Reflections on The Unfinished Revolutions in Personal Computing

Andy van Dam

Brown University

21 May 2019

i3D 2019

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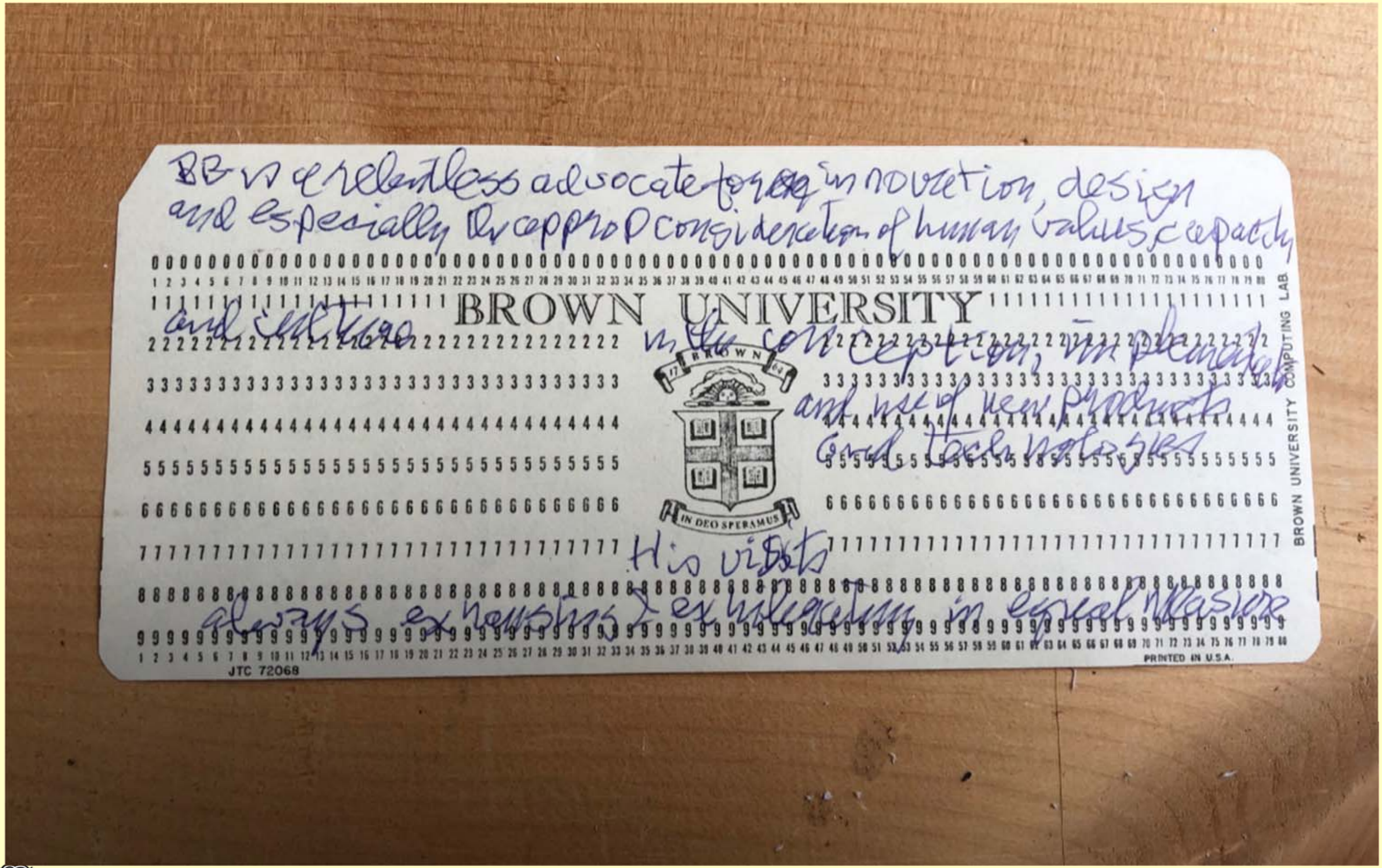
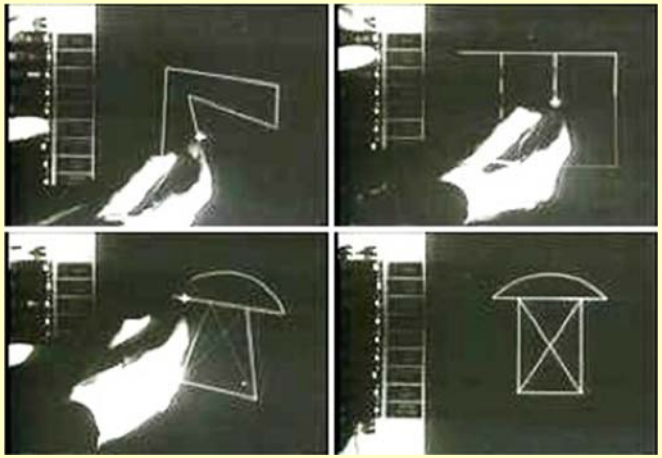

BROWN UNIVERSITY
IN DEO SPERAMUS
BROWN UNIVERSITY COMPUTING LAB.
JTC 72068
PRINTED IN U.S.A.

Ivan Sutherland's 1963 Sketchpad System

- Almost all key elements of an interactive graphics system in the first paragraph of his Ph.D. thesis:

- *"The Sketchpad system uses drawing as a novel communication medium for a computer. The system contains input, output, and computation programs which enable it to interpret information drawn directly on a computer display. It has been used to draw electrical, mechanical, scientific, mathematical, and animated drawings"*



Computer Driven Displays and Their Use in Man/Machine Interaction*

1966

ANDRIES VAN DAM†

Moore School of Electrical Engineering
University of Pennsylvania, Philadelphia, Pennsylvania

1. Introduction and History

Psychologists have estimated that as much as eighty per cent of our sensory data is received in the form of visual stimuli. It is therefore surprising to find that the field of computer driven visual displays has lagged behind the development of the computer complex as a whole,

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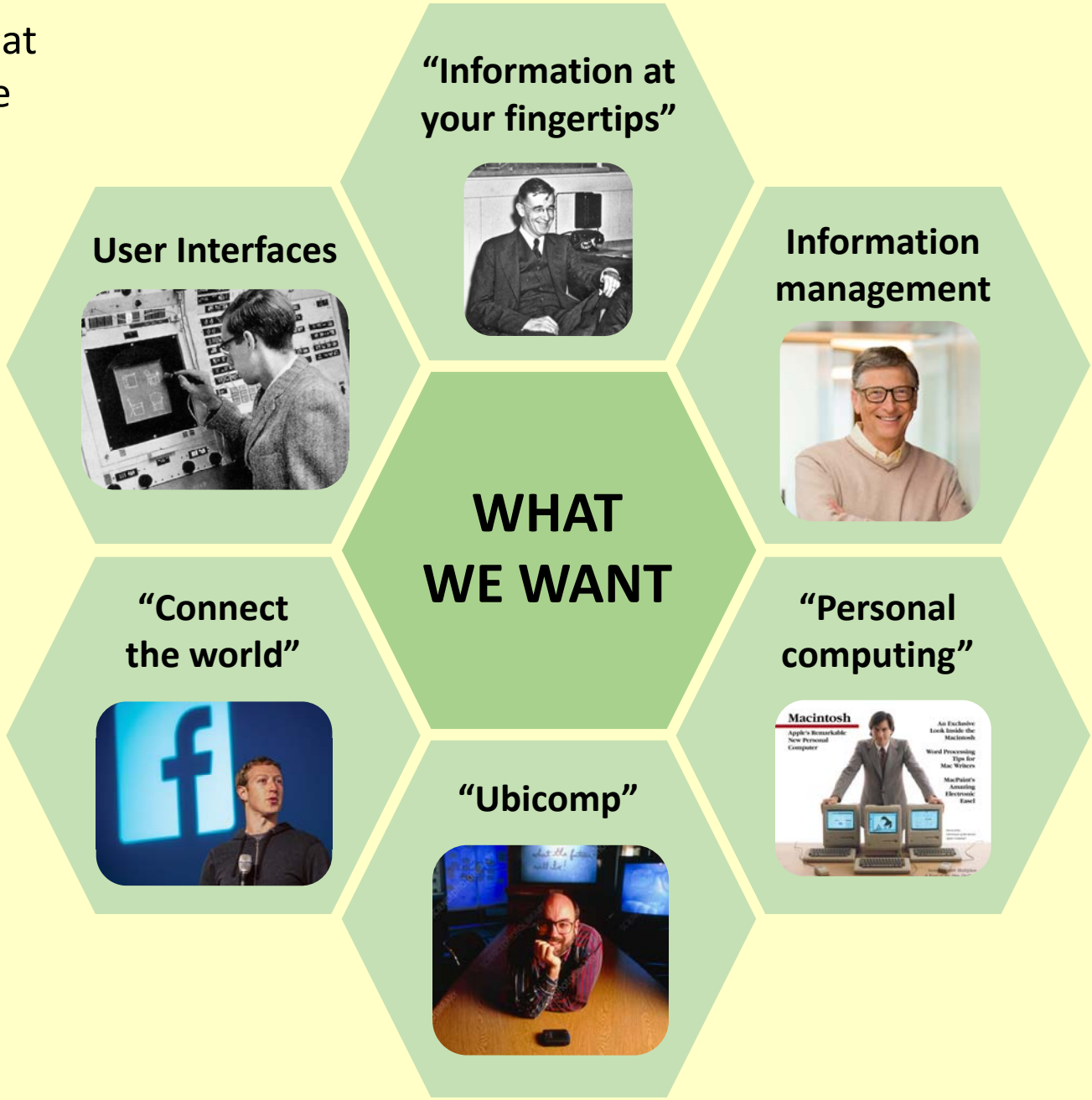
6 visions that inspired me



1. “Information at Your Fingertips” – Bill Gates – 1990 Comdex Keynote Speech

https://www.youtube.com/watch?v=uGA1Chm_8RE

“The term, information at your fingertips, is to remind people what a broad role the personal computer will be playing. It's not a computation device, it's not a word processing or a spreadsheet device. It's a window onto the world of information.”

Machine That Changed The World; The Interview with Bill Gates, 1990
Part of From the Vault, Considering Our Tech-nostalgia
11/20/1990

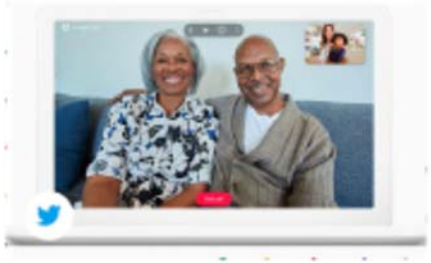
http://openvault.wgbh.org/catalog/V_7C97C4381B7849D791CD357588C2FE89

Google

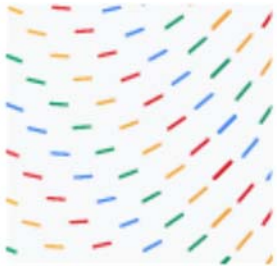
Our mission is to organize the world's information and make it universally accessible and useful.

Company news

birthday,
rates Cuban-
n, comedian
t known for



@google
Starting this week, you can now make high quality #GoogleDuo calls from your web browser → https://t.co/jNB787vmpF https://t.co/KYlQ2yjCUy



AI
Doing our part to share oper responsibly

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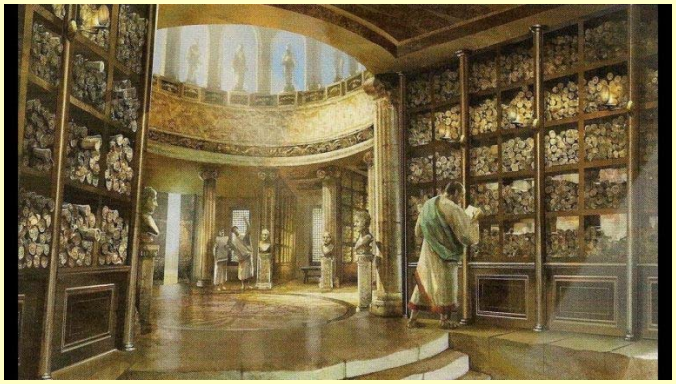
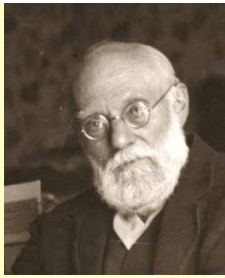
Great Library of Alexandria – 3rd Century BC



"The Great Library of Alexandria in Alexandria, Egypt, was one of the largest and most significant libraries of the ancient world.... comprising a collection of scrolls, Greek columns, a peripatos walk, a room for shared dining, a reading room, meeting rooms, gardens, and lecture halls, creating a model for the modern university campus."

https://en.wikipedia.org/wiki/Library_of_Alexandria

Paul Otlet – 1868-1944

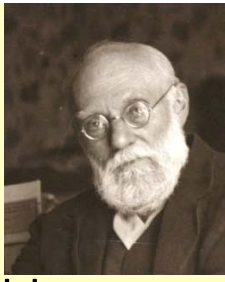


Early 20th Century Networked Knowledge and Global “Internet” Pioneer

Original Mundaneum
Brussels, Belgium
1910

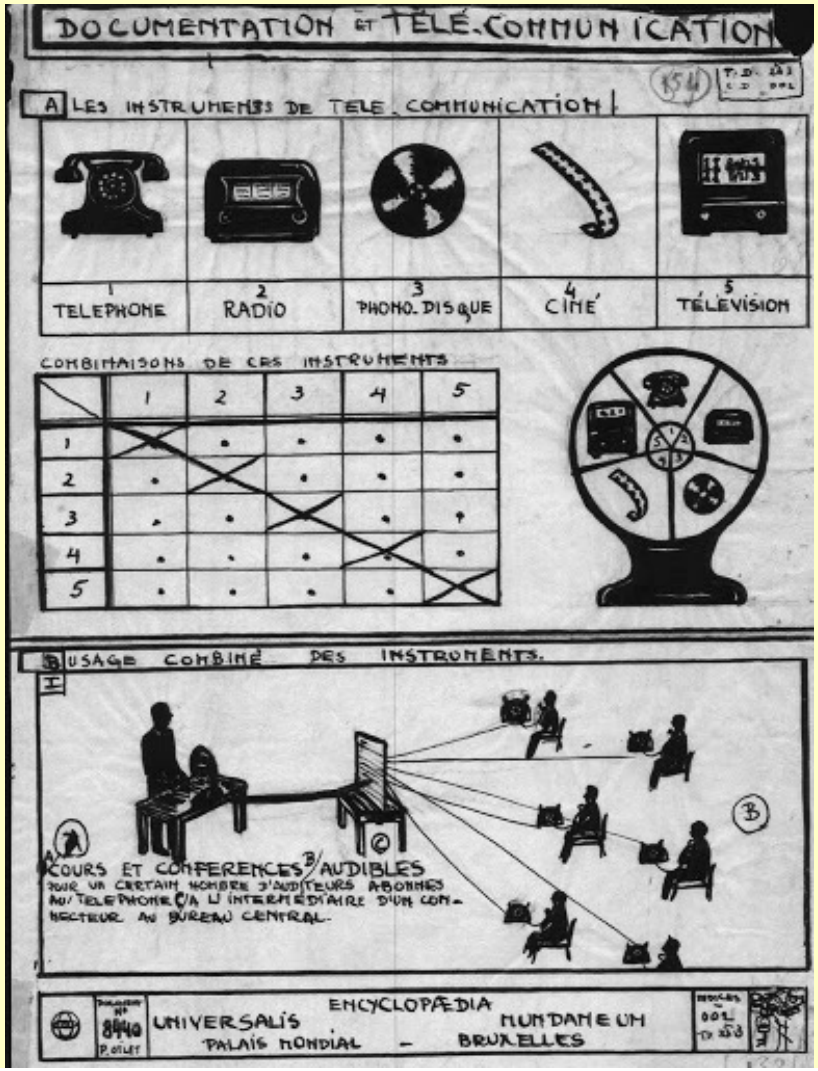
New Mundaneum
Mons, Belgium
1998

Paul Otlet – 1868-1944

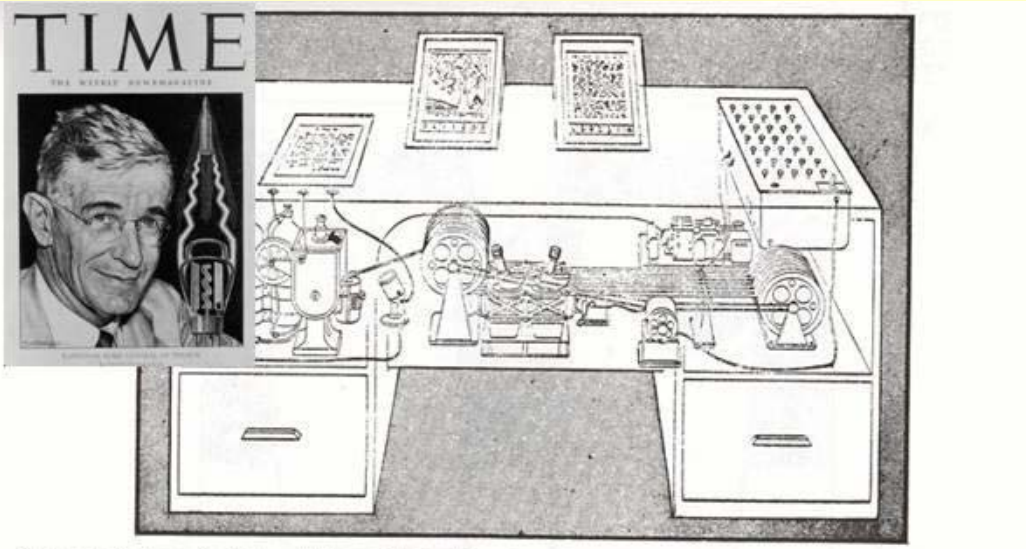


"From afar, anyone would be able to read any text, expanded or limited to the desired subject, projected on an individual screen. Thus, anyone from his armchair would be able to contemplate the whole of creation or particular parts of it."

"Everything in the universe would be registered at a distance as it was produced. Thus a moving image of the world would be established.…



Vannevar Bush – “As We May Think”, The Atlantic, July 1945



Memex in the form of a desk would instantly bring files and material on any subject to the operator's fingertips. Slanting translucent viewing screens magnify supermicrofilm filed by code numbers. At left is a mechanism which automatically photographs longhand notes, pictures and letters, then files them in the desk for future reference (*LIFE* 19(11), p. 123).

The Atlantic

As We May Think

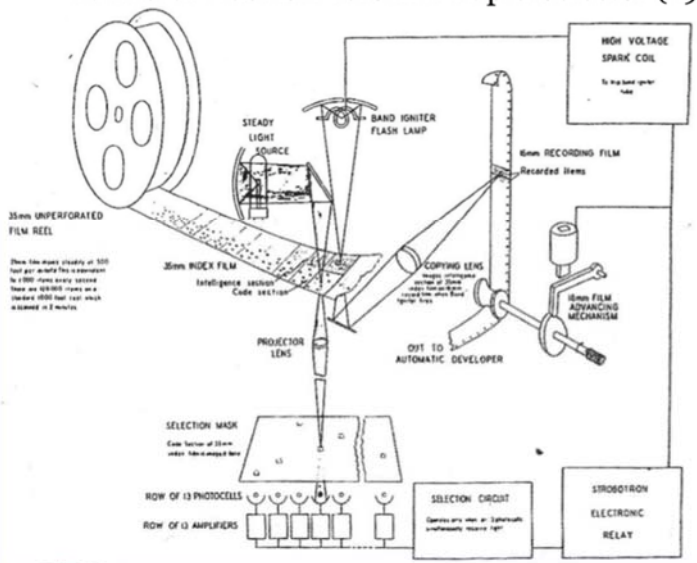
VANNEVAR BUSH | JULY 1945 ISSUE | TECHNOLOGY

TEXT SIZE − +

As Director of the Office of Scientific Research and Development, Dr. Vannevar Bush has coordinated the activities of some six thousand leading American scientists in the application of science to warfare. In this significant article he holds up an incentive for scientists when the fighting has ceased. He urges that men of science should then turn to the massive task of making more accessible our bewildering store of knowledge. For years inventions have extended man's physical powers rather than the powers of his mind. Trip hammers that multiply the fists, microscopes that sharpen the eye, and engines of destruction and detection are new results, but not the end results, of modern science. Now, says Dr. Bush, instruments are at hand which, if properly developed, will give man access to and command over the inherited knowledge of the ages. The perfection of these pacific instruments should be the first objective of our scientists as they emerge from their war work. Like Emerson's famous address of 1837 on "The American Scholar," this paper by Dr. Bush calls for a new relationship between thinking man and the sum of our knowledge. —THE EDITOR

This has not been a scientist's war; it has been a war in which all have had a part. The scientists, burying their old professional competition in the demand of a common cause, have shared greatly and learned much. It has been exhilarating to work in effective partnership. Now, for many, this appears to be approaching an end. What are the scientists to do next?

Vannevar Bush’s Microfilm Rapid Selector (1938)



A machine to rapidly select documents recorded as microfilm images on reels of 35 mm movie film

Coding of document topics as dot patterns on film

Strobotron to fire photo cell detectors matching a topic pattern “mask”

Andries van Dam and David Evans. "SHIRTDIF -A System for the Storage Handling and Retrieval of Technical Data in Image Format" in Proceedings of American Documentation Institute (later ASIS), 1964.

NCR THE NATIONAL CASH REGISTER COMPANY

ELECTRONICS DIVISION

The young lady above is holding a film chip containing an entire copy of the Bible. On this 2 inch by 2 inch frame are stored 1245 pages of text. The 2000 copies shown in the picture represent a document collection of 2,500,000 pages. This display dramatizes the storage and dissemination capabilities of NCR's new photochromic micro-image technology.

NCR MICRO-IMAGE BIBLE*

200:1 REDUCTION RATIO

* COPIED FROM WORLD PUBLISHING CO. BIBLE NO. 714

Further inquiry may be directed to The National Cash Register Company, Electronics Division, Edmund F. Klein, Manager, Military Department, 2815 W. El Segundo Boulevard, Hawthorne, California, area code 213, 757-5111.

NCR THE NATIONAL CASH REGISTER COMPANY

ELECTRONICS DIVISION

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NCR MICRO-IMAGE BIBLE*

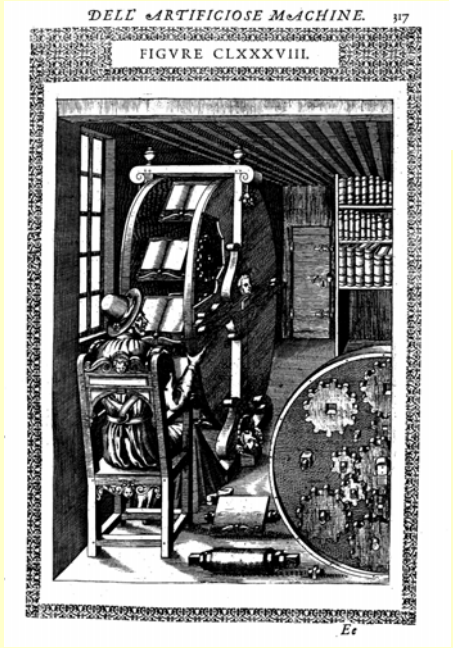
2. Information Management: annotations, threaded discussions, and catalogs

Talmud: 2nd – 5th Centuries CE

Hadith: 8th and 9th Centuries CE

King James Bible 17th Century CE

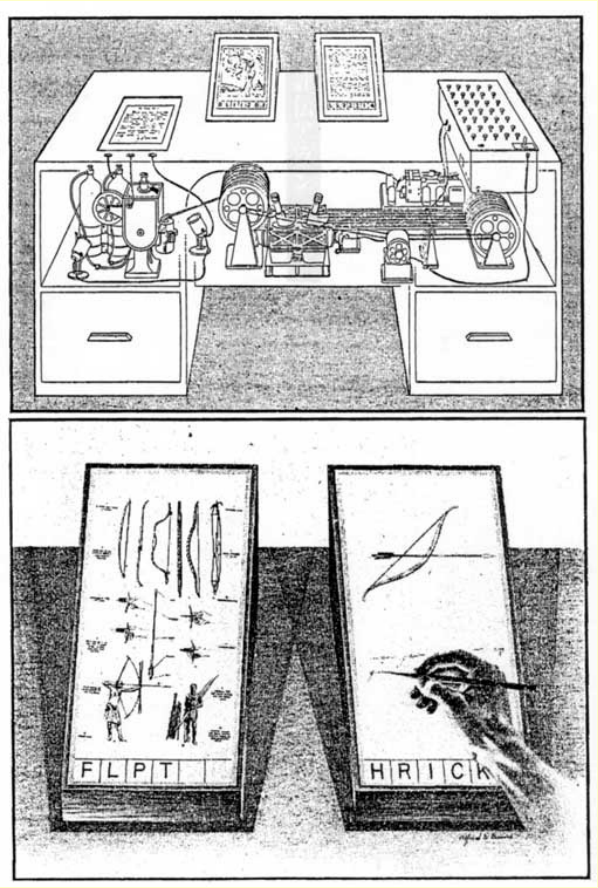
Book Catalog of Christopher Columbus' son 15th Century CE



Book Wheel 16th Century CE

David Foster Wallace 20th Century CE

Vannevar Bush “As We May Think” Building and Using Trails



- Quotes from Vannevar Bush. "As We May Think" in The Atlantic Monthly, July 1945.
- https://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/

- *"Selection by association, rather than indexing, may yet be mechanized. One cannot hope thus to equal the speed and flexibility with which the mind follows an associative trail, but it should be possible to beat the mind decisively in regard to the permanence and clarity of the items resurrected from storage."*
- *…*
- *"Thus he goes, building a trail of many items. Occasionally he inserts a comment of his own, either linking it into the main trail or joining it by a side trail to a particular item.*
- *And his trails do not fade."*
- *…*
- *"Wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them,..."*
- *…*
- *"There is a new profession of trail blazers…*

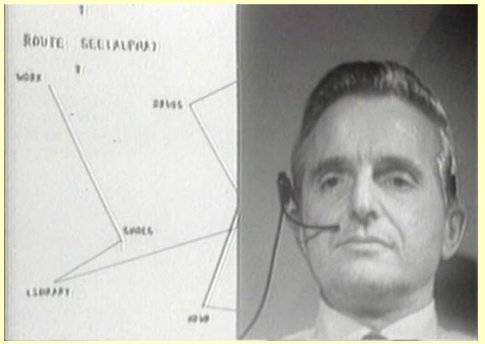

Doug
Engelbart
1925-2013

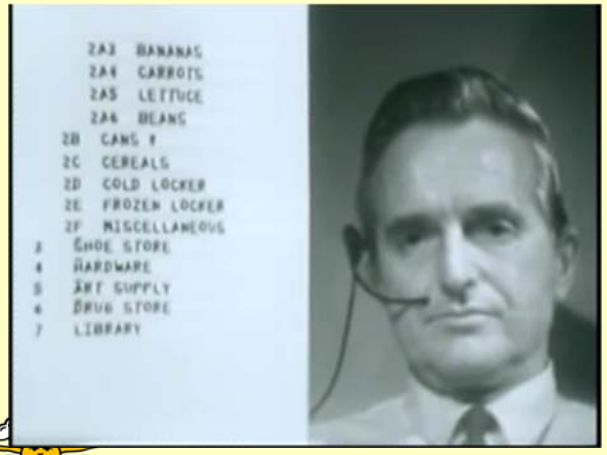
1962

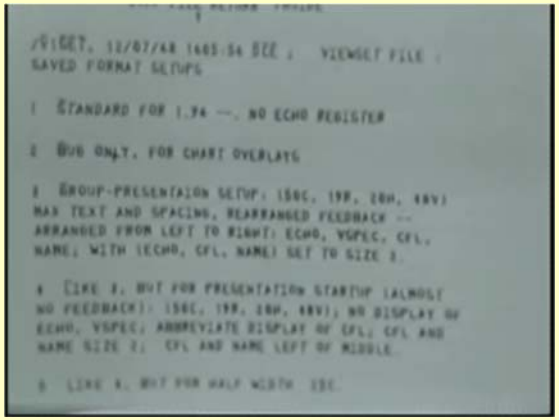

AFOSR 3223
Summary Report
AUGMENTING HUMAN INTELLECT: A CONCEPTUAL FRAMEWORK
Prepared for:
DIRECTOR OF INFORMATION SCIENCES
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
WASHINGTON 25, D.C.
CONTRACT AF 49(638)-1024
By: D. C. Engelbart
STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA
SRI

NLS (oN-Line System) Contributions

- MOAD: Mother of All Demos at FJCC 1968
- Interactive authoring and reading on screens
- Hierarchy (outline) with hyperlinks
- Multiple windows
- Real-time teleconferencing and synchronous collaborative editing
- Bi-manual operation (chord and mouse), cmd-line driven (NOT GUI)
- Links as text strings (like URLs)
- Systematic architecting and software engineering, tools
- Bootstrap community

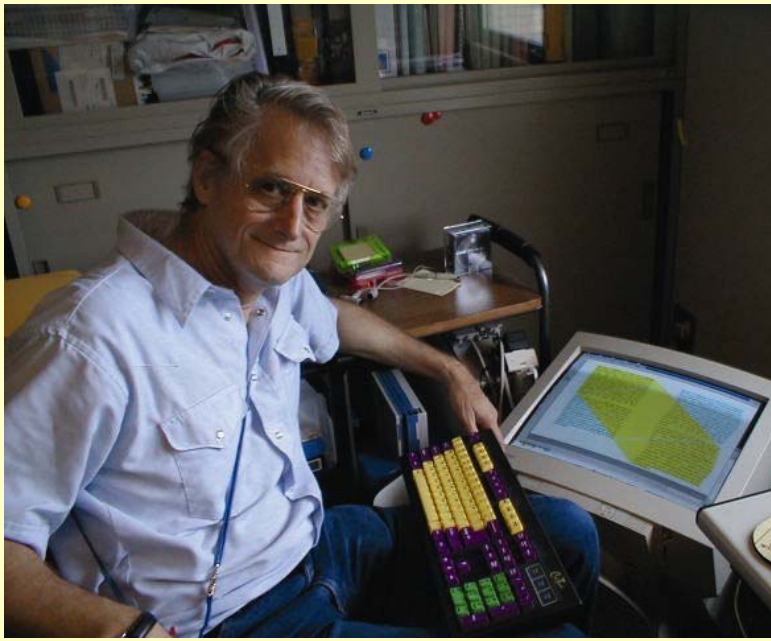




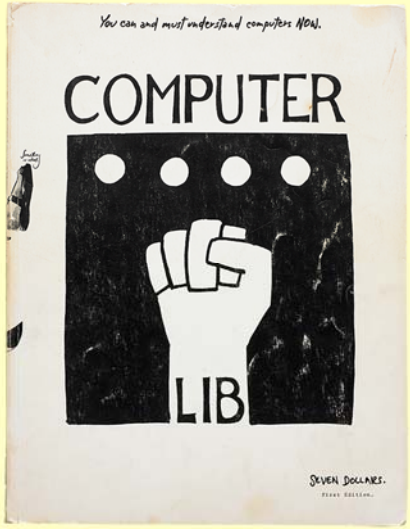


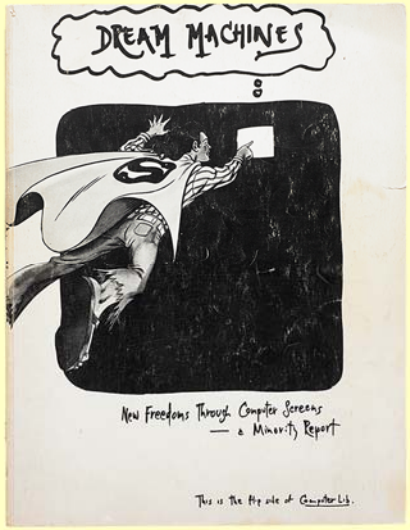
Ted Nelson - Contributions

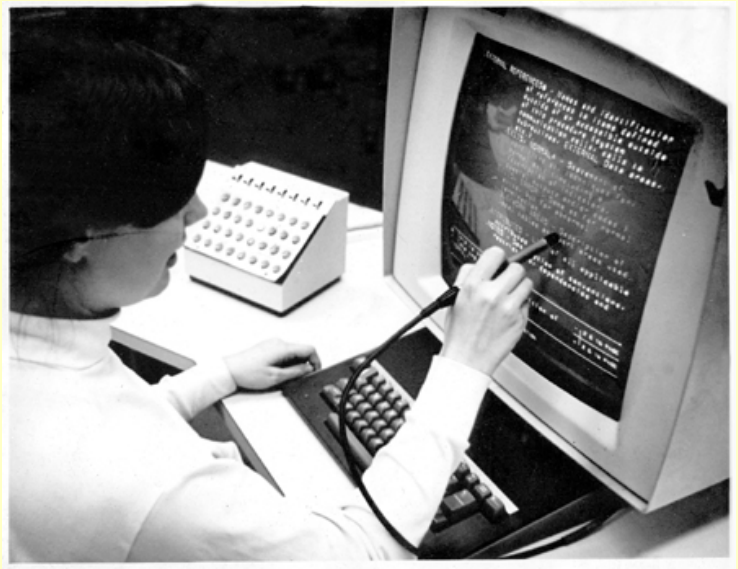
- Coining and evangelizing the word “hypertext”
- Tackling complext issues of structuring, authoring, and “reading” hypertexts
- Describing mechanisms or provenance of authorship and micropayments
- ComputerLib/Dream Machines evocative publications
- Instigator/consultant/client, HES (Hypertext Editing System)



Ted Nelson, Xanadu transclusion

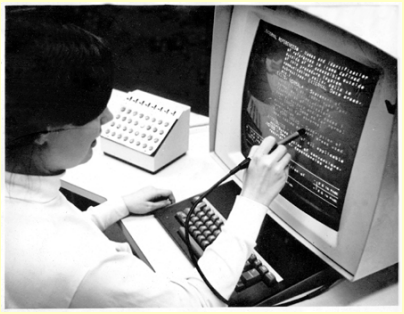






A Half-Century of Hypertext Research at Brown

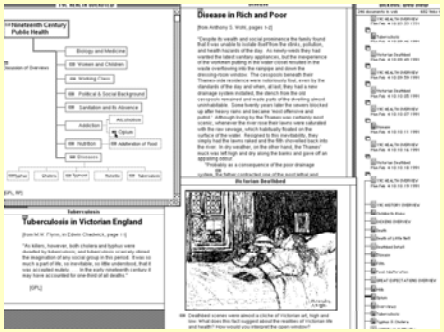
HES (Hypertext Editing System) - 1967



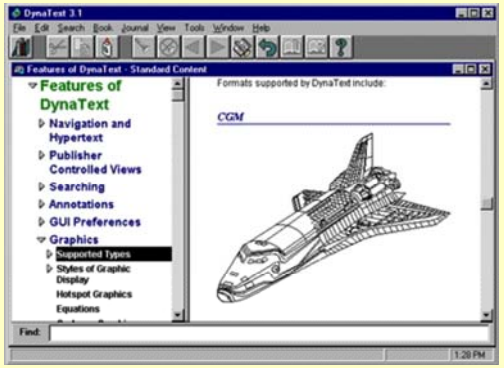
FRESS - 1968

EDS - 1982

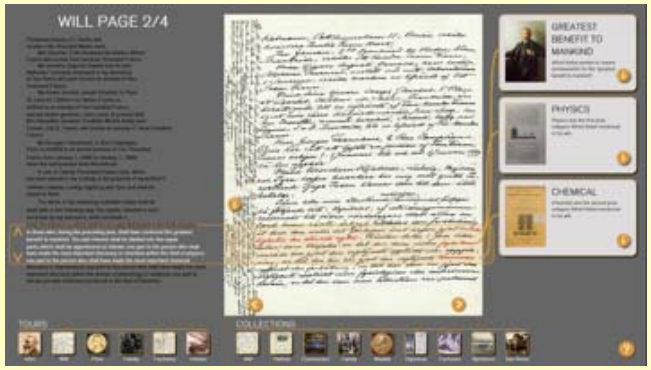
Intermedia - 1985



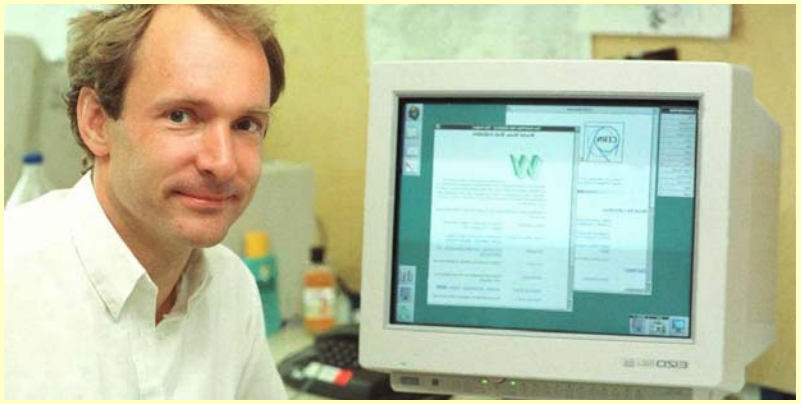
EBT (Electronic Book Technology): DynaText - 1990



TAG (Touch Art Gallery) - 2015



Sir Tim Berners-Lee - WWW



- Hypertext Transfer Protocol (HTTP)
- First open (universal) hypertext
- Hypertext at scale
- But with Mosaic we lost equality of authoring and reading
- A recent Google Doodle:

The World Wide Web (WWW) is the combination of all resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP). A broader definition comes from the World Wide Web Consortium (W3C):

"The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge."

Importance and Evolution of Search

- JIT search has largely replaced hard-wired links, but they are complementary mechanisms
- Google/Bing provide great search over text, with improving image and video search
- Page-rank algorithm, scaling expertise
- Machine learning for pattern recognition
- Many problems can be formulated as pattern recognition problems (e.g., games)
- But, search is still in its infancy
  - ill-specified “human” search requests that depend on text/history/common sense knowledge and reasoning not yet there, e.g., “smart speakers”

EXPERT OPINION

Contact Editor: Brian Brannon, bbrannon@computer.org

The Unreasonable Effectiveness of Data

Alon Halevy, Peter Norvig, and Fernando Pereira, Google

Eugene Wigner's article "The Unreasonable Effectiveness of Mathematics in the Natural Sciences"[1] examines why so much of physics can be neatly explained with simple mathematical formulas such as $f = ma$ or $e = mc^2$. Meanwhile, sciences that involve human beings rather than elementary particles have proven more resistant to elegant mathematics. Economists suffer from physics envy over their inability to neatly model human behavior. An informal, incomplete grammar of the English language runs over 1,700 pages.[2] Perhaps when it comes to natural language processing and related fields, we're doomed to complex theories that will never have the elegance of physics equations. But if that's so, we should stop acting as if our goal is to author extremely elegant theories, and instead embrace complexity and make use of the best ally we have: the unreasonable effectiveness of data.

One of us, as an undergraduate at Brown University, remembers the excitement of having access to the Brown Corpus, containing one million English words.[3] Since then, our field has seen several notable corpora that are about 100 times larger, and in 2006, Google released a trillion-word corpus with frequency counts for all sequences up to five words long.[4] In some ways this corpus is a step backwards from the Brown Corpus: it's taken from unfiltered Web pages and thus contains incomplete sentences, spelling errors, grammatical errors, and all sorts of other errors. It's not annotated with carefully hand-corrected part-of-speech tags. But the fact that it's a million times larger than the Brown Corpus outweighs these drawbacks. A trillion-word corpus—along with other Web-derived corpora of millions, billions, or trillions of links, videos, images, tables, and user interactions—captures even very rare aspects of human behavior. So, this corpus could serve as the basis of a complete model for certain tasks—if only we knew how to extract the model from the data.

Learning from Text at Web Scale

The biggest successes in natural-language-related machine learning have been statistical speech recognition and statistical machine translation. The reason for these successes is not that these tasks are easier than other tasks; they are in fact much harder than tasks such as document classification that extract just a few bits of information from each document. The reason is that translation is a natural task routinely done every day for a real human need (think of the operations of the European Union or of news agencies). The same is true of speech transcription (think of closed-caption broadcasts). In other words, a large training set of the input-output behavior that we seek to automate is available to us *in the wild*. In contrast, traditional natural language processing problems such as document classification, part-of-speech tagging, named-entity recognition, or parsing are not routine tasks, so they have no large corpus available in the wild. Instead, a corpus for these tasks requires skilled human annotation. Such annotation is not only slow and expensive to acquire but also difficult for experts to agree on, being bedeviled by many of the difficulties we discuss later in relation to the Semantic Web. The first lesson of Web-scale learning is to use available large-scale data rather than hoping for annotated data that isn't available. For instance, we find that useful semantic relationships can be automatically learned from the statistics of search queries and the corresponding results[5] or from the accumulated evidence of Web-based text patterns and formatted tables,[6] in both cases without needing any manually annotated data.

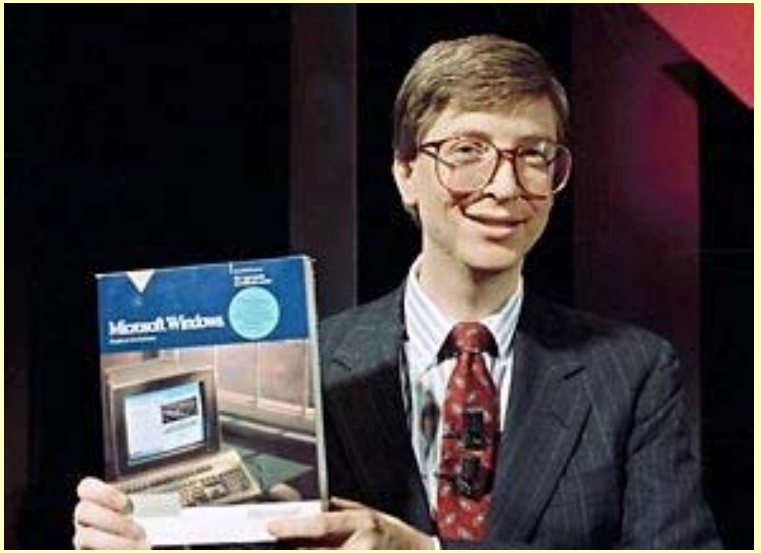
8 1541-1672/09/$25.00 © 2009 IEEE Published by the IEEE Computer Society IEEE INTELLIGENT SYSTEMS

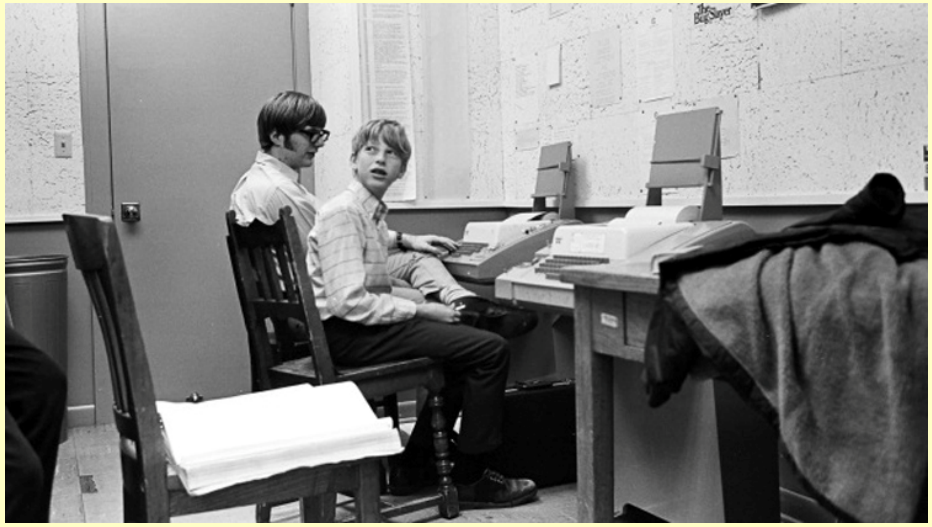
Alon Halevy, Peter Norvig, Fernando Pereira. "The Unreasonable Effectiveness of Data" IEEE Intelligent Systems, V24:N2 , March-April 2009

3. Personal Computing

- Bill Gates' 1980 Microsoft corporate mission statement:

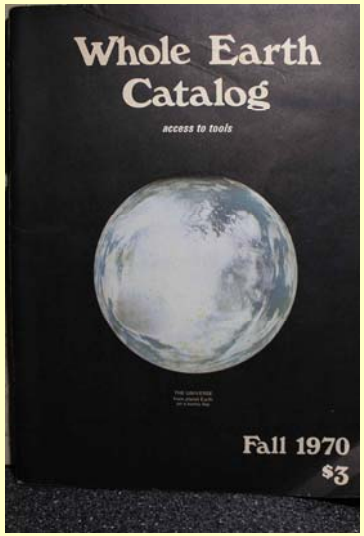
"A computer on every desk and in every home"





Confluence of Two Movements

- Microminiaturization and riding the cost curve (evenually resulting in ”Moore’s Law”
- Rebellion against “the Man”: anti-establishment, anti-DP, anti-military, anti-dehumanization
  - democratization, e.g., “Information Wants to be Free” – Stewart Brand

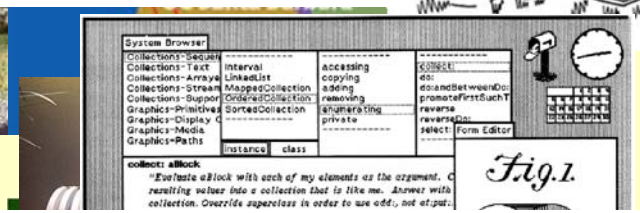


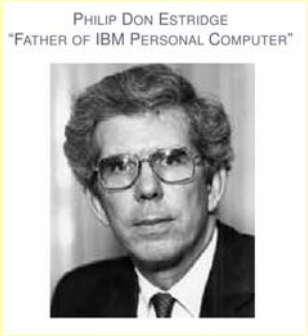
Microsoft original 11 employees - 1980

- Irony of the monopoly powers of FaceBook, Google, …

Visionaries in Personal Computing

- **Vannevar Bush** – Memex
- **Ivan Sutherland** - Sketchpad
- **Doug Engelbart** – NLS
- **J.C.R. Licklider, Vint Cerf, Bob K**
  ARPAnet
- **Bob Taylor** – Xerox PARC
- **Alan Kay** – Dynabook, with **Ade**
  Smalltalk Environment
- **Butler Lampson, Chuck Thacker**, **Bob Metcalfe,** … -
  Alto bitmapped graphics workstation, Ethernet
- **Dan Bricklin and Bob Frankston** – VisiCalc on the Apple II
- **Don Estridge** – IBM's "Father of the PC"
- **Steve Jobs** – from Apple-II to Macintosh

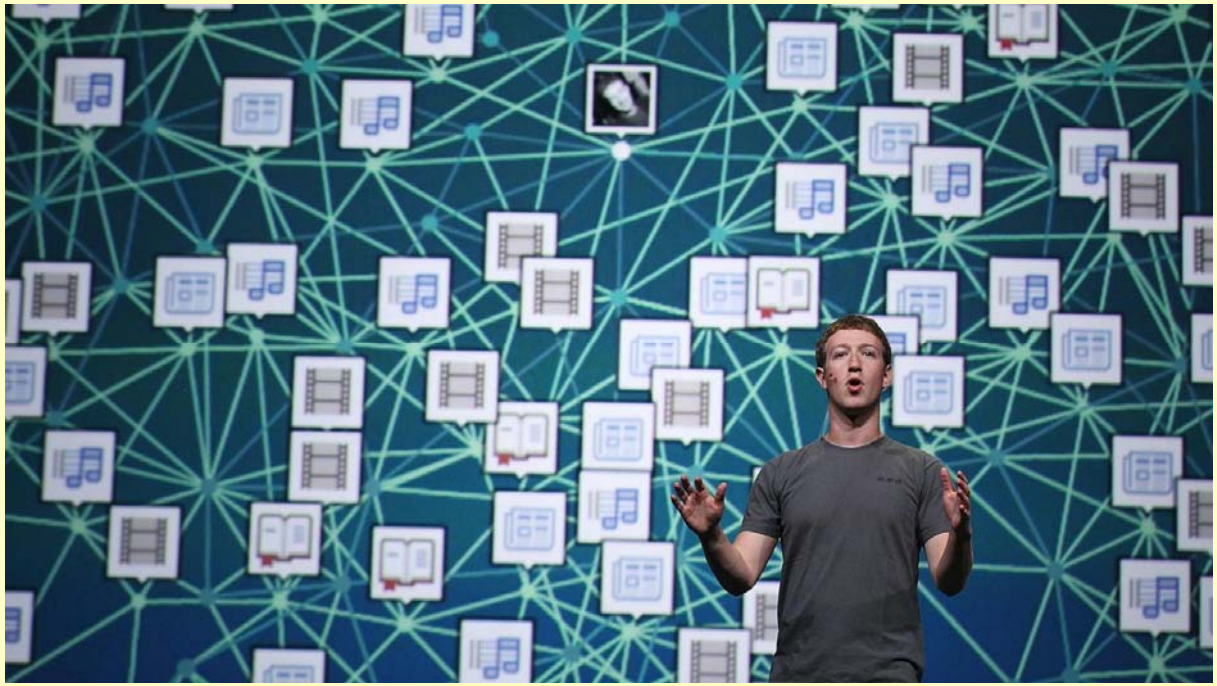




4. “Connect the World”

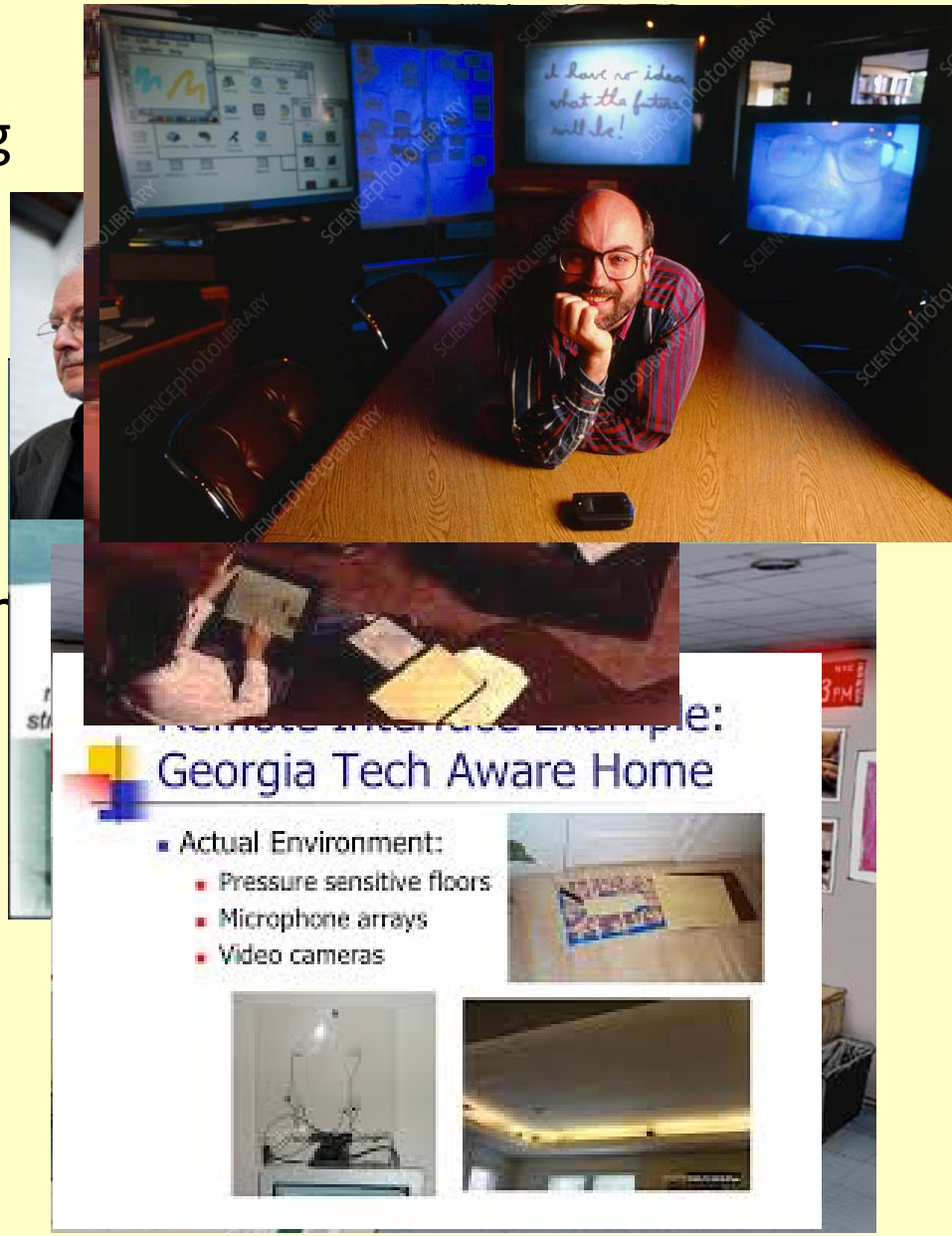
- Facebook’s original mission statement:

  “To give people the power to share and make the world more open and connected.”



5. “Ubicomp” Ubiquitous Computing

- Mark Weiser
  - Xerox PARC – ubiquitous computing
    - pervasive, location-aware
- Norbert Streitz – “Smart Future” EU project
  - smart everything everywhere, ambient intelligence, IoT
- Many smart office, home research projects
  - NSF STC telecollaboration (1991-2002)
  - Georgia Tech’s “Aware Home” (1998 to present)
  - yet vision of integrated real and virtual space with real-time collaboration still not realized



Ubicomp: Ubiquitous → Ubietous Computing

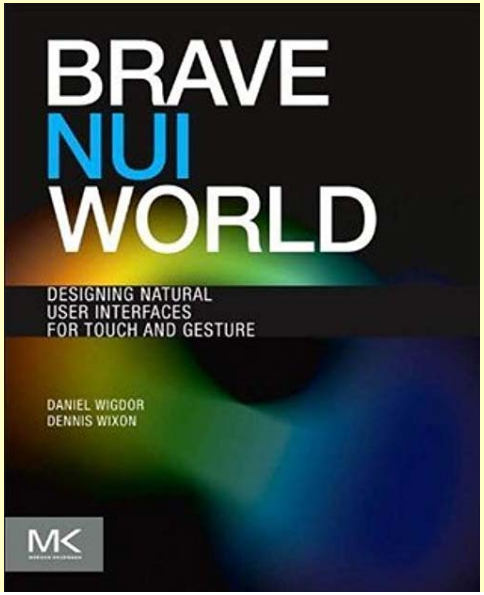
- Buxton's 2018 lectures on Ubiety:
  - importance of place – where and how to use smart devices
  - "moral order"/context – appropriate behavior
  - obeying social relationships, not just physical constraints
- Ecosystem of human activity
  - relationships among locations, devices, roles, time, ...
    - graph structure
      - arcs are the relationships, the transitions between activities
      - nodes are different states, i.e., devices, devices, roles, times
  - complexity management via ecosystem PoV and collaboration
- Example (Buxton talk at Brown in 2018)
  - Xerox PARC – PARCslate & PARCtab with Liveboard ecosystem
    - "Inherent in that design was ubiety not ubiquity"
    - "Every device had value on its own independently but toget could work cooperatively in reasonable ways"
    - "Think about changing the relationships as opposed to mak device"

6. Natural User Interfaces (NUIs)

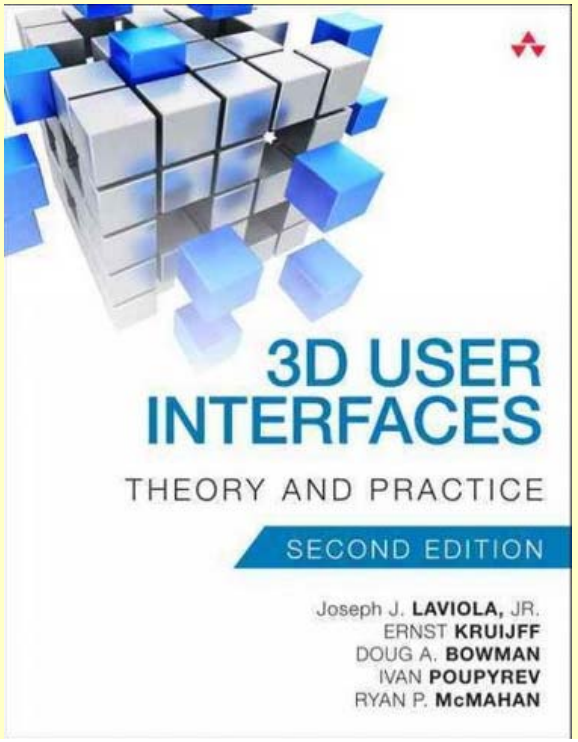
What is the role of a UI?

- To mediate between user(s) and environment(s)
- To manage the complexity of such an ecosystem
- To create a harmonious user experience

How to manage complexity of interacting with real and virtual objects and participants?



2011



2017

The Ultimate User Interface (1/3)

- None! UIs are a necessary evil
- Counterpoint:
  - the aesthetics of a good UI
- Want to communicate and control as we do in and with the real world
  - objects
  - tasks
  - other participants (real and software agents)

The Ultimate User Interface (2/3)

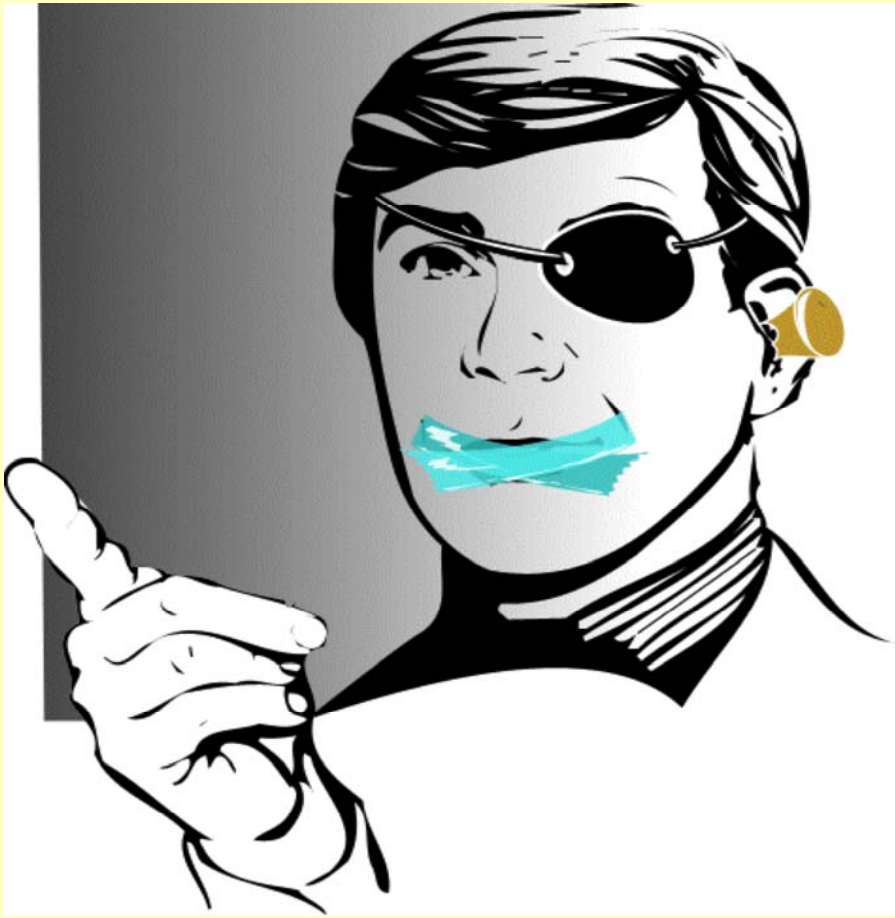
- Models for agents:
  - Jeeves –1915-1974 (P.G. Wodehouse)
    - knows context and place
    - anticipates, infers intent
    - requires NLU, knowledge base
    - vision: Apple's Knowledge Navigator – 1987
  - Beware HAL-9000 (Clarke/Kubrick 2001)

The Ultimate User Interface (3/3)

- Best today
  - transparency
  - minimize cognitive load, maximize muscle memory, automaticity, ...
- Current brain-computer interface research - “cogito ergo fac”
  - invasive embedded electrodes
    - BrainGate Research Team, 100 neurons – 1990s to present
  - non-invasive scull caps
    - fNIRS (near-infrared spectroscopy)
      - Chaudhary et al. PLOS 2017 article
    - U Minnisota EEG robot control
      - https://slate.com/technology/2013/06/minnesota-brain-computer-interface-lets-you-control-flying-robot-with-your-mind-video.html

Limitations of WIMP GUIs

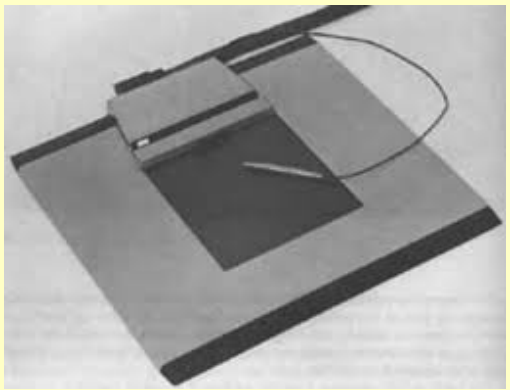
- Designed for one user, at one desktop, with one mouse and keyboard
  - limited
    - vision (flat, 2D)
    - focus
    - audio
    - tactile
    - movement
  - no
    - speech
    - gestures
  - one-handed interaction
  - systems unaware of user



Characteristics of Post-WIMP, Multi-modal UIs

- Also called Perceptual Uis, Natural Uis (NUIs)
- Multiple simultaneous devices, sensory channels, or humans
- High bandwidth, continuous, noisy input
  - body part tracking (head, gaze, hand, …)
  - gesture and speech recognition
- Probabilistic disambiguation, “unification” (sensor fusion)

Rand Tablet - 1964

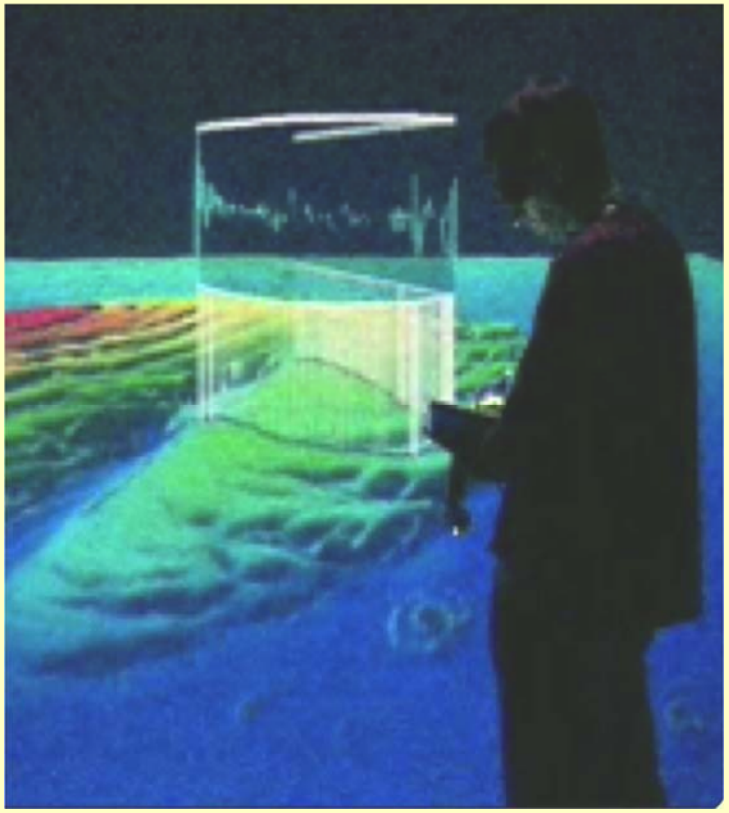


PLATO IV – Touch Panel - 1972

“Put That There” as an Early Research Example

- “’Put That There’: Voice and Gesture at the Graphics Interface” – Richard Bolt, MIT 1980

Exploring the Martian Surface: IVR + Pen/Tablet + Voice Control - 2005



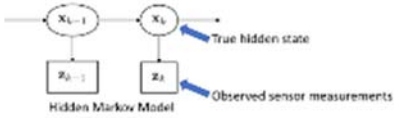
Andries van Dam, Andrew S. Forsberg, David H. Laidlaw, Joseph J. LaViola Jr., and Rosemary Michelle Simpson. "Immersive VR for Scientific Visualization: A Progress Report" in IEEE Computer Graphics and Applications, 20(6), Nov/Dec, pp. 26-52, 2000.

Andries van Dam, David H. Laidlaw, and Rosemary Michelle Simpson. "Experiments in Immersive Virtual Reality for Scientific Visualization" in IEEE Computers & Graphics 26(4), pp. 535-555, 2002.

Human-robot interaction

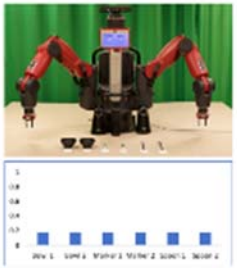
Multimodal Belief Fusion

- Combine multiple sensors to estimate true state
  - Speech, gesture, pose, eye-gaze
  - Called 'sensor fusion' or 'belief fusion'
- Bayesian Filtering: Model world as Hidden Markov Model
  - Each sensor outputs a probability distribution over the true state
  - Combine each sensor's probability distribution with the state estimate from the previous timestep.



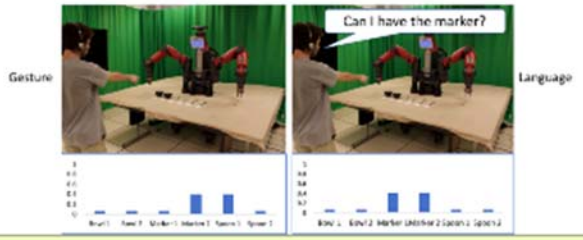
Multimodal Belief Fusion

- Step 1: Start with an initial estimation (uniform is a common choice)



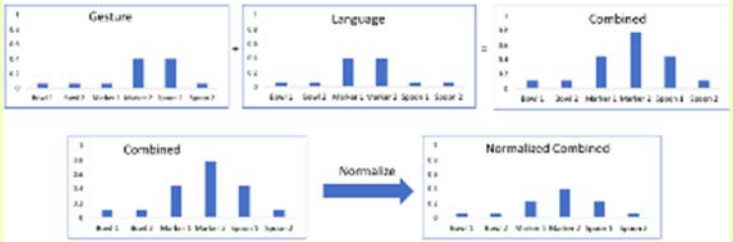
Multimodal Belief Fusion

- Step 2: Collect sensor measurements
  - Note: each sensor is considered conditionally independent from one another
  - Some sensors use hand tuned models, some are machine learned



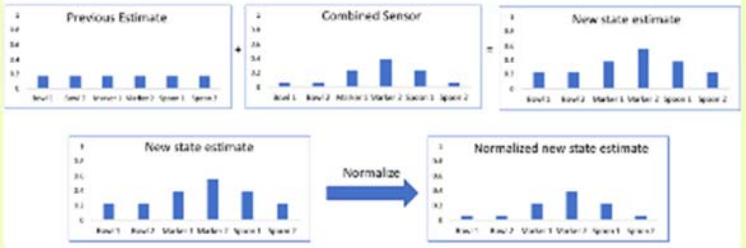
Multimodal Belief Fusion

- Step 3: Average sensor estimations
  - Element-wise addition + normalization to make sure probabilities sum to one



Multimodal Belief Fusion

- Step 4: Integrate with previous estimate
  - Same element-wise addition and renormalization, this time with previous estimate



See What I'm Talking About?
Mixed Reality as a Bidirectional Communication Interface for Human-Robot Interaction

WWW: What We Want in our Apps/UIs (1/2)

- Ubiety: "place"-adaptive in capabilities and constraints
  - agile switching between
    - multiple I/O interaction languages based on platform: direct interaction, speech, agents
    - focused, localized, and multi-threaded modes
      - e.g., in the shower thinking of three different problems/tasks and
      - wanting to take notes on all, create sketches
    - Ex.: intelligent mail reader for driving

- Less direct manipulation and more s
  - "set the table for our visitors" – based from context

WWW: What We Want in our Apps/NUI (2/2)

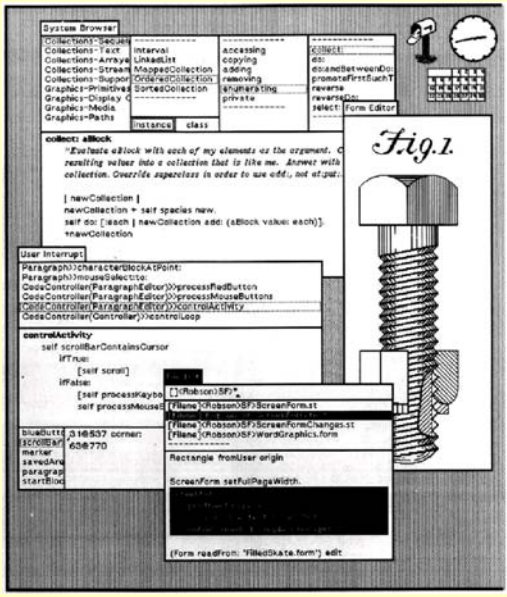
- Autonomous computer-assisted knowledge work still far off
  - limited human-computer collaboration for now
  - autonomous vehicles are easier!
- Increasingly we'll have a federation/society of appliances/devices around us and in us – need:
  - focus-in-context, e.g., fisheye views, LoD, ...
  - situational awareness
  - summarization and inferencing

Assessment of Where We Are: *Information*

- Worldwide accessibility through Internet, smartphones, and laptops
- "Information at Your Fingertips" and information management largely achieved
  - suites of tools such as Microsoft Office and the Google Suite
- Amount of information still overwhelming
- Mostly uncurated – very difficult to find trusted PoV
- Democratization of online "publishing" has had many negative intended and unintended consequences
  - journalists replaced by bloggers, death of newsprint...

Assessment of Where We Are: *Technology*

- Internet hardware and software infrastructure scales astonishingly well, but:
  - "connecting the world" is devolving because of nationalization, e.g., China and Russia
  - inadequate technology and human control causing escalating cyberfraud/crime, data breaches, …
- Integrated environments of '60s and '70s have devolved into
  - silos and lack of interoperation due to commercial imperatives
- Far from ubietous computing with its seamless, frictionless portability of the user's environment
- "smart home/office/city" field is growing exponentially
- but it remains frustratingly inadequate, buggy, and turbulent ("Google's Nest")
  - + the usual privacy/security issues



Assessment of Where We Are: *User Interfaces*

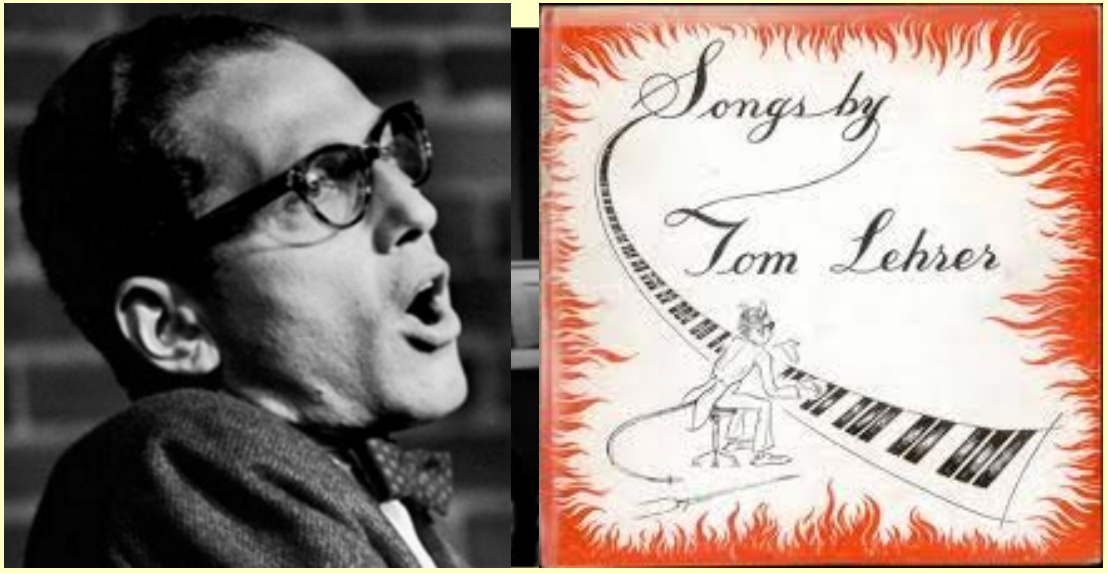
- Core technologies still inadequate
  - voice and gesture recognition, interaction in 3D
  - IVR and its easier-to-adopt cousin AR/MR still very early stage
    - comfort/safety of headsets; tracking
    - autostereoscopic displays
    - distributed haptic feedback
- Bewildering proliferation of apps & their incompatible UIs
  - still no good multi-modal UIs in common use
- Need to control the society of devices around us, and, increasingly, within us, without overwhelming us
  - future of "Human-in-the-Loop" systems, e.g., Boeing 737 Max, jet fighters, semi-autonomous vehicles?

Assessment of Where We Are: *Societal Implications*

- Growing security/privacy issues
- Influence of fake news: fauxtography, deep fakes
- Astonishingly explosive growth of, and dependence on, social media
  - but they all too often play an undesirable, even dangerous role
  - "social media considered harmful"…
- ….

Societal Impact and Ethics

- Kranzberg's First Law
  - "Technology is neither good nor bad; nor is it neutral"
  - Our techno-optimism was unjustified
  - Our "not our job/problem" attitude harmful

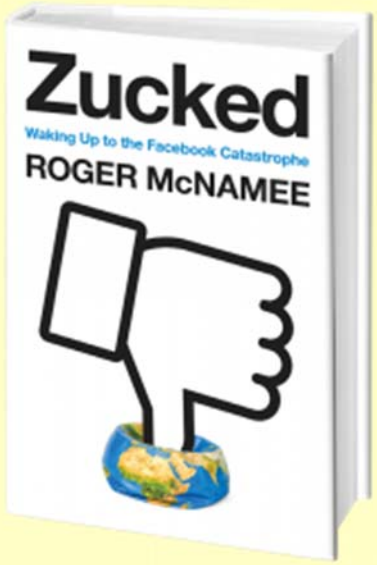


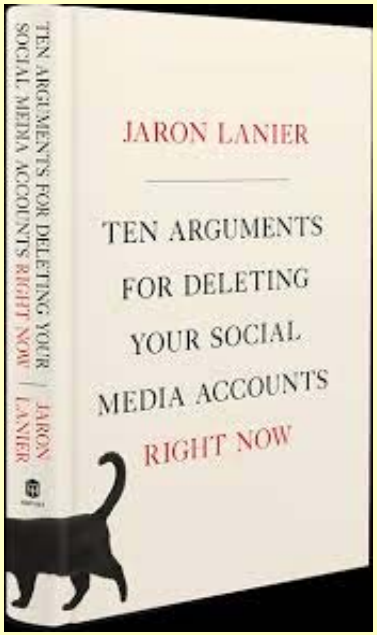
Some Societal Problems

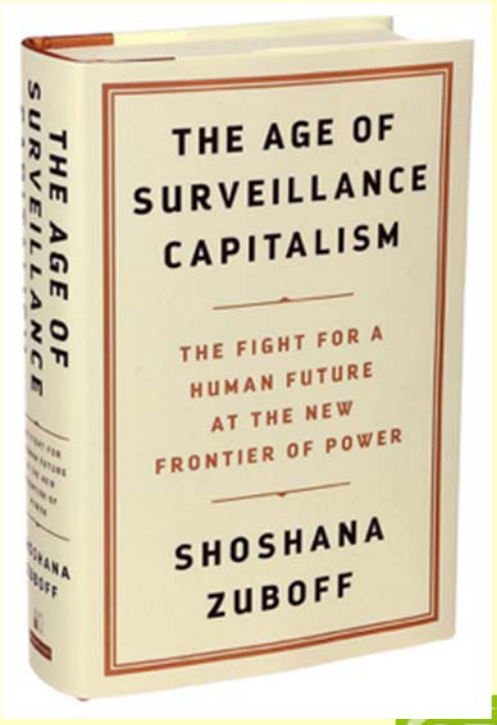
- Addiction – games, social media
- Disproportionate and huge influence of social media
  - behavior modeling → prediction → modification → impact on individuals and on society
  - market dominance, unregulated monopolies

Social Media

- Faustian bargain
  - "free" more compelling than privacy/security
  - companies reap rewards of monetizing our data
  - surveillance capitalism is the new economic driver
- Scale, e.g., billions of users, changes the type of global impact







Four Related Problem Areas in Social Media

- Addiction
- Invasion of privacy: monetizing your data
- Filter Bubbles and the hacking of society
- Economic dominance, surveillance capitalism

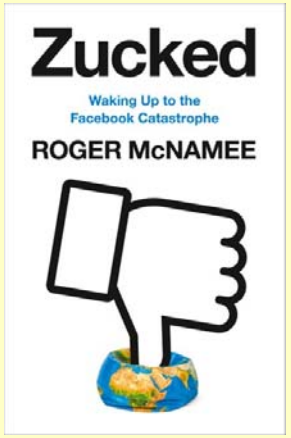
1. Addiction: Attention as a Commodity

- "Time on task" and focus for task performance vs. engagement and "stickiness" to increase lock-in and ad revenue
- ➡ addiction
- 2017 – Tristan Harris's TED talk "How a Handful of Tech Companies Control Billions of Minds Every Day"
  - attention-grabbing strategies that foster addiction to distracting media

Addiction strategies: AI algorithms fed by personalized data

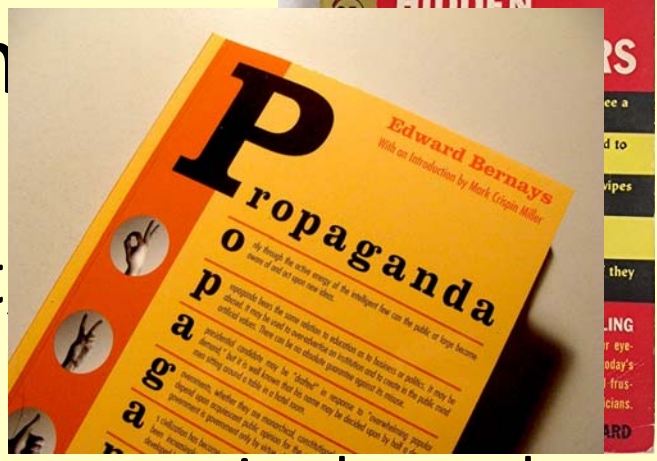
- Based on psychological research (gambling and game industries): brain chemistry + algorithms
  - started with behaviorism
  - Stanford Persuasive Technology Lab
  - bright colors, high-energy sound, micro-rewards (badges, "likes"), all increase dopamine
  - collaborative filtering, recommender systems, affinity groups vs. queue up the next ad or video
  - FOMA (fear of missing out), social insecurity, and the need for approval
  - people increasingly live in the online world where approval is at least as dominant as in the real world -> instant feedback
    - not just viewing but responding to postings – guilt, fear
    - "Teens explain the world of Snapchat's addictive streaks, where friendships live or die"

2. Invading Privacy and Monetizing Your Data (1/2)



- Personalized data (including metadata)
  - You are the most valuable commodity
  - vulnerable to de-anonymizing, theft, tampering
- Data gathered from both app/user and from other users and their apps via social graph
  - without their knowledge, let alone consent
  - "30K data points/person" – Roger McNamee
  - definition of data point? queries, images, extracted and inferred profiles?

3. Behavior Modification



- Behavior manipulation is a very old art, propaganda
  - rulers control their populations, ads influence attitudes and buying behaviors
  - Freud's nephew Edward Bernays wrote the book on PR "Propaganda", the bible of PR
  - Vance Packard covered advertising, PR, government (1957)
    - warned about "depth approach" to manipulation of our subconscious, leading to behavior modification
    - Center for Advanced Study in the Behavioral Sciences at Stanford
    - big difference between susceptibility to ads (effectiveness still controversial) and the effects of microtargeting

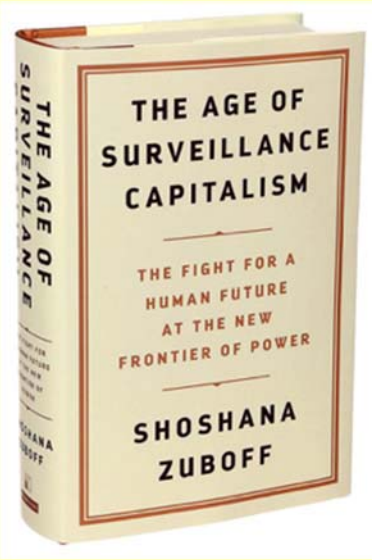
3. Behavior Modification (2/3)

- Behavior modeling → behavior prediction → behavior modification via microtargeting mechanism
  - your personal data blended with aggregate statistics of your "kind" to target your profile
- Filter bubbles
  - you see what you prefer to see – contract rather than expand PoV
  - biases are reinforced, outrage and shock travel faster and have more impact than evidence-based, rational argumentation
  - perversely, contrary evidence more likely to harden a belief
    - The "post-truth" world of alternative facts
    - proof by vigorous assertion → the big lie, AgitProp
  - fake news: bad actors + bots + dupes

3. Behavior Modification (3/3)

- Brain- and democracy-hacking through filter and preference bubbles,
  - "the echo chamber", "weaponization of information"
  - deaths: Myanmar, Sri Lanka, "vaccination causes autism", the resurgence of whooping cough, measles,…
  - hacking of society: Trump election, Brexit, Cambridge Analytica; Brazil, …(cf. paper on Russia's IRA (Internet Research Association) influence on 2016 election)
- (Trump win aided by deliberate
  - gerrymandering (redrawing voting districts to favor incumbents)
  - voter suppression, aided by fake news)
- Tribalism
  - divisiveness, hollowing out of the center, accommodation
  - decline of civic responsibility

4. Surveillance Capitalism (1/2)



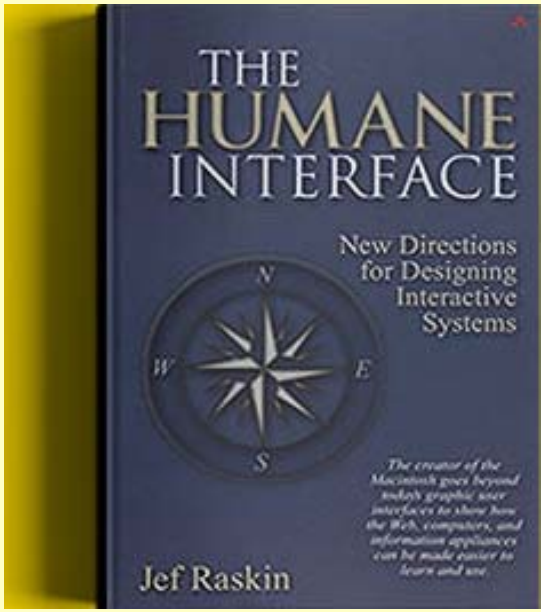
- Surveillance State – Big Brother is here, now
  - cameras, GPS, smart speakers, smart appliances
- Zuboff's "The Age of Surveillance Capitalism"
- The new economics, based partially on "laissez-faire"
  - aka "robber baron", libertarian/Ayn Rand economics rather than Keynesian economics
- Social media created a Golem/Frankenstein but now benefit
  - they are addicted to growth and wealth

4. Surveillance Capitalism (2/2)

- Unregulated **monopoly** power's vicious cycle
  - **Zuckerberg's** 60% controls Facebook, with 2.7B+ users
  - more power and influence than the US president
    - FB, Google,… not just neutral platforms but also "curated content" providers
    - freedom of speech vs. dealing with hate speech – "who appointed him czar?"
  - fierce resistance to regulation, but clearly repeated failures show they can't self-regulate
    - data breaches, content monitoring, "catch and kill" to suppress potential competitors
    - "Deny, deflect, …" rather than let's **really** work together to try to deal with the admittedly really hard issues
    - Google disbanded its Advanced Technology External Advisory Council (b3/26 – d4/5)
- Government regulation, e.g., rights in data
  - individual, corporate, government
  - Europe's GDPR (General Data Protection Regulation) as a first step

Human-Centered Design → Humane Design

- Jeff Raskin. "The Humane Interface: New Directions for Designing Interactive Systems", 2000
- Design can't just be concerned with effectiveness
  - but has to include a concern for the human and societal consequences
  - uses to which the the design could be put
  - potential safeguards
- Center for Humane Computing
  - http://humanetech.com/
- AI as a bellwether



Some "Ethics in AI" Efforts (1/2)

- Concerns about societal impact of social media parallels and intersects with that about AI
  - older and more substantial efforts to learn from…
- Wired stories
  - "Tech Firms Move to Put Ethical Guard Rails Around AI"
    - https://www.wired.com/story/tech-firms-move-to-put-ethical-guard-rails-around-ai/
  - "Tech Giants Team Up to Keep AI from Getting Out of Hand"
    - https://www.wired.com/2016/09/google-facebook-microsoft-tackle-ethics-ai/
- Partnership on AI: http://partnershiponai.org
  - Accenture, ACLU, Amazon, BBC, Facebook, Google, IBM, MSFT,….
  - "The Partnership on AI to Benefit People and Society was established to **study and formulate best practices** on AI technologies, to advance the public's understanding of AI, and to serve as an open platform for discussion and engagement about AI and its influences on people and society."

Some "Ethics in AI" Efforts (2/2)

- OpenAI initiative https://openai.com/about/
- New Research Institute for Ethics in Artificial Intelligence at Technical University of Munich
  - https://www.wi.tum.de/new-research-institute-for-ethics-in-artificial-intelligence/
- One Hundred Year Study on AI, reports every 5 years
  https://ai100.stanford.edu
- Microsoft's Aether Committee: AI and Ethics in Engineering and Research
- Microsoft's "The Future Computed"
  - https://blogs.microsoft.com/wp-content/uploads/2018/02/The-Future-Computed_2.8.18.pdf

Microsoft Golden Rule Ethical Principles for AI (1/4)

FAIRNESS

Treat all stakeholders equitably and prevent undesirable stereotypes and biases.

PROMPTS

From the perspective of your stakeholder, how could the decisions made by this system treat people unfairly based on a personal characteristic they cannot change?

How could the system perpetuate bias or stereotypes?

RELIABILITY

Build systems to perform safely even in the worst-case scenario.

PROMPTS

How could the system malfunction?

How could the system be misused or cause harm?

Microsoft Golden Rule Ethical Principles for AI (2/4)

PRIVACY & SECURITY

Protect data from misuse and unintentional access to ensure privacy rights.

PROMPTS

What concerns might your stakeholder have about the data the system collects, stores, or uses?

What data should you NOT collect?

INCLUSION

Empower everyone, regardless of ability, and engage people by providing channels for feedback.

PROMPTS

Will the system work well for everyone who uses it?

Have you accounted for physical, cognitive, social, or situational differences that could exclude someone or entire groups?

Microsoft Golden Rule Ethical Principles for AI (3/4)

TRANSPARENCY

Create systems and outputs that are understandable to relevant stakeholders.

PROMPTS

What does your stakeholder need to know to understand the system and how decisions are made?

What might they want explained and how will you provide that information?

ACCOUNTABILITY

Take responsibility for how systems operate and their impact on society.

PROMPTS

Who is responsible if something goes wrong or if stakeholders have concerns about how it performs?

How can you undo harm caused by the system or fix mistakes?

Microsoft Golden Rule Ethical Principles for AI (4/4)

Ethics in the CS Curriculum

- "Ethics Education in Context: A Case Study of Novel Ethics Activities for the CS Classroom"
  - Michael Skirpan, Nathan Beard, Srinjita Bhaduri, Casey Fiesler, and Tom Yeh(2018) in the Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18)
- "Tech's Ethical 'Dark Side': Harvard, Stanford and Others Want to Address It"
  - https://www.nytimes.com/2018/02/12/business/computer-science-ethics-courses.html
- "Harvard & MIT Among Nation's First to Introduce CS Ethics Courses"
  - https://www.masstlc.org/harvard-mit-among-nations-first-to-introduce-cs-ethics-courses/
- Embedding ethics in computer science curriculum
  - https://www.seas.harvard.edu/content/embedding-ethics-in-computer-science-curriculum
  - Brown CS new "Ethics TAs"

What to Do? My Call to Arms

- Minimize use of screens
  - social media, games, inane messaging, ...
- Lobby for anti-monopoly and data privacy legislation
- Lobby for subscription vs. ad model
- Demand much greater investment in combatting the negative mechanisms and outcomes
  - great intellectual challenges – e.g., freedom of expression isn't absolute but who shall police based on what criteria?
- Develop, discover, advocate, and pay for trusted PoV
- Educate
- Lobby for ethical behavior within school and job
  - humane design
    - include social benefits, not just universal design
    - design for accessibility and inclusion
  - Center for Humane Technology, …
- You have a choice of what to work on…

Engelbart's Grand Vision

- The glass is half full…we have great tech, e.g., the smartphone ecosystem, but tech hasn't advanced as fast or as well as we might have expected in half a century
  - Arthur Clarke and Stanley Kubrick's classic movie "2001"
- Augmenting Human Intellect, increasing our societal IQ
  - has not materialized
  - in some ways we are going backwards
- Don't just be great technologists, help make tech societally responsible – we CAN fix this…

“To Infinity and Beyond…”