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

Transdisciplinary Education and Collaboration

Gerhard Fischer, Hal Eden, and Holger Dick — Fall Semester 2010

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A Small Number of Answers to Assignment 13

how would you rate the “outside classes”? (e.g. a waste of time or an enrichment of your education)
I would say that none of the outside classes have been a waste of my time, at the very least they've satisfied a requirement. However, the classes won't directly help my in my future, so they haven't been the most useful choice in the world.

how did you select these classes? (e.g. based on interest or based on requirements for your degree program)
I'm taking Chinese out of personal interest; I studied Mandarin on my own for two years, so I wanted to improve my grammar by taking formal classes in the subject.

to be a well educated graduate in your respective discipline — what do you consider the most important objectives?
The most important objectives in being a well-educated graduate is good analytical and critical thinking skills, and good communication skills.
A Small Number of Answers to Assignment 13

to be a well educated graduate in your respective discipline — what do you consider the most important objectives?

Learning the computer languages they use in the real world. Learning to use the tools they use in the real world (ie. Eclipse for programming in Java and contributing to a collaborative programming repository.) We should be learning all the things that are listed on a basic, entry-level job description. It is also useful to learn about human psychology, since so much of what we do uses this knowledge. We should be reading things like Dan Ariely books.

have you pursued these objectives outside of classes (in other settings at CU; outside of CU)?

Yes, definitely. I taught myself web design and development on my own time. I listen to educational podcasts (eg Radiolab) and read related books often. I would comfortably say that I haven't been bored for a long time.
A Small Number of Answers to Assignment 13

to be a well educated graduate in your respective discipline — what do you consider the most important objectives?
I am studying CS and minoring in Technology, Arts and Media. I would consider understanding how people of different backgrounds and experiences work together one of the most important objectives of my education. Some of the best project I have worked on have been ones where the people in the group are not all in the same major. Everyone has something different to bring to the table, which almost always helps. Even working within my major, the people I work with will have a different area of expertise that helps the group.

how would you rate the “outside classes”? (e.g. a waste of time or an enrichment of your education)
I believe that we go through higher education to learn a given skill set. We do not go to a university simply to learn how to have a meaningful and productive life. We go to university to learn a skill and then we use that skill in order to lead a meaningful and productive life.

to be a well educated graduate in your respective discipline — what do you consider the most important objectives?
To be aware of how much you actually don't know
Transdisciplinary Education and Collaboration

- real world problems are **systemic** complex → requiring expertise across several disciplines

  - examples:
    - health care
    - community safety
    - disaster response
    - life-long learning
    - business innovation
    - energy sustainability
    - environmental protection

- educational implication: learners need to feel comfortable working in multi-, inter-, transdisciplinary teams that encompass multiple ways of knowing
Multidisciplinarity ↔ Interdisciplinary ↔ Transdisciplinarity

**multidisciplinarity**: several disciplines are being involved — e.g. in media for cognitive disabilities
- media experts know about assistive technologies
- caregivers look know about different disabilities
- knowledge remains separate

**interdisciplinarity**: integration or blending of knowledge from different disciplines
- media experts and caregivers collaborate
- knowledge becomes integrated

**transdisciplinarity**: forming new knowledge from disciplinary awareness
- new knowledge is created
- participants change their world view and understanding
Transcending the Individual Human Mind

- **Lecture, Oct 13 — social creativity**
  - “Linux was the first project to make a conscious and successful effort to use the entire world as a talent pool” → Raymond, E. S. & Young, B. (2001) The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary

- **Lecture, Oct 25 — 3D Modeling: SketchUp and 3D Warehouse Earth**
  - a task of a magnitude that requires a very large number of “minds and hands”
  - local knowledge is important

- **Lecture, Oct 27 — Communities of Practice and Communities of Interest**
  - Communities of Practice = homogeneous communities
  - Communities of Interest = heterogeneous communities
Local Knowledge


- **Specialties**

<table>
<thead>
<tr>
<th>Beijing</th>
<th>Amsterdam</th>
<th>Paris</th>
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</thead>
<tbody>
<tr>
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<td><img src="image2.jpg" alt="Amsterdam Image" /></td>
<td><img src="image3.jpg" alt="Paris Image" /></td>
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- **Cutlery**

<table>
<thead>
<tr>
<th>Singapore</th>
<th>UK</th>
<th>India</th>
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<tr>
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<td><img src="image5.jpg" alt="UK Image" /></td>
<td><img src="image6.jpg" alt="India Image" /></td>
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</table>
The Fish-Scale Model for Collaboration

Important Claims from the Fish-Scale Paper

- beyond the “Leonardo Aspiration”: "Leonardos who are competent in all sciences or in educating the intellectual superhuman who knows everything”

- claim: competence (disciplinary and inter-/transdisciplinary) is not achieved in individual human minds but as a collective achievement made possible by the overlap of narrow specialties

- knowledge: from individual human minds to a collective social product only imperfectly represented in any one mind
Renaissance Scholars of the 21st Century?

<<Lecture, Sept 13: “Less is More”>>

- **Claim**: the design principles that apply to social engineering
  - discipline specialization vs general holistic knowledge
  - transdisciplinary education and collaboration
  are the same as those of the engineering of information appliances
  - weak-general (Swiss Army Knife, general purpose programming languages)
  - strong-specific systems (Rich Tool Sets, domain-oriented design environments)

- given the constraints on human ability → how can we expect an individual to maintain the requisite specialist knowledge in their technological discipline, while at the same time have the needed competence in industrial design, sociology, anthropology, psychology, etc.,
Growth of Technology and Functionality as a Function of Time

Moore's law: describes a long-term trend in the history of computing hardware. The number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years. The trend has continued for more than half a century and is not expected to stop until 2015 or later.
Humans' capacity is limited and does not increase over time

insights from biological evolution: our neurons do not fire faster, our memory doesn't increase in capacity, and we do not learn or think faster as time progresses

the challenge for human-centered computing: symbiotic human-computer systems / distributed cognition
An Example from the Envisionment and Discovery Collaboratory

—

Individual Walking Distances and Locations for Bus Stops
Desired but **Unrealistic** — The Renaissance Scholar as “Superhuman” (being an expert in multiple domains)
**Realistic**: Learning “something” about the Other Domain

![Diagram showing the relationship between Tools/Media Knowledge and Domain Knowledge]

- **Tools/Media Knowledge**
  - High
  - Low
- **Domain Knowledge**
  - Low
  - High
Objective: Reflective Communities

Tools/Media Knowledge

Domain Knowledge

reflective community
Transdisciplinary Collaboration

Large Conceptual Distance — Limited Common Ground
Software Professionals Acquiring Domain Knowledge
Examples from my Career as a Computer Scientist

- kitchen design → JANUS → domain-oriented design environments → reflection-in-action

- urban planning → Envisionment and Discovery Collaboratory → table-top computing → meta-design + social creativity

- cognitive disabilities → CLever → tools-for-living + tools-for-learning → distributed cognition

- energy sustainability → Hydra → Smart Grid, Smart Meters → change human behavior (persuasive technologies)
Domain Experts Acquiring Media Knowledge

Diagram showing the interaction between software professionals and domain experts with software knowledge, indicating the acquisition of software knowledge.
Boundary Objects (in the domain of Electricity Consumption)

<<Lecture, Nov 8(Hal Eden): Simulations, Visualizations, Eco-Arts >>

- not a boundary object: a bill from Xcel → “The only feedback I get about my energy use is in the form of monthly bills that present complex data that are a month old, and are boring and impersonal”

- “modern” energy representations

- comparing communities

- eco-arts and eco-visualization
# A Current Power Company Bill

## Electric Service - Account Summary

<table>
<thead>
<tr>
<th>Account Activity</th>
<th>Date of Bill</th>
<th>Previous Balance</th>
<th>Total Payments</th>
<th>Balance Forward</th>
<th>Current Bill</th>
<th>Current Balance</th>
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<tr>
<td></td>
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### Electric Service - Account Summary

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<thead>
<tr>
<th>Invoice Number</th>
<th>Meter No</th>
<th>Rate</th>
<th>Residential General</th>
<th>GRSA</th>
<th>Trans Cost Adj</th>
<th>Elec Commodity Adj</th>
<th>Demand Side Mgmt Cost</th>
<th>Purch Cap Cost Adj</th>
<th>Service &amp; Facility</th>
<th>Renew. Energy Std Adj</th>
<th>Subtotal</th>
<th>Franchise Fee</th>
<th>Sales Tax</th>
<th>Total Amount</th>
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<tr>
<td>42785</td>
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<td>867.00 x 0.000080</td>
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### Gas Service - Account Summary

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<th>Rate</th>
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<th>Usage Charge</th>
<th>Interstate Pipeline</th>
<th>Natural Gas 1 Qtr</th>
<th>Service &amp; Facility</th>
<th>Subtotal</th>
<th>Franchise Fee</th>
<th>Sales Tax</th>
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### Comparison Information

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<tr>
<th></th>
<th>Billing Period</th>
<th>Kwh Usage/Month</th>
<th>Therm Usage</th>
<th>Avg. Daily Temp</th>
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<tbody>
<tr>
<td>Gas</td>
<td>This Year</td>
<td>867</td>
<td>136</td>
<td>33°F</td>
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<tr>
<td>Electric</td>
<td>Last Year</td>
<td>822</td>
<td>93</td>
<td>39°F</td>
</tr>
</tbody>
</table>

### Other Information

- Kilowatt-Hours Used: 867
- Previous Reading: 41918 Actual 02/05/2010
- Days in Bill Period: 32
- Current Reading: Estimate 03/09/2010

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*Fischer & Eden & Dick*  23  HCC Course, Fall 2010
“Modern” Energy Representation
(facilitated by Smart Meters)
Online Website (showing real-time and historic energy consumption) →
students compete to find opportunities to save energy
Eco-Arts and Eco-Visualization
Eco-Arts and Eco-Visualization

If DesigNord’s FlowerPod is blooming, users are on the right track, but if it wilts, it points them to suggestions for improvement.
Putting Owners of Problems in Charge
—
Interview with a Geoscientist (CU Boulder)

“I spend in average an hour every day developing software for myself to analyze the data I collected because there is not any available software.

Even if there is a software developer sitting next to me, it would not be of much help because my needs vary as my research progresses and I cannot clearly explain what I want to do at any moment. → shows that pair programming will not do the job and ill-defined problems can not be delegated

So I spent three months to gain enough programming knowledge to get by.

Software development has now become an essential task of my research, but I do not consider myself a software developer and I don’t know many other things about software development.”
From Reflective Practitioners to Reflective Communities
Transdisciplinary Education and Collaboration
—
From Renaissance Scholars to Renaissance Teams

- Renaissance scholars have not been viable for the past 300-400 years → the world has simply become too complex

- the notion of *renaissance team* (or reflective community) is viable:

  a social network of specialists from different disciplines working as a team with a common language