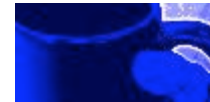


Examples of the Disappearing Computer

Hans-W. Gellersen



Lancaster University
Department of Computing
Ubiquitous Computing Research



“The most profound technologies are those that **disappear**. They weave themselves into the fabric of everyday life until they are **indistinguishable** from it.”

Examples of the Disappearing Computer

Toward a hybrid design

- Combine unique capabilities of computer technology with properties of the physical environment
- Physical integration to the extent that computing becomes indistinguishable from the environment

Three Examples

- Pin&Play: A wall that is also a computer network
- Ambient Display: Hallway posters that double as output medium
- Sensor Table: A coffee table that can sense and receive input

Pin&Play

**A Wall that is also a
Computer Network**

The Pin&Play Network

Concept

- “The wall as network for the things attached to it”
- A new type of network to connect everyday objects on common surfaces such as boards and walls

Use of familiar interaction

- “pinning objects to the wall”
→ “pinning nodes to the network”

Preserve original functionality

- Embedded computing does not displace original uses

Pin&Play Components

Network Surface

- Common surface augmented with conductive material to create two-dimensional network medium

Connectors

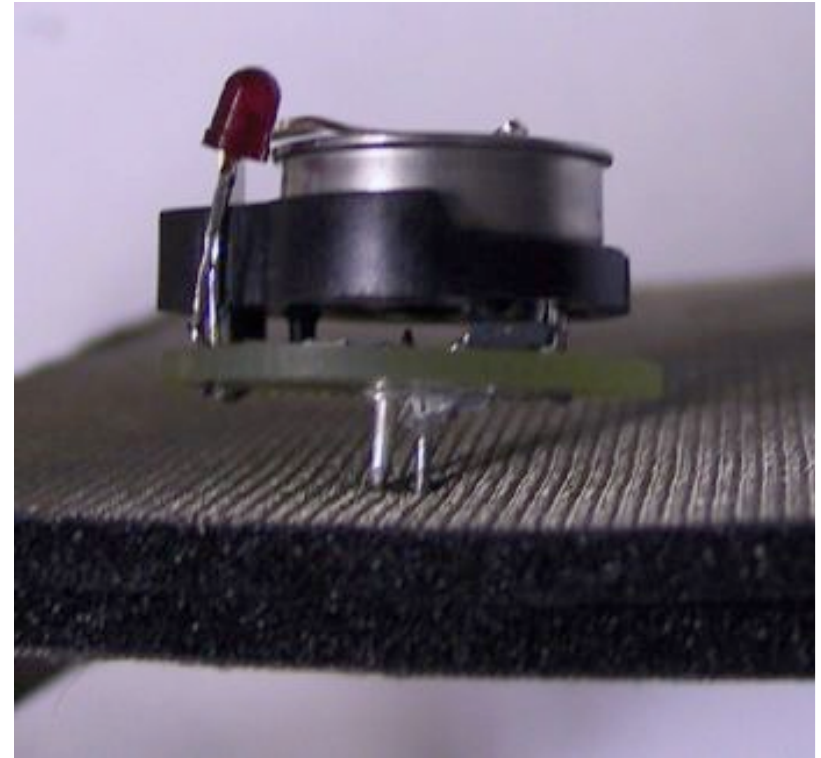
- Pushpin-like physical connector for socket-less attachment of objects

Pin&Play Objects

- any type of device/object with embedded computing, mounted onto connector

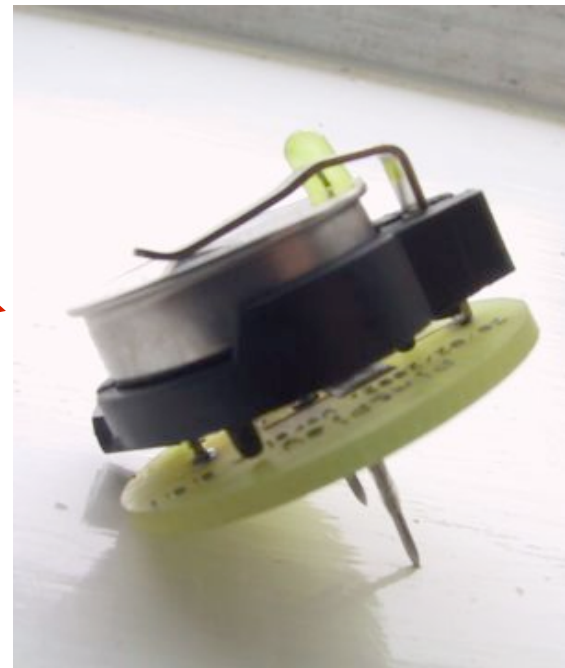
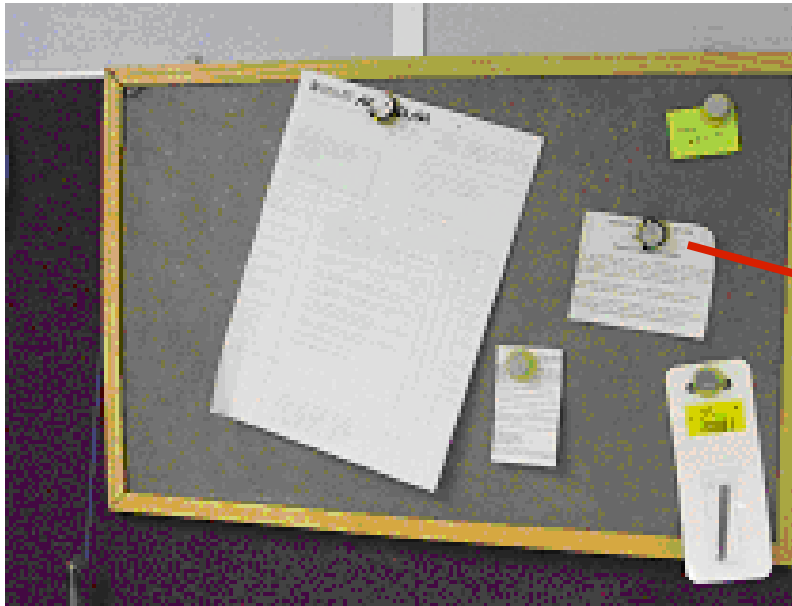
Network:

- “Pin&Play” behaviour: discovery of objects when they become attached



Pin&Play Noticeboard

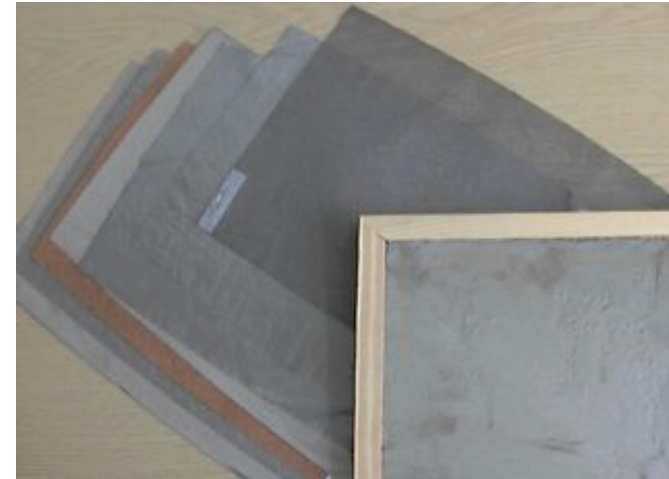
- First demonstrator build for proof of concept



Pin&Play Noticeboard

Pin&Play Surface

- Corkboard augmented with two conductive sheets
- Ground layer on top, data/power layer hidden, cork as insulator
- Low cost, off-the-shelf, deployable at large-scale



Pin&Play Connectors

- Simple connector board with pushpin for two separate connection points



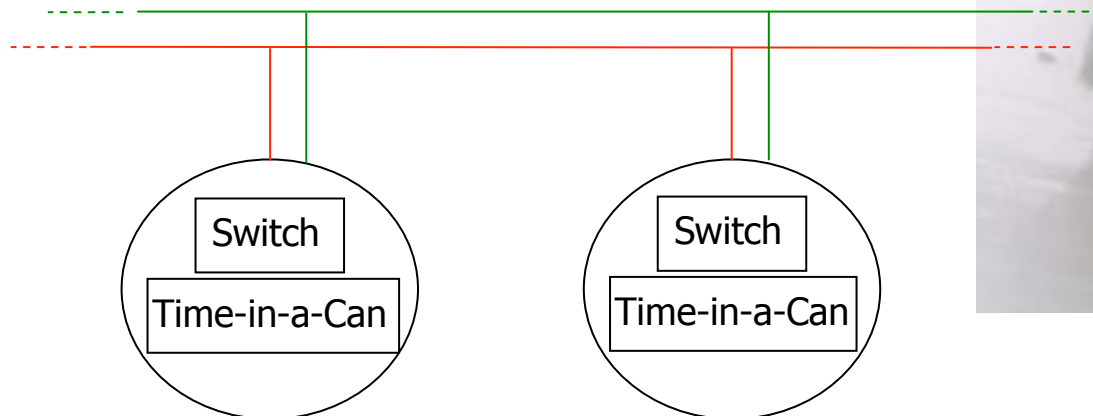
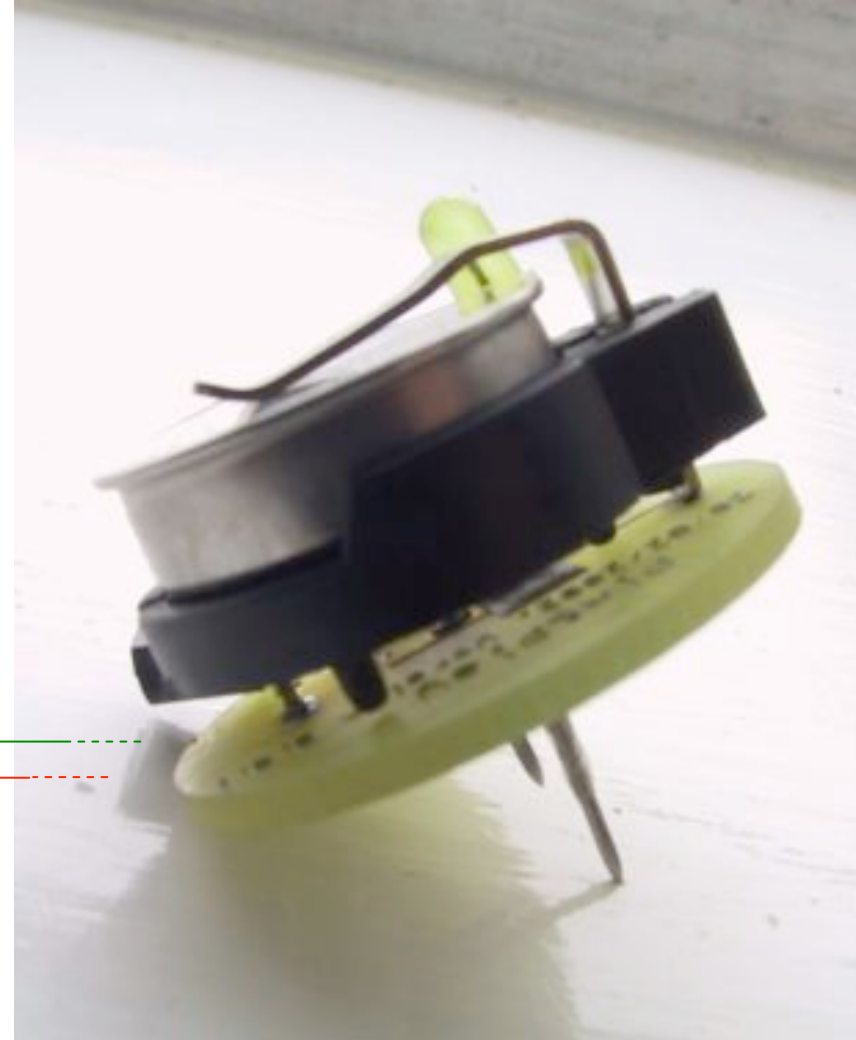
Pin&Play Noticeboard

Network Technology

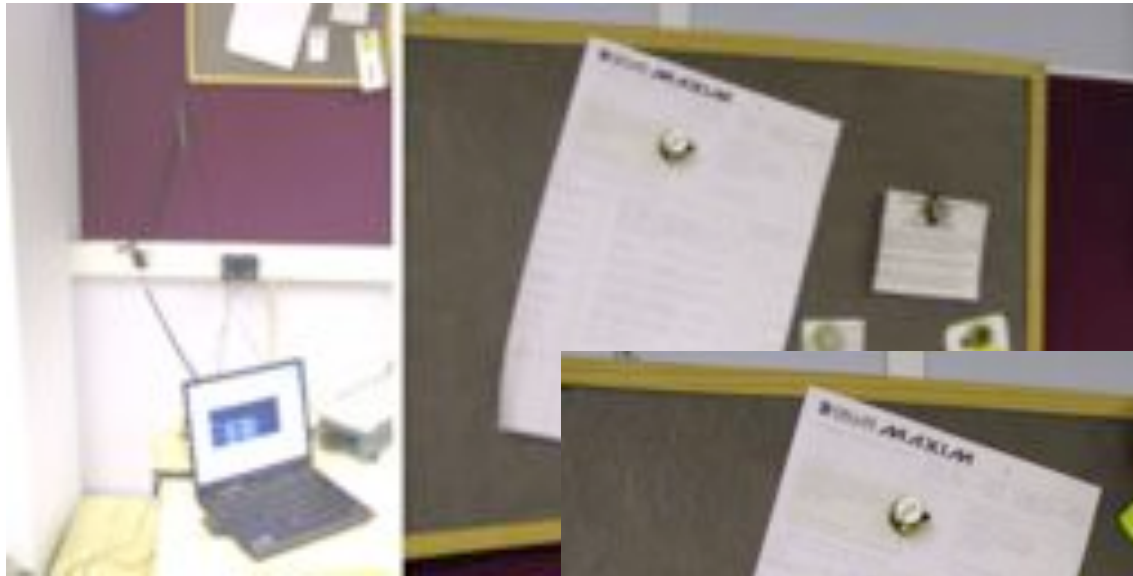
- 1-wire bus, Dallas MicroLAN
- 16300 bits/s

Pin&Play Objects

- “Smart Notification Pin”:
iButton and switchable LED
- Time-in-a-can iButton: memory,
internal calendar and clock



Pin&Play Noticeboard



Network control

- External laptop connected as 1-wire network node
- runs network controller
- used to pre-set pins with priority and deadlines

User interaction

- insert or remove pin
- network detects change
- protocol to determine pin with highest priority



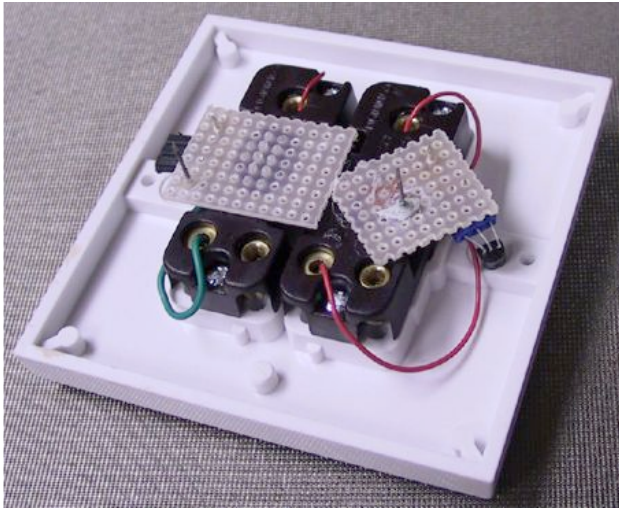
Scaling up ...

... bigger boards, more nodes



Testing versatility ...

... different objects, more applications



Pin&Play Lightswitch

- place it where you like!



Pin&Play

Technology Research

- Network surface development
- Simple and robust protocol design, zero maintenance
- Scalability and density (initial target: 25 nodes/sqm)

Application Research

- Augmented noticeboards, other interactive surfaces
- Embedded home control buses
 - Networking and free placement of controls (light switches, appliance controls etc.)
- Communication bus for wall-attached artefacts
 - Clocks, calendars, sensors, picture frames, ...

Ambient Display

**Hallway posters that
double as output medium**

Ambient Display

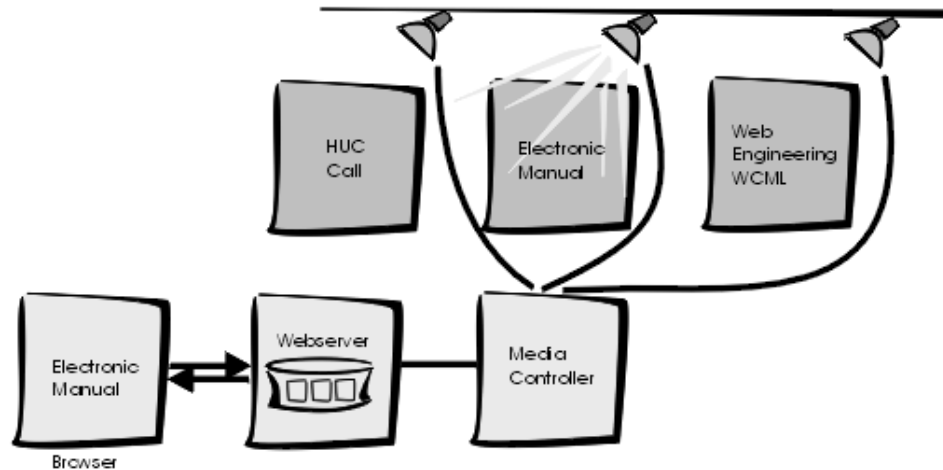
Concept

- Provide information in the ambient environment for peripheral awareness
- Using physical artefacts as display substrate

Application: Web Visitor Awareness

- People have places in the web ("home", "site")
- But visitors come and go unnoticed
- Application concept
 - make activity in your web places visible in your real environment

Hallway Posters

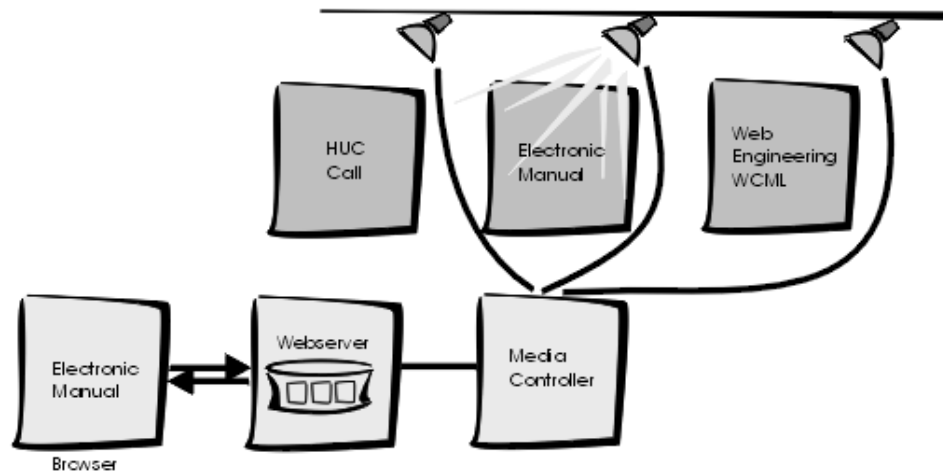


- Associating project web sites with project posters
- Visualizing activity in the web (i.e. interest in the project) through poster lighting
- Web access increases light, decrease over time



project poster:
affordance for finding
project-related information

Hallway Posters



Not just notification!

- **Overview:** visualize web activity over time
- **Comparison:** light distribution over posters provides comparison at a glance



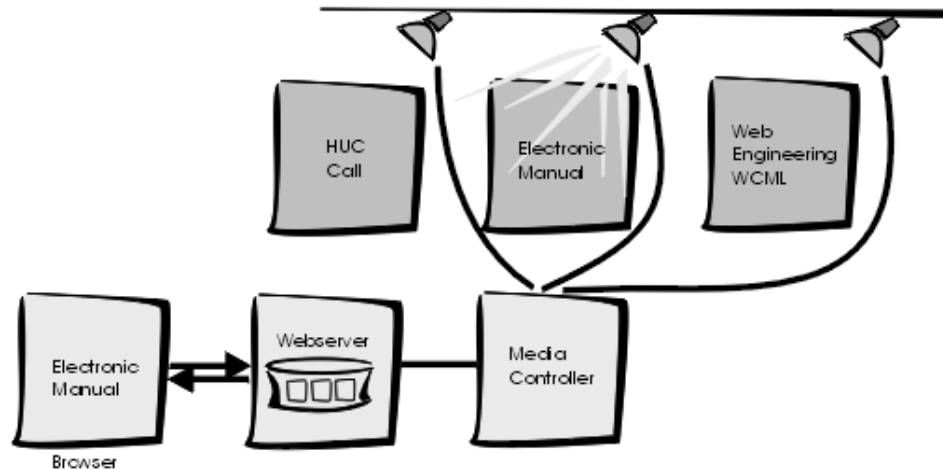
Hallway Posters



Hallway Posters



Hallway Posters



Experience

- In use since 1999
- Non-intentional use (walking-by)
- Not attention-grabbing
- Subtle awareness of web activity

Sensor Table

A coffee table that can sense and receive input

Load-Sensing Surfaces

Concept

- Gravity is ubiquitous: no physical thing can escape it
- Use this force to build interfaces between the physical world and computing
- Augment common surfaces (floors, tables, shelves): this is where gravitation pulls objects to
- Technology: variety of load sensors and pressure gauges with different characteristics

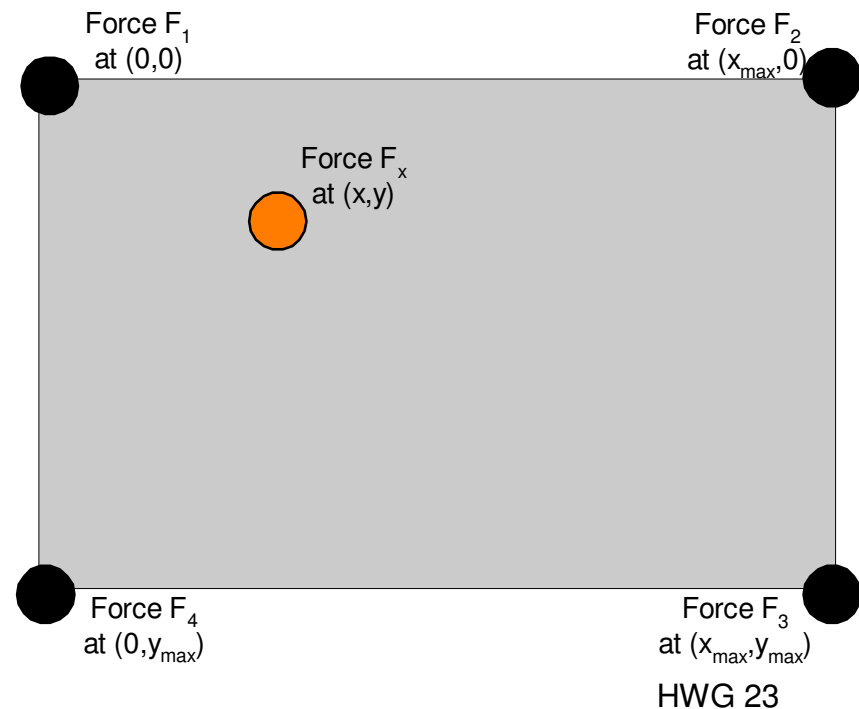
Load-Sensing Surfaces

Principle

- Augment surface at the corners
- Force applied is detected as load depending on position of the pressure point

... more than just weight

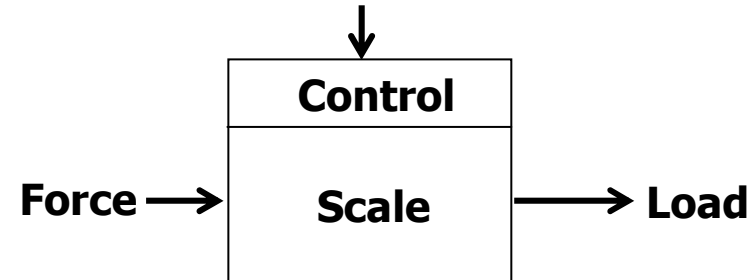
- surface detects weight/pressure
- But also position, traces, etc



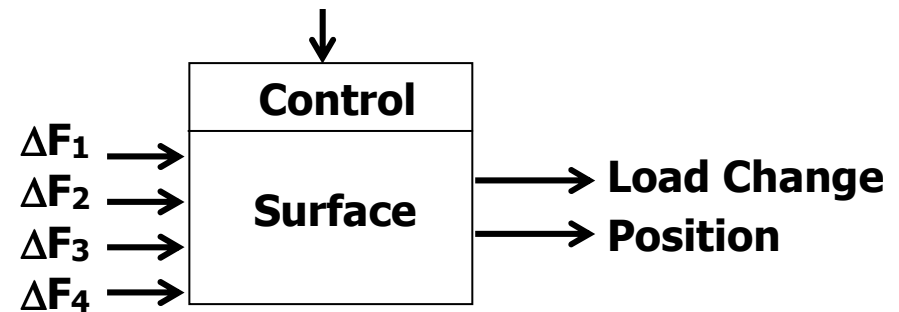
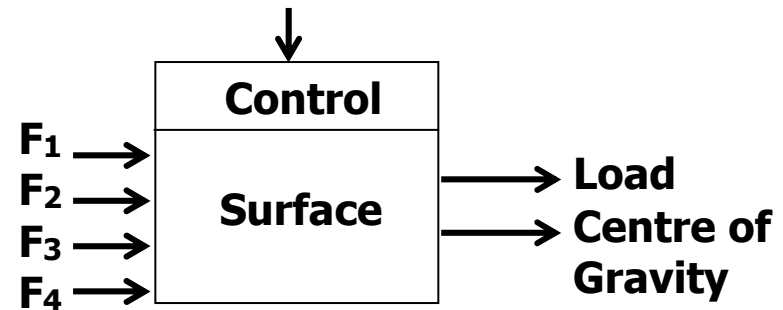
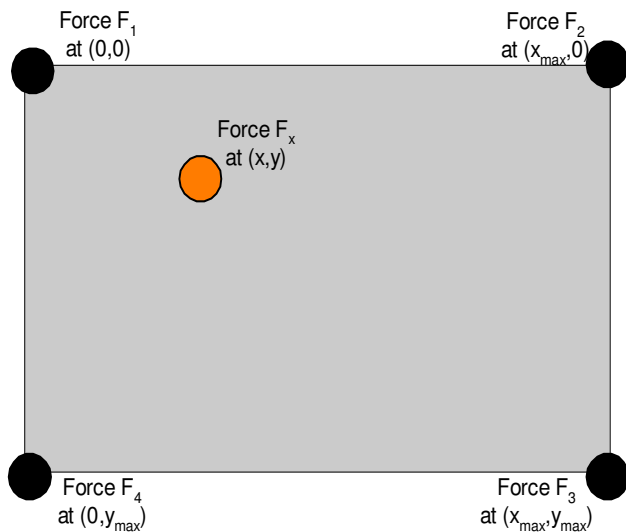
Load Sensing

Basic load sensor

- e.g. your kitchen scale



Load-sensing surface



Load Sensing

Basic event detection

- Object placement
- Object removal

Further event processing

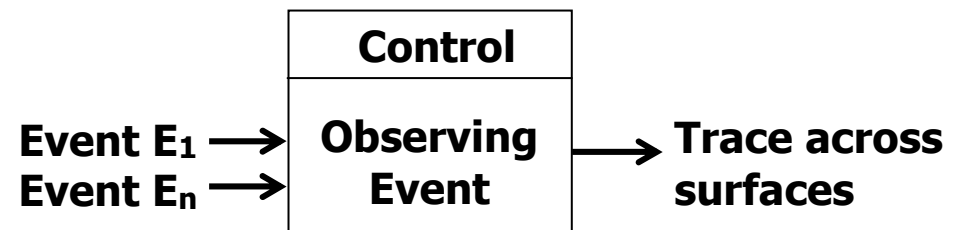
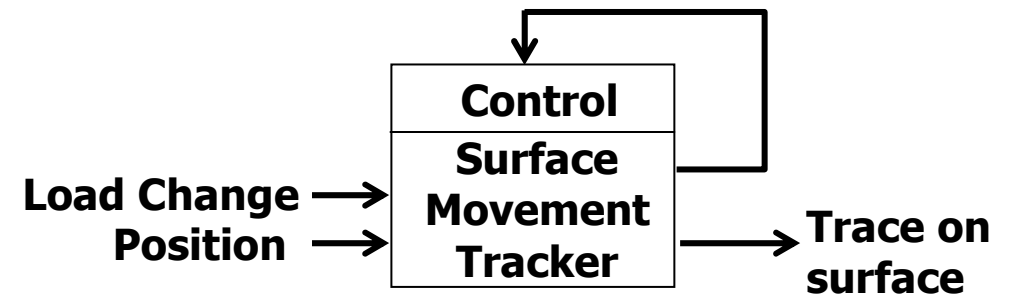
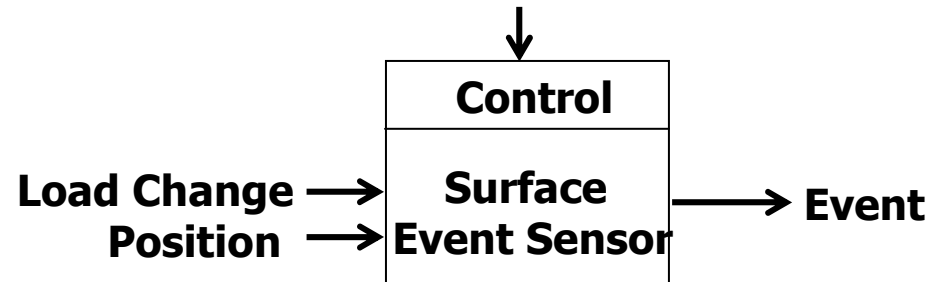
- Detect movement
- Detect specific events
- Detect Object ID/Class

Tracking movement

- Detecting traces on surfaces

Tracking objects

- Tracking across surfaces
- Correlation of events
- Grouping events associated with the same object



Load-Sensing Surfaces

“Weight Lab”

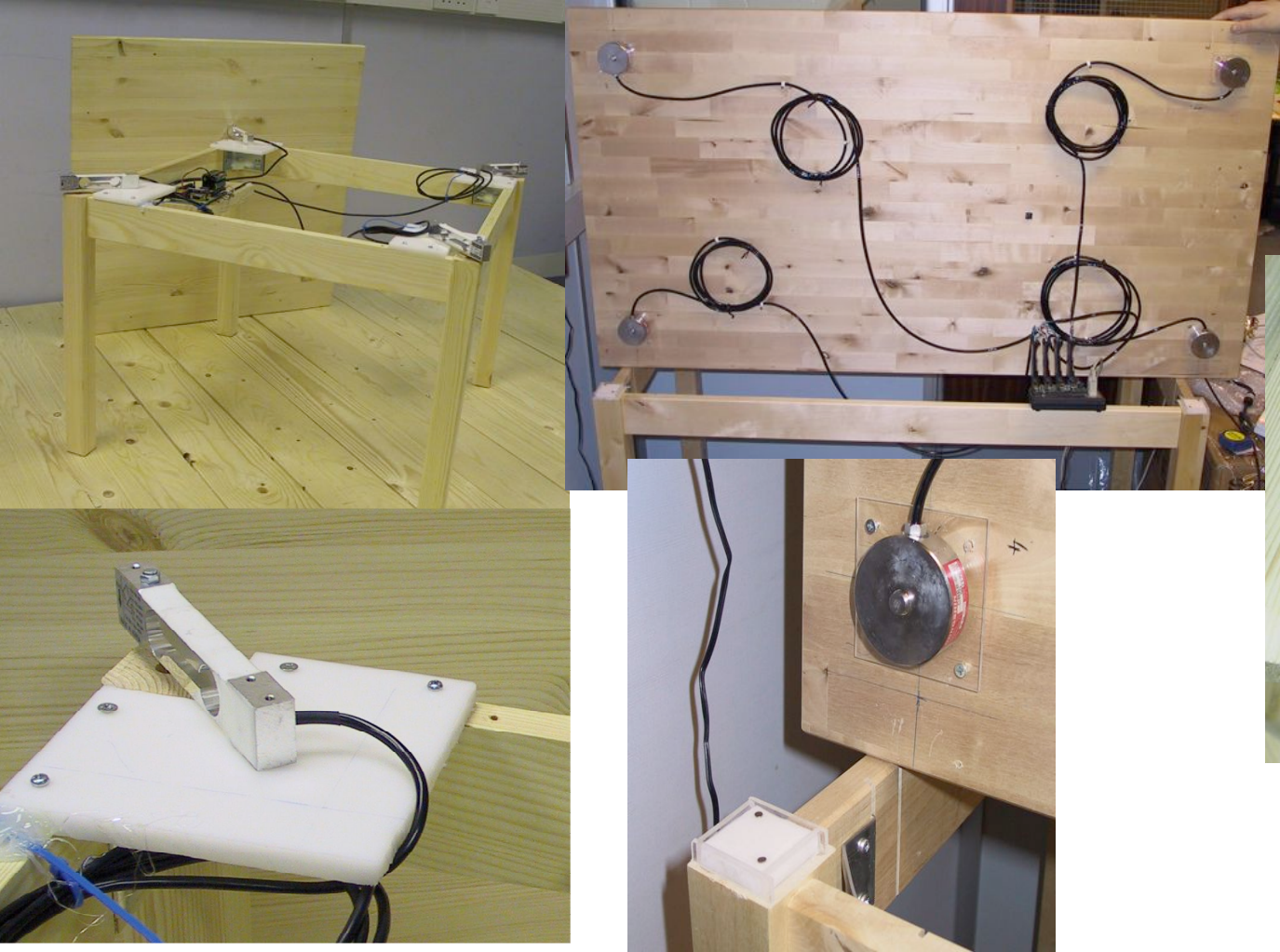
- Various augmented surfaces
- Floor: 240 x 180cm, up to 800kg load
- Larger table: up to 200kg
- Coffee table: up to 8kg, highly sensitive
- Shelves and trays



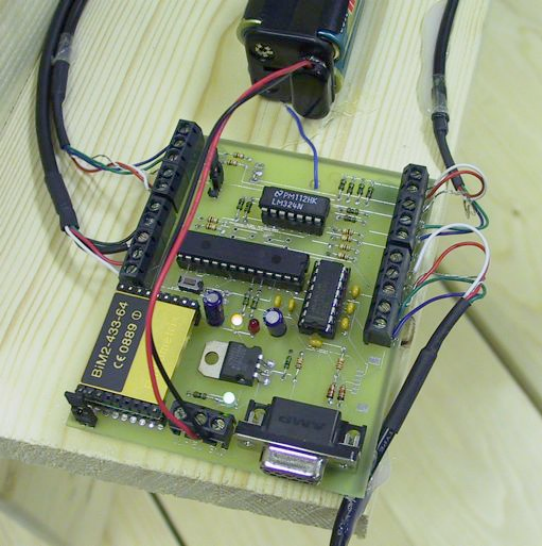
Floor with
embedded
S-load cell



Load-Sensing Surfaces



Augmented tables



Sensor board with wireless communication

Load-Sensing Surface

Context Acquisition

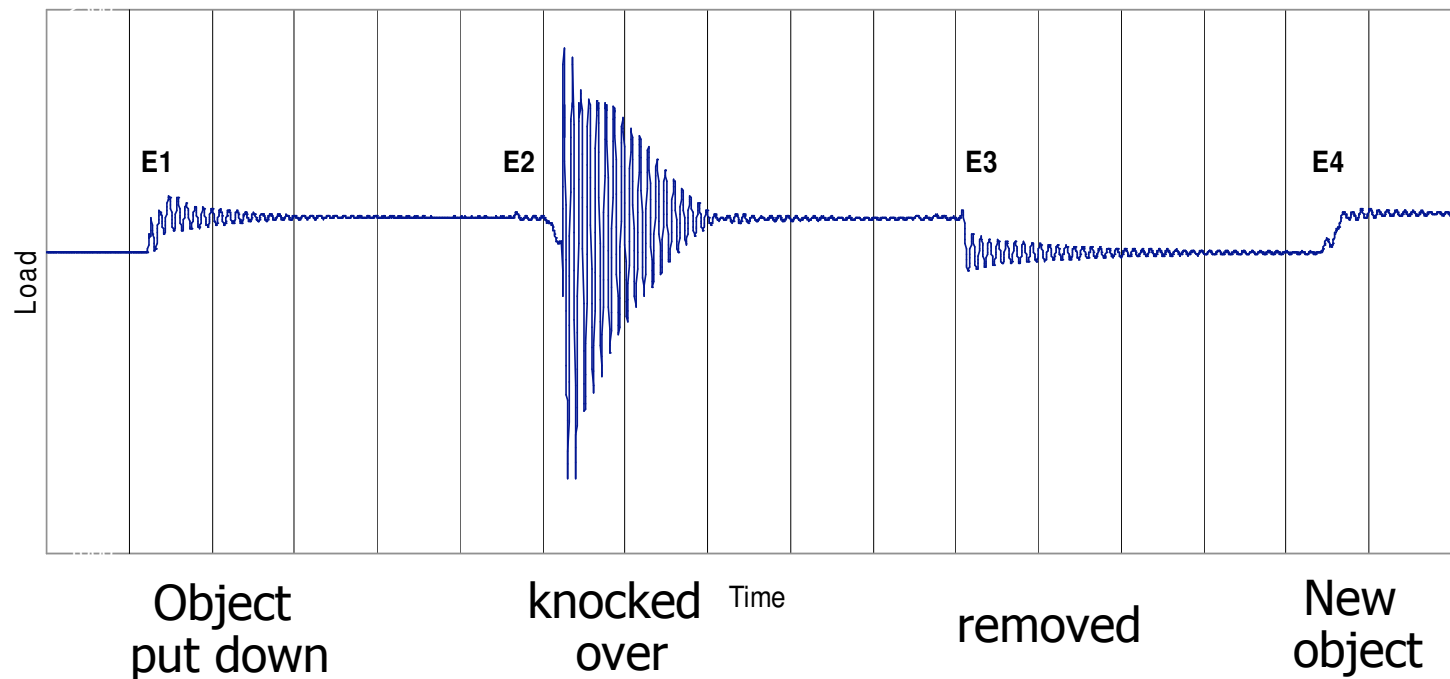
- Weight of objects
 - Detection depends on sensor range (i.e. small weights not detectable on heavy-load surface)
 - Application: object identification (classes/ instances)
- Position of objects
 - cm-level accuracy (depend. on surface size)
 - Table can be pre-loaded
 - Multiple objects can be positioned if placed non-simultaneously



Load-Sensing Surface

Context Acquisition

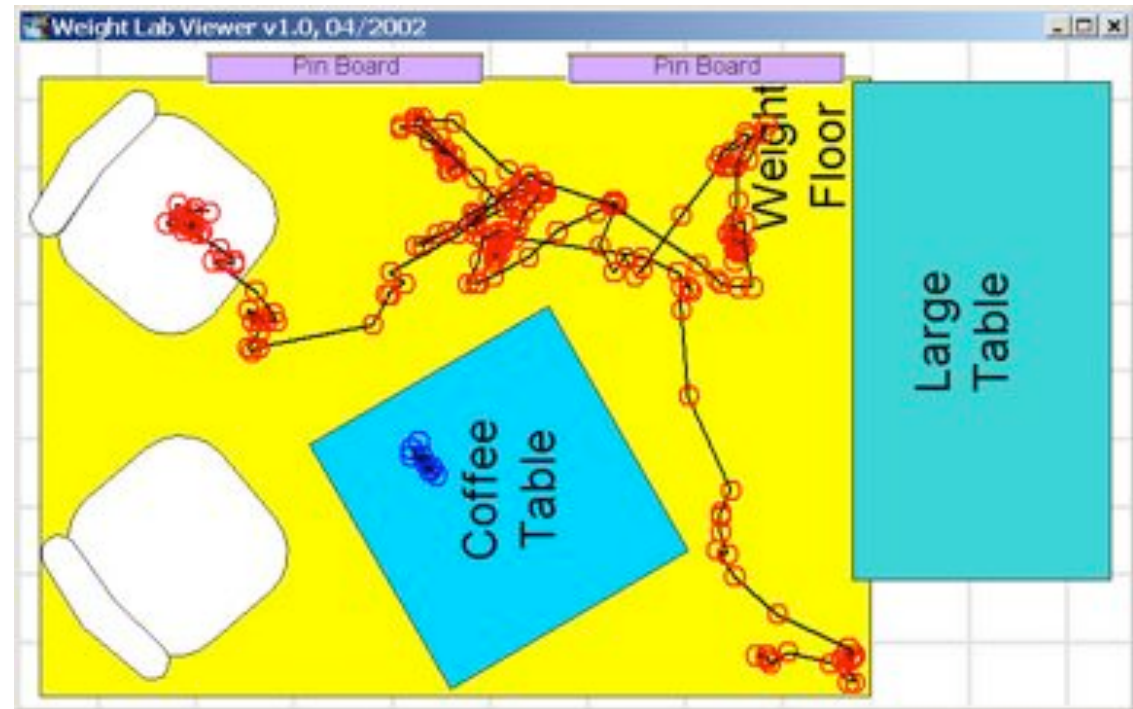
- Beyond weight and position: basic events derived from signal analysis over short time (low-cost analysis in time domain)



Load-Sensing Surfaces

Context Acquisition

- Tracking of people/objects
- Prediction of activities



Load-sensing surfaces

Surfaces as Context-sensor

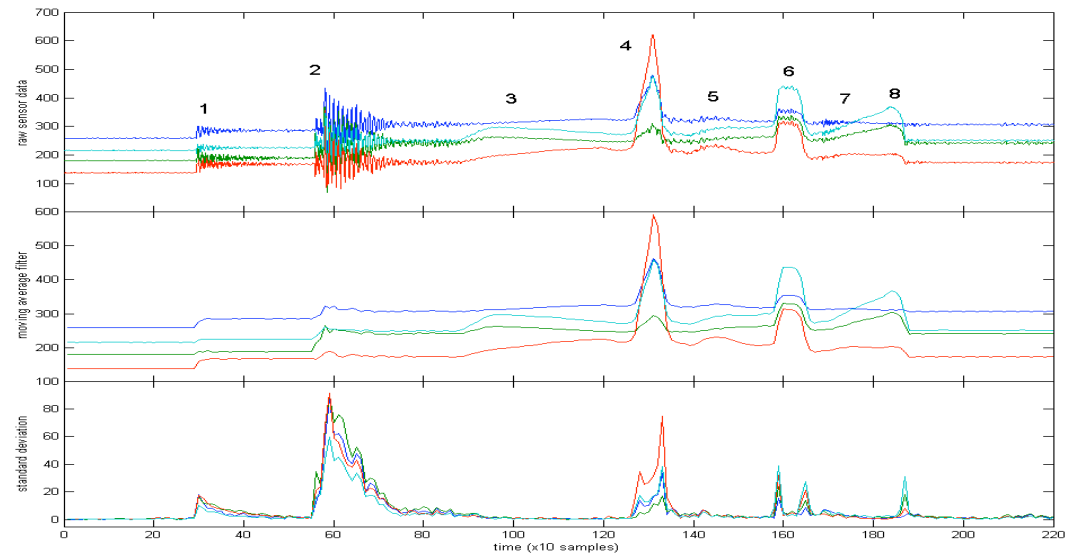
- Object position and movement
- Human activity modelling
- Many applications: track objects, detect breakdown of routines, ...
- **Implicit** human-computer interaction

'Everyday' Surfaces for explicit interaction

- Challenge: when do we interact with the table, and when with the computer

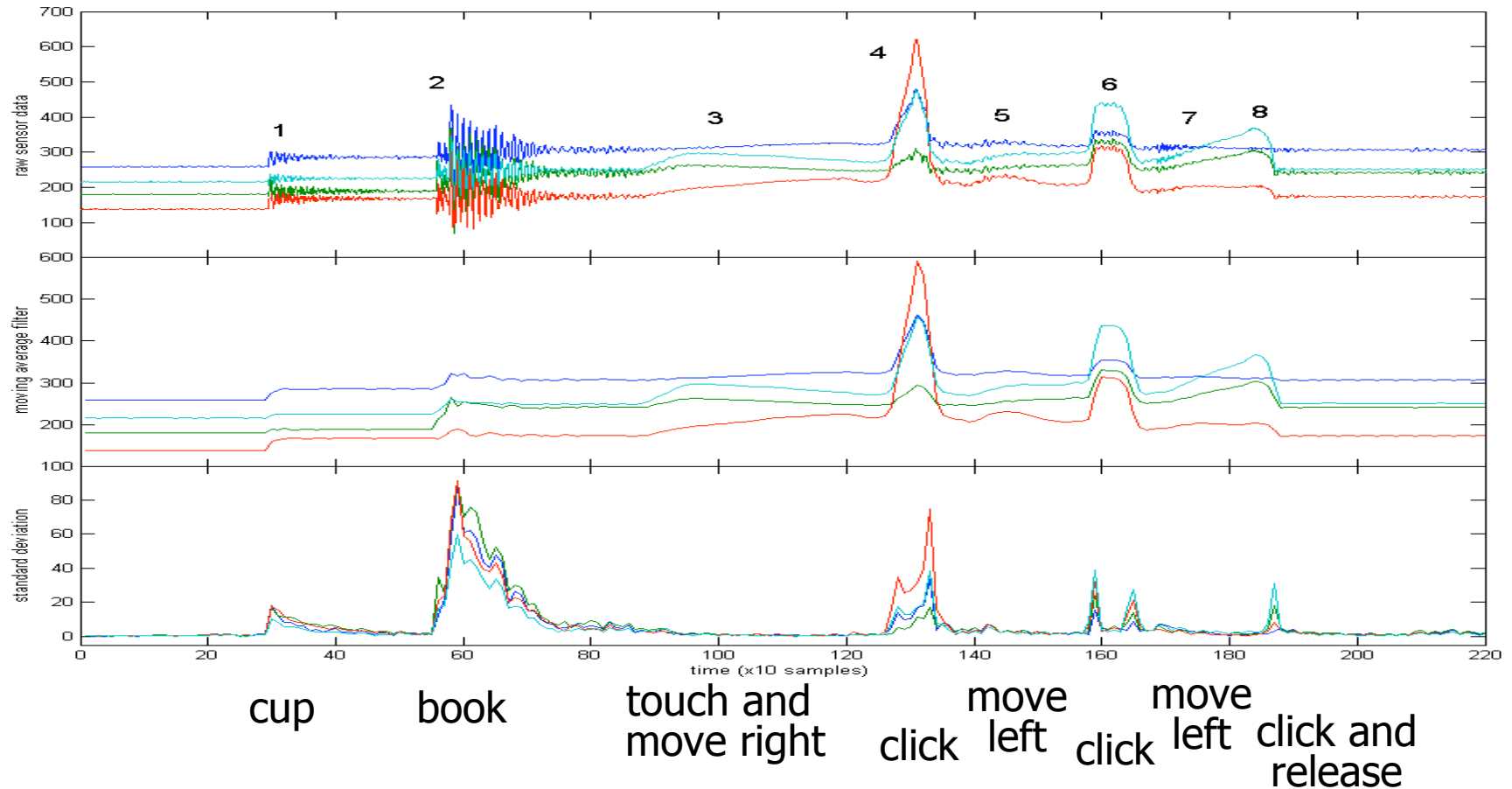
Load-Sensing Surface

Surfaces as Interaction Device



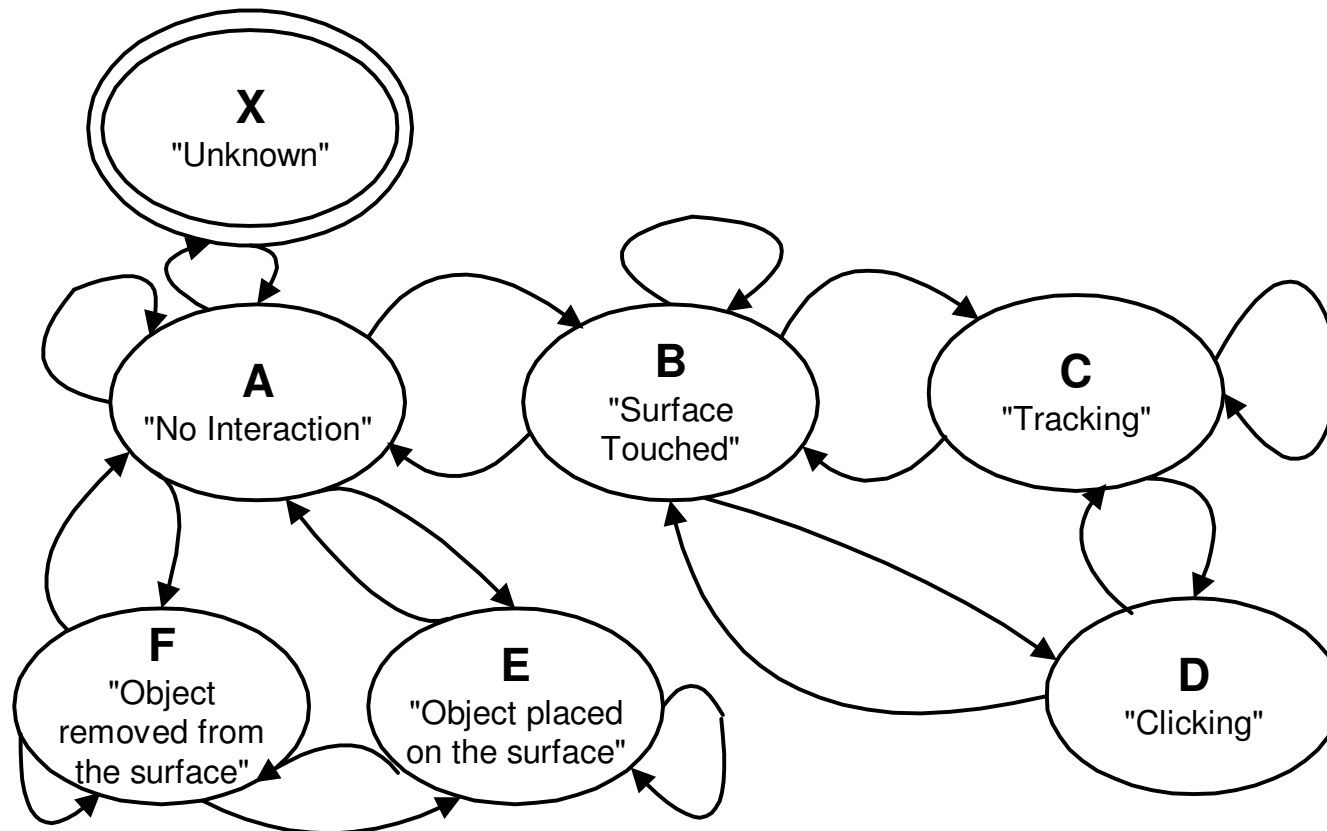
Load-Sensing Surface

Surfaces as Interaction Device



Load-Sensing Surface

Surfaces as Interaction Device



Summary

Unobtrusive infrastructure

- Three examples for infrastructure integrated with everyday environment: input, output and networking
- Building on given physical affordances
- Comparatively low-cost, very deployable

Added functionality

- New forms of interaction
- New applications
- Not compromising existing use and familiarity

- But how can we explore disappearing computer systems without always having to build everything from scratch ?
 - “Smart-Its: Prototyping the Disappearing Computer”

Readings

Background

- [1] M. Weiser and J.S. Brown, "The Coming Age of Calm Technology", in Denning and Metcalfe (eds) "Beyond Calculation: The Next Fifty Years of Computing", Copernicus Heidelberg.
- [2] M. Weiser and J.S. Brown, "Designing Calm Technology",
<http://www.ubiq.com/weiser/calmtech/calmtech.htm>

Pin&Play

- [3] K. Van Laerhoven, A. Schmidt, H. Gellersen, "Pin&Play: Networking Objects through Pins", Proc. UBICOMP 2002, Springer-Verlag
- [4] <http://ubicomp.lancs.ac.uk/pin&play/>

Hallway Posters

- [5] H. Gellersen and A. Schmidt, "Look Who's Visiting: Supporting Awareness for Visitors in the Web", Intl Journal on Human-Comp. Studies (IJHCS), Jan 2002, pp. 25-46.

Sensor Tables

- [6] A. Schmidt et al, "Context Acquisition based on Load Sensing", Proc. UBICOMP 2002, Springer-Verlag
- [7] A. Schmidt et al, "Ubiquitous interaction - Using surfaces in everyday environments as pointing devices", Proc. Workshop on User Interfaces for All (UI4ALL), Oct 2002, Springer-Verlag