

# A Symposium of Large Scale Digital Calculating Machinery

Under the joint sponsorship of Harvard University and the Bureau of Ordnance, United States Navy, 336 representatives of university, industrial and government laboratories and research groups met in Cambridge, Mass. from January 7-10, 1947 to participate in a four-day Symposium on Large Scale Digital Calculating Machinery.

The meetings were held in Harvard's new Computation Laboratory and, in part, the Symposium celebrated the formal opening of this new facility.

In addition to the extensive group of technical papers, the program included a demonstration of the Automatic Sequence Controlled Calculator (usually referred to as the Mark I Calculator), and a preview of the Mark II Calculator which is now being assembled at Harvard for the Bureau of Ordnance. The latter machine will later be reassembled at the Dahlgren Proving Ground of the Navy.

The program of the Symposium was as follows:

## *I. Tuesday, 7 January, 10:00 a.m.*

Opening Addresses by

Edward Reynolds, Administrative Vice-President of Harvard University  
Rear Admiral C. T. Joy, USN, Naval Proving Ground, Dahlgren, Virginia  
Prof. H. H. Aiken, Technical Director of the Computation Laboratory, Harvard University

Inspection of the Computation Laboratory and of Mark II Calculator

## *II. Tuesday, 7 January, 2:00 p.m.*

Existing Calculating Machines, Prof. W. E. Bleick, Chairman

1. "The Work of Charles Babbage" by Mr. R. H. Babbage<sup>1</sup>
2. "Mark I Calculator" by Mr. R. M. Bloch
3. "Brief description and operating characteristics of the ENIAC" by Dr. L. P. Tabor
4. "Bell Telephone Laboratories relay computing systems" by Mr. S. B. Williams
5. "Mark II Calculator" by Mr. R. V. D. Campbell

## *III. Wednesday, 8 January, 9:30 a.m.*

The Logic of Large Scale Calculating Machines, Prof. W. H. Furry, Chairman

1. "Problems of mathematical analysis involved in machine computations" by Dr. A. W. Wundheiler
2. "The organization of large scale calculating machinery" by Dr. G. R. Stibitz

## *IV. Wednesday, 8 January, 2:00 p.m.*

Storage Devices, Dr. J. H. Curtiss, Chairman

1. "Mercury delay lines as a memory unit" by Dr. T. K. Sharpless
2. "Slow electromagnetic waves" by Prof. L. N. Brillouin
3. "High Speed electrostatic storage" by Mr. J. W. Forrester
4. "Magnetic and phosphor coated disks" by Dr. B. L. Moore
5. "The selectron—a tube for selective electrostatic storage" by Dr. Jan Rajchman
6. "Optical and photographic storage techniques" by Dr. A. W. Tyler

## *V. Thursday, 9 January, 9:30 a.m.*

Numerical Methods and Suggested Problems for Solution, Dr. Mina S. Rees, Chairman

1. "Method of finite differences for the solution of partial differential equations" by Prof. Richard Courant

2. "On computational techniques for certain problems in fluid dynamics" by Dr. R. J. Seeger
3. "Computational problems arising in connection with economic analysis of interindustrial relationships" by Prof. W. W. Leontief
4. "On the accumulation of errors in processes of integration on high speed calculating machines" by Prof. H. A. Rademacher
5. "Fluid mechanics computations" by Prof. H. W. Emmons
6. "Firing tables" by Dr. L. S. Dederick

*VI. Thursday, 9 January 2:00 p.m.*

Sequencing, Coding, and Problem Preparation, Prof. J. A. Stratton, Chairman

1. "Coding for large scale calculating machinery" by Dr. H. H. Goldstine
2. "Preparation of problems for EDVAC-type machines" by Dr. J. W. Mauchly
3. "The preparation of problems for large scale calculating machinery" by Mr. J. O. Harrison, Jr.

*VII. Friday, 10 January, 9:30 a.m.*

Input and Output Devices, Prof. E. L. Chaffee, Chairman

1. "Application of printing telegraph techniques to large scale calculating machinery" by Mr. F. G. Miller
2. "Some physical aspects of magnetic recording" by Mr. Otto Kornei
3. "The numeroscope" by Mr. H. W. Fuller
4. "Input and Output Devices for electronic digital calculating machinery" by Mr. S. N. Alexander
5. "An input device using multiple gates" by Dr. Morris Rubinoff
6. "Photographic methods of handling input and output data" by Dr. K. G. Macleish
7. "Transfer between external and internal memory" by Mr. C. B. Sheppard

*VIII. Friday, 10 January, 2:00 p.m.*

Conclusions and Open Discussion, Prof. C. C. Bramble, Chairman

1. "Publication, classification, and patents" by Prof. S. H. Caldwell
2. "Le domaine du calcul mécanique" by Dr. Louis Couffignal (paper not read, but to be included in the published report).
3. "New Vistas in mathematics" by Dr. A. T. Waterman

All of the remarks and papers of the 34 speakers, as well as the related discussions, are to be published in a later volume of the *Annals* of the Computation Laboratory.

Both Harvard University and the Bureau of Ordnance are to be congratulated for their enterprise in making possible this significant meeting. The extensive program reflected every phase of the sweeping progress being made in the field of large-scale calculators, and the large attendance offered a unique opportunity for the numerous small group meetings which do much to facilitate the exchange of helpful information.

The following members registered for the Symposium:

- Milton Abramowitz, mathem., NBSMTP  
 Erik Ackelind, group leader, Northrop Aircraft Corp., Hawthorne Field, Cal.  
 L. V. Ahlfors, prof. math., Harvard Univ.  
 H. H. Aiken, prof. appl. math., Harvard Univ.  
 L. W. Alberts, grad. stu., Harvard Law Sch.  
 S. N. Alexander, group leader, computer components group, National Bureau of Standards (NBS)  
 F. J. Alterman, engin., Reeves Instrument Corp., New York  
 E. G. Andrews, engin., Bell Tel. Lab., New York  
 R. C. Archibald, prof. math., Brown Univ.

- George Arfken, Jr., grad. stu., Yale Univ.  
K. J. Arnold, assist. prof. math., Univ. Wisconsin  
R. H. Babbage, editor, 241 St. James St. West, Montreal, Canada  
Rear Admiral W. D. Baker, commandant, U. S. Naval Base, Boston  
M. D. Baller, group leader, computers, Army Air Force (AAF), Malden, Mass.  
Colin Barnes, prof. physics, Univ. Toronto  
Dr. J. L. Barnes, consultant, Raytheon Mfg. Co., Waltham, Mass.  
R. M. Barrett, electronic engin., Watson Lab., AAF AMC, Cambridge  
Phyllis P. Barrows, res. assist., Harvard Univ.  
C. E. Barthel, Jr., electronic computing and control group, Naval Ordnance Lab., Wash.  
Walter Bartky, prof. math., Univ. Chicago.  
Dr. A. E. Benfield, visiting lect. appl. physics, Harvard Univ.  
William Bentinck-Smith, ed. *Harvard Alumni Bull.*, Harvard Univ.  
R. J. Bergemann, electronic engin., Office Naval Res., Boston  
Dr. Stefan Bergman, res. lect. aeronautical engin., Harvard Univ.  
E. C. Berkeley, methods analyst, Prudential Life Ins. Co., Newark, N. J.  
A. A. Berlinsky, lab. electrician, Bureau of Census, Wash.  
C. H. Berry, prof. mech. engin., Harvard Univ.  
J. H. Bigelow, chief engin., Institute Adv. Studies, Princeton, N. J.  
Garrett Birkhoff, prof. math., Harvard Univ.  
W. E. Bleick, assoc. prof. math., post grad. sch., U. S. Naval Acad., Annapolis, Md.  
Daniel Blitz, res. engin., Raytheon Mfg. Co., Waltham, Mass.  
R. M. Bloch, res. assist., Harvard Univ.  
J. H. Blythe, nautical scientist, Hydrographic Office, Navy Dept., Wash.  
Richard Blythe, res. assoc. electr. engin., Mass Inst. Techn.  
J. M. Boormeester, actuarial assoc., John Hancock Mutual Life Ins. Co., Boston  
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Capt. C. T. Bonney, prof. naval sci. and tactics, Harvard Univ.  
H. R. Boyd, engin., servomechanisms lab., Mass. Inst. Techn.  
C. C. Bramble, prof. math., post-grad. sch., U. S. Naval Acad.  
Dr. A. E. Brandt, statist., Naval Ordnance Lab., Wash.  
Mark Breiter, mathem., office chief ordnance, Pentagon Bldg., Wash.  
Ruth A. Brendel, instr. math., Univ. Buffalo  
P. W. Bridgman, prof. math. and nat. phil., Harvard Univ.  
L. N. Brillouin, prof. appl. math., Harvard Univ.  
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T. H. Brown, prof. business statistics, Harvard Univ.  
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W. L. Campbell, prof. food techn., Mass. Inst. Techn.  
Dr. E. W. Cannon, chief, machinery devel. sect., NBS  
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F. E. Carey, fellow in journalism, Harvard Univ.  
Commander J. H. Carmichael, res. and development div., Navy Dept., Bur. Ord., Wash.  
Arthur Casagrande, assoc. prof. civil engin., Harvard Univ.  
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 Charles Manneback, prof. theoretical physics, Univ. Louvain  
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W. J. Nolan, Jr., res. assoc. electr. engin., Mass. Inst. Techn.  
Dr. Harry Nyquist, engin., Bell Tel. Lab., New York  
J. A. O'Brien, res. assist. electr. engin., Mass. Inst. Techn.  
J. W. O'Connor, office of vice-pres., John Hancock Mutual Life Ins. Co., Boston  
Otto Oldenberg, prof. physics, Harvard Univ.  
B. M. Oliver, engin., Bell Tel. Lab., New York  
R. D. O'Neal, physicist, Eastman Kodak Co., Rochester, N. Y.  
I. B. Parkhurst, assist. business manager, Harvard Coll.  
Dr. C. L. Pekeris, IBM Corp., Watson Lab., Columbia Univ.  
Lt. Comdr. J. T. Pendergrass, Office Chief Naval Operations, Navy Dept., Wash.  
C. G. Peterson, agent, Marchant Calculating Machine Co., Boston  
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Dr. L. A. Pipes, res. physicist, Hughes Aircraft Co., Culver City, Cal.  
G. P. Ploetz, electronic engin., Watson Lab., AAF AMC, Cambridge  
W. A. Porter, constr. supervisor, Harvard Univ.  
H. A. Rademacher, prof. math., Univ. Penn.  
Dr. Jan Rajchman, res. physicist, Radio Corp. Amer. Labs., Princeton, N. J.  
E. A. Rasor, actuarial mathem., Social Security Admin., Wash.  
I. G. Recant, aeronautical engin., Nat. Adv. Comm. Aeronautics, Langley Field, Va.  
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Edward Reynolds, administrative vice-pres., Harvard Univ.  
George Reynolds, engin. aide, Watson Lab., AAF AMC, Cambridge  
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Dr. Morris Rubinoff, instr. physics, Harvard Univ.  
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R. C. Sandborn, stu., Harvard Coll.  
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Lt. Comdr. W. L. Savidge, distr. intelligence officer, First Naval District, Boston  
J. B. Scarborough, prof. math., U. S. Naval Acad., Annapolis, Md.  
A. C. Schaeffer, assoc. prof. math., Stanford Univ.  
F. F. Schaller, jun. engin., N. E. Power Service Co., Boston  
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R. E. Scott, res. assist. electr. engin., Mass. Inst. Techn.  
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- Dr. Harner Selvidge, director special products dev., Bendix Aviation Corp., Teterboro, N. J.
- Dr. C. E. Shannon, engin., Bell Tel. Lab., New York
- Dr. T. K. Sharpless, project super. EDVAC, Univ. Penn.
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- L. B. Slichter, prof. geophysics, Univ. Wisconsin
- A. E. Smith, mathem., Navy Dept., Office Naval Res., Washington
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- V. G. Smith, prof. electr. engin., Univ. Toronto
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- Andrew Sobczyk, mathem., Watson Lab., AAF AMC, Cambridge
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- L. H. Thomas, physicist, IBM Corp., New York
- Lt. P. D. Thompson, AAF, res. assist., Institute Adv. Studies, Princeton, N. J.
- Capt. F. P. Tibbits, ordnance officer, Charlestown Naval Base, Boston
- P. D. Tilton, res. assist. electr. engin., Mass. Inst. Techn.
- Dr. C. B. Tompkins, engin., Engineering Res. Associates Inc., St. Paul, Minn.
- Dr. A. M. Turing, research fellow, National Res. Lab., Teddington, England
- Dr. A. W. Tyler, physicist, Eastman Kodak Co., Rochester, N. Y.
- C. F. Van Aken, chief machine tabul. div., Bureau of Census, Washington
- Capt. A. M. Van Eaton, commanding officer, Office Naval Res., Boston
- F. M. Verzuh, res. assoc. electr. engin., Mass. Inst. Techn.
- J. H. Wakelin, res. supervisor, Engineering Res. Associates Inc., St. Paul, Minn.
- Henry Wallman, assoc. prof. math., Mass. Inst. Techn.
- John Walsh, electr. engin., Watson Lab., AAF AMC, Cambridge
- J. H. Warden, president, The Autocall Co., Shelby, O.
- K. L. Warthman, engin., Bell Tel. Lab., New York
- Dr. A. T. Waterman, chief sci. planning div., Navy Dept., Office Naval Res., Wash.
- J. R. Weiner, engin., Raytheon Mfg. Co., Waltham, Mass.
- Albert Wertheimer, head engin., Navy Dept., Bur. Ord., Washington
- Dr. F. J. Weyl, mathem., Navy Dept., Bur. Ord., Wash.
- D. P. Wheatland, Cruft Lab., Harvard Univ.
- Stephen White, science news writer, *New York Herald-Tribune*
- Lt. Comdr. A. W. Whitney, aide to commandant, First Naval District, Boston
- Hassler Whitney, prof. math., Harvard Univ.
- D. V. Widder, prof. math., Harvard Univ.
- Maria Wilhelm, science sect., *Newsweek Mag.*, New York
- R. E. Wilkins, mech. engin., Harvard Univ.
- S. B. Williams, cons. electr. engin., 366 Clermont Ave., Brooklyn, N. Y.
- Capt. J. H. Willingham, Jr., commandant, Naval Ammunition Depot, Hingham, Mass.
- M. K. Wood, techn. assist., progr. monitoring div., headquarters, Army Air Force, Wash.
- L. F. Woodruff, techn. chief sci. branch, W.D.G.S. 2, Pentagon Bldg., Wash.



R. L. Wooley, electronic engin., Watson Lab., AAF AMC, Cambridge  
 Dr. A. W. Wundheiler, mathem., Navy Dept., Bur. Ord., Wash.  
 Jeff Wylie, bureau head, Boston Office, *Time Mag.*  
 Patrick Youtz, res. assoc. electr. engin., Mass. Inst. Techn.  
 Dr. V. K. Zworykin, director electronic res., Radio Corp. Amer., Princeton, N. J.

S. H. C.

<sup>1</sup> Richard Henry Babbage (1883- ) is a son of Henry Whitmore B. (1855-1911), son of Henry Prevost B. (1824-1918), son of Charles Babbage (1792-1871). He is an assistant editor of Canada's national farm magazine, *Family Herald and Weekly Star*.

## APPENDIX

### A. Existing and Practically completed Digital Computing Machines developed by or presently on loan or contract to the Government.

#### I. Department: War

*Branch or Bureau:* Ordnance Dept.

*Permanent Location of Machine:* Ballistic Research Lab., Aberdeen Proving Ground, Md.

*Type:* A. Relay (small) manufactured by IBM Corp.

B. Relay (small) manufactured by IBM Corp.

C. Electronic (ENIAC) manufactured by Moore School of Electrical Engineering, University of Pennsylvania. See *MTAC*, v. 2, p. 97f.

D. Relay (large) manufactured by Bell Telephone Labs.

#### II. Department: War

*Branch or Bureau:* Army Ground Forces

*Permanent Location of Machine:* Army Ground Forces, no. 4, Fort Bliss, Texas.

*Type:* Relay (small) manufactured by Bell Telephone Labs.

#### III. Department: Navy

*Branch or Bureau:* Office of Naval Research

*Permanent Location of Machine:* Naval Research Lab., Bellevue, Md.

*Type:* Relay (small) manufactured by Bell Telephone Labs.

#### IV. Department: Navy

*Branch or Bureau:* Bureau of Ordnance

*Permanent Location of Machine:* Harvard Computation Lab., Cambridge, Mass.

*Type:* Electromechanical (IBM Sequence Controlled Calculator = "Mark I Calculator").

See *MTAC*, v. 2, p. 185f.

#### V. Department: Navy

*Branch or Bureau:* Bureau of Ordnance

*Permanent Location of Machine:* Navy Proving Ground, Dahlgren, Va. [In probable operation by July 1947].

*Type:* A. Relay (small) manufactured by IBM Corp.

B. Relay (large) "Mark II Calculator," manufactured by the Computation Lab., Harvard Univ. [EDITORIAL NOTE: It is about 12 times faster than Mark I, and cost about \$400 000.]

#### VI. Department: National Advisory Committee for Aeronautics

*Permanent Location of Machine:* Langley Memorial Lab., Langley Field, Va.

*Type:* Relay, manufactured by Bell Telephone Labs. (under contract expiring in 1948).

### B. Present Automatic Digital Computing Machine Construction and Development Projects supported entirely or in part by the Government.

I. *Department: War**Branch or Bureau: Ordnance Department**Description of activity:*

- A. Moore School of Electrical Engineering, Construction of an electronic digital machine ("EDVAC").
- B. Institute for Advanced Study and RCA Labs., Princeton, N. J. Construction of an electronic digital machine (financed only in part by federal funds).
- C. National Bureau of Standards, Washington, D. C., Long-range component development program.

II. *Department: Navy**Branch or Bureau: Office of Naval Research**Description of Activity:*

- A. National Bureau of Standards, Construction of an electronic digital machine.
- B. Servomechanisms Lab., Mass. Institute of Technology, Construction of an electronic digital machine to be used in a large guided-missile flight simulator.

III. *Department: Navy**Branch or Bureau: Bureau of Ordnance**Description of Activity:*

- A. Harvard Computation Lab., Research and preparation of specifications for an electronic digital machine.
- B. Naval Ordnance Lab., White Oaks, Md., Construction of an electronic digital machine, temporarily abandoned (Dec. 1946).

IV. *Department: Commerce**Branch or Bureau: Bureau of the Census**Description of Activity: National Bureau of Standards, Construction of an electronic digital machine.*

J. H. CURTISS

National Bureau of Standards

EDITORIAL NOTE: Other projected digital machines, unaided in their construction by the U. S. Government, are being built by:

- (i) The Eastman Kodak Co., Rochester, N. Y.
- (ii) The University of California, Berkeley.
- (iii) The National Physical Laboratory, Teddington, England, under the direction of Dr. ALAN M. TURING. The planned Automatic Computing Engine will work at the speed of the ENIAC or possibly somewhat higher, and will take advantage of new technical developments, making possible both a greater memory capacity and a higher degree of complexity in the instructions.

## P. G. Scheutz, Publicist, Author, Scientific Mechanician, and Edvard Scheutz, Engineer,—Biography and Bibliography

PEHR GEORG SCHEUTZ (1785–1873), son of a tavern-keeper, after passing examinations in law, practised in different localities before settling in Stockholm in 1812. In 1817 as owner of a printing establishment founded by the well-known writer F. CEDERBORGH, Scheutz devoted himself from that time principally to literary interests. He soon became part owner and co-editor of a newspaper which, with changed name *Argus* (1820–1836), became Sweden's most important political newspaper in the 1820's. During 1826–