The Exciting Future of Computing

Bill Griswold

Computer Science and Engineering
“The Engineer of the future will have to think more like a science fiction writer.”
– Vernor Vinge
Nanotech convergence - Bio, Physics, Eng, and IT

Mems - 1000x Magnification

HP MemorySpot
2 mm

DNA-Conjugated Microbeads

Nano - 400x Magnification

IBM Quantum Corral
Iron Atoms on Copper

5 nanometers

400,000 x!
Embedded Processors Everywhere

- Embedded processors are everywhere
- Most aren’t networked, nor need be
- But what if more were?
  - Should your fridge call the grocery store?
A Nomadic Information Society

• Distributed work environments, travel
  – Contact friends and colleagues easily, find you

• We depend on good information, and lots
  – Decision making, prioritizing
  – Information glut
  – On-the-fly as opportunities emerge

• Much of what we do is move information between artifacts
  – Fridge out of milk → order milk from store

• Anywhere, anytime? Ubiquitous as text?
Example - UCSD’s Challenge

• Campus will grow by 10,000 students in 10 yrs
• Students are increasingly nomadic
  – live, work off-campus; transfer to UCSD as junior
• Facing disintegration of community
  – University creates, imbues “culture of learning”
  – Campus environment reinforces this focus
  – Values not transmitted if overwhelmed, part-time
• How make growing campus feel like small one?
  – Can technology help, rather than harm as usual?
Scenario - Sarah’s Day at UCSD

• A transfer student, slow in becoming full participant in campus life
• Having troubles seeing applications of her coursework to real-world problems
• How can network technology help?
  – Suppose Sarah is carrying mobile smart phone
• Use to make opaque campus infrastructure transparent
  – Help her take advantage of previously unseen opportunities for learning and cultural enrichment
Embodied Virtuality
make information and knowledge manifest in the physical world

http://www.hdb.gov.sg/

AE Innovations

Andrei Pungovschi / AP

Bango

http://www.hdb.gov.sg/
Embodied Virtuality
Ubiquitous Computing
Pervasive Computing
Augmented Reality
Cyber-Physical Systems

Sensors, networks, and (mobile) computers...
linking the physical and virtual worlds...
everywhere, all the time, for everyone.

A unique focus on people and their needs
Opportunities Abound
So, why doesn’t it all just work?!

- The technology is just getting here
- We don’t understand the need
- Murphy’s Law – this stuff is complex
- Imagination and invention takes time

We’re at an exciting time and place
What should the apps be? The UI?
What effects do they have?

location-aware
context-aware
privacy “aware”

Deployed 500 WiFi PDAs...
broadened discourse
creative use of location
IM when closer than average
willingness to be “seen”
need “everywhere, all the time”
Ubiquitous Presenter
Active Learning for the Large Classroom

• Participatory learning is a superior teaching method
• Hard in large classrooms
• UP supports wireless transmission of student submissions, questions, and polls (in ink or text)
  – Web-based for access
  – Instructor uses TabletPC-based UW Classroom Presenter for presentation
  – Mobile phone support (text and photos)
• Now in wide use at UCSD & numerous other campuses
Example – location-based reminders
– Had not proven useful in small areas supported by 802.11b
– Investigated importance of ubiquity with Place-its phone app
  10-person study revealed phenomena unique to ubiquity
  – Slowness and coarseness of positioning not a major shortcoming
  – Location used as a proxy for other kinds of context, e.g., not busy
  – Ubiquity: “Since I was out of town, I would think of things on the drive that I had to do when I got back and I’d put reminders on the phone.”
  – Distinctiveness: “There are certain activities that my calendaring app is not particularly good at reminding me about. Especially ... when I’m not near a computer.... [examples are] grocery shopping, and also when I’m leaving work I’m on my way out, done for the day, not liable to be checking email.
  – Calm: “It was a relief knowing I would’ve been reminded....”

Why Ubiquity? Context Awareness?

Arriving Home: Call Mom
UbiSketch: Bringing Sketching out of the Closet

So over the last few days...
Life has been...
1 HOUR PRE-THESIS DEADLINE

Monday, 8:00 pm
AHHHHHH!
(Not done yet editing)
I'm not sure I can make it

Also not done editing.
Also current frame
after yesterday
monday

I guess what this
Lol.

Also current

Facebook
Photos - SketchBook
3 photos | Back to Photos

Added about a week ago - Comment: Like

It looks like you're looking into the mind of a serial killer.
March 16 at 7:00 pm - Report

Are you implying that I'm a serial killer? I...
March 16 at 7:22 pm - Report

This is just outstanding: forget my flying car, this is a much better use of technology.
March 17 at 8:37 am - Report

Write a comment...
Escaping the palm top

CitiSense – Ubiquitous Personal Sensing
Some Research Problems

• **Software Architecture**
  – Citizens, policy makers, & researchers should be able to easily add sensors, displays, & apps.

• **Inference with noisy commodity sensors**
  – Low cost for ubiquity, heterogeneous due to innovation.

• **Mobile power**
  – Resources will be scarce at the fringes.

• **Security and Privacy**
  – Under multiple authorities, sensors not securable.

• **Use and Efficacy**
  – How will people use and how to design for it?
Escaping the Palm Top – Public Facebook

with Sverre Moen, Jim Hollan
and Barry Brown
Wireless Information System for Medical Response in Disasters

- Bad things happen during response
  - Fire trucks block signals, other networks
  - Network nodes die, devices die
- Server provides backing store & consistency
- Uses remote objects over publish/subscribe
need to cite rollback/replay methods
Typical city has just a few air quality sensors

Miniaturization, packaging, and integration make personal sensing possible

Squirrel transmits photo stream with sensor meta-data

Visualization makes photos grainier as air quality degrades
Laws of Context-Aware Systems

• Ubiquity Law
  – A context-aware system is useful to the degree that a person can benefit from it everywhere (and that everyone can benefit).

• Commoditization Law
  – The cost pressures of ubiquity lead to commoditization, thereby increasing heterogeneity, interoperability, and fragility.

• Systems Law
  – Successfully designing a component of a context-aware system requires understanding key aspects of the whole.
Key Consequences of the Laws

• Ubiquity creates scalability challenges
• Commoditization makes failure a normal mode of operation – how to design for, how to make progress?
  1. Cheap & varying sensors
  2. Disconnected operation
  3. Seamfulness
• System-wide interactions complicate design
  – Issues like failure interweave and crosscut other “drivers”
  – Need holistic design – app. semantics and s.w. architecture
  – Expanding the unit of analysis: ecological design
My Claims

• “Failure as a normal mode” dominates architecture and design – you cannot abstract it away

• Commodization and systems effects are somewhat manageable with object technologies

• Ubiquity + Failure = Better to operate 20% of the time in 100% of the world, rather than 100% of the time in 20% of the world
Future of Education is Inquiry

Faculty-directed Research Projects

Capstone Design Classes

TIES ENG 100L (e.g., DigiNurse, Campus of the Future)

COSMOS

CSE 118 UbiComp

ActiveCampus

Calit2 internships

Summer Programs
The Course: Logistics

• **Discussion:** Tues, Thurs 11:00PM-12:20PM
• **Lecture:** Wednesday 1-2pm, same room
• Get the book
• Bookmark the web site: [www.cse.ucsd.edu/users/wgg/CSE118](http://www.cse.ucsd.edu/users/wgg/CSE118)
• Grading: 50% discussion, 50% project
  – Details on grading page (a lot of them)
The Course: *Academic Preparation* Concept

• Designed like a graduate course
  – Directly engage the research literature
    • A good look at the future – the world’s...and yours?
  – Participatory, loosely structured
    • Mold this course to your interests
    • Get out of it what you put in
  – A peek at what grad school could be like
    • And preparation for it

• Seminar style, roundtable discussion
  – We will have some visitors give talks
  – You must come prepared for class to discuss
The Course: Tu/Th Discussion

1. Read the papers for class
   • Dig into background reading (via web?) if need/want
2. Take notes
   • Mark up the paper
   • Fill out the form (see “How to read...” on web)
   • Bring questions to class (more important than answers)
3. Jump into discussion!
   • Volunteer when you’re ready
   • Polite but assertive
   • If you’re late, you can’t participate

How will I grade discussion?
- quality, not quantity
- ideas and critique supported by evidence
- helping group perform at high level (teamwork)
The Course: Research Project

• Define a team project to empirically explore ubiquitous computing
  – Usefulness, scalability, cost, how, effects...
• Not necessarily big, but insightful or useful
• Come up with own idea or use one of mine
  – Doesn’t have to be implementation, just empirical (experimental)
  – SW resources: Ubiquitous Presenter, S3, Public Facebook, Sousveillance Grid, ...
  – HW resources: Phones, TabletPC’s, Anoto pens
  – Can discuss other resources as needed
The Course: Wednesday Lecture

• Orthogonal material designed to dramatically improve your performance in the course...and in life!
  – Research methods
  – Academic life
  – Project management
  – Software engineering
  – Writing and presentation
  – Creativity
The Course: Living It

• Live the UbiComp lifestyle
  – Go mobile: Wi-Fi laptop, mobile phone...
  – Web 2.0: facebook, flickr, ...
  – Put a small “public display” up at home

• Read about it
  – Subscribe to a mailing list or magazine
    • ACM TechNews: http://www.acm.org/technews/
    • Wired: http://www.wired.com
    • ...

• Observe it, talk about it, bring it into discussion
  – It’s everywhere around you
  – We have an archived mailing list

• Programmable mobile phones for loan (HP WinMobile GSM)
What about those grad students?

• TA Rishi Kapoor will be helping substantively in class
• A few grad students may also be coming to this course because of interest in education
• They will be:
  – Helping with discussions
  – Mentoring your projects
  – Observing and critiquing each other
• I will be:
  – Doing all the above
  – Helping the graduate students become effective educators
• The general structure for this course is learning by doing, *with help*