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

Meta-Design and Social Creativity

Gerhard Fischer
Center for LifeLong Learning & Design (L³D)
Department of Computer Science and Institute of Cognitive Science
University of Colorado, Boulder
http://l3d.cs.colorado.edu/~gerhard/

Presentation, IEMC 2007, Austin
Acknowledgements

- **organizers of IEMC 2007**: thanks for providing me with this opportunity

- **my collaborators at the Center for LifeLong Learning & Design (L3D)**: colleagues, former and current PhD students, Undergraduate Research Apprentices, visitors, …
Overview

- The Center for Lifelong Learning and Design (L³D)
- Basic Message
- Creativity and Design
- Elements of a Conceptual Framework
- Socio-Technical Environments (Examples)
- Implications
- Conclusions
The Center for Lifelong Learning and Design (L³D)

http://l3d.cs.colorado.edu/

- global objective: to do basic research on real problems

- examples of conceptual frameworks:
  - transcending the unaided, individual human mind → distributed intelligence, social creativity, learning on demand
  - making all voices heard → design, meta-design, social knowledge construction, Web 2.0 technologies

- examples of specific socio-technical environments
  - Envisionment and Discovery Collaboratory
  - Google-SketchUp + 3D Warehouse + Google Earth
The Basic Message

- the complexity and uniqueness of design problems transcend the unaided, individual human mind → they require meta-design and social creativity

- explore innovative conceptual frameworks as opportunities to bring humans and media together to achieve new levels of creativity supported by socio-technical environments
The Larger Context
Beyond the Unaided, Individual Human Mind
Why Now?
National Science Foundation

- **5 year strategic plan: terms and concepts**
  - collaboration 17
  - creativity 6
  - innovation 26
  - exploration 11
  - discovery 27
  - STEM 9

- **new programs:**
  - CreativeIT (2007)
Design, Collaborative Design and Meta-Design
Design and Collaborative Design

- **design versus natural science** (Herbert Simon “Sciences of the Artificial”)
  - **natural science**: how things are
  - **design**: how things ought to be

- the need for **collaborative design** because design problems are
  - **complex** → requiring **social creativity** in which stakeholders from different disciplines have to **collaborate**
  - **ill-defined** → requiring the **integration of problem framing and problem solving**
  - have no (single) answer → **argumentation support, consideration of trade-offs**
  - unique (“a universe of one”) → requiring **learning when no one knows the answer**
A Success Example of Design / Creativity in Architecture
Another Success Example of Design / Creativity in Architecture
To Engineer is Human

Meta-Design = Design for Designers

- meta-design explores:
  - the invention and design of a culture in which participants can express themselves and engage in personally meaningful activities

- meta-design requires
  - designers giving up some control at design time
  - active contributors (and not just passive consumers) at use time

- meta-design raises research problems of fundamental importance including
  - new design methodologies
  - a new understanding of collaboration, motivation, innovation and creativity
  - the design of innovative socio-technical environments

- provides a theoretical framework for Web 2.0 technologies
Design Time and Use Time

- **key**
  - system developer
  - user (representative)
  - end user

- **time**
  - design time
  - use time

- **world-as-imagined**
  - prediction
  - planning

- **world-as-experienced**
  - reality
  - situated action
Meta-Design: A Framework for Effective, Large Scale, Distributed, Collaborative Efforts


- **integration of consumer and producer roles** → Fischer, G. (2002) “Beyond 'Couch Potatoes': From Consumers to Designers and Active Contributors”
What Do Meta-Designers Do?

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

- they **underdesign**
  - by creating **contexts** and **content creation** tools rather than content
  - by creating **technical** and **social** conditions for broad participation in design activities
  - by supporting ‘**hackability**’ and ‘**remixability**’

- **examples for meta-design:** exploiting the power of mass collaboration with Web 2.0 Technologies
  - Wikis
  - **Google-SketchUp + 3D Warehouse + Google Earth**
  - Second Life
  - Open source
SketchUp — a 3D Modeling Environment for Content Creation
3D Warehouse: a Web 2.0 Environment

http://sketchup.google.com/3dwarehouse/

- features:
  - search, share, and store 3D models created in SketchUp
  - models include: buildings, houses, bridges, sculptures, cars, people, pets, ...
  - download the 3D models to be modified in SketchUp
  - if the model has a location on earth → download it and view it in Google Earth
  - share 3D models by uploading them from SketchUp

- challenges:
  - what will motivate people to participate?
  - participation requires to learn SketchUp → create learning environments for SketchUp
3D Warehouse

- **Tsim Sha Tsui Clock Tower** by Google
  - ★★★★★ (1 rating)
  - Tsim Sha Tsui Clock Tower,...
  - View in Google Earth

- **Figueroa at Wilshire** by Google
  - Albert C. Martin and...
  - View in Google Earth

- **1500 Walnut Street** by Google
  - This building located at 1500...
  - View in Google Earth

- **CPL Harold Washington Library Center** by Google
  - ★★★★★ (6 ratings)
  - This monumental building,...
  - View in Google Earth

- **Marriott Marquis** by Google
  - This Hotel in Atlanta rises...
  - View in Google Earth

- **Hearst Residence (Hearst Castle)** by Google
  - ★★★★☆ (2 ratings)
  - San Francisco architect Julia...
  - View in Google Earth

- **Milwaukee Art Museum** by Google
  - ★★★★★ (6 ratings)
  - The history of the Milwaukee...
  - View in Google Earth

- **CitySpire Center** by Google
  - ★★★★★ (2 ratings)
  - Designed by Murphy/Jahn, Inc....
  - View in Google Earth
Downtown Denver in 3D
Creativity and Social Creativity
Why is Creativity Needed?

—

Learning When No One Knows the Answer

- **design problems are unique** → learning from the past is not enough

- **sources for new knowledge:**
  - conceptual collisions
  - epistemological pluralism: diversity in how we think; e.g.: formal thinking versus bricolage
  - distributed intelligence
  - symmetry of ignorance
  - emergence
Creativity —The “Wrong” Image?
“The Thinker” by Auguste Rodin
Individual versus / and Social Creativity

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

- individual:
  - individuals participating in collaborative inquiry and creation need the individual reflective time depicted by Rodin's sculpture
  - without such reflection it is difficult to think about contributions to social creativity

- social
  - Rodin's sculpture "The Thinker" dominates our collective imagination as the purest form of human inquiry — the lone, stoic thinker
  - the reality is that scientific and artistic forms emerge from joint thinking, passionate conversations, and shared struggles
Social Creativity

- complex design problems are systemic problems; they seldom fall within the boundaries of one specific domain → they require the participation and contributions of several stakeholders with various backgrounds

- “An idea or product that deserves the label ‘creative’ arises from the synergy of many sources and not only from the mind of a single person” — Mihaly Csikszentmihályi

- “Invention is a social process: it rests on the accumulation of many minor improvements, not the heroic efforts of a few geniuses” — Karl Marx
Distances in Social Creativity: Limitations or Opportunities?

- **spatial dimension**: shared location → shared concerns; *success model*: open source communities

- **temporal dimension**: learning from the past; *success model*: reuse and redesign

- **conceptual dimension**: exploiting symmetry of ignorance, conceptual collisions, epistemological pluralism and breakdowns as sources for innovation; success models: Communities of Practice (CoPs) and Communities of Interest (Cols)

- **technological dimension**: a new understanding of *distributing intelligence* and the identification of *basic skills* in the 21st century
Communities of Practice (CoPs): Homogenous Design Communities

- **CoPs** = practitioners who work as a community in a certain domain

- **examples:** architects, urban planners, research groups, software developers, software users, kitchen designers, computer network designer,

- **learning:**
  - masters and apprentices
  - legitimate peripheral participation (LPP)

- **problems:** “group-think” → when people work together too closely in communities, they sometimes suffer illusions of righteousness and invincibility

- **systems:** domain-oriented design environments (e.g.: kitchen design, computer network design, voice dialogue design, …..)
Communities of Interest (Cols)
Heterogeneous Design Communities

- **Cols** = bring different CoPs together to solve a problem

- **membership** in Cols is defined by a shared interest in the framing and resolution of a design problem

- **diverse cultures**: people from academia and from industry, software designers and software users, students and researchers from different cultures

- **fundamental challenges**:
  - establish common ground by creating boundary objects
  - build a shared understanding of the task at hand
  - learn to communicate with others who have a different perspective
  - primary goal: not “moving toward a center” (such as LPP in CoP) but “integrating diversity and making all voices heard”
Creativity and Innovation — Hot Topics


A New NSF Research Program

**CreativeIT**
Developing the Synergies between Research in Creativity and Computer and Information Science and Engineering


- **program description:**
  - information technology is playing an increasing role in extending the capability of human creative thinking and problem solving
  - creative uses of information technology are leading to new areas of research and innovation

- **research areas:**
  - understanding creative cognition and computation
  - creativity to stimulate breakthroughs in science and engineering
  - educational approaches that encourage creativity
  - supporting creativity with information technology
A Wiki about the CreativeIT Program — Invitation to Participate

http://swiki.cs.colorado.edu:3232/CreativeIT
Examples

- domain-oriented design environments (DODEs) (including critiquing systems) — focused on individual creativity in design

- Envisionment and Discovery Collaboratory — focused on social creativity in design
A DODE for Kitchen Design: Construction

Gerhard Fischer 36  IEMC 2007
A DODE for Kitchen Design: Argumentation

**Janus-Argumentation**

**Answer (Refrigerator, Sink, Stove)**
The distance between sink, stove and refrigerator, the work triangle, should be less than 23 feet.

![Diagram](attachment:figure10.png)

**Figure 10: the work triangle**

**Argument (Walking Distance)**
The work triangle is an important concept in kitchen design. The work triangle denotes the center front distance between the three main appliances: sink, stove and refrigerator. This length should be less than 23 feet to avoid unnecessary walking and to ensure an efficient work flow in the kitchen.

**Argument (Small Room)**
In small kitchens where the work triangle is less than 16 feet.

**Visited Nodes**
- Answer (Refrigerator, Sink, Stove) Section

**Commands**
- Show Example
- Show Example Answer (Refrigerator, Sink, Stove)

**Search For Topics**
- Show Argumentation
- Show Context
- Show Counter Example
The Envisionment and Discovery Collaboratory (EDC)

- the EDC supports:
  - collaborative design (e.g. in: urban planning, emergency management)
  - **social creativity** → learning when no one knows the answer — allowing all stakeholders to act as informed participants and active contributors (→ a Web 2.0 environment)
  - **meta-design** → a version of SimCity in which content is generated by users

- the innovative technologies in the EDC:
  - table-top
  - computationally enriched physical objects
  - visualization reflection-in-action
The Envisionment and Discovery Collaboratory
Face-to-Face Collaboration around the EDC Action Space
Boulder City Council and University of Colorado Regents
Sketching Support in the EDC
Buildings Sketched into a Google-Earth Client
Land Use in the Action Space
Summary View of Land Use Generated in the Reflection Space

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th># of Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Space</td>
<td>62</td>
</tr>
<tr>
<td>Commercial</td>
<td>5</td>
</tr>
<tr>
<td>Light Industry</td>
<td>27</td>
</tr>
<tr>
<td>Single Family</td>
<td>107</td>
</tr>
<tr>
<td>Multi-Family</td>
<td>8</td>
</tr>
<tr>
<td>Agriculture</td>
<td>17</td>
</tr>
</tbody>
</table>
Emerging Insight: Illustrating Multiple Walking Distances
Integrating Individual and Social Creativity: Caretta
Challenges

- creativity and education
- transdisciplinary collaboration
- creativity and outsourcing
Panic-Driven Educational Reform in the USA

- panic #1: USSR first in space → emphasis of STEM (Science, Technology, Education, Mathematics) disciplines
  - this is an area where many other countries do extremely well

- panic #2: US lagging in test scores → high-stake testing
  - this is an area where many other countries do extremely well

- panic #3: outsourcing of knowledge work → education for creativity, imagination, and innovation, thinking outside of the box, unique solutions
  - question: which country does well in this area?
  - question: is #2 and #3 somewhat incompatible

- panic #4: complex problems transcending the unaided, individual human mind, symmetry of ignorance → reflective communities, distributed intelligence, meta-design, social creativity
Reflective Practitioners → Reflective Communities

- the key to address complex problems is
  - not in "Leonardos who are competent in all sciences" or in “educating the intellectual superhuman” who knows everything
  - but to achieve “collective comprehensiveness through overlapping patterns of unique narrowness” → Fish-Scale Model by Campbell
Large Conceptual Distance — Limited Common Ground
Software Professionals Acquiring Domain Knowledge
Domain Experts Acquiring Media Knowledge
From Reflective Practitioners to **Reflective Communities**
Why Should Computer Science be Interested in Creativity?

- **National Science Foundation**
  - Creativity Support Tools Workshop (June 2005)
  - new programs with the Computer Science Directorate:
    - **Science of Design Program**
    - new **Creativity Program**: The Synergy of Creativity with Research in Computer and Information Science and Engineering
    - **American Competitiveness** in the Future Globalized Economy

- **National Research Council**

- **Globalization and Offshoring of Software**
Software Design: Upstream and Downstream Activities

- **upstream**: world → model / specification
  - ill-defined problem
  - integration of problem framing and problem solving
  - collaboration and communication between different stakeholders
  - failure leads to *design disasters* (wrong problem is solved)

- **downstream**: model / specification → implementation / system
  - well-defined problem
  - dealing with difficult technical problems
  - creating reliable code
  - failure leads to *implementation disasters* (wrong solution to the right problem)
## Current Computer Science Education and Outsourcing

<table>
<thead>
<tr>
<th></th>
<th>Upstream Activities</th>
<th>Downstream Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Themes</strong></td>
<td>creative work, communication, collaboration, context, integration of problem framing and problem solving, fuzzy requirements, customer satisfaction</td>
<td>programming, programming languages, compilers, rule-based behavior (tax returns),….</td>
</tr>
<tr>
<td><strong>Emphasis in current CS programs</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Future jobs (not being outsourced)</strong></td>
<td></td>
<td>XXXXXXX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Conclusions

- **the basic message**
  - the complexity and uniqueness of design problems transcend the unaided, individual human mind → they require meta-design and social creativity

- **socio-technical environments in support of meta-design and social creativity:**
  - design → meta-design
  - unaided, individual human mind → media-augmented social creativity to make all voices heard and integrate diversity
  - communities of practice → communities of interest
  - reflective practitioners → reflective communities