

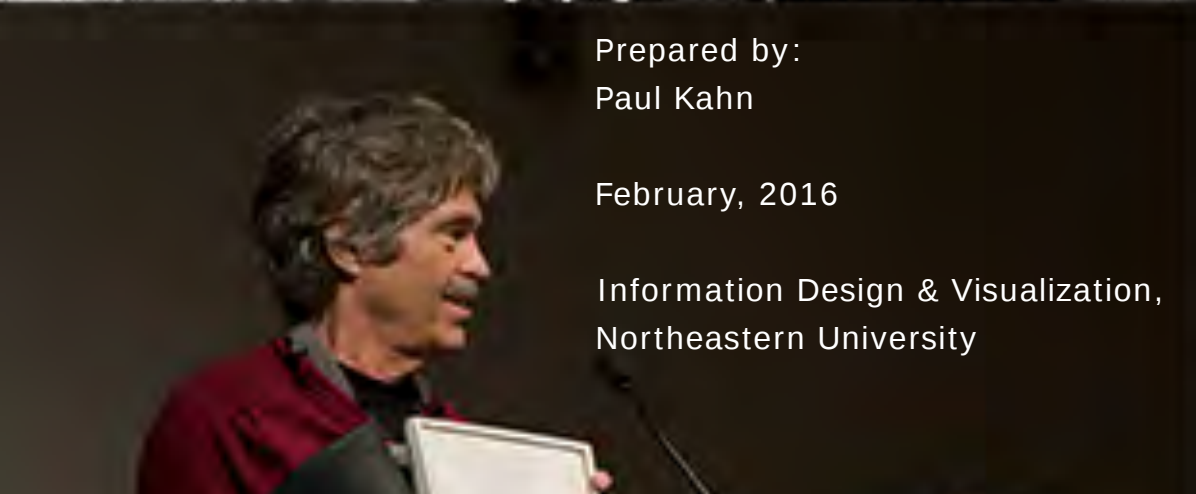
A Person(alized) History of Hypertext



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A Personal History of Hypertext

— Four individuals whose work and writing inspired how we think about and use computers today:

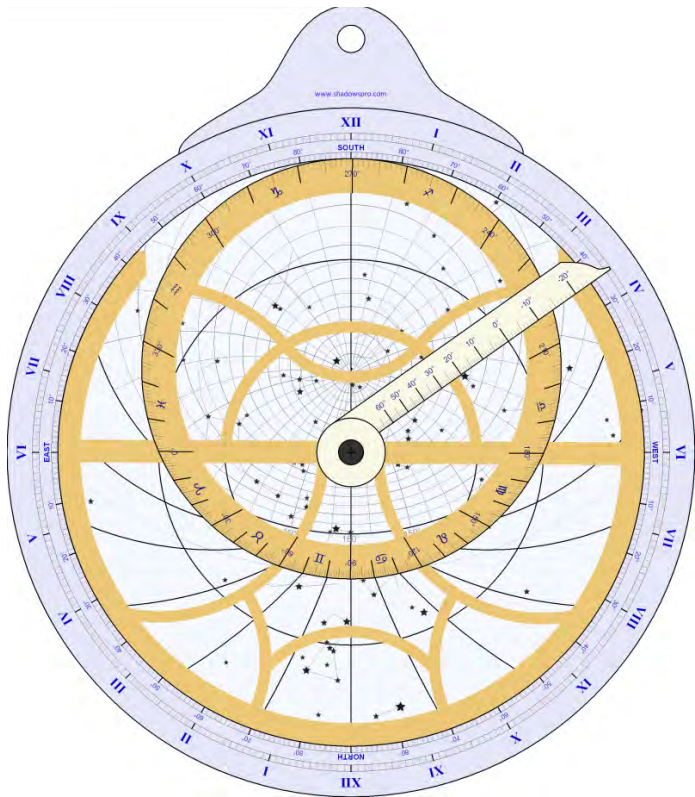
- Vannevar Bush
- Theodore Nelson
- Douglas Engelbart
- Alan Kay

Vannevar Bush (1890-1974)

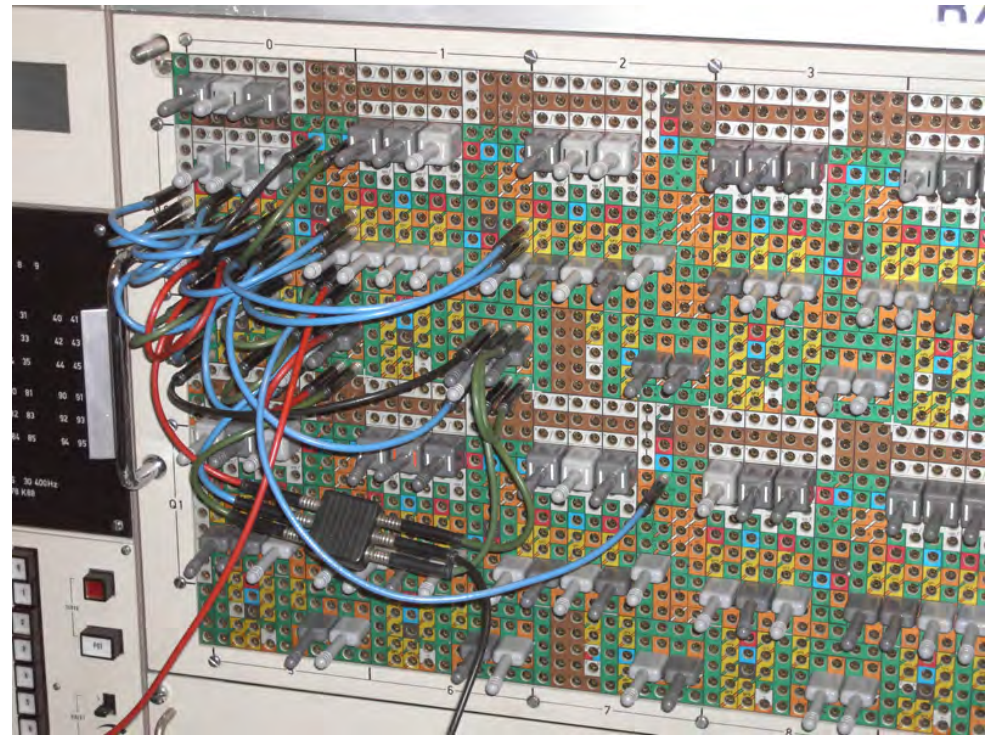
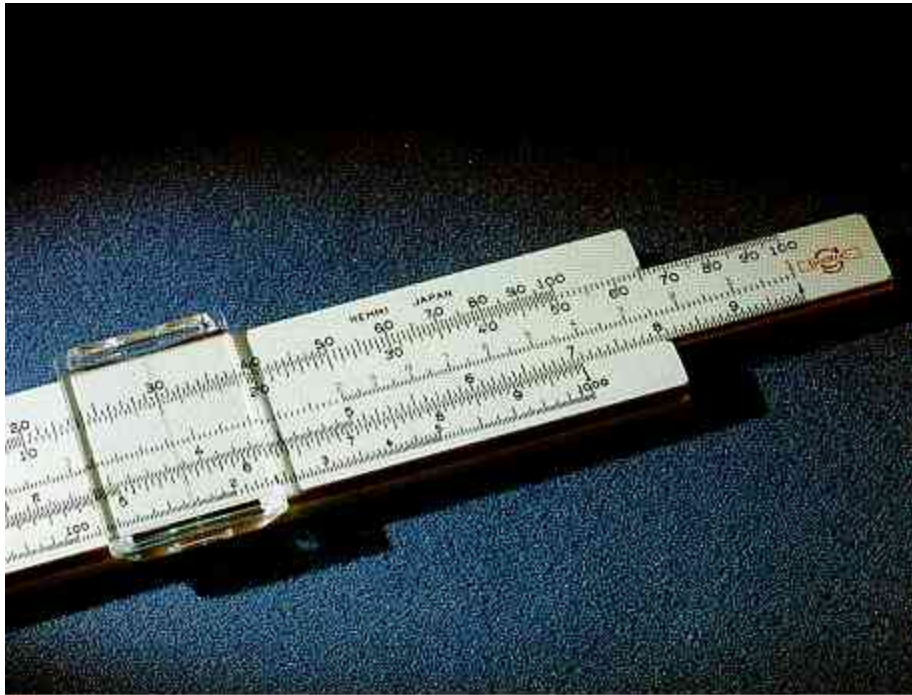
- Inventor of ANALOG COMPUTERS for solving complex differential equations
- Engineering professor at Massachusetts Institute of Technology 1920-1939
- President of the Carnegie Institute of Washington, 1939-1955
- Director of the Office of Scientific Research and Development, 1940-1945
- Founding partner of Raytheon, director of Merck pharmaceuticals



Analog computers: Astrolabe



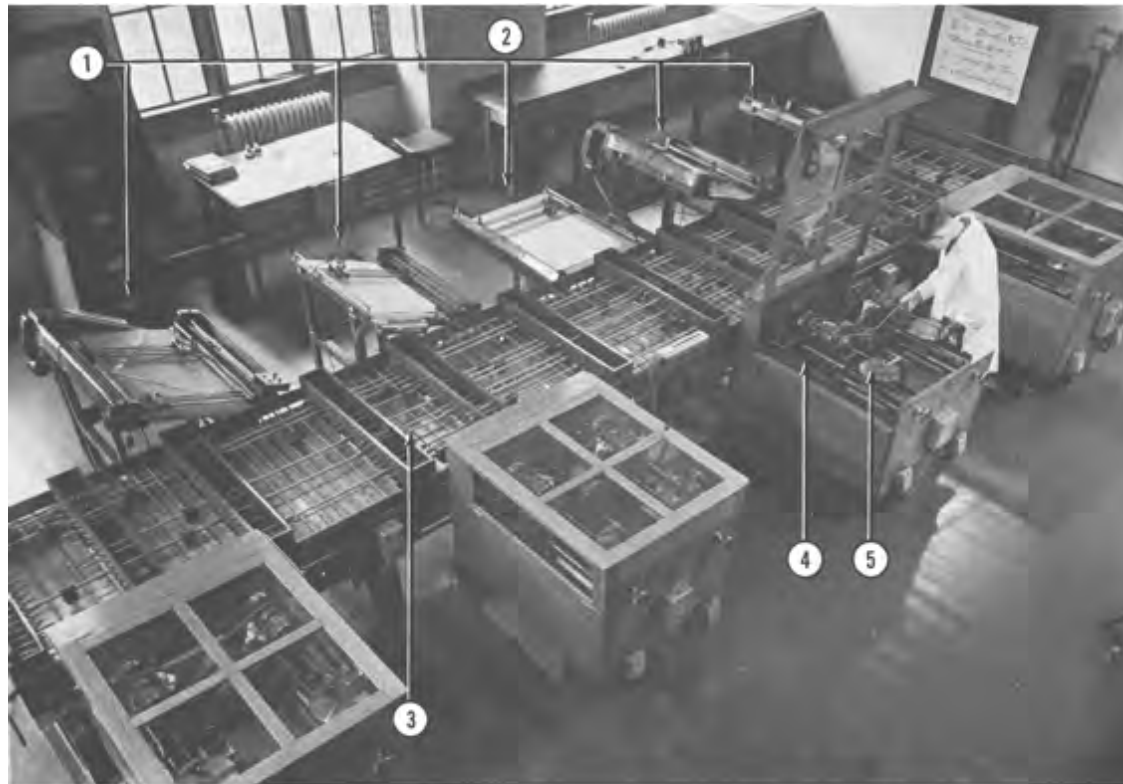
Analog computers: slide rule & electronic switchboards



Analog computers: Paris Metro



Differential Analyzer



1 Input table
2 Output table

3 Shafts and gears used
for interconnection

4 Torque amplifier
5 Integrator disk

Designed by Bush and Harold Hazen at MIT, 1928-31 for solving differential equations

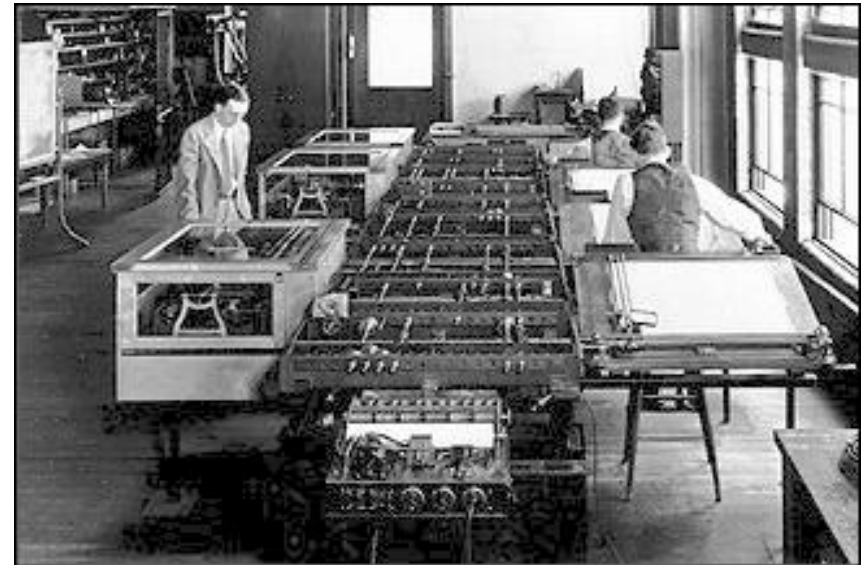
The picture is reproduced from IEEE Spectrum, July 1995

Found on http://www.science.uva.nl/museum/vbush_tbl.html

Differential Analyzer

Overall view of the Differential Analyzer.

The integrator units (six of them) are inside the wood and glass boxes at left, the bus rods which carry numerical information are in the center, and the input and output tables are at right. In the foreground is a numerical tabulator which converted shaft positions to printed numerical output. Samuel Caldwell is standing at left.



[from David A. Mindell website

<http://web.mit.edu/mindell/www/analyzer.htm>, no longer online]

Differential Analyzer

Operator's console of the Differential Analyzer, a literally "graphical" user interface. The operator (at left, Samuel Caldwell) manipulates a pointer by hand to follow the curves on the paper, which are then integrated or otherwise processed by the machine, which drives a plotter to make another graph as output. Vannevar Bush is looking on.

[from David A. Mindell website

<http://web.mit.edu/mindell/www/analyzer.htm>, no longer online]



The UCLA Differential Analyzer

- Commercial computer built by General Electric in 1947



- <http://www.computerhistory.org/revolution/analog-computers/3/143/2393>

Concept: A machine that solves complex problems

— Earth versus the Flying Saucers (1956)



Concept: A machine that miniaturizes and displays document

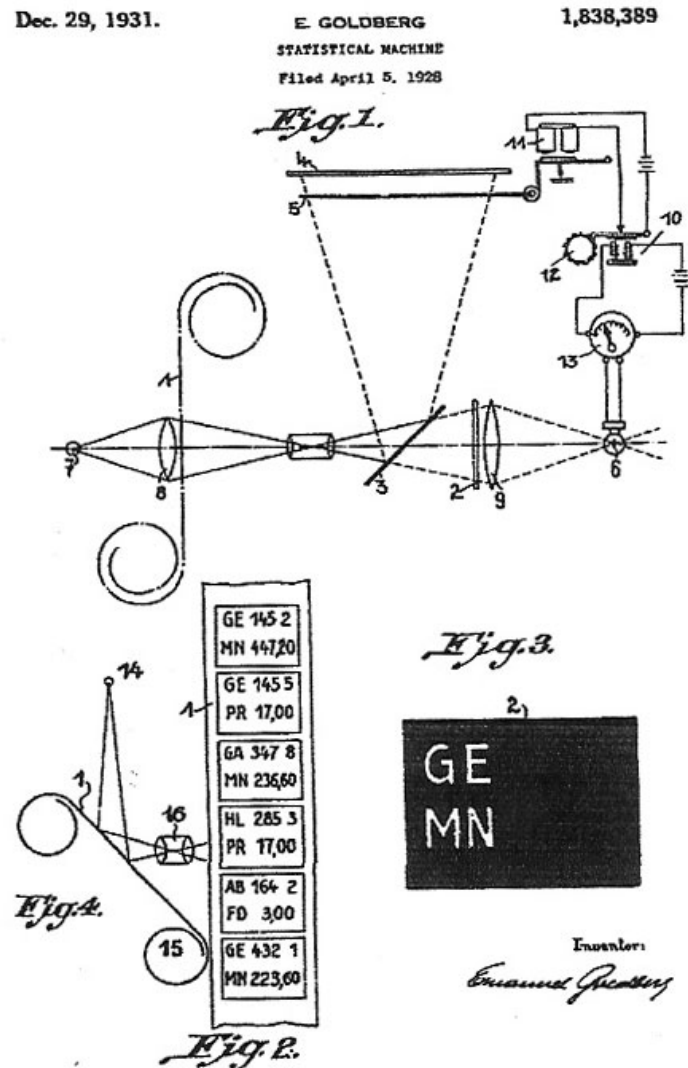
- **Emmanuel Goldberg** of Zeiss Ikon (Dresden) developed the first home-movie camera
- demonstrated high-density microfilm readers and selectors in Brussels (1931)
- Build a prototype microfilm “desk” for storing and retrieving documents

Emmanuel Goldberg's Statistical Machine (1931)

- Patent drawing for Goldberg's Statistical Machine
- See Emanuel Goldberg page

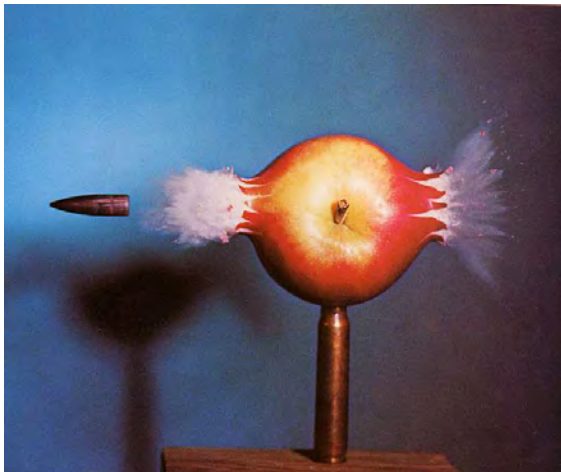


[http://www.berkeley.edu/~buckl
and/goldberg.html](http://www.berkeley.edu/~buckl
and/goldberg.html)



Concept: High-speed photography

- **Harold “Doc” Edgerton**’s stroboscope for high-speed photography could be used for precise control of light source and shutter speed
- 1931: Develops and perfects the stroboscope for use in ultra-high-speed and stop-motion photography. Forms a partnership with Kenneth Germeshausen, an MIT research affiliate to develop further uses for the stroboscope. Edgerton receives his D.Sc. in electrical engineering from MIT.



Concept: Miniaturization and duplication of knowledge

- **Herbert George (H.G.) Wells**, novelist, social commentator, science fiction writer: The Time Machine, The Invisible Man, War of the Worlds
- Fabian socialists and pacifist
- essay “The World Brain” (1937), an essay for the Encyclopédie Française, proposed that the libraries of the world would soon be available to everyone on reels of microfilm



(See https://sherlock.ischool.berkeley.edu/wells/world_brain.html)

Concept: Miniaturization and duplication of knowledge

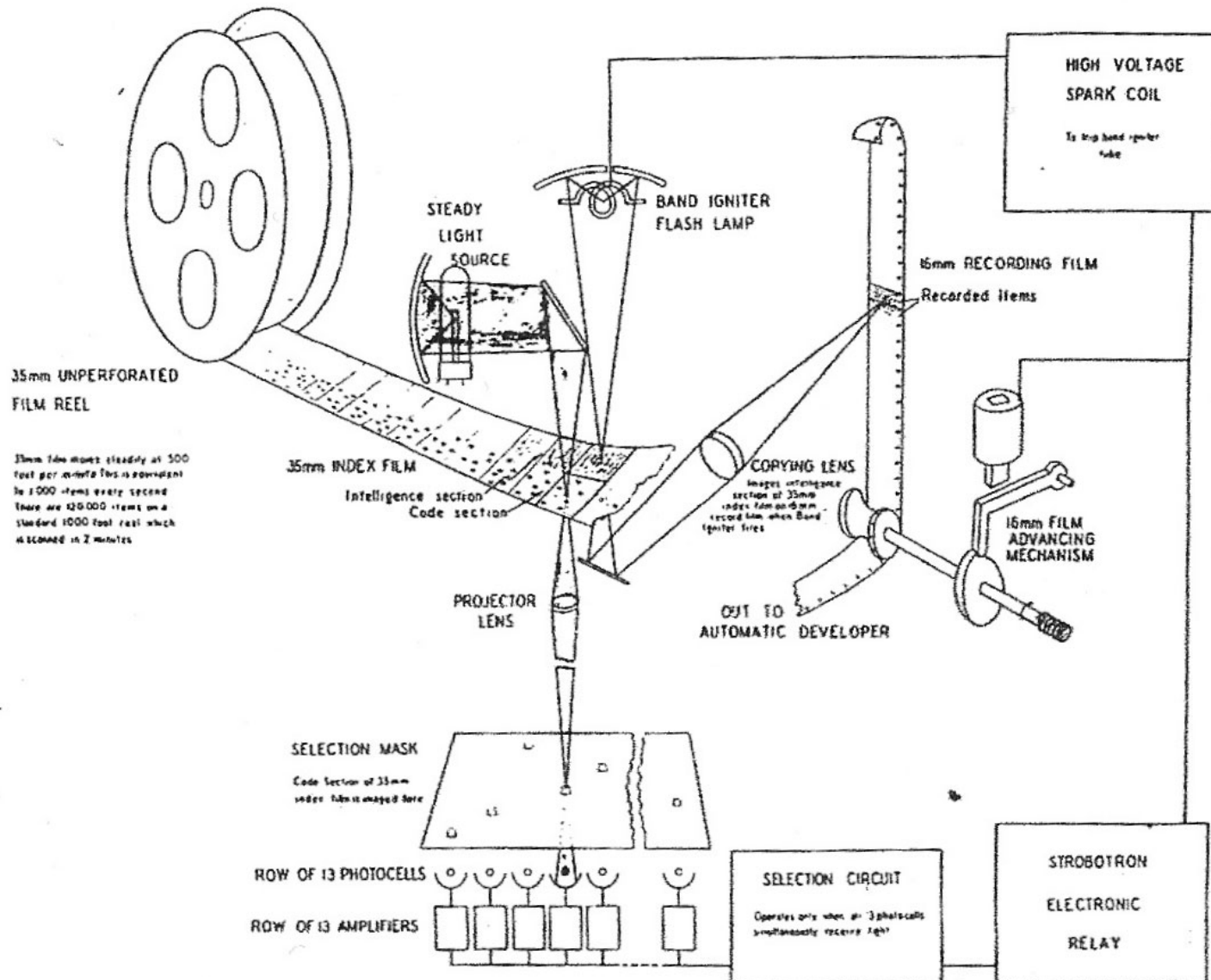
- **There is no practical obstacle whatever now to the creation of an efficient index to *all* human knowledge, ideas and achievements**, to the creation, that is, of a complete planetary memory for all mankind. And not simply an index; the direct reproduction of the thing itself can be summoned to any properly prepared spot. A microfilm, coloured where necessary, occupying an inch or so of space and weighing little more than a letter, can be duplicated from the records and sent anywhere, and thrown enlarged upon the screen so that the student may study it in every detail.

World Brain: The Idea of a Permanent World Encyclopaedia (1937)

Rapid Selector Concept (1930s)

- Sound-on-film development of composite 35mm film techniques throughout the 1920s
- Emmanuel Goldberg of Zeiss Ikon (Dresden) demonstrated high-density microfilm readers and selectors in Brussels (1931)
- Harold Edgerton's stroboscope (1931) for high-speed photography was used for rapid detection and re-photographing of coded frames.
- H.G. Wells essay "The World Brain" (1937) proposed that the libraries of the world would soon be available to everyone on reels of microfilm
- Chester Carlson's (1938) combination of electrostatic printing and photography (xerography) to capture pages on film

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”

Publication of “As We May Think” (summer, 1945)

- Bush writes “Mechanization and the Record” in 1939 and files it away
- The machine he describes as the **Memex** (memory extender) is a microfilm rapid selector miniaturized into a desk
- Features he imagines include projection of pages onto dual screens, photo annotation, xerographic input and recording trails between documents
- He mentions a machine to translate voice into text (**Vocoder**) and a forehead-mounted miniature camera (**Walnut camera**) to permit “hands-free” photographic recording in the laboratory



A SCIENTIST OF THE FUTURE RECORDS EXPERIMENTS WITH A TRAY CAMERA FITTED WITH UNIVERSAL-FOCUS LENS. THE SMALL SQUARE IN THE EYEGLASS AT THE LEFT SHOWS THE OBJECT

AS WE MAY THINK

A TOP U. S. SCIENTIST FORESEES A POSSIBLE FUTURE WORLD
IN WHICH MAN-MADE MACHINES WILL START TO THINK

by VANNEVER BUSH

DIRECTOR OF THE OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT
Condensed from the Atlantic Monthly, July 1945

This has not been a scientists' war; it has been a war in which all have had a part. The scientist, buying their old professional competition in the domain of a common cause, have shared greatly and learned much. It has been exhilarating to work in effective partnership. What are the scientists to do next?

For the biologist, and particularly for the medical scientist, there can be little indecision, for their war work has hardly required them to leave the old paths. Many indeed have been able to carry on their war research in their familiar peacetime laboratories. Their objectives remain much the same.

It is the physicist who have been thrown most violently off stride, who have left academic pursuits for the making of strange destructive gadgets, who have done their part on the device that made it possible to raze back the enemy. They have worked in combined effort with the physicians of our allies. They have felt within themselves the stir of achievement. They have been part of a great team. Now one asks where they will find objectives worthy of their best.

There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear. Yet specialization becomes increasingly necessary for prog-

ress, and the effort to bridge between disciplines is correspondingly superficial.

Professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose. If the aggregate time spent in writing scholarly works and in reading them could be evaluated, the ratio between these amounts of time might well be startling. Those who conscientiously attempt to keep abreast of current thought, even in restricted fields, by doing and continuous reading might well shy away from an examination calculated to show how much of the previous month's efforts could be predicted on call.

Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it. This sort of catastrophe is undoubtedly being repeated all about us as truly significant attainments become lost in the mass of the inconsequential.

Publication has been extended far beyond our present ability to make real use of the record. The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent mass to the momentarily important item is the same as was used in the days of square-rigged ships.

But there are signs of a change as new and powerful instrumentalities come into use. Photocells capable of seeing things in a physical sense, advanced phonography which can record what is seen or even what is not, thermionic tubes capable of controlling power forces under the guidance of

Concept: A machine that extends memory

- Consider a future device **for individual use**, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an **enlarged intimate supplement to his memory**.

It consists of a desk, and while it can presumably be operated from a distance, it is primarily the piece of furniture at which he works. On the top are slanting translucent screens, on which material can be projected for convenient reading. **There is a keyboard, and sets of buttons and levers.** Otherwise it looks like an ordinary desk.

Concept: Literature accessed and linked by a machine

- Wholly new forms of encyclopedias will appear, ready made with a mesh of **associative trails** running through them, ready to be dropped into the memex and there amplified. **The lawyer** has at his touch the associated opinions and decisions of his whole experience, and of the experience of friends and authorities. **The patent attorney** has on call the millions of issued patents, with familiar trails to every point of his client's interest. **The physician**, puzzled by a patient's reactions, strikes the trail established in studying an earlier similar case, and runs rapidly through analogous case histories, with side references to the classics for the pertinent anatomy and histology. **The chemist**, struggling with the synthesis of an organic compound, has all the chemical literature before him in his laboratory, with trails following the analogies of compounds, and side trails to their physical and chemical behavior.

Concept: navigational links as trails

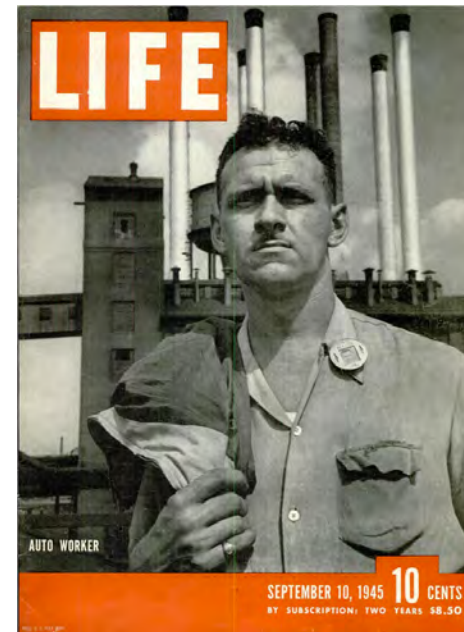
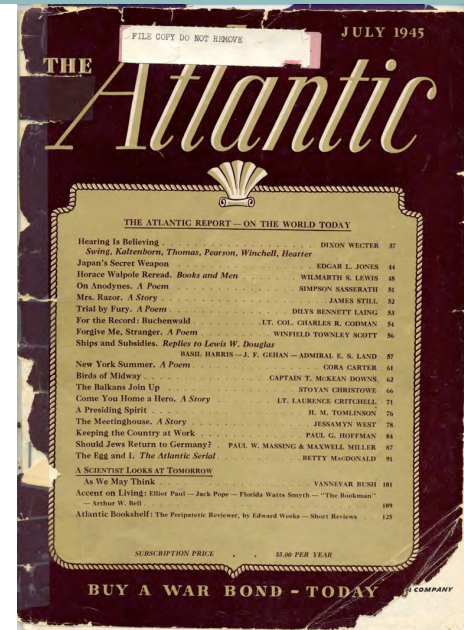
- The historian, with a vast chronological account of a people, parallels it with a **skip trail** which stops only on the salient items, and can follow at any time **contemporary trails** which lead him all over civilization at a particular epoch. There is a new profession of **trail blazers**, those who find delight in the task of establishing useful trails through the enormous mass of the common record. The inheritance from the master becomes, not only his additions to the world's record, but for his disciples the entire scaffolding by which they were erected.

Illustrations for As We May Think (1945)

- The essay is published in July 1945 in *The Atlantic Monthly*



- An illustrated version of the essay appeared in *LIFE* Magazine in September 1945



As We May Think on the web today

- Atlantic Monthly version
<http://www.theatlantic.com/magazine/archive/1969/12/as-we-may-think/3881/>
- LIFE version: Google Books
<https://books.google.com/books?id=uUkEAAAMBAJ&lpg=PA136&dq=LIFE+september+1945&pg=PA112&hl=fr#v=onepage&q=LIFE%20september%201945&f=false>

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"FIRST in FUDGE"
Fudge

Welch's
WEELCH'S

FORGETFUL?
A HOCKETT REMINDER SYSTEM...
ROBINSON REMINDERS
Wichfield Mass.

INDEX is the term of a book which instantly brings this and that material to eye relief on the operator's fingertips. Slating transparent viewing screens suggests appreciation that by code numbers. As left as a mechanism which automatically photographs longhand notes, pictures and books, then this does it in the dark, by flash release.

AS WE MAY THINK CONTINUED

index. Any given book of his library can thus be called up and consulted with far greater facility than if it were taken from a shelf. As he has several projection positions, he can take one item in position while he calls up another. He can add marginal notes and comments, taking advantage of one possible type of dry photography, and it could even be arranged so that he can do this by a stylus scheme, such as is now employed on the videotape seen on railroad waiting screens, say, just as though he had the physical page before him.

**BUILDING "TRAILS" OF THOUGHT ON THE MEMEX—
UNLIKE MEMORY, THEY WOULD NEVER FADE**

All this is conventional, except for the projection forward of present-day mechanisms and gadgetry. It affords an immediate reply, however, to associative mulling, the basic idea of which is a provision whereby any item may be caused at will to select another immediately and automatically. This is the essential feature of the memex. The process of tying two items together is the important thing.

When the user is building a trail, he names it, inserts the name in his code book and taps it out on his keyboard. Before him are the two items to be joined, projected onto adjacent viewing positions. At the bottom of each there are a number of manual levers and a pointer is set to indicate one of these on each item. The user taps a single key and the items are permanently joined. In each code space appears the code word. Out of view, but also in the code space, is material set of data for photostatic viewing; and on each item these data by their positions designate the index number of the other item.

Thereafter, at any time, when one of these items is in view, the other can be instantly recalled merely by tapping a button below the corresponding code space. Moreover, when numerous items have been thus joined together to form a trail, they can be reviewed in runs, rapidly or slowly, by deflexing a lever like that used for turning the pages of a book. It is exactly as though the physical items had been gathered together from widely separated sources and bound together to form a new book. It is more than this, for any item can be joined into numerous trails.

The owner of the memex, let us say, is interested in the origin and properties of the bow and arrow. Specifically he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the Crusades. He has dozens of possibly pertinent books and articles in his memex. First he runs through an encyclopedic, finds an interesting but sketchy article, leaves it occasionally. Next, in a history, he finds another pertinent item and ties the two together. 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. When it becomes evident that the elastic properties of available materials had a great deal to do with the bow, he branches off a side trail which takes him through textbooks on elasticity and tables of physical constants. He inserts a page of longhand analysis of his own. Thus he builds a trail of his interest through the mass of materials available to him.

And his trails do not fade. Several years later, his talk with a friend runs to the quer wars in which a people resist innovations, even of vital interest. He has an example in the fact that the con-

**You'll Always
Look Smarter in a
Paris Garter**

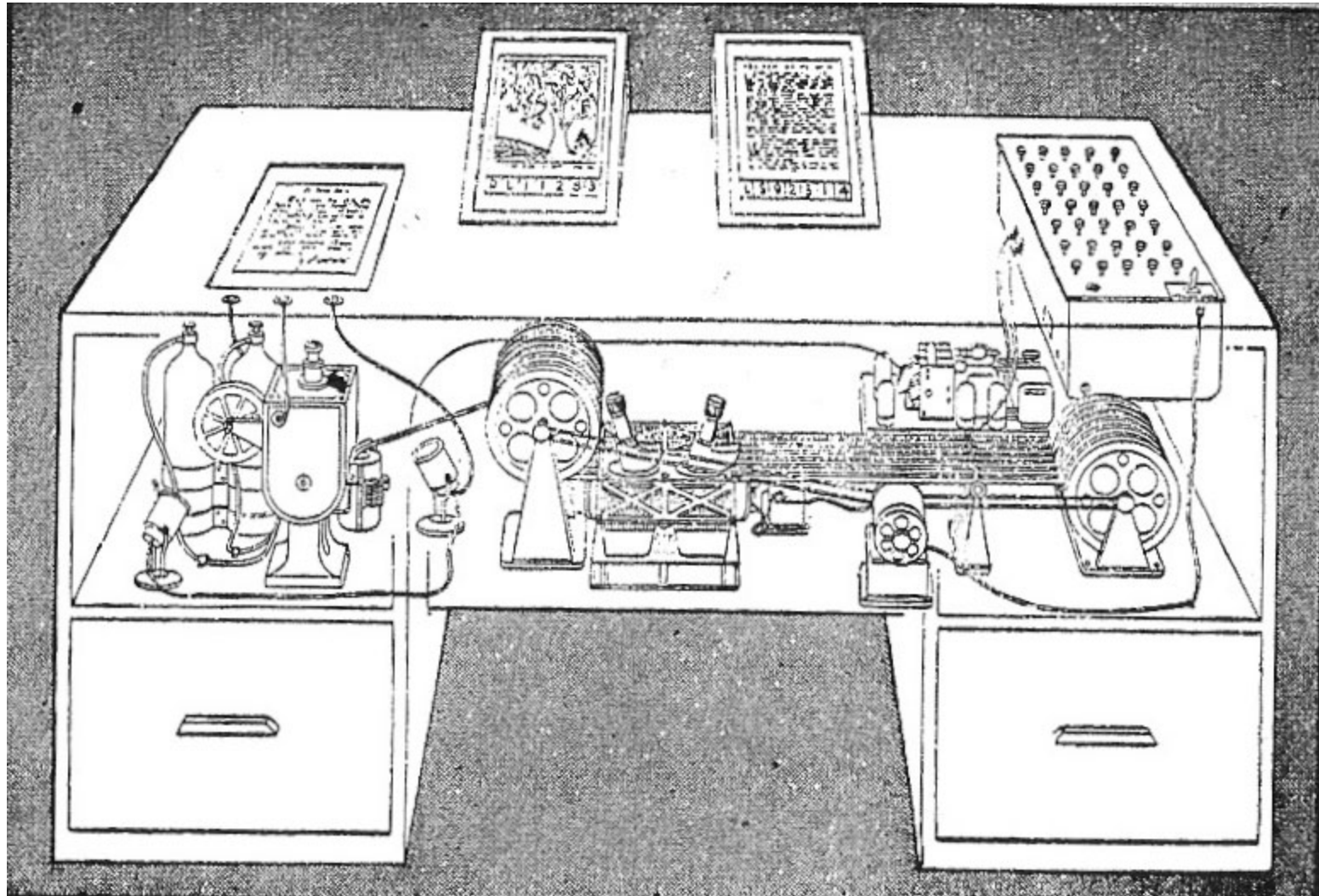
● Depend on Paris to put the stretch back in your garters.
Here are All Elastic Paris Garters—the same fine quality you insist on—many new patterns and colors that you prefer. Wear garters for style—wear Paris for comfort. You will find them at five stores every where at \$50 and \$1.00.
● Also wear smart Paris Socks at \$1 and All Elastic Free-Swinging Suspenders \$1.50 to \$2.50. A. Star & Company, Chicago. New York, Los Angeles.
You can trust Paris—a dependable trade mark that has stood the test of time.

PARIS
GARTERS
NO HAT CAN TOUCH YOU

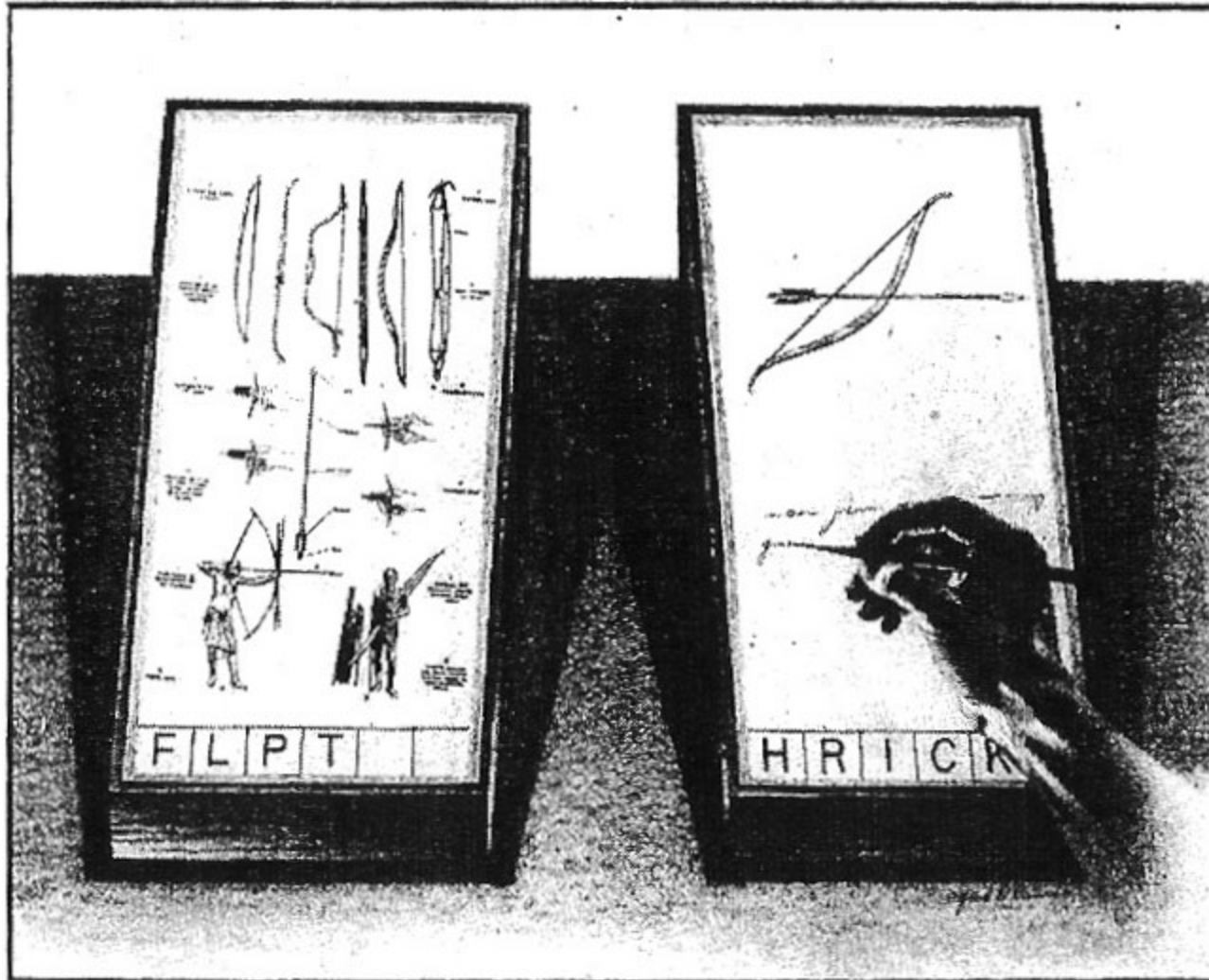
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Memex (illustration by Alfred Crimi)



Annotating on the screen (illustration by Alfred Crimi)



- Memex animation (1995) : <http://www.youtube.com/watch?v=c539cK58ees>
- Bush speaking about the brain and machines:
<http://www.youtube.com/watch?v=iAUC7Q8C6m8>



Vannevar Bush Legacy

- Bush ends his post-war governmental career as the founder of the National Science Foundation (NSF)
- Rapid Selectors built in the 1950s and 1960s for the Library of Congress, Department of Navy, Central Intelligence Agency all fail to operate properly.
- “As We May Think” influences the work of J.C.R. Licklider, Ted Nelson and Douglas Engelbart
- “As We May Think” is reprinted and taught in Information (Library) Science from 1960s onward.
- Computer Science Hypertext research literature refers to Bush’s essay as the earliest example of hypertext concept, starting in the 1980s.