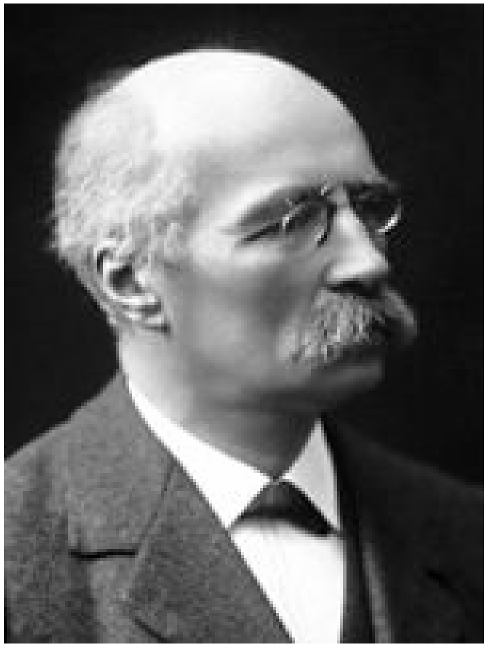
Eugene Garfield and John Desmond Bernal at the 1958 International Conference on Scientific Information, Washington DC.

Ralph Shaw

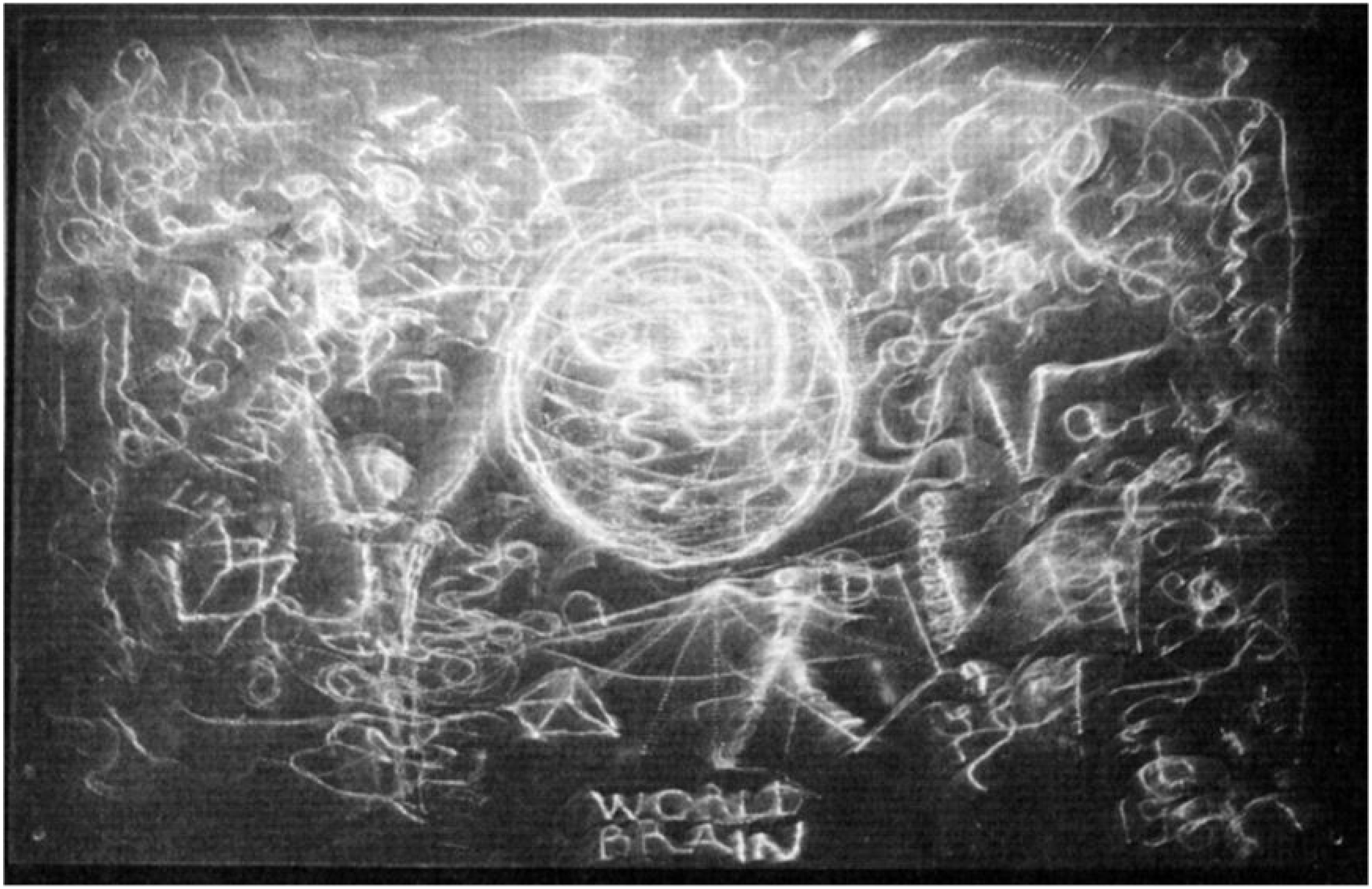
James Murray Luck

Cyril Cleverdon on the left

Paul Otlet

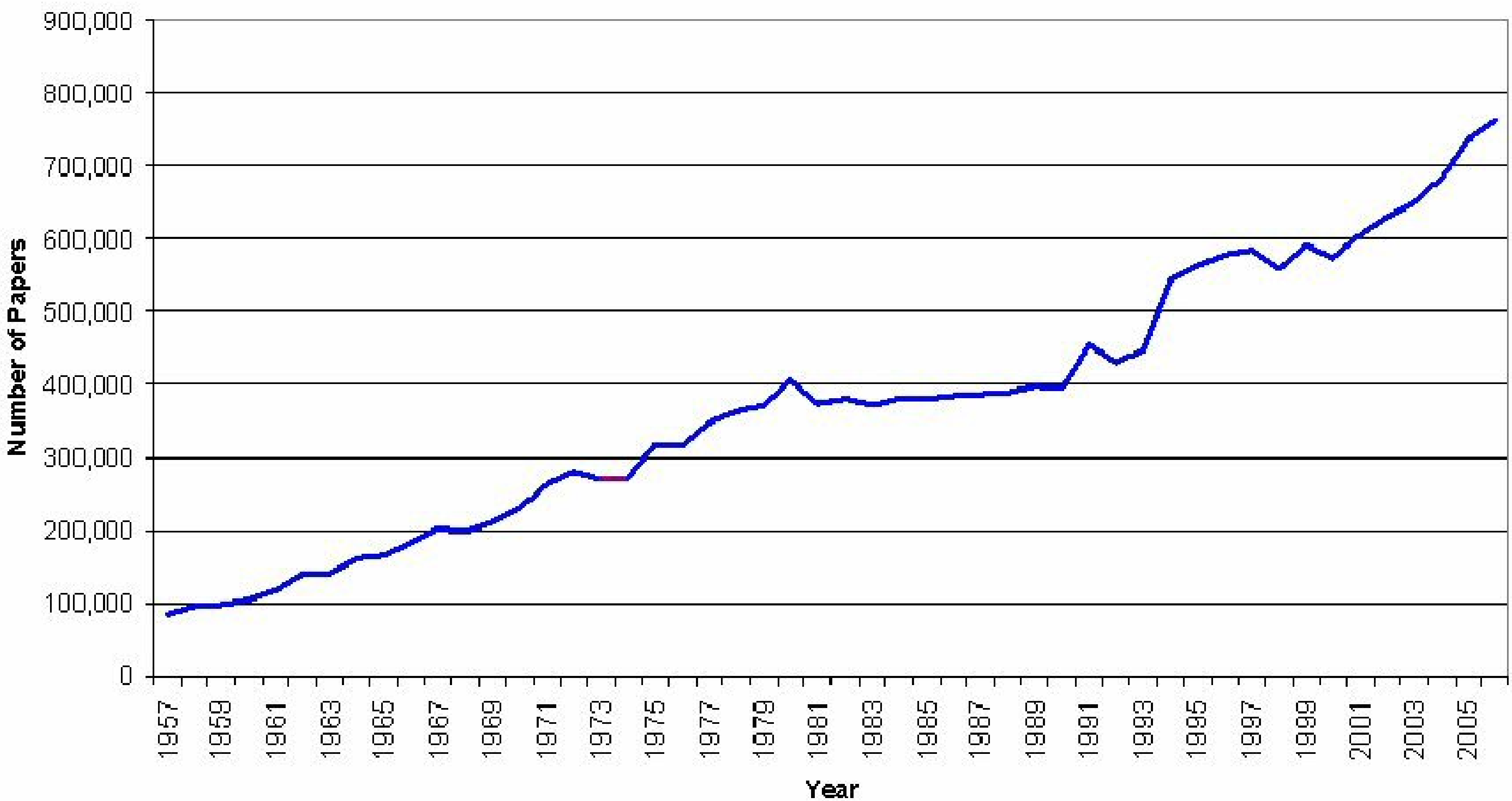


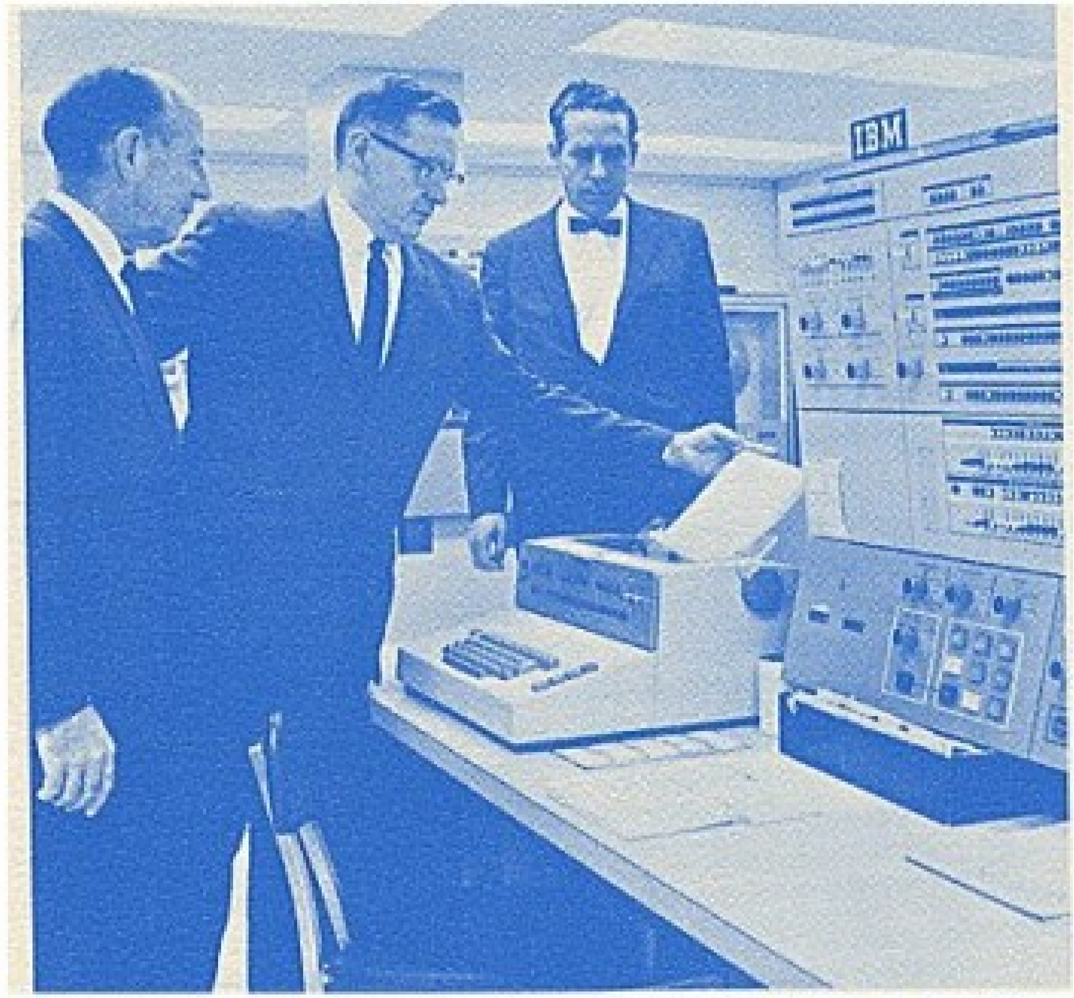
Henri La Fontaine



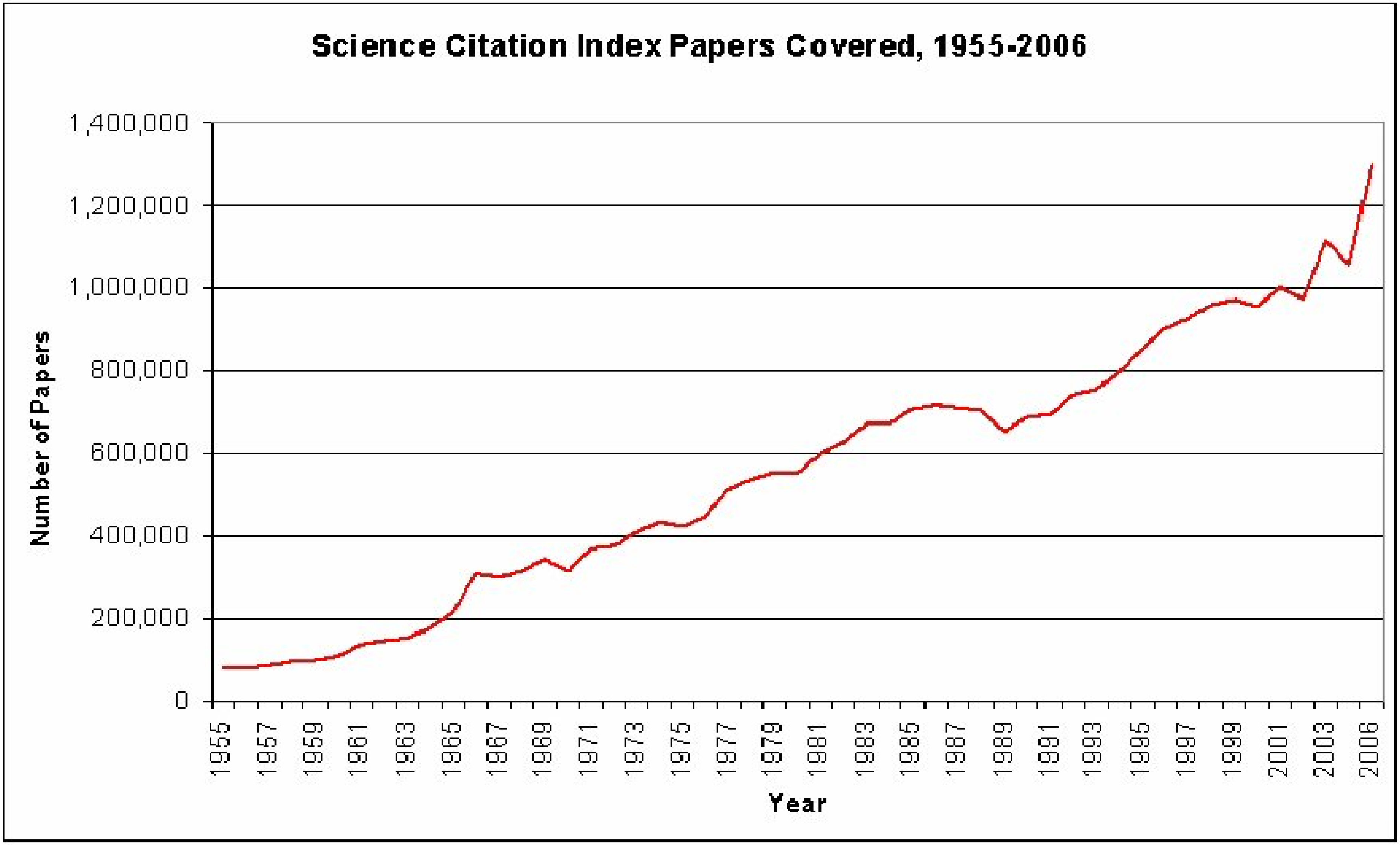
World Brain by Gabriel Lieberman
1980. Engraved aluminum alloy plate. 30” H x 48” W
Chemical Heritage Foundation, Philadelphia

Chemical Abstracts Number of Papers Covered, 1957-2006





Dr. Milton Harris, ACS Board Chairman, Dr. Fred Tate, Assistant Director and Dale Baker, CAS Director (left to right) inspect the IBM 360/40 computer at CAS's Columbus Office.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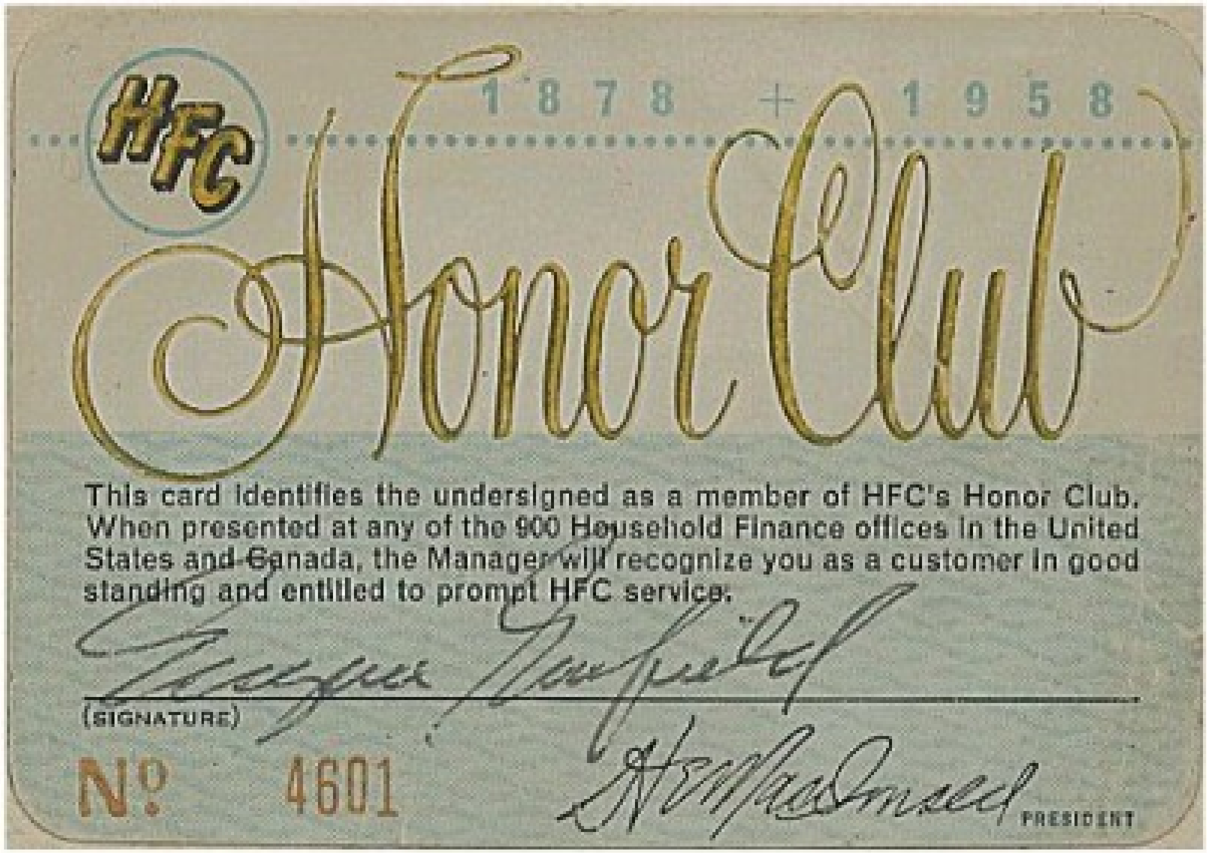
Year

Eugene Garfield and Derek DeSolla Price


Eugene Garfield outside the Log Cabin in New Jersey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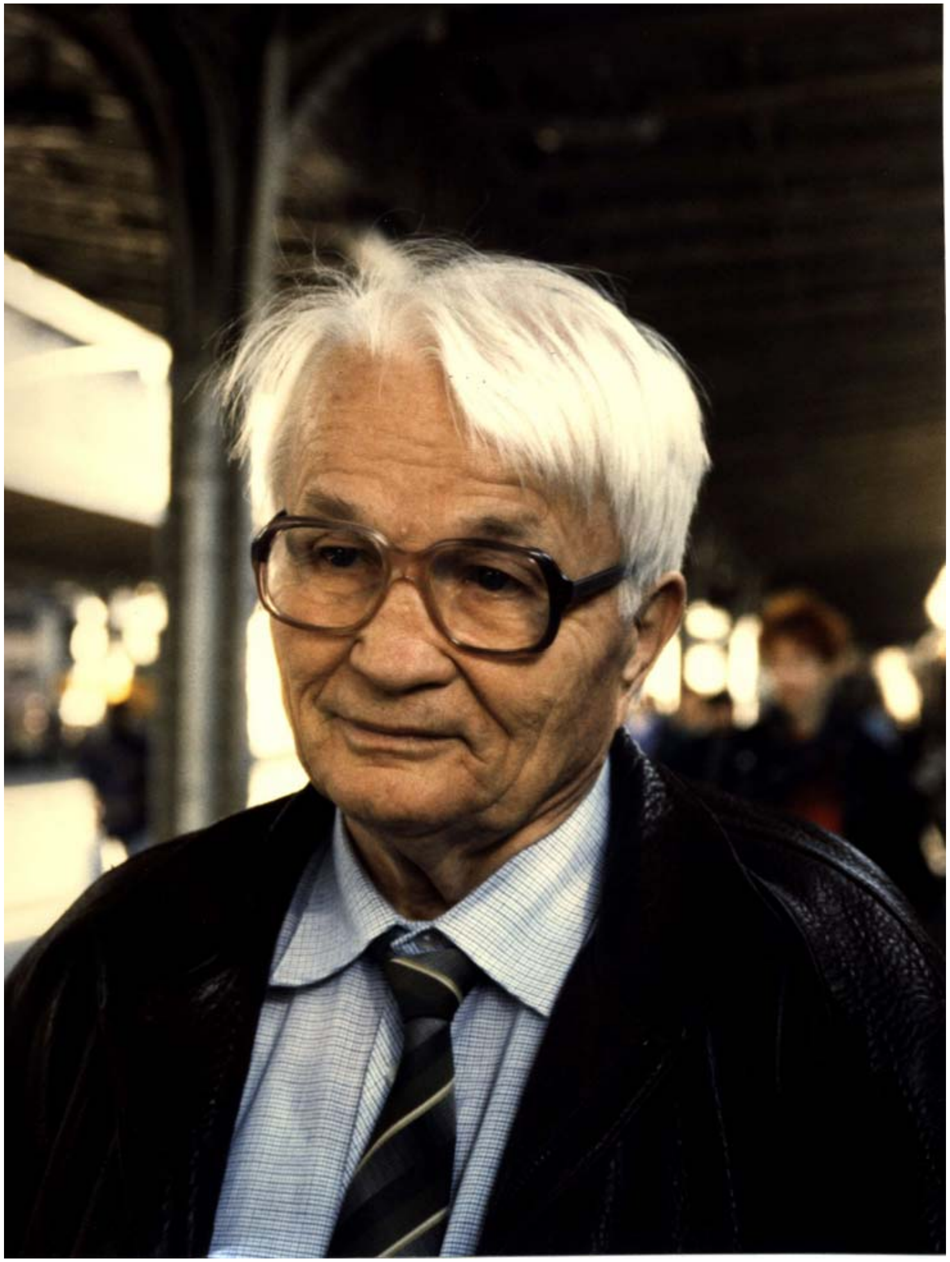
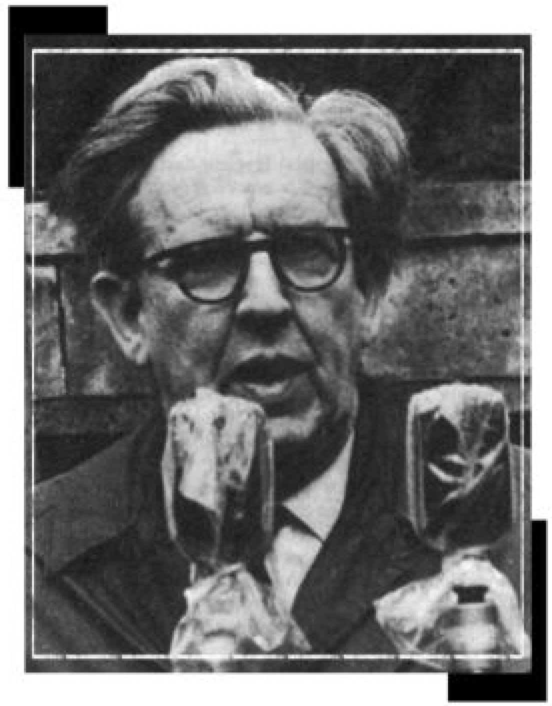


V.V. Nalimov



John Desmond Bernal

Robert K. Merton, Harriet Zuckerman and Eugene Garfield, 1982

Thomas Samuel Kuhn

Science, Government, and Information

The Responsibilities of the Technical Community and the Government in the Transfer of Information

A Report of
The President's Science Advisory Committee

The White House
January 10, 1963

CC/NUMBER 32
AUGUST 12, 1991

This Week's Citation Classic ®

Weinberg A M. Criteria for scientific choice. *Minerva* 1:159-71, 1963.
[Oak Ridge National Laboratory, TN]

I suggest a set of criteria according to which the merit of a proposed scientific enterprise might be judged. The criteria are classified as *internal,* arising from within the relevant science, or external, arising from outside the science that is being judged. Internal criteria include competence of the investigators and ripeness of the field for exploitation—i.e., the likelihood that the proposed research will reach its goal. External criteria include relevance to engineering and other applications, relevance to achievement of social goals, and relevance to the basic scientific fields in which the proposed undertaking is embedded. [This paper has been cited in more than 85 publications.]

Origins of Criteria for Scientific Choice

Alvin M. Weinberg
Oak Ridge Associated Universities
P.O. Box 117
Oak Ridge, TN 37831-0117

"Criteria for scientific choice" was first given in 1961 as an invited lecture, entitled "An Agenda for Science," at a meeting of the honorary society Phi Kappa Phi, at the University of Tennessee. The title "Criteria for scientific choice" was suggested to me by Edward Shils, editor of *Minerva.* At the time, I was a member of the President's Science Advisory Committee, as well as director, Oak Ridge National Laboratory. The paper was my attempt to come to grips with the central problem of scientific administration: the allocation of resources among competing scientific claimants, all of whose proposals are meritorious and are, epistemologically speaking, equally true. Thus, "Criteria" attempts to analyze the meaning of "value" in science. Traditionally, the philosophy of science is mostly concerned with epistemology—how do we decide that a given science is "true." Here I propose an "axiology" of science—how do we decide that a given scientific enterprise is valuable, more valuable than a competing scientific enterprise.

The proposed internal and external criteria are, with one exception, hardly original. The exception is my criterion of "scientific" merit. The scientific merit of a piece of basic science is to be judged by the influence that it has and the illumination it sheds on the neighboring fields of science in which it is embedded. This criterion of embeddedness represents an extension to empirical science of John von Neumann's criteria of merit for a purely mathematical discipline—the bearing it has on the surrounding mathematical discipline.[1] I am grateful to my late colleague, Eugene Guth, for calling my attention to von Neumann's idea.

"Criteria" appeared at the time that budgets for science were being increasingly squeezed. Administrators in government were hungry for advice as to how to allocate the scientific pie, and "Criteria" seemed to offer a rationale, if not a recipe, for making such judgments. A sort of cottage industry devoted to criticizing and improving the criteria has since sprung up among policy analysts.[2,3] Perhaps the main influence of "Criteria" was in the National Science Foundation's (NSF) *Information for Reviewers*: The four NSF criteria derive rather directly from the criteria set forth in the original *Minerva* article.

The organization of the scientific enterprise implicit in "Criteria" is a pyramid in which allocations are made at the top by government administrators.[4] In this sense, science is seen as being organized, more or less, by an intrusive government. This "socialist" view of science contrasts with Polanyi's *Republic of Science,* in which the course of science is determined by myriad independent scientific practitioners. The *Republic of Science* is free market and decentralized. My scientific enterprise is much more socialist and centralized. Actually, I would say that where Polanyi's democratic republic is a good model for Little Science, my socialistic republic applies more to Big Science.[5,6]

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CC/NUMBER 34
AUGUST 26, 1991

This Week's Citation Classic ®

Weinberg A M. Science and trans-science. *Minerva* 10:209-22, 1972.
[Oak Ridge National Laboratory, TN]

Predictions of rare events—for example, the estimate of the number of deleterious biological effects resulting from exposures to environmental insults at dose levels far below the levels at which effect can be seen—lie beyond the power of science. Such questions, which are isomorphic with questions that can be answered by science, are designated as "trans-scientific." Many of the most urgent policy issues, particularly the establishment of regulatory standards for exposure to low-level insult, involve trans-scientific, not scientific, questions. [The *SCI*® and the *SSCI*® indicate that this paper has been cited in more than 105 publications, making it the most-cited article published in this journal.]

Origins of Science and Trans-Science

Alvin M. Weinberg
Medical Sciences Division
Oak Ridge Associated Universities
Oak Ridge, TN 37831-0117

I coined the word "trans-science" at the time Oak Ridge National Laboratory was becoming involved in the debate over nuclear power—in particular the debate over the hazard of low levels of radiation. The public's exaggerated estimate of risk was at the root of the difficulties nuclear energy was facing.[1] If ever there was a trans-science question, this was it.

After the paper was published, Harvey Brooks added another dimension to "trans-science"—the evolution in time of systems governed by large classes of nonlinear equations. Poincaré was one of the first to stress that the ultimate behavior of such systems is sensitive to tiny perturbations in the initial conditions. Chaos is a manifestation of such Poincaré instabilities. Brooks suggested that an analysis of such situations was beyond the power of mathematics, and therefore, was trans-scientific.[2]

The term "trans-science" is used quite widely now. Perhaps most notable was W. Ruckelhaus's admission in 1985 that many of the EPA's regulations hang on the answers to questions that can be asked of science but cannot be answered by science—i.e., are trans-scientific.[3]

In this present Age of Anxiety, we have become a society of very healthy hypochondriacs. Although life expectancy in the West has increased by an astonishing 20 years during the twentieth century, we worry more than ever about small environmental insults that may be carcinogenic. That science cannot shed much light on the biological effects of low-level insult is gradually being recognized in many quarters. For example, W.G. Wagner concludes: "... in order to accommodate trans-science, the judicial framework must change.... Trans-scientific obstacles can be circumvented by referring to more predictable notions of qualitative causation and unreasonable conduct—(thus) the courts may be able to reincorporate the principle of deterrence into the adjudication of toxic torts."[4]

In addition to giving a name to an idea that regulators and toxic torts lawyers had been grappling with, "Science and trans-science" has added another dimension to the perennial quest for limits to science. To the limits of science posed by Heisenberg's uncertainty principle, or the second law of thermodynamics, or, in a different sense, by society's limited ability to support science, we now speak of a "trans-scientific" limit as a distinct philosophic category.

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Weinberg A M. Science and trans-science. *Minerva* 10:209-22, 1972.
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Origins of Science and Trans-Science

Alvin M. Weinberg
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Most Cited papers in *Minerva*

1. ZUCKERMA.H, MERTON RK
   Patterns Of Evaluation In Science - Institutionalisation, Structure And Functions Of Referee System
   MINERVA 9 (1): 66-100 1971
   Times Cited: 309

2. WEINBERG AM
   Science And Trans-Science
   MINERVA 10 (2): 209-222 1972
   Times Cited: 225

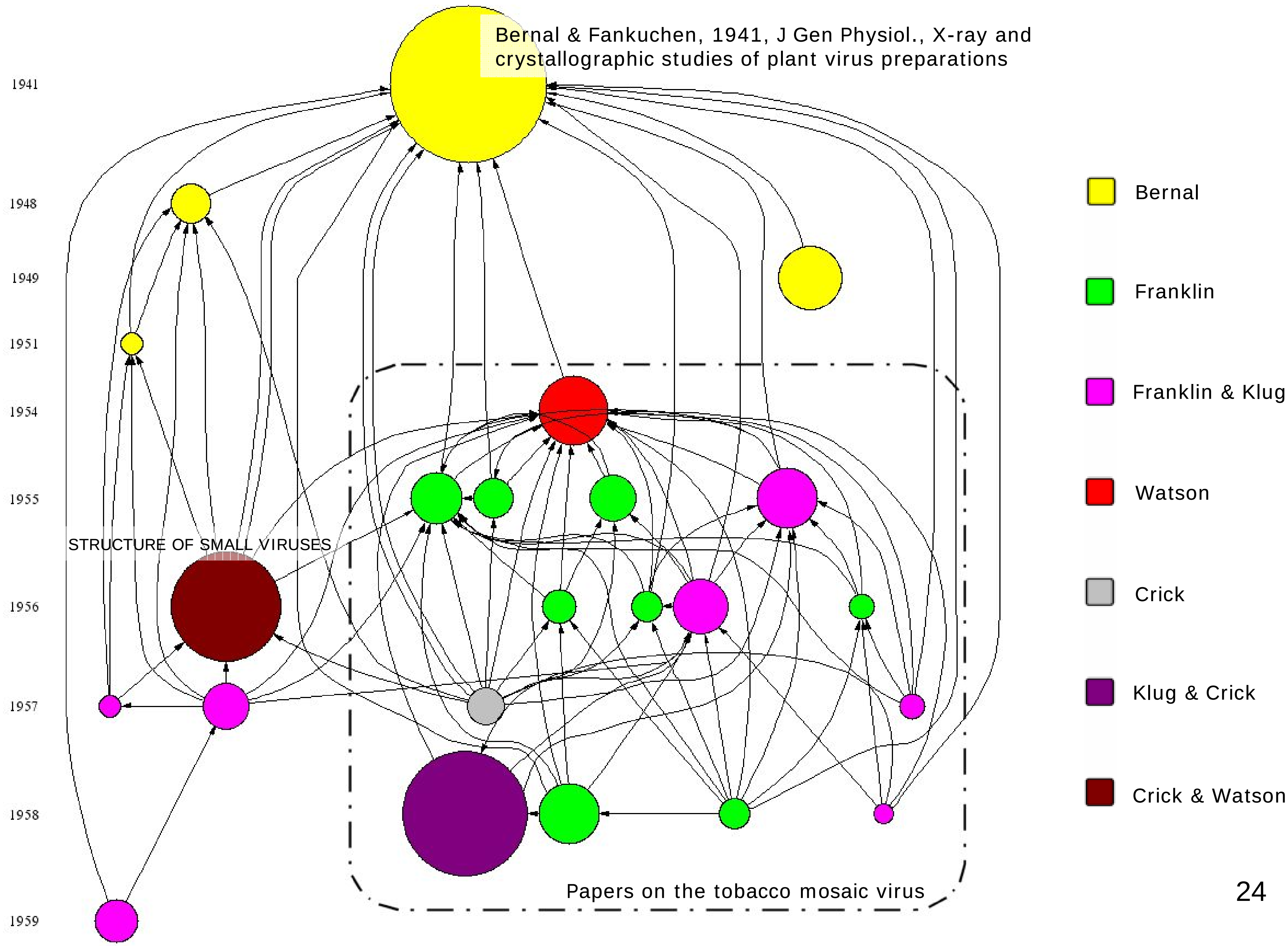
3. POLANYI M
   The Republic Of Science – It's Political And Economic-Theory
   MINERVA 1 (1): 54-73 1962
   Times Cited: 141

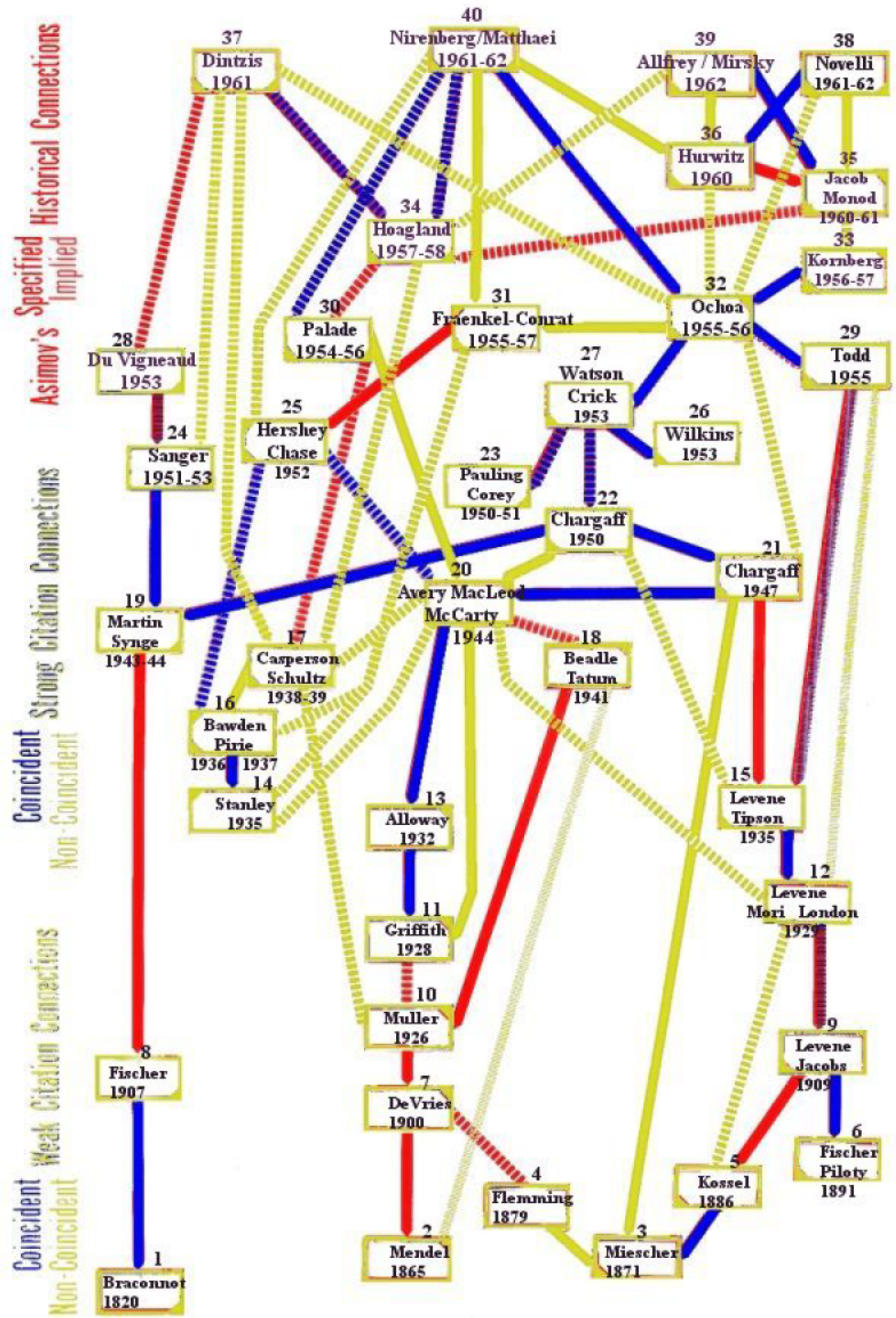
4. MULLINS NC
   Development Of A Scientific Specialty - Phage Group And Origins Of Molecular Biology
   MINERVA 10 (1): 51-82 1972
   Times Cited: 107

5. WEINBERG AM
   Criteria For Scientific Choice
   MINERVA 1 (2): 159-171 1963
   Times Cited: 105

6. ZUCKERMAN H, COLE JR
   Women In American Science
   MINERVA 13 (1): 82-102 1975
   Times Cited: 68

Historiograph showing connections between Bernal & Franklin et al.

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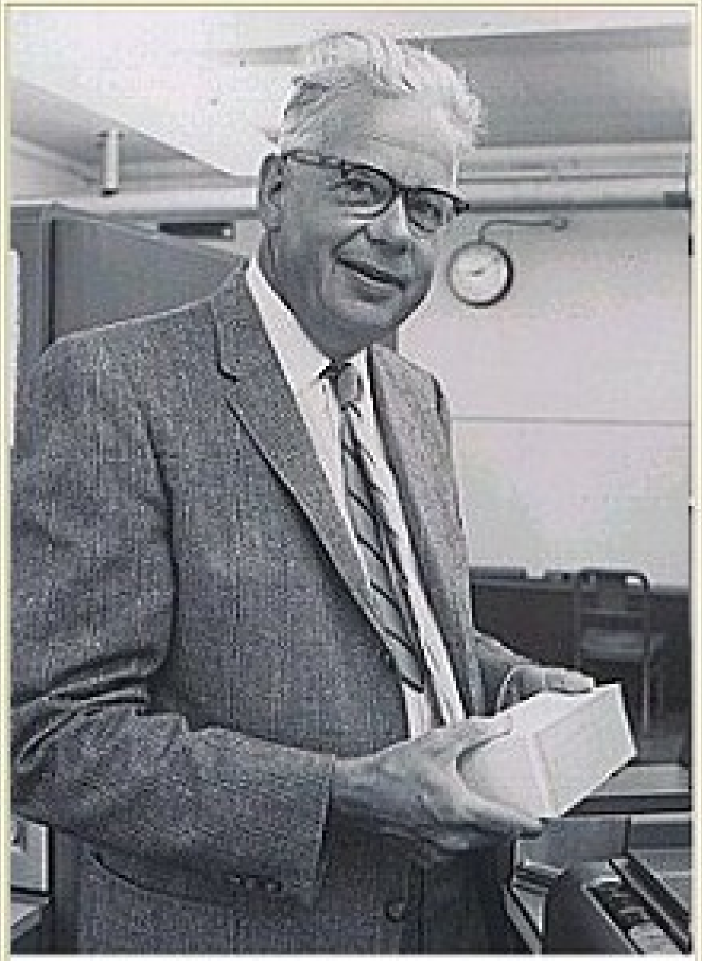
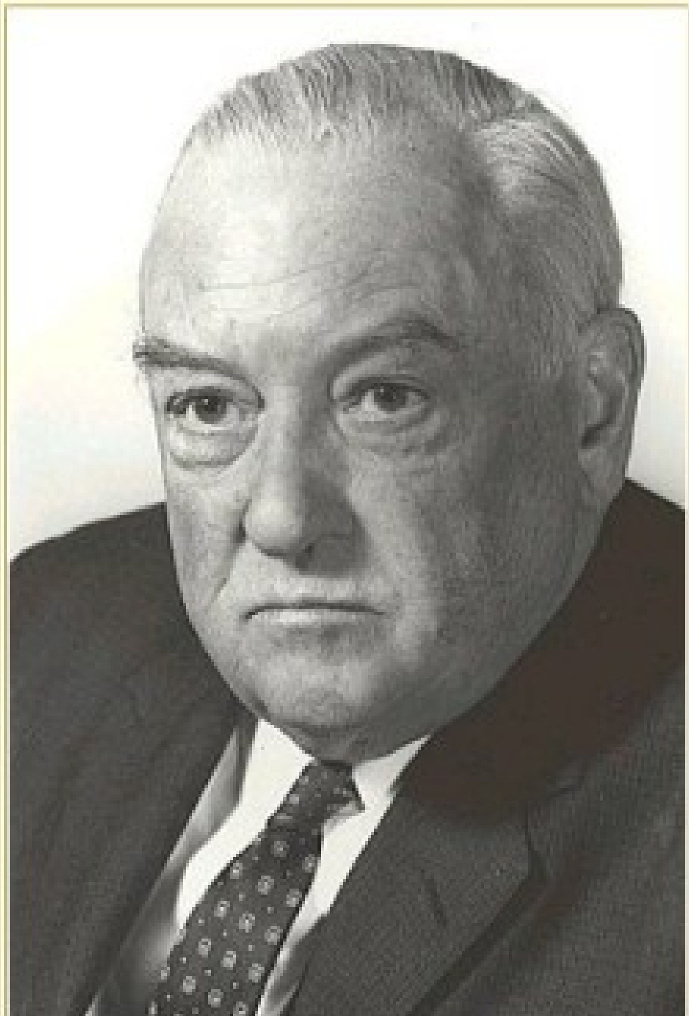
37 Dintzis 1961
39 Allfrey / Mirsky 1962
38 Novelli 1961-62
36 Hurwitz 1960
35 Jacob Monod 1960-61
34 Hoagland 1957-58
33 Kornberg 1956-57
32 Ochoa 1955-56
31 Fraenkel-Conrat 1955-57
30 Palade 1954-56
29 Todd 1955
28 Du Vigneaud 1953
27 Watson Crick 1953
26 Wilkins 1953
25 Hershey Chase 1952
24 Sanger 1951-53
23 Pauling Corey 1950-51
22 Chargaff 1950
21 Chargaff 1947
20 Avery MacLeod McCarty 1944
19 Martin Synge 1943-44
18 Beadle Tatum 1941
17 Casperson Schultz 1938-39
16 Bawden Pirie 1936 1937
15 Levene Tipson 1935
14 Stanley 1935
13 Alloway 1932
12 Levene Mori London 1929
11 Griffith 1928
10 Muller 1926
9 Levene Jacobs 1909
8 Fischer 1907
7 DeVries 1900
6 Fischer Piloty 1891
5 Kossel 1886
4 Flemming 1879
3 Miescher 1871
2 Mendel 1865
1 Braconnot 1820



James Perry

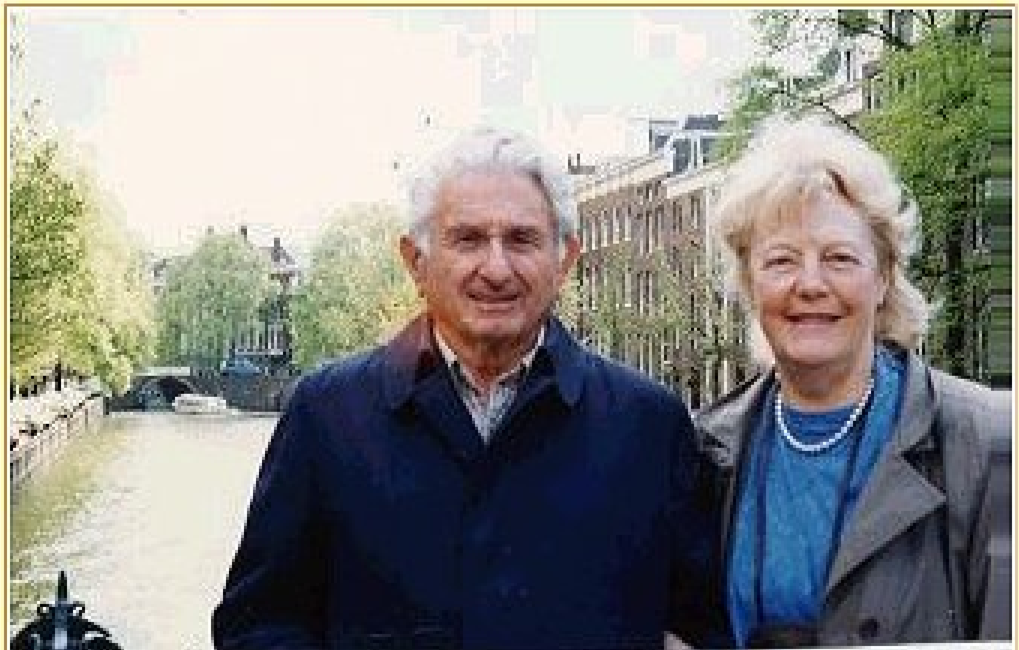


Sanford V. Larkey

Verner Clapp

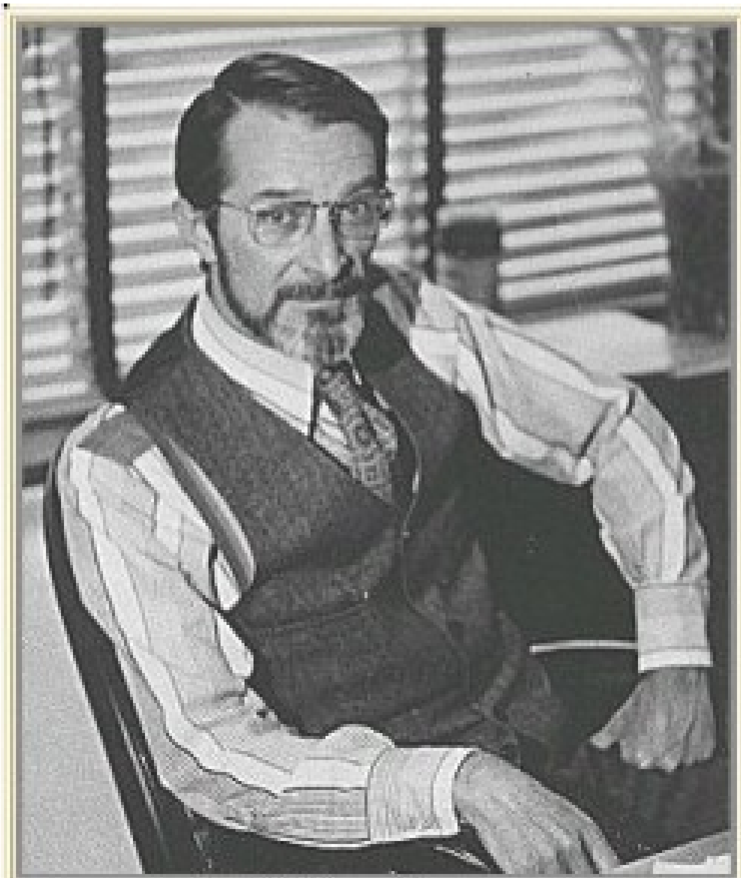
Early photo of
John Mauchly

Co-inventor of the Univac


Seymour Taine with Beryl Ruff

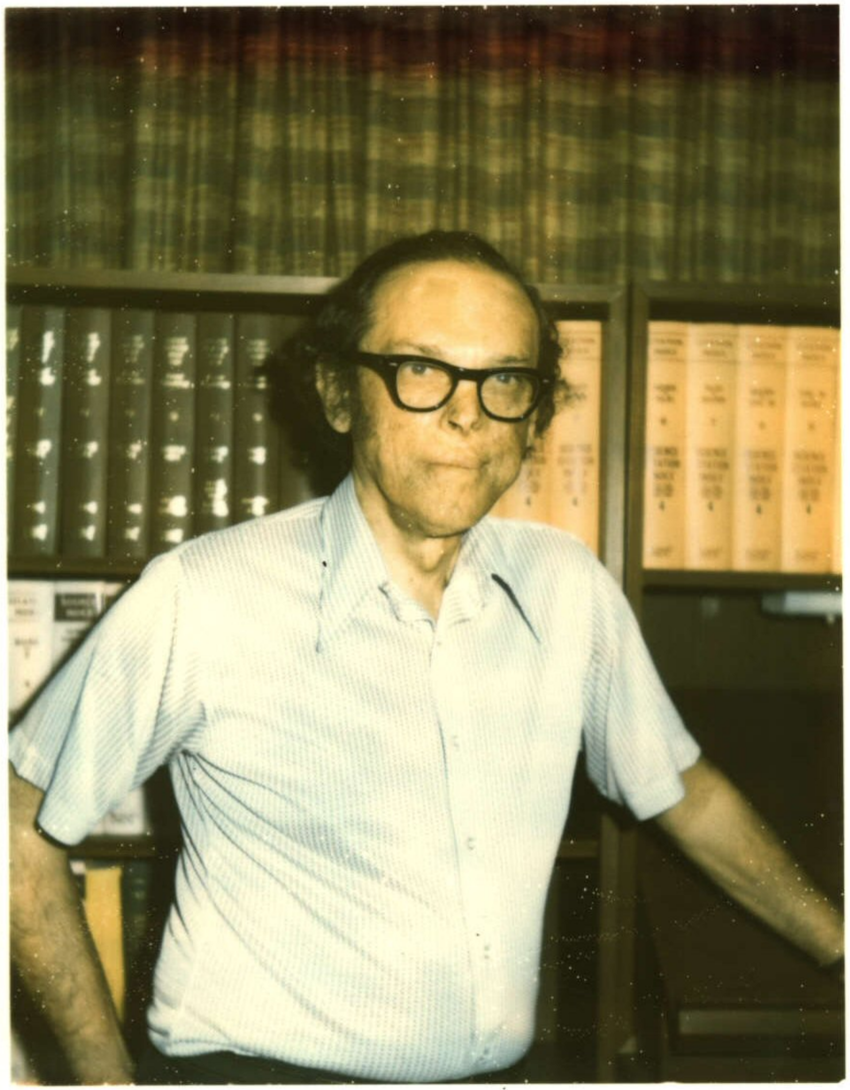
Editor of Index Medicus & Librarian of WHO

Medical Historian and Librarian



Robert Hayne

Associate Editor of Index Medicus



Sam Lazerow

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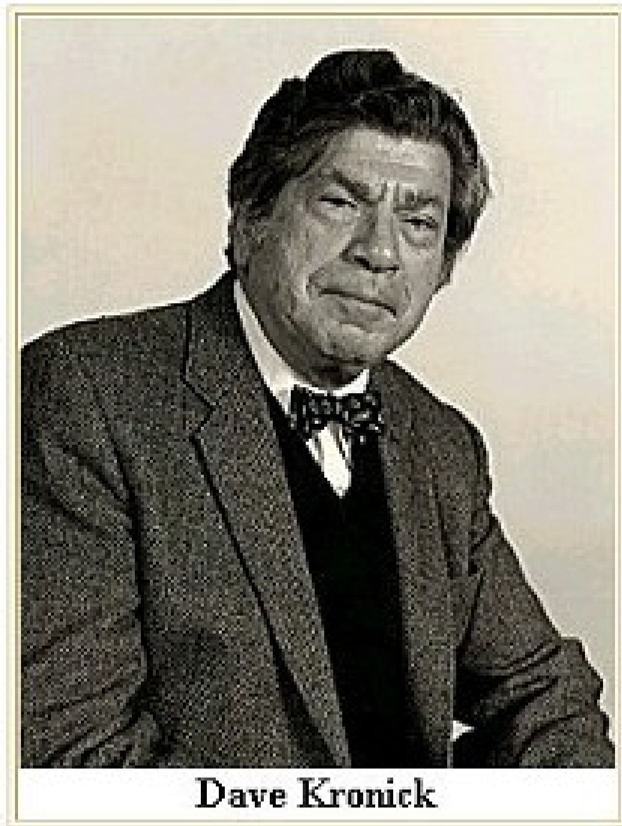
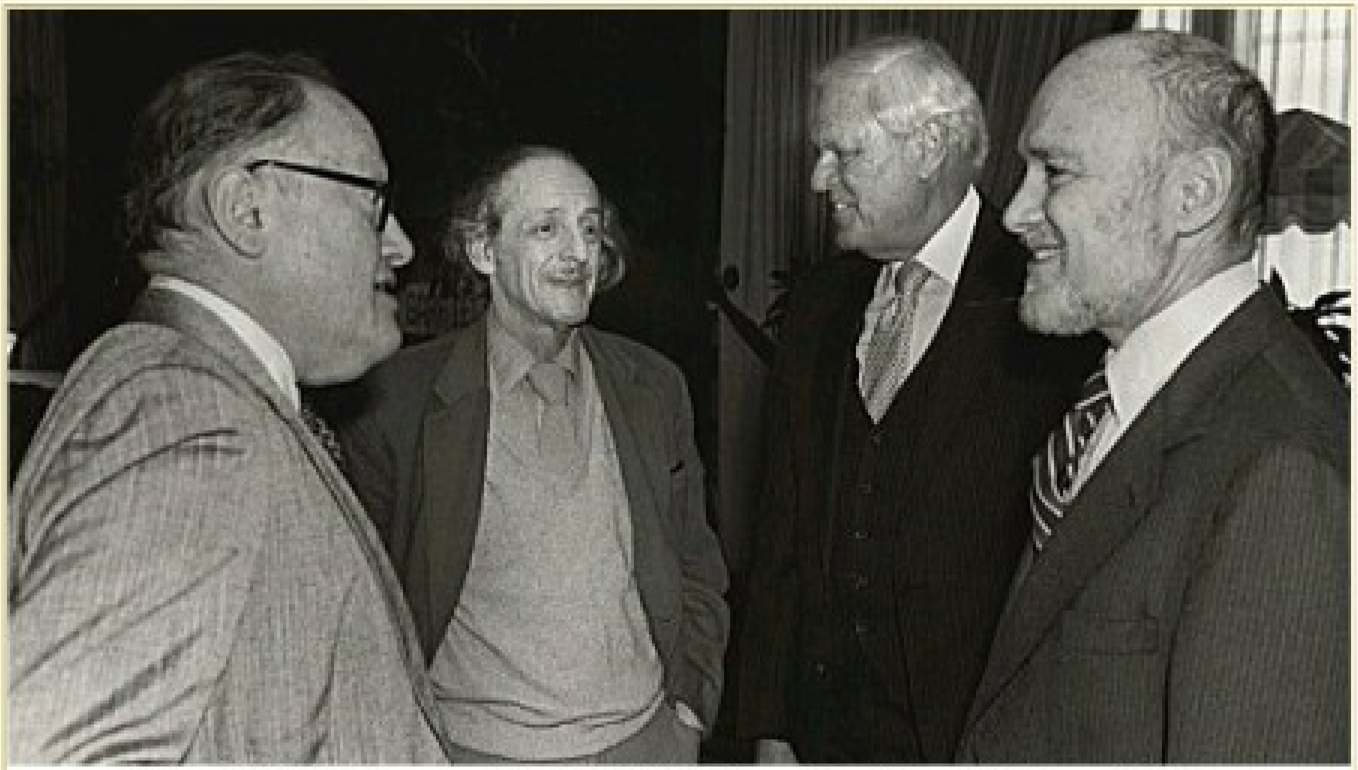


Medical Historian & Librarian



Arthur Seidel, Eugene Garfield, Kimber Vought and Irving H. Sher

Group including Irving Sher and Arthur Elias with Judy Leondar, Charles Bernier and Bob Maizel

Henry Small

Co-inventor of co-citation analysis

Bonnie Lawlor

Senior VP of ISI

Calvin Mooers