Wearable and Ubiquitous Computing

EE382V Activity Sensing and Recognition

UT Austin • Dept. Electrical and Computer Engineering • Fall 2016

Announcements

TA Office Hours: Tuesday 3-4PM at POB 6.308

Class Enrollment

Updating Canvas with Reading and Assignments

(Whenever a S+C is due, it will be indicated as an assignment)

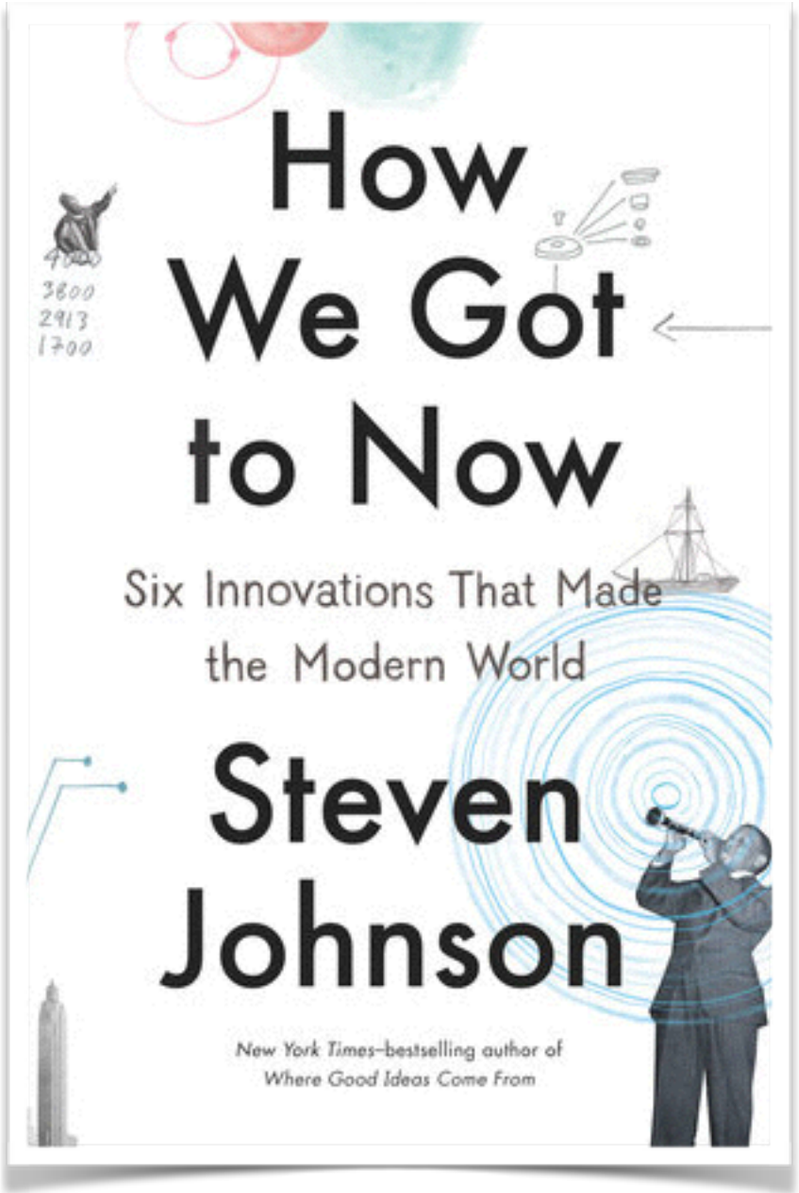
What is Ubiquitous Computing?

Also known as *Pervasive Computing*

Refers to the **3rd Generation of Computing**

Characterized by the widespread **adoption** and **commoditization** of sensing and computing devices

Why Study Ubicomp?

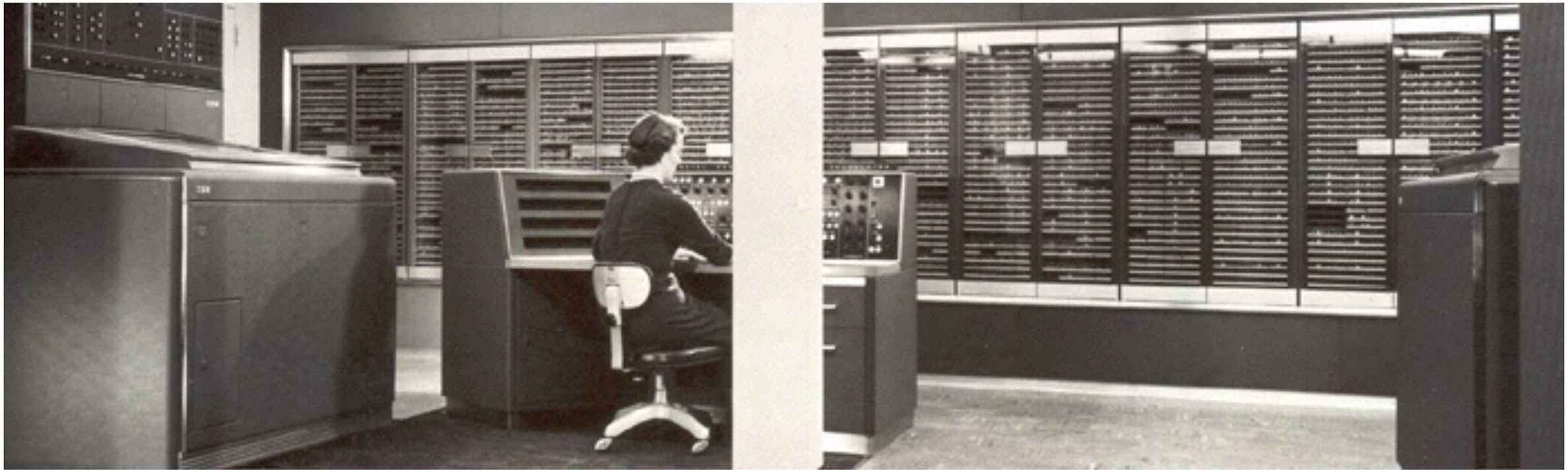


Represents the current era of computing we live in

Valuable to understand how we got here

The field of Activity Perception, Sensing and Recognition was **motivated** and continues to be **fueled** by advances in Ubiquitous Computing technologies

Mainframe Era



"IBM's Naval Ordnance Research Calculator (NORC) was the first supercomputer (1) and the most powerful computer on earth from 1954 to about 1963"

Scientific Calculations

Data Processing

- Decimal integer and floating-point notation and operation.
- Word size: 16 decimal digits + check digit (64 + 2 bits).
- 64 three-address instructions.
- Clock: 1 µsec.
- 15,000 operations per second with automatic error checking.
- Two universal registers, one million digits per second.
- Three address/index registers.
- Add time: 15 µsec. Multiply: 31 µsec. Divide: 227 µsec.
- Random-access CRT memory: 3600 words, 8 µsec access, provided by 264 Williams-type CRTs
- Magnetic tape: 8 units, 4-track, 510 char/inch, 71,500 char/sec.
- Printers: 2 units, 120 char/line, 150 lines/minute.
- Offline card/tape converter.
- Control console: Decimal display of register contents, manual controls, status lights.
- Swappable components (pluggable units).
- Cost: approximately $2.5 million (1950s dollars).
- IBM profit: $1.00 [40].

Personal Computing Era

B5 ⟨V⟩ 2134

	A	B	C	D	E	F
1		Bob		Fred		Tota
2						
3		Sales	MTD	Sales	MTD	Sale
4	Jan 1	1234	1234	2344	2344	357
5	Jan 2	2134	3368	1580	3924	371
6	Jan 3	2321	5689	1025	4949	334
7	Jan 4	2314	8003	2671	7620	498
8	Jan 5	3212	11215	1901	9521	511
9	Jan 6	232	11447	2563	12084	279
10	Jan 7	3232	14679	1535	13619	476
11	Jan 8	2342	17021	3231	16850	557
12	Jan 9	2323	19344	2975	19825	529
13	Jan 10	2342	21686	2388	22213	473
14	Jan 11					
15						
16						
17						

Personal Computer

Spreadsheet

Document Processing

Ubiquitous Computing Era

Inch, Foot, Yard Devices

Calendar, Contact Management, Communication

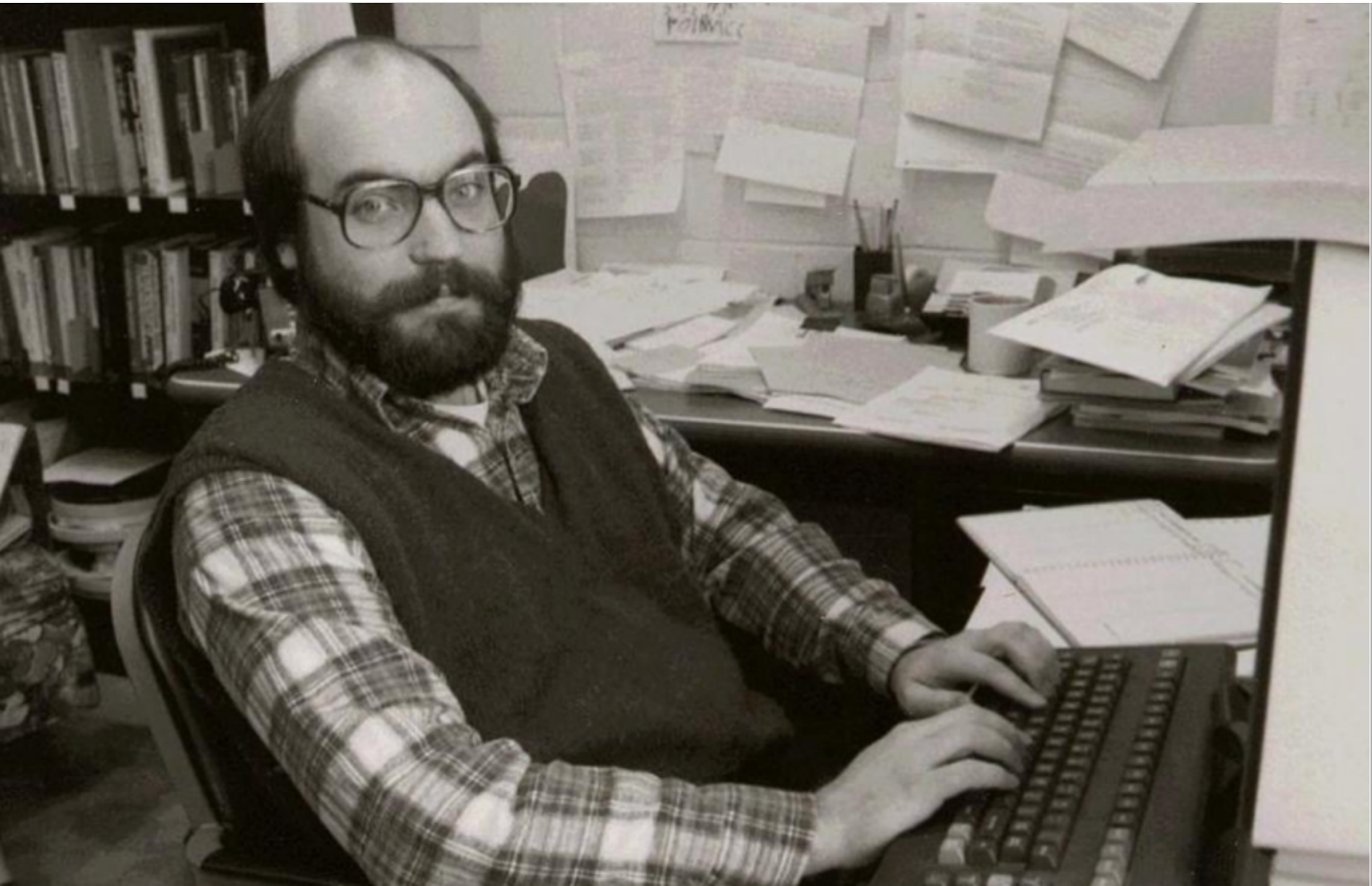
Location Services, Social Media, Education

Generations of Computing

Generation	Vision Began	People-to-Device Ratio	Canonical Technology
1	Mid 30s	Many - 1	Mainframe
2	Late 60s	1 - 1	PC
3	Late 80s	1 - Many	Inch, Foot, Yard

Xerox PARC

Marc Weiser (1952-1999)



Marc Weiser (1952-1999)

The Computer for the 21st Century

Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence

by Mark Weiser

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

Consider writing, perhaps the first information technology. The ability to represent spoken language symbolically for long-term storage freed information from the limits of individual memory. Today this technology is ubiquitous in industrialized countries. Not only do books, magazines and newspapers convey written information, but so do street signs, billboards, shop signs and even graffiti. Candy wrappers are covered in writing. The constant background presence of these products of "literacy technology" does not require active attention, but the information to be transmitted is ready for use at a glance. It is difficult to imagine modern life otherwise.

Silicon-based information technology, in contrast, is far from having become part of the environment. More than 50 million personal computers have been sold, and the computer nonetheless remains largely in a world of its own. It is approachable only through complex jargon that has nothing to do with the tasks for which people use computers. The state of the art is perhaps analogous to the period when scribes had to know as much about making ink or baking clay as they did about writing.

The arcane aura that surrounds personal computers is not just a "user interface" problem. My colleagues and I at the Xerox Palo Alto Research Center think that the idea of a "personal" computer itself is misplaced and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. Such machines cannot truly make computing an integral, invisible part of people's lives. We are therefore trying to conceive a new way of thinking about computers, one that takes into account the human world and allows the computers themselves to vanish into the background.

Such a disappearance is a fundamental consequence not of technology but of human psychology. Whenever people learn something sufficiently well, they cease to be aware of it. When you look at a street sign, for example, you absorb its information without consciously performing the act of reading. Computer scientist, economist and Nobelist Herbert A. Simon calls this phenomenon "compiling"; philosopher Michael Polanyi calls it the "tacit dimension"; psychologist J. J. Gibson calls it "visual invariants"; philosophers Hans Georg Gadamer and Martin Heidegger call it the "horizon" and the "ready-to-hand"; John Seely Brown of PARC calls it the "periphery." All say, in essence, that only when things disappear in this way are we freed to use them without thinking and so to focus beyond them on new goals.

The idea of integrating computers seamlessly into the world at large runs counter to a number of present-day trends. "Ubiquitous computing" in this context does not mean just computers that can be carried to the beach, jungle or airport. Even the most powerful notebook computer, with access to a worldwide information network, still focuses attention on a single box. By analogy with writing, carrying a superlaptop is like owning just one very important book. Customizing this book, even writing millions of other books, does not begin to capture the real power of literacy.

Furthermore, although ubiquitous computers may use sound and video in addition to text and graphics, that does not make them "multimedia computers." Today's multimedia machine makes the computer screen into a demanding focus of attention rather than allowing it to fade into the background.

Perhaps most diametrically opposed to our vision is the notion of virtual reality, which attempts to make a world inside the computer. Users don special goggles that project an artificial scene onto their eyes; they wear gloves or even bodysuits that sense their motions and gestures so that they can move about and manipulate virtual objects. Although it may have its purpose in allowing people to explore realms otherwise inaccessible—the insides of cells, the surfaces of distant planets, the information web of data bases—virtual reality is only a map, not a territory. It excludes desks, offices, other people not wearing goggles and bodysuits, weather, trees, walks, chance encounters and, in general, the infinite richness of the universe. Virtual reality focuses an enormous apparatus on simulating the world rather than on invisibly enhancing the world that already exists.

Indeed, the opposition between the

MARK WEISER is head of the Computer Science Laboratory at the Xerox Palo Alto Research Center. He is working on the next revolution of computing after workstations, variously known as ubiquitous computing or embodied virtuality. Before working at PARC, he was a professor of computer science at the University of Maryland; he received his Ph.D. from the University of Michigan in 1979. Weiser also helped found an electronic publishing company and a video arts company and claims to enjoy computer programming "for the fun of it." His most recent technical work involved the implementation of new theories of automatic computer memory reclamation, known in the field as garbage collection.

Ubicomp Vision

Traditional computing consume too much attention.

Computers vanishing in the background, reuniting humans with the natural human environment.

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

e.g. reading a printed page, absorbing ideas, ignoring the underlying paper and ink technologies

The Sal Scenario

What's the purpose?

- Wakes up, automated coffee
- Neighbor trail (what happened while Sal slept)
- Kids aware, notification
- Foreview mirror for traffic
- Automated login
- Collaborative workspaces

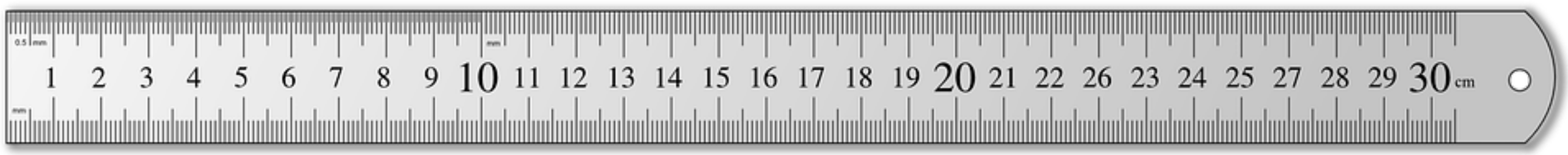
Was it effective?

A New Computing Environment

Augment equivalent objects in the workplace with computing

Decided to build computing devices at different scales of human interaction:

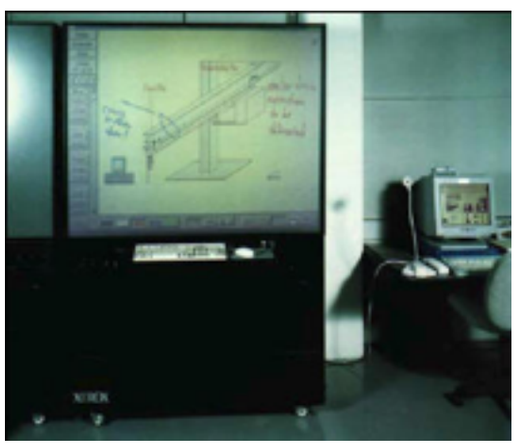
Inch, Foot, Yard



Tabs, Pads and Boards

Tabs communicated wirelessly with a basestation using 10kbps infrared signaling, access to distributed services

Pads employed a communication link with more bandwidth: 250kbps.



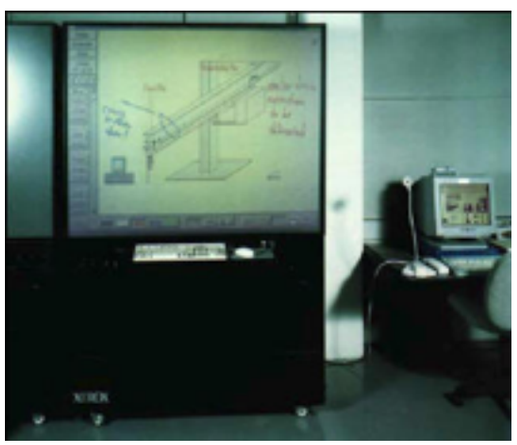
Boards were built around workstations, but with larger displays and pen input

Tabs, Pads and Boards

Tabs, Pads and Boards

Personal Information Manager (PIM), email reader, control room HVAC, play games

Book reader (books fetched from the network), electronic markup, hyperlink

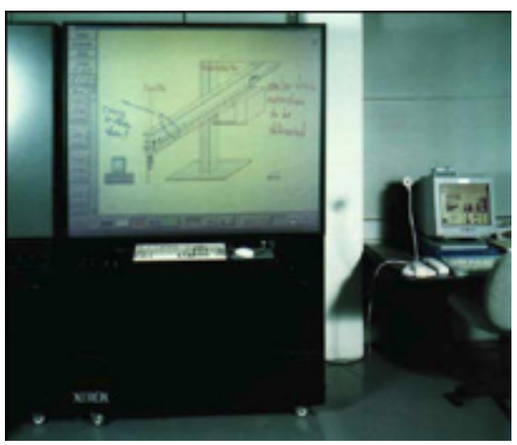


Content recording, search and retrieval, interactive timeline to revisit topics

Tabs, Pads and Boards

Personal Information Manager (PIM), email reader, control room HVAC, play games, **location beacon**

Book reader (books fetched from the network), electronic markup, hyperlink



Content recording, search and retrieval, interactive timeline to revisit topics

Calm Technology

Mark Weiser.

The Coming Age of Calm Technology

Meanwhile at Olivetti in the UK…

Pandora: Integrated multimedia services over a fast network (100Mbps)

Interest in sophisticated telephony services: digital call delivery

Active Badge Location System

First automated indoor location system

Encoded a unique ID in an infrared signal and emitted it to a sensor in the room (one per room)

Context-awareness

Platform to explore **location-based** services and used at Xerox PARC, DEC, MIT Media Lab, Cambridge University and many other labs

Context-Aware Computing

Improve computing capabilities by providing access to information pertaining to the computing/physical/user environment

Location, identities of nearby people and objects, changes to those objects (Schilit and Theimer, 1994)

What are other possible elements of context?

Living Laboratories

Deploy Ubicomp in a real-world setting and assess its value

Classroom 2000

Abowd, 1999 - Georgia Tech, Atlanta

Ubiquitous Computing in the classroom

Capture an entire lesson in a form
that can be referenced later
(questions, answers, discussions,
writings on the board)

Live board-like setup

http://www.cc.gatech.edu/fce/c2000/overview/

Living Laboratories

Deploy Ubicomp in a real-world setting and assess its value

Aware Home

Kidd et al., 1999 - Georgia Tech, Atlanta

Ubiquitous Computing at home

Explore how Ubicomp technologies could support everyday activities in the home environment

Wearable Computing

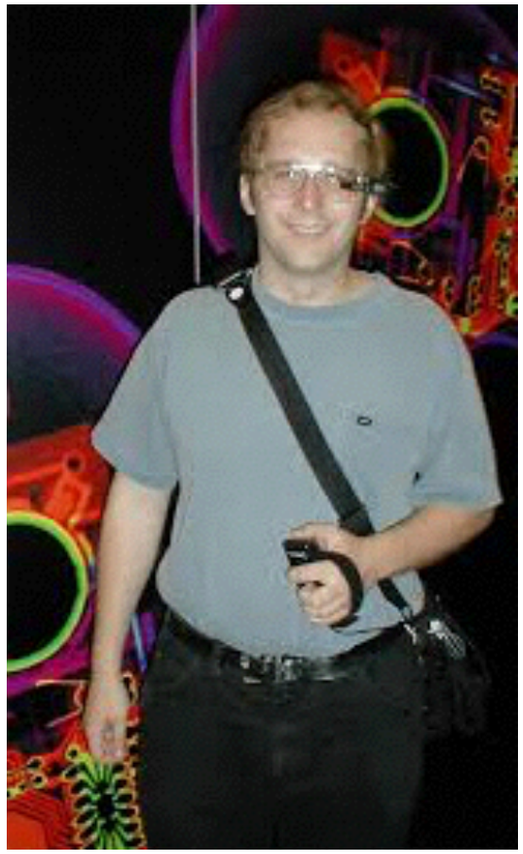
Wearable Computing

MIT Media Lab Cyborgs

A different take on Ubiquitous Computing

Computing incorporated into clothing

Wearable Computing



Thad Starner

Wearable Computing

Steve Mann

Wearable Computing

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

Wearable Computing

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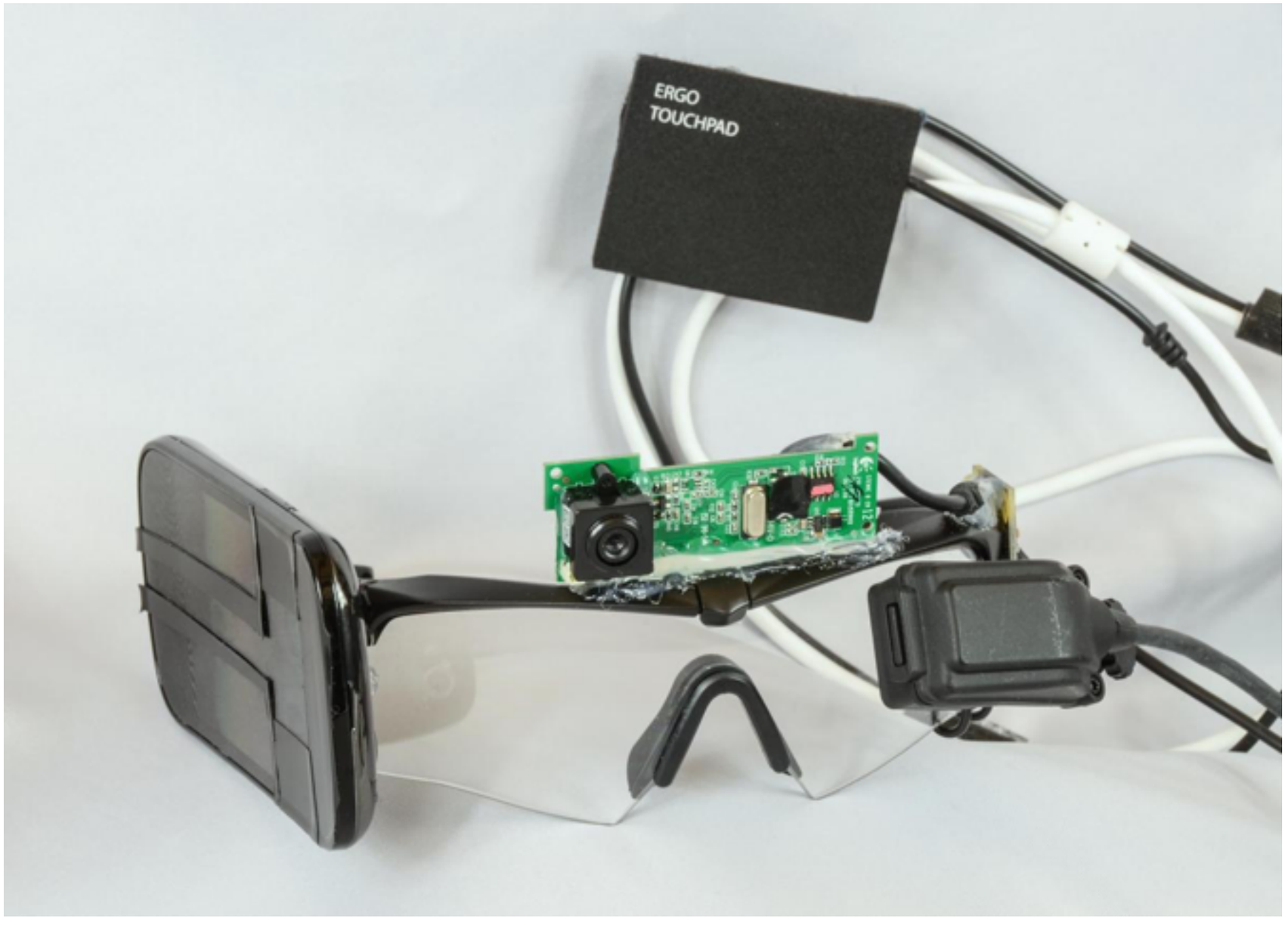
Wearable Computing



Glass Prototype (2010)

Source: A Story of Wearable Computing (Georgia Tech GVU Center)

Wearable Computing

Glass Prototype (2011)

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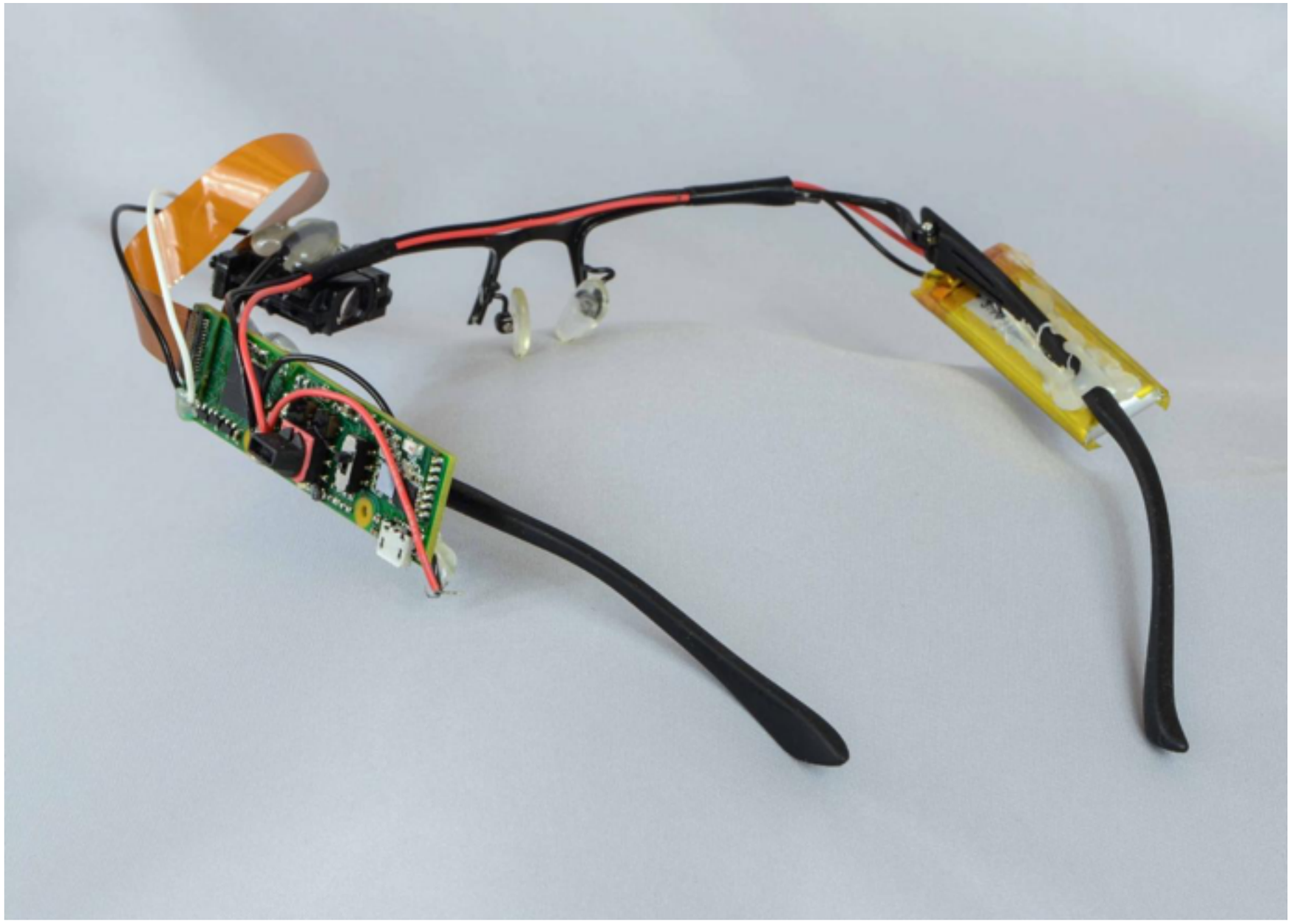

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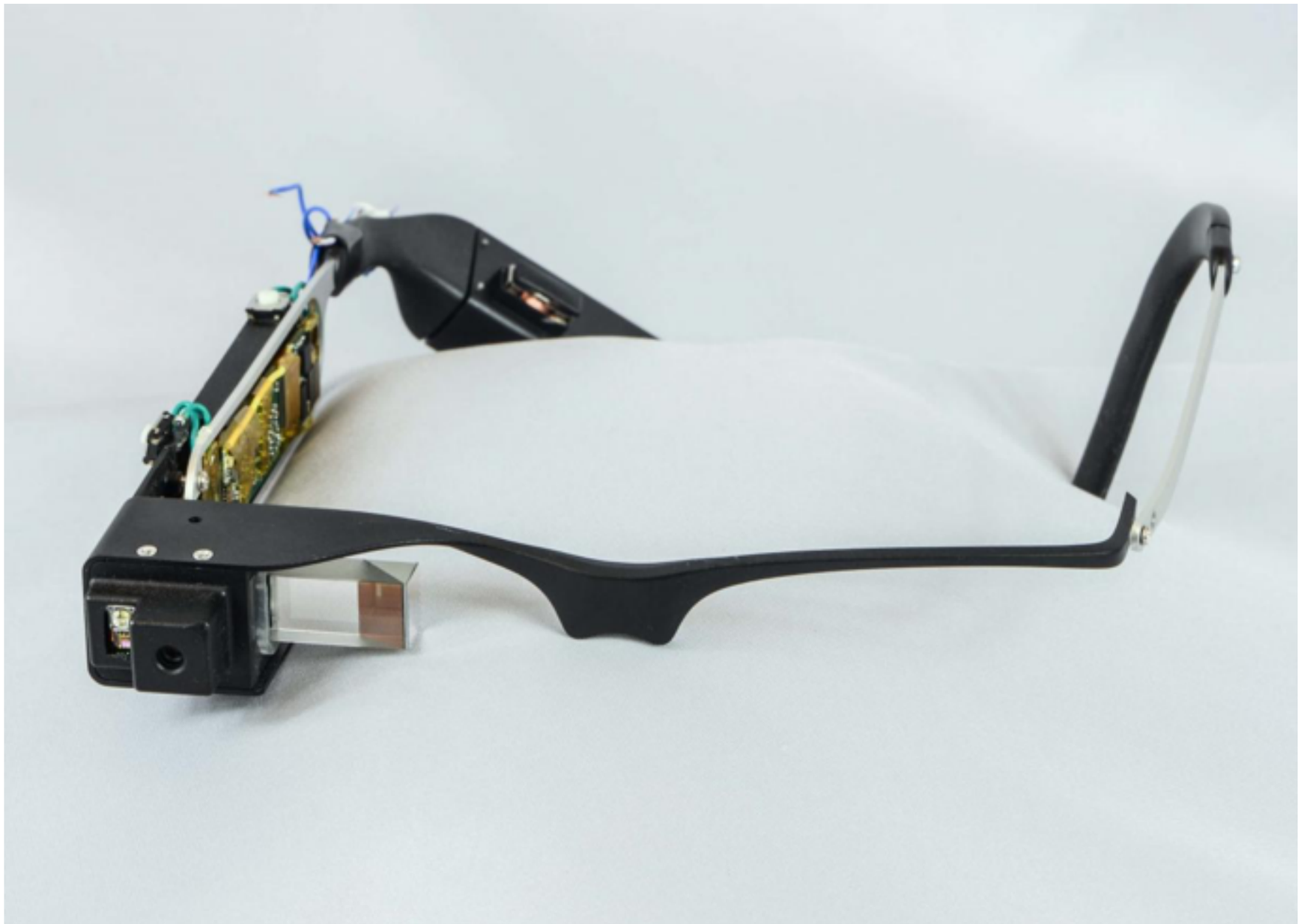

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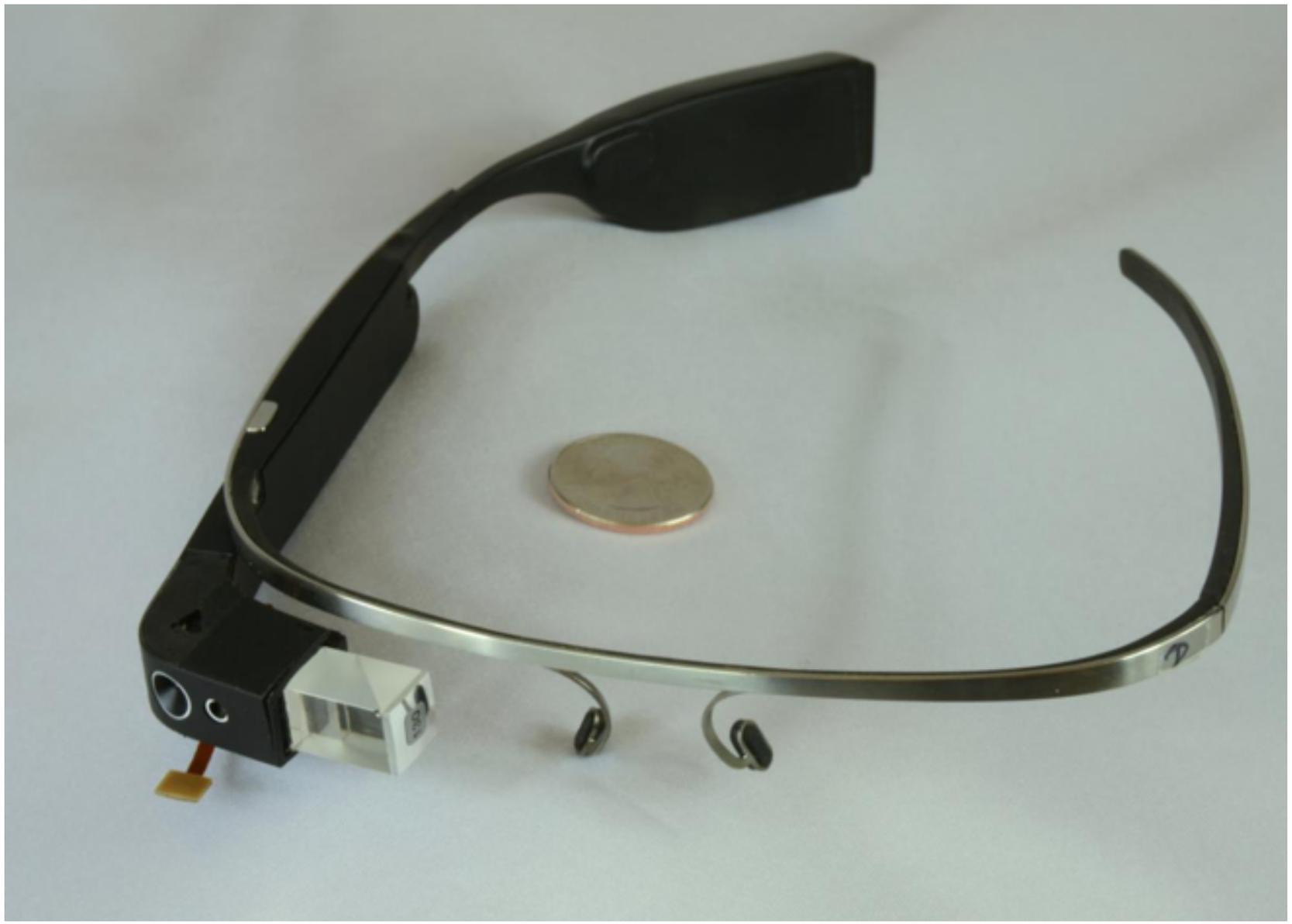


Glass Prototype (2011)

Source: A Story of Wearable Computing (Georgia Tech GVU Center)

Wearable Computing

Glass Prototype (2012)

Source: A Story of Wearable Computing (Georgia Tech GVU Center)

Amft, Lukowicz: From Backpacks to Smartphones. IEEE Pervasive Computing

Many Other Ubicomp Pioneers

IBM (Pervasive Computing)

University of Karlsruhe (Smart-Its)

Lancaster University (GUIDE)

Microsoft Research (SenseCam)

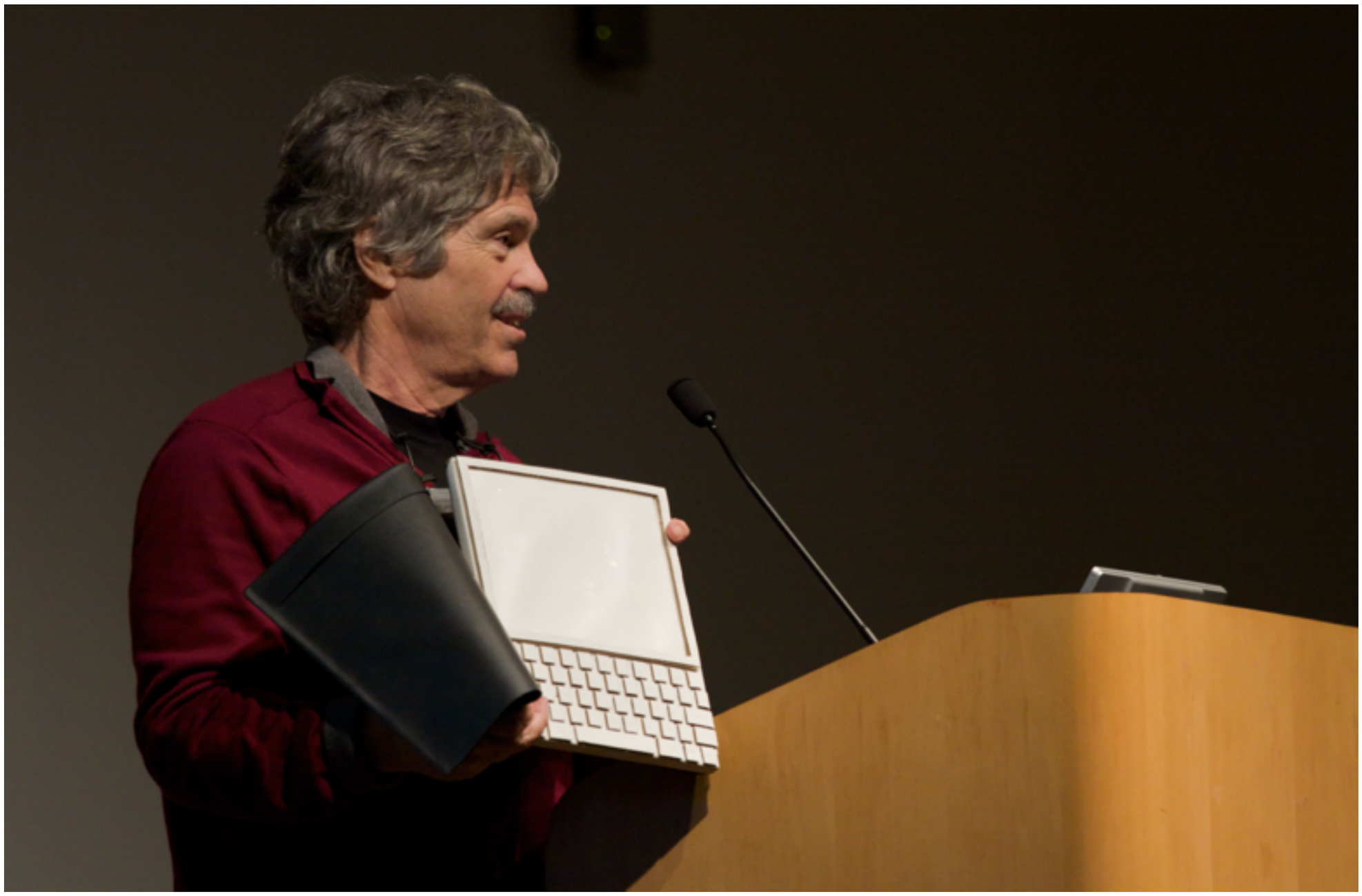
Intel Research (Place Lab)

University of California Berkeley (InfoPad)

University of Tokyo (T-Engine, ITRON)

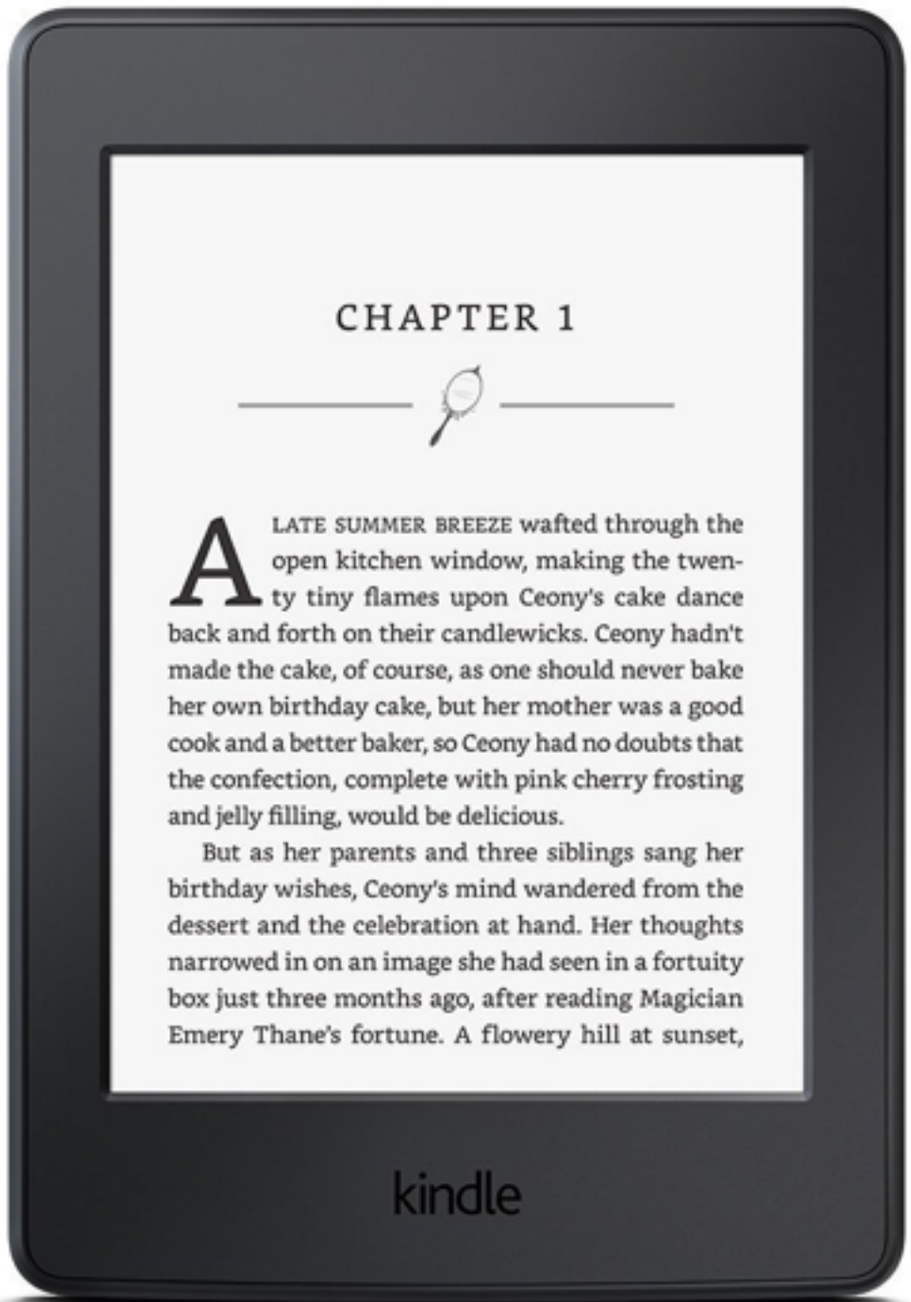
The Vision and Today

The Vision and Today



Alan Kay and Dynabook: reading away from traditional computer screen

The Vision and Today



The Vision and Today

The Vision and Today

(Unanticipated Consequences of Technology)

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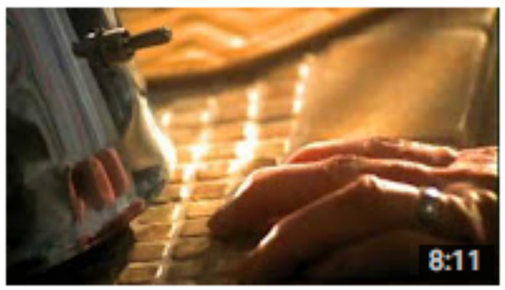
The Vision and Today

(Unanticipated Consequences of Technology)

Homes of the Future



HP CoolTown

Microsoft

Samsung

Future of Ubicomp

Gregory Abowd. What's Next UbiComp. Ubicomp 2012

What next, Ubicomp?
Celebrating an intellectual disappearing act

Gregory D. Abowd
School of Interactive Computing & GVU Center
Georgia Institute of Technology
abowd@gatech.edu

ABSTRACT
Weiser's landmark *Scientific American* article inspired many researchers to explore an exciting socio-technical vision of a third generation of computing. At the 21st anniversary of that published vision, I want to assess ubicomp's maturity and explore the identity challenge it faces. Today, ubicomp as a niche research topic no longer makes sense; we must celebrate its "disappearance" as a well-scoped research agenda because it has become a profound agenda across most of computing, and beyond. This should not be surprising, the 2nd generation of computing, the personal computer revolution, experienced the same profound disappearance. In celebration of this imminent disappearance, I will highlight the unique contributions of the ubicomp community, express some remaining intellectual challenges, and speculate on how to formulate new visions of computing that might succeed this third generation.

Author Keywords
Ubicomp as a field

ACM Classification Keywords
K.2 History of Computing; H.4.0 Information Systems Applications—General; D.2.6 Programming Environments

General Terms
Design, Experimentation, Human Factors, Languages

INTRODUCTION
When Mark Weiser wrote his seminal article defining the concept of ubiquitous computing, he did so in a world that had embraced the personal computing revolution. Two decades later, the world has embraced many of the notions of ubicomp, and it is time to reflect on that reality and decide where to go next. The discipline of ubiquitous/pervasive computing has spread so widely throughout the computing universe—the research and practice of computing—that it should disappear as a niche topic in computing. My thesis is that ubiquitous computing, the third generation of computing, is here and no longer requires special attention, as its ideas and challenges spread throughout most of computing thought today. The struggle to maintain an identity for ubicomp is an intellectual distraction, albeit one that serves a social function that is hard to abandon.

There is a difference between the intellectual area of ubiquitous computing and the community of people who identify themselves as ubicomp researchers. The former is what I believe to be broadening to the point of disappearance. The latter still remains, and is not entirely defined by an intellectual agenda. The ubicomp community will likely remain for many years beyond the publication of this simple commentary, but I offer some constructive ways for it to best operate.

In this paper, I will further explain why ubicomp has and should disappear, based on an observation that its ideas already pervade much of computing research and practice. It is increasingly hard to identify what constitutes ubicomp research today, because it is hard to rule anything out as being unrelated to this current generation of computing. I will explore what has made ubicomp research valuable in the past and distinguishable from other research communities. I will also clarify the relationship between application domains and ubicomp research. Through a comparison to the personal computing generation, I will frame a remaining research challenge to further simplify the development of ubicomp applications.

If ubicomp as the third generation has arrived, what characterizes the next generation of computing? This is an interesting challenge to ponder. Visions of computing are difficult to offer up, as they are far more likely to be wrong than right. However, if we consider visions as ideas whose time has come, we can actually revisit ideas from the past and ask whether today's computing climate will provide an opportunity for those ideas to be realized in new and compelling ways.

Before I proceed with the arguments of this paper, I offer a few notes to the reader to best interpret and respond. Though many of my comments are relevant to other disciplines and communities, both related and unrelated to computing, I am not explicitly attempting to make that more general argument. I am not approaching this paper in the broadest historical context that might make sense to

Upcoming Class(es)

Readings Assigned

Choose one of the readings and write a Summary + Critique

Python + Scipy/Numpy + Scikit-Learn

Install in your computer (you will bring it to class next week)

Anaconda is a good install package for all you will need

Talk to me or TA in case if you have issues

Talk about Projects on Thursday