

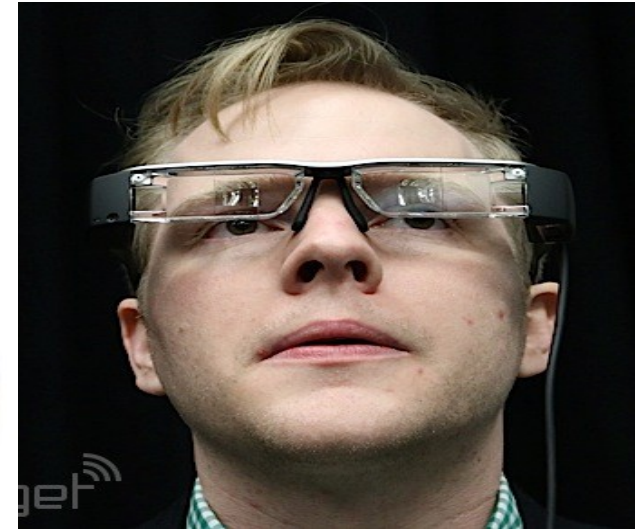
History of Wearables



Professor Thad Starner
Contextual Computing Group
Georgia Institute of Technology

Tech Lead/Manager, Google Glass

Suddenly! Wearable Computing!

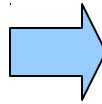


Why Now?

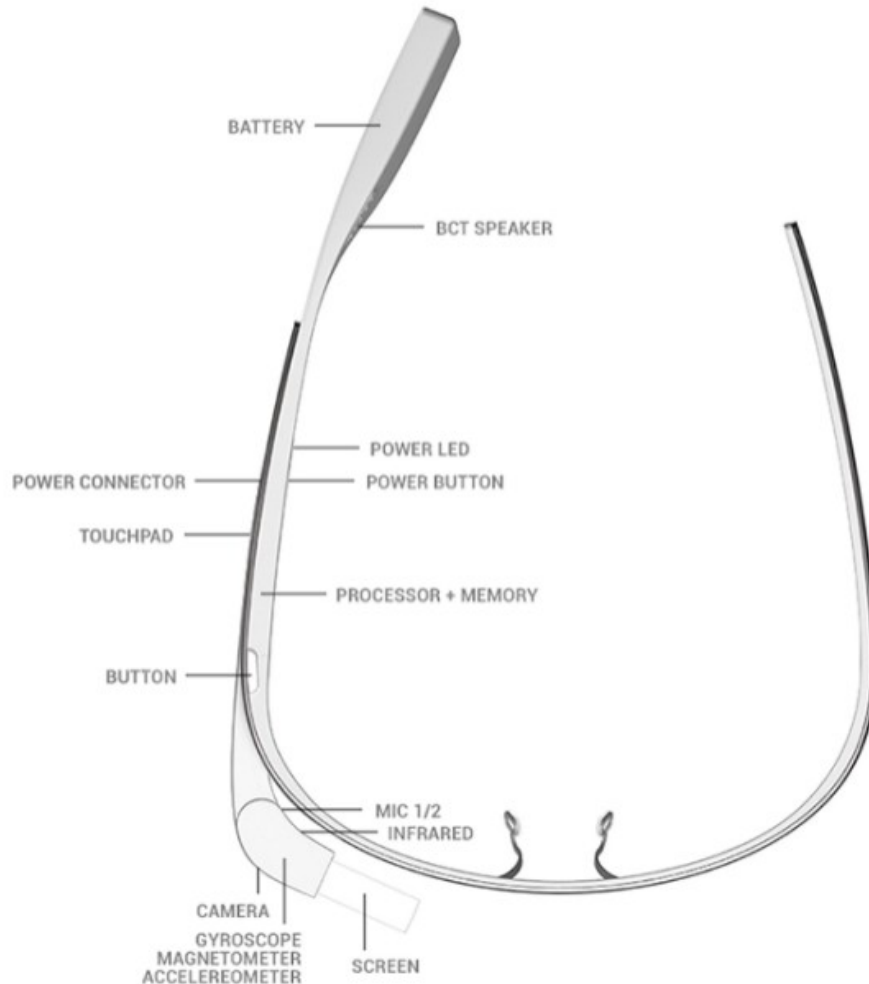


- Bluetooth 4.0 Low Energy body network standard on mobile phones starting 2013-now
- Available, high quality mobile speech recognition ~2010
- Low latency cellular network ~2008: LTE/HSPDA
- Windows interface monopoly broken by smartphones ~2008
- High sensitivity GPS ~2007
- Quality plastic optics ~2003
- GPS selective availability eliminated 2000
- High resolution small displays ~2000
- DC-DC converters 70->95% efficiency ~2000
- Small IMUs ~1998
- Consumer lithium batteries ~1997

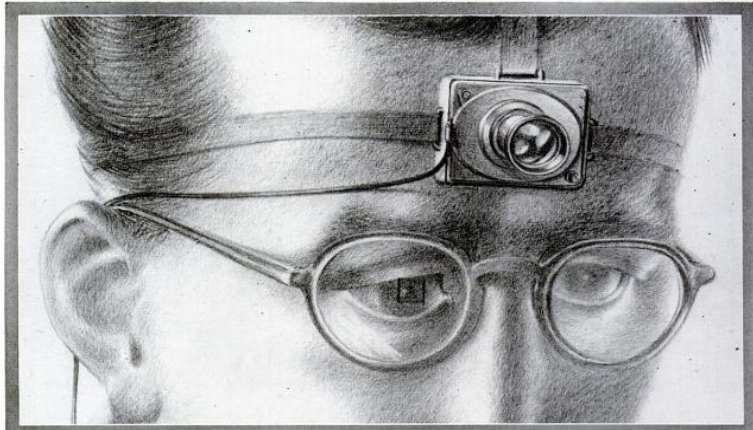
Pursuing Consumer Product: Possible → Practical in 25 years



New Levels of Integration



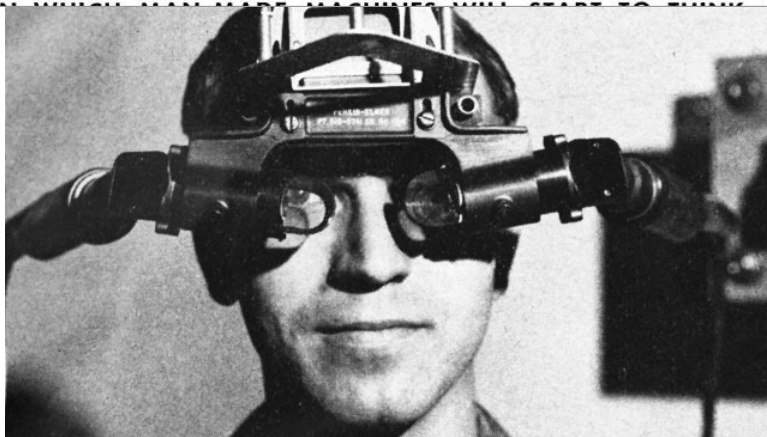
Interface: Early Computing Ideas



A SCIENTIST OF THE FUTURE RECORDS EXPERIMENTS WITH A TINY CAMERA FITTED WITH UNIVERSAL-FOCUS LENS. THE SMALL SQUARE IN THE EYGLASS AT THE LEFT SIGHTS THE OBJECT

AS WE MAY THINK

A TOP U. S. SCIENTIST FORESEES A POSSIBLE FUTURE WORLD



- Vannevar Bush (1945)
- Engelbart: Intelligence Augmentation (1960)
- Sutherland: Sword of Damocles (1968)

Interface: Consumer (Georgia Tech & MIT)



(US Air Force Lab. Grad. Fellow, Industrial Consortia, NSF)

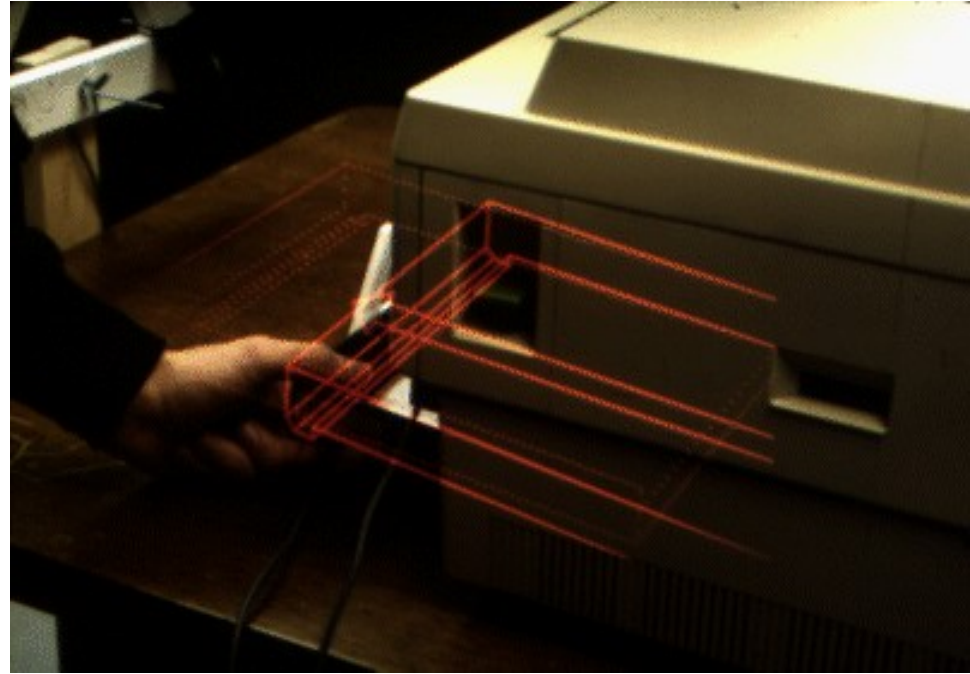
Interface: Task Guidance (CMU)



Current practice	SAVINGS FACTOR	VuMan 3
	Personnel 2 : 1	
Current practice	SAVINGS FACTOR	VuMan 3 Field Trial
	Total inspection and data- entry time savings 70 percent	

(NSF ERC, NSF, DARPA)

Interface: Augmented Reality (Columbia)



(ONR, NSF)

Microdisplays: Upton @ Bell (1967-1980s)



- Cued speech
- Helicopter HUDs for defense
- Scanning fiber bundles



Microdisplays: Reflection Technology (1989)



- Private Eye
- LEDs and scanning mirrors
- Military & beginnings of industrial interest
- Consumer VR 1995

Microdisplays: UW Scanning Fiber (2012)

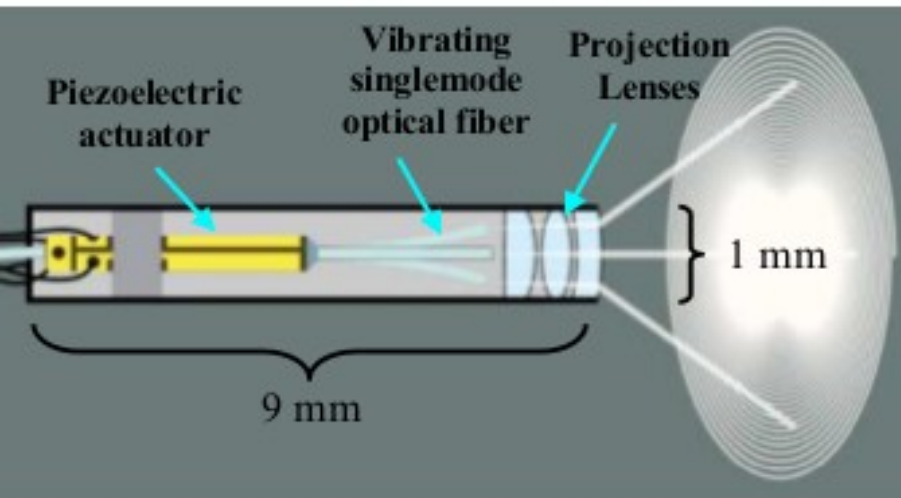
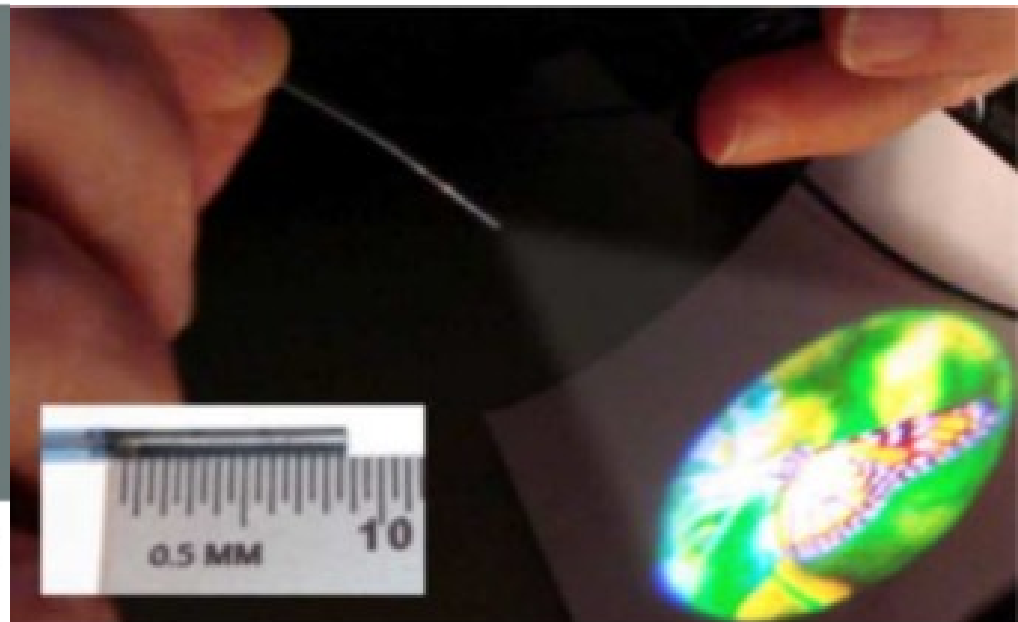


Figure 2. Inside the 1 mm projector: A piezoelectric actuator vibrates the tip of an optical fiber in two axes to create an area-filling spiral scan pattern.



(National Science Foundation MRI & # BES-0421579)

Microdisplays: Panels (Kopin, Displaytech, etc.)



(DARPA)

Microdisplays: VR HMDs (early 1990s)



(NASA, DARPA)

Microdisplays: Military, Industrial, Hobbyist (90s)



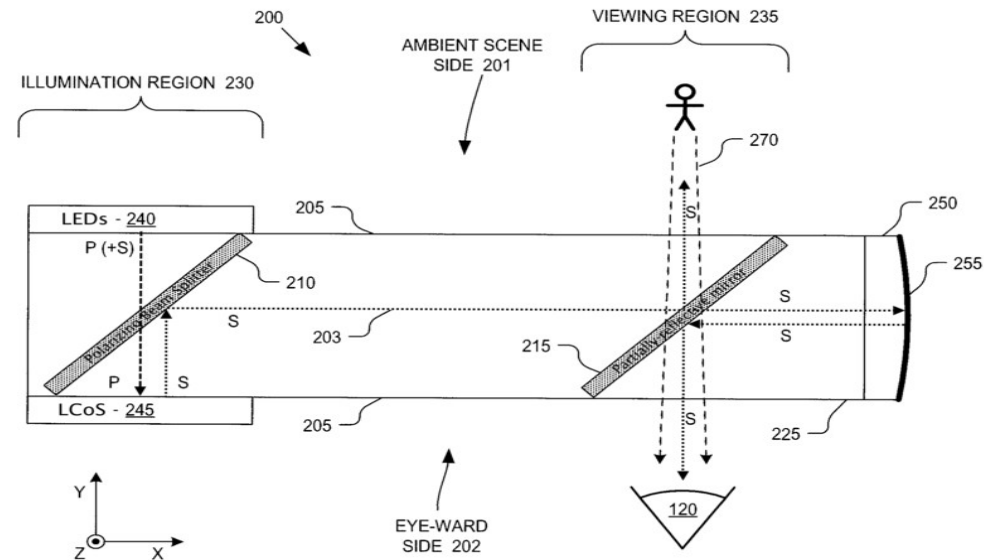
Microdisplays: Video Viewers (early 2000s)



Microdisplays: On-the-go Displays



(MicroOptical 1997)



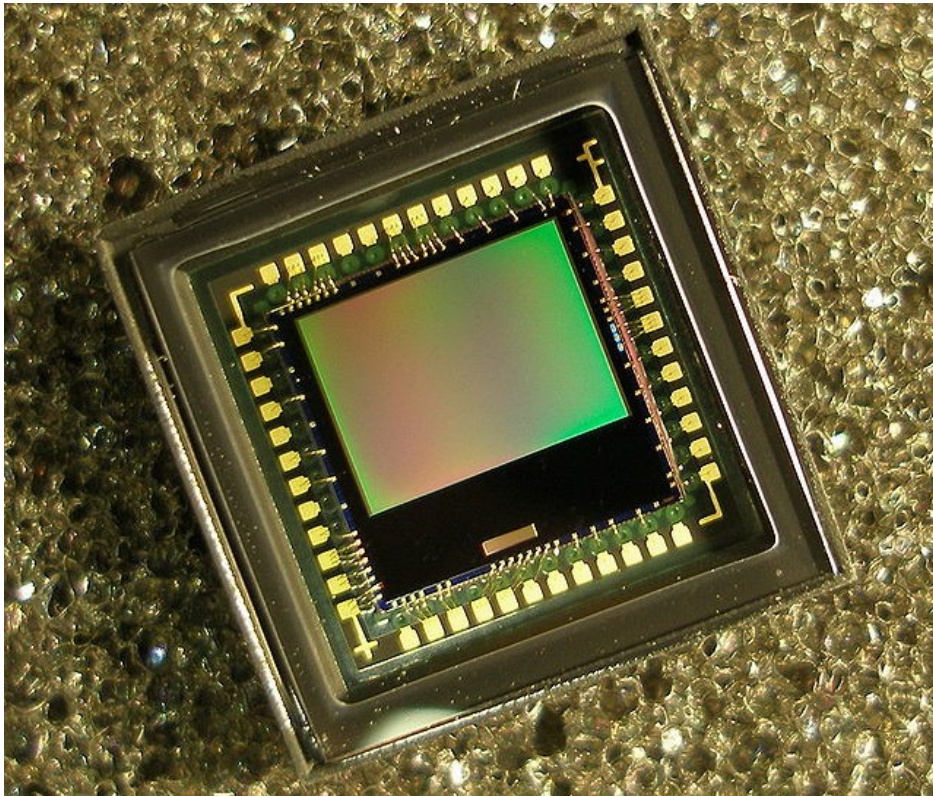
(Google Glass 2013)

Networking: 802.15



- Started as Ad Hoc Committee Meeting for Wearables Standards 1997
- Led by Dick Braley at Fedex
- Incorporated Bluetooth and Zigbee

Sensing: CMOS Camera (early 1990s)



- Eric Fossum
- NASA JPL (1993-1995) → Photobit Corp. → webcam -> cameraphones

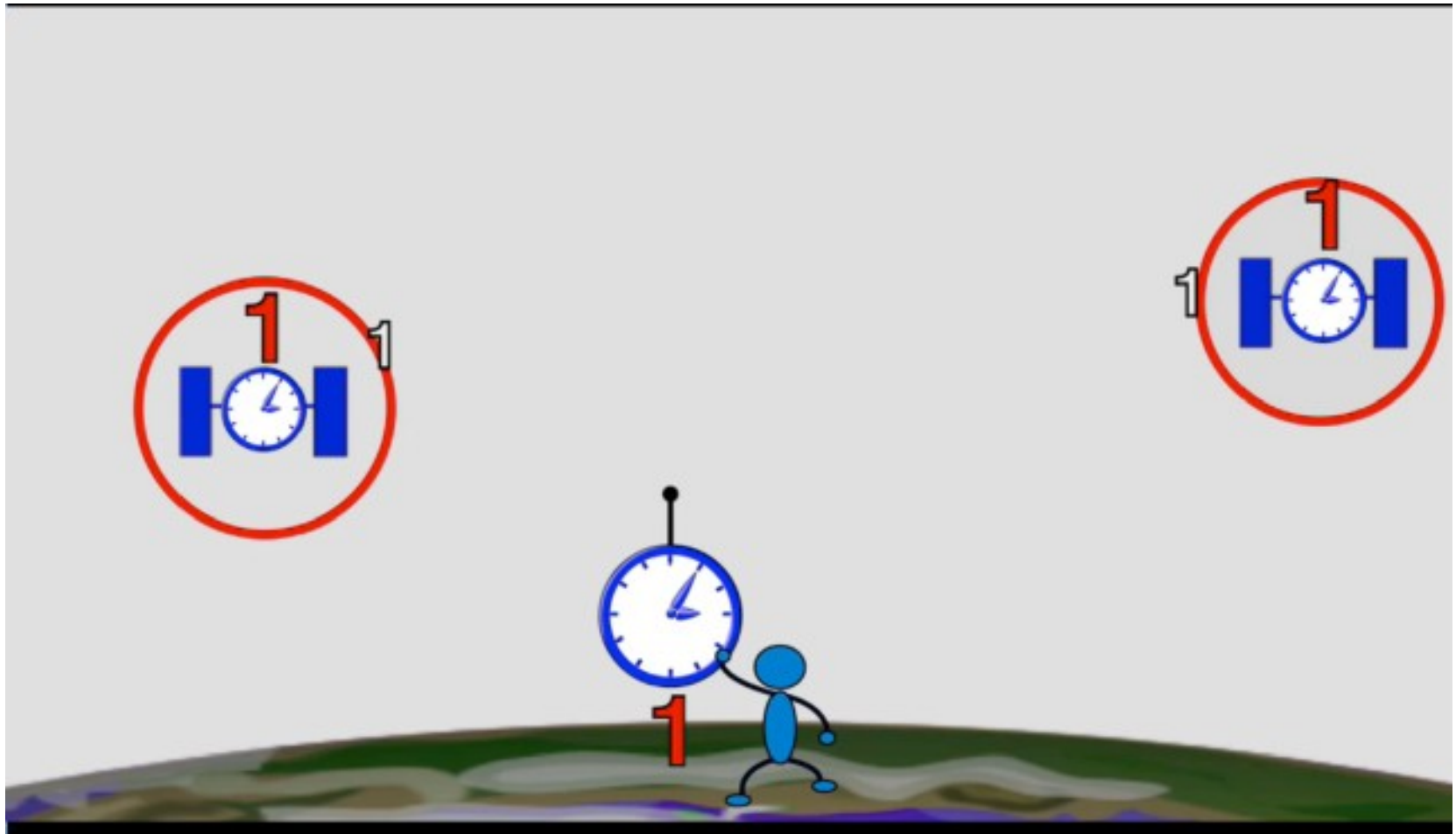
Sensing:

Inertial head trackers (late 1990s)



- Eric Foxlin, MIT (NASA, AFOSR, NRL)
- Intersense (SBIRs)
- 3x3mm high precision IMU chips today

Sensing: GPS



Sensing: Speech Recognition

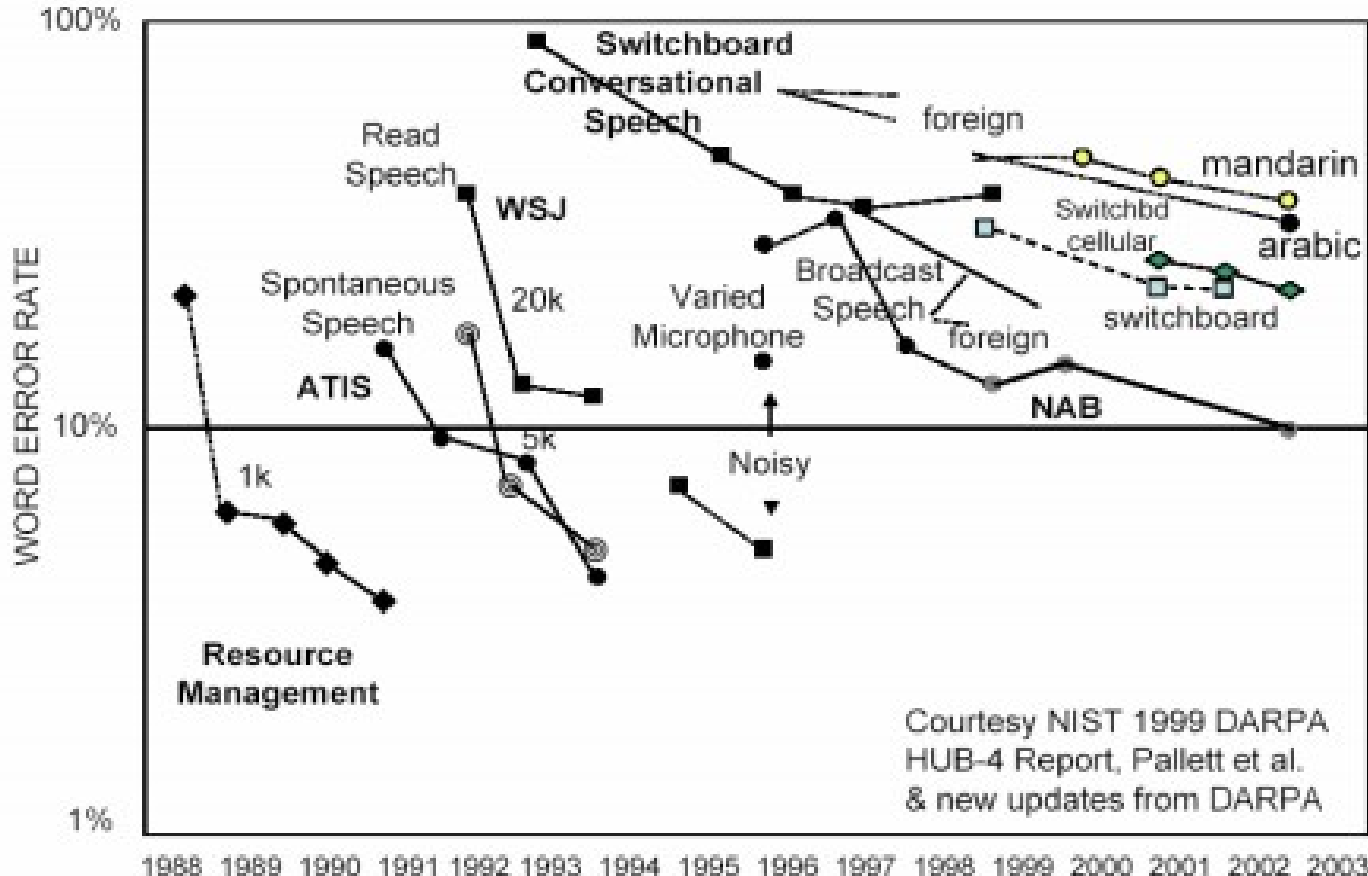


- Bell Lab Audrey 1952; IBM Shoebox
- HMMs: Institute for Defense Analyses (60s)
- DARPA Speech Understanding Research 1971-1976: CMU Hearsay, BBN HWIM, ...
- DARPA/NIST Tasks 80s-90s (ATIS, Switchboard, WSJ, Resource Management): CMU Sphinx, BBN BYBLOS, SRI DECIPHER

Sensing: Speech Recognition



DARPA Speech Recognition Benchmark Tests



Finally! Wearable Computing!

