical problem** (providing tools, environments, and substrates is necessary, but not sufficient)

- EUD should be conceptualized as **meta-design**

- in a society which wants to be **more democratic, more innovative, more creative** → there is a huge need to EUD and meta-design

- where are we at the moment?
  > *"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

Explore Technical Issues in Real-World Settings
—
Improvisations versus Standardization

- **example:** SAP Info, July 2003, p 33: "Reduce the Number of Customer Modifications"

- **rationale:**
  "every customer modification implies costs because it has to be maintained by the customer. Each time a support package is imported there is a risk that the customer modification my have to be adjusted or re-implemented. To reduce the costs of such on-going maintenance of customer-specific changes, one of the key targets during an upgrade should be to return to the SAP standard wherever this is possible"

- **compare:**
    - **"forking"** in Open Source
    - **"reseeding"** in Seeding, Evolutionary Growth, Reseeding Model

Mindsets, Cultures, and Environments for EUD and Meta-Design

- how we can **educate and support skilled domain workers**
    - who are neither novices nor naive users, but
    - who are interested in their work and
    - who see the computer as a means rather than as an end

- how we can create **co-evolutionary environments**
    - in which users change, because they learn, and
    - in which systems need to change, because users become co-developers and engage in end-user modification and programming

Conclusions

- **meta-design offers:**
    - to invent and design a culture in which all participants in collaborative design processes can express themselves and engage in personally meaningful activities

- **meta-design requires**
    - a new **mindset** of all participants
    - designers giving up some **control**
    - **active contributors** and not just passive consumers at use time

- **meta-design raises many issues and research problems of fundamental importance for end user development**
    - new design methodologies
    - a new understanding of cognition, collaboration, and motivation
    - the design of new media and new technologies