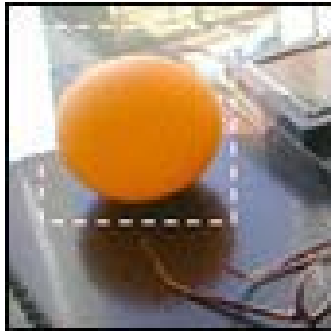


Augmenting Humans via Objects and the Environment



Anind K. Dey

Ubicomp Software Architect, Intel Research Berkeley

Assistant Adjunct Professor, UC-Berkeley

Outline

- **UIs for Ubiquitous Computing**
- **Augmenting Objects**
- **Augmenting Environment**
- **Lots of applications and design examples**

Characteristics of Good User Interfaces

- **Fits in with current work practices and tools**
- **Easy to learn, maintain mental model**
- **Leverages real-world knowledge**

Future Interfaces: Natural Input

- **Speech**
 - Becoming commercial
 - But lots of work to make usable in real situations



- **Handwriting**
 - PDAs
 - Tablet computers



- **User of these technologies**

Future Interfaces: Augmented Human Cognition

- Augment everyday objects
- Augment environment



TecO
MediaCup

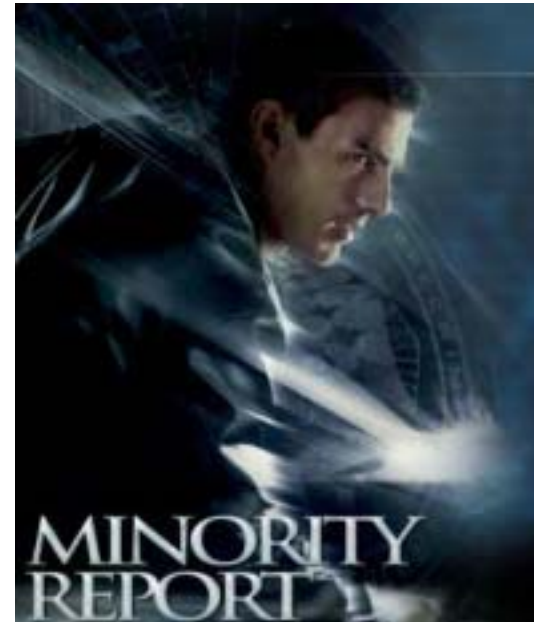


Aware Home
Georgia Tech

- Research focus: use of sensors to improve human-computer interaction
- IT Innovation forecast

Movie Break!!!

- **Minority Report**
- **2054 prediction**
- **Futurist thinktank**
- **Jetpacks**
- **Mag-lev cars**
- **Ubiquitous personalized ads**
- **Great new UIs**
- **Website & Videos**



Augmenting Objects

- **Designer's Outpost**
- **Ambient displays**
- **DataTiles**
- **FieldMouse**

Designers' Outpost

(Klemmer, Everitt, Landay)

- Leverage existing work practice
- Combining...
affordances of paper **and**
advantages of electronic media
to support design practice
- Electronic wall surface
Regular Post-it Notes
- Computer Vision, Pen, and
Physical Tools UI
- Video



A division of Intel Labs

Ambient Displays

(Dey, Mankoff and many students)

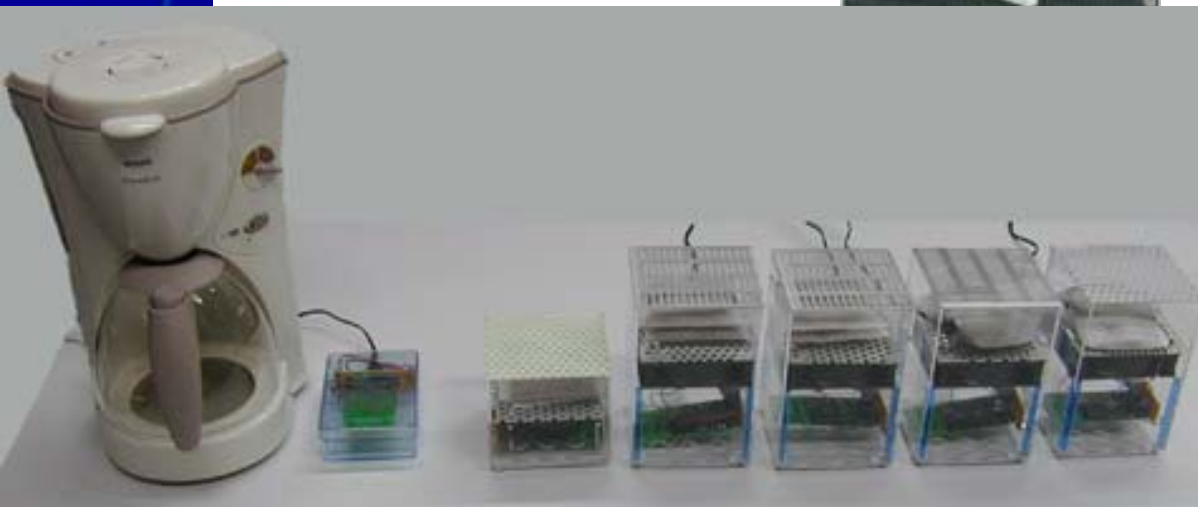
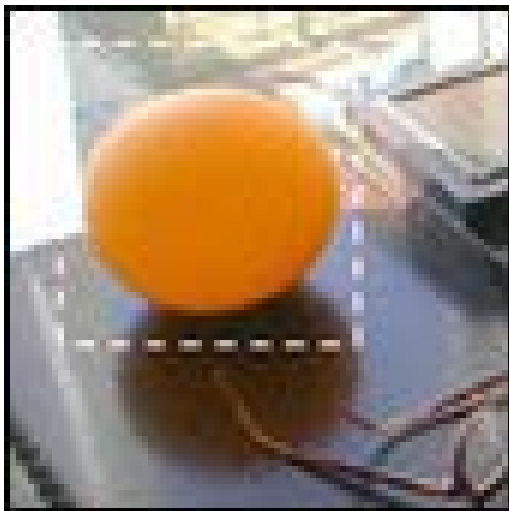
- Peripheral cues of some (potentially) interesting event in your environment
- Any modality: listen, feel, smell, see, taste
- Typically abstracted information
- Use perceptual channels that aren't already overloaded
- Provide awareness through everyday objects

Natural Ambient Displays



Innovative Ambient Displays

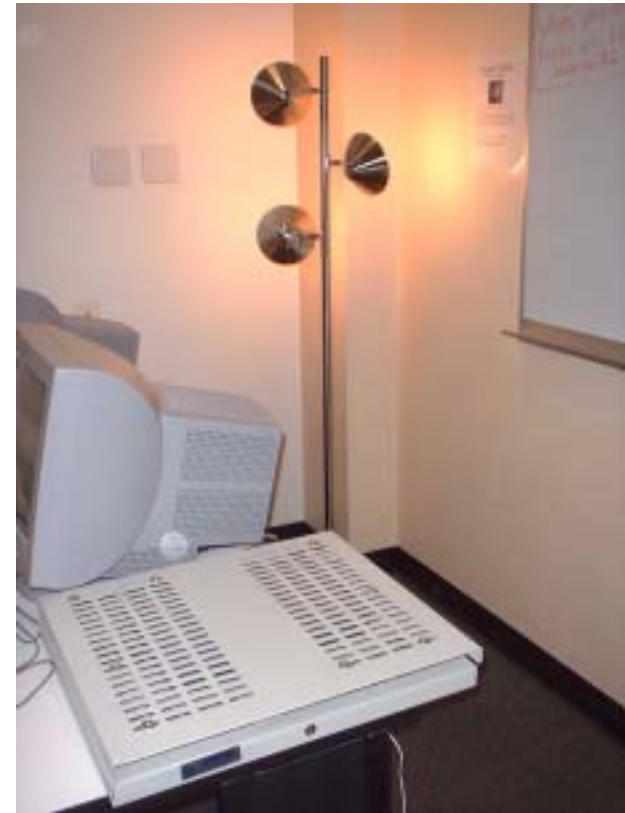
(many others)



Interesting Issues

- Explore the design space
- Provide information that is *relevant* to a space or a group of people
- Do it in an *interesting/provocative/aesthetic* way
 - Transitions: overview to specific; static to interactive
 - Enhance everyday artifacts
- Have some way of *measuring* the results

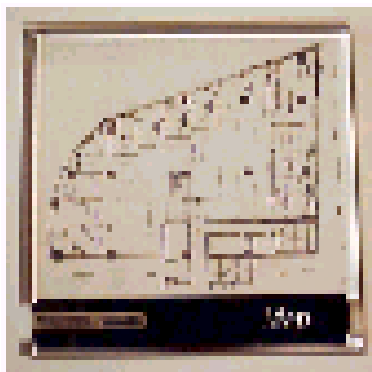
Our Ambient Displays



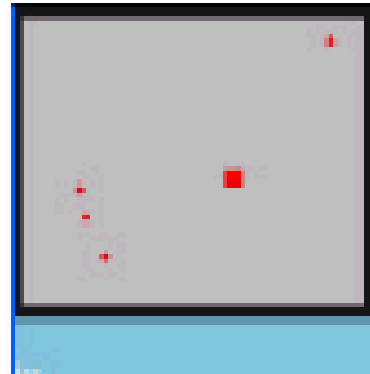
Current Status

- **Displays deployed and evaluation data collected**
- **Evaluation: Questionnaires, monitoring and instrumentation**
- **Completing results of study**

DataTiles (Rekimoto)



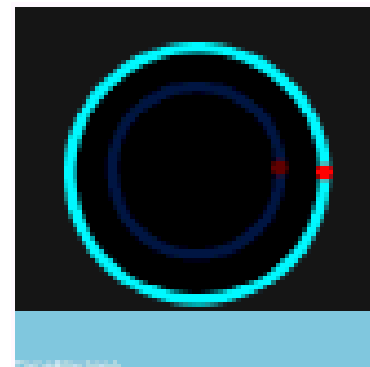
+



=



+

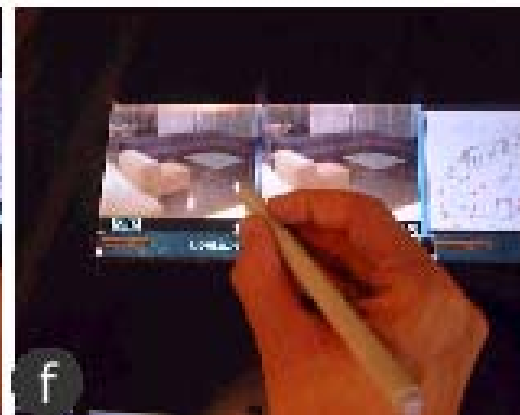
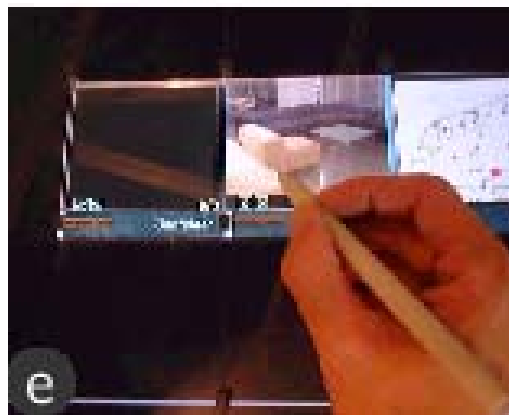
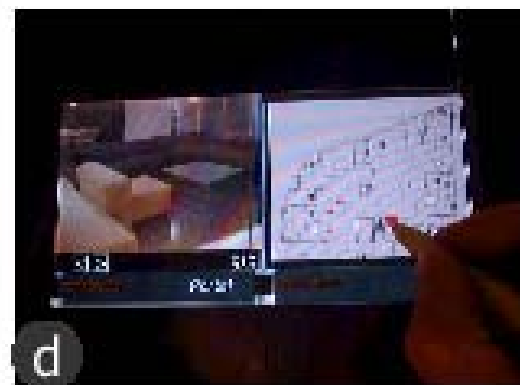
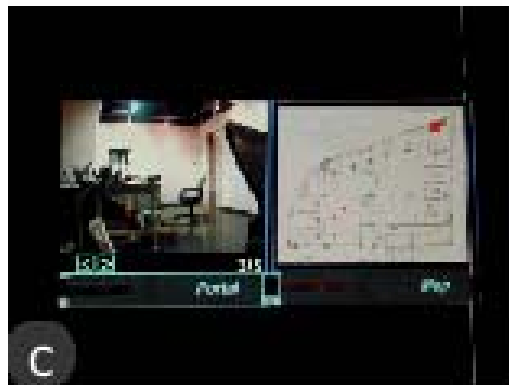
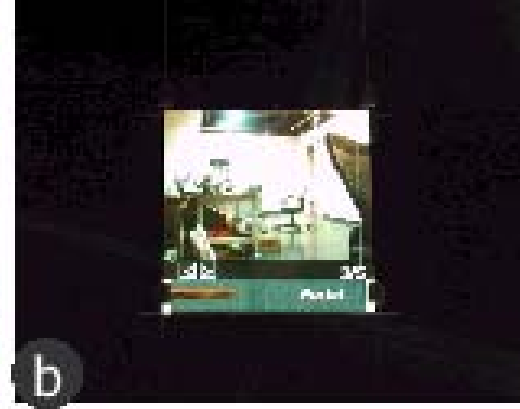


=



DataTiles

- Emergent behavior when you put objects close to each other
- Adds power to physical interaction
- Video













A division of Intel Labs

FieldMouse (Siiio)

- Physical icons and authoring tools





Nintendo e-Reader



Nintendo e-Reader



Character Data

Game/Music/Animation Data

Augmenting Objects Summary

- **Adding computational ability to everyday objects**
 - merits of each project
- **Range of effectiveness: blending into natural activities**
- **Easier for input than for output**
- **Constraints on form, power lead to constraints on function**
- **Scaling is an issue**

Augmenting the Environment

- **Illuminating Clay, CadCast**
- **Aware Home**
- **Smart Spaces indoors and outdoors**



Illuminating Clay & CadCast (Ishii)

- Augment the environment to enable novel interactions with it
- CadCast **VIDEO**
- Illuminating Clay **VIDEO**

Interaction Toolkits

- **Value of toolkits: Mac GUI TK**
 - Enable faster development by introducing abstractions
 - Enable development of new systems
 - Encourage use of design guidelines
- **Context Toolkit**

Context Toolkit

- **Make sensors easier to use to support complex human computer interaction**
 - Sense and take action
 - Monitor, control environment
- **Combining technologies → fusion and analysis of multiple homogeneous/heterogeneous sensors**
- **Detect interesting activity and determine the correct action to take → context-awareness: applications, middleware, evaluation**

Context Toolkit

**Make sensors easier to use to support
complex human computer interaction**

- Sense and take action
- Monitor, control environment

Intel/Berkeley

Smart

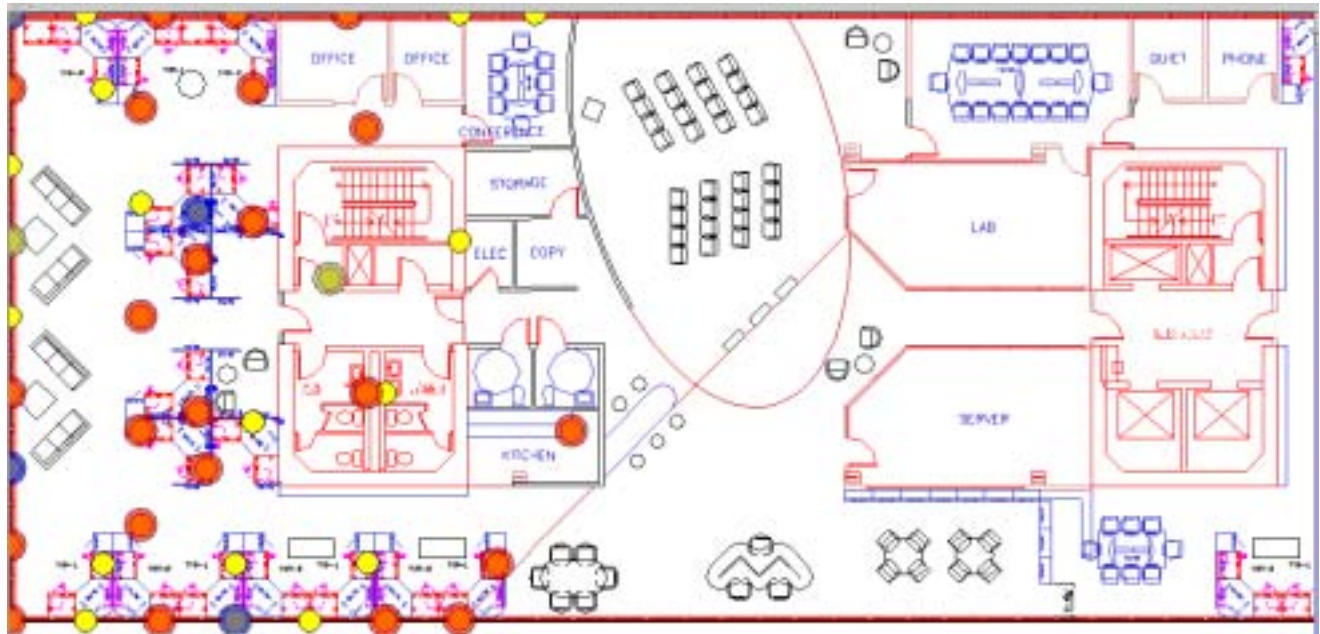
Dust

Motes



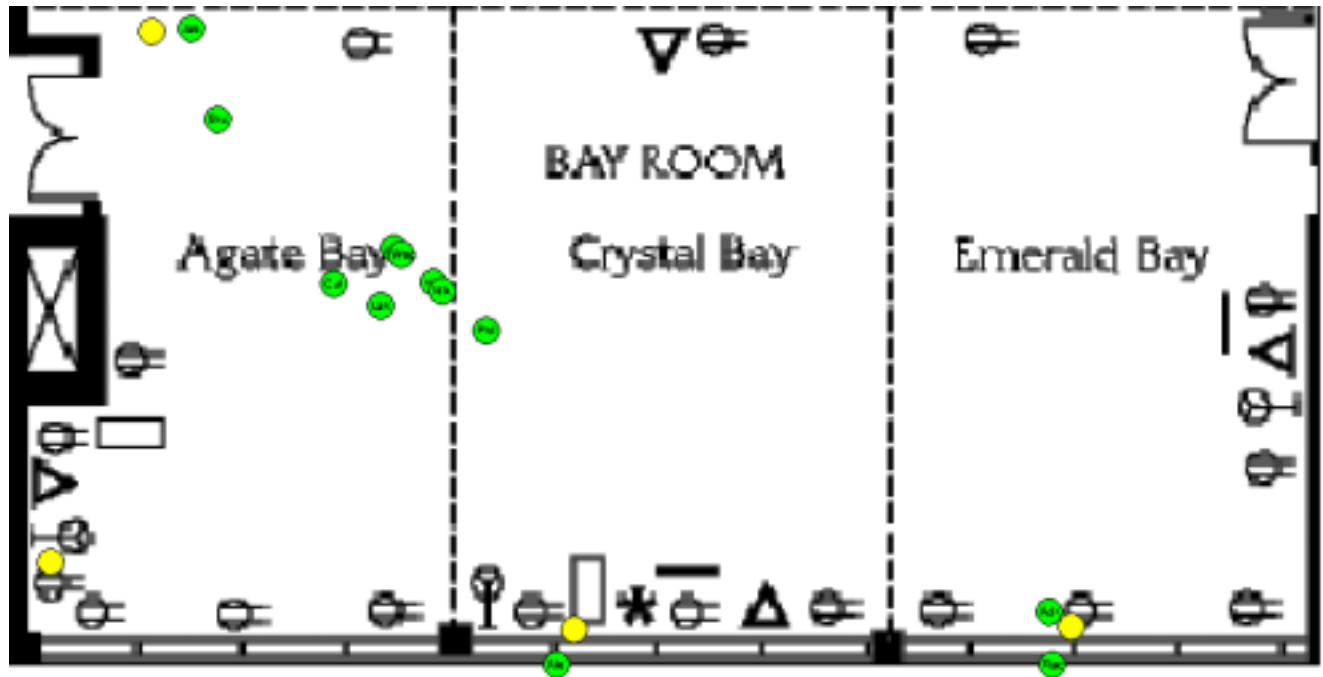
Smart Spaces

- Create long-running, reliable sensor network in the lab for simple environmental monitoring



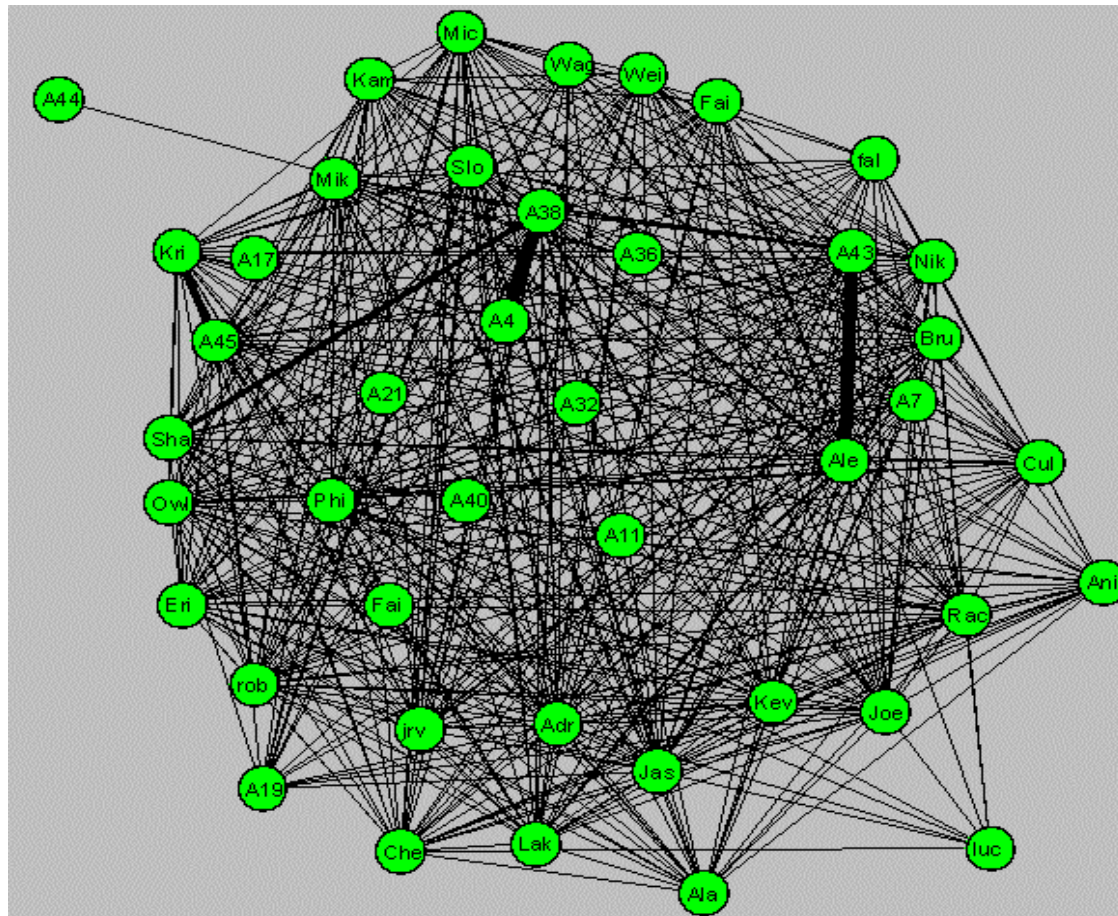
Smart Spaces

- People and object tracking

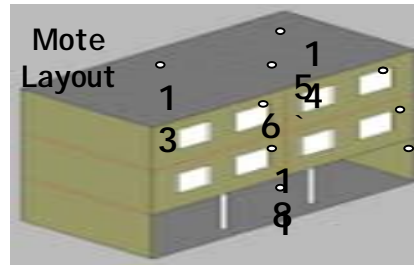


Smart Spaces

- Social networks



Structural performance due to multi-directional ground motions (Glaser & CalTech)

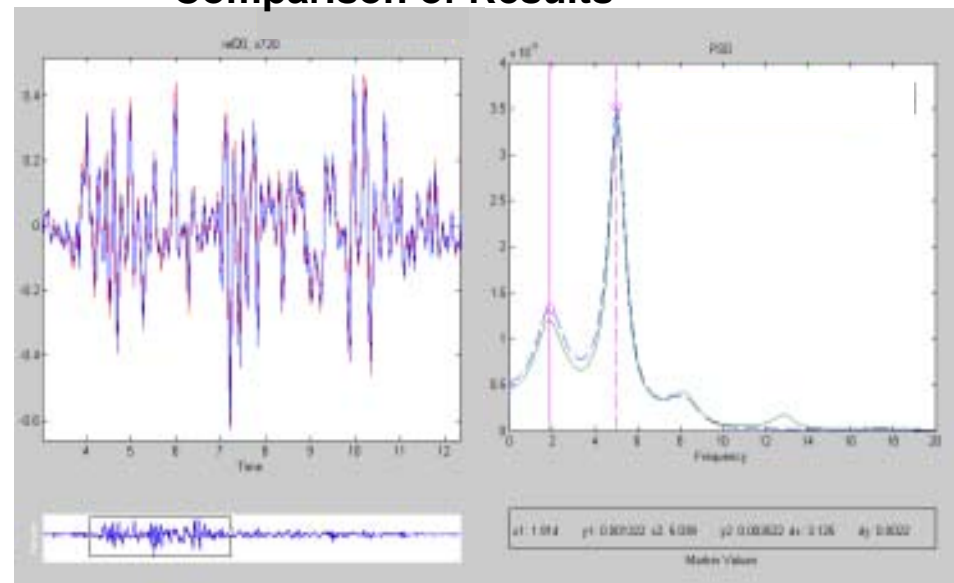


Mote infrastructure



Wiring for traditional structural instrumentation + truckload of equipment

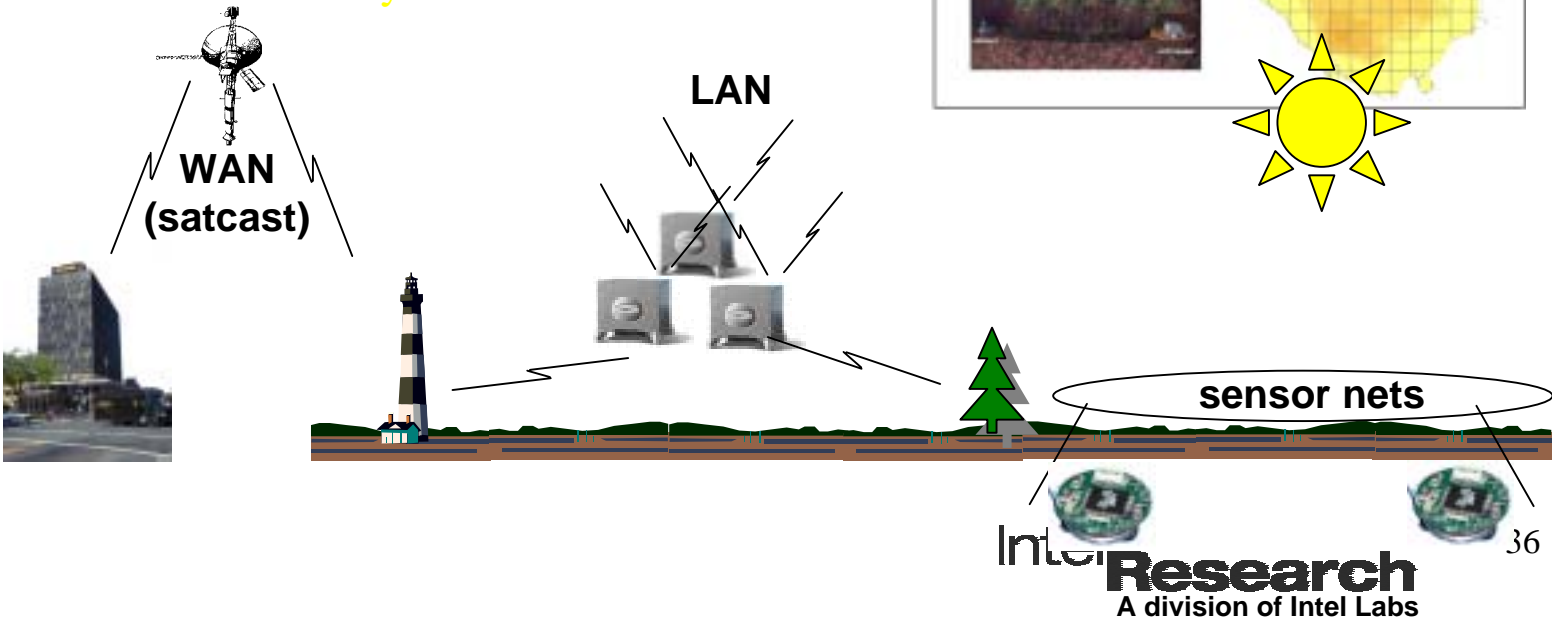
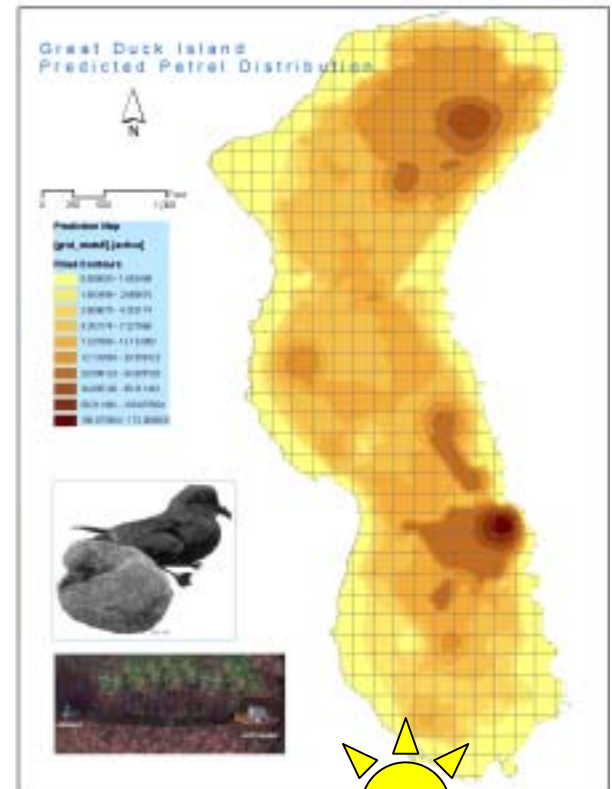
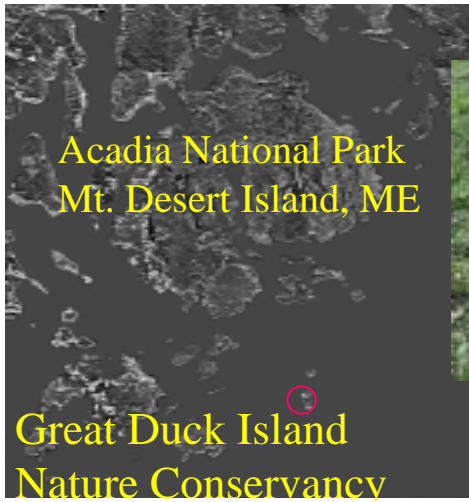
Comparison of Results



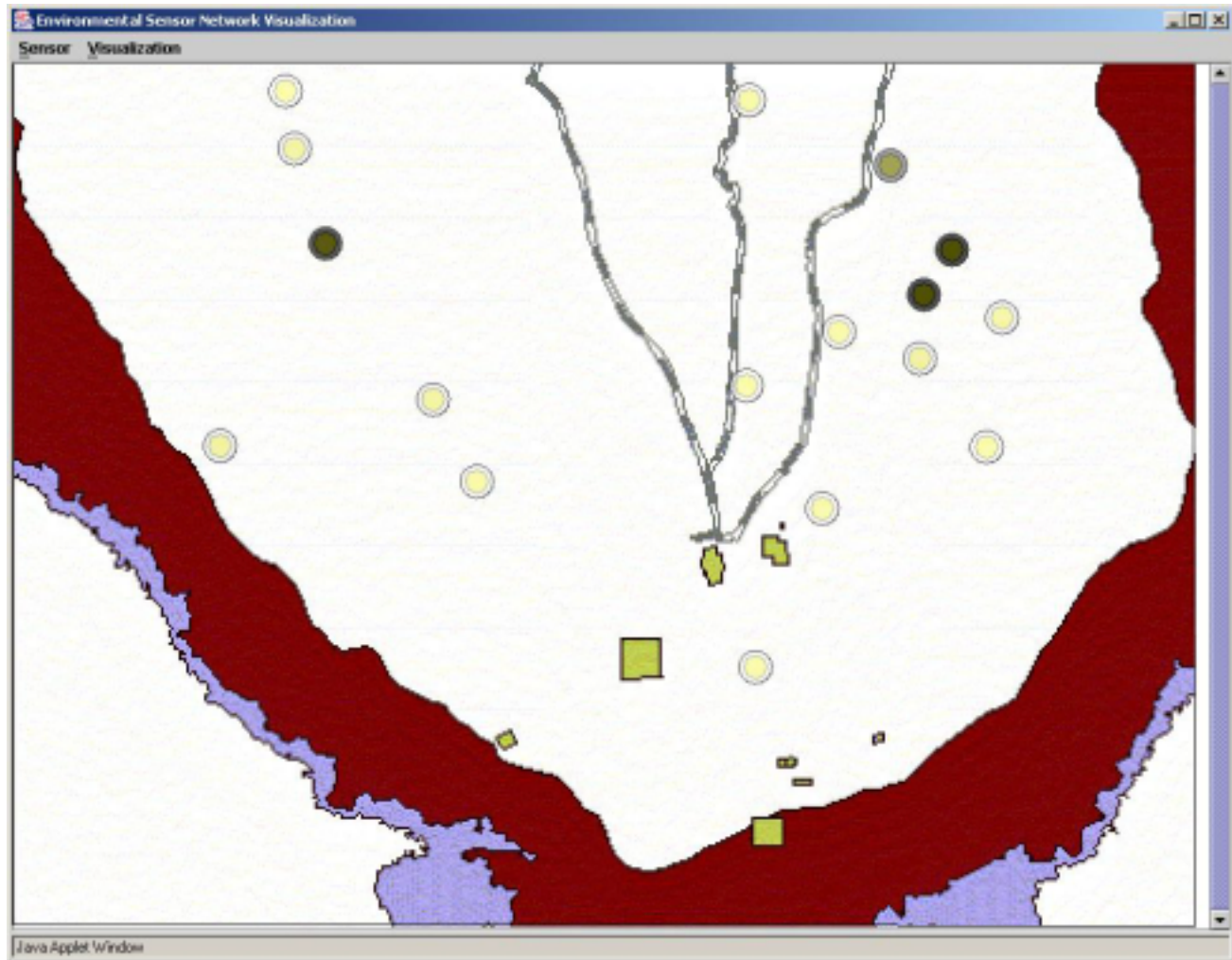
A division of Intel Labs

Habitat Monitoring

(Mainwaring, Dey, Polastre)



Habitat Monitoring



Web View

Great Duck Island Network Dashboard - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print Mail

Address <http://kettle.cs.berkeley.edu:8080/cgi-bin/test/gdi-dashboard2> Go

Great Duck Island Network Dashboard

LATEST INFORMATION as of Wed Jun 26 13:17:57 PDT 2002

Node ID	Packet Time	Light	Temperature	Voltage	Time Since Last Update (ms)
53	2002-06-26 13:15:08	255	109.75 °F	3.145 V	169068
22	2002-06-26 13:17:46	255	116.02 °F	3.120 V	11068
26	2002-06-26 13:17:54	255	116.02 °F	3.145 V	3068
98	2002-06-26 13:18:01	255	116.02 °F	3.145 V	-3932
74	2002-06-26 13:18:02	255	120.76 °F	3.145 V	-4932
59	2002-06-26 13:18:02	255	70.77 °F	3.171 V	-4932
92	2002-06-26 13:18:03	255	111.51 °F	3.042 V	-5932
70	2002-06-26 13:18:03	255	110.63 °F	3.287 V	-5932
82	2002-06-26 13:18:06	255	74.22 °F	3.197 V	-8932

Done Internet

Mixture of Mobile and Fixed Sensors

- New
- big
- Ta
- Int

notes | map

Bird:

Activity:

Terrain:

Location:

OK

Stop watch

Count

GPS for
data
network

Sensor Network Demo

- Building smart spaces
- Habitat monitoring
- Precision Agriculture

- Uls at:

<http://kettle.cs.berkeley.edu:8080/sensor.html>

<http://www.greatduckisland.net/mapview>

Augmenting Environments Summary

- **Adding computational ability to an environment**
- **Range of effectiveness: blending into natural activities**
- **Output is easier**
- **Fewer constraints on form, power**
- **Sensing is more indirect and more difficult**

Closing Thoughts...

- User interfaces have to fit habits
- Natural input and augmented input are keys
- Augment human directly or indirectly:
 - objects or environment or both
- Use of sensors is critical
- <http://www.cs.berkeley.edu/~dey>