MISC
HISTORY

Handbook

International Conference on Information Processing

Unesco House
Paris, 15-20 June 1959

International Conference on Information Processing

RWBemer, USA

Handbook

International Conference on Information Processing

Unesco House

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Introduction

The International Conference on Information Processing is convened by Unesco in pursuance of resolution 2.41 adopted by the General Conference at its tenth session in November-December 1958. The conference will be held from 15 to 20 June at Unesco's Permanent Headquarters in Paris.

The project to hold such a conference arose out of a suggestion made by the Joint Computer Committee (United States of America) in 1957 and was subsequently endorsed by the International Advisory Committee on Research in the Natural Sciences Programme of Unesco (fifth session, Moscow, May 1957). It reflects the considerable progress made in recent years in the design and utilization of electronic computers.

It is not surprising, therefore, that special institutions have sprung up recently and that more are being established in many countries; and that computing divisions have been set up, or are being set up, in large research laboratories, which have to carry out a considerable volume of complicated mathematical computations.

In September 1957 Unesco itself established a provisional International Computation Centre in Rome with the assistance of the Italian Institute of Higher Mathematics. The centre is called upon to fulfil important tasks as regards international co-operation in the field under review.

The utilization of information processing machines, the construction and operation of which require considerable financial resources, raises new mathematical and engineering problems which are at present attracting the attention of research workers.

The International Conference on Information Processing now convened by Unesco is intended to facilitate research and the international exchange of information and experience in this field. The conference is of a non-governmental nature, open to all scientists and engineers of a high standing in the Member States of Unesco, of the United Nations and of the Specialized Agencies.

In preparing this conference Unesco has been assisted by an international group of consultants. The national or regional groups listed below have acted as liaison bodies between Unesco and interested persons:

France: Association Française de Calcul,
Institut d'Astrophysique,
98 bis Boulevard Arago,
Paris-14.

Federal Republic of Germany:
Deutscher Ausschuss für Rechenanlagen,
c/o Prof. Dr. A. Walther,
Technische Hochschule,
Darmstadt 16.

Italy: Istituto Nazionale per le Applicazioni del Calcolo,
Piazzale delle Scienze 7,
Roma.

Japan: The Special Committee on Computers in the National Research Council,
c/o Prof. H. Yamashita,
Electrical Engineering Department,
University of Tokyo,
Bunkyo-ku-Tokyo.

Netherlands:
Mathematisch Centrum,
2 E Boerhaavestraat 49,
Amsterdam.

Scandinavia (Denmark, Finland, Iceland, Norway, Sweden):
Laborator Stig Comet,
c/o Matematikmaskinnamnden,
Box 6131,
Stockholm 6.

Union of Soviet Socialist Republics:
Prof. D. Panov,
Pl. Vosstania 1, Kw 213,
Moscow.

United Kingdom:
Group B,
British Conference on Automation and Computation,
The Institution of Electrical Engineers,
Savoy Place,
London, W.C.2.

United States of America:
U.S. Committee for the International Conference on Information Processing,
c/o I. L. Auerbach,
Box 4999,
Washington 8, D.C.

Yugoslavia:
Dr. Rajko Tomović,
Institut Boris Kidrić,
B.P. 522,
Beograd (Belgrade).

Contents

Annexes

Organization of the Conference

Opening Session

The opening session will take place in the Grand Amphithéâtre of the Sorbonne (entrance 47 Rue des Ecoles, Paris-5e) at 11 a.m. on Monday, 15 June. The president of the conference is Professor Howard H. Aiken (U.S.A.).

Agenda and Organization of Work

The agenda and programme of work have been drawn up by the Director-General of Unesco with the advice of an international group of scientific consultants specially called for this purpose.

Details about the programme of the conference will be found in the second part of this handbook.

The daily time-table of the conference will be posted on the two announcement boards situated in the foyer of the Conference Building and in the hall of the Secretariat Building. Unless specified differently, morning sessions will be from 10 a.m. to 1 p.m. and afternoon sessions from 3 p.m. to 6 p.m.

Privileges and Immunities

For the duration of their mission, participants will enjoy the privileges and immunities accorded to them under

Articles 9 and 25 of the Headquarters Agreement contracted between the Government of France and Unesco. In case of inquiries, please apply to the Conference Planning Officer (room S.382, ext. 3719).

Officers of the Conference

The officers of the conference are appointed by the Director-General of Unesco with the advice of the previously mentioned group of scientific consultants.

The president will be Professor Howard H. Aiken (U.S.A.)

The names of the vice-presidents of the conference and of the chairmen and the vice-chairmen of sessions will appear in the first issue of the information bulletin.

Group of Scientific Consultants and Participants

The following consultants have helped Unesco in the preparation of the conference:

S. N. Alexander (U.S.A.)
I. L. Auerbach (U.S.A.)
J. Carteron (France)
J. Coales (U.K.)
S. Comet (Sweden)
Ph. Dreyfus (France)
E. Durand (France)
A. Ghizzetti (Italy)
M. Goto (Japan)
A. S. Householder (U.S.A.)
C. Manneback (Belgium)
P. Namian (France)
D. Panov (U.S.S.R.)
W. L. van der Poel (Netherlands)
R. de Possel (France)
R. Rind (France)
C. S. Scholten (Netherlands)
K. Steinbuch (Federal Republic of Germany)
A. Walther (Federal Republic of Germany)
A. van Wijngaarden (Netherlands)
M. V. Wilkes (U.K.)
H. Yamashita (Japan)

A complete list of accredited participants will be distributed at the opening of the conference.

Conference Secretariat

President:	Professor Howard H. Aiken, room S.386, ext. 3722.
Secretary-General:	Professor P. Auger, room S.386, ext. 3722.
Secretary:	Mr. J. A. Mussard, room S.385, ext. 3720.
Planning officer:	Mr. J. P. Urlik, room S.382, ext. 3719.
Editor:	Mr. S. de Picciotto, room S.372, ext. 3730.
Press liaison:	Miss Y. Tabbush, Press room, S.332, ext. 3701, 3702.
Secretariat:	Room S.383, ext. 3720.
Scientific secretaries:	Room S.371, ext. 3731, 3733.
Information bulletin:	Room S.373, ext. 3710.

Symposia

The programme of the conference includes a series of symposia in the afternoons. For details see the second part of this handbook and announcements in the information bulletin.

Evening Lectures

A series of lectures including a round-table discussion will take place in the evenings. The purpose of the lectures will be to enable non-specialists to become acquainted with the basic principles and possibilities of modern computation methods. Details of the evening lectures will be announced in the information bulletin.

Working Languages

The working languages of the conference are English, French and Russian for which simultaneous interpretation will be provided.

The working languages of the symposia will be English and French.

The evening lectures will be given in French whenever possible, but interpretation into English will be available.

Conference Documentation

Discussion papers will be available in English or French. Abstracts of these papers will, however, be published in English, French, Russian and Spanish.

The Russian version will be prepared with the help of the Academy of Sciences of the Union of Soviet Socialist Republics. The German national group has undertaken to provide a German version of the abstracts.

Organization of the Discussions

Participants wishing to take part in any discussion should complete the special forms provided by the Reception Service and hand them to the scientific secretaries (room S.371, ext. 3731 and 3733).

Proceedings

The Proceedings of the conference will be published after the conference under the auspices of Unesco. They will contain the full texts of the papers presented orally to the conference (English or French); abstracts of these papers

(English, French, Russian, Spanish); discussion summaries based on texts provided by the speakers themselves (English or French); summaries of the symposia (English or French) as well as the reports made by the introductory speakers of the conference sessions (English or French).

For all inquiries concerning the preparation of the Proceedings please apply to the Conference Editor (room S.372, ext. 3730).

Order forms for reprints or all of the Proceedings can be obtained from the Conference Editor.

Information Bulletin

A daily information bulletin will be published throughout the conference (room S.373, ext. 3710). The bulletin will contain general information of interest to participants, details relating to the programme of meetings, and announcements.

The bulletin will appear every morning in English and in French and may be obtained at the Reception Service.

Press Conferences

It is planned to hold daily press conferences in the Press Room (room S.332) of the Conference Building at the close of the afternoon sessions. The press conferences will be organized with the help of the scientific secretaries and the chairmen of the daily sessions will attend them. For further details apply to the Press Liaison Officer (ext. 3701 and 3702).

Guidance for Speakers

Languages. English, French or Russian may be used during the discussions. Interventions in any of these languages at conference sessions will be simultaneously interpreted into the other two languages.

To facilitate accurate interpretation of their statements, speakers are requested not to exceed a speed of about

100 words per minute (speakers may find it advisable to time their presentation in advance); they should maintain a clear and even flow of words, particularly when using scientific formulae or terms. Whenever possible, simple words and phrases should be used.

Discussions. As a rule, 30 minutes in all will be available for the presentation and discussion of each paper. The following suggestions are intended to help speakers make the best use of their limited time. The work of the conference will follow the order prepared by the secretariat, as shown in the programme (page 19). Since the full texts of all the discussion papers will be available to participants at the opening of the conference, authors of such papers only need to summarize and high-light important points in their oral presentation in order to stimulate constructive debate.

The presentation of each paper will normally be followed by a general discussion based upon that particular paper.

Participants wishing to take part in any discussion are requested to inform the secretariat by completing and handing to the scientific secretaries (room S.371, ext. 3731 and 3733) special forms which will have been distributed to them upon registration.

Speakers are requested to be as brief as possible. The chairman of each meeting will first call speakers who have previously handed in their discussion forms.

In view of the size of the Conference Hall and in order to gain time, the front row has been reserved for discussion speakers who are requested to take a seat in that row at the beginning of the session at which they intend to speak.

Summaries of speeches. All speakers are requested to submit to the scientific secretaries (room S.371, ext. 3731 and 3733) as soon as possible after it has taken place, a summary of their intervention in English or in French.

Symposia. Three hours will be available for each symposium at which specialists will be invited to speak on the main aspects of the subject reviewed. The organization of symposia has been entrusted to co-ordinators who can be contacted through the scientific secretaries (room S.371, ext. 3731 and 3733).

Participants should try as far as possible to use only French or English. In principle there will be no interpretation as it will be practically impossible to recruit and brief a sufficient number of well-trained interpreters to cover both the plenary sessions and the symposia of the conference. However, speakers who cannot express themselves in English or French should inform the secretariat which will then try to provide ad hoc interpretation.

Projection of slides, films and diagrams

Projection facilities are provided in the Plenary Hall (room I) for the presentation of slides and of 16 mm. and 35 mm. films (both optical and magnetic sound).

Slides should bear the speaker's name on the edge and be numbered on the top right-hand corner in the sequence required by the speaker. They should be handed to the scientific secretaries (room 371, ext. 3731 and 3733) in charge of meetings in a box labelled with the speaker's name and the number of his paper.

Slides of the following dimensions may be used: 5×5 cm. ($2'' \times 2''$), 8.5×8.5 cm. ($3\frac{1}{4}'' \times 3\frac{1}{4}''$), 8.5×10 cm. ($3\frac{1}{4}'' \times 4''$).

Speakers are requested to collect their slides themselves after the meetings.

A special device is also available for projecting diagrams on to a screen as the speaker draws them with a grease pencil on a glass sheet (rooms I and II).

Programme of Plenary Sessions and Symposia

Monday, 15 June

P. E. de Possel (France)
VP L. Amerio (Italy)

Documents Unesco/ NS/ICIP

Morning (11 a.m. to 12).
Opening session.

Afternoon (3 to 6 p.m.). *Session A.*
Methods of Digital Computing
Rapporteur: J. Kuntzmann (France)

Session on Errors and Approximations

F. Ceschino and J. Kuntzmann: Faut-il passer à la forme canonique dans les problèmes différentiels de conditions initiales ? (France) A.1.3

J. H. Wilkinson: Rounding errors in algebraic processes. (U.K.) A.1.8

Ch. Blanc: Sur l'estimation des erreurs d'arrondi. (Suisse) A.L.1

P. Henrici: Theoretical and experimental studies on the accumulation of error in the numerical solution of initial value problems for systems of ordinary differential equations. (U.S.A.) A.1.13

H. J. Maehly: Rational approximations for transcendental functions. (U.S.A.) A.1.12

D. B. Gillies: The exact determination of the characteristic polynomial of a matrix. (U.S.A.) A.1.10

Symposia

Symposium on the influence of very large memory designs and capabilities on information retrieval.
Co-ordinator: G. W. King (U.S.A.)

Symposium on switching algebra.
Co-ordinator: M. Goto (Japan)

Tuesday, 16 June

P – H. YAMASHITA (JAPAN)
VP – STIEFEL (GERMANY)

Morning (10 a.m. to 1 p.m.). *Session B.*

	Documents Unesco/ NS/ICIP
ENG **Logical Design of Digital Computers** Rapporteur: M. V. Wilkes (U.K.)	
" C. Strachey: Time sharing in large, fast computers. (U.K.)	B.2.19
" B. J. Loopstra: Input and output in the X-1 system. (Netherlands)	B.2.3
W. F. Schmitt and A. B. Tonik: Sympathetically programmed computers. (U.S.A.)	B.2.18
J. Bosset: Sur certains aspects de la conception logique du Gamma 60. (France)	B.2.21
A. L. Leiner, W. A. Notz, J. L. Smith and R. B. Marimont: Concurrently operating computer systems. (U.S.A.)	B.2.17

Afternoon (3 to 6 p.m.). *Session C.*

Common Symbolic Language for Digital Computers Rapporteur: S. Gorn (U.S.A.)	
J. Poyen and B. Vauquois: A propos d'un langage universel. (France)	C.3.2
I. I. Basilevsky, Iu. A. Shreider and I. Ia. Akushsky: Methods of logical recursive and operator analysis and synthesis of automata. (U.S.S.R.)	C.3.5

P- A. WALTHER (GERMANY)
VP- ~~G. HOPPER~~ H. GOOD

✓ FOR ALGOL BULLETIN?

Documents Unesco/NS/ICIP

F. G. Duncan and E. N. Hawkins: Pseudocode translation on multi-level storage machines. (U.K.) C.3.4

F. L. Bauer and K. Samelson: The problem of a common language, especially for scientific numerical work (motives, aims, restrictions and results of the Zürich conference on ALGOL. (Fed. Rep. of Germany) C.3.3

J. W. Backus: The syntax and semantics of the proposed international algebraic language of the Zürich ACM-GAMM conference. (U.S.A.) C.3.6

Symposia

Symposium on the relationship between digital and analogue computing.
Co-ordinator: J. Carteron (France)

Symposium on the logical organization of very small computers.
Co-ordinator: W. L. van der Poel (Netherlands)

Wednesday, 17 June

		Documents Unesco/ NS/ICIP
Morning	(10 a.m. to 1 p.m.). *Session D.* ***Methods of Digital Computing*** (continued)	
	Sessions on Partial Differential Equations, Applications and Linear Programming	
	A. A. Dorodnitzin: The experience of the use of high-speed computers for solving partial differential equations. (U.S.S.R.)	D.1.14
	L. Collatz: Methods of computation on digital computers for partial differential equations. (Fed. Rep. of Germany)	D.1.6
	D. J. Evans: The solution of elliptic difference equations by stationary iterative processes. (U.K.)	D.1.7
	R. S. Varga: Over-relaxation applied to implicit alternating direction methods. (U.S.A.)	D.1.11
	G. Letellier and R. Lattes: Résolution sur calculateur électronique d'un problème d'algèbre diophantienne. (France)	D.1.4
	G. R. Parisot: Les programmes logarithmiques—Application aux calculs des programmes convexes spécialement linéaires. (France)	D.1.5

Afternoon (3 to 6 p.m.). *Session E.* — Documents Unesco/NS/ICIP

Logical Design of Digital Computers (continued)

W. L. van der Poel: Zebra, a simple binary computer. (Netherlands)	E.2.2
M. Lehman: The specification development of a cost-limited digital computer. (Israel)	E.L.4
W. Buchholz, F. P. Brooks Jr. and G. A. Blaauw: Processing data in bits and pieces. (U.S.A.)	E.2.8
S. A. Lebedev and K. Sulim: A new computing machine. (U.S.S.R.)	E.2.4
I. Ia. Akushsky, L. B. Emeljanov-Iaroslavsky, E. A. Kljamko, V. S. Linsky, G. D. Monachov: Methods of speeding-up the operation of digital computers. (U.S.S.R.)	E.2.5
G. Metze and J. E. Robertson: Elimination of carry propagation in digital computers. (U.S.A.)	E.2.6

Symposia

Symposium on linear programming.
Co-ordinator: S. Vajda (U.K.)

Symposium on error detection and correction.
Co-ordinator: R. W. Hamming (U.S.A.)

Symposium on collection, storage and retrieval of information.
Co-ordinator: B. W. Adkinson (U.S.A.)

Thursday, 18 June

P – S. COMET (SWEDEN)
VP – M. MASTERMANN (U.K.)

		Documents Unesco/NS/ICIP
Morning (10 a.m. to 1 p.m.). *Session F.*	***Automatic Translation of Languages*** Rapporteur: D. Panov (U.S.S.R.)	
	V. E. Giuliano and A. G. Oettinger: Research on automatic translation at the Harvard Computation Laboratory. (U.S.A.)	F.4.1
	V. H. Yngve: The COMIT system for mechanical translation. (U.S.A.)	F.4.3
	K. E. Harper and D. G. Hays: The use of machines in the construction of a grammar and computer programme for structural analysis. (U.S.A.)	F.4.4
	S. Takahashi, H. Wada, R. Tadenuma and S. Watanabe: English-Japanese machine translation. (Japan)	F.4.5
	I. K. Belskaia: Machine translation methods and their application to the Anglo-Russian scheme. (U.S.S.R.)	F.4.7

Afternoon (3 to 6 p.m.). *Session G.*

Logical Design of Digital Computers (continued)

	Documents Unesco/ NS/ICIP
H. Takahashi and E. Goto: Application of error correcting codes to multi-way switching. (Japan)	G.2.9
S. Muroga: Logical elements on majority decision—Principle and complexity of their circuit. (Japan)	G.2.10
R. Vacca: A three-valued system of logic and its application to base three digital circuits. (Italy)	G.2.14
G. C. Tootill: The use of cyclic permuted chain codes for digitizers. (U.K.)	G.2.15
A. Svoboda: The numerical system of residual classes in mathematical machines. (Czechoslovakia)	G.2.16

Symposia

Symposium on machine translation.
Co-ordinator: D. G. Hays (U.S.A.)

Symposium on automatic programming.
Co-ordinator: A. Perlis (U.S.A.)

Friday, 19 June

P – W. L. VAN DER POEL
VP – INZINGER (AUSTRIA

Morning (9.30 a.m. to 1 p.m.). *Session H.*
Pattern Recognition and Machine Learning
Rapporteur: K. Steinbuch (Fed. Rep. of Germany)

	Documents Unesco/NS/ICIP
Session on Pattern Recognition	
H. Wada, S. Takahashi, T. Iijima, Y. Okumura and K. Imoto: An electronic reading machine. (Japan)	H.6.13
H. Sherman: A quasi-topological method for the recognition of line patterns. (U.S.A.)	H.L.5
W. Sprick and K. Ganzhorn: An analogous method for pattern recognition by following the boundary. (Fed. Rep. of Germany)	H.0.94
H. Kazmierczak: The potential field as an aid for character recognition. (Fed. Rep. of Germany)	H.0.101
S. Frankel: Information-theoretic aspects of character reading. (U.S.A.)	H.L.2
G. W. Hughes and M. Halle: On the recognition of speech by machine. (U.S.A.)	H.6.1

WONG ? PRINCIPIA MATH - ALL THEOREMS IN 3 MIN

P – BASILEVSKY (USSR)
VP – S.N. ALEXANDER (USA)

Afternoon (3 to 6 p.m.). *Session I.* **Documents Unesco/NS/ICIP**

Pattern Recognition and Machine Learning (continued)

Session on Proving of Logical Propositions

A. Newell, J. C. Shaw and H. A. Simon: Report on a general problem-solving programme. (U.S.A.) — I.6.8

P. C. Gilmore: A programme for the production of proofs for theorems derivable within the first order predicate calculus from axioms. (U.S.A.) — I.6.14

H. Gelernter: Realization of a geometry theorem proving machine. (U.S.A.) — I.6.6

B. Dunham, R. Fridshal and G. L. Sward: A non-heuristic programme for proving elementary logical theorems. (U.S.A.) — I.6.10

R. J. Solomonoff: A new method for discovering the grammars of phrase structure languages. (U.S.A.) — I.6.12

Symposia

Symposium on numerical analysis on computers.
Co-ordinator: R. Sauer (Fed. Rep. of Germany)

Symposium on the logical organization for very high speed computers.
Co-ordinator: N. M. Metropolis (U.S.A.)

Saturday, 20 June

P– C. MANNEBACK (BELGIUM)
VP– BIERMANN (GERMANY)

Morning (10 a.m. to 1 p.m.). *Session J.* Documents Unesco/NS/ICIP
Pattern Recognition and Machine Learning (continued)

Session on Machine Learning and on Collection, Storage and Retrieval of Information

D. G. Willis: Plastic neurons as memory elements. (U.S.A.) J.6.7

S. N. Braines, A. V. Napalkov and Iu. A. Shreider: Analysis of the working principles of some self-adjusting systems in engineering and biology. (U.S.S.R.) J.6.9

T. Kilburn, R. L. Grimsdale and F. H. Sumner: Experiments in machine learning and thinking. (U.K.) J.6.15

M. E. Stevens: A machine model of recall. (U.S.A.) J.5.4

C. N. Mooers: Some mathematical fundamentals of the use of symbols in information retrieval. (U.S.A.) J.5.5

A. F. Parker-Rhodes and R. M. Needham: A reduction method for non-arithmetical data, and its application to Thesauric translation. (U.K.) J.5.6

Afternoon (2.30 to 5.30 p.m.). *Session K.*
Special Session on Computer Techniques of the Future Organizer: I. L. Auerbach (U.S.A.)

W. E. Proebster, S. Methfessel and C. Kinberg: Thin magnetic films. (Switzerland) K.2

P– I.L. AUERBACH
VP– A. SPEISER (SWITZERLAND)

	Documents Unesco/NS/ICIP
J. Raffel and D. O. Smith: A computer memory using magnetic film. (U.S.A.)	K.6
W. B. Ittner III: Physical characteristics of cryogenic components. (U.S.A.)	K.3
Y. Hirshberg: The possible use of the photochromic effect for information handling devices. (Israel)	K.5
H. E. Billing and A. O. Rudiger: The possibility of speeding up computers using parametrons. (Fed. Rep. of Germany)	K.2.11
J. W. Leas: Microwave solid-state techniques for high speed computers. (U.S.A.)	K.4
D. A. Buck and K. R. Shoulders: An approach to microminiature printed systems. (U.S.A.)	K.1

Afternoon (5.45 to 6.30 p.m.).

Closing session

Afternoon (3 to 6 p.m.).

Symposia

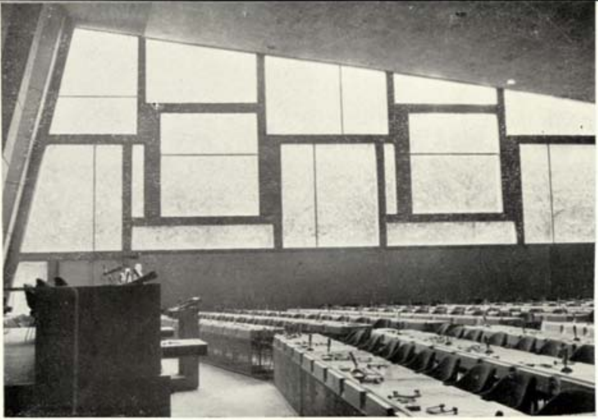
Symposium on the methods for solving linear systems.
Co-ordinator: J. H. Wilkinson (U.K.)

Symposium on programming procedures.
Co-ordinator: E. W. Dijkstra (Netherlands)

Secretariat façade, lobby and Conference Building. [Photo Unesco - D. Berretty]

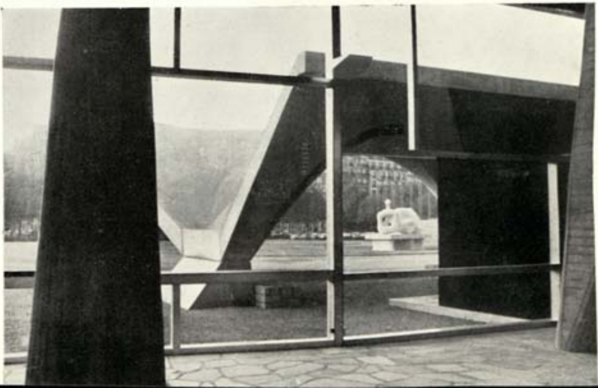
Firemen's ladder and Secretariat façade. [Photo Unesco]

General vue of Secretariat and Conference Building. [Photo Unesco - Lajoux]



Room II — Main Commission Room. [Fhoto Unesco - M. Laloux]

The Piazza, seen from Secretariat Hall. [Photo Unesco]



Situation and Address

Unesco's Permanent Headquarters is situated near the Eiffel Tower and Ecole Militaire. A plan of the conference premises will be found at the end of this handbook (Annex B). Participants will find there the meeting rooms, offices and work rooms, the Press Room and indications as to general services such as reception, travel and hotel accommodation, bank, restaurant and bar, newspaper stand and bookshop.

Telegraphic address: PROCINFORM

Postal Address :
Before conference: Unesco, Natural Sciences Department, Room 4016, Place de Fontenoy, Paris-7e
During conference: Unesco, Reception Service, Conference Building, Avenue de Suffren, Paris-7e.

Telephone:
Unesco: SUFfren 9870 and 8600, SOLferino 9948.
Reception Service: Ext. 3756, 3757, 3758.

Transport

Unesco House is easily accessible by public transport.

Underground (stations are listed in order of proximity)

Ségur — Ligne 10: Porte d'Auteuil—Gare d'Austerlitz

Cambronne	Ligne 6:	Etoile—Nation
Ecole Militaire	Ligne 8:	Charenton—Place Balard
St. François Xavier	Ligne 14:	Invalides—Porte de Vanves

Buses

28: Gare St. Lazare—Porte d'Orléans
49: Gare du Nord—Porte de Versailles
80: Mairie du XVe—Marie du XVIIIe
86: Champs de Mars—Saint Mandé
92: Gare Montparnasse—Porte de Champerret

Parking

Parking space has been reserved for participants on the tree-lined avenue adjoining the Unesco precincts along Avenue de Ségur.

Participants wishing to avail themselves of these parking facilities may obtain a special parking label from the Reception Service.

Reception of Participants

The Reception Service is situated in the foyer of the Conference Hall (entrance 125 Avenue de Suffren, ext. 3756, 3757 and 3758).

It will register participants, distribute documents, circulars, mail and messages, look after lost property, and provide general information. Special conference badges will also be available (white for participants, blue for secretariat).

Paris Hostesses

The Official French Tourist Office (Direction générale du Tourisme) will maintain a special office in the hall of the Secretariat Building for the duration of the conference (ext. 2129). Paris hostesses will provide participants with maps of Paris, tourist folders and information on excursions, travel and entertainment.

Travel and Hotel Accommodation

The office of 'General Tours', Unesco's Travel Agency, in the hall of the Secretariat Building, is available to participants of the conference (ext. 2121, 2122 and 2123). The office will arrange hotel accommodation and travel reservations, organize excursions, obtain theatre and concert tickets and provide general tourist information.

Bank

The Unesco branch of the 'Société Générale' in the hall of the Secretariat Building may be used by participants for the cashing of travellers' cheques and letters of credit, and for other banking business (ext. 2127 and 2128).

The bank is open Mondays to Fridays from 10 a.m. to 12 noon and from 2 p.m. to 4 p.m.

Restaurant and Bar

Participants will find a bar in the foyer of the Conference Building at which drinks and snacks are served. They may also use the Unesco restaurant on the seventh floor of the Secretariat Building at which fixed-price (700 francs) and 'a la carte' lunches and dinners are served. The restaurant is open every day (except Sunday) from 12 noon to 3 p.m. and from 6.30 p.m. to 10 p.m.

For the reservation of tables please telephone ext. 3801.

Medical Service

Unesco's medical service, on the third floor of the Secretariat Building, ext. 3042 and 3035 (afternoons only), may be called upon for first aid.

Cloak-room

Cloak-room facilities are provided in the foyer of the Conference Building and on the seventh floor of the Secretariat Building near the restaurant.

Participants are invited to use these cloak-room facilities as Unesco cannot accept responsibility for the loss of articles left elsewhere.

Post Office

A post office will be found opposite Unesco House in Avenue de Saxe. The office is open Mondays to Saturdays from 8.30 a.m. to 7 p.m.

Public Telephone

Several public telephone booths are available in the foyer of the Conference Building and in the hall of the Secretariat Building near the main entrance (Place de Fontenoy).

Participants may obtain the necessary coins or change for telephoning at the newspaper stand.

Newspaper Stand

A newspaper and book stand, operated by 'Brentano's', will be found in the hall of the Secretariat Building (ext. 2120). Newspapers, periodicals and magazines from different countries as well as cigarettes, matches, postcards and other items may be obtained there.

Unesco Bookshop and Souvenir Stand

Participants wishing to buy Unesco publications may do so at the Unesco bookshop in the hall of the Secretariat Building near the newspaper stand (ext. 2028).

A Souvenir Stand for the sale of postcards and commemorative stamps will be found near the main entrance (ext. 2119).

Visitors' Service

Participants and their families may wish to avail themselves of the facilities offered by the Unesco Visitors' Service near the main entrance (Place de Fontenoy), to visit Unesco House accompanied by a guide who will explain its architectural features and art decoration (ext. 2112, 2113 and 2114).

Working Room for Participants

A working room and lounge is at the disposal of participants on the lower ground floor of the Conference Building (room S.388, ext. 3724, 3725 and 3726). Office facilities have also been provided here for the co-ordinators of the symposia.

Exhibition of Information Processing Equipment

An International Exhibition of Information Processing equipment will take place in the Grand Palais, Champs-Elysées from 13 to 23 June 1959. The Grand Palais is situated in the neighbourhood of Unesco House, 15 minutes walk or 5 minutes by car (parking facilities), or 10 minutes by direct bus (No. 49).

This exhibition is organized in association with the conference in order to provide a general view of research and progress in information processing equipment. The exhibition will be open to conference participants and guests on weekdays from 1 p.m. to 9 p.m. and to the general public on Saturday and Sunday from 10 a.m. to 6 p.m.

Exhibition Lectures

Lectures on recent data processing equipment will be given at the Grand Palais as part of the exhibition arrangements on 22 and 23 June. Interpretation from French into English and vice versa will be provided. Details will be announced in the information bulletin.

Manufacturers' Stand

Representatives of firms producing information processing equipment will have facilities in the foyer of the Conference Building to supply information to participants and to organize visits to factories (ext. 3769).

Annex A
Rules of Procedure

I. Membership, Programme and List of Participants

Rule 1. Participants
Those persons whose requests to participate in the conference have been approved by the Secretariat of Unesco may take part in an individual capacity in the work of the conference.

Rule 2. Programme
The conference shall consider the items included in the programme of the conference, prepared by the Director-General of Unesco with the advice of the consultants appointed for the preparation of the conference.

Rule 3. List of participants
The secretary-general of the conference shall prepare a list of participants and circulate it to the conference for information.

II. Officers and Secretariat

Rule 4. Officers of the conference
The officers of the conference shall comprise the following: the president and vice-presidents of the conference, the chairmen, vice-chairmen and introductory speakers of sessions. They shall be appointed by the Director-General of Unesco in advance of the conference, from among the participants eminent in the different subjects to be examined by the conference with the advice of the consultants appointed for the preparation of the conference.

Rule 5. Secretary-General
The Director-General of Unesco shall appoint a secretary-general of the

conference and such other officials as may be required for the secretariat of the conference.

Rule 6. Duties of the secretariat

1. It shall be the duty of the secretariat to receive and distribute working documents, to interpret speeches made at meetings, to prepare the records of the conference, and to perform all other work necessary to the smooth running of the conference.
2. The secretariat may, at any moment, with the approval of the president or the chairman, make to the conference or its bodies, either orally or in writing, communications on any matters under consideration.

III. Organization of the Work of the Conference

Rule 7. Meetings

The work of the conference shall be conducted in plenary meetings, in accordance with the programme prepared by the Director-General of Unesco.

Rule 8. Presentation of papers

The secretary-general shall circulate the list of papers to be discussed in the meetings. Each paper shall be presented by the author or by a competent person nominated by the author. Otherwise the paper shall be withdrawn from discussion.

Rule 9. Publicity of meetings

All plenary meetings shall be held in public.

Rule 10. Duties of the chairmen of sessions

1. The chairman shall open and close each meeting of the conference. He shall direct the discussions, ensure observance of these rules and accord the right to speak. He may suspend or adjourn a meeting, or adjourn the discussion on the item under consideration.
2. The chairman shall call upon participants wishing to take part in discussions in the order in which they signify their wish to speak, unless another procedure is required for an orderly discussion. He may close the list of speakers and close the discussions.
3. For the convenience of discussion, the chairman may limit the time to be allowed to each speaker.

Rule 11. Proposals

No proposals requiring adoption by voting shall be submitted or entertained by the conference.

Rule 12. Acting chairmen

If the chairman is absent during a meeting or any part thereof, he shall be replaced by the vice-chairman. A vice-chairman acting as chairman shall have the same duties and powers as the chairman.

IV. Languages

Rule 13. Working languages

1. English, French and Russian shall be the working languages of the conference. Speeches made in one of the working languages shall be interpreted into the other two languages.
2. The speakers are also free to use any other language provided that they make their own arrangements for the interpretation of their speeches into one of the three working languages.

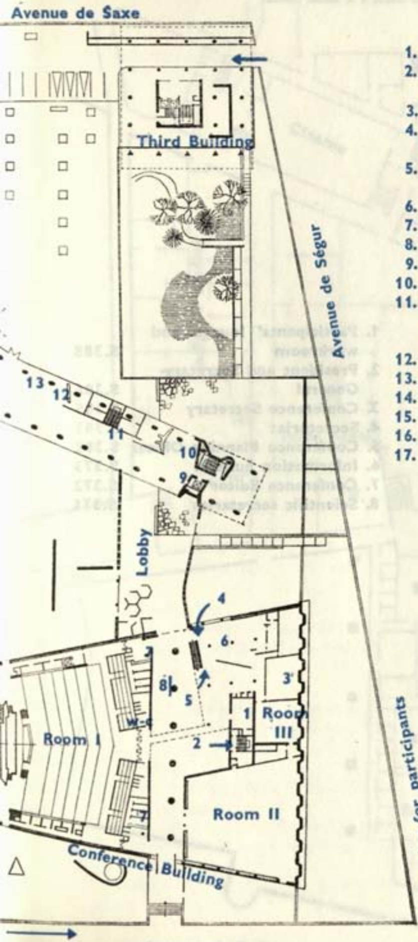
V. Records

Rule 14. Proceedings

1. The Proceedings will be published under the auspices of Unesco after the end of the conference. In addition to introductory material relating to the convening of the conference, its organization and composition, they will comprise the full text of all papers presented orally to the conference and all interventions during the meetings on the basis of the texts provided to the secretariat by the speakers themselves.
2. The edition of the Proceedings will be bilingual in English and French, each paper or intervention appearing in its original language with no translation. The summaries of the papers, however, will appear in four languages: English, French, Russian and Spanish.
3. Unesco reserves the right to publish or have published the Proceedings in languages other than English and French.

Annex B
Plans of Unesco Headquarters

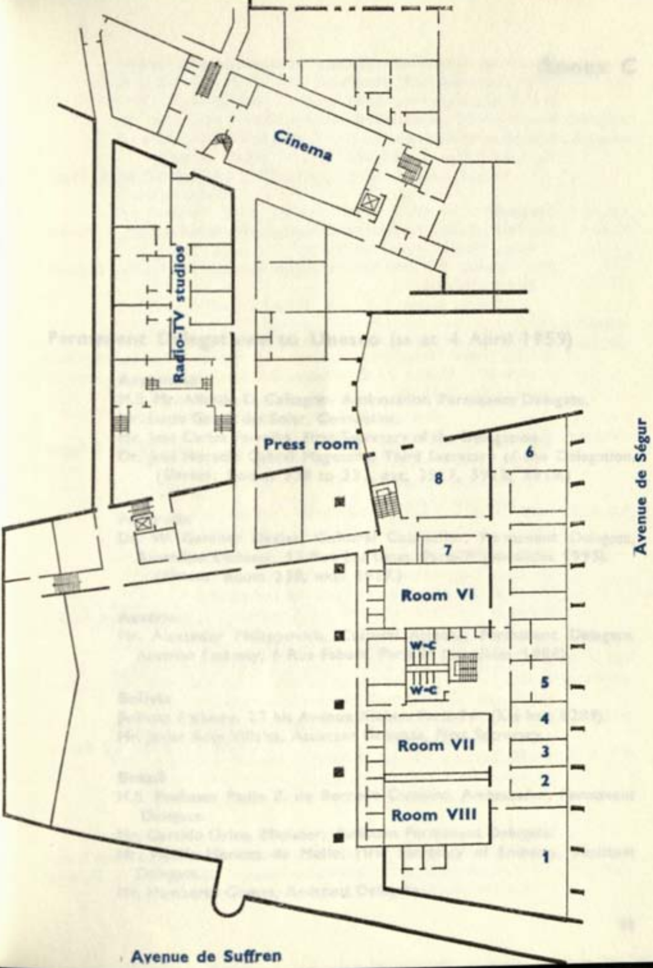
Permanent Headquarters of Unesco
Ground Floor



1. Reception of participants
2. Access to committee rooms (below ground)
3. Documents distribution
4. Access to Rooms IV and V (first floor)
5. Access to Press Room (below ground)
6. Bar
7. Cloakrooms
8. Manufacturers' stand
9. Tourist office
10. Bank
11. Access to radio-television studios, cinema (below ground)
12. Travel agency
13. Newspaper kiosk
14. Unesco bookshop
15. Gifts
16. Visitors' service
17. Library

Conference Building
Basement

1. Participants' lounge and workroom	S.388
2. President and Secretary-General	S.386
3. Conference Secretary	S.385
4. Secretariat	S.383
5. Conference Planning Officer	S.382
6. Information bulletin	S.373
7. Conference Editor	S.372
8. Scientific secretaries	S.371


Cinema
Radio-TV studios
Press room
6
8
7
Room VI
W-C
W-C
5
4
Room VII
3
2
Room VIII
1
Avenue de Ségur
Avenue de Suffren

Annex C

Permanent Delegations to Unesco (as at 4 April 1959)

Argentina

H.E. Mr. Alfredo D. Calcagno, Ambassador, Permanent Delegate.
Mr. Lucio Garcia del Solar, Counsellor.
Mr. Juan Carlos Ferreira, First Secretary of the Delegation.
Dr. José Horacio Cabral Magnasco, Third Secretary of the Delegation.
(*Unesco:* Rooms 328 to 333, ext. 3917, 3918, 3919.)

Australia

Dr. W. Gardner Davies, Cultural Counsellor, Permanent Delegate, Australian Embassy, 13 Rue Las Cases, Paris-7e (Inv alides 1995).
(*Unesco:* Room 338, ext. 3927.)

Austria

Mr. Alexander Philippovich, Cultural Attaché, Permanent Delegate, Austrian Embassy, 6 Rue Fabert, Paris-7e (Inv alides 1888).

Bolivia

Bolivian Embassy, 27 bis Avenue Kléber, Paris-16e (Klé ber 8289).
Mr. Javier Arce Villalta, Assistant Delegate, First Secretary.

Brazil

H.E. Professor Paulo E. de Berredo Carneiro, Ambassador, Permanent Delegate.
Mr. Osvaldo Orico, Minister, Assistant Permanent Delegate.
Mr. Mellilo Moreira de Mello, First Secretary of Embassy, Assistant Delegate.
Mr. Humberto Gomes, Assistant Delegate.

Mr. Antonio Dias Tavares Bastos, Assistant Delegate.
Miss Viviane Izambard, Attachée.
Mrs. Attala Soares Mauny, Attachée.
Miss Maria de Lourdes Campos, Attachée.
Mrs. Maria Oliva Fraga.
Mr. Cicero Dias, Attaché.
(*Unesco:* Rooms 413-421, ext. 3952, 3954, 3956, 3958, 3960.)

Bulgaria

Mr. Boris Milev, Permanent Delegate, Bulgarian Legation, 1 Avenue Rapp, Paris-7e (Invalides 8590).

Mr. Bogomil Nikolov Rainov, First Secretary, Bulgarian Legation, Deputy Delegate
(*Unesco:* Room 339, ext. 3928.)

Cambodia

H.R.H. Prince Norodom Norindeth, Permanent Delegate, Cité Universitaire, Maison du Cambodge, 27 Boulevard Jourdan, Paris-14e (Port-Royal 4568).

Chile

H.E. Mr. Carlos Morla Lynch, Ambassador, Permanent Delegate, 32 Avenue Marceau, Paris-16e (Élysées 8451).

Mrs. Pila Subercaseaux Aldunate. Civil Affairs Attachée.
(*Unesco:* Room 341, ext. 3930.)

China

Professor Chen Yuan, Permanent Delegate.
Dr. Chou Ling, Secretary to the Delegation.
Dr. Chao Keh-ming, Secretary to the Delegation.
Professor Sun Tan-yueh, Cultural Counsellor to the Embassy, Adviser to the Delegation.
Dr. Kuo Yu-shou, Adviser to the Delegation.
(*Unesco:* Rooms 436 to 439, ext. 3975, 3977, 3978.)

Colombia

H.E. Mr. Hernando Téllez, Ambassador, Permanent Delegate.
Dr. H. Arbelaez, First Secretary, Colombian Embassy, 22 Rue de l'Élysée, Paris-8e (Anjou 4608).
Dr. Julio Asuad, Minister-Counsellor.
(*Unesco:* Room 422, ext. 3847, 3961.)

Costa Rica

H.E. Mr. Rodolfo Pinto Echeverria, Costa Rican Ambassador in France, Permanent Delegate, Costa Rican Embassy, 44 Rue Hamelin, Paris-16e (Kléber 4865).

Cuba

H.E. Dr. Raimundo Lazo y Baryolo, Ambassador Extraordinary and Plenipotentiary for Cultural Questions, Permanent Delegate

Dr. Flora Diaz Parrado, Minister-Counsellor, First Assistant Delegate.

Dr. Hilda Labrada Bernal, Secretary of Embassy, Second Assistant Delegate.

(*Unesco:* Rooms 215/16, ext. 3856.)

Czechoslovakia

Mr. Vladimir Cihák, Embassy Attaché, Assistant Permanent Delegate, Czechoslovak Embassy, 15 Avenue Charles Floquet, Paris-7e (Ség ur 2910).

(*Unesco:* Room 310, ext. 3899.)

Dominican Republic

H.E. Dr. Salvador E. Paradas, Envoy Extraordinary and Minister Plenipotentiary, Permanent Delegate, 20 Rue Vidollet, Geneva (Switzerland).

Ecuador

Dr. Luis Enrique Jaramillo, Permanent Delegate.

Mr. Cristobal de Acevedo, Assistant Delegate.

Mrs. Isabel Rosales de Zaldumbide, Assistant Delegate for Art Questions.

(*Unesco:* Room 320, ext. 3909.)

El Salvador

Mr. Antonio Salazar, Minister-Counsellor, Salvadorian Embassy, Permanent Delegate, 12 Rue Galilée, Paris-16e (Klé ber 5321).

Mrs. Elena Sol de Gutierrez, Assistant Delegate, 20 Avenue George V, Paris-8e.

France

Mr. Robert Morisset, Permanent Delegate.

Mr. Raymond Rodriguez, Assistant Delegate, French Service for Unesco, Ministry of Foreign Affairs, 37 Quai d'Orsay, Paris-7e (Inv alides 1640).

Mr. Yves Brunsvick, Secretary-General of the National Commission, Officer for Liaison with Unesco, Ministry of Foreign Affairs.

Mr. Yves Igot, Assistant to the Secretary-General of the National Commission.

Mrs. Marianne Ranson, Assistant to the Secretary-General of the National Commission.

(*Unesco:* Room 242, ext. 3882.)

Federal Republic of Germany

Professor Otto von Simson, Permanent Delegate, Embassy of the Federal Republic of Germany, 15 Avenue Franklin D. Roosevelt, Paris-8e (Ély sée 3351).

Greece

Mr. Georges Averoff, Cultural Counsellor, Permanent Delegate, Royal Greek Embassy, 17 Rue Auguste Vacquerie, Paris-16e (Klé ber 6064).
(*Unesco*: 239, ext. 3879.)

Guatemala

Mr. Oscar Bertholin y Galvez, Permanent Delegate, Guatemalan Embassy, 73 Rue de Courcelles, Paris-8e (Car not 7863).

Hungary

Mr. Kalman Ujlaki, Permanent Delegate, Hungarian Legation, 15 Rue de Berri, Paris-8e (Ély sées 3741).
(*Unesco*: Room 319, ext. 3908.)

Iran

H.E. Dr. G. A. Raadi, Ambassador, Permanent Delegate.
Mr. Achena, Member.
Mr. Toubia, Member.
Mr. Ostovani, Member.
(*Unesco*: Rooms 308, 311 to 314, ext. 3897, 3901, 3903.)

Israel

H.E. Mr. Jacob Tsur, Israeli Ambassador in France, Permanent Delegate, Israeli Embassy, 143 Avenue de Wagram, Paris-17e (Wag ram 8682).
Mr. Yehuda Horam, Second Secretary at the Embassy, Assistant Delegate.
(*Unesco*: 441, ext. 2132.)

Italy

Mr. Gian Franco Pompei, Counsellor of Embassy, Permanent Delegate.
Mr. Alessandro Pedroni, Assistant Delegate, Italian Embassy, 51 Rue de Varenne, Paris-7e (Lit tré 6732).
(*Unesco*: Rooms 407, 408, ext. 3946, 3947.)

Japan

H.E. Mr. T. Furukaki, Japanese Ambassador in France, Permanent Delegate, Japanese Embassy, 24 Rue Greuze, Paris-16e (Klé ber 4610).
Mr. Noboru Sugiura, Counsellor at the Embassy, Deputy Permanent Delegate.
Mr. Manabu Yamamoto, Attaché at the Embassy, Assistant Permanent Delegate.
(*Unesco*: Room 205, ext. 3844.)

Korea

Mr. Yong Shik Kim, Minister of the Republic of Korea in France, Permanent Delegate, Korean Legation, 33 Avenue Mozart, Paris-16e (Mir abeau 4928).

Lebanon

H.E. Mr. Charles Ammoun, Minister Plenipotentiary, Permanent Delegate.
(*Unesco:* Rooms 207, 208, (ext. 3846, 3847.)

Mexico

Dr. Silvio Zavala, Cultural Counsellor at the Mexican Embassy, Permanent Delegate.

Mr. Jesus Cabrera Muñoz-Ledo, Assistant Delegate.
(*Unesco:* Rooms 227, 229, (ext. 3867, 3869.)

Monaco

Mr. René Bocca, Delegate of the Principality accredited to Unesco, First Secretary (Cultural Affairs), Legation of Monaco, 2 Rue du Conseiller-Collignon, Paris-16e (Tro cadéro 1329).

Morocco

The Permanent Delegate, Moroccan Embassy, 3 Rue Le Tasse, Paris-16e (Tro cadéro 6935).

Panama

H.E. Mr. Raimundo Ortega Vieto, Ambassador of the Republic of Panama in France, Permanent Delegate, 53 Rue de Prony, Paris-17e (Wag ram 9540).

Paraguay

H.E. Mr. Ramon Caballero de Bedoya, Ambassador, Permanent Delegate, 15 Rue Lamennais, Paris-8e (Ély sées 5649).

Peru

H.E. Mr. Ventura Garcia Calderôn, Ambassador, Permanent Delegate, 92 Avenue de Suffren, Paris-15e (Suf fren 5536).

Mr. Alberto Jochamowitz, Deputy Delegate, 5 Avenue Mac-Mahon, Paris-17e (Gal vani 6683).

Mr. Roberto McLean y Estenos, Minister Plenipotentiary, Assistant Delegate.
(*Unesco:* Room 342, ext. 3931.)

Philippines

H.E. Mr. Salvador P. Lopez, Ambassador of the Philippines in France, Permanent Delegate, Embassy of the Philippines, 26 Avenue Georges-Mandel, Paris-16e (Klé ber 5838)

Mr. Mauro Mendez, Minister-Counsellor.

Mr. Melquiades Ibanez, Counsellor

Mr. Ernesto C. Pineda, Third Secretary.

Miss E. Zacarias, Attachée.

Mr. Mariano C. Landicho, Attaché.

Poland

Mr. Miroslaw Zulawski, Cultural Counsellor, Permanent Delegate, Polish Embassy, 1-3 Rue de Talleyrand, Paris-7e (Inv alides 6080).

Mr. Antoni Osmanski, Member of the Delegation.

Rumania

Mrs. Ligia Macovei, Permanent Delegate, Legation of the People's Republic of Rumania, 17 Rue Brémontier, Paris-17e (Car not 1071). (*Unesco:* Room 241, ext. 3881.)

Spain

H.E. Mr. Federico Diez y de Ysasi, Minister Plenipotentiary, Permanent Delegate.

Mr. D. Joaquin Pérez Villanueva, Member of the Delegation, Member of the Executive Board of Unesco.

Mr. L. Segovia, Assistant

(*Unesco:* Rooms 305 to 307, ext. 3894, 3895, 3896.)

Switzerland

Mr. Bernard Barbey, Minister Plenipotentiary (Cultural Affairs Officer), Permanent Delegate, Swiss Embassy, 142 Rue de Grenelle, Paris-7e (Inv alides 6292).

Union of Soviet Socialist Republics

H.E. Dr. V. S. Kemenov, Ambassador, Permanent Delegate.

Mr. A. V. Zhukov, Deputy Permanent Delegate.

Mr. Nicolas S. Novikov, First Secretary of the Delegation.

Mr. E. Yakovlev, Second Secretary of the Delegation.

Mr. A. Tepliachin, Third Secretary of the Delegation.

Mr. V. E. Miakuchko, Attaché to the Delegation.

(*Unesco:* Rooms 236 to 238, 240, ext. 3877 3878, 3880.)

United Arab Republic

Dr. Hussein I. El Hakim, Permanent Delegate.

Dr. Abdellatif, Assistant Delegate.

Mr. Abdel Hamid Sabbour, Attaché to the Delegation.

(*Unesco:* Rooms 410 to 412, ext. 3949, 3950 3951.)

United Kingdom

The Permanent Delegate, British Embassy, 35 Rue du Faubourg St-Honoré, Paris-8e (Anj ou 2710).

United States of America

Mr. Henry J. Kellermann, Permanent Delegate.

Mrs. Magdalen G. H. Flexner, Assistant.

Miss Betty C. Gough, Assistant.

Mrs. Frances E. Osgood, Administrative Assistant.

(*Unesco:* Rooms 217 to 222, ext. 3857, 3859, 3860.)

Venezuela

H.E. Dr. Mariano Picón Salas, Ambassador, Permanent Delegate.

H.E. Dr. C. Parra-Perez, Ambassador, Permanent Delegate.

H.E. Dr. Zerega Fombona, Ambassador, Permanent Delegate. (*Unesco:* Rooms 423 to 425, ext. 3962, 3963, 3964.)

Yugoslavia

Mr. Petar Segedin, Cultural Counsellor, Permanent Delegate, Embassy of the People's Federative Republic of Yugoslavia, 1 Boulevard Delessert, Paris-16e (Tro cadéro 8901).

Cultural Attachés or Representatives responsible for Liaison with Unesco

Canada

Mr. Gérard Bertrand, Second Secretary, Press and Cultural Affairs Section, Canadian Embassy, 35 Avenue Montaigne, Paris-16e (Bal zac 9955).

Ceylon

Mrs. Anil de Silva, Government of Ceylon Liaison Officer, 9 Avenue de la Porte de Vanves, Paris-14e (Blo met 2000).

Denmark

Mr. Mogens Hermannsen, Counsellor of Embassy, Press and Cultural Affairs Officer, Danish Embassy, 77 Avenue Marceau, Paris-16e (Klé ber 8300).

Finland

Mr. Paul Jÿrkankallio, Secretary for Cultural and Press Questions, Finnish Embassy, 30 Cours Albert Ier, Paris-8e (Ély sées 0020).

Indonesia

Indonesian Embassy, 49 Rue Cortambert, Paris-16e (Tro cadéro 2331).

Iraq

Dr. H. Al-Hilali, Cultural Attaché, Legation of the Republic of Iraq, 4 Argelanderstrasse, Bonn (Federal Republic of Germany).

Netherlands

Mr. S. de Gorter, Counsellor (Cultural Affairs and Press), Netherlands Embassy, 11 Rue de Constantine, Paris-7e (Inv alides 4472).

Sweden

Mr. Lars Langaker, Cultural Attaché, Swedish Embassy, 25 Rue de Bassano, Paris-8e (Ély sées 1791).

Tunisia

Mr. Mohamed Ettri, Cultural Counsellor, Tunisian Embassy, 25 Rue Barbet-de-Jouy, Paris-7e (Inv alides 8023).

Turkey

Mr. Bahattin Ornekol, Cultural Attaché, Turkish Embassy, 56 Rue de la Victoire, Paris-9e (Tri nité 7716).

Viet-Nam

Embassy of the Republic of Viet-Nam in France, 45 Avenue de Villiers, Paris-17e (Car not 9519).
(*Unesco:* Room 309, ext. 3898.)

Permanent Observer

Holy See

Mgr F. Pirozzi, Permanent Observer of the Holy See accredited to Unesco, Papal Nunciature in France, 10 Avenue du Président-Wilson, Paris-16e (Pas sy 5834).
(*Unesco:* Room 224, ext. 3864.)

Annex D

Embassies and Legations in Paris

Afghanistan, 32 Avenue Raphaël, Paris-16e.	Jas min	6609
Albania, 131 Rue de la Pompe, Paris-16e.	Klé ber	8938
Argentina, 33 Rue Galilée, Paris-16e.	Klé ber	1469
Australia, 13 Rue Las Cases, Paris-7e.	Inv alides	2741
Austria, 6 Rue Fabert, Paris-7e.	Inv alides	1888
Belgium, 9 Rue de Tilsitt, Paris-17e.	Éto ile	6100
Bolivia, 27 bis Avenue Kléber, Paris-16e.	Klé ber	8289
Brazil, 45 Avenue Montaigne, Paris-8e.	Ély sées	3968
Bulgaria, 1 Avenue Rapp, Paris-7e.	Inv alides	8590
Burma, 60 Rue Ampère, Paris-17e.	Car not	5927
Cambodia, 21 Rue Franklin, Paris-16e.	Tro cadéro	4116
Canada, 35 Avenue Montaigne, Paris-8e.	Bal zac	9955
Ceylon, 194 Avenue Victor-Hugo, Paris-16e.	Tro cadéro	3249
Chile, 2 Avenue de la Motte-Piquet, Paris-7e.	Inv alides	8490
China, 11 Avenue Georges V, Paris-8e.	Ély sées	6777
Colombia, 22 Rue de l'Élysée, Paris-8e.	Anj ou	4608
Costa Rica, 46 Rue Hamelin, Paris-16e.	Klé ber	4865
Cuba, 60 Avenue Foch, Paris-16e.	Klé ber	5230
Czechoslovakia, 15 Avenue Charles-Floquet, Paris-7e.	Ség ur	2910
Denmark, 77 Avenue Marceau, Paris-16e.	Klé ber	8300
Dominican Republic, 34 Rue Beaujon, Paris-8e.	Car not	1018
Ecuador, 34 Avenue de Messine, Paris-8e.	Lab orde	1021
El Salvador, 12 Rue Galilée, Paris-16e.	Klé ber	5321
Ethiopa, 35 Avenue Charles-Floquet, Paris-7e.	Ség ur	4073
Finland, 30 Cours Albert-Ier, Paris-8e.	Ély sées	0020
Federal Republic of Germany, 13 Avenue Franklin-Roosevelt, Paris-8e.	Ély sées	3351
Ghana, 8 Villa Saïd, Paris-16e.	Klé ber	0532

Greece, 17 Rue Auguste-Vacquerie, Paris-16e.	Klé ber 6064
Guatemala, 73 Rue de Courcelles, Paris-8e.	Car not 7863
Haïti, 10 rue Théodule-Ribot, Paris-17e.	Wag ram 4778
Holy See, 10 Avenue du Président-Wilson, Paris-16e.	Pas sy 5834
Honduras, 11 bis Boulevard Delessert, Paris-16e.	Tro cadéro 0898
Hungary, 15 Rue de Berri, Paris-8e.	Ély sées 3741
Iceland, 124 Boulevard Haussmann, Paris-8e.	Lab orde 8154
India, 15 Rue Alfred-Dehodencq, Paris-16e.	Tro cadéro 3930
Indonesia, 49 Rue Cortambert, Paris-16e.	Tro cadéro 2331
Iran, 5 Rue Fortuny, Paris-17e.	Car not 8290
Ireland, 4 Rue Rude, Paris-16e.	Pas sy 7358
Israël, 143 Avenue de Wagram, Paris-17e.	Wag ram 8682
Italy, 51 Rue de Varenne, Paris-7e.	Lit tré 6732
Japan, 24 Rue Greuze, Paris-16e.	Klé ber 4610
Korea, 33 Avenue Mozart, Paris-16e.	Mir abeau 4928
Laos, 74 Avenue Raymond-Poincaré, Paris-16e.	Klé ber 0298
Lebanon, 42 Rue Copernic, Paris-16e.	Pas sy 5209
Liberia, 8 Rue Jacques-Bingen, Paris-17e.	Wag ram 5855
Libya, 48 Avenue de New-York, Paris-16e	Poi ncaré 3369
Luxembourg, 33 Avenue Rapp, Paris-7e.	Sol férino 4733
Mexico, 9 Rue de Longchamp, Paris-16e.	Pas sy 4144
Monaco, 2 Rue du Conseiller-Collignon, Paris-16e.	Tro cadéro 1329
Morocco, 3 Rue Le Tasse, Paris-16e.	Tro cadéro 6935
Nepal, 71 Avenue Paul-Doumer, Paris-16e.	Opé ra 3637
Netherlands, 85 Rue de Grenelle, Paris-7e.	Bab ylone 1240
New Zealand, 9 Rue Léonard-de-Vinci, Paris-16e.	Klé ber 6650
Nicaragua, 47 bis Avenue Kléber, Paris-16e.	Pas sy 3684
Norway, 6 Place de Narvik, Paris-8e.	Lab orde 8735
Pakistan, 18 Rue Lord-Byron, Paris-8e.	Bal zac 2332
Panama, 53 Rue de Prony, Paris-17e.	Wag ram 9540
Paraguay, 155 Avenue Victor-Hugo, Paris-16e.	Klé ber 2003
Peru, 50 Avenue Kléber, Paris-16e.	Pas sy 3115
Philippines, 26 Avenue Georges-Mandel, Paris-16e.	Klé ber 5838
Poland, 1 and 3 Rue de Talleyrand, Paris-7e.	Inv alides 6080
Portugal, 3 Rue de Noisiel, Paris-16e.	Klé ber 1216
Rumania, 17 Rue Brémontier, Paris-17e.	Car not 1071
San Marino, 4 Rue de Berri, Paris-8e.	Ély sées 4331
Spain, 13 Avenue Georges V, Paris-8e.	Ély sées 2933
Sudan, 5 Rue Charles-Lamoureux, Paris-16e.	Poi ncaré 2508
Sweden, 25 Rue de Bassano, Paris-8e.	Ély sées 1791
Switzerland, 142 Rue de Grenelle, Paris-7e.	Inv alides 6292
Thaïland, 8 Rue Greuze, Paris-16e.	Poi ncaré 3221
Tunisia, 25 Rue Barbet-de-Jouy, Paris-7e.	Inv alides 8023
Turkey, 17 Rue d'Ankara, Paris-16e.	Aut euil 4450

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Annex E

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Languages Division	2302
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Reception service	3756 to 3758
Working room and lounge for participants and co-ordinators of symposia	3724 to 3726
Bank (Société Générale)	2127, 2128
Bookshop	2028
Manufacturers' stand	3769
Medical service	3042, 3035 (afternoon only)
Newspaper stand	2120
Restaurant	3801
Souvenir stand	2119
Tourist office	2129
Travel agency (General Tours)	2121 to 2123
Visitors' service	2112 to 2114


8
7
4
3
1

International Conference on Information Processing

Conférence internationale sur le traitement numérique de l'information

participants

Unesco
Paris, 15-20 juin 1959

LIST OF PARTICIPANTS

including all names received up to 1st June 1959
Names received after that date will appear in the Information Bulletin № 1

TABLE OF CONTENTS

LISTE DES PARTICIPANTS

avec tous les noms reçus jusqu'au 1er juin 1959
Les noms reçus postérieurement à cette date paraîtront dans le Bulletin d'Information nº 1

TABLE DES MATIERES

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European Productivity Agency:
PIETSCH, Dr

Organisation for European Economic Co-operation:
LOEWENTHAL

INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS

International Union of Geodesy and Geophysics:
DUFOUR, H.

Union of International Engineering Organizations:
CAMBOURNAC, L.

International Federation of Documentation:
PIETSCH, Dr.

Paris • June 13-23, 1959

INTERNATIONAL CONFERENCE ON INFORMATION PROCESSING

UNDER THE SPONSORSHIP OF UNESCO

(UNITED NATIONS EDUCATIONAL, SCIENTIFIC, AND CULTURAL ORGANIZATION)

AND AUTO-MATH 59

CONFERENCE EVENTS and OFFICIAL TRAVEL ARRANGEMENTS

The United States Committee for the International Conference on Information Processing

Sponsored by

INSTITUTE OF RADIO ENGINEERS (IRE)	ASSOCIATION OF COMPUTING MACHINERY (ACM)	AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (AIEE)

INTERNATIONAL CONFERENCE ON INFORMATION PROCESSING

Unesco House • Paris, France • June 13-23, 1959

The United Nations, through UNESCO, is sponsoring a global computer conference. American participation is being coordinated by the United States Committee for the International Conference on Information Processing (USICIP) representing IRE, ACM, and AIEE. Similar groups in 13 other nations are working with UNESCO on the program.

The scope of the conference will include 54 formal technical papers in five major areas, informal symposia in at least 13 major application categories, AUTO-MATH 1959, a major exhibit with technical papers concerning the equipment displayed or announcing new equipment designs, and foreign facility tours.

PARTICIPATION

American representation at the conference will be on an individual basis. Membership in one of the sponsoring technical societies is NOT a prerequisite for attendance and participation. However, registration will be coordinated by the United States Committee so that an official list of attendees may be submitted to the UNESCO Secretariat. Symposia will be held in conjunction with the conference at which interested individuals can participate in the discussion of the special subjects listed below under "Symposia."

PLENARY SESSIONS

The formal technical program covering five subject areas will be presented in ten three-hour plenary sessions in the new UNESCO House June 15 through June 20. A general rapporteur will present an introductory discussion on each of the five subjects. There will be simultaneous oral translation of the technical papers into English, French, Russian and German. Comments from the floor will be invited, and the published Conference Proceedings will contain the entire text of the papers and the discussion from the floor, provided the latter is also submitted in writing. All abstracts and preprints will be provided to officially registered conference participants prior to the conference.

PLENARY SESSIONS

Honorary Chairman: Professor Howard H. Aiken (USA)

Honorary Vice Chairmen

M. Goto (Japan)
S. A. Lebedev (USSR)
J. W. Mauchly (USA)
M. Peri (France)
M. Picone (Italy)
G. Santesmases (Spain)
M. V. Wilkes (United Kingdom)
A. van Wijngaarden (Netherlands)
K. Zuse (German Federal Republic)

1. METHODS OF DIGITAL COMPUTING

Rapporteur: J. Kuntzmann (France)

Errors Approximations

President: E. de Possel (France)

Vice President: L. Amerio (Italy)

Rounding errors in algebraic processes, J. H. Wilkinson (U.K.)

Sur l'estimation des erreurs d'arrondi, Ch. Blanc (Switzerland)

Theoretical and experimental studies on the accumulation of error in the numerical solution of initial value problems for systems of ordinary differential equations, P. Henrici (USA)

Rational approximations for transcendental functions, H. J. Maehly (USA)

The exact determination of the characteristic polynomial of a matrix, D. B. Gillies (USA)

Partial Differential Equations, Applications and Linear Programming

President: A. Ghizzetti (Italy)

Vice President: J. Carteron (France)

The use of high-speed digital computers for the solution of partial differential equations, A. A. Dorodnitzin (USSR)

Methods of computation on digital computers for partia. differential equations, L. Collatz (Germany)

The solution of elliptic difference equations by stationary iterative processes, D. J. Evans (U.K.)

Overrelaxation applied to implicit alternating direction methods, R. S. Varga (USA)

Resolution sur calculateur electronique d'un probleme d'algebre diophantienne, G. Letellier and R. Lattes (France)

Les programmes logarithmiques—Application aux calculs des programmes convexes specialement lineaires, G. R. Parisot (France)

2. LOGICAL DESIGN OF DIGITAL COMPUTERS

Rapporteur: M. V. Wilkes (U.K.)

Logical Design in General

President: H. Yamashita (Japan)

Vice President: Stiefel (Germany)

Zebra, a simple binary computer, W. L. van del Poel (Netherlands)

The specification development of a cost-limited digital computer, M. Lehman (Israel)

Processing data in bits and pieces, F. B. Brooks, G. A. Blaauw and W. Buchholz (USA)

A new computing machine, S. A. Lebedev and K. Sulim (USSR)

Methods of speeding up the operation of digital computers, G. D. Monachov, I. Ia. Akushsky, L. B. Emerjanov-Iaroslavsky, E. I. Kijamko and V. S. Linsky (USSR)

Elimination of carry propagation in digital computers, G. Metze and J. E. Robertson (USA)

Time Sharing

President: Booth (U.K.)

Vice President: A. Svoboda (Czechoslovakia)

Time sharing in large fast computers, C. Strachey (U.K.)

Input and output in the X-1 computers, B. J. Loopstra (Netherlands)

Sympathetically programmed computers, W. F. Schmitt and A. B. Tonik (USA)

Sur certains aspects de la conception logique du gamma 60, J. Bosset (France)

Design of concurrently operating computer systems, A. L. Leiner, W. A. Notz, J. L. Smith and R. B. Marimont (USA)

High-Speed Computation and Other Subjects

President: A. S. Householder (USA)

Vice President: P. Dreyfus (France)

Application of error correction codes to multiway switching, H. Takahasi and E. Goto (Japan)

Logical elements on a majority decision principle and the complexity of their circuit, S. Muroga (Japan)

A three valued system of logic and its application to base three digital circuits, R. Vacca (Italy)

The use of cyclic permuted chain codes for digitizers, G. C. Tootill (U.K.)

The application of the numerical system of residual classes in mathematical machines, A. Svoboda (Czechoslovakia)

3. COMMON SYMBOLIC LANGUAGE FOR DIGITAL COMPUTERS

Rapporteur: S. Gorn (USA)

President: A. Walther (Germany)

Vice President: G. Hopper (USA)

A propos d'un language universal, J. M. Poyen and B. Vauquois (France)

Methods of logical recursive and operator analysis and synthesis of automata, I. I. Basilevsky, Iu. A. Shreider and I. Ia. Akushsky (USSR)

Pseudo-code translation on multi-level storage machines, F. G. Duncan and E. N. Hawkins (U.K.)

The problem of a common language, especially for scientific numerical work (motives, restrictions, aims and results of the Zurich Conference on Algol), F. L. Bauer (Germany)

Survey on the syntactical construction of the Zurich recommendation of the ACM and GAMM, J. Backus (USA)

4. AUTOMATIC TRANSLATION OF LANGUAGES

Rapporteur: D. Panov (USSR)

President: S. Comet (Sweden)

Vice President: M. Mastermann (U.K.)

Research in automatic translation at the Harvard Computation Laboratory, V. E. Giuliano and A. G. Oettinger (USA)

The COMIT system for mechanical translation, V. H. Yngve (USA)

The use of machines in the construction of a grammar and computer program for structural analysis, K. E. Harper and D. G. Hays (USA)

Machine translation from English to Japanese, S. Takahashi, R. Tadenuma, S. Watanabe and H. Wada (Japan)

Machine translation methods and their application to Anglo-Russian scheme, I. K. Belskaia (USSR)

5. PATTERN RECOGNITION AND MACHINE LEARNING

Rapporteur: K. Steinbuch (Germany)

Pattern Recognition

President: W. L. van del Poel (Netherlands)

Vice President: Inzinger (Austria)

Electronic reading machine, H. Wada, S. Takahashi, T. Iijima, Y. Okumura and K. Imoto (Japan)

A quasi-topological method for recognition of line patterns, H. Sherman (USA)

Procede analogique de reconnaissance des signes par tracage des contours, W. Sprick (Germany)

Quantitative research on potential methods, Kazmierczeck (Germany)

Information-theoretic aspects of character reading, S. Frankel (USA)

Proving Theorems

President: Bassilevsky (USSR)

Vice President: S. N. Alexander (USA)

On the recognition of speech by machine, G. W. Hughes and M. Halle (USA)

Report on a general problem solving program, A. Newell, J. C. Shaw and H. A. Simon (USA)

A program for the production of proofs for theorems derivable within the first order predicate calculus from axioms, P. C. Gilmore (USA)

Realization of a geometry theorem proving machine, H. Gelernter (USA)

A non-heuristic program for proving elementary logical theorems, B. Dunham, R. Fridshal and G. L. Sward (USA)

A new method for discovering the grammars of phrase structure languages, R. J. Solomonoff (USA)

Machine Learning

President: C. Manneback (Belgium)

Vice President: Biermann (Germany)

Plastic neurons as memory elements, D. G. Willis (USA)

Analysis of the working principles of some self-adjusting systems in engineering and biology, S. N. Braines, A. V. Napalkov and Iu. A. Shreider (USSR)

Experiments in machine learning and thinking, T. Kilburn, R. L. Grimsdale and F. H. Sumner (UK)

A machine model of recall, M. E. Stevens (USA)

Some mathematical fundamentals of the use of symbols in information retrieval, C. N. Mooers (USA)

A reduction method for non-arithmetic data and its application to Thesauric translation, A. F. Parker-Rhodes and R. M. Needham (U.K.)

SPECIAL SESSION ON COMPUTER TECHNIQUES OF THE FUTURE

President: I. L. Auerbach (USA)

Vice President: A. Speiser (Switzerland)

Program to be Announced

SYMPOSIA

Thirteen symposia have been set for the advance schedule. Registrants have been asked to indicate their preferences on the official UNESCO application form. Additional symposia may be organized on request to officials at the conference. These requests will be handled within the limits of available facilities. Scheduled symposia to date include:

1. Relationship between digital and analogue computing.
2. Collection, storage and retrieval of information.
3. Automatic programming.
4. Numerical analysis on computers.
5. Influence of very large memory designs and capabilities on information retrieval.
6. Logical organization for very high speed computers.
7. Methods for solving linear systems.
8. Linear programming.
9. Logical organization of very small computers.
10. Programming procedures.
11. Switching algebra.
12. Error detection and correction.
13. Machine translation.

AUTO-MATH 1959

The world's first global exhibition of information processing equipment, running the entire gamut of computation and peripheral equipment, from small electronic computers to complete data control systems, will be on display from June 13 to June 23. The exhibits will include both commercially manufactured equipment and special products of government laboratories and institutions. It is expected that the main manufacturers of such equipment from France, Germany, Japan, United Kingdom, United States and other countries will have exhibits. Technical expository papers related to equipment are scheduled for June 15-19th.

OFFICIAL TRAVEL ARRANGEMENTS

Although the conference is scheduled during the peak season for European travel, the USICIP has arranged to circumvent transportation and accommodation problems by the designation of an official travel agency, LANSEAIR Travel Service, Inc. LANSEAIR, with the cooperation of the officially designated airlines, American, KLM, and SAS has reserved air space from both East and West Coasts and hotel accommodations in Paris for groups of registrants and exhibitors. These group arrangements include the following benefits for USICIP registrants:

- *Protected connections with official USICIP overseas flights.*
- *Direct flights from New York.*

- *Flights over the North Pole from Los Angeles.*
- *Special stopover privileges in both U.S.A. and Europe.*
- *Consolidated ticketing.*
- *Additional baggage allowances on connecting domestic flights.*
- *Baggage pool privileges on special international flights.*
- *Paris hotel accommodations.*
- *Extended tours, permitting European computer facility visits.*

While use of the official travel agency by registrants is entirely optional, cooperation in utilizing its service would be most helpful to the U. S. Committee in collecting and coordinating the information on participants required by UNESCO and the State Department. The official Travel Agent will serve U. S. participants in part or in whole as you may desire. This means that if you have mixed travel, such as transportation to and from Paris on official business and vacation transportation at your own expense, he is prepared to handle either or both, along with hotel arrangements and any tours you may wish to take. The Fly-Now, Pay-Later plan is also available. Those who make entirely independent arrangements should notify the USICIP Arrangements Committee of their travel plans.

TRAVEL TO THE CONFERENCE

Departures from New York International Airport are scheduled on special USICIP/KLM flights for: June 7, 8, 9, 10, 11, 12, 13.

Departures from Los Angeles International Airport over the Polar Route are scheduled on special USICIP/SAS Polar Flights for: June 7, 8, 9, 10, 11, 12, 13.

Departure from Houston is scheduled on special USICIP/KLM flight for: June 13.

Departures from Montreal are scheduled on special USICIP/KLM flights for: June 10, 13.

Connections for these departures via the official overseas carriers are being arranged on the official domestic carrier, American Airlines. In cases where more expeditious service is available from certain cities on other carriers, you will be booked for the fastest, most convenient mode of air travel.

COMPUTER FACILITY VISITS

During the conference, visits to computer facilities in the immediate vicinity of Paris will be arranged. After the conference, you may wish to visit some of the many other computer activities throughout Europe, using the extra stopover privileges on your USICIP airline tickets via KLM and SAS. To assist you in planning such visits, itineraries of the special post-conference tours include cities in which computer facilities are located.

Official Group Travel Provisions

Because of the great number of participants involved, it was not found possible to provide the same type of hotel accommodations in Paris for everyone. The hotels chosen can be roughly classified as 1A, 1B, 2A and 2B, with prices ranging from $12.00 per person a day down to $5.00 per person a day including Continental breakfast and dinner. On the application form enclosed, there is a space for you to check the type of hotel desired. Billings will be made on the actual prices of the hotel to which the committee assigns you, once all the information is received. The actual prices of the tours are shown beneath each tour, and the one selected will be sent to you in complete detail, when you indicate your choice on the application form. Below you will find merely skeletonized itineraries to give you an outline of the places visited, together with total cost. The air fare to and from New York and to and from Los Angeles is included. The stay in Paris, together with the services of our representative who will meet you at the air terminal and take you to the hotel will be computed later, as previously stated, once the actual assignments are known.

OVERSEAS FLIGHT ONLY

For those who will merely require the overseas flight, the following prices apply with stop-over privileges included:

New York/Paris/New York	**First Class**	**$ 831.60**
	Economy Class	**$ 502.20**
Houston/Paris/Houston	**First Class**	**$1017.00**
	Economy Class	**$ 652.30**
Los Angeles/Paris/Los Angeles	**First Class**	**$1139.40**
	Economy Class	**$ 710.20**
Montreal/Paris/Montreal	**First Class**	**$ 806.40**
	Economy Class	**$ 493.20**

European stopover privileges: Glasgow—Edinburgh—London—Amsterdam—Brussels

ITINERARY NO. 1

June 24—PARIS to NICE by air.

June 25—NICE, with side trip to Monte Carlo.

June 26—NICE to ROME by air.

June 27-28—ROME. Complete sightseeing.

June 29—ROME to ZURICH by air.

June 30—ZURICH. Sightseeing. PM trip to Lucerne.

July 1—ZURICH to AMSTERDAM by air.

July 2—AMSTERDAM sightseeing. PM excursion to Volendam and Marken.

July 3—AMSTERDAM to BRUSSELS by air.

July 4—BRUSSELS. Morning sightseeing. PM by air to LONDON.

July 5—LONDON. Full day sightseeing.

July 6—LONDON. Half-day trip to Eton and Windsor Castle. Half day free for shopping. Evening departure for New York.

July 7—Arrive NEW YORK.

ITINERARY NO. 2

June 24—Leave Paris by rail for Lucerne.

June 25-26—LUCERNE, with mountain excursions.

June 27—LUCERNE by chartered motorcoach to INNSBRUCK via Vaduz, Liechtenstein, one of the most scenic Alpine drives in Europe.

June 28-29—INNSBRUCK, with side trips into Germany to visit Garmisch — Partenkirchen and Oberammergau.

June 30—INNSBRUCK, over the Brenner Pass, through the Dolomites to VENICE.

July 1-2—VENICE, with sightseeing and time free.

July 3—VENICE to FLORENCE.

July 4—FLORENCE. Sightseeing.

July 5—FLORENCE/ASSISI/ROME.

July 6, 7, 8—ROME, with complete sightseeing.

July 9—ROME to medieval Sienna.

July 10—SIENNA to GENOA.

July 11—GENOA, along the Italian Riviera to MONTE CARLO.

July 12—MONTE CARLO free.

July 13—MONTE CARLO by air to LONDON.

July 14, 15, 16—LONDON, with full sightseeing and trip to Windsor.

July 17—LONDON by air to Edinburgh. Sightseeing.

July 18—EDINBURGH, through the Trossachs and via Loch Lomond to GLASGOW and PRESTWICK Airport to embark for the U. S.

July 19—Arrive NEW YORK.

Tour No. 1

FROM NEW YORK BACK TO NEW YORK .... $ 852.00

FROM LOS ANGELES BACK TO LOS ANGELES $1060.00

Tour No. 2

FROM NEW YORK BACK TO NEW YORK .... $ 988.00

FROM LOS ANGELES BACK TO LOS ANGELES $1196.00

The prices include Economy Class transportation by air where applicable, including the trans-Atlantic portion, hotels based on twin-bedded rooms with private bath wherever available, breakfast and dinner throughout, luxury bus and/or first class transportation, sightseeing, gratuities to hotel servants, and the services of professional guides and conductors. • A detailed and descriptive writeup of the tour selected will be sent on receipt of the application form.

ITINERARY NO. 3

June 24—Leave PARIS by air for BRUSSELS. PM sightseeing.

June 25—BRUSSELS by chartered motorcoach to LUXEMBOURG and on to COBLENZ.

June 26—Down the Rhine Valley to Heidelberg, thence to the Black Forest overnighting in Freudenstadt.

June 27—FREUDENSTADT over the Swiss Border and on to BREGENZ on Lake Constanz in Austria.

June 28—VADUZ-LIECHTENSTEIN to LUCERNE.

June 29—LUCERNE free.

June 30—LUCERNE, ANDERMATT, COMO, MILAN.

July 1—MILAN to SAN MARINO, the world's oldest Republic.

July 2, 3, 4—ROME, with full sightseeing program.

July 5—ROME, ASSISI, FLORENCE.

July 6—FLORENCE. Sightseeing.

July 7—FLORENCE to GENOA.

July 8—GENOA to MONTE CARLO.

July 9—MONTE CARLO. Morning free. PM to AVIGNON.

July 10—AVIGNON, LE PUY, VICHY.

July 11—VICHY to PARIS, to connect with flight to LONDON.

July 12-13—LONDON sightseeing, including Windsor.

July 14—LONDON. Free, with PM departure for New York.

July 15—Arrive NEW YORK.

Tour No. 3

FROM NEW YORK BACK
TO NEW YORK.................................$ 891.00

FROM LOS ANGELES BACK
TO LOS ANGELES $1099.00

ITINERARY NO. 4

June 24—PARIS to FRANKFURT by air.

June 25—FRANKFURT. Sightseeing.

June 26—FRANKFURT to VIENNA, by air.

June 27-28—VIENNA. Full sightseeing program.

June 29—VIENNA to ZURICH by air. Continue by rail to LUCERNE.

June 30-July 1—LUCERNE, with sightseeing and mountain excursions.

July 2—LUCERNE by rail to VENICE.

July 3-4—VENICE. Sightseeing by gondola and on foot.

July 6—FLORENCE with half-day sightseeing. Balance of day free for shopping.

July 7—FLORENCE, ASSISI, ROME by bus.

July 8-9—ROME. Sightseeing.

July 10—ROME to NAPLES.

July 11—NAPLES to CAPRI and return in evening to NAPLES and take the Rapido to ROME.

July 12—ROME. Day free.

July 13—ROME by air to MADRID.

July 14, 15, 16—MADRID with complete city sightseeing, a day's excursion to Toledo and a side trip to EL ESCORIAL.

July 17—MADRID/NEW YORK.

July 18—Arrive NEW YORK.

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Tour No. 4

FROM NEW YORK BACK
TO NEW YORK.................................$1112.00

FROM LOS ANGELES BACK
TO LOS ANGELES $1320.00

REGISTRATION FORM

The official UNESCO registration form can be obtained on request to the

USICIP
Box 4999
Washington 8, D. C.

TRAVEL APPLICATION FORM

The following travel application form is for your convenience in requesting the desired transportation and/or hotel accommodations in Paris, and in addition for indicating your desire to participate in the post conference tours. Upon receipt of the application form, full information on passport regulations, health certificates required, detailed tour data, currency conversion tables and general travel tips will be forwarded to the participant.

OFFICIAL ICIP TRAVEL APPLICATION FORM

To: LANSEAIR
c/o U. S. Committee for ICIP
Box 4999
Washington 8, D. C.

I wish transportation from New York to Paris on the date I have circled:
June 7 — June 8 — June 9 — June 10 — June 11 — June 12 — June 13

I wish transportation from Houston to Paris on June 13 ☐

I wish transportation from Los Angeles to Paris via the Polar Route on the date I have circled:
June 7 — June 8 — June 9 — June 10 — June 11 — June 12 — June 13

I wish transportation from Montreal to Paris on June 10 ☐ June 13 ☐

I wish to leave the West Coast via American Airlines ☐

I will be leaving.. (state name of town) on .... (state date) for New York — Houston — Los Angeles — Montreal (delete cities not applicable) and wish flight arrangements to be made for me with my connecting overseas flight.

I wish to leave Europe on..(Specify exact departure date)

I am interested in traveling overseas via Economy ☐ or First ☐ Class (check applicable class).

In Paris I desire the following type hotel accommodation: 1A ☐ 1B ☐ 2A ☐ 2B ☐

I wish to take Tour No. 1 ☐ No. 2 ☐ No. 3 ☐ No. 4 ☐

I enclose my deposit in the amount of $100.00 which I understand will be refunded in full in the event of cancellation.

I am interested in the Fly Now, Pay Later Plan ☐

To assist USICIP in effective handling of your travel arrangements, please return this official application form by March 15th, or as soon as possible thereafter. (Any prior material sent you was purely to establish whether or not you were interested. **This is the official travel application form.**)

NO. OF PERSONS IN PARTY...ADDRESS..

NAMES.. ....

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I. WORK OF THE CONFERENCE

BUREAU OF THE CONFERENCE

President: Howard H. Aiken (U.S.A.)

Vice-Presidents:
M. Goto (Japan)
S.A. Lebedev (USSR)
J. Mauchley (U.S.A.)
J. Peres (France)
M. Picone (Italy)
J. Garcia Santesmases (Spain)
A. van Wijngaarden (Netherlands)
M. V. Wilkes (U.K.)
K. Zuse (Federal Republic of Germany)

LIST OF CHAIRMEN AND VICE-CHAIRMEN OF SESSIONS

	Chairman	Vice-Chairman
Monday, 15 June Session A	R. de Possel (France)	L. Amerio (Italy)
Tuesday, 16 June Session B	H. Yamashita (Japan)	S. Beltran (Mexico)
Session C	A. Walther (Germany)	H. Good (U.S.A.)
Wednesday, 17 June Session D	A. Ghizzetti (Italy)	J. Carteron (France)
Session E	A.D. Booth (U.K.)	A. Svoboda (Czecho-slovakia)
Thursday, 18 June Session F	S. Comet (Sweden)	M. Mastermann (U.K.)
Session G	A.S. Householder (U.S.A.)	Ph. Dreyfus (France)
Friday, 19 June Session H	W.L. van der Poel (Netherlands)	R. Inzinger (Austria)
Session I	I.I. Basilovsky (USSR)	S.N. Alexander (U.S.A.)
Saturday, 20 June Session J	V. Belevitch (Belgium)	L. Biermann (Federal Republic of Germany)
Session K (Special Session)	I.L. Auerbach (U.S.A.)	A. Speiser (Switzer-land)

ASSIGNMENT OF SCIENTIFIC SECRETARIES

Monday, 15 June

Session A	Errors and Approximations	Mlle. R. LAPEYRE (assisted by P. BLUNDELL)
Symposium	The influence of very large memory designs and capabilities	G. TARNAWSKY (assisted by Miss C. POPPLEWELL)
"	Switching Algebra	M. LERMOYEZ

Tuesday, 16 June

Session B	Logical design of digital computers	M. LERMOYEZ (assisted by K. PRAUSE)
" C	Common symbolic language for digital computers	P. BLUNDELL (assisted by BIRUKOV)
Symposium	Relationship between digital and analogue computing	M. LERMOYEZ (assisted by G. TARNAWSKY)
"	Logical organization of very small computers	K. PRAUSE (assisted by Miss POPPLEWELL)

Wednesday, 17 June

Session D	Partial differential equations, applications and linear programming	Mlle. R. LAPEYRE (assisted by BIRUKOV)
Session E	Logical design of digital computers	K. PRAUSE (assisted by Mlle. LAPEYRE)
Symposium	Linear programming	P. BLUNDELL
"	Error detection and correction	Miss C. POPPLEWELL
"	Collection, storage and retrieval of information	G. TARNAWSKY (assisted by M. LERMOYEZ)

Thursday, 18 June

Session F	Automatic translation of languages	G. TARNAWSKY (assisted by Miss POPPLEWELL)
Session G	Logical design of digital computers	M. LERMOYEZ (assisted by BIRUKOV)
Symposium	Machine translation	G. TARNAWSKY (assisted by Miss POPPLEWELL)
"	Automatic programming	P. BLUNDELL (assisted by Mlle. LAPEYRE)

Friday, 19 June

Session H	Pattern recognition	Miss C. POPPLEWELL (assisted by K. PRAUSE)
Session I	Proving of logical propositions	P. BLUNDELL (assisted by BIRUKOV)
Symposium	Numerical analysis on computers	Mlle. R. LAPEYRE (assisted by G. TARNAWSKI)
"	The logical organization for very high speed computers	Miss C. POPPLEWELL (assisted by M. LERMOYEZ)

Saturday, 20 June

Session J	Machine learning and on collection, storage and retrieval of information	Miss C. POPPLEWELL (assisted by G. TARNAWSKY)
Session K	Computer techniques of the future	K. PRAUSE (assisted by M. LERMOYEZ and G. TARNAWSKY)
Symposium	The methods for solving linear systems	Mlle. R. LAPEYRE (assisted by P. BLUNDELL)
"	Programming procedures (cancelled)	

EVENING LECTURES

The following evening lectures will take place in Room I at 9 p.m. on the following days:

Monday, 15 June	Professor Dr. A. WALTHER (Federal Republic of Germany)	Electronic calculating machines: How do they work?
Tuesday, 16 June	Professor A. van Wijngaarden (Netherlands)	The serious game
Thursday, 18 June	Dr. E.L. Harder (U.S.A.)	Computers and automation
Friday, 19 June	Mr. E. Delavenay (Unesco)	Automatic translation of languages: Problems of research and organization

III. MISCELLANEOUS NOTICES

CREATION OF AN INTERNATIONAL FEDERATION OF INFORMATION PROCESSING SOCIETIES

The meetings of consultants which were held during the past two years at Unesco House in order to prepare the International Conference on Information Processing also permitted an exchange of views regarding the possible creation of an International Federation of Information Processing Societies. The main reason for this proposal is the fact that Unesco has only accepted responsibility for the convening of the first International Conference on Information Processing. As a consequence, future conferences and symposia in this field should be the responsibility of a non-governmental scientific organization.

On Saturday, 13 June, the representatives of national societies from Canada, Denmark, Finland, France, German Federal Republic, Japan, the Netherlands, Poland, Sweden, the United Kingdom and the United States of America met at Unesco House in order to adopt the final statutes of the Federation. Italy was also represented by observers pending the creation of an Italian national society. The representative of Spain who arrived too late to attend the meeting confirmed that his country intended to join the new Federation.

It was agreed that the Statutes would enter into force on 1 January 1960, provided that seven Societies notified their acceptance.

It is hoped that it will be possible to make plans concerning the Secretariat of the new Federation and to establish the date and place of the second International Conference on Information Processing before the end of the present Conference.

All correspondence concerning the new Federation should be addressed to Mr. I.L. Auerbach, Auerbach Electronics Corporation, 109 North Essex Avenue, Narberth, Pennsylvania, with a copy to Mr. Jean A. Mussard, Natural Sciences Department, Unesco.

THE INTERNATIONAL COMPUTATION CENTRE AND ITS CORRESPONDING INSTITUTIONS

Meeting of 22 June

On Monday, 22 June, there will be a joint meeting of the Preparatory Committee of the International Computation Centre and of representatives of the Centre's corresponding institutions. The meeting will be held in Room VI.

The object of this meeting is to discuss ways and means of improving the co-operation between the corresponding institutions in matters such as exchange of personnel, exchange of scientific and methodological experience, and the rôle of the International Computation Centre as a link between the corresponding institutions.

In addition, the meeting may consider questions concerning future international collaboration in the field of information processing, which may arise from the present Conference.

Those corresponding institutions which have not yet communicated the name of their representative to the above meeting are requested kindly to inform Miss Campbell, Room S.383.

SPECIAL VISIT TO THE MUSEE DES MONUMENTS FRANCAIS

The French National Commission for Unesco invites all participants of the Conference to visit the Musée des Monuments français, Palais de Chaillot, Place du Trocadéro on 17 June, 1959, at 9 p.m. Invitations have been sent to all participants. Should any participant not have received his or her invitation, a card may be obtained at the Reception Service.

BROCHURES

1. The German Committee for Electronic Computers (DARA) has prepared the following brochure for the participants of the Conference:

"Information Processing in German-speaking Countries"

Participants may obtain a copy of this brochure by completing a form (obtainable at the Documents Distribution office in the foyer of the Conference building) and leaving it with the Conference Secretariat in Room S.383.

2. The periodical "TITEL VON VERÖFFENTLICHUNGEN UBER ANALOG-UND ZIFFERN-RECHNER UNDE IHRE ANWENDUNG" may also be had by participants on completion of a form obtainable from the Documents Distribution office in the foyer of the Conference building.

PARIS HOSTESSES

The official French Tourist office (Direction générale du Tourisme) has kindly agreed to maintain a special office in the hall of the Secretariat building throughout the Conference (ext. 2129).

Paris hostesses will provide participants with maps of Paris, tourists' folders and information on excursions, travel and entertainment.

The office will be open every day from 9.30 a.m. to 11.30 a.m. and from 5 p.m. to 7 p.m.

VISIT TO FACTORIES

(a) France

Participants wishing to visit the following factories - Cie. BULL, Société IBM-France and the Société d'Electronique et d'Automatisme are requested to contact the representatives of these firms, who will be at their service at the desks in the foyer of the Conference building (see plan in the Conference Handbook, Annex B).

II. OFFICIAL ANNOUNCEMENTS

SYMPOSIUM ON THE USE OF AUTOMATIC COMPUTING IN THE SOCIAL SCIENCES

This symposium will take place at Unesco House at 9 p.m. on Thursday, 18 June 1959 in Room II of the Conference building. It is organized by the French National Commission of Unesco.

The subject of the discussion concerns precise investigations into the field of archaeology and demography. The purpose of this symposium is to show the advantages of a document designed to give social science specialists the information which would allow them to contemplate the use of automatic methods in the treatment of their data.

SYMPOSIUM ON MACHINE TRANSLATION, THURSDAY, 18 JUNE

Miss O.F. Kulagina, Academy of Sciences of the USSR., has kindly agreed to contribute to the symposium.

RUSSIAN BIBLIOGRAPHY

Participants wishing to obtain the Russian bibliography on the treatment of partial differential equations (paper by Professor A.A. Dorodnitzin) may apply to the Secretariat of the provisional International Computation Centre (Miss Campbell), Unesco House, Room S.383.

TOTAL CONFERENCE PARTICIPATION AS AT MONDAY, 15 JUNE

The total number of participants on 15 June 1959 was 1,772, from 37 countries and 13 International Organizations (represented by 20 participants). The following 14 countries were represented by more than 10 participants each:

France	479
U.S.A.	408
Federal Republic of Germany	217
U.K.	164
Sweden	87
Italy	83
Netherlands	79
USSR	38
Belgium	34
Switzerland	24
Poland	18
Japan	16
Denmark	14
Austria	10
	1,671

In addition, 81 participants were present from 23 other countries.

IMPORTANT NOTICE CONCERNING THE ORGANIZATION OF DISCUSSIONS IN PLENARY SESSIONS

Experience shows that most persons wishing to participate in discussions omit to hand over to the scientific secretary concerned, the special card which has been prepared for this purpose.

In such cases the Secretariat cannot guarantee that the interventions in discussions will appear in the Proceedings. It is furthermore highly desirable that Chairmen and Rapporteurs of sessions know before the beginning of the session the names of the persons who wish to be called upon to speak.

Therefore, all persons who wish to take part in the discussion of a certain paper are urgently requested to complete the special card which is available at the reception desk, and to hand it over to the scientific secretary concerned, in room S.371.

INTERPRETATION AT SYMPOSIA

In response to the request of many participants, from Wednesday afternoon (17 June) full simultaneous interpretation in English, French and Russian will be provided in Conference Room II.

No official interpretation can be provided in the other symposia; the Secretariat will try to supply an unofficial interpretation into Russian in Room IV. Those taking part in the symposium in Room IV are therefore requested to speak in English or French.

MEETING OF BUREAU FOR SESSION H

Since Session H "Pattern recognition and machine learning" commences at 9.30 a.m. on Friday, 19 June, members of the Bureau of the Session should note that their meeting in Room V is at 8.30 a.m.

ORDER FORM FOR THE PROCEEDINGS OF THE CONFERENCE

Participants are reminded that an order form for the Proceedings of the Conference is attached at the back of Journal No. 1.

OFFICE OF THE CONFERENCE EDITOR

The Conference Editor, Mr. S. de Picciotto, has now his office in room S.373 (Extn. 3710).

GERMAN TRANSLATION OF ABSTRACTS OF PAPERS TO BE PRESENTED AT PLENARY SESSIONS

The German texts of the abstracts of discussion papers may be obtained by participants from the Documents Distribution Office, in the foyer of the Conference building.

III. MISCELLANEOUS NOTICES

ANNOUNCEMENT FROM THE EDITORIAL BOARD OF THE BRITISH COMPUTER SOCIETY

The Editorial Board of the British Computer Society, which publishes The Computer Journal and The Computer Bulletin, have announced that members of ACM, AFCAL (France) and CS/SA (South Africa) may purchase these journals at reduced prices through their local societies.

The Council of the Society will consider entering into similar arrangements with established Computer Societies in other countries. Interested participants should communicate with their local societies, or should write direct to "The Office Manager, The British Computer Society Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2, England."

(Submitted by Mr. H.W. Gearing (U.K.))

SECOND INTERNATIONAL CONFERENCE ON MEDICAL ELECTRONICS

Participants who are interested in the above conference to be held at Unesco House from 24-27 June 1959, are informed that a copy of the advance abstracts can be consulted by applying either to:-

Dr. G. Verdeaux, Deputy Secretary,
2nd International Conference on Medical Electronics,
63 Boulevard St. Michel,
Paris 5.

or Mr. T.E. Ivall, Publications Officer,
2nd International Conference on Medical Electronics.
(Mr. Ivall is attending the present Information Processing Conference).

Several of the papers deal with the uses of electronic computers in medical research.

AMENDMENT TO THE PROGRAMME OF TECHNICAL LECTURES TO BE GIVEN AT THE "AUTO-MATH 59" EXHIBITION

Participants are requested to note that the subject of the afternoon lecture to be given at 4.30 p.m. on Monday, 22 June 1959, is now changed to:

Librascope
"Data processor for the Federal Aviation Agency"
L.M. SCHMIDT (U.S.A.)

(See programme in Part IV)

MEETINGS

(a) Participants interested are invited to attend a meeting which will take place in Salle VI at 9 a.m. on Friday, 19 June, 1959, to discuss international co-ordination of standards for digital computer definitions and logic symbols and block diagrams. The co-ordinator of the meeting is Professor G.W. Patterson (U.S.A.).

(b) There will be an informal meeting on Friday evening, 19 June, 1959, for participants of the First and Second Congresses on the Application of the Theory of Probability in Telecommunication (Teletraffic, Copenhagen 1955, The Hague 1958). Those interested are invited to get in touch with any of the following: Messrs. N. Bech (Denmark), L. Kosten (Netherlands) and W. Matković (Yugoslavia).

EXHIBITION OF INFORMATION PROCESSING EQUIPMENT. AUTO-MATH 59

Participants are reminded that this exhibition is open to them free of charge on showing their participant's card. Complimentary tickets may also be obtained for the wives of participants on application to the Reception Service.

The exhibition is open at the Grand Palais, Champs Elysées, until 23 June 1959 at the following hours: Weekdays from 1 p.m. - 9 p.m. and on Saturday and Sunday from 10 a.m. - 6 p.m.

Public Transport:- By metro to Marbeuf/Franklin D. Roosevelt, or by the following bus routes:- 28, 32, 42, 49, 73, 80, 83. Bus No. 49 goes direct from Unesco House to the exhibition.

FOR THE ATTENTION OF GERMAN PARTICIPANTS TO THE CONFERENCE

The hours of the reception at the Embassy announced in the Conference Journal No. 3 of 17 June 1959, have been extended to 9 p.m. in order to allow German participants who have been at the ALGOL-IAL meeting to attend.

VISIT TO FACTORIES AND ELECTRONIC EQUIPMENT

(a) France

Participants wishing to visit the following factories - Cie. BULL, Société IBM-France and the Société d'Electronique et d'Automatisme are requested to contact the representatives of these firms, who will be at their service at the desks in the foyer of the Conference building (see plan in the Conference Handbook, Annex B).

Catalogues and folders from some of the firms are available to participants. Those interested are requested to apply for them to the secretariat in Room S.383.

II. OFFICIAL ANNOUNCEMENTS

CLOSING OF THE CONFERENCE

This is the last number of the Journal of the International Conference on Information Processing. The members of the Unesco Secretariat and the Scientific Secretaries wish to seize this occasion to thank participants for the spirit of co-operation and goodwill which has prevailed throughout the past week. They hope participants are enjoying their stay in Paris and are satisfied with the work of the Conference.

The Secretariat in particular wishes to thank the members of the Bureau of the Conference and all those who have carried out duties in connexion with the Conference.

All participants are requested kindly to note that the closing session will take place tonight at 5.45 p.m. in Room I. Farewell messages will be given by Professor Howard H. Aiken, President of the Conference, Professor Pierre Auger, Secretary-General of the Conference and Professor V.A. Kovda, Director of the Department of Natural Sciences representing the Director-General of Unesco.

The Conference, which is drawing to a close today, has been the means of allowing national bodies and Academies of Science in several countries to get together in order to set up an International Federation for Information Processing. A provisional Bureau has been formed and the preparatory work for a second International Conference on Information Processing, which may be held in 1963, will be undertaken without delay by the new federation.

The Unesco Secretariat wishes this new federation every success.

To conclude, participants are reminded that the present Conference will be followed by a series of technical lectures to be held at the Grand Palais on Monday 22 and Tuesday 23 June 1959 in conjunction with the "Auto-Math 59" Exhibition. All those interested are cordially invited to attend these lectures.

AWARD OF THE "MEDAILLES DE LA VILLE DE PARIS" TO CONFERENCE PARTICIPANTS

The Paris City Council has graciously decided to award the Médaille de la Ville de Paris to the distinguished persons who helped Unesco in the organization of the Conference.

At a brief ceremony last night in the Office of the Director-General, the Vice-President of the Paris Municipal Council, Monsieur Jacques Dursort, in the presence of the Acting Director-General, Monsieur René Maheu, handed the medals to the following:

Médaille en Vermeil

Howard H. AIKEN (U.S.A.): President of the Conference

Médailles en Argent

I.L. AUERBACH (U.S.A.)
I.I. BASILOVSKY (USSR)
Stig COMET (Sweden)
A.A. DORODNITZIN (USSR)
A. GHIZZETTI (Italy)
A. WALTHER (Federal Republic of Germany)
A. van WIJNGAARDEN (Netherlands)
M.V. WILKES (U.K.)
H. YAMASHITA (Japan)

INTERNATIONAL FEDERATION OF INFORMATION PROCESSING SOCIETIES

As a direct result of the activity surrounding the organization and actual occasion of the Unesco-sponsored International Conference on Information Processing, the existence of a permanent international body devoted to the science of information processing has been virtually assured.

Representatives of computer societies from 18 countries met in Paris today to take the preliminary steps necessary to create an International Federation of Information Processing Societies which would carry on the sponsorship of future international conferences on information processing, including mathematical and engineering aspects, to establish international committees to undertake special tasks falling within the spheres of action of national member societies, and advance the interests of these member societies in international co-operation in the burgeoning information processing field.

An adequate number of countries has already indicated intentions to ratify the statutes of such a federation. A Provisional Bureau has been formed today that will act on behalf of the Federation of International Processing Societies until the first quarter of 1960 when actual ratification will have been confirmed by the various countries. Representatives of the various computer societies represented at the constituent meeting today thus acted as private individuals until they could report back to their respective societies with a proposal for ratification of the statutes. However, each of these representatives is a highly placed individual in his own country and in the societies with which he is affiliated.

Unesco's rôle in these activities has been completely unofficial, except that part of its mission in sponsoring the first International Conference on Information Processing was to bring together representatives of the many nations interested in the science of information processing so that the seeds for growth of further international activity in this field might be properly planted and cultivated.

Unesco's endorsement of the formation of an International Federation of Information Processing Societies was given in a strongly worded statement by Professor Pierre Auger, Secretary-General of the Unesco-sponsored International Conference on Information Processing:

"It is an absolute necessity that there be an international body to serve the needs of the science of information processing. There are already similar international organizations serving such sciences as geodesy, astronautics, radio, medicine, astronomy, mathematics, chemistry, physics, etc. Unesco has agreements for providing consultative services and co-operation to the international, non-governmental organizations representing these other sciences, helping them to widely express the views of their members, and also receiving from them expert information, advice and technical co-operation. In sponsoring this current International Conference on Information Processing, Unesco accepted responsibility only for convening the first international meeting for those interested in the science of information processing. We had expected, and apparently correctly so, that such a meeting would act as the catalyst for the formation of an international federation. We look forward to the possibility of an agreement, similar to the co-operative agreements with other international bodies representing other sciences, with this new International Federation of Information Processing Societies, which already appears to represent the pre-eminent national organizations for this vital science."

Chairman of the Provisional Bureau for the International Federation of Information Processing Societies (IFIPS) is Mr. Isaac L. Auerbach who represents the National Joint Computer Committee of the U.S.A. and is also U.S. Consultant to Unesco for the International Conference on Information Processing. He was elected unanimously by the group to serve until sometime in 1960, when the Federation will hold its first meeting. Vice-Chairmen will be Professor A.A. Dorodnitzin, subject to the agreement of the Academy of Sciences of the USSR, and Professor A. van Wijngaarden of the Centre Mathématique, Amsterdam, the Netherlands, who represents the Dutch Computer Society. It was also decided to ask the Director-General of Unesco to authorize Mr. Jean Mussard, Secretary of the Unesco International Conference on Information Processing, to be Acting Secretary of the Federation.

It seems likely that the next International Conference on Information Processing, and an associated technical exhibit, will now be held in the year 1963, this time sponsored by an International Federation of Information Processing Societies. Each country represented in the Provisional Bureau has been asked to consider the possibility of proposing a site for such a conference and exhibit.

Seat of the IFIPS, the new Federation, will be in Brussels, Belgium, legal home of many international scientific societies. In the interim, all activity is being co-ordinated through Mr. Auerbach at Auerbach Electronics Corporation, 109 North Essex Avenue, Narberth, Pa. U.S.A., and through the proposed Acting Secretary of the Provisional Bureau, Mr. Jean Mussard, at his Unesco House address in Paris, France.

THE INTERNATIONAL COMPUTATION CENTRE AND ITS CORRESPONDING INSTITUTIONS

Meeting of 22 June

On Monday, 22 June, there will be a joint meeting of the Preparatory Committee of the International Computation Centre and of representatives of the Centre's corresponding institutions. The meeting will be held in Room VI, at 10 a.m.

The object of this meeting is to discuss ways and means of improving the co-operation between the corresponding institutions in matters such as exchange of personnel, exchange of scientific and methodological experience, and the rôle of the International Computation Centre as a link between the corresponding institutions.

ORDER FORM FOR THE PROCEEDINGS OF THE CONFERENCE

Participants are reminded that an order form for the Proceedings of the Conference is attached at the back of Journal No. 1.

GERMAN TRANSLATION OF ABSTRACTS OF PAPERS TO BE PRESENTED AT PLENARY SESSIONS

The German texts of the abstracts of discussion papers may be obtained by participants from the Documents Distribution Office, in the foyer of the Conference building.

ADDENDUM TO LIST OF PARTICIPANTS

The following name should be added to the list of participants to the Conference:

SWEDEN
Mr. D.E. Ahlstrom,
Swedish State Power Board,
Stockholm

IV. PROGRAMME CORRIGE DES CONFERENCES TECHNIQUES DONNEES A L'EXPOSITION "AUTO-MATH 59"

REVISED PROGRAMME OF TECHNICAL LECTURES DELIVERED AT THE "AUTO-MATH 59" EXHIBITION

GRAND - PALAIS

Lundi 22 juin 1959
Monday 22 June 1959

Matin - Morning

Chairman / Président: E. M. GRABBE (U.S.A.)

9 a.m.	9h.	Intertechnique - Ramo Wooldridge: "The RW 40 Data Processing System" by S. ROTHMAN (U.S.A.)
9.30 a.m.	9h.30	Compagnie des Machines Bull: Le "GAMMA 60" par Ph. DREYFUS (France)
10.30 a.m.	10h.30	Burroughs Corporation: "The Burroughs 220 High Speed Printing System" by D. BOLITHO (U.S.A.)
11 a.m.	11h.	L.M.T. (Standard Electric Lorentz): R.G. BASTEN (Germany) "The Transistorized Digital Computer ER 56"
11.30 a.m.	11h.30	Hitachi Ltd.: "HIPAC 101" (Hitachi Parametron Automatic Computer) by Shohei TAKADA (Japan)

Après-midi - Afternoon

Chairman / Président: F. H. RAYMOND (France)

3 p.m.	15h.	Benson-Lehner Corporation: "Input-Output Systems" by Jean MAURIER, General Manager for France
3.30 p.m.	15h.30	R.C.A.: "The R.C.A. 501 System" by J. Wesley LEAS (U.S.A.)
4 p.m.	16h.	Société d'Electronique et d'Automatisme: "Nouveaux éléments logiques Symmag"

Après-midi (suite)
Afternoon (contd.)

4.30 p.m.	16h.30	Librascope "Data Processor for the Federal Aviation Agency" by L.M. SCHMIDT (U.S.A.)
5 p.m.	17h.	National Cash Register Company: "From Magnetic Character Recognition to Photochemical Storage Devices" by P. NAVET (Switzerland)
5.30 p.m.	17h.30	Telemeter Magnetics Inc.: "The General Purpose Input-Output Systems" by R. BROWN and R. STUART-WILLIAMS (U.S.A.)

Mardi 23 juin 1959
Tuesday 23 June 1959

Matin - Morning

Chairman)
Président) Shigeru TAKAHASHI (Japan)

9 a.m.	9h.	ZEISS: "The Zeiss Electronic Computer ZRA 1" by Dr. W. KAMMERER (Germany) Dr. H. KORTUM (Germany) F. STRAUB (Germany)
9.30 a.m.	9h.30	I.B.M.: "The Input-Output Devices of the Stretch Computer" by H.K. WILD (U.S.A.)
10 a.m.	10h.	Nippon Electronic Industry: "Transistorized Drum Computer NEAC 2201"
10.30 a.m.	10h.30	The Stromberg-Carlson Co.: "Two New High-Speed Electronic Digital Computer Read-Out Systems" by G.L. JOHNSON (U.S.A.)
11 a.m.	11h.	Société d'Electronique et d'Automatisme: "Le Calculateur Cab 500" par Mme. A. RECOQUE et Mlle. S. BECQUET (France)

Mardi 23 juin 1959
Tuesday, 23 June 1959

Après-midi - Afternoon

Chairman)
Président) Mario TCHOU (Italie)

3 p.m.	15h.	I.B.M. France: "L'Ordinateur IBM 7070" par B. RENARD (France)
3.30 p.m.	15h.30	Zuse K.G. "Programmation de la calculatrice Zuse" Dr. T. FROMME (Germany)
4 p.m.	16h.	Magnacard "The Magnacard System" by R.M. HAYES (U.S.A.)
4.30 p.m.	16h.30	FRIDEN INC.: M. POFFE (Pays-Bas)

IV. ADDENDUM TO LIST OF PARTICIPANTS
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INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS
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CAMBOURNAC, L., Union of International Engineering Organizations
DUFOUR, H., International Union of Geodesy and Geophysics
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IBM 705 DATA PROCESSING SYSTEMS BULLETIN

THE 705 INSTRUCTION EN/DECODER

The 705 Instruction EN/DECODER has been developed to facilitate translation between symbolic instruction representation and machine representation. A symbolic instruction consists of a mnemonic operation code (OPER); a type of address designation (I : *for indirect, — for direct); a five digit "actual" address; and a two digit Auxiliary Storage Unit (ASU) designation. An instruction is said to be "decoded" when it appears in this form.

In normal practice, the conversion of symbolic instructions to the five-character machine representations is accomplished automatically during the program assembly process. Frequently, however - - especially during program testing - - it is desirable to perform this, or the reverse process, manually. The seven tables which comprise the EN/DECODER allow this to be done rapidly.

Table A relates the symbolic operation code and the first character of the machine language instruction (MLI). The seven characters at the top of Table A apply to the 705III only. In cases where no mnemonic equivalent is shown it is necessary to refer to the list of "Multiple Meaning Operation Codes" on the inside cover of the EN/DECODER. The interpretation of the codes in this list is dependent on the particular 705 Model being used as well as the instruction address or ASU designation.

The second, third and fourth characters of the MLI can be any of the forty characters in the three identical tables, B, D, and E. There are only twenty-four possible values of the fifth character (since an indirect address, to be valid, can only refer to a location with a units address digit of 4 or 9). These are shown in Table G.

In relating the two instruction representations, the third and fourth MLI characters correspond to the third (hundreds) and fourth (tens) position, respectively, of the actual address and to the ASU designation as well. More specifically:

a. The $\left\{\begin{matrix}\text{third}\\\text{fourth}\end{matrix}\right.$ digit of the actual address is in the same <u>row</u> of Table $\left\{\begin{matrix}\text{D}\\\text{E}\end{matrix}\right.$ as the $\left\{\begin{matrix}\text{third}\\\text{fourth}\end{matrix}\right.$ character of the MLI; and

b. The $\left\{\begin{matrix}\text{row}\\\text{column}\end{matrix}\right.$ location of the ASU designation in Table F is the same as the <u>column</u> location of the $\left\{\begin{matrix}\text{third}\\\text{fourth}\end{matrix}\right.$ character of the MLI in Table $\left\{\begin{matrix}\text{D.}\\\text{E.}\end{matrix}\right.$

With these relationships in mind, it should be apparent that given the ASU designation and the third and fourth digits of the actual address, one can determine the two corresponding characters of the MLI, or vice-versa.

The second and fourth characters of the MLI relate to the indirect address designation and the first, second, and fifth digits of the actual address. The rules which must be applied in this instance are:

a. The $\left\{\begin{array}{l}\text{second}\\ \text{fifth}\end{array}\right.$ digit of the actual address is in the same <u>row</u> of Table $\left\{\begin{array}{l}\text{B}\\ \text{G}\end{array}\right.$ as the $\left\{\begin{array}{l}\text{second}\\ \text{fifth}\end{array}\right.$ character of the MLI;

b. The column location of the first digit of the actual address in Table C is the same as the <u>column</u> location of the second MLI character in Table B; and

c. The row in Table C corresponding to the location of the first digit of the actual address and the direct or indirect designation is the same as the <u>column</u> location of the fifth character of the MLI.

As before, following these rules permits translation in either direction.

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International Business Machines Corporation
590 Madison Avenue, New York 22, N. Y.

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IBM CORPORATE STANDARDS DIRECTORY

FEBRUARY 1, 1962

MEANINGS OF ABBREVIATIONS USED

IN MEMBER NAME FIELD

A	ALTERNATE
C	CHAIRMAN
IR	OFFICIAL IBM REPRESENTATIVE
O	OBSERVER
S	SECRETARY
ST	SECRETARY-TREASURER
T	TREASURER
TA	TECHNICAL ADVISOR
VC	VICE CHAIRMAN
X	UNOFFICIAL CONTACT

IN ORGANIZATION/COMMITTEE NAME FIELD

C	COMMITTEE
OBS	OBSERVER
SC	SUBCOMMITTEE
TF	TASK FORCE
TG	TASK GROUP
WG	WORKING GROUP
WP	WORKING PARTY
XXX	ORGANIZATIONAL REPRESENTATIVE
ZZZ	COUNTRY REPRESENTATIVE

KEY TO AREA OF STANDARDIZATION

STANDARDS - GENERAL
02 - GENERAL COMPUTER STANDARDS
03 - GENERAL OFFICE MACHINES STANDARDS
05 - GLOSSARY AND TERMINOLOGY

10 - ENG & MFG DOCUMENTATION, GENERAL
11 - DWGS AND SPECIFICATIONS
12 - DIAGRAMS AND FLOWCHARTS
13 -
14 - PROBLEM DESCRIPTION
15 - GENERAL SYMBOLS
16 - TECH MANUALS, PARTS LISTS, ETC
17 -
18 - INFORMATION RETRIEVAL
19 -

20 - LANGUAGE STRUCTURE
22 - PROGRAMMING LANGUAGES
24 - OPERATING SYSTEMS
26 - PROCESSOR LANGUAGES

30 - CHARACTER SETS AND CODING
32 - CHARACTER RECOGNITION
33 - CHARACTER RECOGNITION, MAGNETIC
34 - CHARACTER RECOGNITION, OPTICAL
36 - LINE AND PAGE PRINTERS
38 - CHARACTER PRINTERS, TYPEWRITERS

40 - I/O MEDIA, GENERAL
41 - MEDIA, CARDS, PHYSICAL
42 - MEDIA, CARDS, ELECTRICAL
43 - MEDIA, PERFORATED TAPE, PHYSICAL
44 - MEDIA, PERFORATED TAPE, ELECTRICAL
45 - MEDIA, MAGNETIC TAPE, PHYSICAL
46 - MEDIA, MAGNETIC TAPE, ELECTRICAL
47 - MEDIA, MAGNETIC CARDS, PHYSICAL
48 - MEDIA, MAGNETIC CARDS, ELECTRICAL

50 - MEDIA TRANSPORTS
56 - INPUT OUTPUT DEVICES
58 - STORAGE DEVICES

60 - DIGITAL DATA TRANSMISSION
66 - INTERFACES

70 - ENG & MFG DESIGN, GENERAL
71 - SEMICONDUCTORS & TUBES
72 - INDUCTIVE, RESISTIVE AND CAPACITIVE

73 - MAGNETIC, PHOTOELECTRIC & ULTRASONIC
74 - CABLES & CONNECTORS, ELECTROMECHANICAL
75 - SYSTEMS, SUBSYSTEMS & MAJOR ASSEMBLIES
76 - PACKAGING
77 - MFG DEVICES
78 - MATERIALS
79 - SAFETY

80 - ENG & MFG PROCESSES AND PROCEDURES
81 - REHABILITY & MAINTENANCE
82 - TESTING, QUALITY CONTROL, ETC
83 -
84 - SOLDERING, WELDING, WRAP, ETC
85 - PROCUREMENT
86 -
87 -
88 -
89 -

98 - ASSOCIATED-NON-STANDARDS
99 - NON-STANDARDS

INTERNATIONAL----

CCITT	CONSULTATIVE COMMITTEE INTERNATIONAL - TELEPHONE & TELEGRAPH			
CCITT	SG A	US DELEGATION	RUSHFORTH	
CCITT	SG A	US DELEGATION	HOPNER	A
CCITT	SG A	FRENCH DELEGATION	HENRY, A	
CCITT	SG A	FRENCH DELEGATION	DESBLACHE	
CCITT	SG A	FRENCH DELEGATION	MESTRE	
CCITT	SG A	X3 LIAISON	CADDEN	
CCITT	SG A	X3 LIAISON	CADDEN	
ECMA	EUROPEAN COMPUTER MANUFACTURERS ASSOC.			
ECMA		OFFICERS	PEDRETTI	T
ECMA	TC1	INPUT/OUTPUT CODES C	EADIE	VC
ECMA	TC2	PROGRAMMING LANGUAGES C	GENUYS	
ECMA	TC3	FLOWCHART SYMBOLS C	BERNARD	
ECMA	TC4	CHARACTER RECOGNITION C	VAN STEENIS	C
IEC	INTERNATIONAL ELECTROTECHNICAL COMMISSION			
IEC	TC 3	SYMBOLS FOR AUTOMATIC CONTROL		
IEC	TC 53	COMPUTERS & INFO. PROCESSING	CREDLE	C
IEC	53A	DIGITAL INPUT OUTPUT EQUIPS.	EADIE	C
IEC	53B	DIGITAL DATA TRANSMISSION	GUILHAUMOU	C
IEC	53C	ANALOGUE EQUIPS IN INFO. PROC.SYS		
IEC	53D	INPUT OUTPUT MEDIA		
IEC	TC 53	LONDON MEETINGS - NOVEMBER 1961		
	TC 53	SECRETARIAT	CREDLE	
	TC 53	REP.ISO/TC97	ANDRUS	
	TC 53	UNITED STATES DELEGATION	CADDEN	
	TC 53	FRENCH DELEGATION	GUILHAUMOU	
	TC 53	GERMAN DELEGATION	SCHROETER	
		ITALIAN DELEGATION	PEDRETTI	
		UNITED KINGDOM DELEGATION	EADIE	
ISO	INTL. ORGANIZATION FOR STANDARDIZATION		ANDRUS	X
ISO	TC 46	DOCUMENTATION	GREMS	
ISO	TC 95	OFFICE MACHINES		
ISO	WG A	TYPEWRITERS		
ISO	WG B	ADDING & CALCULATING MACHINES		
ISO	WG C	ACNTG.BOOKKEEPING.BILLING.CSH.R.		
ISO	WG D	DUPLICATING & REPRO. MACHINES		
ISO	WG E	DICTATING MACHINES		
ISO	WG F	ADDRESSING.MAILING.&SPEC. MACH.		
ISO	WG G	TERMINOLOGY		
ISO	WG H	INPUT OUTPUT EQUIPMENTS	PEDRETTI	C
ISO	WG I	BASIC PAPER LAYOUT		
ISO	WG X	COORDINATION WORKING GROUP		
ISO	TC 95	TURIN MEETINGS - JUNE 1961		
	TC 95	REP. ISO/TC97	ANDRUS	O
	TC 95	FRENCH DELEGATION	GUILHAUMOU	

	TC 95	ITALIAN DELEGATION	BIANCHI	
	TC 95	ITALIAN DELEGATION	PEDRETTI	
ISO	TC 97	COMPUTERS & INFO. PROCESSING	ANDRUS	TA
ISO	WG A	GLOSSARY		
ISO	WG B	CHARACTER SETS & CODING		
ISO	WG C	CHARACTER RECOGNITION		
ISO	WG D	INPUT AND OUTPUT MEDIA		
ISO	WG E	PROGRAMMING LANGUAGES		
ISO	WG F	DIGITAL DATA TRANSMISSION		
ISO	TC 97	GENEVA MEETINGS - MAY 1961		
	TC 97	SECRETARIAT	ANDRUS	TA
	TC 97	UNITED STATES DELEGATION	BEMER	
	TC 97	UNITED STATES DELEGATION	CREDLE	O
	TC 97	FRENCH DELEGATION	GUILHAUMOU	
	TC 97	ITALIAN DELEGATION	GIOVANI	
	TC 97	ITALIAN DELEGATION	PEDRETTI	
	TC 97	DANISH DELEGATIO OBS	GRAUSLUND	
	TC 97	SWEDISH DELEGATION	OFVERBERG	
	TC 97	UNITED KINGDOM DELEGATION	EADIE	
IFIPS	INTL FED OF INFO. PROCESSING SOCIETIES			
IFIPS		COUNCIL	SPEISER	ST
IFIPS		COMMITTEE ON TERMINOLOGY - US	BEMER	
IFIPS		COMMITTEE ON TERMINOLOGY -FINLAND	TOLLET	
IFIPS		IFIP CONGRESS - US PROGRAM COMM.	ASTRAHAN	
IFIPS		IFIP CONGRESS - US PROGRAM COMM.	BEMER	
IFIPS		IFIP CONGRESS - US PROGRAM COMM.	MC PHERSON	
IFIPS		IFIP CONGRESS - US PARTICIPATION	BUCHHOLZ	
IFIPS		IFIP CONGRESS - US PARTICIPATION	THOMSEN	
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IRAM	INSTITUTO ARGENTINO DE RACIONALIZACION DE MATERIALES		PENA	X
		AUSTRALIA----		
SAA	STANDARDS ASSOCIATION OF AUSTRALIA			
		AUSTRIA----		
ONA	OESTERREICHISCHER NORMENAUSSCHUSS			
		BELGIUM----		
IBN	INSTITUT BELGE DE NORMALISATION		MALDAGUE	X
		BRAZIL----		
ABNT	ASSOCIACAO BRASILEIRA DE NORMAS TECNICAS		FRANKENHUIS	.X
		BULGARIA----		
INRA	COMITE SUPERIEUR DE NORMALISATION DE LA REPUBLIQUE POPULAIRE DE BULGARIE			
		BURMA----		
UBARI	DEPARTMENT OF STANDARDS, UNION OF BURMA APPLIED RESEARCH INSTITUTE			

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CHILE----

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CSN   URAD PRO NORMALIZACI

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DS	DANSK STANDARDISERINGSRAAD		GRAUSLUND	X

EGYPT----

EOS   EGYPTIAN ORGANIZATION FOR STANDARDIZATION

FINLAND----

SFS	SUOMEN STANDARDISOIMISLIITTOR.Y.		TOLLET	X

FRANCE----

AFNOR	ASSOCIATION FRANCAISE DE NORMALISATION		GUILHAUMOU	
AFNOR	E 55	COMMISSION TO ISO TC/95	GUILHAUMOU	
AFNOR	Z 6	COMMISSION TO ISO TC/97	GUILHAUMOU	
AFNOR	Z 6 SC	CHARACTER SETS & CODES	GUILHAUMOU	S
AFNOR	Z 6 SC	CHARACTER SETS & CODES	CORBY	A
AFNOR		GLOSSARY	BOULOGNE	
CEF	COMITE ELECTRONIQUE FRANCAIS			
AFNOR		CHARACTER RECOGNITION	GUILHAUMOU	
CEF	WG 53	CALCULATORS & INFORMATION MACH.	GUILHAUMOU	
CEF	WG 53	CALCULATORS & INFORMATION MACH.	ROBINEAU	
AFNOR		INPUT-OUTPUT MEDIA	NUSBAUMER	
AFNOR		PROGRAMMING LANGUAGES	GENUYS	
AFNOR		DIGITAL DATA TRANSMISSION	DESBLACHE	
FNIE	FEDERATION NATIONALE DES INDUSTRIES ELECTR.			
FNIE		DELEGATION TO IEC TC/53	GUILHAUMOU	

GERMANY----

DNA	DEUTSCHER NORMENAUSSCHUSS		PETERSEN	X
DNA		DATA PROCESSING COMMITTEE		
DNA	SC 1A	GLOSSARY	IRRO	
DNA	SC 1B	FLOWCHARTING	GRAMMEL	
DNA	SC 2A	CODED CHARACTER SETS	NOLLE	
DNA	SC 2B	CHARACTER RECOGNITION	SCHADE	
DNA	SC 3	I/O MEDIA	SCHROETER	
DNA	SC 4	INTERFACES	PETERSEN	
DNA	SC 5	PROGRAMMING LANGUAGES	REMUS	

GREECE----

ENO COMITE HELLENIQUE DE NORMALISATION AUPRES D
LA CHAMBRE TECHNIQUE DE GRECE

HUNGARY----

MSZH MAGYAR SZABVANYUGYI HIVATAL

INDIA----

ISI INDIAN STANDARDS INSTITUTION

INDONESIA----

DNI DEWAN NORMALISASI INDONESIA

IRAN----

SOI STANDARDS ORGANIZATION OF IRAN

IRELAND----

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SII THE STANDARDS INSTITUTION OF ISRAEL

ITALY----

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JAPAN----

JISC JAPANESE INDUSTRIAL STANDARDS COMMITTEE TANAKA x

MEXICO----

DGN DIRECCION GENERAL DE NORMAS

NETHERLANDS----

NNI STICHTING NEDERLANDS NORMALISATIE-INSTITUUT SWAAB x

NEW ZEALAND----

NZSI NEW ZEALAND STANDARDS INSTITUTE

NORWAY----

NSF NORGES STANDARDISERINGS-FORBUND WETHAL x

PAKISTAN----

PSI PAKISTAN STANDARDS INSTITUTION

POLAND----

PKN POLSKI KOMITET NORMALIZACY JNY

PORTUGAL----

IGPAI REPARTICAO DE NORMALIZACAO

ROMANIA----

OSS OFICIUL DE STAT PENTRU STANDARDE

SPAIN----

IRATRA INSTITUTO NACIONAL DE RACIONALIZACION DEL
TRABAJO

	SWEDEN----		
SIS	SVERIGES STANDARDISERINGSKOMMISSION	OFVERBERG	X
	SWITZERLAND----		
SNV	ASSOCIATION SUISSE DE NORMALISATION	KAESLIN	X
	TURKEY----		
TSE	TURK STANDARDLARI ENSTITUSU		
	UNION OF SOUTH AFRICA----		
SABS	SOUTH AFRICAN BUREAU OF STANDARDS		
	UNITED KINGDOM----		
BSI	BRITISH STANDARDS INSTITUTION	EADIE	X
BSI	DPE/ DATA PROCESSING EXECUTIVE COMM.	EADIE	
BSI	DPE/1 CODING		
BSI	DPE/1/1 CODING - PUNCHED CARDS	EADIE	
BSI	DPE/1/2 CODING - PAPER TAPE	EADIE	
BSI	DPE/1/3 CODING - MAGNETIC TAPE	YOUNG	
BSI	DPE/2 PUNCHED CARDS - PHYS. PROPERTIES	EADIE	
BSI	DPE/3 PAPER TAPE - PHYS. PROPERTIES		
BSI	DPE/4 MAGN TAPE - PHYS & MAG PROPERTIES	YOUNG	
BSI	DPE/4/1 MAGN TAPE - PRECISION SPOOLS	EADIE	C
BSI	DPE/4/2 MAGN TAPE - READ/WRITE HEADS		
BSI	DPE/5 DATA TRANSMISSION	SMITH, K L	
BSI	DPE/6 STATIONERY FEEDING MECHANISMS	EADIE	
BSI	DPE/7 INPUT KEYBOARDS		
BSI	DPE/8 CARD READERS & PUNCHES		
BSI	DPE/9 PAPER TAPE READERS & PUNCHES		
BSI	DPE/10 DATA LOGGERS	SMITH, K L	
BSI	DPE/11 OUTPUT PRINTERS		
BSI	DPE/12 INTERCONNECTION - PERIQUIP & COMP	EADIE	
BSI	TLE/ TELECOMMUNICATIONS EXEC COMMITTEE		
BSI	TLE/1 TERMIN & SYMBOLS FOR TELECOMMUN		
BSI	TLE/1/3 GLOSSARY OF TERMINOLOGY	SMITH, G D	
BSI	TLE/2 GRAPHICAL SYMBOLS FOR EE & TELEC		
BSI	TLE/2/-/3 FUNCTIONAL SYMBOLS	TAUB	
BSI	TLE/4		
BSI	TLE/4/14 CORE STORES	MACARIO	
BSI	OEM/ OFFICE EQUIP. & MACHINES EXEC.		
BSI	OEM/3/1 TYPEWRITERS INCL ELECTRICS	MUSK	
BSI	OEM/4/1 COMMERCIAL FORMS & STATIONERY	EADIE	
BSI	OEM/4/2 DIVIDEND WARRANTS & TAX VOUCHERS	EADIE	
EEA	ELECTRONIC ENGINEERING ASSOCIATION		
EEA	DATA PROCESSING EXECUTIVE C	JONAS	
EEA	DATA PROCESSING TECHNICAL C	EADIE	
EEA	CODING-CARDS,P TAPE,MAGN TAPE WP	EADIE	
EEA	MAGNETIC TAPE,EXCEPT CODING WP	YOUNG	
EEA	INPUT/OUTPUT EQUIPMENT WP	EADIE	
EEA	DATA TRANSMISSION WP	SMITH	

EEA		STORAGE SYSTEMS WP		
EEA		CORE STORES WP	MACARIO	
EEA		CONTRACTS WP	CHRISTIE	
EEA		COMPONENTS WP	CARDIFF	
EEA		ENVIRONMENTAL TESTING WP	CARDIFF	
EEA		MICROWAVE TECHNIQUES WP	SMITH	
EEA		PRINTED WIRING TECHNIQUES WP	HERBERT	
EEA		VALVES,TRANSISTORS &RELATED SEMICONDUCTORS WP	CARDIFF	
BETA	BUSINESS EQUIPMENT TRADE ASSOCIATION			
BETA		AUTO DATA PROCESSING SECTION	EADIE	
BCS	BRITISH COMPUTER SOCIETY			
BCS		STANDARDS ADVISORY COMMITTEE	EADIE	
		U.S.S.R.----		
	KOMITET STANDARTOV, MER I IZMERITEL NYH PRIBOROV PRI SOVETE MINISTROV SSSR			
		VENEZUELA----		
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		YOUGOSLAVIE----		
JZS	JUGOSLOVENSKI ZAVOD ZA STANDARDIZACIJU			
		UNITED STATES----		
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ASA		COMPANY MEMBER CONFERENCE	ANDRUS	
ASA		STANDARDS COUNCIL BEMA	BIRKENSTOCK	
ASA		1962 ANNUAL CONFERENCE	O FARRELL	C
ASA	C85			
ASA	C94		GEISLER	EIA
ASA	X3	COMPUTERS & INFO. PROCESSING	LAW	
ASA	X3	COMPUTERS & INFO. PROCESSING	BARTELT	A
ASA	X3.1	CHARACTER RECOGNITION	HENNIS	
ASA	X3.1	CHARACTER RECOGNITION	GROCE	A
ASA	X3.1.1	FONT DEVELOPMENT WG	GROCE	
ASA	X3.1.1	FONT DEVELOPMENT WG	LEIMER	
ASA	X3.1.1	FONT DEVELOPMENT WG	SPINA	S
ASA	X3.1.2	PRINTING WG	MERELLO	
ASA	X3.1.3	FORMAT & APPLICATIONS WG	HENRY	
ASA	X3.2	CODED CHARACTER SETS & I/O MEDIA	BLUE	
ASA	X3.2	CODED CHARACTER SETS & I/O MEDIA	BARTELT	A
ASA	X3.2.1	MAGNETIC TAPE FORMATS TG		
ASA	X3.2.2	PERFORATED TAPE FORMATS TG		
ASA	X3.2.3	PUNCHED CARDS TG		
ASA	X3.3	DATA TRANSMISSION	CADDEN	
ASA	X3.3	DATA TRANSMISSION	WARDEN	A
ASA	X3.3.1	LIAISON TO CCITT STUDY GROUP A	CADDEN	

ASA	X3.3.2	GLOSSARY		
ASA	X3.3.3	DESCRIPTION OF EQUIPMENT	CADDEN	C
ASA	X3.3.4	ESTABLISHMENT OF INTERFACES		
ASA	X3.3.5	RELIABILITY		
ASA	X3.4	COMMON PROGRAMMING LANGUAGES	HEISING	
ASA	X3.4	COMMON PROGRAMMING LANGUAGES	SAMMET	A
ASA	X3.4.1	LANGUAGE STRUCTURE	~~GOLDFINGER~~	
ASA	X3.4.2	SPEC. OF CURRENT PROG. LANGUAGES	HEISING	
ASA	X3.4.2	SPEC. OF CURRENT PROG. LANGUAGES	PALMER, J	A
ASA	X3.4.4	PROCESSOR METHODOLOGY	BOEHM	
ASA	X3.4.5	TC 97 WORKING GROUP E SECRETARIAT		
ASA	X3.5	TERMINOLOGY & GLOSSARY	GREMS	
ASA	X3.5	TERMINOLOGY & GLOSSARY	MULLERY	A
ASA	X3.6	PROBLEM DESCRIPTION & ANALYSIS	GREMS	
ASA	X3.6.1	METHODOLOGY		
ASA	X3.6.2	INPUT/OUTPUT & FILES		
ASA	X3.6.3	DATA TRANSFORMATION		
ASA	X3.6.4	TERMINOLOGY & GLOSSARY	GREMS	C
ASA	X3.6.5	FLOWCHARTING		
ASA	X3.7	MAGNETIC CHARACTER RECOGNITION		
ASA	X3.10	INTERNATIONAL ADVISORY COMMITTEE		
ASA	X4	OFFICE MACHINES	BECHTEL	VC
ASA	X4.A1	STD. ELEC. PORTABLE & SPEC TYPERS		
ASA	X4.A2	ADD. MACH & CALCULATORS		
ASA	X4.A3	STD ACCT & BKPG MACH & CASH REG		
ASA	X4.A4	INPUT/OUTPUT EQUIPMENT	MC FARLANE	
ASA	X4.A5	DUPLIC, REPRO & MAILING MACHINES		
ASA	X4.A6	DICTATION EQUIPMENT		
ASA	X6	COMPUTERS & INFO. PROCESSING	WARREN	
ASA	Y14	DRAFTING PRACTICE		
ASA	Y14.15.3	LOGIC DIAGRAM DRAFTING PRACTICE	O FARRELL	C
ASA	Y32	GRAPHICAL SYMBOLS		
ASA	Y32.14	LOGIC DIAGRAM SYMBOLS	O FARRELL	S
ASA	Y32.14	LOGIC DIAGRAM SYMBOLS	BEMER	
ASA	Y32.14	LOGIC DIAGRAM SYMBOLS	BODEN	
ASA	Y32.14	LOGIC DIAGRAM SYMBOLS	PREISS	
ASA	Z39	DOCUMENTATION	GREMS	
ASA	Z39.5	INTERNATIONAL SUBCOMMITTEE	GREMS	
ASA	Z39.11	MACHINE CODING & INDEXING	GREMS	C
CODASYL		COMMITTEE ON DATA SYSTEMS LANGUAGES		
CODASYL		EXECUTIVE COMMITTEE		
CODASYL		ADVISORY BOARD	GOLDFINGER	
CODASYL		COBOL MAINTENANCE COMMITTEE	DONALLY	
CODASYL		DEVELOPMENT COMMITTEE	GOLDFINGER	
CODASYL		LANGUAGE STRUCTURE SC	GOLDFINGER	C
CODASYL		LANGUAGE STRUCTURE SC	SAMMET	
CODASYL		SYSTEMS SC	GRAD	
EIA		ELECTRONIC INDUSTRIES ASSOCIATION	HAVENS	IR

EIA	ELECTRONIC INDUSTRIES ASSOCIATION	WARREN	AIR
EIA	BOARD OF DIRECTORS	CREDLE	
EIA	CONGRESSIONAL INFORMATION C		
EIA	EDUCATIONAL COORD C. DIV COUNCIL	SOLOMON	
EIA	ELECTRONIC IMPORTS C	CREDLE	
EIA	LAW COMMITTEE	RUSSELL	
EIA	LEGISLATIVE POLICY COMMITTEE	FREY	
EIA	SERVICE COMMITTEE	LANGE	
EIA	INDUSTRIAL ELECTRONICS DIVISION		
EIA	EXECUTIVE COMMITTEE	CREDLE	VC
EIA	PLANNING BOARD	CREDLE	
EIA	COMPUTING & DP SYSTEMS SECTION	SIMMONS	
EIA	MILITARY PRODUCTS DIVISION		
EIA	EXECUTIVE COMMITTEE	BENTON	
EIA	FIELD SUPPORT & MAINTENANCE	WHITNEY	
EIA	SPARE PARTS	SINCHAK	
EIA	SPARE PARTS	MC CLOSKEY	
EIA	MILITARY SYSTEMS&MGMT RELATIONS		
EIA	PARTS DIVISION		
EIA	INDUCTIVE COMPONENTS SUBDIVISION		
EIA	FERRITE & POWDERED IRON CORES	FOX	
EIA	PRINTED & MODULAR COMPONENT		
EIA	MOLECULAR ELECTRONIC SECTION	KENNARD	
EIA	TUBE & SEMICONDUCTOR DIVISION		
EIA	SEMI-CONDUCTOR SECTION	RITZ	
EIA	GOVERNMENT LIAISON	RITZ	
EIA	CONSUMER PRODUCTS DIVISION		
EIA	MATERIALS PROCUREMENT	SHERIFF	
EIA	TECHNICAL PUBLICATIONS	ZEITER	
EIA	TECHNICAL PUBLICATIONS	MIZEL	A
EIA	MILITARY RELATIONS DEPARTMENT		
EIA	EXECUTIVE COMMITTEE	HECKEL	
EIA	ACCOUNTING & COST PRINCIPLES COMM	HECKEL	
EIA	ACCOUNTING & COST PRINCIPLES COMM	CONRAD	
EIA	FACILITIES&GOVERNMENT PROPERTY C	FLYNN	
EIA	FACILITIES&GOVERNMENT PROPERTY C	HOBBS	
EIA	FACILITIES&GOVERNMENT PROPERTY C	WEIL	
EIA	GENERAL CONTRACT PROVISIONS COMM	CONNELL	
EIA	GENERAL CONTRACT PROVISIONS COMM	MEDDAUGH	
EIA	INDUSTRIAL SECURITY COMMITTEE	SIMPSON	
EIA	INDUSTRIAL SECURITY COMMITTEE	WOOD	
EIA	INDUSTRIAL SECURITY COMMITTEE	O DONNELL	
EIA	PATENTS AND COPYRIGHTS COMMITTEE	KLITZMAN	
EIA	PATENTS AND COPYRIGHTS COMMITTEE	WOOD	
EIA	RENEGOTIATION COMMITTEE	HECKEL	
EIA	TERMINATION COMMITTEE	MEDDAUGH	
EIA	TERMINATION COMMITTEE	SOON	
EIA	MAILING LIST		
EIA	INTERNATIONAL DEPARTMENT OF EIA		
EIA	EXECUTIVE COMMITTEE	CAMPBELL	
EIA	INTERNATIONAL NEWS REPORT		
EIA	ENGINEERING DEPARTMENT		

EIA		INTERNATIONAL STANDARDS COMMITTEE		
	IS1	COMPONENTS SUB-COMMITTEE	GEISLER	
EIA	TMP	TEST METHOD & PROCEDURES COMM	KENNEDY	
EIA	CN	COLORS AND NUMBERS COMMITTEE	KERILA	
EIA	QA	QUALITY ASSURANCE PRACTICE COMM	TACKLEY	
EIA	QA	QUALITY ASSURANCE PRACTICE COMM	PAYNE	A
EIA	VE	VALUE ENGINEERING COMMITTEE	MC CABE	
EIA	VE	VALUE ENGINEERING COMMITTEE	TURNS	A
EIA		CONTRACTURAL RELATIONS SUB-COMM	MEDDAUGH	
EIA	MCA	MICROMINIATURE COMP ADVISORY COMM	COUNIHAN	
EIA	R	ENTERTAINMENT RECEIVER PANEL		
EIA	M	MILITARY EQUIPMENT PANEL		
EIA	M1	MIL COMPONENTS ENGINEERING COORD	KENNEDY	
EIA	M1	MIL COMPONENTS ENGINEERING COORD	NITSCHKE	A
EIA	M2	MILITARY DRAWING STANDARDIZATION	TULP	
EIA	M2	MILITARY DRAWING STANDARDIZATION	GOEROLD	A
EIA	M3	MIL TEST EQUIPT & INSTRUMENTATION		
EIA	M4	MILITARY EQUIPT SPECIFICATION	BISCARDI	
EIA	M4	MILITARY EQUIPT SPECIFICATION	GOEROLD	A
EIA	M4.1	ENVIRONMENT FOR MIL EQUIPMENT	MC GREGOR	
EIA	M5	MILITARY ELECTRONIC SYSTEMS	BRYANT	
EIA	M5	MILITARY ELECTRONIC SYSTEMS	GOLD	A
EIA	M5.1	MIL ELECTRONICS ADVISORY GROUP	VAN COTT	
EIA	M5.2	RELIABILITY SUBCOMMITTEE	GOLD	
EIA	M5.2	RELIABILITY SUBCOMMITTEE	REEVE	A
EIA	M5.3	MEASUREMENT REPORTING&EVAL TECH	MARCUS	
	M5.5	MAINTAINABILITY	MARCUS	
EIA	M5.5	MAINTAINABILITY	TOMAS	A
EIA	M5.7	HUMAN FACTORS	VAN COTT	C
EIA	M5.7	HUMAN FACTORS	CRITES	A
EIA	M5.8	RADIO INTERFERENCE	SULLIVAN	
EIA	M5.8	RADIO INTERFERENCE	POWERS	A
EIA	M6	MIL ELECTRON DEVICES APPLICATIONS	GLASS	
EIA	M6	MIL ELECTRON DEVICES APPLICATIONS	BLOSE	A
EIA	M6.2	SEMICONDUCTOR RELIABILITY	PACKARD	
EIA	COMPONENT PARTS PANEL			
EIA	P1	RESISTIVE COMPONENTS		
EIA	P1.2	PRECISION FILM	SLONAKER	
EIA	P1.4	WIREWOUND	SLONAKER	
EIA	P1.5	PRECISION POTENTIOMETERS	KOPCZAK	
EIA	P2	CAPACITIVE COMPONENTS		
EIA	P3	INDUCTIVE COMPONENTS	COOPER	
EIA	P3.7	ELECTROMAGNETIC DELAY LINES	WERBIZKY	
EIA	P4	ULTRASONIC DELAY LINES & DEVICES		
EIA	P5	ELECTROMECHANICAL DEVICES	ULSH	
EIA	P5.1	CONNECTORS	ALLEN	
EIA	P5.2	SOCKETS	MALITZ	
EIA	P5.6	RACKS PANELS & ENCLOSURES		
EIA	P7.1	HOOK-UP WIRE		
EIA	P7.1.3	CONDUCTOR DESIGN	MANNY	
EIA	P7.1.4	CURRENT CARRYING CAPACITY		
E	P7.4	SOLDERS & FLUXES	GRUENDLE	
	P7.5	SOLDERLESS WRAPPED CONNECTIONS	ULSH	

EIA	P7.5	SOLDERLESS WRAPPED CONNECTIONS	SELZO	A
EIA	P7.5.1	MATERIAL PARAMETERS	FOX	
EIA	P7.5.2	CONNECTION PARAMETERS	SELZO	
EIA	P7.5.4	TEST PROCEDURES	CORISH	
EIA	P8	SOUND SYSTEM COMPONENTS		
EIA	P8.6	MAG TAPE,REEL,CARTRIDGE,CONTAINER	ROARK	
EIA	P9	PRINTED & MODULAR COMPONENTS	LORENZ	
EIA	P9	PRINTED & MODULAR COMPONENTS	SHAFER	A
EIA	P9.1	CERAMIC-BASED PRINTED CIRCUITS		
EIA	P9.2	PRINTED WIRING BOARDS	BARTON	
EIA	P9.2	PRINTED WIRING BOARDS	VEST	A
EIA	P9.2.1	CONDUCTIVITY & TEMPERATURE RISE	BARTON	
EIA	P9.3	3D MODULAR COMPONENTS	SHAFER	
EIA	INDUSTRIAL ELECTRONICS PANEL			
EIA	TR20	TEST & MEASUREMENT EQUIPMENT	GORMAN	
EIA	TR23	AUTOMATIC TEST SYSTEMS	BOSMAN	
EIA	TR23	AUTOMATIC TEST SYSTEMS	STEADING	A
EIA	TR23.1	PRODUCT TESTING STANDARDS	DONALD	
EIA	TR27	COMPUTING&INFORMATION PROCESSING		C
EIA	TR27.2	MACH TOOL NUMERICAL CTRL SYS REG	MORGAN	
EIA	TR27.2.1	CONTOURING & POSITIONING	MATSA	
EIA	TR27.2.2	CONSTRUCTION STANDARDS		
EIA	TR27.3	DATA TRANSMISSION SYS & EQUIP	DOTY	
EIA	TR27.3	DATA TRANSMISSION SYS & EQUIP	TATE	A
EIA	TR27.5	COMPUTING&INFO PROC SYS LIAISON	BOSMAN	C
EIA	TR27.6	INPUT/OUTPUT EQUIPMENTS	WILLIAMS	
EIA	TR27.6.1	CARDS&CARD INPUT/OUTPUT EQUIPT	EICHORN	
EIA	TR27.6.2	PAPER TAPES&PAPER TAPEI/O EQUIP	HELLER	
EIA	TR27.6.2	PAPER TAPES&PAPER TAPEI/O EQUIP	WILLIAMS	VC
EIA	TR27.6.3	MAG TAPES&MAG TAPE I/O EQUIPT	SKOV	
EIA	TR27.6.3	MAG TAPES&MAG TAPE I/O EQUIPT	WILLIAMS	A
EIA	TR27.6.4	DOCUMENT READING	GROCE	
EIA	TR27.6.5	ANALOG-DIGITAL COVERSION EQUIPT	JURSIC	
EIA	TR27.7	CENTRAL PROCESSING EQUIPT	GEISLER	
EIA	TR27.7	CENTRAL PROCESSING EQUIPT	CASE	A
EIA	TR27.7.1	COMPUTER COMPONENTS REQUIREMENT	GEISLER	C
EIA	TR27.7.1	COMPUTER COMPONENTS REQUIREMENT	LORENZ	
EIA	JOINT TECHNICAL ADVISORY COMM OF EIA & IRE			
EIA	EIA STANDARDS LABORATORY			
EIA	JOINT ELECTRON DEVICES ENGRG COUNCILS			
EIA	JTS	JOINT COMMITTEES		
EIA	JTS4	PHOTOSENSITIVE ELECTRON DEVICES	REID	
EIA	JTS7	DEFINITIONS & TYPE DESIGNATIONS		
EIA	JT	ELECTRON TUBE COMMITTEES		
EIA	JT1	HIGH POWER VACUUM TUBES		
EIA	JT5	LOW POWER VACUUM TUBES		
EIA	JT5.3	MECHANICAL TESTS		
EIA	JT5.4	RADIO & TELEVISION RATINGS		
EIA	JT5.7	MILITARY SPECIFICATIONS		
EIA	JT5.8	PULSE RATINGS		
EIA	JT6	CATHODE RAY TUBES		
EIA	JT6.3	PHOSPHORS&OPTICAL CHARACTERISTI		

EIA	JT7	DEFINITIONS & TYPE DESIGNATIONS		
EIA	JT11	SAMPLING PROCEDURES	MORREALE	
EIA	JT12	POOL & GAS TUBES		
EIA	JT13	MICROWAVE DEVICES		
EIA		SEMICONDUCTOR DEVICES COMMITTEES		
EIA	JS1	POWER RECTIFIER COMPONENTS	FRANK	
EIA	JS1	POWER RECTIFIER COMPONENTS	HANKE	A
EIA	JS2	SIGNAL DIODES	SAIA	
EIA	JS3	UHF & MICROWAVE DIODES		
EIA	JS5	SELENIUM&COPPER OXIDE DIODES&RECT		
EIA	JS6	POWER TRANSISTORS		
EIA	JS8	ENTERTAINMENT SIGNAL TRANSISTORS		
EIA	JS9	INDUSTRIAL SIGNAL TRANSISTORS	JOHNSON	
EIA	JS10	MECH STANDARDIZATION & PACKAGING	ROBERTS	
EIA	JS11	SAMPLING PROCEDURES	KEHAYIAS	
EIA	JS12	MILITARY SPECIFICATIONS		
EIA	JS13	SPECIAL DEVICES		
EIA		MARKETING DATA DEPARTMENT		
EIA		MILITARY MARKETING DATA	WEAVER	
EIA		COMPUTER & DATA PROCESSING		
EIA		INDUSTRIAL RELATIONS DEPARTMENT		
EIA		INDUSTRIAL RELATIONS DIGEST PUBL		
EIA		WALSH-HEALLY COMMITTEE		
EIA		SAFETY AND HEALTH	DE REAMER	
ACM		ASSOCIATION FOR COMPUTING MACHINERY	DE CARLO	IR
ACM		COUNCIL	GILCHRIST	S
ACM		COUNCIL	BEMER	NY
ACM		COUNCIL	GASS	
ACM		PROGRAMMING LANGUAGES C	BACKUS	
ACM		PROGRAMMING LANGUAGES C	BEMER	
ACM		PROGRAMMING LANGUAGES C	GREEN	
ACM		ALGOL MAINTENANCE SC	FRANCIOTTI	
ACM		ALGOL MAINTENANCE SC	KOGON	
ACM		OPERATING SYSTEMS SC	BEMER	C
ACM		INFORMATION RETRIEVAL SC	GREMS	C
ACM		STANDARDS COMMITTEE	BEMER	
ACM		STANDARDS COMMITTEE	GREMS	
ACM		PROGRAMMING TERMINOLOGY SC	GREMS	
AFIPS		AMERICAN FED OF INFO. PROCESSING SOCIETIES		
AFIPS		EXECUTIVE COMMITTEE - AIEE	IMM	
AFIPS		BOARD OF GOVERNORS - AIEE	IMM	
AFIPS		BOARD OF GOVERNORS - ACM	GILCHRIST	
AFIPS		BOARD OF GOVERNORS - IRE	BUCHHOLZ	
AFIPS		FINANCE COMMITTEE	ASTRAHAN	C
AFIPS		ADMISSIONS COMMITTEE	GILCHRIST	C
AFIPS		JOINT GLOSSARY COMMITTEE	GREMS	
AFIPS		JOINT GLOSSARY COMMITTEE	MULLERY	
AIEE		AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS	MC PHERSON	IR
AIEE	B80.60	PROF DEVEL & RECOGNITION DEPT		

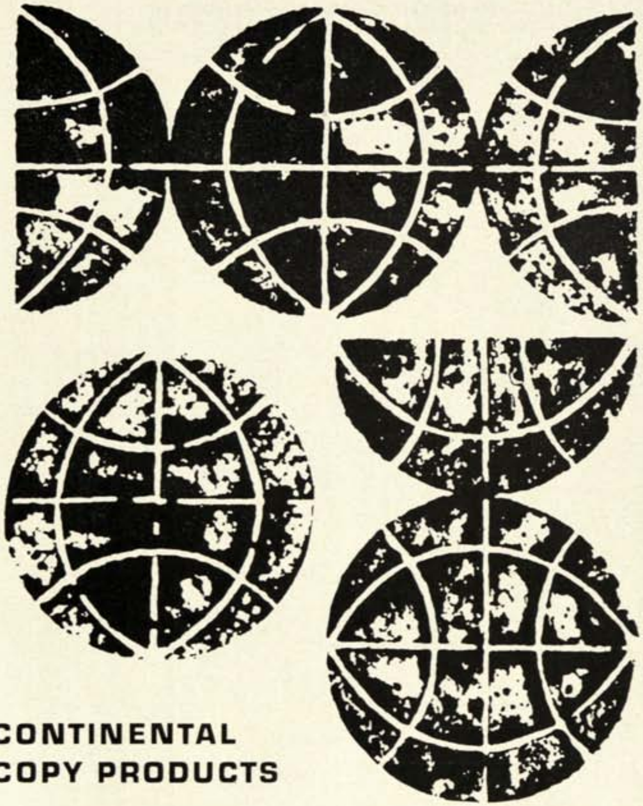
AIEE	B80.60.F8	EDISON MEDAL	PIORE	
AIEE	B80.60.F4	PROFESSIONAL CONDUCT	MC PHERSON	
AIEE	B80.60.D4	TECHNICAL OPERATIONS DEPT		
AIEE	B80.60.H	NEW TECHNICAL ACTIVITIES	PALMER	C
AIEE		COMMUNICATION DIVISION		
AIEE		COMMUNICATION SWITCHING SYSTEMS C	MARKLE	C
AIEE		COMMUNICATION THEORY C	FONTAINE	
AIEE		COMMUNICATION THEORY C	PETERSEN	
AIEE		COMMUNICATION THEORY C	WOOD	
AIEE		DATA COMMUNICATION C	ARMISTEAD	
AIEE		DATA COMMUNICATION C	BARBEAU	
AIEE		DATA COMMUNICATION C	WOOD	
AIEE		RADIO ENGG&ELECTRONIC PHYSICS RVW	WOOD	
AIEE		INDUSTRY DIVISION		
AIEE		FEEDBACK CONTROL SYSTEMS C	MARCY	C
AIEE		FEEDBACK CONTROL SYSTEMS C	LOHMAN	
AIEE		ADMINISTRATIVE-PAPERS REVIEW WG	LOHMAN	
AIEE		COMPUTERS & LOGIC DEVICES SC	LOHMAN	
AIEE		COMPUTERS & LOGIC DEVICES SC	HOAGLAND	
AIEE		INSTRUMENTATION DIVISION		
AIEE		RECORDING & CONTROLLING INSTR. C	HAMRICK	
AIEE		POWER DIVISION		
AIEE		ROTATING MACHINERY C		
AIEE		SINGLE PHASE & FRACTIONAL H.P. C	GORGA	
AIEE		SCIENCE & ELECTRONICS DIVISION	IMM	
AIEE		BASIC SCIENCES		
AIEE		APPLIED MATHEMATICS SC	BAIRD	
AIEE		COMPUTING DEVICES	CASE	
AIEE		COMPUTING DEVICES	IMM	
AIEE		COMPUTING DEVICES	MC PHERSON	
AIEE		COMPUTING DEVICES	ORMSBY	
AIEE		COMPUTING DEVICES	PREISS	
AIEE		APPLIC TO AUTOMATION PROCESSES SC	CHIEN	
AIEE		APPLIC TO BUSINESS PROCESSES SC	WORTHINGTON	
AIEE		APPLIC TO DESIGN, EVAL & SIMUL SC	ORMSBY	
AIEE		COMPUTER PROGRAMMING SC	MC PHERSON	
AIEE		COMPUTER RELIABILITY SC	MC CARTER	
AIEE		COMPUTER STANDARDS SC	PREISS	C
AIEE		COMPUTER STANDARDS SC	BEMER	
AIEE		COMPUTER STANDARDS SC	BODEN	
AIEE		COMPUTER STANDARDS SC	MC FARLIN	
AIEE		SYMBOLOGY TG	BODEN	C
AIEE		COMPUTER SYSTEMS SC	CARTER	
AIEE		1962 WORKSHOP - ARTIF INTELL WG	CARTER	C
AIEE		DESIGN AUTOMATION SC	CASE	C
AIEE		DESIGN AUTOMATION SC	LEIMER	
AIEE		DESIGN AUTOMATION SC	PREISS	
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	MC FARLIN	S
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	EARLE	
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	ELGOT	
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	FORBES	
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	KAY	
AIEE		LOGIC & SWITCHING CIRCUIT THEORY	MILLER	

AIEE	LOGIC & SWITCHING CIRCUIT THEORY	PREISS	
AIEE	LOGIC & SWITCHING CIRCUIT THEORY	ROTH	
AIEE	LOGIC & SWITCHING CIRCUIT THEORY	SHELLY	
AIEE	NEW ACTIVITIES SC	IMM	
AIEE	REPRESENTATIVE TO AFIPS	IMM	
AIEE	ELECTRICAL INSULATION		
AIEE	SOLID INSULATION SC	CALLINAN	
AIEE	ELECTRONIC TRANSFORMERS	COOPER	
AIEE	MATERIALS SC	COOPER	
AIEE	ELECTRONICS	KOON	C
AIEE	RELIABILITY & QUALITY CONTROL SC	KOON	
AIEE	MAGNETIC AMPLIFIERS	SHEVEL	
AIEE	MAGNETIC AMPLIFIERS	FETH	
AIEE	COMPUTER MAGNETICS SC	SHEVEL	
AIEE	COMPUTER MAGNETICS SC	FETH	
AIEE	THEORY SC	FETH	
AIEE	SEMICONDUCTOR RECTIFIERS	FRANK	
AIEE	EQUIPMENT SC		
AIEE	EQUIPMENT FOR ELECTRONIC LOADS	FRANK	
BEMA	BUSINESS EQUIPMENT MANUFACTURERS ASSOC.	BIRKENSTOCK	IR
BEMA	BOARD OF DIRECTORS	BIRKENSTOCK	VC
BEMA	BOARD OF DIRECTORS	BECHTEL	
BEMA	OMG ADVISORY COMMITTEE	BECHTEL	
BEMA	DPG PLANS & POLICY COMMITTEE	BIRKENSTOCK	
BEMA	DPG PLANS & POLICY COMMITTEE	DOUD	A
BEMA	DPG ENGINEERING COMMITTEE	ANDRUS	
IRE	INSTITUTE OF RADIO ENGINEERS		
IRE	1961 FELLOW AWARDS SELECTOR COMM	WOLFF	
IRE	4.10 SOLID STATE CIRCUITS	ROYER	
IRE	4.10 SOLID STATE CIRCUITS	HENLE	
IRE	8 ELECTRONIC COMPUTERS	HAYNES	
IRE	8.3.1 MAGNETIC MATERIALS	SCHAAL	
IRE	8.3.1 MAGNETIC MATERIALS	WILLIAMS	
IRE	19.1 MAGNETIC RECORDING	KORNEI	
IRE	21 SYMBOLS COMMITTEE	WARREN	
IRE	28 SOLID STATE DEVICES	LAMPE	
IRE	28.2 SUPERCONDUCTIVE ELECTRONICS	DELANO	
IRE	28.4 JOINT IRE-AIEE SEMICONDUCT DEVICE	JOHNSON	
IRE	28.4.4 TESTG TRANSISTORS LARGE SIG APPL	REIMER	
IRE	28.5 DIELECTRIC DEVICES	SCHAFFERT	
IRE	28.5.3 ELECTROSTATOGRAPHIC DEVICES	SCHAFFERT	
IRE	28.9 MICROSYSTEMS ELECTRONICS	COUNIHAN	

NUMBER OF THE DATA PROCESSING SYSTEMS INSTALLED AND ORDERED IN GERMANY

Stand : 1-7-1965 with comparison figures of 1-7-1964

Manufacturer/Model	Stand : 1-7-1965			1-7-1964
	Installed	Ordered	Total	Total
BULL-GE				
Serie 300	11	—	11	11
Gamma 10	19	133	152	72
Gamma 115	—	5	5	—
Gamma 30	28	10	38	32
Serie 400	2	15	17	3
	60	163	223	118
BURROUGHS				
B 200/300	11	4	15	4
CONTROL DATA				
CDC 160	1	—	1	—
CDC 160 A	2	—	2	5
CDC 8090	2	1	3	—
CDC 8092	—	2	2	—
CDC 1604 A	1	—	1	1
CDC 3100	—	2	2	—
CDC 3200	2	3	5	1
CDC 3400	2	1	3	—
CDC 3600/3800	—	1	1	1
CDC 6400	—	1	1	—
	10	11	21	8
DIGITAL EQUIPMENT				
PDP-5	1	—	1	1
PDP-6	2	—	2	—
PDP-7	—	1	1	—
PDP-8	—	4	4	—
	3	5	8	1
ELECTROLOGICA				
EL X-1	15	1	16	16
EL X-8	—	5	5	4
	15	6	21	20
EUROCOMP				
RPC 4000	6	2	8	6
LGP 30	30	—	30	32
LGP 21	22	1	23	18
	58	3	61	56
FACIT				
EDB 3	1	—	1	1
FRIDEN				
6010	45	10	55	39
HONEYWELL				
H 120	—	5	5	—
H 200	7	22	29	8
H 300	—	—	—	1
H 1200	—	2	2	—
	7	29	36	9
IBM				
305	12	—	12	15
650	10	—	10	15
705	1	—	1	1
1401	770	35	805	800
1410	60	—	60	50
1440	155	80	235	230
1460	18	5	23	25
1620	80	—	80	75
1130	—	28	28	—
7010	6	—	6	4
7040/44	5	—	5	5
7070/72/74	21	—	21	21
7090/94	6	—	6	7
360/20	—	450	450	—
360/30	1	290	291	85
360/40	1	70	71	10
360/50	—	25	25	6
360/65	—	6	6	—
	1 146	989	2 135	1 349
ICT				
558	4	—	4	7
1202	1	—	1	1
1300	1	—	1	4
1301	3	—	3	7
1500	5	—	5	5
1902	—	3	3	1
1903	—	1	1	—
1904	—	2	2	—
1909	—	4	4	—
Pegasus	1	—	1	1
	15	10	25	26
MONROE SWEDA				
Monrobot XI	3	1	4	—
NCR				
315	12	6	18	9
315-RMC	—	1	1	1
803	11	—	11	14
503	1	1	2	1
	24	8	32	25
REGNECENTRALEN				
Gier	2	—	2	2
REMINGTON UNIVAC				
UCT I/II	47	—	47	48
U 1004 I/II/III	149	46	195	160
U 1040/50	3	30	33	9
U 418	—	2	2	—
U III	8	—	8	8
U 490	1	1	2	1
U 1107	3	—	3	2
	211	79	290	228
SEL				
ER 56	9	—	9	6
SIEMENS				
DVA 2002	37	2	39	38
DVA 3003	15	10	25	28
DVA 4004	—	27	27	—
	52	39	91	66
STC (ITT)				
Stantec	6	—	6	6
TELEFUNKEN				
TR 4	10	5	15	12
TR 10	6	1	7	6
	16	6	22	18
ZUSE				
Z 22	45	—	45	45
Z 23	70	7	77	60
Z 25	35	29	64	41
Z 31	4	2	6	4
	154	38	192	150
	1 848	1 401	3 249	2 132



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Electronic Computers: A Historical Survey

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The first large scale electronic computers were built in connection with university projects sponsored by government military and research organizations. Many established companies, as well as new companies, entered the computer field during the first generation, 1947–1959, in which the vacuum tube was almost universally used as the active component in the implementation of computer logic. The second generation was characterized by the transistorized computers that began to appear in 1959. Some of the computers built then and since are considered super computers; they attempt to go to the limit of current technology in terms of size, speed, and logical complexity. From 1965 onward, most new computers belong to a third generation, which features integrated circuit technology and multiprocessor multiprogramming systems.

Key words and phrases: electronic computers, computer history, time-sharing, vacuum tube computers, transistorized computers, super computers, magnetic drum computers, university computer projects

CR categories: 1.2, 1.3

A complete history of electronic computing would be a very large volume. This paper makes no attempt at completeness; it is an essay that tries to capture and communicate some of the atmosphere surrounding the development of the computer industry from its beginnings in university laboratories to its present size and status. I have been an interested observer, and to some extent a participant, since the very early days. Some of the statements made here are based on recollection and hearsay; some may be false, although none are intentionally so.

As an ACM lecturer during the academic year 1965–1966, I presented a talk, entitled "History of Electronic Computers," to a number of ACM chapters and to the Southeastern Regional Conference of the ACM. This paper consists mainly of material prepared for that talk. There is far more text than could be presented in an hour talk, and no single presentation covered all of it. I planned to publish it in the spring of 1966 as a companion paper to my historical survey, "Programming Systems and Languages," published two years earlier [83]. For a number of reasons the final draft of the paper was delayed until the spring of 1968. Because of the delay, it seemed desirable to make a few changes, almost all of them to provide additional information to bring this history up to date.

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Perhaps the title of this paper should be "Electronic Computers in the United States," except that a few developments in Great Britain are included. A more complete history would include the very significant contributions made in France and Germany and in the Scandinavian countries, as well as in many other parts of the world. The reader is referred to Hoffmann [80] for a brief history and an extensive bibliography on computers developed outside, as well as inside, the United States.

UNIVERSITY PROJECTS

ENIAC

The first large scale electronic computer was the ENIAC [1, 2], the Electronic Numerical Integrator and Calculator, built by professors Eckert and Mauchly and their coworkers at the University of Pennsylvania for the Ballistic Research Laboratories of the United States Army Ordnance Corps. The Ballistic Research Laboratories in Aberdeen, Maryland, had the responsibility for the calculation of

CONTENTS

trajectories and firing tables and had been actively involved in the development of electromechanical computers. They were quite receptive to a proposal, made in 1943 by a group of engineers and mathematicians associated with the Moore School of Electrical Engineering of the University of Pennsylvania, to build an all-electronic computer based on the very high speed vacuum tube switching devices that had been known for some years [3].

The really radical aspect of the ENIAC project was in its proposal to build a machine containing 18,000 vacuum tubes, a machine whose ability to function at all would depend on the simultaneous functioning of almost all of these tubes, without failure, over reasonable periods of time. Nothing comparable had ever been attempted, and some interpretations of tube reliability statistics were very pessimistic.

Stories are told about how all the lights in West Philadelphia would dim when the ENIAC was turned on, and how the starting transient would always burn out three or more tubes. Yet the ENIAC was quite successful. It was completed in 1946 and was used as a productive computer for about ten years at Aberdeen, from its dedication on February 15, 1946, until it was turned off for the last time on October 2, 1955.

EDVAC and EDSAC

The ENIAC, as originally designed, was not a stored program computer. Programs were installed and changed by engineers who changed the wiring among its various components. The concept of the general purpose, stored program computer was first published in 1945 in a draft of a report that proposed a new computer, the EDVAC (Electronic Discrete Variable Computer) [4, 5]. The draft was written on behalf of the ENIAC project by Dr. John von Neumann, a consultant to the project, who is considered by some to have been the inventor of the stored program computer. Others, including myself, feel that Dr. John Mauchly and Dr. J. P. Eckert deserve recognition, along with Dr.

von Neumann, as co-inventors of the stored program digital computer as we know it today.

The general purpose, stored program digital computer required large amounts of storage, more than it was economical to provide when using vacuum tube flip-flops as storage elements. Acoustic delay lines with mercury as the transmission medium had been used for data storage in radar applications, and although far from ideal as a computer memory device, these mercury delay lines did represent a practical working component around which computers could be designed. The first of these computers, the EDVAC, was started at the Moore School in 1946. The first to be completed was the EDSAC (Electronic Delay Storage Automatic Calculator) at Cambridge University in England [6]. The EDSAC was started early in 1947 by Professor Maurice Wilkes, who had spent the preceding summer with the computer design group at the University of Pennsylvania. The EDSAC performed its first computations, the first performed by a stored program computer anywhere, in May 1949. The completion of the EDVAC was delayed by (among other things) the fact that Professors Eckert and Mauchly left the University of Pennsylvania to form their own computer manufacturing company.

IAS Computer

In the United States and England, other university computer projects soon followed. At the Institute for Advanced Study at Princeton, New Jersey, the IAS computer was started in 1946 by Professor von Neumann and his colleagues. A series of reports published by that project were among the most important tutorial documents in the early development of electronic computers [7]. The IAS computer used a random access electrostatic or cathode-ray tube storage system and parallel binary arithmetic. It was very fast, especially when compared with the delay line computers, with their sequential memories and serial arithmetic. By 1952, when the IAS computer was completed, a number of other computers of the same design had been started, and several others have been built since, including the ORDVAC and the ILLIAC built at the University of Illinois, the JOHNIAC at the Rand Corporation, the MANIAC at Los Alamos, and the WEIZAC at the Weizman Institute in Israel.

Whirlwind

The Servomechanisms Laboratory at the Massachusetts Institute of Technology was one of the most active groups in the early history of electronic computers. The MIT Whirlwind I, which was started in 1947, was probably the first computer designed with eventual real-time application in mind. The computer used 0.5 microsecond circuitry and could multiply two 16-bit numbers in 16 microseconds [8].

One of the major contributions of the Whirlwind project was a set of detailed, very well annotated logical diagrams of the computer. Although not formally published, they achieved fairly wide private circulation and helped to educate many early workers in the computer field (including the author).

The most important contribution of the MIT Computer projects was their development of the coincident-current magnetic core memory. They built the Memory Test Computer to test their first core memory and later installed one in Whirlwind. The core memory designs developed at MIT were made available to the computer industry and served as the basis for the memories built by IBM and several other computer manufacturers.

Manchester University Computers

The University of Manchester in England began building computers in 1947. The first practical electrostatic storage system, the Williams tube memory, was developed there [9]. The first index registers were the B lines on a 1949 Manchester computer. (For this reason, index registers were often called B registers or B boxes in the early literature.) That same computer [10] had a magnetic drum auxiliary storage system organized into fixed length blocks called pages, which were the units moved into high speed electrostatic storage during program execution. This was the beginning of a continuing interest at Manchester in efficient utilization of hierarchies of storage that years later led to the design of the Atlas Computer, a very influential second generation computer, which is discussed in the section on time-sharing.

SEAC and SWAC

The National Bureau of Standards played a very important part in the early development of digital computers. By 1948 they had already made plans to purchase two very large Hurricane computers under development by Raytheon Corporation. One of these computers was to be installed in Washington, and the other at the NBS Institute for Numerical Analysis which had been established on the campus of the University of California at Los Angeles.

Producton of the Raytheon computers was proceeding quite slowly, and the NBS decided to build its own interim computers, one in the East and one in the West. The western computer, a relatively modest effort, was originally called the Zephyr, to contrast its size and objectives with very large efforts like the Raytheon Hurricane, the MIT Whirlwind, and large analog computers like the REAC Cyclone and the RCA Typhoon.

The Zephyr was eventually rechristened the SWAC (Standards Western Automatic Computer) [11]. It was one of the fastest of the early computers, though limited in the scope of its applications by its very small (256 words) electrostatic storage.

The eastern interim computer was the very successful SEAC (Standards Eastern Automatic Computer) [12]. The SEAC, the first stored program computer running in the United States, was placed in operation in 1950 and was used into the early 1960's. Originally it had only mercury delay line storage, but other memory systems were added. Several other computers, of which the best known was the MIDAC at the University of Michigan, were based on the SEAC design.

THE COMPUTER INDUSTRY: FIRST GENERATION

UNIVAC

In 1947 Professors Eckert and Mauchly left the University of Pennsylvania and organized the Eckert-Mauchly Computer Corporation. In their first years as an independent company they built a relatively small binary computer, the BINAC [15], for the Northrop Corporation, and they began working on the design of the UNIVAC, the UNIVersal Automatic Computer [14]. Their first major contract, negotiated with the National Bureau of Standards, called for the delivery of a UNIVAC to the Bureau of the Census for use in connection with the 1950 census.

The BINAC apparently never worked satisfactorily, but the UNIVAC was in many ways an outstanding technological achievement. The first UNIVAC was delivered on June 14, 1951. For almost five years after that it was probably the best large scale computer in use for data processing applications. Internally, it was the most completely checked commercial computer ever built. Perhaps its most impressive achievement was its magnetic tape system, a buffered system that could read forward and backward at speeds comparable to some quite recent tape systems.

The financial backer of the Eckert-Mauchly Computer Corporation was killed in an airplane accident, and the company ran into financial difficulties. As it turned out, they had underestimated both the time and the money needed to produce the very ambitious UNIVAC system. After firm orders had been accepted for delivery at about $250,000 per system, it became apparent that it would cost much more than that to build them. Under these circumstances it was attractive to accept an invitation to become the Eckert-Mauchly Division of Remington Rand Corporation. Prices were immediately increased, although some deliveries had to be made at bargain prices. Some orders, most significant perhaps those from the

Prudential Life Insurance company, were canceled.

Remington Rand was launched into the computer field with a product that was years ahead of any of its competitors. In 1952 Remington Rand further solidified its position of leadership in the computer field by acquiring Engineering Research Associates of St. Paul, Minnesota. Engineering Research Associates had already achieved a considerable reputation in the design of computing systems and components [15]. They had done important work in the design of their one-of-a-kind 1101 and 1102 magnetic drum computers, and in cooperation with a government security agency they had designed the ERA 1103, a very powerful scientific computer using parallel arithmetic and cathode-ray tube storage. Eckert-Mauchly and Engineering Research Associates were eventually incorporated into the Univac Division of Remington Rand. The UNIVAC computer became known as UNIVAC I, and the 1103 and its successors were called Univac Scientific Computers.

It is of some interest, in retrospect, to ask why Remington Rand, starting with computer hardware so far ahead of the rest of the field, fell so far behind. Part of the answer lies in the fundamental difficulty of integrating a number of previously independent companies into the framework of an existing organization. Remington Rand had absorbed two of the outstanding companies in the young computer field but it never succeeded in getting them to work together as parts of a larger unit.

From the beginning, the UNIVAC I sales effort was insufficient, unaggressive, and unimaginative. The Eckert-Mauchly personnel, for the most part, had a scientific rather than a business orientation. They realized the limitations of their machine and would tend to dampen the enthusiasm of prospective customers who came to them with prophetic visions of the potential of electronic data processing. They knew that these visions would become reality only on a later generation of computers, and they did not encourage the very expensive experimentation which would almost invariably prove them to have been right. Most of this experimentation was eventually carried out on competitor's equipment, spurred on by promises made by salesmen who often understood little or nothing about the capabilities of the equipment they were selling.

There were, of course, some other basic problems besides lack of sales effort. During the first crucial years, Remington Rand would only sell, not lease, UNIVAC I systems. A leasing policy would have required a great deal of capital, and Remington Rand, which had recently emerged from some serious financial difficulties, was not prepared to undertake the expansion that would have been necessary.

The early UNIVAC I system was incomplete, especially in the area of peripheral equipment. Punch-card-to-tape conversion equipment which had been developed by Eckert-Mauchly for the Bureau of the Census handled only 80-column cards. For several years there thus existed an anomalous situation: Remington Rand UNIVAC I systems were normally supported by IBM punch card installations and could not use Remington Rand's 90-column cards.

For the first few years, prior to the development of the UNIVAC 600-line-a-minute printer, the only printer for the UNIVAC system was the Uniprinter, which operated at electric typewriter speed directly from magnetic tape.

On the input side, UNIVAC I introduced the concept of direct recording onto magnetic tape from a typewriter keyboard. A keyboard operated tape verifier, which was supposed to be part of the input preparation system, was never fully operational. Verification and correction usually had to be done on the computer, and the computer time required for these tasks was quite appreciable. This kind of operation may be revived in the new generation of computers with on-line keyboards and very large random access memories. It was not a successful concept in terms of computers in the UNIVAC I class.

The UNIVAC I was the only mercury delay line storage computer that achieved the status of a commercial product. By 1953 it was apparent that computers with magnetic core memories could be produced that would make the UNIVAC I obsolete. In 1954 IBM announced its 705 computer, and Remington Rand responded about a year later with the announcement of the UNIVAC II, a computer with magnetic core memory that would be able to run UNIVAC I programs and would, in addition, be far more powerful than the UNIVAC I. Plans called for the UNIVAC II to be designed in Philadelphia and produced in St. Paul. So many difficulties arose in this process that the production responsibility was finally shifted back to Philadelphia. Deliveries kept being delayed and orders dwindled as many customers switched to the 705. IBM delivered its first 705 by the end of 1955. It was two years later that the first UNIVAC II was delivered. These two years were sufficient to give IBM a lead in the large scale commercial computer field that no manufacturer has since been able to challenge.

IBM

IBM, the International Business Machines Corporation, entered the field of automatic computation by way of electromechanical equipment designed to complement its line of punch card machines. In the 1930's they introduced their 600 series of calculating punches. Between 1939 and 1944 they cooperated with Professor Howard Aiken of Harvard University to build the MARK I Calculator [16], which according to Dr. Bowen [17] was "... the first machine actually to be built which exploits the principles of the analytical engine as they were conceived by Babbage a hundred years before." The MARK I was the largest electromechanical computer ever built. At Harvard, Professor Aiken went on to build the MARK II [18], a large relay computer, and then the MARK III and MARK IV, which were one-of-a-kind magnetic drum computers. At its headquarters in New York, IBM built the huge SSEC [19] (Selective Sequence Electronic Calculator), which was put into operation in January 1948. The SSEC was only partly electronic, it used 13,000 vacuum tubes along with 23,000 electromechanical relays.

By 1947 IBM had an electronic multiplier in its product line, and by the end of 1948 they had started to deliver the 604 Electronic Calculating Punch, which made electronic computing speeds available in punched-card handling systems. They had this area of electronic calculation almost completely to themselves for years. It was only in 1951 that Remington Rand came out with its 409-2 electronic calculator that introduced some slight competition into this field. Without very great fanfare IBM produced and installed hundreds (later thousands) of their electronic calculating punches. While some of the other office equipment manufacturers were still debating the practicality of electronic computing and looked at electronics as something that might eventually invade the business office, most of the major business offices had already taken a first step into electronic computing, at least on the level of the 604, a machine with over 1400 vacuum tubes.

The 604 was quite limited in its sequencing and calculating abilities. In 1948 Northrup Corporation, one of IBM's customers on the West Coast, joined a calculating punch to a 400 series accounting machine, and this concept was developed and marketed by IBM as the Card Programmed Calculator (CPC). The CPC was not a stored program computer, but it did have the ability to execute programs of arbitrary length. A program consisted of a deck of cards, each of which contained a code which called on a more or less complex program sequence within the 604. In addition to performing calculations, each step could print a line or punch a card. The CPC was only semiautomatic, in the sense that punch card machines are semiautomatic; it required a human operator to feed and remove cards. Iterative programs could be run by feeding the same cards through over and over again. The CPC was slow by electronic computer standards, running at a maximum speed of 150 instruction cards per minute. Yet it is hard to exaggerate its role as an interim computer, carrying the major computing load in dozens of computation centers while they were waiting for the stored program computers to live up to their promises in terms of delivery and performance.

Even though IBM was by far the leader in the use of electronic calculation in punch card machines, it was quite slow in entering the commercial large scale computer field. While the National Bureau of Standards was negotiating its contract to obtain the UNIVAC I for the Bureau of the Census, IBM contended that magnetic tape was unreliable, untested, and risky. It suggested that the census would be well advised to stick to punch card methods. To some people in IBM, magnetic tape processing must have loomed as a threat to the punch card processing field, in which IBM had been able to establish a near monopoly.

The Korean War (which started in 1950) brought about a great expansion in the defense-related industries and a greatly increased need for computation of all kinds. It was then that IBM announced its Defense Calculator, a large scale scientific computer using a 2048-word Williams tube memory backed up by magnetic drum and magnetic tape storage. Its random access storage and parallel binary arithmetic would make the Defense Calculator much faster than the UNIVAC I for scientific calculation. The first Defense Calculator, now known as the IBM 701, was delivered early in 1953 [20]. By that time IBM had announced the 702, a completely separate computer development for the commercial data processing field [21]. The 702 was a character-oriented computer with 10,000 characters of electrostatic Williams tube memory. The first 702 was delivered early in 1955, but long before that it had become clear that the machine was inadequate in a number of very important respects. The electrostatic memory did not have the reliability required in data processing applications. The computer was too slow; it had a 23-microsecond-per-character memory cycle, and took 115 microseconds to read out a standard five-character instruction. The magnetic tape system could read forward only and was completely unbuffered. The computer used slow, on-line card readers and printers. Some of these drawbacks could be overlooked in view of the early state of development of the computer art, but it was quite obvious to anyone who cared to make the comparison that the competing Remington Rand UNIVAC I was a superior data processing system.

One of the most important characteristics contributing to the success of IBM has been its ability as a company to react very quickly and with a great deal of energy to crises created either by its own mistakes or by competitive pressures. The 702 presented such a crisis—a better machine was needed to replace it even though the 702 itself was still far from delivery. A parallel effort was initiated to develop a similar but much more capable computer. The 705 was announced and the 702 was withdrawn from the market. To meet delivery commitments, a number of 702's were completed and delivered, but the computer had been declared obsolete and deliveries of the 705 started less than a year after the delivery of the first 702. The effort was a major strain on the resources of IBM, which was not then the huge, immensely wealthy corporation it has since become. The effort was successful, even though there are some who argue that the 705, at least in its earliest delivered form, was still inferior to the UNIVAC I that had been delivered four and a half years earlier.

In the 705, the cathode-ray tube memory was replaced by the faster and more reliable magnetic core memory [22]. Logically it was still a character-oriented machine, but physically the memory was organized into groups of five characters each and access time was 17 microseconds for five-character instructions and for five-character data units.

One of the early 702 customers was Commonwealth Edison Company, which had investigated the UNIVAC and had great respect for the power of a buffered tape system. Since they would not order a system without this feature, IBM agreed to develop a special external buffering system which eventually led to the Tape Record Coordinator (TRC). This was a tape controller containing 1024 characters of magnetic core storage plus associated logical circuitry. The addition of several TRC's to a 705, though very expensive, made it into a quite powerful data processor, especially when, in the model II, the amount of internal core storage was significantly increased. The model III introduced in 1958 provided a faster core memory and internal buffering. Backward reading tapes on IBM computers had to await a later computer generation, and as a result, sorting speeds on the 705 were always slower than on comparable competitive equipment.

By 1959, the year that marks the start of the second and transistorized computer generation, the 705 was firmly established as the standard in the large scale, data processing field. Like all the vacuum tube computers it was very vulnerable to competition from the much less expensive, more powerful computers that could then be built.

Scientific Computers

The electrostatic storage system on the IBM 701 was very unreliable compared with the mercury delay line storage then in use. The mean time between memory failure at 701 installations was often less than 20 minutes. All serious programs had to provide for frequent storage of the contents of the 2048-word main memory on a magnetic drum for use in restart procedures. In spite of its storage problems, the 701 was so much faster than most other computers available at the time that it was reasonably successful. Eighteen 701's were installed in the period from 1953 to 1956.

When magnetic core storage became available, a 701M computer was planned, but the resulting product was sufficiently different to warrant the use of a new model number, 704.

The 704 provided three index registers, built-in floating-point instructions, and a minimum of 4096 words of magnetic core storage with a 12-microsecond cycle time. Three bits were used to select an index register, and additional bits were needed to address the expanded main memory. The 704 therefore dropped the two-instructions-per-word format of the 701. It kept the 36-bit word with a single one-address instruction per word.

The 704, first delivered in 1956, was quite outstanding for its time and achieved a near monopoly for IBM in the large scale scientific computer field. The only competition was provided by Remington Rand's 1103 series—the 1103A, in which the electrostatic memory of the 1103 was replaced by magnetic core memory, and the 1103AF, that added floating-point hardware. The 1103 was the first computer to provide a program interrupt feature [23]. This feature was added at the request of a customer, Richard Turner, who was in charge of an 1103 for NACA (now NASA) in Cleveland, Ohio. An interrupt system was later included in the design of IBM's 709 computer, and interrupt systems have been used in most computers built since that time. The 1103 series used an efficient two-address instruction format in a 36-bit word. Its magnetic drum storage was a directly addressable extension of main memory. These computers, collectively known as Univac Scientific Computers, were considered by many of their users to be superior to the IBM 700 series, but there were relatively few installations. A record of late delivery and poor support contributed to the poor sales record of the 1103 series.

The early scientific computers were designed in accordance with a philosophy that assumed that scientific computing was characterized by little or no input or output. The 701 and early installations of the 704 used an on-line card reader (150 cards per minute) for input, and printed output could be obtained only from an on-line printer that could print 150 short lines or 75 full lines per minute.

By the time the 704 was being delivered, the need for off-line peripheral equipment was quite apparent and arrangements were made to use card-to-tape and tape-to-printer equipment that had been designed for the 705. There were a number of unfortunate incompatibilities between the 704 and the 705, which had been designed by different divisions of IBM. Character codes were different, and the 704 used odd parity checking while that on the 705 was even. The 705 peripheral equipment would not (until much later) handle binary cards. The off-line equipment was widely used in spite of these inconveniences. Really adequate off-line peripheral conversion equipment became available much later, in the 1960's, with the introduction of the 1401 and other small peripheral computers by IBM and other manufacturers.

In the 701 and 704 there was no buffering for tapes or drums or on-line input/output devices. All information going to and from main memory passed through the MQ register in the arithmetic unit. An increasing understanding of the data handling needs of scientific computing and the realization that large binary computers could be used for data processing applications caused IBM and others to reassess the input/output needs of such computers. At IBM this led to the development of the 709, which used the same 12-microsecond core memory as the 704 and was only slightly faster. It had all the instructions of the 704 as well as some useful new features, such as indirect addressing. The major difference, and the really important advance over the 704, was a new input/output system that permitted reading from tape or cards, writing to tape or printer, and computation to proceed simultaneously. This was made possible by time-sharing the core memory between the central computer and as many as six data channels. Variations of this approach to internal buffering have become standard on most computers, even quite small ones, in recent years.

The 709 had a very brief career. By the time the first 709 was delivered in 1958, transistors suitable for economical use in high speed computers had been developed; so the vacuum tube 709 computer was obsolete. It gave way quite soon to a much more powerful successor, the 7090, which is discussed in a later section.

A buffered version of the Univac Scientific Computer, the 1105, was introduced slightly later than the 709. The 1105 replaced the UNIVAC I at the Bureau of the Census for use in connection with the 1960 census. It too was one of the vacuum tube computers whose career was cut short by the introduction of the more powerful transistorized computers.

Raytheon and Honeywell

Raytheon Corporation was very active in the earliest days of electronic computers. In 1948 it had under development a very large mercury delay line computer [25] which it had reason to believe would make it the leading supplier of computers to the United States Government. The first Raytheon computer, then called the Hurricane, was scheduled for a west coast Naval station as part of a defense network that would eventually have a number of the large computers. The National Bureau of Standards ordered two of the Raytheon computers, one for its Washington headquarters and one for its Institute for Numerical Analysis in Los Angeles. The RAYDAC, as the computer was eventually called, incorporated a number of advanced features in arithmetic checking and built-in binary-to-decimal and decimal-to-binary conversion. Production proceeded quite slowly, and the NBS changed its plans and built its own interim computers, the SEAC and SWAC, which have been discussed. By the time the RAYDAC was completed it was already outmoded. The first and only RAYDAC built was installed at Point Mugu in California and was run as a general purpose computer for several years.

Raytheon had developed a computer design capability but the RAYDAC was not a marketable product. In 1954, Minneapolis Honeywell Corporation, interested in getting into the computer field, and Raytheon, which already had some reasons for wanting to get out, jointly set up the Datamatic Corporation, which became the heir to the Raytheon computer department. Raytheon eventually sold its share of Datamatic Corporation to Honeywell, and it became the Datamatic division, and eventually the computer division of Honeywell. The first product offered by Datamatic was the DATAMATIC 1000 [26], a magnetic core memory, data processing computer designed to compete with the very largest data processing systems. Built on a grand and expensive scale, the DATAMATIC 1000 had enough air conditioning to cool not only the computer but also the room in which it would be installed. Its most interesting feature was its tape system, which used three-inch-wide magnetic tape and fixed-length blocks such that the interblock gap equalled the block length. When reading in one direction, the interblock gap was the recording area that was used when reading in the reverse direction. The use of three-inch-wide tapes and the existence of no waste space in the interblock gaps combined to permit the storage of very large files of information on relatively few tapes. By the end of 1957, when the first DATAMATIC 1000 was delivered, IBM had been delivering 705's for two years, and the 1000's were too late and too high priced for the market at that time. Sales were so poor in 1957 and 1958 that the computer was withdrawn from the market, and there were strong rumors circulating that Honeywell was about to leave the computer field. Honeywell decided instead that the new generation of transistorized computers would provide a new opportunity for a more successful entry into the computer market and developed the Honeywell 800, which is discussed in the section on the second generation.

RCA

RCA, the Radio Corporation of America, has been active in the computer field almost from its inception. The RCA Research Laboratories in Princeton, New Jersey, has been one of the centers of research in computer memory systems since the mid-forties. The design of the Institute for Advanced Study computer, which was started in 1946, called for the use of RCA Selectron electrostatic storage tubes, which were then under development. The Selectron did not turn out to be quite satisfactory; so the IAS computer switched to Williams tubes, and research at RCA turned toward the development of magnetic core memories.

RCA was probably the first computer manufacturer to build an operational coincident current, magnetic core memory, the type of memory that has since become standard throughout the industry [27]. RCA felt that this development gave them an important competitive advantage, which they set out to exploit in the BIZMAC [28], a very large data processing system designed specifically for business use. The magnetic core storage was new and expensive, and the BIZMAC was therefore designed to use a small magnetic core memory backed up by a large magnetic drum. Programs were stored on the drum and executed from core; block transfers of up to 32 instructions "surged" from drum to core for execution.

The BIZMAC was advertised as the first and only truly variable-word-length computer. Only significant information, no filler information, had to be stored on magnetic tape.

The BIZMAC magnetic tape system design attempted to almost completely eliminate tape mounting and dismounting. A system would have 100, 200, or more low cost tape transports, and a reel of tape would more or less permanently occupy its own transport.

In addition to general purpose computers, a BIZMAC system could have one or more sorters, which were special purpose computers with built-in programming for tape sorts. All components of the system were interconnected through a relay switching center. A telephone dialing scheme at the BIZMAC control center made it possible for tapes to be switched between computers and sorters. The resulting sorted files could then be switched to output devices for printing or punching. No tape handling was involved; everything was remotely controlled by a pair of mutually checking operators.

A very large BIZMAC system was installed at the Ordnance Tank Automotive Command (OTAC) headquarters in Detroit. Several smaller BIZMAC systems were built, one of which was installed on a trial basis at Higbe's department store in Cleveland.

The BIZMAC ranks with the RAYDAC and the DATAMATIC 1000 as one of the "interesting failures" that characterized the first generation of large scale, data processing systems. Perhaps the most important reason for this was RCA's inability to recognize the tempo of development in the computer industry. In 1952 and 1953 RCA engineers felt that they were ahead of the rest of the industry, and the details of the BIZMAC project were carefully guarded company secrets. By 1956 when the first BIZMAC was delivered and put into operation it was already outmoded. As soon as large magnetic core memories became available on large scale computers, a computer based on a small core memory backed up by a drum was competitive only with other drum computers.

Several other computing systems made use of special purpose electronic sorters. In almost every case, users came to the conclusion that sorting could be handled better on a general purpose computer. In areas like sorting, special purpose equipment is almost always too limited. The actual applications require far more logical ability than is built into a special purpose device.

The idea of switching many low cost tape transports seems to have been poorly conceived. The trend has been toward faster and more sophisticated, and therefore more expensive, tape units on large computers.

The concept of a computing system based on an automatic switching center through which large numbers of peripheral devices can be switched to a number of computing elements is sufficiently attractive that other attempts have been and will be made to produce a practical realization. One such attempt, also completely unsuccessful, was made in 1958–1961 by Ramo-Wooldridge in connection with its 400 system [29], which was designed around a large electronic switching system. It is possible to see analogies to many BIZMAC features in a number of the most recent computing systems.

Magnetic Drum Computers

Magnetic drums and disks were among the earliest devices considered for use in digital computer storage systems. Eckert [30], referring to a thesis written by Crawford at MIT in 1942, states that "Out of this thesis grew the magnetic drum and magnetic disk memory system." He further states that "In 1944 the author (Eckert) submitted to the Moore School of Electrical Engineering at the University of Pennsylvania a memorandum which recommended the use of drums or disks for the general storage of all data required by a computer—not only the numbers being processed, but also instructions.... This memorandum became the basis for the design of the EDVAC memory. The EDVAC design was subsequently switched from magnetic disks and drums to mercury tanks, ..."

By 1948 or 1949 practical magnetic drum storage systems had been developed at Manchester University, at Harvard, and by ERA (Engineering Research Associates) in St. Paul, Minnesota. Magnetic drum storage provided relatively slow random access, and even the earliest magnetic drum computers made use of devices such as recirculating tracks and minimum-access-time coding to improve performance.

At Harvard University in 1949–1950

the MARK III computer [31] was built for the Naval Proving Ground at Dahlgren. Around the same time, ERA designed its 1101 computer [32]. Both were relatively large computers but, mainly because the magnetic drum was too slow to be the main memory of a large scale computer, neither was very successful.

Magnetic drums could provide large amounts of medium speed storage, 5–25 millisecond access time, at a very low price per bit compared with mercury delay line or electrostatic or magnetic core storage. Using the magnetic drum as the main memory, it was possible to build relatively low priced computers. While these computers were not comparable in speed and capacity with the very large, very expensive computers being built, they provided computational and data processing capabilities that were not otherwise available to those who could not justify or afford the large systems.

Many companies entered the computer field between 1950 and 1953 with new magnetic drum computers. It was almost too easy to design and build a prototype computer. It was not quite as easy to develop a production facility, a marketable product, and adequate support.

On the West Coast a new company, Computer Research Corporation, built a very compact binary computer, the CADAC [34]. The CADAC and the later production model, the CRC 102A, relied on minimum-access-time coding to make up for its 12.5 millisecond average access time. Computer Research Corporation merged with National Cash Register Corporation (NCR), which marketed the 102A and introduced an expanded decimal version, the 102D. Along with the 102D it introduced a magnetic tape unit that did not use tape reels, but allowed tape to fall freely into the bottom of the unit. Performance was marginal and only a few 102D systems were installed before the system was withdrawn from the market.

On the East Coast Dr. Samuel Lubkin started the Electronic Computer Corporation. Dr. Lubkin had worked with the computer group at the University of Pennsylvania, and his company included a number of engineers who had helped develop UNIVAC. By making a very low bid, the newly formed company obtained a contract to design and build a small computer, the ELECOM 100 [35], for the Ballistic Research Laboratories at Aberdeen. Electronic Computer Corporation was later absorbed by the Underwood Corporation and went on to produce the ELECOM 120 and 125. The 125 system included an independent file processor for off-line electronic sorting and other basic data processing tasks. Underwood ran into equipment problems and financial difficulties and eventually withdrew from the computer field in 1957.

Consolidated Engineering Corporation of Pasadena, California, set up a computer division that designed and built the CEC-201 computer [36]. This was a slightly larger, more powerful computer than the CADAC or ELECOM systems, and, possibly for this reason, it was more successful. A "high speed" recirculating-loop memory stored 80 words with an average random access time of .85 milliseconds, one tenth the 8.5 milliseconds average random access time to the 4000-word main drum memory. A 20-word block transfer could move a segment of program or data into high speed memory in one drum revolution time (17 milliseconds).

The computer division of Consolidated Engineering was spun off as the ElectroData Corporation, and the computer was called the Datatron. Deliveries started in 1953. One of the early customers, Socony Mobil Oil Company, insisted on punch card input/output, and a card converter was designed to permit the use of a relatively fast card collator as input and an IBM 407 tabulator as output.

A magnetic tape system was developed with a search command that permitted the tape system to search for a 20-word block by block number while the computer was engaged in other processing.

The Datatron was the first product-line computer that featured a hardware index register. By properly specifying the sign digits, the index register could also be used as a relocation register during input of programs.

The useful life of the Datatron system was extended several years by the introduction of floating-point hardware, by the development of the Cardatron, which provided buffering and editing features for card equipment, and the Datafile, which provided relatively fast-access bulk storage on strips of magnetic tape [33]. In 1956 the Burroughs Corporation absorbed the ElectroData Corporation.

For a time the smaller companies had the medium scale computer market to themselves, but in 1953 IBM announced its magnetic drum computer, the 650 [39]. The 650 had a number of advantages over most of its competitors. Its drum rotated at 12,500 rpm, which was considerably faster than the typical 3600 rpm drums used by most other computers. The 1+1 addressing system, in which each instruction contained the address of the next instruction to be executed, was well suited to minimum access coding. It was designed as a card handling computer, with buffered card equipment integrated into the system. On the negative side, it had a relatively small drum, only 2000 10-digit words of storage. Initially, at least, it was a limited system with cards as its only input and output. Other systems, like the Datatron, offered magnetic tape auxiliary storage and on-line printers and typewriters.

IBM's position in the punch card field was a tremendous advantage for the 650; for hundreds of business organizations it seemed to be the natural next step. IBM itself underestimated the importance of this factor and planned to produce only about fifty 650's, to be sold mainly to scientific users; instead, it produced and sold over 1000.

The 650 was eventually expanded to permit the use of tapes and on-line printers. A disk storage unit, the RAMAC, was developed for use with another small computer, the IBM 305 [38], and also as auxiliary storage for the 650. Late models of the 650 could have a 4000-word drum plus 60 words of core storage, which made the large 650 system a quite powerful, although rather expensive, machine. Vacuum tube successors to the 650 were considered, but they never reached the market. IBM's eventual successors to the 650 were the transistorized computers: the 1620, in the area of small scientific computers; the 1400 series, for use in small data processing installations; and the 7070 series, in the medium-to-large class.

Remington Rand had two quite separate magnetic drum machine developments. The Univac File Computer was developed in St. Paul; the early model, model 0, was a plug-board controlled calculator with auxiliary magnetic drum storage. The later model 1 was a full scale, stored program computer with large drums provided for fast access file storage. The system could have had an off-line tape sorter and could have become quite large. But the model 1 equipment was late in delivery and in a higher price class than most other magnetic drum computers; so it was not a very successful product.

The Remington Rand management did not feel that the company could support two magnetic drum computers in the field at the same time. By 1955 the Univac center in Philadelphia had built a very high performance, magnetic drum computer for the Air Force Cambridge Research Center [40] which used magnetic amplifiers as active elements and had only 15 vacuum tubes. Commercial versions were designed and eventually became known as the solid state 80 and 90, the numbers referring to the use of 80-column and 90-column cards, respectively. These computers were withheld from the market for several years while Remington Rand tried to promote the File Computer into a successful product. Under the name UCT, they were marketed in Europe before release in the United States. The first solid state computers were delivered in the United States in 1958, after IBM had already installed many hundreds of 650's. Even so, over 500 solid state systems were installed.

The solid state computers used a 16,500 rpm drum providing 1.7 milliseconds average access time to 4000 words. Recirculating tracks were used to obtain .425 milliseconds average access to an additional 1000 words. The 1+1-address instruction code permitted minimum access time coding to further reduce access delay.

The Remington Rand designers had used magnetic amplifiers at a time when they thought transistors were not yet practical. The UNIVAC III, announced successor to UNIVAC I and II, was also the successor to the solid state line.

There were many other magnetic drum computers. The two computers that achieved the greatest success in the very small computer class were the LGP 30 manufactured by Librascope Corporation, and the Bendix G-15 computer [40] manufactured by the computer division of Bendix Corporation. The LGP 30 was a very basic computer with a very limited instruction code. The G-15 was much more sophisticated, essentially a microprogrammed computer, and it became popular only after software developments made it unnecessary for its users to write their programs in machine code.

Burroughs

In 1948 Burroughs set up its research division in Philadelphia with personnel who had participated in most of the major computer projects. Burroughs built its first magnetic drum computer, a prototype of the UDEC, in 1950 and seemed on the way to becoming a power in the computer field.

In spite of this auspicious start, by 1956 Burroughs had produced only one product-line computer, the E101, which was on so small a scale that it prompted Dr. Wormersley, an English scientist who was visiting the Burroughs Research Center at Paoli, to make a comment about a mountain that had labored to produce a mouse.

Burroughs was hampered very much by its tradition as a producer of key-driven machines in competition with punch card systems. The E101 was about as far as they could go with manual input. Paper tape might have been adequate for small scientific computers, but it was not adequate for the commercial applications that were of interest to Burroughs. Burroughs management can hardly be blamed for being hesitant about producing computing systems that would rely on a major competitor, IBM, for all of its input and output.

When Burroughs bought control of a small company called Control Instrument Corporation in 1951, it inherited a project that was on the way to producing a very high speed tabulating machine that would read 900 cards a minute and print 900 lines a minute. It continued this development and set up a product line of so-called series G equipment consisting of high speed card readers and printers. This equipment was offered as peripheral equipment on other computers, such as the IBM 705, but after many difficulties it was finally withdrawn.

With the series G equipment as input and output, Burroughs was able to design a large scale, data processing system, the BEAM IV (Burroughs Electronic Accounting Machine No. IV). (Numbers I, II, and III had been designed but had never reached the status of products.) Before the first BEAM computer was completed, Burroughs decided to purchase ElectroData Corporation, which had had some success in marketing its magnetic drum systems. The BEAM was a much larger computer, designed to be competitive with the machines in the same class as the 705, but the almost completed BEAM IV was scrapped in favor of a new medium sized computer, the 220, to be designed by the newly acquired ElectroData Division.

The 220 was the last of the vacuum tube computers. The strategy was to come on the market just ahead of the transistorized computers. This strategy met with some success, especially when IBM's rumored vacuum tube successor to the 650 did not materialize.

SECOND GENERATION: TRANSISTORIZED COMPUTERS

Transistors vs. Vacuum Tubes

Almost from the time it was invented in 1948 [41], the transistor was expected to become the key to revolutionary advances in computer technology.

A major factor in the step from the ENIAC to the EDVAC and later stored program computers was the development of computer circuits that permitted the use of large numbers of germanium diodes in combination with relatively few vacuum tubes: a typical computer might have 1000 tubes and 50,000 diodes. The tubes, the active elements that determined the speed and capability of the computer, were expensive since they consumed large amounts of power and generated large amounts of heat. The transistor would make it possible to replace vacuum tubes by semiconductor devices similar to the diodes, which would be small and would produce very little heat. This would make it possible to think in terms of computers with the number of active components orders of magnitude greater than in the largest vacuum tube computers. As an example, the Stretch computer, a relatively early, though very large, transistorized computer, used over 150,000 transistors. The more recent CDC 6600 contains over 500,000 transistors, and it is reasonable to expect that computers with over 1,000,000 transistors will be built in the next few years.

With almost any new component there is a period of what appears to be stagnation, a period in which the component seems to be available and yet it is hardly being used. This may be a period of engineering development; it may be the period during which problems of production in economic quantities are being solved. Many promising ideas and components never emerge from this period, as practical considerations keep delaying their use. For a while it looked as if the transistor might be delayed for a very long time because of considerations of this kind. Reliable switching speeds were relatively slow; it was difficult to produce transistors with uniform characteristics; circuits had to be designed with excessive latitude, or had to require careful selection of transistors to insure that a replacement transistor would perform in the same way as the one it was replacing. Bell Telephone Laboratories and others built experimental transistorized computers; IBM announced the 608, a transistorized calculating punch, but it was high priced and offered no advantage over existing vacuum tube machines. The earliest transistorized computers offered commercially were medium speed, business-oriented systems in which very high switching speeds were not considered essential.

A breakthrough in the use of transistors for very high speed computing appeared from a quite unexpected source with the 1954 development of the surface barrier transistor by the Philco Corporation. This was the transistor used in the Lincoln Laboratories TX-0 [42] computer and in several other of the early high speed, transistorized computers. It was the first of a series of transistor developments that produced transistors suitable for the highest speed computers. There was no longer much doubt that it was practical to achieve and exceed the performance of vacuum tube circuits with all of the advantages of the small, low power, solid state components. Within four years of the development of the surface barrier transistor the vacuum tube was obsolete as a computer component.

Business-Oriented Computers

As mentioned above, the earliest transistorized computers were medium speed, business-oriented systems. National Cash Register was one of the first major companies to withdraw from the vacuum tube computer market with the announced intention of returning with a transistorized model. Its 304 [43] was a joint effort, designed by NCR and built by General Electric. It was the first all-transistorized computer in its class, but it was quite slow and of very limited capacity, and very few were sold.

RCA also tried to reestablish itself in the computer field with its transistorized 501 [44]. It too was quite slow, and much of the success it achieved was due to its having one of the very earliest COBOL compilers. The COBOL compiler was also very slow, but for many users a slow COBOL was better than no COBOL.

IBM's announced successor to the 650 and the 705 was the 7070 [45], which came out a little bit later, but was more powerful than the competitive machines mentioned above. The 705 series was supposed to die with the 705 model 3, and customers were expected to convert willingly to the word-oriented 7070. Some of the customers, with huge investments in 705 programs, were not at all willing to convert, and IBM was forced against its own technical judgment to produce the 7080, a transistorized extension of the 705, a large, clumsy, uneconomical, expensive machine, which was assured of success because it could run 705 programs.

The Honeywell 800 [46] created quite a stir when it was announced. It was in the medium price range, but the performance it promised was beyond that of other computers in its price class. I remember the comment of a Philco executive to the effect that "We sell them their transistors and we know that they can't make a profit on that machine at that price." I am told that the IBM reaction was similar. The 800 had a very interesting hardware-assisted multiprogramming system [47] with eight sets of sequencing and control registers time-sharing the arithmetic and control circuity. They also engaged in what was for that time an unusually extensive software effort. Their FACT business compiler, although not completely successful, did help to sell a fair number of 800 systems.

Burroughs came out a bit later than the others with its very interesting B 5000 [48] computer. The 5000 was very strongly influenced by the ALGOL effort. It contains hardware which makes its arithmetic registers behave as if they were at the top of a pushdown stack. The hardware also assists in the implementation of ALGOL features like recursive subroutine calls and dynamic storage allocation at run time.

The 5000 was late in delivery and disappointingly slow when finally delivered in 1963. A more recent and faster version, the 5500, is now being delivered and has a number of enthusiastic supporters.

The development of both transistors and relatively low cost, magnetic core memories made it possible to build relatively small computers that were quite powerful compared with even the large vacuum tube computers. The IBM 1400 series and 1600 series, which came out in 1960, proved that some models could be marketed by the thousands. Other manufacturers found, often to their surprise, that there was a huge market for small computers. Many hundreds of RCA 301's and CDC 160's were sold. There were also the Burroughs 200 series, the Honeywell 400 series, the GE 200 series, the NCR 300 series, and others.

Philco

The development of the surface barrier transistor launched Philco into the computer industry. Under contract with a Government security agency, they built a small, high speed, transistorized computer, the TRANSAC S-1000, patterned after the UNIVAC 1103 series, and under contract with the Navy they designed a larger computer called the CXPQ. The CXPQ was a partial prototype of the TRANSAC S-2000. Philco executives felt that they were a year or more ahead of most companies in the development of big transistorized computers, and by the end of 1957 they had decided to launch a major production and marketing effort based on the large scale TRANSAC S-2000 [49], later known as the Philco 2000.

The 2000 is a high speed binary computer which is in many ways a modern successor to the old Institute for Advanced Study computer. Among other features, the 2000 provided a tape system with the capability for automatic switching of all tapes to all channels—a capability that was not available in competitive systems. The 2000 was expected to prove very attractive as a replacement for the IBM 704 and the 709 systems that IBM had just begun to deliver. Several of the early orders were for such replacement at United Aircraft Corporation, and at the GE-KAPL and Westinghouse-Bettis AEC-Naval Reactor Board installations.

Although Philco had a head start, it lacked sufficient momentum. By the standards of the computer industry the Philco computer effort was small and poorly financed, and Philco was not ready to undertake the expansion that would have been necessary for a large penetration of the computer market. Before the first complete 2000 system had been delivered in January 1960, the IBM 7090 was in production with a 2.18-microsecond memory, as compared with the 10-microsecond memory of the 2000, and with faster arithmetic speeds. The first complete 2000 delivered was a model 211, which had already changed from the surface barrier transistor of the original model 210 to the faster MADT transistors. Also, a commitment had been made to replace the memory by a 2-microsecond memory under development. The 2-microsecond memory called for an even faster main frame, and the model 212 of the Philco 2000 series with look-ahead and very fast arithmetic was developed in an effort to bolster Philco's position in the industry. The model 212, delivered early in 1963, may very well have been the most powerful computer then being delivered, comparing favorably with the CDC 3600 and the IBM 7094 model II. In order to support a system with this kind of computing capacity, a more advanced tape system and other peripheral devices were necessary.

By this time the Philco Corporation, whose financial condition had been poor for a number of years, was merged into the Ford Motor Company. Although Ford certainly had the necessary resources, it decided against a large investment in the computer industry. There was a final flurry of activity and the announcement of a new model 213 at the Fall Joint Computer Conference in 1964, but as of this writing the Philco computer effort has for all practical purposes ceased to exist.

CDC

CDC's story is one of the many Cinderella stories in the computer industry. A group of Univac employees, including some of the original ERA people, broke away and formed Control Data Corporation in 1957. They had worked on the design of military transistorized computers while with Univac and they had a computer designed and ready for marketing, as well as their first order, from the US Naval Postgraduate School in Monterey, in almost no time at all. Their first 1604 was delivered in early 1960. Their computer was a basic 48-bit binary computer, not as powerful as the 7090 or 2000, but much lower priced. Initially they provided no software support. They sold to universities at a discount and were low bidder on a number of government contracts.

The company thrived. Its 3600 [50], which it started to deliver in 1963, was a much faster, much improved version of the 1604. It made CDC a major factor in the large scale computer market. In the past few years it has grown at a tremendous rate, and its products cover almost the whole range: from very small computers and peripheral devices to the super computers in the 6000 series.

IBM 7090 Series

Early in 1958 the Ballistic Missile Early Warning System (BMEWS) project requested bids from computer manufacturers to supply a number of very large, fast computers for data analysis and general computation. They made it clear that they would not consider vacuum tube computers, since several manufacturers had already announced transistorized computers that would be able to handle the job. As is the case in many such procurements, the time allowed for delivery was quite short and penalties for late delivery would be high. IBM seemed to be out of the running since its large transistorized computer, the Stretch, was far too expensive and delivery was still several years away. IBM won the contract by offering to deliver the 709, a vacuum tube computer, almost immediately to permit design and checkout of programs. It then undertook to deliver, in a little over a year, a completely transistorized, logically compatible computer, the 709TX. The 709 was a synchronous computer in which the time for each instruction was defined as an integral number of memory cycles. The 709TX was to be five times as fast as the 709; each instruction would take the same number of memory cycles, but each memory cycle would be only 2.4 microseconds, compared with 12 on the 709. A 2-microsecond memory was under development for the Stretch project, and the Stretch word of 64 information bits and 8 check bits was conveniently adapted to handle pairs of 36-bit 709TX words.

For a short time IBM held back from offering the TX computer to other customers. It had only recently started delivering the 709 system and it was reasonable to expect that the new system would completely eliminate 709 sales, since it was logically compatible, very much more powerful, and not very much more expensive. IBM was aware that the 709 had been very poorly timed and would have to be written off. Transistorized computers like the TRANSAC S-2000 and the CDC 1604 would have made the 709 obsolete very soon anyway, although perhaps not quite as completely and dramatically as their own 709TX did. The new computer, now called the 7090, was officially introduced and met with tremendous acceptance. Before the first delivery was made, the speed was increased by cutting the memory cycle to 2.18 microseconds and decreasing the number of memory cycles needed for multiplication and several other instructions.

The first two 7090's were delivered to BMEWS right on schedule in November 1959. IBM had not quite finished the impossible task of getting the computers designed and built that rapidly, but it was close, and engineers in numbers variously estimated as between 20 and 200 went along to Greenland with the computers to finish them and get them to work. Commercial delivery of 7090's started soon after, and there was much grumbling in SHARE, the most influential IBM user's organization, about how poorly the computers were performing. Competitors were temporarily heartened by rumors that IBM had overreached itself and could not get the 7090 to run reliably, but the situation turned out to be quite temporary. Bugs were removed and necessary engineering changes were made. An air-cooled memory was designed to replace the earlier oil-cooled memory system. The 7090 became an extremely reliable computer and a tremendously successful one. Hundreds of 7090 systems were sold; a typical 7090 system was valued at over $3,000,000 at delivery.

Most 7090's were eventually converted into the slightly faster 7094, which has built-in double-precision operations and four additional index registers. The 7094 model 2 provided even faster arithmetic and a faster, interleaved memory.

In 1962–1963 IBM introduced the very popular 7040 and 7044 computers. These were very similar to the 7090 series but provided somewhat less in performance at a considerably lower price. A combination of a 7094 with a 7040 or 7044, with a special memory-to-memory channel, was marketed as the Direct-Coupled System. The smaller computer acted as an input/output processor and supervisor, limiting the 7094 to the actual execution of jobs staged and buffered through the 7040.

Two other IBM second generation computer efforts are mentioned very briefly. The IBM Military Computer was a very large computer designed and built in 1958–1962 for the Strategic Air Command's command and control applications. During the first generation, IBM had supplied many computers, similar in many ways to the 704 and 705, for use by the SAGE air defense system. They hoped that the powerful transistorized Military Computer (rechristened the ANFSQ-32) would be used for replacements. It was not so used and only a few were built. One of these was installed at the headquarters of the System Development Corporation in Santa Monica and years later became quite well known as the Q-32, the computer on which SDC's large time-sharing system was developed.

In 1960–1961 there were rumors of a completely new large scale series of computers, the IBM 8000 series. At least one prototype was built but IBM decided, in the spring of 1961, to abandon the 8000 series in favor of a new system design project using a new microcomponent technology. The resulting System/360 belongs to the "third generation."

Univac

In the business data processing area, Univac introduced the UNIVAC III in the early 1960's. This was a quite sophisticated computer requiring elaborate software support. It never became very popular, probably because it was too expensive for the middle-priced field, in which it was designed to compete.

The M460 [51], a military computer built by Univac in St. Paul, was one of the earliest large scale transistorized computers, but it was Control Data rather than Univac that produced the successful commercial computers that continued that line of development.

Univac's own transistorized successor to the 1103 series was the 1107, introduced much later than competitive scientific computers. The first delivery was made at the end of 1962. The 1107 was advertised as the Univac thin film computer, since it used 128 registers of magnetic thin film storage as an addressable control memory along with more conventional magnetic core and magnetic drum memory.

The 1107 appeared on the market too late to be a major factor among second generation scientific computers. Its major importance was to serve as a model for the very successful third generation 1108, a compatible successor to the 1107 which can use 1107 software and can run 1107 programs. This, coupled with IBM's failure to produce an adequate compatible successor to the 7090 series, finally gave Univac the opportunity, in 1967–1968, to become a leader in the large scale scientific computer field.

SUPER COMPUTERS

NORC

At almost any given time in the recent history of computer development there has existed within the computer industry the capability to design computers that would be orders of magnitude more powerful than those being delivered commercially. The industry has always been ready to design and build such computers for anyone who was willing to put up the money for what might prove to be an uneconomic venture.

An early venture of this type was the NORC (Naval Ordnance Research Calculator) [52], built by IBM for the US Naval Weapons Laboratory at Dahlgren. The NORC was started in 1951 and was accepted at Dahlgren in June 1955. It was rated by its designers as able to perform 15,000 three-address operations per second. Floating-point addition took 15 microseconds, and multiplication took 31 microseconds. These times are especially impressive in view of the fact that the NORC was a binary-coded decimal computer with a 16-digit word consisting of 1 sign digit, 2 exponent digits, and 13 fraction digits. The high speed multiplication was achieved by the brute force approach of providing nine registers to store the product of the multiplicand with each of the nine nonzero decimal digits. The original main memory of the computer was a 2000-word Williams tube storage system. In March 1960 the electrostatic storage was replaced by a magnetic core memory, and as of the spring of 1966 the computer was still in use at Dahlgren.

The NORC was strictly a one-of-a-kind development. By the time the NORC was nearing completion, industrial use of computers had grown to the point where a number of companies, mainly in the aircraft industry, would be willing to pay the necessary price for the fastest computer available. With the 704 development already under way, IBM refused to be pushed into building additional NORC's. It was probably a wise decision.

LARC and Stretch

By 1956 it was already apparent that transistors could be used in very large numbers and at very high speed to produce computers whose performance would dwarf that of the largest vacuum tube computers ever built. Several manufacturers were already developing relatively small transistorized computers for the commercial market. The computer industry was investing some of its own money in preliminary research toward the development of the big transistorized computers, but the real venture capital in this area came from the United States Government through the Livermore and Los Alamos research laboratories of the Atomic Energy Commission (AEC). Livermore entered into a contract with Remington Rand Univac for the development of the LARC (Livermore Atomic Research Computer). Los Alamos contracted with IBM for a computer, originally called Stretch, which later, when IBM thought it could be sold commercially, was given the number 7030.

In December 1956 at the Eastern Joint Computer Conference in New York, in two papers delivered at the same session, brief summaries of the design objectives of LARC and Stretch were presented by J. P. Eckert of Univac and by S. W. Dunwell of IBM [53, 54]. Both were talking in terms of speeds 100 times greater than those of the 1103A's and 704's that their companies had recently started to deliver. Three years later, in a similar session at the 1959 Eastern Joint Computer Conference in Boston, papers by Eckert, E. Bloch, and others presented many of the details of what had been achieved in the building of LARC and Stretch [55–57].

The timing of the projects together with the simultaneous reports at computer conferences gives the impression of a design competition between the two giants of the large scale computer field. To some extent this is misleading, since the ground rules of the two projects were quite different. Eckert, in connection with LARC, stated in 1956 that "The system was balanced at a time when all components were in hand, so that the design balance would not be upset by component changes during the design period." At the same time, in connection with Stretch, Dunwell stated that "... we are endeavoring to employ the most advanced techniques and components possible with today's technology. Many of these techniques are still in the research phase of their development."

In line with their stated philosophy, the LARC designers used the surface barrier transistor, a component of proved reliability, and designed around a four-microsecond cycle, magnetic core memory that they had developed. This memory was about three times as fast as the memories then in general use. The Stretch project was planning to use the very much faster drift transistors and a two-microsecond memory. Both of these components, which had been successfully demonstrated only in small quantities under laboratory conditions, eventually proved to be very successful and contributed to the greater speed of Stretch. Any comparison between the two computers should take into account the fact that Stretch was a year or more later than LARC, both in design and delivery. They were both very impressive developments.

An unusual feature of LARC was the fact that it was basically a binary-coded, decimal, floating-point computer. This had also been true of NORC, but almost all other computers designed for large scale scientific computing have used floating-point binary arithmetic.

The LARC design provided for an input/output processor and one or two computing units, all operating in parallel and all communicating with the high speed core memory. The input/output processor is itself a stored program computer with its own instruction storage. The use of a programmed computer to handle the details of controlling input and output devices provided great flexibility. This quite advanced approach had an unfortunate side effect: the performance of just about every program run on the machine could be adversely affected by any inefficiencies in the processor programs. The LARC designers placed perhaps too much faith in the ability of the systems programmers to produce optimum performance in a very complicated hardware system.

The first LARC was installed at Livermore early in 1960, and another one was built and installed at the David Taylor Model Basin near Washington. The intention was to produce and market LARC as a commercial product, but only a few orders were forthcoming and no more LARCS were built.

The first Stretch was delivered to Los Alamos in 1961. The original design called for a separate character-oriented processor and a separate binary arithmetic processor, but these were combined in the delivered machine. The original design called for a

0.5-microsecond memory in 2048-word modules, but this was dropped from the final design. One of the most interesting and complicated features of the computer is the look-ahead unit that picks up, decodes, and calculates effective addresses and fetches operands several instructions in advance. A look-ahead unit, working with an interleaved memory, can provide instructions and operands to one or more processing units at a rate much greater than would be possible in a strictly sequential system. The unit's purpose is to make a very high speed processor with a relatively low speed memory perform as fast as it would with a much faster memory. Some very ingenious logical design went into the handling of problems that arise when an already decoded instruction word is found to have been modified by an instruction just ahead of it, or when a conditional branch makes look-ahead appear ambiguous, or when an interrupt has to be processed.

For a number of reasons the Stretch computer, though remarkably fast, failed to achieve the 100 times 704-speed that was its advertised design objective; in some application areas it was disappointingly slow. It was difficult to implement a good multiprogramming system on the computer, and, except in a few very large programs, it would be necessary to use multiprogramming to realize the full capacity of the system. The look-ahead system provided more problems than had been fully anticipated. The transfer rate of the disk system had to be cut in half in order to insure the reliability of the high speed parallel data transfers.

With orders for about fifteen systems in hand, IBM was forced to announce (in May 1961) that the machine would not perform up to specifications and therefore there would be a corresponding reduction in price to those who had already placed orders. Since the lower price would not provide any margin of profit for IBM, the 7030 Stretch computer was withdrawn from the product line. Some orders were canceled and only seven 7030's were completed and installed.

Both LARC and Stretch must be evaluated as failures, since both companies involved hoped to produce a marketable product and failed to do so. Yet both were successful in providing a major stimulus to the computer industry in the years from 1956 to 1959. If there had been no project Stretch, IBM might very well have been two years later in the development of the 7090, the most successful large scale computer any company has marketed. It was really the 7090 that killed the Stretch computer as a marketable product by providing a computer that cost about one third as much which would, for most users, do considerably more than one third as much work. If competition by Philco, Control Data, and others had not forced IBM to produce the 7090, the Stretch would almost certainly have had a longer, more successful career in the computer market.

CDC 6600

Even before the first Stretch had been accepted at Los Alamos, work had already begun on the 6600 [58] by the Control Data Corporation. (This was another computer effort supported by the AEC Livermore Laboratory.) The original design specifications called for a computer three times as powerful as Stretch, and the machine that was delivered in 1964 was faster than that. Some of the speed of the 6600 comes from the use of multiple arithmetic and logical units, and ten peripheral processors, which are themselves small computers, are an integral part of the system. The design philosophy of the machine contained the concept of an executive control vested in these peripheral processors which can direct, monitor, and time-share the very powerful central processor. According to the manufacturer, the central processor executes, on the average, over 3 million operations per second. By the end of 1965 most large AEC installations either had a 6600 or had one on order.

IBM Series 90

For several years after the unsuccessful Stretch venture, IBM seemed, at least to observers on the outside, to have lost interest in the very-large-computer market. In answer to a direct question about IBM's reaction to the 6600, an IBM spokesman at SHARE, who could be assumed to be speaking for the company, commented that every company had to get something like that out of its system—and IBM had already done so with Stretch.

Soon after the announcement of the 360 series it became apparent that IBM was ready to try again to establish its position in the super computer field. Negotiations were under way with Los Alamos for the production of a very fast series 90 in the 360 line. Control Data then announced its 6800 machine, logically identical to the 6600 but four times as fast and no more expensive than the 6600. IBM countered with the announcement of a model 91, a model 92, and a model 95, in rapid succession.

IBM finally settled on a single product-line model, the 91, which revived the look-ahead feature of Stretch. The model 91 has a 60-nanosecond basic cycle and uses a memory rated at 750-nanosecond cycle time, though its effective speed is less because of its very large size. The design goal was to execute instructions at the rate of approximately one per 60-nanosecond cycle. Memory interleaving, look-ahead, adequate buffers, multiple arithmetic and logical units, and very fast arithmetic are all used in the design in an attempt to achieve the stipulated processing speed. "Pipeline system" has been used to describe their approach, since a number of instructions are simultaneously in different phases of their execution as they flow through an instruction-execution pipeline.

Even though the system should be able to operate at almost full processor speed with the 750-nanosecond memory, it is possible to insure that performance level by using a very much faster thin film memory. The model 95 is the same computer as the 91 except for the presence of 1,000,000 bytes of thin film memory with a 120-nanosecond cycle time. The effective speed is closer to 200 nanoseconds because of the physical dimensions of this large memory.

In a move reminiscent of the end of the Stretch project, IBM in 1967 announced that it would take no more orders for the series 90 computers and would deliver only the twenty systems for which it had already accepted orders. In 1968 IBM announced a new, very large system, the model 85, logically simpler but in some areas almost as powerful as the 91. The 85 uses automatic block transfers into a small (16K–32K bytes) integrated circuit memory. It has been suggested that the model 91 was withdrawn because of the advanced state of development of the 85, which provides better price/performance characteristics.

CDC 7600

Control Data Corporation withdrew its 6800 computer from the market and announced a new, more powerful 7600 system. It has also been marketing, with some success, a 6400 series very much like the 6600 except for the removal of much of the parallelism, which made the price much lower.

In 1968 CDC started to deliver its extended core storage (ECS), a large magnetic core peripheral memory designed for block transfers to and from main memory at a rate of 10,000,000 60-bit words per second. This ECS is offered as an optional peripheral device on the 6000 series, but at least 500,000 words of a much faster ECS will be required on the 7600. A swapping memory of this size and speed can change the nature of processing on the computers to which it is attached.

The 7600 has larger, more powerful peripheral processors than the 6600, and more and faster input/output channels. Reports of the first programs run on the 7600 in the fall of 1968 indicate that the central processor will be able to execute instructions at the rate of 20–25 million per second.

ILLIAC IV

In quite another area, for a number of years Dr. Daniel Slotnick, while working for Westinghouse, tried to get support for the construction of a highly parallel machine, SOLOMON [60], which would use a large array (the number 1024 was mentioned) of arithmetic units joined together in a square matrix. The Atomic Energy Commission suggested that perhaps it was time for some other agency to pioneer in the super computer field, but no other support was forthcoming.

Dr. Slotnick moved to the University of Illinois, and in this new environment he was able to obtain support from ARPA (The Advanced Research Projects Agency of the Department of Defense) to design and build a SOLOMON-like computer, now appropriately named ILLIAC IV [63]. The actual construction of the computer is being done under contract by Burroughs Corporation in Paoli. The ILLIAC IV will have 256 processing elements, each of which has its own thin film memory of 2048 64-bit words and its own high speed adders for full 64-bit floating-point operations. The 256 processors are organized into arrays of 64 processors each. An array has a control unit (CU) which issues the instructions that are transmitted to all processors in the array. The designers state that [61] "All processing elements of an array execute, of course, the same instruction in unison under control of the CU; local control is provided by the mode bit in each processing element which enables or disables the execution of the current instruction." Each processor also has an index register which can modify the address field in the instructions that it executes. A large central computer, the Burroughs 6500, provides more conventional computing capability in addition to general supervisory control over the entire system.

The designers predict that the ILLIAC IV will be fantastically fast in certain areas of computation: hundreds of times as fast as the 6600 and thousands of times as fast as the 7094 in specific applications [62]. However, the approach used in the ILLIAC IV has been the subject of a good deal of controversy among computer designers. In an angry session at the 1967 Spring Joint Computer Conference, Dr. Slotnick presented the case for the parallel computer, and Dr. Gene Amdahl of IBM pointed out what he considers to be the weakness of the parallel processor approach [64].

Dr. Amdahl was himself involved in the design of a new Advanced Computer System (ACS) for IBM in Sunnyvale, California. Although nothing could then be said about this new computer, it was rumored to be a single processor machine with performance goals on the order of 100–200 million operations per second. That ACS project was apparently dropped in 1968 in line with an IBM policy to avoid the introduction of new computers that are not software compatible with the 360 series discussed in the section on the third generation.

THIRD GENERATION

Vacuum tube computers constituted the first generation, and all of the early transistorized computers are said to belong to the second generation. The distinction between the second generation and the third is not nearly as clean-cut, however. New computers, and most of the computers that remained on the market after 1965, are called third generation computers by their manufacturers; some even contend that they are already in the fourth generation.

The major new technological development has been in the area of integrated circuits. Those manufacturers that have based their new product line on monolithic integrated circuits claim that the use of such circuits is the true distinguishing characteristic of third generation equipment. Those who still use discrete components insist that it is the performance of the system and not the nature of the components that characterizes a computer as belonging to the third generation.

IBM System/360

IBM started the design of its System/360 in 1961 [65]. A major aim was to standardize within IBM such computer characteristics as instruction codes, character codes, units of information, and modes of arithmetic. Theoretically at least, the same programs would run, perhaps slowly, on the small, inexpensive 360, and, much more rapidly of course, on the larger, more expensive models. This compatability was achieved by the technique of microprogramming in read-only memory. The physical and logical organizations of the hardware on the microprogram level were quite different from one model to another. In a sense, all the smaller models were designed to simulate the largest, conventionally wired model.

On April 7, 1964, IBM officially announced six new computers, the original models 30, 40, 50, 60, 62, and 70 of System/360 [66]. These computers, along with other members of the same family that would be announced later, were intended to replace all existing IBM computer series. They offered greater power at lower prices than the earlier systems. There was no attempt to be directly compatible with any previous series. IBM introduced the word "emulator" to describe a simulation technique using routines on the microprogram level. These emulators would permit 1400 series programs to run on the model 30, and 7000 series programs to run on the largest microprogrammed models. Though very efficient compared with software simulators, the emulators represented an inefficient use of the 360 computers, and most applications would have to be reprogrammed for the new equipment.

The 360 is both word-oriented and character (or byte)-oriented. All 8-bit bytes are directly addressable. Word operations use 32-bit words, and in some cases 64-bit double words. It is a binary computer with hexadecimal floating-point arithmetic as well as decimal arithmetic that operates on strings of four-bit decimal digits. The system supports a large variety of input/output and peripheral storage devices by way of a "standard I/O interface." There already exists a very extensive literature describing the 360 [67] and its hardware and software features.

Initially, only the smaller models, those up to the model 50, could have "multiplexor channels," which are necessary to drive card readers and printers and communication equipment; the larger models would need one or more smaller computers attached to handle input and output. This was soon changed: multiplexor channels were made available on all models so that the large models as well as the smaller ones can operate in single processor as well as in multiprocessor configurations.

IBM developed a new technology for the 360 systems which they call Solid Logic Technology (SLT). They still use discrete transistors, but very small ones. Their circuits are hybrid rather than monolithic integrated circuits. Even though the hybrid circuits have some superior characteristics, it would seem to this observer that IBM underestimated the speed with which monolithic integrated circuit technology would develop when it decided to proceed in a different direction.

It soon became apparent that the 360 line did not serve all classes of users. At the low end, an incompatible model 20 was introduced. For the medium-priced scientific market a model 44 was designed that stressed calculating speed for scientific and real-time applications, using a subset of the 360 instruction code. At the high end of the line, a number of changes were made which resulted in the 65 and 75 (replacing the 60, 62, and 70), and the 67, 85, and 91, which were discussed earlier.

The 360 represented a major reorientation on the part of IBM and has had tremendous impact on the computer industry. Thousands of 360's have been delivered and many thousands are on order. Many features of the 360 have been accepted as standards by other manufacturers.

RCA Spectra 70

Not very long after the introduction of the 360, RCA announced its Spectra 70 series [68], a series of computers almost completely compatible with the IBM 360. RCA was saying, in effect, that the standardization that IBM felt would be so valuable within their company might be equally useful if it were adopted by the computer industry, or at least by part of the industry.

The RCA Spectra 70 used model numbers 35, 45, 55 to indicate performance in between IBM's 30, 40, 50, 60—presumably at prices that would make its product attractive. These RCA models use monolithic integrated circuits. A large number of the Spectra 70 computers have been sold and installed.

Honeywell

In December of 1963 Honeywell announced its very successful 200 computer. It was essentially an improved and very much faster and more powerful version of IBM's 1401 computer. Since IBM was not going to provide a compatible successor to the 1400 series, Honeywell undertook to do so, reasoning, apparently correctly, that many customers would prefer not to reprogram, and that greater economy could be achieved by compatible hardware than by emulation. A "Liberator" software package was designed to handle those areas in which some incompatibilities existed between the 1401 and the 200.

The 200 has been very successful and has been developed into a whole line of computers, from a small 100 to a very large 1200 [69]. Honeywell has become second only to IBM in the business data processing computer field.

GE

The General Electric 600 series looks in many ways like a successor to the IBM 7090 series, but it was not intended to be program compatible and has not been very successful as a replacement for the earlier machines. GE has been very active in the area of time-sharing, and several of its efforts in that area are discussed in the section on time-sharing.

Other Third Generation Systems

All the major computer manufacturers are now offering third generation systems. Burroughs is marketing a full line of computers, up to the very large 6500, 7500, and 8500. Partly as a result of its own improved peripheral equipment, and partly as a result of greatly increased interest in multiprogramming systems, there has been an upsurge in orders for its 5500 system. Univac, whose very successful UNIVAC 1108 has already been mentioned, is also marketing a new 9000 series with considerable success. Control Data Corporation, which has become a dominant factor in the area of very large computers, is also marketing a number of new computers in its medium price 3000 series. National Cash Register stayed with its 300 series for quite a long time, but in 1968 it announced a very promising new line, the NCR Century Systems.

A number of smaller companies in the computer field have introduced very interesting and very successful third generation systems. Among these are the Digital Equipment Corporation PDP series and the Scientific Data Systems Sigma series.

TIME-SHARING

Atlas System

Manchester University and MIT, which had both made very significant contributions to the early development of computers, were the chief sources of some of the most interesting recent developments. By 1959 the computer designers at Manchester, in cooperation with Ferranti Ltd., completed the design of the Atlas System. The Atlas uses some ingenious and, incidentally, expensive hardware in an attempt to solve the related problems of overlay and hierarchic storage organization, and the allocation of main memory in a multiprogramming environment. The Atlas approach, the single-level storage system [70], permits each programmer to write his program as if he has all of a very large core memory available to himself.

In the Atlas, memory is organized into pages of 512 words each, and the programmer can use up to 2048 logical pages even though the actual core memory of the computer might have as few as 32 physical pages. The same logical page may be in and out of core memory a number of times during the execution of a program and it may thus occupy different physical pages, even during a single run of the program. During execution of a program, one or more of its logical pages are in main memory, where any logical page may be stored in any physical page, and the rest of the program is in fast auxiliary storage. The computer contains rather elaborate address-translation hardware so that an address that refers to a location in any logical page is automatically interpreted as referring to the physical page in which that logical page currently resides. If the logical page is not physically present it will be fetched into core memory from the drum. Normally there will be some pages of several different programs in core memory, so that the time required to fetch a page needed by one program will be used as execution time by another program.

An interrupt and memory-protect system are also included in the Atlas hardware, as are other features to assist the very elaborate executive programs required to keep the necessary records and to keep such a system running at a reasonable level of efficiency.

Project MAC and the GE 645

The Atlas paging scheme is extremely attractive in a computer environment in which large numbers of users are served simultaneously and in which the reallocation of main memory goes on at a very high rate. At MIT the chief subject of interest to the computer group for a number of years has been the time-sharing of large central computer facilities by large numbers of on-line users. With massive financing by Government research agencies, MIT's project MAC had built such a system using IBM 7094 equipment [71]. However, the 7094 performs very poorly in such an environment, and in 1963–4 they were looking forward to a new generation of computers in which the hardware might assist rather than hinder the time-sharing executive systems that they wished to design.

MIT had worked very closely with IBM for a number of years, and most observers assumed that the new equipment for project MAC would be IBM equipment, even after the announcement of IBM's System/360, which indicated little or no hardware assistance to multiconsole time-sharing systems. IBM apparently adopted the attitude that the project MAC requirements were for a one-of-a-kind system which it was prepared to supply when the MIT group would come through with a reasonable set of specifications.

At this point the General Electric computer department, which had entered the large scale computer market with its 635 computer, proposed a number of modifications that would convert the 635 into a new computer (the 636, later known as the 645) specifically designed for a large, time-shared multiconsole system as planned by Project MAC [72]. One feature would be modularity, which would permit multiple processors to communicate with multiple memory modules and peripheral controllers. Another feature was an adaptation and extension of the Atlas paging scheme, in which there is another level of organization, the segment, and a more complicated hardware-assisted address-translation algorithm.

In the middle of 1964, Project MAC ordered a dual processor 645 system from General Electric, and shortly after that the Bell Telephone Laboratories announced that it was going to order four such systems (later reduced to three). It was clear that a time-sharing bandwagon was forming and there was going to be a great rush to get on the General Electric delivery list.

IBM 360 Model 67

IBM reacted almost violently to the situation. Clearly it had made a mistake; this was not a one-of-a-kind or even a small market. Its technical staff had evaluated hardware address-translating systems and had decided that the logical elegance that was gained would cost too much in extra hardware, in very complicated software, and in degradation of performance.

The correctness or incorrectness of the technical judgment was irrelevant; in a sales-oriented company, technical judgment cannot be allowed to interfere with sales judgment. By order from the top, IBM was fully converted to the principle of maximum support of large time-sharing systems. The IBM sales organization was told to spare no expense to avoid losing any more orders in the large scale, time-sharing field.

It was not too difficult to add paging hardware to the largest microprogrammed models (60 and 62) of the 360 line, and soon models 64 and 66 were being offered, with an order from Lincoln Laboratories for amazingly early delivery of both hardware and software. However, it was soon apparent that this was not enough. The 60 and 62 were too slow and expensive and the 64 and 66 didn't go far enough. The only thing to do was to scrap the whole lot of them.

In their place there were announced the much faster model 65, at the price of the slow model 60, an even faster model 75, and the model 67, with segments, pages, modularity, and other features, a number of which had been developed in cooperation with the first model 67 customer, the University of Michigan [73].

There are many attractive features embodied in the time-sharing concept: conversational on-line debugging, man/machine interaction, file interrogation, information retrieval, graphical input and output, machine-aided design, computer-assisted instruction; these and other key areas of computer research and application can be made accessible to large numbers of users only by way of multiaccess time-shared computing systems. In 1965 the model 67 seemed to be the most promising of the possible approaches to large-scale time-sharing, and most major universities and many research organizations ordered, or planned to order, systems built around one or more model 67 processors.

IBM launched a major software development effort to construct a time-sharing operating system (TSS) for the model 67. Enthusiastic potential users were planning installations in which hundreds of consoles would be on-line simultaneously. By the middle of 1966 it became apparent that the performance of the system would be marginal at best. Simulation studies indicated that the original software system would find it difficult to support even a very few consoles.

Most customers withdrew their orders. A number of model 67 systems were delivered in 1967, and the early TSS system release provided limited service to about eight on-line typewriter consoles. Other software developments at the University of Michigan, at General Motors Corporation, and at IBM's Cambridge center have produced alternate software systems for the 67, and a second version of TSS promises performance improvements over the first version. It seems clear (as of June 1968) that even with the best possible software, model 67 performance will fall far short of the performance expected and promised in the atmosphere of enthusiasm for time-sharing that prevailed in 1965. It seems unlikely that a really satisfactory level of performance will be achieved in any large scale time-sharing system without major hardware developments that may become available in the fourth or fifth computer generation.

Multics

The software effort for the GE 645 is a joint effort of personnel from General Electric, MIT, and Bell Telephone Laboratories [74]. Their Multics system has many interesting features, and introduced and elaborated a number of important concepts, but here too it is almost impossible to be optimistic about the eventual performance of the system on the 645.

Other Time-Sharing Systems

Even though the large time-sharing systems have been disappointing, they have had a major influence on the development of a number of fairly successful smaller systems. General Electric, using a software system developed at Dartmouth College, has been very successful in marketing its 265 computer as a small time-sharing system. The 265 uses the GE 235, a small second generation computer, in combination with their Datanet 30, a special purpose communications-handling computer.

Many of the small scale time-sharing systems are software systems on conventional computers, but there have been a number of special models and special hardware features designed specifically for time-sharing application. The SDS 940, a modification of the more conventional 930, was developed at the University of California and is being successfully marketed by Scientific Data Systems. This computer has been installed by a number of companies offering time-sharing services commercially by way of teletype consoles and voice-grade telephone lines. RCA has added some address-translation hardware and made other modifications to their Spectra 70 model 45 and is marketing the resulting model 46 for time-sharing use. The Control Data 3300, the Digital Equipment Corporation PDP 10, and the Scientific Data System Sigma 7 are other computers that incorporate special hardware features for use in a time-sharing system. The use of computers by way of on-line remote consoles is becoming increasingly popular and will be a major consideration in future developments.

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Much additional information about the computers mentioned here, as well as the many others not included, can be found in the proceedings of the various organizations in the computer field. The reader is particularly referred to the Proceedings of the Spring and Fall Joint Computer Conferences sponsored by AFIPS, to the *Journal of the Association for Computing Machinery* and *Communications of the ACM,* to the IEEE *Transactions on Electronic Computers* (formerly *IRE Transactions*), to *Datamation*, and to the publications of the British Computer Society.

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SPECIAL REPORT: DEC's Ambitious Software Strategy page 66

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MARCH 15, 1991

J. Presper Eckert, inventor, with the UNIVAC I

40 Years Of Computing

page 27

A Retrospective With:
Carl Reynolds,
Gordon Bell, Gene Amdahl,
Thomas Watson Jr.,
Fred Brooks, John Opel,
Robert Metcalfe,
Dan Bricklin, Rod Canion,
Alan Kay, John Armstrong,
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and others

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IBM's RS/6000: A 12-Month Checkup page 73

A Novell Use For Minis page 83

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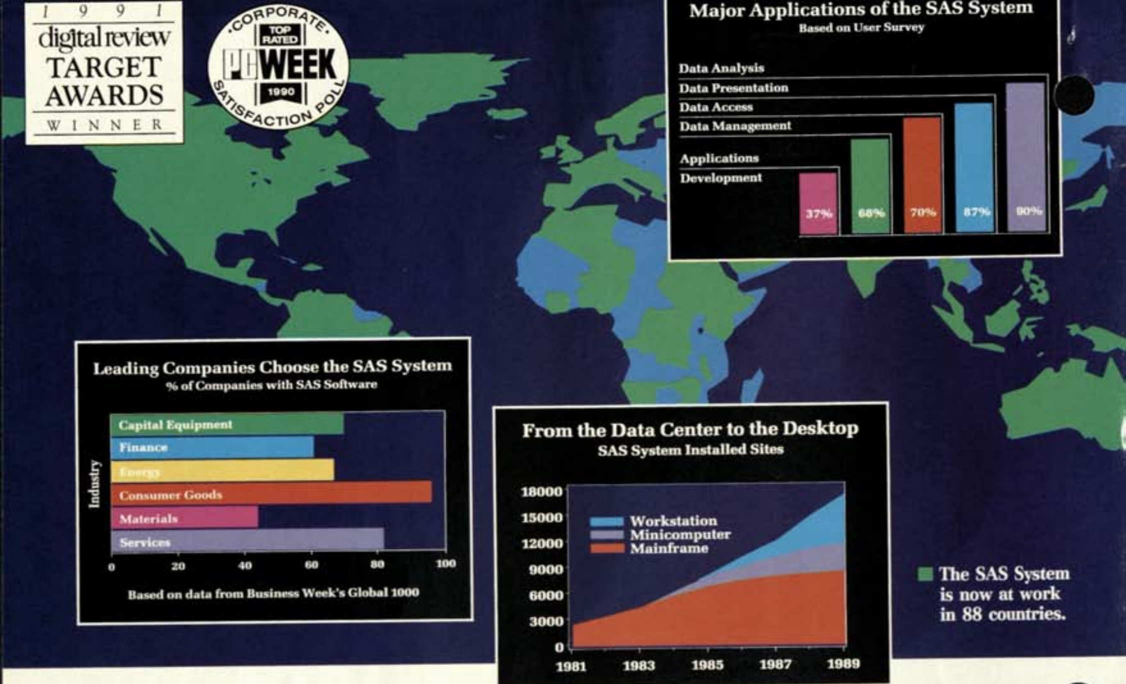

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VOLUME 37 NUMBER 6

COVER STORY

40 Years Of Computing 27

What Hath He Wrought? 30

BY DAVID R. BROUSELL
An interview with Dr. J. Presper Eckert, the coinventor of the UNIVAC I and the world's first electronic digital computer.

Cover shows Eckert in the late 1940s and today; photography by Eugene Mopsik.

Where it all began: Eckert outside U. of Penn.'s Moore School.

40 Years On The Frontier 34

BY LINDA RUNYAN Fasten your seat belts, and hang on tight. You're about to take a trip through 40 years of commercial computing. In this special section, DATAMATION celebrates the people and the technologies that created one of the world's most dynamic industries. It all started with the shipment of Remington Rand Inc.'s UNIVAC I to the U.S. Census Bureau 40 years ago this month.

1951 40 Years Of Computing 1991

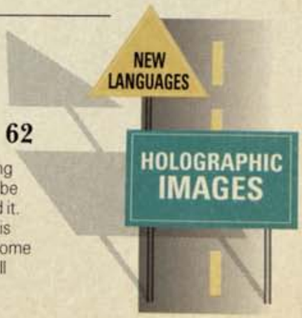
Trivia Contest 59

BY ANDREA OVANS AND CHRIS STAITI After spending weeks in our dusty, ill-lit storerooms poring over back issues of DATAMATION, we have come up with what we believe are a baker's dozen of the most formidably trivial questions we could find, three for each decade.

40 YEARS OF COMPUTING

Miles To Go 62

BY JEFF MOAD What will be coming up in the next decade and beyond may be even more exciting than what preceded it. If that's not completely certain, what is is that the technological innovations will come at a faster pace than ever before and will affect larger numbers of people and organizations.



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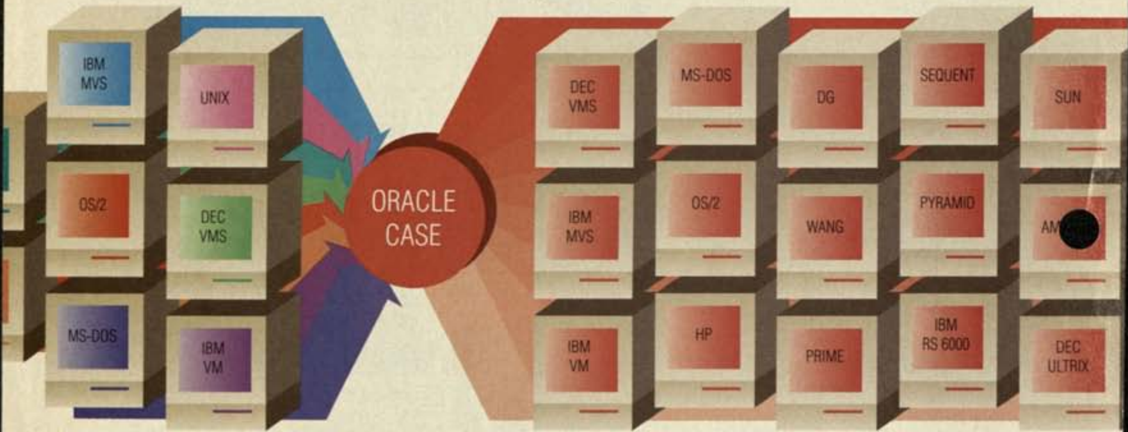

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INSIDE DATAMATION

A Journey Just Begun

On March 31, 1951, the first UNIVAC I was shipped to the U.S. Bureau of the Census. It was a momentous day and the culmination of many years of pioneering effort for the inventors of the machine, Dr. J. Presper Eckert and the late Dr. John Mauchly, and for Remington Rand, the company that sponsored them. But it was more than just an important day. A lot more. What the shipment did was mark the start of a new era, the era of commercial electronic computing. It was an era that would give rise to a new industry, a new class of workers and a new set of rules for business itself.

In this issue, we look back to that great event and what has happened since. It's a journey back in time that begins with a conversation with the man who made much of what we do today with computers possible. As the coinventor of the UNIVAC I, and, before that, the famous ENIAC, Dr. Eckert, now 72, sums up what he thinks 40 years of computing has accomplished (see "What Hath He Wrought?" page 30). His conclusions may surprise you.

BROUSELL AND ECKERT at U. Penn.'s Computer Lab.

Next we reexamine what enabled computing to grow as fast as it has. But DATAMATION is not just looking at the technological advances that helped to propel an industry. We've gone beyond that important analysis to probe the underlying forces that drove computing over 40 years—the funding by the Defense Department, the demand by the insurance companies and banks for solutions to everyday business problems, the need to distribute computing power to more and more locations, and the desires among users for tools to enhance their own productivity.

In "40 Years On The Frontier," page 34, former DATAMATION senior editor Linda Runyan, with the good offices of the DATAMATION staff, has assembled a stellar cast for this journey back in time. Providing powerful perspectives on the industry are the Brookings Institution's Ken Flamm, former IBM System/360 developer and now professor Fred Brooks, Ethernet inventor Bob Metcalfe, former Aetna MIS chief Irv Sitkin, Compaq's Rod Canion, VisiCalc inventor Dan Bricklin, Digital Equipment's VAX designer Gordon Bell, TCP/IP inventor Vinton Cerf and Gene Amdahl, among others. Also joining us, in rare interviews, are two former IBM chief executives. Thomas J. Watson Jr. discusses the secret of IBM's success, page 38, and John R. Opel presents his views on productivity and the benefits of computing, page 48.

But that's not all, folks. We didn't want to provide a retrospective of the industry without also taking a glimpse of the future. So we asked senior writer Jeff Moad to seek out the best minds in the industry to gain a perspective on what's ahead. In his article, "Miles To Go," page 62, Moad talked with Apple Computer fellow Alan Kay, IBM vice president for science and technology John Armstrong, eminent computer inventor Bob. O. Evans, Xerox research fellow Bernardo Huberman, MIT's Nicholas Negroponte, IBM fellow John Backus and Unisys chief technical officer John Wise.

All in all, our journey has convinced us that computing has come a long way in 40 years, affecting business and society at large in ways Dr. Eckert and the men and women of his time never imagined. But in many ways computing has only just begun. Imagine what the next 40 years may bring.

David R. Brousell, Editor

Coming Next Issue:

- Sybase's Big Blue Connection
- The future of Motorola's 88000 RISC chip
- A look at NetFrame, one of the new crop of superservers
- How *FORTUNE* 1,000 IS shops are using UNIX

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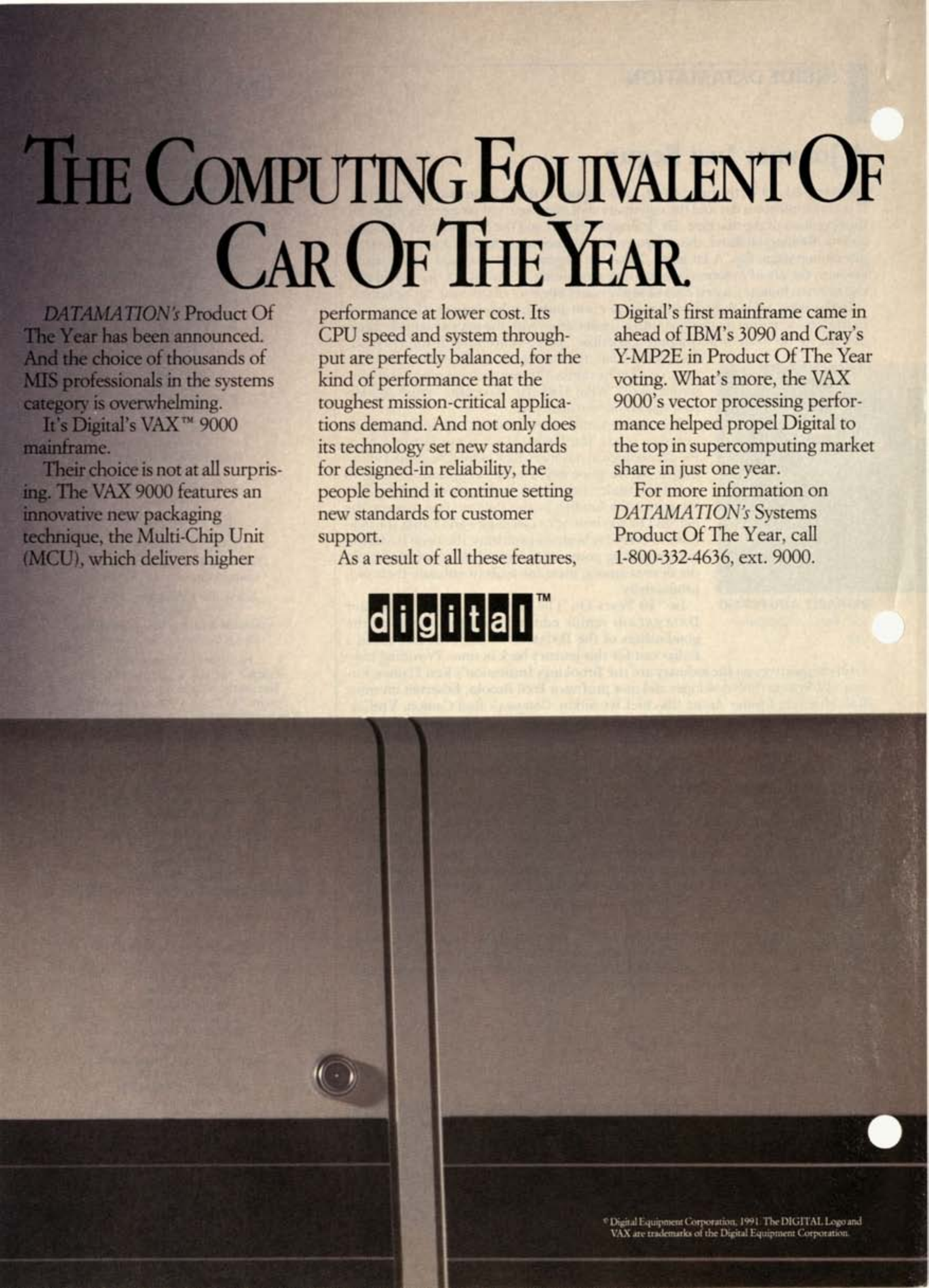
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Fasten your seat belts, and hang on tight. You're about to take a trip through 40 years of commercial computing. In this special section, DATAMATION celebrates the people and the technologies that created one of the world's most dynamic industries.

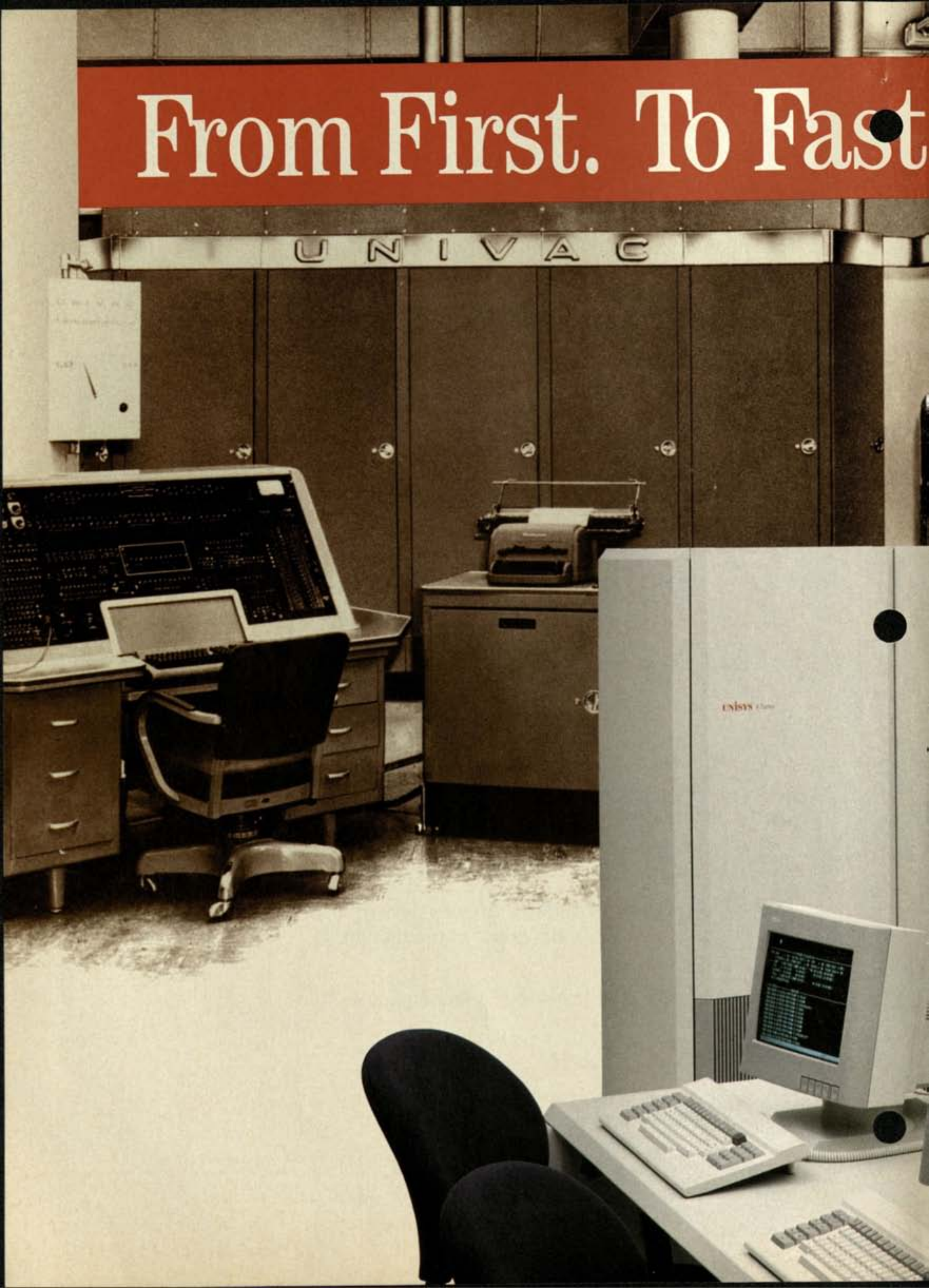
It's always been the cost of computing power that has driven computers and their applications.

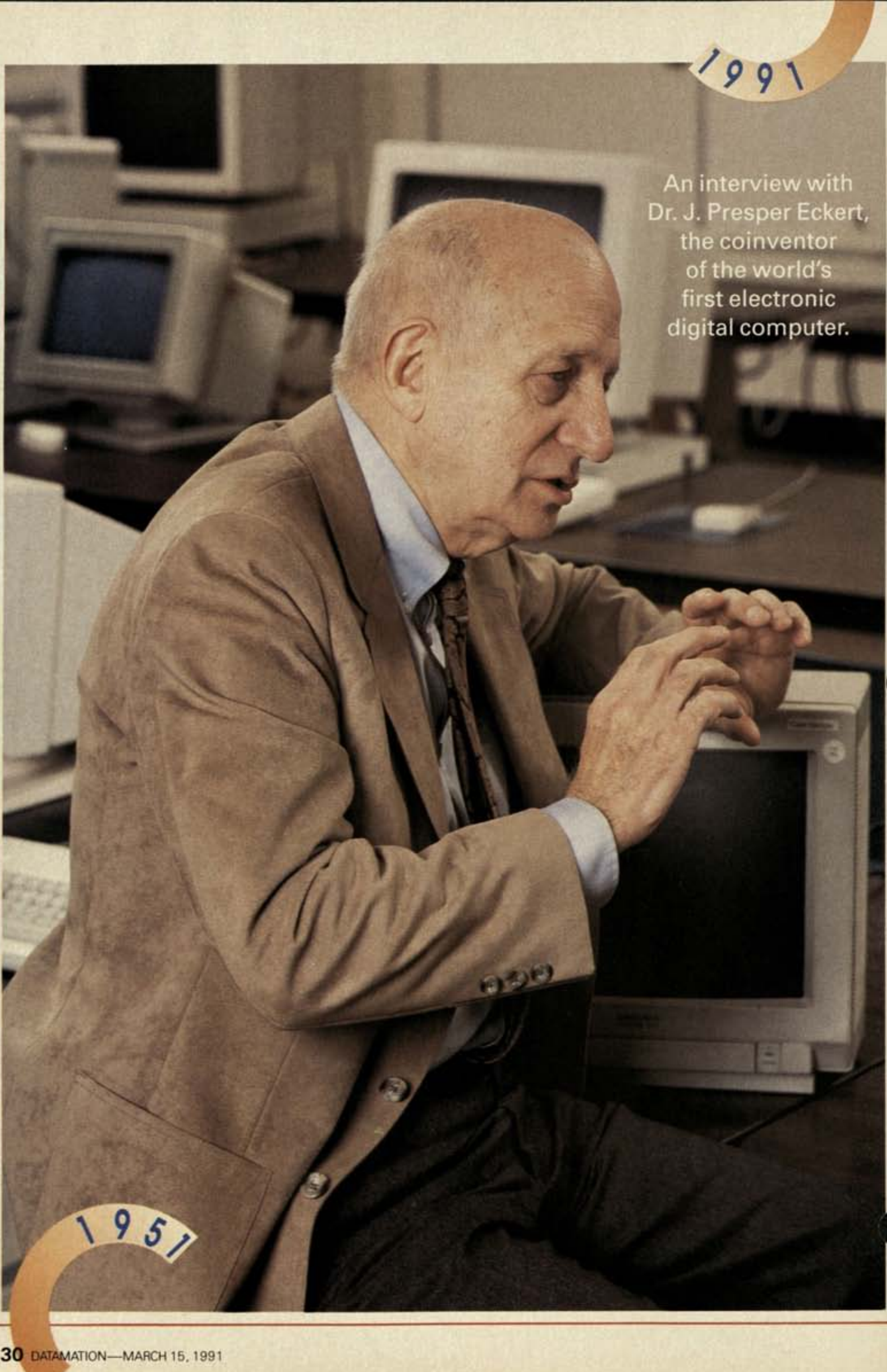
40 Years Of Computing

1951 1991

It all started with the shipment of Remington Rand Inc.'s UNIVAC I to the U.S. Census Bureau 40 years ago this month. Starting from this point, DATAMATION's retrospective includes:

DATAMATION wishes to thank the following individuals and organizations for their help in preparing this special report: DATAMATION associate editor John McMullen; Frederick Withington; DATAMATION contributing editor Kurt Rothschild; Unisys Corp.'s Martin Krempasky, director of trade press and consultant relations, and Michael Stugrin, corporate director of public relations; and Mike King, IBM corporate media relations.


From First. To Fast
UNIVAC
UNISYS



An interview with Dr. J. Presper Eckert, the coinventor of the world's first electronic digital computer.

40 Years Of Computing

What Hath He Wrought?

By David R. Brousell

Q: Did you have any idea what you were creating when you built the ENIAC and, later, the UNIVAC I?

A: Yes and no. I thought it would be a universally applicable idea, like a book is. But I didn't think it would develop as fast as it did, because I didn't envision we'd be able to get as many parts on a chip as we finally got. The transistor came along unexpectedly. It all happened much faster than we expected.

Q: Do you think there's any future role for the mainframe as it now exists?

A: Well, yes, if it's a super high-speed thing like a Cray or something that does specialized problems that can't be done otherwise in real time. For example, if you're going to do weather predictions, there's no way to chop up the weather into a thousand little pieces and do them independent of one another at the same time on a thousand machines. So you need a fast machine to do it. Otherwise, you'll end up taking longer to predict the weather than it takes the weather to happen. That wouldn't be very useful.

Q: No, I guess not. How about in business? Is there any role for mainframes?

A: I don't think so. Most of the machine problems are thousands of little problems mulled together, and it's usually possible to organize those and make them work off a central memory system of some sort.

Q: You see mostly PCs?

A: Well, even if there's a mainframe, I think the mainframe will consist of a couple of hundred small computers, chips built into a box, working like a telephone exchange.

Q: What do you think computing has accomplished over the past 40 years?

A: What we were beginning to see back about 1960, I guess it was, 30 years ago, was that we were starting to have more people doing paperwork than doing production work in the United States.

I think that all the computer has done so far is stem the tide to prevent it from getting worse, preventing a paperwork explosion, preventing the paperwork explosion that never occurred, which is the result of the computer arriving in time.

Q: How about in terms of individual creativity? Have computers spurred creativity in individuals?

A: Certainly in the scientific area, because it allows you to tackle problems you couldn't tackle before. Instead of spending all your time grinding away at a desk with pencil and paper, you have more of your time to be thinking about the results and less time doing the dog work.

Q: That's mostly paperwork reduction, too, though.

A: Yes. But one of the things I worry about in the world is the loss of individuality. Of course, Communists made a 70-year experiment, and it shows you what happens when you [try to suppress] individuality. It doesn't work, does it? It bothers me when I see conglomerates eating each other up and getting fewer and fewer people, because that's a form of communism. We're going to end up with communism for big business, instead of communism for the government. And that's just as bad. The evil in the world is bigness, in my opinion—in big medicine, big everything.

Q: How about the computer industry itself, the way it looks today, is it too big in some respects?

A: I don't know how to evaluate that. But what I was trying to get at here was that the computer is the chance for people to survive against this overwhelming bigness. Because it means that, to a great extent, I can buy special parts to put in this machine that will increase its performance 100 times, special parallel processors and things. And I can order these things for a few thousand, five or ten thousand bucks. That means I, as an individual, could afford to go out and compete with a mainframe.

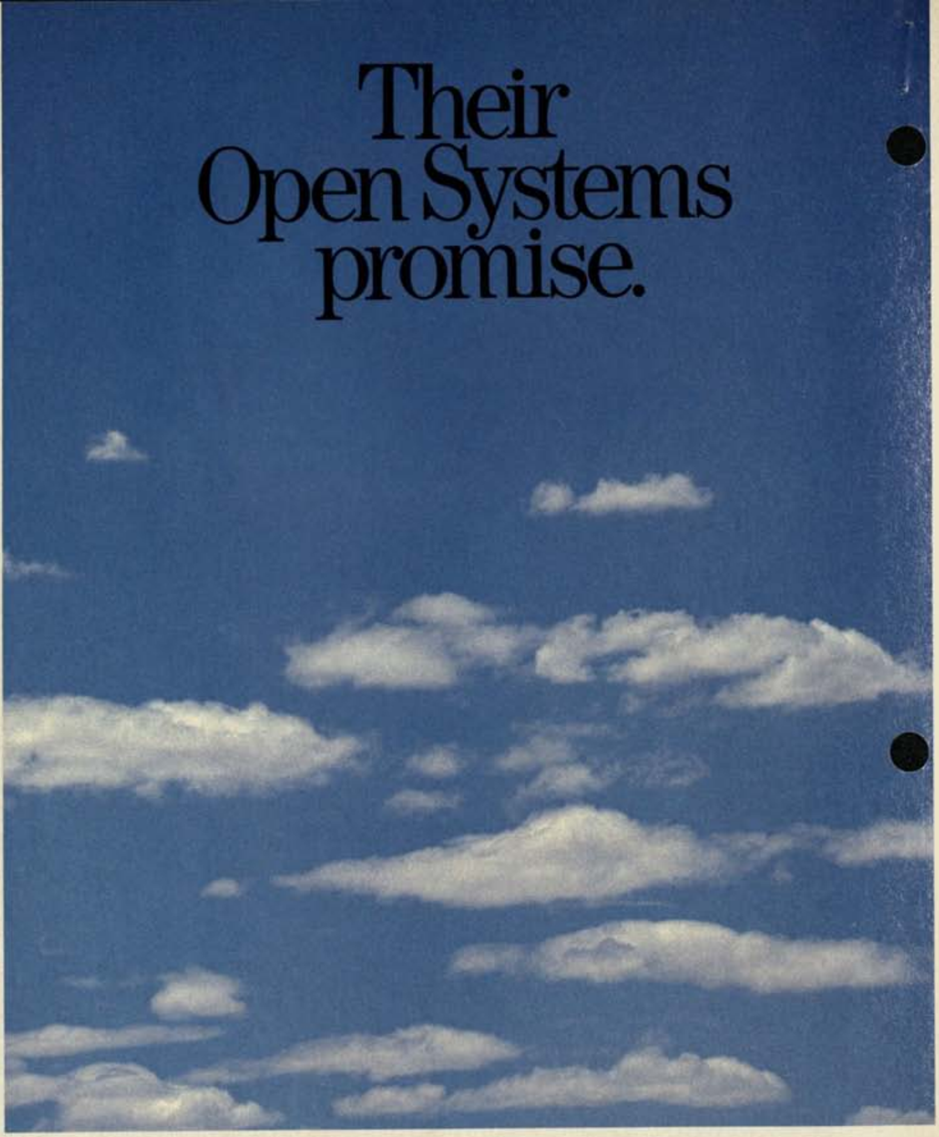
What it amounts to, though, is the computer helps the individual because he can buy a machine and do on his own what he would have to work for a big corporation to do in the past. It turns out, most of the developments and inventions do not come out of huge companies. They come out of small businesses.

Q: It's an interesting statement because I think the conventional wisdom is that the computer enabled the creation of even bigger businesses.

A: It may have, and from that point of view it's the enemy. But I know some guys in big companies whose main task is to worry about what these little [computers] in all the departments are doing to them. Because it allows somebody to walk out of the company with their ideas much more easily than when they [the company] had it all on the mainframe and could control it. And they are worried about the security of the companies, customer lists and everything else. But I think this is good in a laissez-faire capitalistic system. Because big companies becoming these monopolies and preventing this from happening is another kind of a police state, as far as I'm concerned.

Q: So you see yourself then, not primarily as the inventor of the computer, but as some sort of freedom fighter?

A: Well, yeah, because it's worked out that way. I think.



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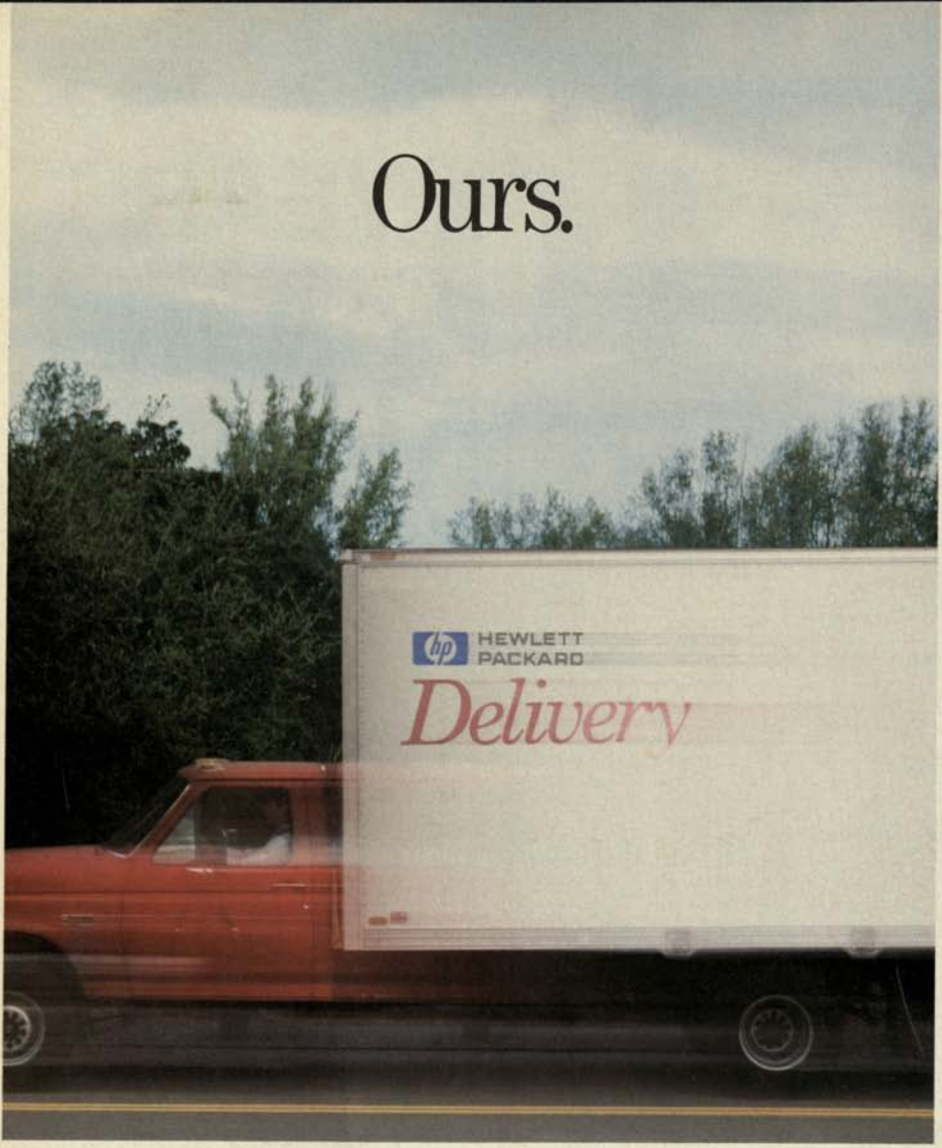

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40 Years Of Computing 1951 1991

What were the factors that have driven computing? Large systems for the government, insurance, banking and aerospace led the way, followed by departmental and individual applications. But the key is price/performance.

A RETROSPECTIVE

40 YEARS ON THE FRONTIER

1991

By Linda Runyan

The forces that kindled the computer revolution four decades ago, advancing computing frontiers throughout the world and throughout organizations, are still wielding a potent influence on the scope and shape of information systems today. The pioneering push these forces engendered propelled the computer out of the back room, into the glass house and onto the desktop and laptop. In that 40-year process, a $256 billion global industry was spawned that, in turn, nourished national economies by giving birth to new businesses, enabling work to get done better and faster.

That progress, attained at a breathtaking pace, would not have been possible without economic incentives. In the parlance of information processing, those incentives translate into price/performance, the consistent and primary driver of computing over the past four decades. And in the driver's seat has been the U.S. government, the earliest and still the largest consumer of processing power, in its multifaceted role as user, funder and facilitator.

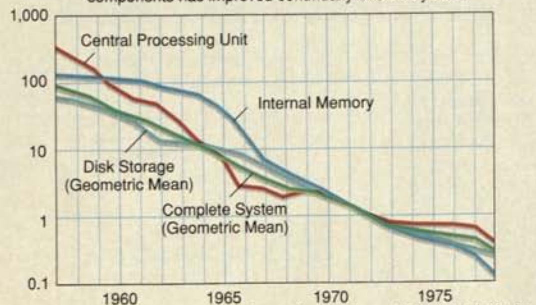
"It's always been the cost of computing power that has driven computers and their applications, at the low end as well as the high end," declares economist Kenneth Flamm, a senior fellow at The Brookings Institution in Washington, D.C. "Every time the prices tumble like a rock, there's a huge expansion in demand for computers and new kinds of applications."

Flamm's studies show a 25% price/performance improvement in computing in real dollars every year from 1957 to 1978, and, he says, there have probably been even greater gains since then.

One person who saw those price/performance possibilities all along the way was Irwin Sitkin, who retired in 1989 from his post as vice president of corporate administration at Aetna Life & Casualty Co. in Hartford, Conn.

The Power Of Price/Performance

The price/performance of major computer system components has improved continually over the years.



Source: Kenneth Flamm, The Brookings Institution

The Unshackling Of Minds

"Price/performance," explains Sitkin, "enabled people to unshackle their minds from the restrictions they had before. All of a sudden, they became willing to use this tremendous improvement in price/performance to do more than just process transactions. They began to use it to actually manage information, so that their company could do more effective business than it had ever done before."

Eminent computer designer Fred Brooks, professor of computer science at the University of North Carolina at Chapel

Hill, puts price/performance at the top of his list of factors fueling the growth of the industry. "The tremendous change in the performance/cost ratio," declares Brooks, a designer of the IBM 360 computer in the 1960s, "is the single most important driver."

But among the factors that initially created demand for computing back in the late 1940s were the rise in labor costs and the increase in government paperwork. "Everything just got so much more complicated," Brooks explains, "which meant that you had to have new tools to handle all of it."

Brooks's last point brings us right back to Uncle Sam—an Uncle Sam with an ambitious social agenda in the time of President Franklin D. Roosevelt and his New Deal.

"The New Deal, with its flurry of public welfare programs, put an administrative burden on business, and that burden made computers essential," says IS veteran Carl Reynolds, who retired in 1989 from his position as staff vice president at Hughes Aircraft Co. in Long Beach, Calif.

Respected computer industry commentator Frederick Withington agrees that the increasing popularity of social programs created mounds of paperwork. These programs, pushed by both the private and public sectors, he says, were part of "a social phenomenon that started with the New Deal. Without computers," he contends, "the New Deal philosophy could not have grown as it did over time."

What the government did, quips Ethernet inventor Robert Metcalfe, "was create a bureaucratic problem that had to be solved with computers." So necessity could be called the mother of the machine age. "The testers of technology are always people who need it the worst," points out Jim Burroughs, director of the National Computer Systems Laboratory at the National Institute of Standards and Technology (NIST). "If you really need something, then you go out and try it even if it's not perfect yet."

Computing technology was far from perfect when the Feds began testing it out in the early 1950s. Even so, the economics were on their side, making them ideal pioneers. "In the early days," explains Tom Giammo, assistant commissioner for IS at the Patent and Trademark Office (PTO), "a unit of computing was very expensive. So in order to get the economics to pay off, you had to have tasks where you did reasonably simple things a massive number of times. The government had and still has many jobs with that characteristic on the commercial side as well as the scientific side."

The U.S. Bureau of the Census launched the commercial-computing era in 1951 when it took delivery of Remington Rand Inc.'s first UNIVAC I, which performed repetitive number crunching on population and survey data. And paving the way for the development of the UNIVAC I was a series of government-funded events that began during World War II.

ENIAC Goes To War

In 1943, at the height of America's war against Japan and Germany, the heat was on Drs. J. Presper Eckert and John W. Mauchly to develop a calculating device for computing ballistic firing tables crucial to the war effort. What they came up with was, of course, the Electronic Numerical Integrator and Computer (ENIAC), the world's first electronic digital computer.

Nevertheless, it wasn't until after the war that the first all-electronic digital computer actually went into action at the Atomic Energy Commission's (AEC) Los Alamos Scientific Laboratory in New Mexico. This time the heat was atomic, and the idea was to help scientists create the first hydrogen bomb. As a result, Los Alamos and Lawrence Livermore Laboratories in California soon became prime pioneering customers for computers.

The Census Bureau launched the era of commercial computing in 1951 when it took delivery of Remington Rand's UNIVAC I.

Gordon Bell, the designer of Digital Equipment Corp.'s VAX computer and now chief scientist at Stardent Computer Inc. of Concord, Mass., says he paid particular attention to these prime users. "When I went to DEC in 1960, I met the Livermore people. And from then on, I listened to them because they had the hard problems, and you always went to the users with hard problems. Livermore and Los Alamos," adds Bell, "were important forces in graphics and image processing."

Livermore and Los Alamos, which are now both Cray supercomputer users, also prompted much of the progress in high-performance computing, progress that continues today in supercomputers and parallel processing. Those efforts started in the early 1960s when IBM teamed up with Los Alamos engineers to design its STRETCH machine, which was needed for nuclear weapons design. Many of the architectural features of this legendary system were picked up in the IBM System/360,

TIME LINE

THE '50s

1951

Census Bureau accepts delivery of UNIVAC I from Remington Rand.

First Ferranti Mark I is delivered to the University of Manchester in England.

IBM decides to produce the 701, the first electronic binary computer.

1952

UNIVAC I successfully predicts the outcome of the 1952 presidential election.

1953

IBM initiates development of the 702 for commercial applications.

NCR introduces its CRC 1020 commercial computer.

First magnetic core memory goes into MIT's Whirlwind computer.

1954

English Electric starts building DEUCE computer.

GE's Appliance Division develops the first successful industrial payroll application for UNIVAC I.

IBM announces the 650, the first mass-produced computer, and sets to work on the 704.

1955

Remington Rand merges with Sperry Corp. to create Sperry Rand.

IBM starts work on its innovative experimental STRETCH computer.

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which went on to be the cornerstone of commercial computing.

The rocket race, which began in the late 1950s, also helped further high-performance frontiers and, in turn, helped advance the development of machines for the commercial marketplace. As Reynolds points out, "I don't think there's any question that it was the government's demand for technical computing, whether in nuclear energy, or aircraft design, or aerodynamics that really fueled the development of the basic machine. The government's needs are what drove computing initially."

The demands that helped determine the scope and sphere of early computer processing emanated from the Department of Defense. During the 1950s, both the Army and the Navy became significant users of systems. But even in that savvy systems crowd, the Air Force still stood out. Setting the processing pace, the high flyers purchased the second UNIVAC I in August 1951. And that was just the beginning.

"While DOD overall was the biggest user of computers in the late 1950s, the Air Force Materiel Command was probably the largest user within DOD," reckons Jack Jones, who, up until 1987 was executive vice president of administration for shipping company Norfolk Southern Corp. in Virginia. Jones was working as a civilian employee for the Air Force back in 1959 when "they recognized that computers would help them greatly with their inventory and other things."

The Consequences Of SAGE

One year earlier, the Air Force had achieved a computing milestone that would have far-reaching consequences for the computer and the companies that were destined to perpetuate it. In a windowless blockhouse at McGuire Air Force Base in New Jersey, the Semi-Automatic Ground Environment (SAGE) system blipped into operation in July 1958.

While the project, designed to computerize the nation's air defense system, was important in and of itself, the people and the processing techniques behind it were even more significant. Chief among these individuals was Jay Forrester, the master builder of the SAGE system, who had created the concept of magnetic core memory while working on the Whirlwind computer at the Massachusetts Institute of Technology.

Helping Forrester work on Whirlwind, the fastest machine of the early 1950s, was Kenneth H. Olsen, who built a special computer to test out core memory. The new storage medium, which paved the way for the low-cost mass production of computers, was adopted by the computer industry in the early 1960s.

Whirlwind, the progenitor of SAGE, once and for all vanquished the vacuum tube. It also vaulted Olsen into the commercial computer arena. One year before SAGE blipped on, the electrical engineer launched Digital Equipment Corp., a

UNIVAC I: The Commercial Pioneer

The Universal Automatic Computer, or UNIVAC as it became known, was the brainchild of Drs. J. Presper Eckert and John W. Mauchly. In the mid-1940s, the dynamic duo invented the Electronic Numerical Integrator and Computer (ENIAC), which is regarded as the first digital computer. In 1947, they formed the Eckert-Mauchly Computer Corp., where they began work on the now legendary Binary Automatic Computer (BINAC), the successor machine to the ENIAC. The duo's company was acquired in 1950 by Remington Rand Inc., where development of the UNIVAC, which was funded by the U.S. Bureau of the Census and the Prudential Insurance Co., was completed.

The UNIVAC I weighed a hefty 16,000 pounds and used more than 5,000 vacuum tubes. It performed roughly 1,000 calculations per second. A total of six machines were built. While considered sluggish by today's standards, the UNIVAC was a veritable speed demon in its heyday.

On March 31, 1951, the Philadelphia branch of the Census Bureau formally took delivery of UNIVAC I from Remington Rand. The price paid by the bureau for the first machine was $159,000. The bureau actually ordered three machines, and the other two were each priced at $250,000. The mammoth machine, which could crank out operations such as adding or comparing numbers, was used to tally part of the 1950 U.S. population census.

Such cranking and calculating was minimally used in the 1950 census, since UNIVAC I's work was limited to tabulations for only a few states. After that, the mighty machine applied its number-crunching muscle to bureau surveys. The 1954 economic censuses were the next order of computing business. For those calculating chores, the Census Bureau brought in a second UNIVAC I and added a printer and a device to convert punched cards to magnetic tape.

While all this tallying brought the UNIVAC I glory in government circles, it wasn't until the Census's computer tackled the 1952 Eisenhower-Stevenson presidential election that it won more widespread fame.

But it wasn't until three years later, when General Electric Co.'s Appliance Park facility in Louisville, Ky., installed the UNIVAC I for a payroll application, that the first commercial internally stored program digital computer actually began crunching numbers in the commercial sphere. By then, the Census Bureau had already moved its own historic hardware hulk to its headquarters in Suitland, Md.

In 1957, the UNIVAC Is were retired, and the famous original was shipped to the Smithsonian Institution to preserve it for posterity.

mighty manufacturer that would go on to take on IBM, the mightiest computer company of them all. IBM, which was the prime contractor for SAGE, went on to put the core and real-time application experience it gained during the massive project to work in its later products.

SAGE does much to showcase the government's major role, not just as a user, but as a stimulator, of technology. "By the early 1960s," comments Brookings's Flamm, "the standard computer design that was destined to be the bread and butter of computing all the way to 1990 was largely developed on government funds."

Much of that funding was funneled through the DOD. And the principal DOD arm handing out the resources for research was the Advanced Research Projects Agency (ARPA), which is now called DARPA. 3Com Corp. founder Metcalfe credits DARPA with having "funded, supported and encouraged the development of advanced computer science."

ARPA's legacy lives on today in such achievements as time-sharing; packet switching; the Transmission Control Protocol/Internet Protocol (TCP/IP); user interfaces, exemplified by the mouse and digitized tablets; and software tools for integrated circuit design, which benefited the burgeoning semiconductor business. Today, DARPA's development dollars are being channeled into advancing neural networks and parallel processing, which promise to shape the architecture of the 1990s and beyond.

The Driver Behind Open Systems

On the software side, ARPA gave the world the Ada language, which is currently helping companies like aircraft maker The Boeing Co. develop commercial software. DOD has also aided the private sector in its software development efforts by sponsoring the Software Engineering Institute at Carnegie Mellon University in Pittsburgh.

The most significant effort on the software front, however, is the Feds' push for UNIX, currently embodied in the requirement for the Portable Operating System Interface for UNIX, more commonly known as POSIX. "The movement toward UNIX gained a lot of momentum from the government's standardization on POSIX," declares Flamm, adding, "by mandating POSIX and GOSIP [Government Open Systems Interconnection Profile] in their procurement specifications, the government continues to give crucial support to the movement toward open systems and standards."

Parallel with developments in the government sector were the first big commercial applications in insurance and banking. The volumes of transactions required to handle escalating work loads in these industries in the 1950s was mind- as well as machine-boggling.

"Insurance was a great big transaction-processing factory," confirms Aetna alumnus Sitkin, who spent 35 years tackling those vast volumes of transactions with technology. "But we also had the economies of scale on our side," he notes.

Economies of scale was music to the ears of cost-conscious bankers, who followed the insurers' lead and hopped on board the computer bandwagon. One of the earliest hardware hoppers was San Francisco's Bank of America, which launched the Electronic Recording Method of Accounting (ERMA) system, which went into pilot operation in 1952 and was installed at the Bank of America in 1959. ERMA, which

STRETCH: Supercomputing's First Outpost

For Fred Brooks, noted professor of computer science at the University of North Carolina at Chapel Hill, it's a stretch but not a strain on his memory to recall the time in the mid-1950s when he helped IBM design its high-visibility, high-performance computer, the STRETCH machine. The aptly named system, which did indeed stretch the state of the art in computing in the 1950s, contributed significantly to its commercial successor, the IBM System/360 family.

Some of the development work on this early supercomputer came from the so-called Cradle of Computing, the Los Alamos Scientific Laboratory (LASL) in New Mexico. Only nine of these supercomputer kings were created by IBM, each measuring 30 feet long by six feet high. Their primary application was in scientific computing.

On the commercial side, STRETCH pioneered computing principles that were later embodied in the 360 line. "The most important of those," says Brooks, "was the notion that a machine is run by an operating system, not by an operator. And we put in, for the first time, such things as an interruption mechanism, a timer, a supervisory mode, along with various other technical things that you must have to give an operating system control."

Another important STRETCH advance was the use of variable-sized floating points for the 8-bit byte and disk, instead of tape technology for the operating system. In addition, STRETCH had the first input/output channels. The standard I/O interface concept was subsequently picked up in the 360, an architecture that Brooks himself helped mold. According to Brooks, "STRETCH also pioneered the notion of integrating scientific and commercial applications on the same system."

Brooks, who was fresh from graduate school when he began trying out his technical talents on STRETCH, went on to use those talents in the late 1950s to head up the 360 hardware team, which included Gene Amdahl. It turned out to be important, although ironic, work for Brooks, who is best known today for his efforts on the software side. His 1975 book, *The Mythical Man Month*, remains the definitive work on software development.

TIME LINE

THE '50s *continued*

First user groups formed: SHARE for IBM users and USE for UNIVAC users.

1956

Sperry starts work on its ill-fated LARC machine, which is similar to STRETCH.

Ferranti begins building ATLAS, similar to STRETCH and LARC machines.

40 Years Of Computing

TIME LINE

THE '50s *continued*

GE enters the computer business.

1957

Honeywell announces its giant Datamatic 1000.

Control Data Corp. and Digital Equipment Corp. are founded.

First FORTRAN compiler goes to work with an IBM 704.

DATAMATION begins publication.

1958

TI's Jack Kilby devises the first integrated circuit, based on germanium.

Air Force's SAGE air defense system goes on line at McGuire AFB in New Jersey.

1959

IBM announces its popular 1401 computer.

Hitachi, NEC and Oki Electric debut computers in Japan.

ERMA, the check-processing pioneer, begins its encoding operations.

THE '60s

DOD's CODASYL committee comes up with COBOL.

1961

Patent for a silicon-based integrated circuit granted to Robert Noyce.

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overnight revolutionized check processing by introducing magnetic encoding, also helped plunge General Electric Co., the project's prime contractor, into the computer business.

Punched cards had helped IBM take that same plunge into digital computing and establish early dominance in the data-processing domain. Punch cards, which had been processed manually, were now being pumped through the computer in a batch mode. Also operating in that mode was the original UNIVAC at the Census Bureau, as well as another installed in 1954 in GE's Appliance Park facility in Louisville, Ky., which boasted the first commercial application, a payroll program.

The manual punched card prepared the way for its computing successors. Withington explains this essential evolution: "Since punched cards were already doing payrolls and every type of financial operation, it was relatively simple for computers to take over the same chores once they got in the door. So the early commercial users quickly wrote programs for the whole set of accounting applications that the punched card installation had been doing—accounts payable, accounts receivable, general ledger, payroll, inventory control, sales accounting and customer billing."

By 1954, IBM and UNIVAC computers started trickling into the big insurance companies. For example, the IBM 650, announced on July 14, 1953, was installed at the John Hancock Mutual Life Insurance Co. in December 1954 in Boston. The 702, announced in September 1953, was installed at Monsanto Co. in St. Louis in February 1955. These machines soon began a much more massive migration into various businesses, since "punched-card shops in roughly 1,000 companies could now afford a computer," says Withington.

At these companies, punched-card people were beginning to learn how to write IBM 650-based programs. "Then suddenly," says Withington, "10,000 sites became potential computer users because of the availability of canned programs and the large proliferation of partially trained programmers. In retrospect, it was really amazing how many ordinary folks went out to a one-week programming course and then staggered away with some kind of accounting program."

Once those thousands of installations were penetrated, the stage was set for the next big wave of data processing. That wave, which washed another 10,000 sites into the systems fold, was ridden by IBM, which made a business beachhead with its 1401 computer, announced in 1959.

On-line operations control applications, pioneered by the Air Force with its SAGE system, also began to emerge in the commercial arena in the early 1950s, virtually as

TOM WATSON JR.

Thomas J. Watson Jr., was president of IBM from 1952 to 1961, chief executive from 1956 to 1971 and chairman from 1961 to 1971. He has been chairman emeritus since 1981.

Q: One of the first commercial computer installations was General Electric's ERMA at the Bank of America. How did that affect IBM?

A: It scared the hell out of me. For some reason, the Bank of America didn't like our approach....[But] what scared me the most [was that] the Census put in three UNIVAC Is [in the early 1950s]. And I heard about that. And we were building machines for the government. But we were very concerned because that was our backyard. And they also sold a couple to absolutely commercial applications.

So we redoubled our effort on a machine called the 701, which we also called the Defense Computer. And we sold 20 of those....[But] we began to get concerned that while we were following this military track somebody was coming into the backyard with commercial machines and census machines. So we redoubled our efforts, came out with a 702 that sold in just a few quantities, and then the 703, which sold in substantial quantities, and the 704 and the 705.

Q: So it's...

A: Just let me say one other thing. By

THE SECRET OF IBM'S SUCCESS

the end of the third year of this competition, I think the count had gone up to about 15 or 20 IBM to about 12 of the Remington Rand [UNIVAC] machines. And, from then on, why we just zoomed ahead, and they stayed in the dust.

Q: What enabled you to zoom ahead?

A: Because we put everything we had into it. Remington Rand's Jim Rand was an odd and interesting fellow. And he was more of a—how should I say—a figures man, who would buy and sell things. And he bought a farm equipment company, bought a razor company, and so forth. And we just plugged away at computing and office work. And that was the reason why we were successful.

Furthermore, we had about 400 trained systems people, most of whom went off in the service. And my wise old father [Thomas J. Watson Sr., the founder of IBM] paid every serviceman 25% of his pay as long as he was out of IBM. So every month every one of us who were in the service got a check for a quarter of our usual monthly pay.

So every one of those people came back to IBM. And there was the secret of our monopoly. We had a monopoly on people who knew how to apply these gadgets. It didn't matter really whether it went a hundred a minute or two thousand a second, they still knew how to draw the flow charts and plan the applications and store the various things that had to be stored. And while they were a little reluctant, to tell you the truth, to accept it to start with, when they began to see the potential of how rapidly things could be done and how many new jobs could be done, they jumped on the bandwagon, and we enthusiastically pushed forward.

We just plugged away at computing and office work. And that was the reason why we were successful.

Q: You mean the commercial companies were reluctant to accept it?

A: No, our salesmen. Very new idea. As a matter of fact, I got a suggestion from the Metropolitan Life Insurance Company that had three floors filled with punch cards, the rattle alone of which was kind of eating them out of house and home, and also from Time/Life, who had the whole subscription file on punch cards, saying, "We just can't carry this much stuff around anymore, three cards for a customer. And you've got to move to tape." Well, I'd heard of tapes, and I'd heard of electronics. But this was bread and butter. These were big applications that we were going to lose. So we went from a half a dozen electronic engineers to several hundred and then to several thousand over the period of the next decade.

Q: So you think it was a combination of your focus as well as the fact that you had a lot of loyalty among the people who worked for you and their knowledge of their own business customers that enabled you to push ahead of Remington Rand at that time?

A: Yeah, I think we were solely focused on applying computing machines to customers. And we had nothing else to divert us. We had a separate typewriter division, which wasn't anything we made much of a fuss over. So from 1952 on, we were just pressing computers. And it got so fashionable that when our first commercial customer [of the 702], which happened to have been Monsanto, put in a computer, it was housed in the most exquisite way inside of glass with ramps for people to walk around outside. And it was like them exhibiting a great new jewel.

—David R. Brousell

TIME LINE

THE '60s *continued*

1963

ASCII becomes a standard. GE releases IDS, the first commercial DBMS.

The first computer-aided design (CAD) auto part rolls off the GM assembly line.

American Airlines's SABRE system takes on-line processing to a new plane.

1964

IBM gives birth to its unified System/360 family.

GE acquires Compagnie Machines Bull and Olivetti's computer operation.

Timesharing System and BASIC developed at Dartmouth College.

1965

Digital Equipment unveils the PDP-8, pioneering the minicomputer path.

Brooks Bill becomes law for Feds purchasing computer wares.

1966

Justice Department begins antitrust probe of IBM, and FCC commences Computer/Communications Inquiry.

1968

Memory and microprocessor maker Intel Corp. is formed.

The first software patent (for a sort) is issued to Martin Goetz.

Edsger Dijkstra launches structured-programming concept.

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Compaq presents PCs for people with basic needs. (But not-so-basic wants.)

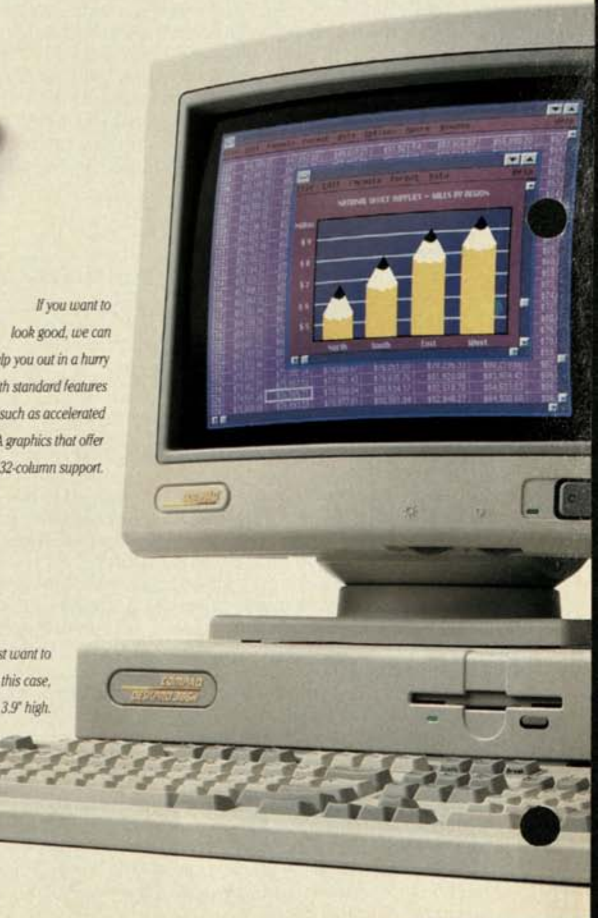
Your need for speed is met two ways. The COMPAQ DESKPRO 386N is powered by Intel's 16-MHz 386SX microprocessor while the COMPAQ DESKPRO 286N is powered by a 12-MHz 286 microprocessor.

If you want to look good, we can help you out in a hurry with standard features such as accelerated VGA graphics that offer 132-column support.

"Shhh..."

Everyone needs a little peace and quiet. That's why both PCs employ dual-speed fans and a fixed disk drive time-out to ensure quiet operation.

Sometimes, you just want to keep a low profile. In this case, our CPU is just 3.9" high.




People want their personal space. Our CPU footprint is a trim 15" wide by 14.9" deep. So it won't take over your desk.
There are times when you need a little outside help. Built-in parallel, serial and pointing device interfaces let you connect a mouse, modem and printer without using a slot.
You need tools that work the way you work. That's why you'll find the flexibility to use a 3½- or 5¼-inch diskette drive, a fixed disk drive or even a diskless model.
These days, you want a sense of security. Especially if you work on a network. A range of software and hardware features are built in to safeguard data and PC components.
The COMPAQ DESKPRO 386N and COMPAQ DESKPRO 286N Personal Computers are not-so-basic solutions for both stand-alone and networked computing. They were designed from the ground up not just to be the most affordable COMPAQ PCs ever, but to live up to our mandate of simply working better.
This means they deliver optimized performance and a long list of integrated features. It means they offer the flexibility to be easily configured to your needs. It also means they've survived the industry's most exhaustive tests for reliability and for compatibility. Things you simply cannot place a price tag on.
So when you compare COMPAQ with lower-priced alternatives, look beyond the basics. You'll find COMPAQ delivers the better value. For more details and the location of your nearest Authorized COMPAQ Computer Dealer, just call 1-800-231-0900, Operator 135. In Canada, 1-800-263-5868, Operator 135.
COMPAQ
It simply works better.

40 Years Of Computing

TIME LINE

THE '60s *continued*

FCC decision permitting other vendors' attachments to phone lines is protested by AT&T.

1969

Antitrust suit filed against IBM on the last day of the Johnson administration.

Work on ARPANET packet-switching network begins.

soon as the computer appeared. After SAGE came the first airline reservation system, the Reservisor from Teleregister Co., which had earlier devised the first stock quotation system. Such systems, based on dumb terminals, soon became a blessing to stock brokers.

American Airlines Inc., using smarter terminals and a general purpose computer, improved the whole reservation system concept in 1963, taking on-line operations onto a much higher plane with its Semi-Automated Business Reservation Environment (SABRE) system. Yet these applications remained basically grounded in the remote job entry (RJE) environment until time-sharing software arrived, which facilitated the coupling of operations control with a hefty amount of computing power.

"It wasn't until the mid-1960s," points out Withington, "that operations control could begin to spread to areas such as manufacturing, utility power-plant control, retail point of sale (POS) and bank-teller terminals." That spread was made possible by IBM 360-generation systems, which packed powerful time-sharing software and terminals that could make use of the software.

In the mid-1960s, time-sharing took computer processing into a new, interactive phase. Initially, it was based on mainframes and dumb terminals and used primarily in the engineering community. Time-sharing systems that were programmed in BASIC also burgeoned on university campuses that had shunned batch operations.

Sitkin remembers how time-sharing turned thinking around at Aetna. "IBM's time-sharing machine, the 360/67, had the Virtual Machine (VM) operating system. The 360/67 was so fast and the memory so much larger that it could occasionally swap out resources, giving people the illusion that they had total control over the machine while they were running their programs. In fact, we were doing personal computing on the machine."

This time-sharing concept, Sitkin says, "prompted us to change our attitude toward computing. We realized that we could do more than just pump hundreds of thousands of millions of transactions to get accounting or statistical data. We could do actuarial applications while the machine was serving other applications, as well."

The 360 Breakthrough

Unveiled with some fanfare in 1964, the IBM System/360 family was clearly a technological turning point. The introduction of 360-generation systems ushered in a long-awaited unifying influence that users welcomed, particularly since it relieved the pressure on their pocketbooks. To a large extent, the 360 enabled companies to preserve their software investments by provid-

ERMA: Staking A Claim In Banking

You wouldn't have expected something that sounded so drab as the Electronic Recording Method of Accounting (ERMA) system to spark the sensation it did throughout the staunchly conservative banking community. But that, in fact, is exactly what ERMA did by using a computer and magnetic encoding to change forever the checking system in the United States.

The brave bank that took this bold leap forward was San Francisco's Bank of America, which in the early 1950s commissioned the Stanford Research Institute in Menlo Park, Calif., to come up with the creative concept that evolved into a fully computerized demand deposit accounting system in 1959.

At the time, BofA described ERMA as "the greatest advance in bookkeeping in the history of banking." It was this advance that greatly speeded up check processing, eliminating the time-consuming manual handling and pigeonhole sorting that was threatening to bog banks down in a paper pit.

In technical terms, the system, which could handle some 50,000 checking accounts every working day, consisted of an electronic reading device, magnetic drum storage, magnetic tapes, an automatic check sorter, a printer and a small general purpose computer. In the first on-line control version of ERMA, which started in 1952, a GE 105 computer from General Electric Co.'s embryonic computer operation was used in batch mode. That was later replaced at the end of the 1950s with the upgraded GE 210.

Once ERMA had proven the feasibility of printing bank numbers in magnetic ink on checks, the Federal Reserve picked up on the idea, and the encoding scheme soon went nationwide. This change bothered the country's banking establishment, who worried that customers would not accept the notion of being a number. But the BofA breakthrough had "perhaps the biggest public impact of any computer application of its time," says long-time computer industry commentator Frederick Withington. "By 1962, everybody's checks had changed."

TIME LINE

THE '60s *continued*

UNIX is invented by Bell Labs's Ken Thompson and Dennis Ritchie.

IBM lives up to its 1968 pledge to unbundle software.

CDC 7600 launches supercomputing.

THE '70s

Amdahl Corp. is formed, kicking off plug-compatible mainframe movement.

GE sells its computer business to Honeywell.

1971

Univac buys RCA's computer customer base.

The microprocessor, invented by Ted Hoff, goes to market as the Intel 4004.

1972

Supercomputer designer Seymour Cray founds his own firm.

1973

Philips, Siemens and CII bond together in Unidata Consortium.

The Dataspeed 40 terminal takes AT&T onto computer turf.

Ethernet is invented at Xerox PARC by Robert Metcalfe.

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ing a compatible migration path.

The 360 came with the most elaborate and comprehensive set of software ever delivered with a machine. On the hardware side, IBM came out with an unprecedented 144 products for the 360. Among them were disks, tapes, communications gear and a wide array of other new input/output devices for the 8-bit byte. The concept of a standard I/O was inherited from precursor STRETCH.

The early commercial users quickly wrote programs for the whole set of accounting applications.

UNC's Brooks, who was in charge of hardware on the IBM 360 project, sums up some of the system's other salient points. "We used binary addressing, which displaced the kind of decimal and character addressing that until then had dominated in commercial applications with the IBM 1401. The unified software enabled all the basic applications—scientific, engineering and commercial—to be on one basic architecture."

That architecture was destined to advance computing into the information systems age. "The 360 was a merger of computing with communications, a merger that first started happening in the late 1960s, as users started to go on line," says Sitkin. "That enabled us to do more than just accounting and statistical transaction-processing work and get into the IS realm."

The System/360 family, which included seven computers in all, was a stunning success for IBM. That success was reflected in escalating sales, which sent IBM's revenues skyrocketing in 1965.

Such stellar success attracts attention, and, for IBM, unwelcome attention on the part of the Justice Department resulted in an ill-fated antitrust suit, filed at the beginning of 1969. A slew of other antitrust actions instigated by various vendors in the leasing and plug-compatible peripherals

The PDP-8: The First Stolen Computer?

Bob Metcalfe, the father of Ethernet and founder of 3Com Corp., was initiated into the computer world during the late 1960s while he was an undergraduate at the Massachusetts Institute of Technology in Cambridge, Mass. The 44-year-old communications sage offers the following anecdotes about a punch-card panel and a pilfered PDP-8.

I can remember being on a panel at the Fall Joint Computer Conference in 1966 in San Francisco. The panel featured a debate between the advocates of the punched card and the advocates of the interactive terminal. The punched card was principally being promoted by IBM, while the interactive terminal was principally being promoted by Digital Equipment Corp.

The punched card promoters maintained that it was better to use punched cards than interactive terminals because punched cards make the programmer think about his work, which he only gets to submit once a day. This is not the case, they argued, with interactive computing, where the user can type his program in and get the answers back quickly. Thus, he's likely to waste a lot of computer time without thinking about it.

Everyone was serious about these issues at the time. There were doubts on both sides. The PDP-8 had an interactive programming language called Focal. I was using it to teach high school students how to program computers and develop simple models. DEC had loaned it to me for use on an MIT project, and then it was stolen by a fraternity on campus. I believe this PDP-8 was the first computer ever stolen.

Bob Metcalfe while at college.

I thought that DEC was going to be very upset with me and make me pay them back. Instead, they decided to use it as a promotion: The PDP-8—The First Computer Small Enough To Be Stolen. I remember when DEC came over to MIT to investigate. They didn't bring the police. They brought their marketing and PR people.

40 Years Of Computing

TIME LINE

THE '70s *continued*

Work begins on communications protocol that will lead to TCP/IP.

1974

Privacy Act, which protects against the misuse of computer data, zips through Congress.

SNA is announced.

IBM's John Cooke designs first RISC machines.

1975

N.V. Philips exits the mainframe arena, and Honeywell Bull merges with CII.

Xerox moves out of mainframes, and Singer abandons electronic retailing.

Wang delivers word-processing products that lead the wave of WP wares.

Congress drafts Consumer Communications Reform Act, much to the consternation of AT&T.

The CP/M operating system is introduced by Digital Research.

1976

Aetna joins IBM and COMSAT in Satellite Business Systems.

AT&T offers Dataphone switched digital service.

Microsoft and Apple Computer are formed; the Apple I is introduced.

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A RETROSPECTIVE

business would continue to send IBM to courts across the country throughout most of the 1970s.

Also squaring off against IBM were fledgling software firms that were girding to do battle with Big Blue over the software bundling issue, which threatened their fragile business. That issue, however, was quickly resolved when IBM unbundled its software in 1969.

One of the early bloomers in software was Atlanta-based Management Science America Inc., which was acquired last year by Dun & Bradstreet Corp. MSA chairman John P. Imlay Jr., currently chairman of D&B subsidiary Dun & Bradstreet Software Services Inc., describes how packaged software turned computing power into what he calls "competing power." "Most programmers used to work on mundane applications, such as payroll and general ledger. When that became packaged, they were freed up to do things that could make their companies more competitive."

Alternatives on the hardware front also began to appear in the 1970s. At the tail end of 1970, IBM's design wizard Gene Amdahl formed Amdahl Corp., which five years later cranked out the 470 V/6, the first plug-compatible mainframe (PCM). The landmark machine, which cost Amdahl $40 million to produce, would subsequently save users many more millions.

The Joys Of Competition

Prices on IBM mainframes fell roughly four times faster between 1975 and 1981 than they had during the preceding five years. The credit, maintains Jack Biddle, president of the Computer & Communications Industry Association in Arlington, Va., "goes to Amdahl, who drove down the cost of the 360 family. He also provided entry-level users with a much lower priced product than they could have had in the 360 or 370 environment."

With the price constraint removed, smaller organizations could make the mainframe move, thanks to the Amdahl alternative. "Many smaller companies," confirms Amdahl, "were now able to afford a computer for the first time."

When asked to describe the changes wrought by the PCM movement he pioneered, Amdahl, who is currently chief executive officer of Andor Systems in Cupertino, Calif., replied: "It brought mainframes into the technology race. And the stakes were high enough that it advanced technology at a faster rate, as well." What took technology on that faster track was large-scale integration (LSI), which would continue to pack more and more circuits on a chip. Amdahl's machines were the first to use LSI.

The mainframe was not the only machine in the technology race. In the 1970s, the minicomputer, which Digital put on the

INTERVIEW

JOHN OPEL

John R. Opel was chairman and chief executive of IBM from 1980 to 1986. He is currently chairman of IBM's executive committee.

Q: Do you think that computing has had a positive effect on business over the last 40 years, in particular on white collar productivity?

A: Well, you start with a false assumption and you can reason perfectly. And there's one thing you'll be sure to get: a false conclusion. The false assumption is that white collar, per se, is productive. The existence of a white collar worker is, in fact, not productive....

White collar workers—that is, large clerical forces—can't really add a hell of a lot, except providing information and living by certain paradigms we give them. You know, you go down to the red mark and, when you get to the red mark, hit the right button....But what you want to do is eliminate them, not make them more productive.

Q: Eliminate white collar workers?

A: Yeah. What you want to do is eliminate the need for that kind of worker. And white collar is a broad term. I'm thinking about clerical work. I think much of it has been.

Q: Because of information systems?

A: Sure. If you try to do an airline reser-

PRODUCTIVITY AND SOCIETY

vation system of clerks, you can't do it. So, they've been eliminated.

Q: What other effects has computing had on business, good or bad?
A: I don't think there's any doubt about the enormous effect on efficiency. You do more for less. And you do things you could not otherwise accomplish. Whether you're talking about producing an inventory, whether you're talking about shortening the cycle time from beginning to end on a design, whether you're talking about distribution, whether you're talking about building something. All of that, just sheer management of information and providing it to decision makers, has an enormous effect. And there just isn't any question about it.

Q: What about social effects?
A: The fact is that industrial society, if you think about it, enlarges itself by changing the span of control in a given market. And to do that, it requires information, which is the sine qua non of industrial society.

If you're in...an industrial society, [you] have a need for or a demand for much information. And if you have the technology to supply it, and it's constantly improving, they feed on each other. You've got a closed loop, and you've got a hell of a winner.

And it's an interesting thing. It goes well beyond where people think of it going, because it accelerates the change in the society. The interesting thing about it is that, like information of any kind, whether it be the kind you use to manage your business or the kind you use to run your country or whatever, it tends to integrate the society. It tends to rise above the kind of superficial, arbitrary boundary lines that we placed on most of our societies politically, with national sovereignty and things of that kind. And those examples are bound to computing, as well.

I'll give you an example of what I mean. You know what information will do. If the government can't keep control of information, the people decide for themselves. You know, the free market begins to take place—as we see in the world, in Europe, today. The revolutions that we see, the changes that we see in the politics of the world, I think, are a function of information. Similarly, the use of technology to develop information systems that rise outside these political boundaries also has tremendous effects.

The revolutions that we see, the changes that we see in the politics of the world, I think, are a function of information.

The fact is that there isn't an aspect of our society that hasn't been, I think, touched by this kind of technology in a very positive way. It could be from education to health to these practical and kind of nice things like the credit system, or practical things like the transportation system. Beyond that, it isn't like Dr. Ehrlich's magic bullet or anything like that.

Q: Right. It's not going to cure a common cold.
A: No. But it's sure as hell the underpinning of a society that otherwise could not function with the kind of benefits that you derive from a highly productive industrial world. And I think the politics of it, as I say, are affected in a positive way. Now, I think that's arguable because there are negatives as well as positives, and there are always people who are threatened by change.

But I think you have to acknowledge that it's the sine qua non of continuation, of developing industrial society. And the politics come along for free.

—David R. Brousell

TIME LINE

THE '70s *continued*

1977

The 64-key Data Encryption Standard gives users more security.

Hobby Computer market born with MITS Inc.'s Altair 8800, Radio Shack's TRS-80 PC and Commodore's PET PC (Personal Electronic Transacter).

1979

Intel and CalComp sell off PCM peripherals business to National Semiconductor.

VisiCalc, Daniel Bricklin's electronic spreadsheet, hits the market.

IBM passes the $20 billion mark; Digital hits $2 billion.

THE '80s

1980

Deregulation of AT&T is key finding of FCC's Computer Inquiry II.

IBM trots out the $3 million 3081 mainframe and System/38, which comes with a relational DBMS.

MCI gets a cool $1.8 billion in its AT&T suit.

1981

Burroughs buys ailing Memorex Corp.

Osborne PC goes portable, and laptopper Compaq is created.

IBM announces its Personal Computer with MS-DOS developed by Microsoft.

Itel files for Chapter 11 bankruptcy protection, and ICL gets a financial transfusion from the U.K. government.

A RETROSPECTIVE

40 Years Of Computing

TIME LINE

THE '80s *continued*

1982

Sun starts moving workstations onto new high-performance terrain.

Ironically, the Feds' massive IBM and AT&T cases reach settlement the same day.

FBI nabs Hitachi and Mitsubishi employees for attempting to obtain stolen IBM documents.

Lotus Development Corp. sets up shop and announces Lotus 1-2-3 spreadsheet software.

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computing map, broadened the base of computing users and helped stretch the tentacles of technology further and further out into the organization.

"The minicomputer took central computing and dispersed it," says Sitkin. "And that dispersal was done in the name of improving accessibility to the computing resource."

"The minicomputer broke up the central ownership of the computing resource," adds Howard Frank, chairman of Network Management Inc. in Fairfax, Va. In communications, the mini began to pervade things like front ends. "All of a sudden," he notes, "you could hang something in front of the computer, and you could do DP applications that required communications a lot more efficiently."

The mini also made communications more cost effective and brought a new breed of user into the computing camp. "The minicomputer spawned the development of cheap and reliable concentration devices that made more efficient use of leased lines," says Frank. "And it also brought computers to people who hadn't been able to afford them before."

The man behind the mini, Gordon Bell, reveals Digital's minicomputer mandate: "Our goal was to have minicomputers be totally accessible vis a vis things like hardware and drivers so that you could integrate them. In that sense, the minicomputer was a precursor to the chip. Because we thought of computers as components—as things that went into other systems."

Today, Bell views minicomputers as another node on the network. "Roughly every decade," he explains, "a new computer class was formed. It started with mainframes, went to minis and then to PCs and workstations. Once all the PCs and workstations are in, you've blown the whole computer apart. So then what we needed was the local area network to put it all back together again into a single system."

The Precursor To The PC

Bell, like many others, also considers the minicomputer to be the precursor to the personal computer. And, indeed, the mini had made its way into the office via personal as well as word-processing applications, well before the mighty little machine arrived on desktops throughout the land.

The word-processing world merged with the DP domain in 1976 when Digital set its 310W machine to work on word-processing chores. Other mini makers soon followed, and the marriage of WP and DP was consummated under the glare of fluorescent lighting.

The office computer started then to tackle text-processing applications for professionals. But those particular office automation dreams summarily went up in smoke as soon as the PC put in an appearance and abruptly halted all office automation experiments on minis.

The PC, which was pioneered at Xerox Corp.'s Palo Alto Research Center (PARC), started its stand-alone life outside the lab as a hobbyist's lark. It wouldn't be long before it proved its worth in the office as a more cost-effective word processor than the mini, which it torpedoed dead in the water. But before that happened, the micro needed an application that would drive it directly to the desktop.

That application, which clearly signaled the arrival of the personal-computing age, was conceived in 1978 by Daniel Bricklin while he was a graduate student at Harvard University. The next year, Bricklin's company, Software Arts Inc., rolled out VisiCalc, the first electronic spreadsheet for PCs. The initial version of VisiCalc was tailored for the Apple II.

The spreadsheet software, which did much to boost the popularity of Apple Computer Inc.'s Apple II, dramatically accelerated desktop demand. It also paved the way for the next spreadsheet program, Lotus 1-2-3, created by Mitch Kapor and Jonathan Sachs. Produced by Lotus Development Corp., 1-2-3 expanded Bricklin's

The Amdahl 470 V/6: A Tale Of Two Colors

The first computer developed by Amdahl Corp. founder Gene Amdahl was the Amdahl 470 V/6. Notable for being the first machine to employ large-scale integration (LSI) technology, it was also remarkable for its red logo and color scheme. Or at least that was the intention.

"Some people called us Big Red because of our color, which they thought we had chosen to contrast ourselves with IBM's Big Blue", recalls Amdahl, now chief executive officer of Andor Systems. The color we originally chose, however, was selected for quite a different reason. I purposefully selected a warm red in the Oriental tradition. Red is also the color of youth and vitality."

Amdahl takes the wraps off his 470 V/6, which will be retired this year.

Some youths at Texas A&M University, however, were set to get inflamed over Amdahl's color until a change was made. Amdahl recounts the tale of two colors: "The color of our V/6 machine was similar to the orangish-red color of Texas A&M's arch rival, the University of Texas. So when Texas A&M bought our machine, they were concerned about the color. I proposed that we put a sticker on the machine that said "Stolen from the University of Texas." But one of our guys had a better idea. He carefully spray painted the maroon Texas A&M color on the machine right before they installed it."

40 Years Of Computing 1951 1991

TIME LINE

THE '80s *continued*

Supercomputers from IBM (3084), CDC (Cyber 190 series 800), Burroughs (B 7900) and Cray (X-MP) debut.

Software AG president John Maguire tells a Senate subcommittee that Soviets offered $500,000 bribe for Adabas's source code.

1983

IBM purchases 15% stake in Rolm.

AT&T acquires 25% interest in Italy's Olivetti.

IBM introduces System/36.

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basic software to include data management and graphics facilities.

What was the secret of the spreadsheet's success? Bricklin, who is now vice president in Watertown, Mass., of Scottsdale, Ariz.-based Slate Corp., says VisiCalc was successful because it filled a void on the computing landscape. "It was something you couldn't do even if you had access to an IBM mainframe," he says. "VisiCalc was very interactive. It had the unique ability to let you edit numbers on the screen and do immediate recalculations."

Rod Canion, president and CEO of Compaq Computer Corp. in Houston, recounts the magic moment he experienced when he fired up his PC with VisiCalc: "When I first sat down and used VisiCalc, it was like a light bulb went on. It was then that I realized the power of the PC as a productivity tool."

The word-processing world merged with the DP domain in 1976 with Digital's 310W machine.

Thanks to VisiCalc, many people in the workplace would come to recognize the value of PCs as productivity prods. As Withington puts it: "The spreadsheet helped users discover PCs for the desktop. Once there, they began to power WP applications. These two pivotal applications greatly expanded the PC user base." That base would balloon further in the late 1980s, when electronic mail, desktop publishing and local database applications were added to the user's micro menu.

After the micro started gaining momentum in the office, it wasn't long before it took its next big leap onto laptops throughout the land. The person that prompted that leap was British-born Adam Osborne, who presented the world with the first commercially successful portable in 1981, the same year that Compaq was launched. A year later, Canion remembers, "we sat down in a Houston pie shop and sketched our ideas for a portable. It was important that Compaq's computer not look like Osborne's."

In 1981, the same year as Canion's pie-shop brainstorming session, IBM finally took the PC plunge, a plunge that would firmly plant the personal computer in nourishing corporate soil. That soil also nourished the laptoppers, and Compaq flourished. "What's changed dramatically since then," reports Canion, "is that portables have gone from 30 pounds to five pounds, and the overall dimensions have shrunk even more. Today, there's more computing power in portables by an order of magnitude of 20, and they're also more affordable."

The engine that has generated PC power has been sophisticated software, which was brought to the corporate masses in the form of MS-DOS. Delivering those programs to the desktop was Bill Gates, who built a booming $953 million business—Microsoft Corp. in Redmond, Wash.—around the MS-DOS standard.

The proliferation of PCs in business subsequently generated a demand to link to-

The VAX: Digital's Battle Within

Returning from a three-week skin-diving trip to Tahiti in 1978, Gordon Bell, Digital Equipment Corp.'s high-energy vice president of engineering, was ready to do battle with the top executives at Digital and prove to them that his hierarchical approach to computing via VAX was the way to go.

Bell's VAX strategy called for Digital to have VAX machines in every part of the computing hierarchy. That meant, according to Bell, that "a user in either a centralized mainframe environment or in a distributed minicomputer environment could compute anyplace he wanted—through a cluster of high-speed minis or through individual workstations [MicroVAXs], which were actually precursors to the personal computer."

This was Bell's VAX vision. Right off the bat, he recalls, "I began fighting engineers and marketing people. It was clear to me that we simply had to get rid of all the garbage we had and go solely to VAX."

Bell: We had to get rid of all the garbage.

The fighting lasted into 1979, when Bell finally presented his case to Digital's board of directors.

Bell remembers that "Ken [Olsen] sat there, half the time arguing that I was crazy and the other half of the time letting me express my thoughts. He was clearly worried. And I also remember the head of the PDP-11 product line saying that the VAX move was total suicide, too high of a risk."

It was a risk that paid handsome rewards. Digital's sales quadrupled from $1 billion in 1977 to $4 billion in 1983, thanks to VAX. "By the time I left in 1983, we had implemented the first phase of the stratagem and all the VAX projects at DEC were in place. I didn't see how that strategy could get messed up for at least another five years. And, in fact, it didn't. It took seven years."

TIME LINE

THE '80s *continued*

1984

Government breaks up AT&T, and the RBOCs start spinning off.

GM pays $2.5 billion for service company EDS.

Apple brings fruitful Macintosh PC to market.

1985

Storage Technology puts mainframe business up for sale.

AT&T declares that it will establish a single UNIX standard.

Token Ring is announced.

1986

Sperry and Hitachi tie the knot in a technology exchange.

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gether those innumerable islands of automation, an activity that Microsoft is currently hard at work on.

"PCs," points out NMI's Frank, "were the driving factor for extending LANs everywhere." Today's LAN-locked enterprises would never have been able to make these crucial communications connections without Ethernet, which Metcalfe invented at Xerox PARC eight years before IBM unveiled its PC.

LAN links to workstations were established as soon as the new generation of power-packed machines wended their way into organizations in the early 1980s. The workstation wave was set into motion by Sun Microsystems Inc. of Mountain View, Calif., and Apollo Computer Inc. of Chelmsford, Mass., which was purchased in April 1989 by Palo Alto-based Hewlett-Packard Co.

The engine that has generated PC power has been sophisticated software, like MS-DOS.

Workstations, explains Metcalfe, "enabled you to do many more things than you could do with PCs. They could handle complexity and perform much larger computational tasks."

But the real gains from workstations, he stresses, came in graphics. "For the first time, machines began to deal in the medium of human beings," says Metcalfe, who believes that imaging will be a big application area for workstations. But to accommodate that aborning application, communications will have to speed up. Providing that zip will be LANs, which innovator Metcalfe predicts will continue to get faster and faster.

Communications innovations, stretching from the simple modem to complex network architectures, have already played a crucial role in the spread of computing. In the 1970s, computers began to propel progress on the communications front. By the 1980s, when the telephone plant had switched to digital technology and computing had become increasingly diffused throughout organizations, that scenario had turned around. "Now in the 1990s," declares Sitkin, "the focus is on communications, not on the computer. The computer—big, little or in between—is just a node hanging off a communications network."

ARPANET, the pioneering packet-switching network that added efficiency to data transmissions, was conceived and built between 1969 and 1972. Vinton Cerf, who was in charge of the DARPA team that developed the TCP/IP protocol, describes the benefits of packet switching: "Before packet switching began to emerge in the 1970s, there was a very rigid type of communications allocation. So, in the beginning, the most critical thing that packet switching did was make it easy for time-shared machines to interact with each other."

That efficiency enabled organizations to achieve economies of scale in communications, explains Cerf, who is now vice president of the Corporation for National Research Initiatives in Reston, Va. "Packet switching allowed extremely flexible sharing of common resources. So instead of having, for example, ten 2.5 kilobit per second pipes, you could have one 50Kbps pipe that could be shared among a number of

A DATAMATION Invocation

The time has come, the '80s past,
To talk of olden lore:
Of papertape and keypunches,
Of Williams tubes and more.
And whether Jovial is friendly,
And why an Apple has no core.

Here friends from all our yesterdays,
Assembled or compiled,
Have come to drink to days gone by
And get a little wild.
So let the chips fall where they may,
And leave the chad all piled.

Chief Programmer, please hear our plea,
Who rules the land of OS,
Von Neumann's code, the Master Node,
Of 1's and 0's the Boss:
Don't let these years, now in arrears,
Become a total loss.

Put in a word, at least a byte,
For dwarfs that used to be:
For Honeywell and UNIVAC,
RCA and GE.
And don't let mighty Burroughs code
Be lost from memory.

And save some space, at least a meg,
In some great virtual store,
For Johniacs and ENIACS
And Maniacs galore,
For LARCs and STRETCH and Whirlwind
To loop in evermore.

You know we've tried to slash our 0's
And cross our every Z.
So please don't let the world forget
Our bubble memories,
Of flip-flops, batch, time-sharing
Or our good old BCD.

As '90s loom, we ask just this:
Please hold us in your hand;
Protect us from the viruses
That worm through all our LANs;
And keep the errors in our code
From being cast in sand.

—Richard McLaughlin

40 Years Of Computing

TIME LINE

THE '80s continued

Joint ventures with Honeywell and Groupe Bull enable NEC to become the world's third largest computer company.

1987

IBM announces its PS/2 family, and rival AT&T debuts its PC from Olivetti.

After 32 months, Storage Technology comes out of Chapter 11.

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applications. In that way, economies of scale could be achieved."

Computing users got even more flexibility from the TCP/IP protocol, which enabled them to link together many different kinds of packet-switched networks. Those links, in turn, enabled disparate computers to be tied together so they could talk to one another.

Developed between 1973 and 1980, TCP/IP entered the commercial sphere in the 1980s and became widely implemented and adopted. TCP/IP spawned the Internet, the gargantuan global network that now hooks together some 5,000 other networks. Cerf reports that the sprawling Internet "is becoming a research and educational backbone that we hope will spin off commercially available capability."

Some say that TCP/IP will gradually give way to the Open Systems Interconnection (OSI) model being promulgated by the International Standards Organization. The two well-known standards for public connectivity, the Integrated Services Digital Network (ISDN) and X.25, are implementations of the third layer in the seven-layer OSI Reference Model.

For many organizations, OSI has come to epitomize the open systems' concept, which promises to provide computing users with more flexibility and freedom of choice. Many predict that open systems will be a major driver of computing in years to come. And the push is coming from users on both sides of the Atlantic who are getting behind standards, in particular OSI. "The standards that I feel are going to be important are the ones that establish protocols for communications. That's what basically underlies the quest for open systems," confirms Ron Brzezinski, national partner in charge of information strategy and planning at Coopers & Lybrand in New York City.

A Long-Term Process

That quest is proving quite a challenge for most organizations still tied by their purse strings to proprietary products. Those ties, as Brzezinski points out, will be difficult to break in the short run. "Roughly 50% of the capital expenditures made by U.S. business last year went into information technology. That magnitude of investment means that open systems will by necessity be a long-term standardization process."

IS veteran Reynolds believes that the push toward open systems "is a real effort to permit large growth in applications." It's also an effort that will be expensive. "So the costs will have to be shared by many people in the short run. This is another place where the government is a driver. And I hope they keep it up," he says.

"It will take a tremendous investment from both a user and vendor perspective to bring everything together in an open systems environment," agrees NIST's Burroughs. The impetus on the government side, he notes, comes from its huge inventory of mixed hardware.

This mixed machine milieu grew out of the government's competitive purchasing policies, policies that make the Feds fitting testers of open systems technology.

The spirit of open systems, say many in the industry, embodies the spirit of America's democratic ideals. Forty years ago, no one could have foreseen that computerization would lead to democratization—in the workplace and beyond. That novel notion would have never occurred to sanctimonious system gurus who enshrined and entombed the mainframe in sparkling glass.

"The day of democratization has absolutely arrived," declares econo-mist Flamm.

For many organizations, OSI has come to epitomize the open systems concept, which promises to provide flexibility.

"It used to be the high priests of the mainframe that controlled all computing in an organization. But, over the last 40 years, technology turned the tables. And that dramatic change is felt within any organization today that uses a computer, no matter how humble or how high."

Compaq's Canion, who characterizes the change as "a redistribution of the computing wealth," says the accelerating PC push gave people computing power that soon began to exceed the computing muscle delivered to them by the mainframers. "A lot of people just didn't see the benefits of a more effective, more efficient end user."

"The computer," sums up Withington, "shrunk and homogenized the globe. It provided a set of tools that have challenged us to expand our capabilities and effectiveness. And it democratized both people and the enterprise they served by amplifying their intellect in extraordinary ways that we never could have foreseen 40 years ago."

TIME LINE

THE '80s *continued*

1988

Fujitsu pays IBM $237 million to settle suit alleging it copied IBM system software.

1989

Compaq jumps from the desktop to the floor with its SystemPRO PC.

THE '90s

Concentrating on its core computer business, IBM spins off low-end printer, keyboard and typewriter operations.

A struggling AT&T makes a $6 billion bid to buy NCR.

Hitachi offers two IBM-compatible mainframes.

IBM introduces the System/390 family.

40 Years Of Computing 1951–1991 TRIVIA CONTEST

BY ANDREA OVANS AND CHRIS STAITI

Forty years is plenty of time for trivia to accumulate in any field, and ours is no exception. After spending weeks in our dusty, ill-lit storerooms poring over back issues of DATAMATION, we have come up with what we believe are abaker's dozen of the most formidably trivial questions we could find. So, we challenge you, based on your own experience (or your access to our back issues in your local libraries) to come up with the answers. We guarantee that all answers can be found somewhere in the pages of DATAMATION.

1950s

1. What were Perseus, Pegasus, Mercury and Pluto?

2. On June 15, 1959, two former airline manufacturing executives and an exemployee of the Corporation for Economic and Industrial Research in Washington, D.C., officially started up this company, primarily for the purpose of manufacturing compilers.

3. They thought they could complete it in six months, but it took three years to develop. It consisted of 25,000 instructions. Irving Ziller, Robert A. Nelson and Sheldon Best worked on it along with only three or four other individuals. But John Backus got most of the credit (mistakenly, he said) and the 1975 National Medal of Science for it.

1960s

4. Jackson Granholm coined this word in DATAMATION and defined it as "an ill-sorted collection of poorly matching parts, forming a distressing whole."

5. The first ones were 10 1/2 x 22 inches, moved at 80 miles per hour and were first adopted as a standard by the Association of American Railroads.

6. Who said this?

"If you make a small inexpensive computer, you have to sell a lot to make a lot of money. And we intend to make a lot of money."

1970s

7. What did the IBM 370 model 145 have that the 155 and 165s did not?

8. This computer company went out of business 11 years after it started, in the same year that the machine that launched it died, too.

9. Introduced in 1972, it was 3/4 x 1/4 inches, contained a 4-bit adder and 48-bit program counter, a stack and address incrementer, an 8-bit instruction register and decoder, control logic and 45 instructions, and was offered as part of a set that cost $66.

1980s

10. Who manufactured Capricorn and Coconut, and what were they?

11. In 1982, we said this game maker was "pioneering technical innovations that may make conventional approaches to computing obsolete." Perhaps it would have, if its chief scientist Alan Kay, hadn't jumped ship to Apple Computer Inc.

12. Although they appeared here in the spirit of openness, IBM and Digital chiefs John Akers and Ken Olsen refused to shake hands for photographers at this announcement.

13. Extra credit: What was the cover date of DATAMATION's first issue?

CONTEST RULES

Winners will be announced, and all the answers will be revealed, in our July 1, 1991 issue. A laptop computer will be awarded the enterprising soul who comes up with the first set of correct answers we receive or the highest number of correct answers we receive first. DATAMATION employees and their relatives are ineligible for this contest. The rest of you, sharpen your pencils.

Please send replies, including your BUSINESS CARD, to Trivia Contest, DATAMATION, 275 Washington Street, Newton, MA 02158, or by fax to (617)-558-4506.

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PREDICTIONS

MILES TO GO

By Jeff Moad

Apple's Alan Kay

Forty years of commercial computing have certainly spawned many technological advancements, but contrary to what some believe, the industry is by no means mature in a technological sense. In fact, what will be coming up in the next decade and beyond may be even more exciting than what preceded it. If that's not completely certain, what is is that the technological innovations will come at a faster pace than ever before and will affect larger numbers of people and organizations.

The more intriguing breakthroughs top researchers and scientists are working on include:

- Continuing rapid advances in base-level semiconductor, packaging and optical technologies, which will enable vendors to pack ever more computing power and storage capacity into ever less space.
- New tools to help IS professionals understand and manage computer networks that have grown so large they have begun to behave almost independently of their human creators.
- New ways for users and computers to communicate: for users, voice and visual input; for computers, more expressive ways of displaying information, including full-motion holographic images.
- New languages and advanced compiler techniques that will allow software developers to dramatically increase their productivity by moving well beyond the object-oriented paradigm.

"The whole juggernaut of enabling technologies is going to go steaming ahead at the same incredible rates that we've seen for the last 15 to 20 years," predicts John Armstrong, IBM's vice president for science and technology. "The engine that has driven this revolution over the last 20 years or so is not going to run out of gas."

Fueling innovation into the next generation—as it has for the last 40 years—will be continuing improvements in base-level technologies. Semiconductor vendors will continue to provide improvements in miniaturization, packing more and more circuits onto a chip. That means more computing power and memory on ever smaller platforms, opening up the possibility even of small, handheld devices with the power to drive new types of interfaces using MIPS-hungry voice- and handwriting recognition technologies.

Continuing advances in miniaturization also means ever falling prices for computing power. As semiconductor fabrication and packing techniques improve and permit in excess of a million circuits on a chip, IBM's Armstrong predicts, a dollar will buy between eight and 30 times more computing power over the next 10 years. That trend will make it economical to use semiconductor-based technologies in new ways, such as in color, flat-panel and field-effect displays, which will replace tube displays. Such displays will provide brighter graphics and—perhaps just as significant—will cut down on dangerous emissions, according to John Wise, chief technical officer at Unisys Corp. in Blue Bell, Pennsylvania.

From Head To Disk

Improvements in component miniaturization and reliability also will lead to breakthroughs in storage technologies. "There's still a couple of orders of magnitude improvement left in conventional disk drive technologies, as we reduce head-to-disk flying heights and introduce things like perpendicular recording," predicts Bob O. Evans, a partner at Technology Strategies & Alliances in Menlo Park, Calif., and one of the creators of the breakthrough IBM 360 series mainframes in the 1960s.

Evans and others also see newer storage approaches, such as optical technologies, maturing to the point that they'll increase storage capacities and economies. Vendors already are combining optical technologies with more proven magnetic-recording techniques to yield multigigabyte, rewritable storage devices.

Beyond that, researchers at the Microelectronics and Computer Technology Corp. in Austin are experimenting with optical holographic technologies, which they say have the potential to revolutionize data storage. MCC's so-called Bobcat project has produced a second-generation prototype of a rewritable storage device that features high capacities and data transfer rates of up to 1.2 gigabytes per second. MCC senior vice president Barry Whalen says the Bobcat device will be ideal for storing multimedia data such as video images.

In the end, scientists predict, ever smaller and cheaper compute power and storage will mean one thing. As IBM's Armstrong puts it: "All data will be on line. Everybody will be a user. Everybody will be connected."

A World On Line

Of course, that prospect raises new challenges—and new opportunities for technology breakthroughs. When everyone is on line, for example, how do you deal with the massive burden that will be placed on network resources? How do you manage networks that connect hundreds or thousands of different types of devices or even predict their behavior? Scientists like Armstrong believe that as high-speed fiber optic cable becomes pervasive, linking homes, offices and local-area networks around the world, the need for increased physical bandwidth will be satisfied. And projects like the U.S. government's new High-Performance Computing Initiative's 1-gigabit network project will lead to innovative new ways to use that increased bandwidth.

But that still leaves open the question of understanding and managing the massive new data networks. "Up until now, we've concentrated on the easy part—creating standard ways of getting bits from here to there," says Unisys's Wise. "Now comes the hard part—determining what those bits are, what we want them to do and how to provide security and management to global networks."

The whole juggernaut of enabling technologies is going to go steaming ahead at the same incredible rates.

At Xerox Corp.'s Palo Alto Research Center (PARC), scientists predict that as computer networks continue to grow larger users will need completely new tools and techniques for understanding and managing them. Xerox research fellow Bernardo Huberman is leading a group that is developing such tools. Without them, he says, networks, as they grow, may become increasingly chaotic, virtually taking on a mind of their own.

"As the network gets very large, it becomes more and more like some kind of species that is coexisting with us," says Huberman. In attempting to manage such networks, it makes little sense to look at the performance of each individual node, he continues. What's needed is a much higher level understanding of how the network is behaving as a whole.

PARC's research to date has focused on looking at large networks as something like economic systems. PARC researchers, in projects called Spawn and Strand, have found they can at least make network performance less chaotic by enforcing a system of rewards for systems and applications that perform well. For example, an application that makes the right decisions about which servers to call would be rewarded by being given more resources, such as more memory. Inefficient applications would be given fewer resources. "We are now trying to model some of the properties we've observed and build network and application management tools," says Huberman.

Beyond those tools, Huberman predicts, will be breakthroughs in programming languages and techniques that will add intelligence to network applications so they can automatically sort through the vast amount of data surging through huge networks and present only what is pertinent to the user. "We still don't have a good language for programming networks and distributed computation," says Huberman.

PARC alumnus and current Apple Computer Inc. fellow Alan Kay predicts that a new form of programming, which he calls "agent-oriented" programming, will one day emerge to help applications sift through the mass of data available on large networks. A more intelligent alternative to object-oriented programming, Kay says, agent-oriented programming will be based on artificial intelligence languages such as Inference Corp.'s ART. As such, the approach will make use of AI techniques like inferencing, which will give self-defining agents in a system the ability to learn what types of information a user or application would be interested in seeing.

IBM's John Armstrong

The ability for software to understand the needs of the user will introduce a new relationship between systems and people, and it will make possible new types of interfaces, says Kay. "The icon-based interfaces we developed in the '70s were oriented toward being able to easily teach people about the system. The new interfaces will be based on teaching the system about what the user needs."

Kay and others also predict that users in the near future will be given new, more expressive ways to tell computers exactly what they want. Researchers at the Massachusetts Institute of Technology's Media Laboratory, for example, are currently hard at work on enabling computers to understand not only human speech but also visual images.

"Voice and visual interfaces will bring two areas of significant change to computing," predicts Nicholas Negroponte, the Media Lab's director. "First, people will be able to deal with computers in passing, without having to sit down and overtly type on a keyboard or move a mouse. In that way, our use of computers can be more concurrent with other things we do. And, secondly, particularly with visual recognition, we can use what I call 'subcarriers of information.' For example, the system will be able to see our facial expressions and read information from that."

Scientists like Kay and Negroponte predict that computer recognition of continuous human speech will be a reality by the middle of the 1990s. Recognition of visual images is a tougher problem, but well within reach, says Negroponte.

At the same time, Negroponte says, scientists are making surprisingly rapid progress toward creating revolutionary new ways for computers to present information to people. The Media Lab, for example, recently demonstrated the first computer-generated moving holographic image. The 16,000-processor Connection Machine supercomputer is capable of creating incredibly high-resolution images and projecting them at 30 frames per second. Using it, MIT researchers created a 1-inch holographic cube that responded to changes in real time. "We're still not quite to the level of Star Wars," says Negroponte, "but in another 10 years, we could be."

An Emphasis On Productivity

While some scientists work on improving communication between computers and their users, others are attacking what undoubtedly continues to be the most significant bottleneck in the IT industry: the gap between the speed with which engi-

NEW LANGUAGES

neers can develop new hardware and the time it takes programmers to write software for it. "There's still about a 10-year gap between hardware and software, and so far we haven't done much to close that," says Peter Weinstein, a research director at AT&T Bell Laboratories in Murray Hill, N.J.

A Broad View of Languages

But that doesn't mean software scientists aren't trying. At IBM's Almaden Research Center in San Jose, for example, researchers led by IBM Fellow John Backus continue work on FL, a new language that Backus says could bring a 10-fold improvement in the efficiency and productivity of software developers and maintainers. FL, which stands for Function Level, represents nearly 20 years of work by Backus to create a style of programming that would allow developers to stop what he calls the repetitive "word jockeying" forced on them by lower level languages like COBOL and take a very broad view of programs and data.

Backus says his group recently began proving some of his theories using the first FL optimizing compiler. "We believe we're beginning to prove out the viability of this technology," he says.

Taking a very different approach to the same problem are researchers at MCC. According to Whalen, the consortium next month will kick off what it calls its "cooperative programming" project, an effort to provide product developers with a method for linking hardware and software development from the initial design phase all the way through implementation. The project will leverage a number of technologies, including an object-oriented database already developed at MCC; special groupware to keep hardware and software development in lockstep; and object-oriented extensions to the VHDL hardware description language, which will be used for simulation.

"In the past, we have always developed the hardware first and then the software, which became the pacing item," says Whalen. "Very often, the lack of software has led to the failure of technologies, or it's taken years for them to catch on. But product cycles are getting shorter, and we just don't have time to wait for the software anymore."

Unisys's John Wise

Seminar 9635, "History of Software Engineering", Schloß Dagstuhl, August 26-30, 1996

The 1968/69 NATO Software Engineering Reports

Brian Randell

The idea for the first NATO Software Engineering Conference, and in particular that of adopting the then practically unknown term ``software engineering" as its (deliberately provocative) title, I believe came originally from Professor Fritz Bauer. Similarly, if my memory serves me correctly, it was he who stressed the importance of providing a report on the conference, and who persuaded Peter Naur and me to be the editors. (I was at the time working at the IBM T.J. Watson Research Center in the U.S.A., but had got to know ``Onkel Fritz" through having been a member of the IFIP Algol Committee for several years.) As a result, it was agreed that Peter and I would stay on for an extra week after the conference in order to edit the draft report, though we arranged to move from Garmisch-Partenkirchen to Munich for this second week.

Quoting from our Report of the 1968 Conference [Naur and Randell January 1969]:

> ``The actual work on the report was a joint undertaking by several people. The large amounts of typing and other office chores, both during the conference and for a period thereafter, were done by Miss Doris Angemeyer, Miss Enid Austin, Miss Petra Dandler, Mrs Dagmar Hanisch and Miss Erika Stief. During the conference notes were taken by Larry Flanigan, Ian Hugo and Manfred Paul. Ian Hugo also operated the tape recorder. The reviewing and sorting of the passages from written contributions and the discussions was done by Larry Flanigan, Bernard Galler, David Gries, Ian Hugo, Peter Naur, Brian Randell and Gerd Sapper. The final write-up was done by Peter Naur and Brian Randell. The preparation of the final typed copy of the report was done by Miss Kirsten Anderson at Regnecentralen, Copenhagen, under the direction of Peter Naur."

As I and other participants have since testified, a tremendously excited and enthusiastic atmosphere developed at the conference. This was as participants came to realize the degree of common concern about what some were even willing to term the ``software crisis", and general agreement arose about the importance of trying to convince not just other colleagues, but also policy makers at all levels, of the seriousness of the problems that were being discussed. Thus throughout the conference there was a continued emphasis on how the conference could best be reported. Indeed, by the end of the conference Peter and I had been provided with a detailed proposed structure for the main part of the report. This was based on a logical structuring of the topics covered, rather than closely patterned on the actual way in which the conference's various parallel and plenary sessions had happened to be timetabled.

Peter and I were very pleased to have such guidance on the structuring and general contents of the report, since we both wished to create something that was truly a conference report, rather than a mere personal report on a conference that we happened to have attended. Indeed Peter argued that we should not provide any additional text at all ourselves, but rather produce the main part of the report merely by populating the agreed structure with suitable direct quotations from spoken and written conference contributions. I, however, persuaded him that brief editorial introductions and linking passages would improve the continuity and overall readability of the report. So, (together with the decision that a small selection of the written texts would also be incorporated in full as appendices), we arrived at the final form of the report.

In Munich we worked from the notes taken by the rapporteurs, which we had arranged would be keyed, as they were made, to footage numbers on the recorded tapes. The tapes were not systematically transcribed, since this process typically takes five to six times real time. Rather we used the rapporteurs' notes, and our memories, to locate particularly interesting and apposite sections of the tapes and just these were transcribed. We thus built up a large set of transcribed quotations, which we supplemented with suitable quotations from the written contributions. Then, for each section of the report, one or other of us attempted to turn the relevant set of quotations into a coherent and pseudo-verbatim account of the discussion on that topic, bringing together material from quite separate sessions when appropriate since many topics had been revisited in various parallel and plenary sections.

The work in Munich was as enjoyable as it was intense, and afforded plenty of opportunity for re-hearing some of the more memorable discussions, so that many of these became etched much more deeply into my memory, and had a stronger effect on my subsequent research, than would have been the case had I merely taken part in the conference. The report was virtually complete by the end of the week in Munich, and then Peter Naur took everything back with him to Copenhagen where a complete first draft was produced using a paper tape-controlled typewriter (I assume a flexowriter) - a technique that seemed novel at the time but one that he correctly advised us would greatly aid the preparation of an accurate final text. (My memory tells me that this draft was then circulated to participants for comments and corrections before being printed, but no mention is made of this in the report so I may be wrong.)

The actual printing and distribution was done by NATO, and the Report became available in January 1969, just three months after the conference. Copies were distributed freely on request and it rapidly achieved wide distribution and attention. One of the more delightful reactions to it from amongst the participants was that of Doug McIlroy, who described it as ``a triumph of misapplied quotation!". (It was only many years later did I learn from a short article by Mary Shaw that Al Perlis gave out copies of the report to the CMU computer science graduate students with the words ``Here, read this. It will change your life." [Shaw 1989])

Such was the success of the first conference that the organizers sought and obtained NATO sponsorship for a second conference, to be held one year later in Italy. Peter Naur, wisely, was not prepared to repeat his editorial labours, but I - rather rashly - after some initial hesitation agreed to do so, this time in co-operation with John Buxton. As I recall it, the plans for the second conference were discussed at a meeting held in an office at NATO Headquarters. My main memory is that the office was dominated by a very large and impressive safe, which to my amusement was revealed to be completely empty when our host, at the end of the meeting, opened it so as to put away the bottles from which drinks had earlier been served to us. During these preparatory discussions I provided, based on my hard-won experience at Munich, what I proudly considered to be a very well thought-out list of requirements regarding the facilities that we would need to have in Rome. (The most important of these was that the editorial team should have full time access to an Italian-speaker who would help sort out any difficulties that might arise - of this, more later.)

My initial (over)confidence was also in part due to the fact that this second time around, John and I had been offered the full time services of two experienced technical writers from ICL, namely Ian Hugo (who had been closely involved in the preparation of the first report) and Rod Ellis, and we had each arranged to be accompanied to Rome by an expert secretary, Margaret Chamberlain and Ann Laybourn, respectively. Ian, incidentally, went on to help found Infotech, a company that subsequently over a period of years organized a large number of technical conferences, each of which led to the publication of a State-of-the-Art Report, whose format closely matched that of the NATO reports.

In the event the second conference was far less harmonious and successful than the first, and our editorial task turned out to be very different. Quoting from our introduction to the Report of the 1969 Conference [Buxton and Randell April 1970]:

``The Rome conference took on a form rather different from that of the conference in Garmisch and hence the resemblance between this report and its predecessor is somewhat superficial. The role played by the editors has changed and this change deserves explanation. ... The intent of the organizers of the Rome conference was that it should be devoted to a more detailed study of the technical problems, rather than including also the managerial problems which figured so largely at Garmisch. ... The resulting conference bore little resemblence [sic] to its predecessor. The sense of urgency in the face of common problems was not so apparent as at Garmisch. Instead, a lack of communication between different sections of the participants became, in the editors' opinions at least, a dominant feature. Eventually the seriousness of this communications gap, and the realization that it was but a reflection of the situation in the real world, caused the gap itself to become a major topic of discussion. ... In view of these happenings, it is hardly surprising that the editors received no clear brief from the conference as to the structure and content of the report."

Thus the task of producing a report which was both respectable and reasonably accurate was much more difficult than I could have imagined - and was not aided by all sorts of difficulties that we suffered, almost all of which would have been much more easily dealt with if a local organizer had been provided as agreed. Nevertheless, a number of the participants expressed pleased surprise at our report, when they afterwards received a draft for checking, and evidently thought more highly of it than of the conference that it purported to document.

The conference had been held outside Rome in a rather charmless American-style hotel whose facilities and cuisine I'm sure did little to engender a harmonious atmosphere. It had been agreed beforehand that we would move to a (particular) hotel in Central Rome for the report writing - only during the conference did we discover that no attempt had yet been made to reserve accommodation at this hotel. Needless to say, the hotel turned out to be full, and so last minute arrangements had to be made, and our offices and families alerted to the change of plans.

On the Saturday morning following the conference the six of us, plus all our luggage, and a very impressive set of typewriters, tape-recorders, boxes of paper and other office supplies, etc., were transported by minibus to Central Rome to the very pleasant substitute hotel, which was situated just across from the main entrance to the Roman Forum. In fact we arrived rather too early for the hotel, since only the small suite we were to use as an editorial office was available, our bedrooms not yet having been vacated and cleaned. We thus had to accept the hotel receptionist's suggestion that we all be initially installed in this one suite until our own rooms were ready.

I still treasure the memory of our arrival, which was watched open-mouthed by the various hotel staff and guests in the lobby. This was not just because of our number and our mountain of luggage, and the small army of porters - just one of whom had a door key - that were being employed to move it. It was undoubtedly also due to the interesting appearance the six of us must have made - in particular the fact that Margaret Chamberlain was wearing an extremely short miniskirt. This fashion apparently had yet to spread from London to Rome, where it was still regarded at least by all the Italian men as quite sensational. And Rod Ellis was wearing a splendid long black leather jacket and the sort of thick-soled suede shoes that at that time were known, in Britain at least, as ``brothel-creepers". But most memorable of all was John Buxton's remark when the last of the porters had bowed himself out of our suite, and the six of us were standing around our luggage mountain wondering what to do first. He suddenly said, ``I've had a great idea. Let's phone down to the front desk and ask for two thousand foot of colour film and a stronger bed, please."

This provided a wonderful start to a week in which we managed to find continual solace in humour despite the pressure of work and the many adversities we had to face. For example, by mid week, almost all of the original typewriters and tape recorders were no longer operational, and we were threatening to abandon Rome and to move to Brussels in order to complete the work at NATO Headquarters. Even the stapler had broken. As Ian Hugo has reminded me, ``the suite had a bathroom which was surplus to requirements and the bath became the final resting ground for dead typewriters, tape recorders, etc; by the end of the week it was full to overflowing!" However we soldiered on, though in the end half of the Report had to be bravely typed by Ann Laybourn on a totally-unfamiliar German-keyboard typewriter that we had managed to borrow ourselves from the hotel.

All these adversities - whose impact would have been much less had we had the promised local assistant - in fact helped to bind us together as a team. Rod Ellis' brilliant gift for mimicry also helped by providing many welcome moments of general hilarity as, suiting his choice to the topic at hand, he switched effortlessly in conversations with us between the voices of Edsger Dijkstra, Fritz Bauer, and many of the other participants whose conference comments had been captured for posterity by our tape recorders.

We did in fact finish the report by early on the Friday evening - in good time for a final celebration dinner, once Rod and Ian had returned from the University of Rome where they had made copies of the draft report (and, rather fittingly, broken the photocopier). It was in keeping with the rest of the week, though, that nearly all the restaurant waiters in Rome chose that moment to go on strike - indeed, we saw a large procession of them march right past our windows shouting and waving banners - so that we had to content ourselves with an in fact excellent dinner in the hotel.

Something I had completely forgotten until I reread the introduction to the 1969 Report while preparing this brief account was that this second report was typeset at the University of Newcastle upon Tyne, to where I had moved from IBM in the interim. In fact some of the world's earliest work on computerized type-setting had been done at Newcastle. Quoting from the report: ``The final version of the report was prepared by the Kynock Press, using their computer type-setting system (see Cox, N.S.M and Heath, W.A.: ``The integration of the publishing process with computer manipulated data". Paper presented to the Seminar on Automated Publishing Systems, 7-13th September 1969, University of Newcastle upon Tyne, Computer Typesetting Research Project), the preliminary text processing being done using the Newcastle File Handling system ...". (However, I perhaps should also mention that this second report took three months longer to produce than its predecessor report.)

Unlike the first conference, at which it was fully accepted that the term software engineering expressed a need rather than a reality, in Rome there was already a slight tendency to talk as if the subject already existed. And it became clear during the conference that the organizers had a hidden agenda, namely that of persuading NATO to fund the setting up of an International Software Engineering Institute. However things did not go according to their plan. The discussion sessions which were meant to provide evidence of strong and extensive support for this proposal were instead marked by considerable scepticism, and led one of the participants, Tom Simpson of IBM, to write a splendid short satire on ``Masterpiece Engineering".

John and I later decided that Tom Simpson's text would provide an appropriate, albeit somewhat irreverent, set of concluding remarks to the main part of the report. However we were in the event ``persuaded" by the conference organizers to excise this text from the report. This was, I am sure, solely because of its sarcastic references to a ``Masterpiece Engineering Institute". I have always regretted that we gave in to the pressure and allowed our report to be censored in such a fashion. So, by way of atonement, I attach a copy of the text as an Appendix to this short set of reminiscences.

It was little surprise to any of the participants in the Rome conference that no attempt was made to continue the NATO conference series, but the software engineering bandwagon began to roll as many people started to use the term to describe their work, to my mind often with very little justification. Reacting to this situation, I made a particular point for many years of refusing to use the term or to be associated with any event which used it. Indeed it was not until some ten years later that I relented, by accepting an invitation to be one of the invited speakers at the International Software Engineering Conference in Munich in 1979. The other invited speakers were Barry Boehm, Wlad Turski and Edsger Dijkstra. I was asked to talk about software engineering as it was in 1968, Barry about the present state, Wlad about the future of software engineering, and Edsger about how it should develop. I had great fun in preparing my paper [Randell 1979] since I included numerous implied challenges to Barry, whose talk was scheduled immediately after mine, to justify claims about progress since 1968. He studiously ignored all these challenges, or perhaps failed to recognize them, I'm sorry to say.

In my 1979 attempt at describing the 1968/9 scene I did not feel it appropriate to dwell on my experiences in helping to edit the two NATO Reports - so I am very pleased to have had cause to complete my personal software engineering reminiscences, so-to-speak. I thank the organizers of this conference for giving me this opportunity and, in particular, a belated means for me to publish the text that was so sadly censored from the Report of the 1969 Conference.

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REPORT

Inter-American Computing Symposium

Mexico City, November 16, 1970

The one-day discussion group convened at the headquarters of ILACIC, the Instituto Latino Americano de Ciencias de la Informacion y la Computacion. Appendix A of this report lists the attendees, and Appendix B shows the agenda. The first order of business was to arrange the agenda topics in priority order for the day's discussion.

Herb Bright suggested that agenda item 7 was really part of item 1 (that is, languages in general).

Item 9 (trends in Latin America) was the most popular item. Prof. Beltrán summarized the current situation. The largest user in all Latin American countries is the government; the figure is 72% in Mexico. The largest machines are those controlled directly by the government, or by state-owned companies. In Mexico, large machines include the following:

3 CDC 6400
360/65
B6500
6 360/50
2 B5500

Columbia has a 360/65. Most of the machines in Central America are of the 1401 class; they total perhaps 40 or 50 machines. Argentina has a GE625. Brazil has some large machine installations in banks. Chile has a governmental authority responsible for computation.

The overall trend is to advance from the clerical uses of computers to broader use, related to control and development of economies. The key lies in the word "planning." In terms of hardware, due to the economics of the situation, the trend is to many small machines rather than few large machines. Only recently have the Latin American countries begun to use communications links between computing installations. In Mexico, there is a definite trend toward the use of remote terminals attached to large machines.

The introduction of computers for any specific application is usually difficult. For example, a proposal to computerize the election procedures was rejected on the grounds that some 50,000 election officials and clerks would be displaced. On the other hand, the large-scale enterprises (Pemex, Social Security, and the Ministry of Finance) have demonstrated great gains from the introduction of computers. The larger users have tended toward centralization; private companies would tend more toward decentralization.

They are trying to profit from the mistakes made in the U.S. "Simply copying the history of computing in the U.S. would be bad."

In Mexico and one or two other countries, the universities have led the way to computerization. Generally, this is not true.

The question (No. 4) of overproducing programmers is of no interest in Latin America; they are short of programmers of all types.

The trend of popular opinion against computers which has appeared in the U.S. is not evident in Mexico; quite the contrary.

Frank Wagner posed this question: If you had a clear-cut application that would probably increase productivity and create employment, then which of the three functions -- hardware acquisition, systems analysis, and programming -- would be the biggest bottleneck? Sr. Vargas voted immediately for systems analysis. But he pointed out that there is a fourth bottleneck, namely, the opposition by union groups to new applications. Dr. Pedro Solís and Sr. Roberto Bermúdez reinforced the opinion that the greatest shortage in Mexico is of systems analysts. The feedback loop between the users and the schools seems to be lacking (as exists in the U.S. with the professional organizations and the users groups). Another alleviating factor in the U.S. is the existence of applications packages. Frank Wagner cited the experience of insurance companies, who could proceed rapidly because of the 360 insurance packages. In Latin America, such packages have not caught on.

Bob Bemer suggested having one of the big conferences (Spring Joint, for example) held in Mexico. Prof. Beltrán pointed out that the papers at such conferences do not deal with the fundamental concepts that they need. Herb Bright noted that successful implementation tends to come with the second version (that is, after one conversion).

Prof. Halstead referred to the efforts of ACM to define a computing science curriculum (not that any college actually follows the plan, but it does furnish guidelines). Dan McCracken said that the ACM plan seems to be aimed at those who will become compiler writers, and that that would not be the way to go in the developing countries. Frank Wagner recommended having computing students spend two years on case studies as the best way of creating people who think the way industry wants them to think. George Glaser cited the work of Dan Teichrow's committee in ACM as a step in the right direction, although their work has not yet been reported in the journals.

Clarence Poland stated that the usual U.S. experience is that there is no school to which you can send your people to upgrade them from programmer to systems analyst, and that most companies conclude that you have to do it in-house. "It is not yet a teachable subject, I'm afraid."

Item 9: should Mexico construct its own hardware and software, or should it send its money north? Several people had stated categorically that Mexico should buy what it needs and not try to compete.

Sullivan Campbell recommended that sub-assemblies and final assemblies might well be done in Mexico.

Is it healthy, world-wide, to have a few countries producing the capital goods (and Prof. Beltrán rates computers as capital goods, as opposed to consumer goods) for all the others? There is an analogy to the situation in the U.S. between the universities and the computer manufacturers; everyone agrees that the universities should not build their own computers. But that is where a parallel active industry already exists. In Mexico, the situation is quite different. Advanced electronic devices (integrated circuits) are produced in Mexico, by firms that are branches of U.S. firms, and that are taking advantage of the lower labor costs. If Mexico can anticipate using 80 to 100 new, medium-scale machines in the next 5 years, it might make good sense to plan now to build them, and import only the large-scale machines. The problem has sociological, political, and economic facets. The rationale for the creation of a new industry is different in the developing countries.

Paul Armer noted that the cost of the CPU itself is only a small portion of the total cost of a new system; that it should be possible to build on what has already been done well.

Campbell stated that the key to success in manufacture is automation plus low-cost labor, both of which exist already in Mexico.

Amdahl gave it as his opinion that even if the total cost were higher (to produce a computing system in Mexico as opposed to buying a U.S. system), all the money involved stays within Mexico, and hence would operate to improve the economy of the country. He laid out a plan as follows. Start by producing under license, essentially copies. Build up a manufacturing base, where skilled labor dominates over technological knowledge. Gradually take over larger and larger portions of the manufacturing process. An entry by the state into computer production might be entirely feasible.

According to Campbell, Mexico could get machinery into production just about as fast as it could be done in the states.

Sergio pointed out that 30 years ago it was flatly stated that it made no sense to try to assemble automobiles in Mexico. Today they have many assembly plants; the idea works. The same idea for computers (controlled and possibly subsidized by the government) might also work. Cars are now made in many countries. McCracken asked if they made their own cameras in Mexico, too.

Jose Guerra: Not every country can produce every needed product. On the other hand, no country has a monopoly on know-how and people, and each country can make what it needs, if it is economically efficient to do so. Is it worthwhile to produce something internally, if it costs three times as much?

Poland: The question is not one that can be expressed as a yes/no choice in 25 words or less. It is a complex decision, made up of thousands of smaller decisions, each of which must be decided at the right time, box by box, component by component. The real key is to establish a decision structure.

van Norton: Nor can the decision (or decisions) be made for all countries in the same way. It may be, as Campbell said, that the time is ripe for Mexico, but it may not be right for a country that has electricity for only two hours a day.

Wagner: What is probably needed, then, for a country like Mexico, is a master plan - a policy dictated from the top - that would be good for 25 years or so. For example, it might be part of such a policy that nothing should be done for which a systems analyst can see that implementation calls for creation of a computing system that differs significantly from what is in current use in the rest of the world.

Bright: Amdahl outlined a plan that has profound implications; it also poses profound difficulties. I think the Mexican community should make a serious study of why applications packages have failed in Mexico. Such packages offer tried-and-true software, ready-made. Perhaps they do not transfer directly to the needs of Mexican business and government, but the principle is still good.

White: If the real shortage here is systems analysts, that almost implies a surplus of hardware. It takes as long to develop a good systems analyst as a good hardware designer. For long-range goals, it then becomes necessary to plan how to allocate your available resources. We accept, almost as a truism, that hardware is useless without an equal expenditure of time and effort on the systems software. I think it follows that if you plan to create hardware, then you should concentrate first on creating a pool of thoroughly competent software people. Further, you should plan that the software you design must be designed to be non-fatal if it fails.

Armer: I think it takes a lot longer to train a hardware designer than a systems analyst or a systems programmer.

White: If so, that only strengthens my argument.

Wagner: They are radically different breeds of people, that's all.

Gruenberger: Suppose the answer to the main question is "yes." Suppose Mexico did develop an industry -- hardware, software, peripherals, systems, and packages -- and it flourished and became quite large. Then, what advice would you give to Brazil?

Poland: The same as we are outlining here. Do not plunge into a grand scheme all at once, including a Portugese version of PL/I (which would then be PL/dos), but develop a policy first, and a mechanism for making each decision within that policy. Through all this, everyone should keep in mind the NIH (Not Invented Here) syndrome. Anyone can look at a finished system and say "I could do that better", and he probably could. But it would be a terrible waste of resources, and should be avoided.

Bemer: Note also the Japanese experience, where to develop a computer industry they built a consortium and ran into lots of political problems.

Prof. Beltrán: You have all talked as though Mexico should develop an indigenous computer industry. We didn't reinvent the automobile here; we only forced manufacturers to set up plants here, and to integrate within ten years to the point where the car is produced 100% here. We must be careful also to differentiate between production costs and sales costs, for any product.

Jose Guerra: For the right product at the right time, production in Latin Americancan be competitive at world prices, without question. Polyester is made in Mexico, and exported to world markets. Some peripherals are made in Brazil, which are similarly marketed.

Wagner: I assume that an auto made in Mexico appears to the user exactly like a car made anywhere else. There is a danger that with computers, the end product -- hardware and software -- may look different to the user.

Gruenberger: We move to item 5 on our agenda. Can we conclude (assuming that the facts are facts, and not quibbling over what is "new" about the 360 design) that we are at a permanent plateau, and nothing new will develop?

The consensus was that the agenda item was badly stated -- that one has to define carefully what constitutes "new" -- that while there may be no new technical gimmicks, the applications are surely new -- that the whole subject is dull anyway. So we went on to the subject of languages, which subsumes items 7 and 8 and part of 10 of our agenda.

Bright: What language/machine combinations have given us, it seems to me, is a demonstration that problems can be broken down, analyzed, and solved. I see an analogy with the calculus: any expression can be differentiated, but not every expression can be integrated. The whole question of computer languages reduces to improved capability of stating problems in a form in which they can be analyzed. Much as we may regard it as ugly, COBOL did provide a new data description capability that allowed solution of heretofore difficult problems. Much of the software development of the past decade has been toward this end: to make problem solutions possible that are difficult in the normal sequential mode of operation, which is the only computer we have. What languages do is bridge the gap between the parallel world of problems and the serial world of our computers.

Bernstein: The experience of mathematics shows that it is frequently expedient to devise new notation to allow for manipulation of ideas. Our current programming languages are notoriously poor at this.

Gruenberger: One of the points we are considering is that of the 1000 or so languages in existence there are five leaders, and it is argued that we might do better with just one, and then, which one?

Bernstein: But mathematics doesn't have just one language. It has a basic body of notation, and then about 70 languages which are not necessarily transferable among each other.

Gruenberger: And the analogy might not hold, either.

Halstead: You can write a derivation in algebra and have it read and corrected by mathematicians anywhere in the world. But if you write a program in, say, Algol, you wait for someone to certify it; it is not apparent by reading it that it works. This indicates to me that we do not yet have a good language. Current work is toward "algebracizing" languages, and this seems to me to be fruitful work. At present there is no way to examine a computer program and validate it, except by running it, and applying validating techniques to the end results. As a result, we frequently look like fools, and always on national TV.

Bemer: The problem is simpler than all that. If you can move it around and operate on it without knowing the content, then it's data. If you have to perform some transformation that has meaning, then it's information. The problem with our programming languages is that they are hodgepodges of these two different pieces. There is no good reason why there should be more than one data movement language. Where we do need different languages is where we need to perform transformations on information.

Halstead: The number of GO TO's in a program is inversely related to the talent of the programmer. Languages that allow GO TO's have something in them that prevents proving that one is equivalent to another. We can't show that we couldn't have a language that did not have GO TO statements.

Poland: Our chief worry should be how to create mechanisms that will allow doctors to be better doctors; to make managers better at managing; to make engineers better engineers; to let accountants do their work better -- all with computers.

Wagner: But for all these people, if they had a language they could understand, they could more rapidly discern what the computer could do for them. I have noticed, during the recent growth of file management languages, that business system analysts (who may be weak in computing) quickly grasp the distinction between what can be done, what can't be done, and what can be done awkwardly, when they deal primarily with the specialized language that was created for their needs. Now, regarding the language provability that Halstead spoke of, it seems to me we had that long ago, in one form, in the Report Program Generators that started with 9-PAC. You could take a picture of a report and ask whether any given RPG would produce precisely that report, and get a yes-no answer.

Bemer: I want to make a clear distinction between problem-oriented languages (which are great for doctors, lawyers, and Indian chiefs) and the procedure-oriented languages which we must have as a tool in order to make the others. The present procedure-oriented languages are all cluttered up, and in many installations several of them operate at once, in opposition to each other.

Halstead: One hope might be the de-compiler concept as a device to raise our level of language to the point where they can be analyzed.

White: Can anyone write a procedure-oriented language that will do what Bemer wants? I don't think we're capable yet of specifying the problems that are involved. Even for small problems, given several languages each of which should be able to handle the problem, I don't think we can specify the problem clearly and unambiguously so that several people, each capable in one language, could all come up with the same results. We must get to that point long before we try to standardize languages.

Poland: I agree that it is difficult to define a problem well enough to transfer it out of a man's head (where it may be vague to begin with) to another man's head, or to a computer. We should exploit that fact -- that people come to computers with murky problems in their minds. We should utilize data base languages, inquiry languages, and terminals, to interact with the computer in conversational mode to explore the solution dynamically. Such a technique won't do everything (an airline reservations system must be carefully planned), of course.

Bright: What you are describing is what the systems analysts (that our Latin-American friends tell us constitute the bottleneck) ought to be learning; namely, how to translate real world problems into the artificial world of the computer.

van Norton: The solution is simple: use the language of the Lambda calculus. Isn't there conceivably a philosophy that would let us proceed in an orderly manner, rather than in our traditional manner of repeating the same mistakes endlessly? Perhaps we're trapped, but I can't believe that the problem is insolvable. Maybe we're looking for the philosopher's stone, but in this area someone should be doing just that.

Wagner: And that <u>is</u> the function of the university.

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Bemer: I've been involved in standards efforts for a long time. Either you can get agreement on a tiny area (that then has little effect), or you can wait for agreement on large areas, and when you get it, it's obsolete. I propose, in place of what has been done up to now, a system of registering standards, to provide a kernel of agreement. You could also register a minimum number of variations. For example, when you read the magnetic label on a disk pack and it says,,"This is Type 4 format," you could look it up somewhere and conclude that you could read the stored information properly. The present American Standards Institute doesn't object to this idea; they just don't understand it, and continue going the old way; they're sort of wishy-washy.

Bernstein: Just what should be registered as standards in your Plan?

Bemer: Plans should be made for long-term goals. Interchange codes -- all of them -- should be registered. In fact, "when in doubt, register" should be the key to the plan. As soon as a registry number is assigned to EBCDIC, then IBM will move to establish one standard for EBCDIC, because it is then in their own best interest to do so.

Bernstein: How about languages? Should they be registered?

Bemer: Sure. If there are several PL/I's, each of them can be registered.

Bernstein: I always understood the objective of standards work was to cut down the number of variations that could exist and gain currency. It seems to me that this registration procedure would defeat that.

Bemer: You would have to demonstrate a level of usage before the registering agency would assign you a number. The work would be done by the same people, but with a different viewpoint. The registration procedure would be one of petition, essentially. It's a scheme to strike a balance between general agreement, which is impossible, apparently, and general anarchy. The principle should apply to <u>parts</u> of languages, as well as complete languages. (But notice, if there is anything that we <u>can</u> standardize on, that can still be done too.) As things stand today, I believe that even within IBM there is no standard for EBCDIC.

There is a high level of standard that must be established first. For example, if the first record on a disk pack identifies the complete format of the pack, then that record must be standardized. This should be done by the central agency, and I'm sorry to say that little has been done on this matter.

I am getting support for this notion. There is already an agency for registering code standards. For file structures, data languages, file formats, and the like, there is no mechanism now. Anyone who grabs the ball can become the registering agency.

White: But the world has changed since standards efforts began. Today we have volumes of information that we want not to be disseminated.

Bemer: But we must differentiate between data that we want to keep private (and this can be done by law, by contract, by scrambling, and other means), and information that we want to have distributed and now can't.

Bernstein: We have defined standards for a COBOL, a FORTRAN, and (coming up soon), a JOVIAL, and a PL/I. What we lack is any procedure for verifying that any given implementation of one of those languages confirms to the established standard.

Bemer: There are some test programs that do a large part of that. Such a program is run, for example, on a CDC 6400 COBOL, and the results are given, as well as a list of the features that were used. This provides a way to certify, to some extent, a new COBOL on another machine.

Bernstein: But that turns it around the other way. I want something corresponding to the ASA rating of film, which is independent of what camera is used.

Poland: Be careful to distinguish between a standard and certification. The ASA standard on your film does not mean that the film is certified to adhere to that standard. It is a point of departure, and a good one, but that's all.

Bemer: And there are standards and standards. For example, we've had flowcharting standards for seven years, but last June I heard of a DPMA group that was setting out to do it all over again. If a standard isn't properly promulgated, it's fairly useless. To my knowledge, the French are the only ones who go about distributing standards systematically.

Poland: Discussions on standards usually degenerate sooner or later. Recall that one of the reasons given for standardizing character code sets was to conserve computer time in translation; this was a stupid reason. It sometimes makes me wonder whether we should try to standardize at all.

Wagner: But in order to be able to transmit information over telephone lines, it is vital to have standard codes in order to have line control.

Bernstein: So it goes back to what Bemer said; namely, you standardize on the thing that's important // not the character codes, but the function codes.

Bright: I'll give you a trivial example of why this is necessary. If the characters include one for carriage return and line feed, it will be tough to separate those functions, if you need to, without decoding the intent of the programmer.

Gruenberger: So what shall we do? We could write a letter to some international body. As a matter of fact, we have a representative of an international body right here, in Mr. Zemanek.

Poland: Our discussion has been between people who are professional standards types, and those who seem to hate standards efforts. I'd like to hear from those who have been silent. Are standards of any interest to those in Latin America?

Beltrán: What we need to have standardized are basic things, like the services we get from manufacturers. This includes basic systems software, and customer assistance, both in software and machine service. On the higher level, such as languages, we seek more orderly development, rather than standardization as such; we are in the same position as you are. I think we need guidelines, rather than standards.

White: Yes, that's the key. You want to be able to label something, "This is standard Fortran, except..."

Bernstein: The only use I've seen for standards in languages is in going out to buy a compiler, when you can say that you want "Fortran IV, ANSI standard" and you have then given the complete specs.

Bemer: And you'd then get 33 different compilers from 33 vendors, since the standard isn't sufficient.

Where we are making progress is in interface standards for peripherals; that work is going ahead. The weak area here is at the device level, for controllers and similar devices.

Another weak area lies in the lack of distribution of the working papers that lead up to new standards. There should be, for example, a repository in Mexico for all such working papers.

Bright: In the work I have participated in, it has appalled me how much effort is misdirected, inefficient, and wasted. Since what comes out of these efforts affects everyone, it would seem only fair that the people who are affected should have some voice in the work; I think that this applies particularly to Mexico. I can't see how having access to working papers is going to help much.

Gruenberger: I'm going to divert us over to topic 6 (professionalism and licensing), for which I have prepared a position paper (appendix C). My position is that it would be difficult, if not impossible, to establish a certified professional license of any kind in computing, at least at this time.

Andree: DPMA has two such...

Gruenberger: Which adds to my argument.

Wagner: With the exception of the clergy, all the listed professions are controlled or licensed by the state. Every state has a category of registered professional engineer, which certifies to some degree that the holder is not a charlatan, for which the holder agrees not to act like a charlatan, and if he does, the state can withdraw the piece of paper.

Vargas: In Mexico, as soon as there are 100 people with a common body of knowledge, they can ask the government to set up a college, which then has the authority to grant the title relating to their area of competence. From then on, anyone using the title illegally can be sued.

Beltrán: This will take place in computing as soon as there are 100 people who have earned a baccalaureate degree in computing and who undertake to set up the college.

McCracken: One of the reasons why it won't work (in the U.S.) is that if you could devise an adequate test, most of those in the field couldn't pass it -- which is precisely why you need it.

Bernstein: Not every accountant is a CPA; only those who have to certify public documents. Similarly, not every programmer need be certified.

Bright: I'm not sure I know what licensing or certification accomplishes. Consider two facts. (1) In order to become a licensed engineer in California, I had to do extensive studying on locomotive design. (2) In my company, the only two people I have had to fire for incompetence were both holders of the DPMA certificate. They were graduates of large universities, so they weren't completely incompetent, but they were not competent in computing technology.

Gruenberger: But notice, Herb, that you invoked, in your argument, a well-recognized certification procedure; namely, the university degree.

Wagner: For the two men you fired, all you can say is that they didn't come up to <u>your</u> standards. They may well have exceeded the DPMA"s standards.

McCracken: But the Mexican precedent that we just heard about doesn't involve an examination at all.

Amdahl: Let's extend this notion to hardware. The best logic designer I've ever known didn't have a college degree.

McCracken: You could postulate the world's greatest expert on broken bones who doesn't have a medical degree, but most of us prefer to go to a man who has that degree.

Bernstein: It's a question of liability. How much damage can a programmer do?

McCracken: He can cause the wings to fall off of airplanes.

Wagner: If there were a qualifying exam for logic designers, I suspect that Amdahl's man could find a way to meet the requirements, possibly by substituting years of experience for the degree.

Poland: The analogy with other professions, particularly medicine, breaks down in one significant aspect. Computer people, on the whole, are employed by large corporations, so that each individual represents only an increment of skill and knowledge. It's just the other way with a doctor, and with him I need protection against the quack or charlatan.

Moreover, the use of computers almost never exists for itself; it exists to aid something else, like medicine or engineering. I question the need of trying to make computing a profession at all.

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Bemer: There is a search on for someone to head up part of the Safeguard system of the ABM to certify the design, implementation, costing, tes testing, and simulation of the system. This seems to be a good opportunity for the computing fraternity to put its reputation on the line, rather than to stay aloof and say that the system will or won't work. What should the profession do to insure that the job is done right?

Bernstein: Is there a profession? And, if so, should it be involved in things that could be called political?

Campbell: To me, the problem is largely one of economics, and we have agreed that we are not economic experts.

Bemer: Well, it wasn't put to me as an economic problem.

McCracken: It's one of the three parts of the Safeguard system command, with the responsibility of evaluating the Safeguard system, including its computer components. They're looking for a manager. They are not committed to an endorsement of the system, and they will not be asked to rule on the economic, military, or political aspects of the system. The job pays $30,000. It calls for a technical evaluation, and it seems to me that such an evaluation should be made by good people.

van Norton: It sounds to me similar to the guy who took the gauleiter's job because if he didn't, a worse person would have.

Beltrán: I will comment here, but speaking only for myself personally. I have always had strong views about using computers for non-constructive purposes. While serving as director of the university computing center, I turned down proposals for projects initiated by our Ministry of Defense. In the U.S., you have problems that are much more complex, and many computer people are involved, directly or indirectly, in projects relating to the military. This problem does not come up in Mexico.

I realize that the ABM system is largely defensive, and that we in Mexico cannot divorce ourselves from world events, but I think it is bad that computer people get involved in deleterious applications.

Bemer: I don't think that what we're talking about involves politics. If it can be demonstrated that the ABM system will work as it is supposed to, that would be good to know. If it can be demonstrated that it won't work, then that should be known. In either case, we're ahead of the present situation, where congressmen make assertions about the system with no real basis for making them.

McCracken: And the congressmen put it bluntly: they say that technical experts will find technical reasons for supporting opinions that they form on other grounds.

Bernstein: I can't see this as a problem for the "profession." You can't expect to find a man who is completely objective, so you'll always have to filter his conclusions through his bias. What's more, you could never expect the "profession" as a group to agree on any one man. It remains a matter of individual conscience. "Would I take the job? Would I do it honestly, competently, and objectively?" -- those are the questions.

McCracken: One of the marks of a professional is that he assumes responsibility for the end results. Then one of the tasks of a profession is to promote that sense of responsibility. I think we can take the appeal that came to Bemer (and to me) as an appeal to each of us personally, to find a way to help this agency implement a task that is very important. Unfortunately, this subject seems to arouse much emotion.

Poland: Try a situation that is less emotional. Many large-scale systems have been installed and have failed. There, too, it would have been nice to have had someone to turn to who could evaluate the entire system before too much money was committed.

Wagner: It is a black mark against our profession (or our industry, if you prefer) that we have not come up with recognized experts, consultants, or consulting groups who could evaluate large systems and who would be recognized as experts by the public (who needs the protection).

McCracken: In the case of the ABM, a group was set up, of which Amdahl is a member, to give advice on the computing aspects of the problem.

Wagner: And that's the black mark against our profession: the group was set up. We have no body of reputable groups that could have been engaged to render an opinion that would be respected. Instead we have an ad hoc committee, which automatically raises the suspicion that they may have been picked to support the "right" view.

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Glaser: I see a growing disillusionment among computer users, particularly businessmen, with the product of our labors. It seems immaterial whether it's due to poor programming, or poor systems analysis, or poor problem definition. I see this as a major problem to our industry, and I see no way to alleviate it, other than simply wearing people down, in order to lower their expectations.

van Norton: The keyword is "product acceptance." Your company (McKinsey & Co.) has been helpful, in its brochures, in educating the potential user. There is a large area of resentment which leads people, consciously or unconsciously, to sabotage the introduction of even relatively simple systems. It reduces, as always, to an education problem.

Bernstein: Maybe the solution is to deliver more acceptable systems (though I don't know how we achieve that), and then do the education in a sneaky fashion, by making the product so delightful to use that no one would think of doing anything else. The real place to concentrate education is among computer people.

Wagner: Even if we can demonstrate clear cases of unethical conduct -- or outright quackery-- we have no mechanism for disbarment, much less a place even to register a complaint.

Glaser: We have in today's paper, an article quoting Marvin Minsky, predicting genius level for computer programs within 5 to 8 years.

Wagner: If Minsky ran the risk of having his certificate lifted, he'd be more careful in what he says.

Armer: But he believes it.

Wagner: We've just been through another national election, with the usual number of debacles blamed on computers. As I see it, the places, like Los Angeles, that had a debacle earlier, had rather smooth elections this time. All the new debacles were first-time places. Yet, we saw no articles in the press about the ones that ran smoothly. I think this typifies a real problem: our industry's public relations are in sad shape.

White: We might improve things generally if we wrote more penalty clauses into our contracts; that is, if we backed up our own claims for good performance.

Bright: We can trace a line of reasoning from previous comments that leads me to propose a formal resolution for this group; namely, that we do not have a profession at the present time. We might consider the parallel in the medical field, which went from a bad situation to a licensed profession in about 20 years.

McCracken: Let me reword it as follows: In the absence of a mechanism for throwing out charlatans, we should not claim to be a profession.

Bright: Let me add that there cannot be a profession until there is a solid body of knowledge and a means of measuring it.

Glaser: We should state that we consider it desirable to achieve that status, and that measures be instituted to get there. This implies that we know what professionalism entails. There is a motion coming before ACM this week, proposing a code of ethics and some enforcing mechanism (which amounts to little more than threatening to take away ACM membership).

Appendix A

Foreign Participants

Prof. Fred Gruenberger, Chairman, San Fernando Valley State College

Dr. Gene Amdahl, Amdahl Corporation
Prof. Richard Andree, University of Oklahoma
Mr. Paul Armer, Harvard University
Mr. Robert Bemer, General Electric Co.
Mr. Mort Bernstein, System Development Corp.
Mr. Herbert Bright, Computation Planning, Inc.
Dr. Sullivan Campbell, Graphic Sciences, Inc.
Mr. George Glaser, McKinsey & Co.
Prof. Maurice Halstead, Purdue University
Mr. Daniel McCracken, Writer
Mr. Clarence Poland, IBM
Prof. Roger van Norton, University of Arizona
Mr. Francis V. Wagner, Informatics Inc.
Mr. Robert White, Informatics Inc.
Sr. Jose Guerra, IBM World Trade, Montevideo
Dr. Heinz Zemanek, IFIP, Austria

Mexico

Prof. Sergio Beltrán, ILACIC

Sergio Alcarez
Sergio Beltrán, Jr.
Ulises Beltrán
Roberto Bermúdez
Dr. Pedro Solís Cámara
Raúl Camargo
J. M. Copeland
Lauro Cuevas
Guillermo Encinos
Sigfrido Hurtado
José Luis Peña
Enrique Prasnyski
Sr. Ramirez
J. A. Sánchez
Miguel Vargas

Appendix B

AGENDA

1. What are the broad problems facing the computing community? Simply listing the problems and then ordering them may provide insight into how the industry's human resources should be allocated.

2. What are the trends in Latin America? What size machines are being used? In what areas is computing south of the border ahead of the U.S.? Are there problem areas listed in (1) above that are of special importance to the Spanish-speaking countries?

3. Is the output of trained people from the colleges improving in quality? What should be done to improve things more?

4. Have we overproduced programmers? If so (and we are still grinding them out), what should be done to slow down production?

5. Except for the design of the 360, there have been no new ideas worth noting (according to Ken Powell) since 1957. Does this imply that there won't be any more -- that computing is now established and stable -- or does it mean that we're overdue for some new ideas?

6. The State of California has conducted hearings on the licensing of computer professionals. Is this a good idea?

7. PL/I has been around now for some six years, and is still making little headway. How can this be explained?

8. What do people do with COBOL? There are several good packaged file management systems now available (e.g., the MARK IV system of Informatics) which do everything that one needs to do with files. What inhibits the spread of such tools? Putting it another way, what keeps COBOL alive?

9. Should the developing countries establish their own hardware industry (both main frames and peripherals), or should they use foreign hardware and devote their resources to application and software development? Can we summarize the advantages and disadvantages?

10. The standardization problem is not being solved. What can and should be done, nationally and internationally?

Appendix C

COMPUTING AND PROFESSIONALISM

* We have accepted professions that can be taken as models: law, medicine, the clergy, engineers, CPA's.

* Each of these professions has standards that are promulgated and accepted; there are avenues to acquiring the accepted body of knowledge; they are licensed by the state; there are procedures for lifting the license; they have codes of ethics; misuse of the license is grounds for civil and criminal action. Those who qualify and are licensed are given a mantle of authority, a seal of quality, privileged communication (for lawyers), a license to kill (for doctors) -- in return for which the user accepts a level of responsibility. Can these things be made to fit computer people?

* How do we establish what constitutes quality computing?

* What mechanism could be set up by the state to license, examine, qualify,and disbar people?

* Thus, even if it might be desirable to have something called a Certified Public Computing Professional, is it feasible to set up the machinery to do it, in the same sense as it has been done for the professions listed above?

SOME NOTES ON THE HISTORY OF ALGOL

W.L. van der Poel *)

This lecture can only be an anecdotic approach to the history of ALGOL. Its full treatment possibly warrants a longer story than can be given in one hour. Furthermore this lecture is not purely meant as a scientific effort to treat the history of ALGOL but as an attempt to lift the veil of what has happened in the Working Group 2.1 on ALGOL of the International Federation for Information Processing and for this occasion especially to talk about the rôle Van Wijngaarden has played in this group.

Let me first recall some of the basic facts of the early history of ALGOL. I shall not go into the period before 1962 when the ALGOL movement was purely an undertaking of a more or less well defined group of individuals. This resulted in the Report on the Algorithmic Language ALGOL 60 [1], written by 13 people under the editorship of Peter Naur. Shortly after its publication it became clear that there still were some gross errors left in addition to many more subtle ambiguities. In 1962 the original authors accepted that any collective responsibility which they might have with respect to the development, specification, and refinement of the ALGOL language would be transferred to a newly formed Working Group, installed by the Technical Committee 2 of IFIP. The result of this meeting was also the issue of a Revised Report on the Algorithmic Language ALGOL 60 (Ed. P. Naur) [2]. But all this can be read much better in the introduction to the Revised Report.

The Rome meeting did not count as a meeting of WG 2.1. This started in August, 1962 in Munich. After this a long and sometimes irregular series of meetings was held:

Sept. 1963 in Delft, The Netherlands. March 1964 in Tutzing, Germany. Sept. 1964 in Baden, Austria in conjunction with a working conference on Formal Language Description Languages. May 1965 in Princeton, U.S.A. .

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Oct. 1965 in St. Pierre de Chartreuse near Grenoble, France. Oct. 1966 in Warsaw, Poland. May 1967 in Zandvoort, The Netherlands. June 1968 in Tirrenia near Pisa, Italy. August 1968 in North Berwick, Great Britain. December 1968 in Munich, Germany. Here the circle was closed and the Report on the Algorithmic Language ALGOL 68 was accepted for publication. After this further meetings have been held in Sept. 1969 in Banff, Canada. July 1970 in Habay-la-Neuve, Belgium. March 1971 in Manchester, Great Britain and the last one in August 1971 in Novosibirsk, USSR. Furthermore there was an informal but important meeting of a few people in spring 1966 in Kootwijk, The Netherlands.

The period from 1962 to 1965 was devoted to defining a subset for ALGOL 60 and for defining some basic Input/Output procedures for ALGOL 60. Although I know that some people do not agree, this period is in my own opinion not the most glorious period of the Working Group. It was more a kind of cleaning up of previous things and getting acquainted with our way of working. This period has been covered mainly in the form of 194 quotations from letters collected by R.W. Bemer, A Politico-Social History of ALGOL [3]. Although Bemer has given an outside view on the inner workings of WG 2.1 and that period certainly merits the view of an insider, I shall not dwell any longer before 1965.

The meeting in 1965 was some kind of turning point in the actions of the WG. We had our hands freed from ALGOL 60 and we could think on a new ALGOL. As we did not know under which year the new ALGOL would appear it was informally termed ALGOL X. This was going to be the short term goal. Possibly another more extended language could result later, which very unofficially was termed ALGOL Y. Randell gave the following definition:

> ALGOL X is a language which could be described, if necessary, in such a way that entities comprising the text of a program are completely distinct from the entities whose significance can be changed by the program. ALGOL Y is a name for a suggested successor to ALGOL X in which this distinction may well be removed.

Some individuals could perhaps have had another understanding of X and Y but the Randell definition has always been adhered to in the WG.

This Princeton meeting was a kind of churn of ideas. Many new ideas were brought in and a lot of scattered ground work was done in subcommittees. Only one complete proposal of a language was on the table, i.e. EULER of N. Wirth [4]. In skimming through the papers I see the case clause emerging, I see fundamental proposals on operators, on the parameter mechanism, on basic concepts etc. But the chaotic state of affairs can perhaps be seen from a remark I made as chairman at that time:

> I am appalled at the lack of decisiveness of the committee. Having been present at the subcommittee meeting and previewing its report, there was a remarkable lack of decisions. Discussions centered around [many details followed here on small points only]. It seems to me that taking the restricted view is putting the clock backward and we revert to an efficient FORTRAN kind of computer. Even PL/I goes further. We must seriously ask ourselves: what do we want to accomplish? Where are we going? Do we want to compete with PL/I or do we really want to make a breakthrough by providing something more powerful and better defined than before. We have a few excellent reports on the table and what we do is losing our time on a number of small, perhaps incompatible issues of which it is not even known whether they can be combined. We must seriously consider our course of action and I would recommend that we will adopt one complete proposal as the guiding principle and then try to fit in a number of details which are missing or which have not yet been considered. When we go on with fighting over details first and when the main lines of the issue of ALGOL X are not fixed in principle, then ALGOL X will always, like the camel, be a horse designed by a committee.

Between our discussions of serious matters we were very well aware of our sometimes silly behaviour as was jocularly expressed in "working rules" by P.Z. Ingerman in the following way:

1) Whenever a point shows a danger of being clear, it shall be referred to a committee.
2) A subcommittee shall prepare two or more contradictory clarifications of the point referred to it.
3) These clarifications shall be reported by the individual members of the committee, no committee report having been achievable.

4) The clarifications shall be discussed until one of them is in danger of being understood, at which point return to 1).

There was always some time devoted to discussion of ALGOL Y. As source of inspiration two articles of Van Wijngaarden were used. One was called Generalised Algol [5] and delivered at the Rome conference, the other was called Recursive Definition of Syntax and Semantics [6] and was given at the Baden conference. The EULER language can be considered as an outgrowth of these ideas, as Wirth was one of Van Wijngaarden's pupils in the time he spent at Berkeley. Let's recall a little discussion in Baden on ALGOL Y.

Bauer: From Tutzing we agreed provisionally that vW's generalized ALGOL approach could do what we want in AY. Can it be unified with Böhm's lambda-calculus?

Van Wijng.: I don't know. Don't know if the operations I allow myself can match.

Bauer: How close are we to agreement?

V.d. Poel: Wirth and vW. are very close.

Bauer: Shall we exclude the lambda-calculus?

Garwick: Hopefully AY will be simpler than A60. How many symbols are required to define A60?

Van Wijng.: Don't know, but all would go on one sheet of paper.

Garwick: Then you consider it practical?

Van Wijng.: Yes.

Unfortunately there exist no informal minutes from the Princeton meeting, but one important decision was taken. Everybody was invited to write his approximation of a complete report for ALGOL X for the next meeting.

At the beginning of the St. Pierre de Chartreuse meeting we saw three volunteers who had done their job: the first was by Van Wijngaarden, Orthogonal design and description of a formal language [7]. Premature and preliminary edition, intended for use by IFIP WG 2.1 only it says on its cover. As only some 30 copies of it were produced this certainly is a collectors item nowadays. The second was from Niklaus Wirth, A Proposal for a Report on a Successor of ALGOL 60 [8]. This was also produced at the Mathematical Centre as Wirth was working there for some time. The third was from

Gerhard Seegmüller, A Proposal for a basis for a report on a successor to ALGOL 60 [9].

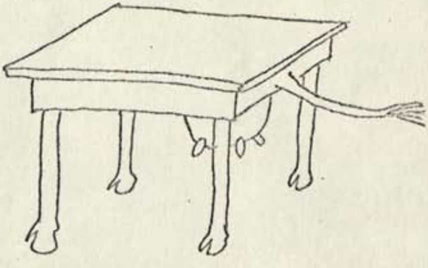
Furthermore there was an important paper on a topic called Record Handling by C.A.R. Hoare. This paper brought in many ideas on the way how to bring in the what we now call "structured values". From this report on Record Handling from Hoare I cite:

> For example the question "who is the mother of" is answered by asking the value of the reference field "mother" which is allocated for this purpose in the declaration of the record class for cows.
> In real life, most relationships are confined to holding between members of given classes; for example a house cannot be the mother of a cow, nor can a cow contain a table. ...

As a reaction to this Van Wijngaarden circulated the following rebuke around the table of which I happen to have a copy. This illustrated how a cow can contain a table and how an object can be both a cow and a table. He furthermore asks: "Can't a house be the mother of a cow if even a mountain can be the mother of a mouse?"

COMMENTS TO "RECORD HANDLING" BY C.A.R. HOARE

Page 5: Can't a cow contain a table?



Page 2: Can't an object be both a
a cow and a table?

Page 5:

Can't a house be the mother of
a cow if even a mountain can be
the mother of a mouse?

A. van Wijngaarden, 25.10.1965

This St. Pierre meeting can be considered as the true beginning of the new language. The first two formal resolutions taken at that meeting ran as follows:

1. That a subcommittee be set up, consisting of Hoare, Seegmüller, Van Wijngaarden and Wirth: the subcommittee to be charged to prepare a draft report from the existing material, mainly that which they have themselves presented, taking into consideration to the best of their knowledge and ability what the committee here has expressed as its wishes and views. The subcommittee should exist and hopefully work between this meeting and the next.
2. Whatever language is finally decided upon by WG 2.1, it will be described by Van Wijngaarden's metalinguistic techniques as specified in MR 76. [The orthogonal design etc.]

The method of description introduced in MR 76 consisted of a second level of production rules, the so-called meta rules, to produce in their turn the production rules of the language. So we recognise for example:

F sequence: F; F sequence, F.
G list : G; G list, comma symbol, G.

The meta syntactic notions are indicated here by single capital "syntactic marks". This made some of the rules terribly hard to read. As a result a request was made to make these meta syntactic notions more intelligible by using words for them. It is strange to note that in later meetings the opposite view was heard that the whole syntax description was too verbose, should be made shorter and could hot be translated in foreign languages (natural languages).

Sentences such as:

The text of the program is considered to be presented as an ordered sequence of symbols. This order will be called the lexicographic order. Typographical display features such as blank space and change to a new line do not influence this order.

can be found almost unchanged in the final Report on ALGOL 68.

At that time the Orthogonal Design made a distinction between three different kinds of minus, i.e. the "mines symbol" for the sign of signed numbers, the "minus symbol" for the monadic negation operator, and the "minuss symbol" for the dyadic subtraction operator. APL kept this distinction between the sign of a number and an operator, ALGOL 68 dropped it later out of practical reasons.

Discussion went on on many topics such as exemplified in:

Hoare: The purpose of the for statement is to single out the common cases of loops, to provide convenient notation for such cases, and to help the reader realize this. Therefore I propose that the controlled variable be invisible outside the for statement and constant inside the controlled statement, and defined as by Wirth rather than by Seegmüller.

Bauer: I prefer Seegmüller's description.

...

Van Wijng.: We should allow programmers to omit parts of the step until element where the standard use was required.

Naur and Randell objected to this as being an instance of empty options.

Bauer: We should either allow all 8 possible omissions or no omissions at all.

Alan Perlis, one of the original ALGOL 60 report authors joined us as an observer in that meeting for the last time. I include here a few of his quotations.

Perlis: There are three main categories of programming, namely scientific computation, business data processing, and symbol manipulation. These are separate at least in as much as their practitioners are separate. We should propose an ALGOL X which is satisfactory for all three fields.

Another was during discussion of parallel processing:

Perlis: Your language allows parallel execution, but does not permit accurate description of the effects of different rates of execution.

As you will see, not all wishes ventilated in the WG were taken in the final report. The same is true for the next statement:

Perlis: An implicit declaration of the controlled variable removes flexibility - for instance it cannot be other than single precision.

In general the St. Pierre meeting was a most constructive meeting. Naur introduced his notion of Environment Enquiries and also contributed a proposal for the introduction of the report, explaining its aims and purpose. Although we were always short of time and often worked during the evening time as well on subcommittees, there was a lot of fun and jokes. In my own notes I find a lot of funny jokes and quips of which I cannot always trace its author or inventor.

Would you please call a syntaxi for me?
We have forgotten to put Gargoyle on the fire!

(Gargoyle was a system writing language devised by Jan Garwick [21].) Another double bottomed saying (I think coming from Ingerman, who always was a maker of pun and fun) was:

This language fills a much needed gap.

As a sideline I find here a nice definition of artificial intelligence.

Artificial intelligence is the misusing of machines to act like human beings.

The four people designated by the committee to write a single report for the next meeting, i.e. Hoare, Seegmüller, Wirth and Van Wijngaarden actually came together between meetings in April '66 in Kootwijk Radio, Holland. At that time Barry Mailloux had joined the Mathematical Centre as a research student. Mailloux attended the Kootwijk meeting as an observer. I also could attend as an observer in my quality as chairman of WG 2.1. Very soon it became clear that the Kootwijk meeting would become a breakpoint of opinion between Hoare and Wirth on one side and Seegmüller and Van Wijngaarden on the other side. Hoare and Wirth had progressed between themselves so far in the direction of particular proposal which took the direction of the "diagonal approach" that it was very difficult to reconcile this with the "orthogonal approach". The orthogonal approach is the approach in which all possible combinations of two or more independent concepts were allowed, while the diagonal approach only would insert those possibilities in the language as were seen fit for some purpose. Such situation arose e.g. in the declaration of simple quantities as constants or as variables and in the same way declaring procedures as constants or variables. The same diagonality appears in the conformity relation, which under the diagonal approach would be made applicable only to records (as has been laid down in SIMULA 67, another offshoot of the record ideas of Hoare), but would also be applicable to other "modes" such as united modes in the orthogonal approach. Also the speed by which the different parties thought they could produce a final report was not agreed upon. Let me quote some passages from the subcommittee report.

> The other two members of the subcommittee (Hoare and Wirth) felt that their primary duty was to produce a report which WG 2.1 would have a good chance of accepting as ALGOL 66 [!], even if such a report should be inferior to one which might be accepted in the following year.
>
> ...
>
> In view of this fundamental disagreement on approach, it was agreed that Wirth and Hoare should proceed on the original plan to edit the most important of the unanimously agreed improvements into the "Contribution" and a summary of the changes is being sent to members of WG 2.1 for their consideration.
>
> ...
>
> All abbreviations in the metalanguage and metametalanguage should be replaced by full words of the English language.

The "Contribution to the development of ALGOL" by Wirth and Hoare [10] ultimately resulted in ALGOL W, developed at Stanford University [11]. This was taken out of the realm of activity of WG 2.1.

Barely before the meeting in Warsaw (which had already been postponed because of the enormous difficulties in turning out a document) a new proposal was sent around. This proposal did not yet contain any I/O procedures and had to be considered as incomplete. Nevertheless it was accepted at the meeting as the working document, commissioned from the subcommittee working in Kootwijk. Hoare supported the document if it would not be simply rubber-stamped by WG 2.1, but he withdrew from the subcommittee. Wirth on the other hand was not able to come to Warsaw. He wrote a letter in which he stated that he was not prepared to discuss the report before Van Wijngaarden had fulfilled the task taken upon him in Kootwijk. He further thought that the document should be released if and when an implementation of the language had been proved to be practically possible.

The document as it was now on the table contained the parameter mechanism with the identity declaration as it is now in the Report on A68. But many things had not been invented yet. There were no coercions, there were no definable operators yet. Let me again quote from what was said. (These quotations are partially derived from the informal minutes of the meetings, partly from my own note book. The informal minutes were not formally accepted at the meetings, but they are pretty reliable, thanks to our different secretaries, R. Utman for Princeton and before, B. Randell for St. Pierre and W. Turski from Warsaw onward.)

In the introductory discussion on the just submitted new document:

Van Wijng.: I think that the delay in producing the final version may not be very long.

We still were optimistic at that time! The parameter mechanism was explained.

McCarthy: I could propose a new notation but I think I should do it in writing. Two questions more: 1. Can we have other constructions like quaternions in the language. 2. Could we do the list processing in the language.

Van Wijng.: Yes, to both questions.

...

McCarthy: Why cannot we have overloading as defined by Hoare in the NATO Summer School Notes. I advocate it!

Van Wijng.: I do not need this concept. I can do everything without it, via an appropriate procedure. ... The procedure is a much more fundamental thing. I am against having too many specialized things.

McCarthy: So it is a matter of taste. If I put a resolution for having overloading would we vote on it, or would it upset all other things. ... Could you, or any other expert, help me to work it out.

Van Wijng.: O.K.

We now know that it actually got in between Warsaw and Zandvoort. (Overloading was a term, which was used for operators, which had to be redefined for other data types such as matrices or quaternions.)

Woodger: Stop talking about notation. Overloading should belong to ALGOL Y.

But a few minutes later the same Woodger said:

Woodger: If overloading should be in ALGOL Y, why not in X. Why do we not put a good thing into ALGOL X when we find one, other than because of the fear that all good things would be put into ALGOL X and nothing will be left for ALGOL Y.

References always were a hot topic. Wirth had struggled with them before and had declared himself against several times.

Bauer: That was the problem of conceptual economy to merge references and references to records. Was it difficult to bring them together?

Van Wijng.: I recognize them as being the same thing. It did not cause any difficulty, on the contrary, it simplified the matters.

...

Landin: What if I want to remember whether the name of the variable to which I assigned the value had a "q" in it. ... I should have a mechanism of manipulating an identifier.

Van Wijng.: Not at all - the identifier is used for identification only, it has no inherent features. If you want your language to be conscious of the identifier structure please do so, but that is not ALGOL.

...

Van Wijng.: I will tell you the history of my thoughts. In Princeton, there was no talk on records and, of course, not on references and their restriction. In Grenoble, I did not include any records into the orthogonal language because I did not feel safe on these grounds. It has been decided, however, that we should include records into the language. We were thinking how to glue these things together, and the best way we could do it was adopted. I did not change my mind, my thoughts have envolved.

In this way these meetings went on. It is really very hard to swallow new thoughts from somebody else in another frame of reference. You must first map it back to your own frame of reference before you can really digest it.

S. Moriguti was our designated representative from Japan. But Japan is far away and the Japanese wanted rather to give a different person the opportunity to go to the meeting. So we had had in the previous meetings three times another representative for Mr. Moriguti. In Warsaw we had for the first time a fourth representative, Nobuo Yoneda. But he was quite different from all others. He mastered the English language fluently and he was one of the sharpest analytical minds in our group. At the table speeches on the closing banquet it was remarked that "Yoneda was the best Moriguti we ever had". He was going to stay as a member in his own right since then.

A few more quotations from the end of the meeting:

Van Wijng.: I want to add that the document published will include I/O. ... I do not expect that future differences in documents will be very big.

Again what an unwarranted optimism!

V.d. Poel: I think the document should be published in the ALGOL Bulletin and should be submitted to as many journals as will accept it free of charge.

Randell: By the time it comes out in, say, CACM, it will be obsolete.

McCarthy: As a piece of scientific information it will not be obsolete.

When discussing some points on structured values for which of course the example <u>person</u> was always chosen, I remember the following sentence enunciated by McCarthy:

McCarthy: Persons may be said to be cartesian products of some members and their father.

Historical!

At last the following formal resolution was taken:

a) The document identified as Warsaw 2 [this was the submitted document] be amended in the manner indicated in the discussion of this document. These amendmends will include at least the incorporation of the I/O Proposal and the addition of missing sections of explanation, motivation and pragmatics.

b) This amended document is to be published as a working paper of WG 2.1 in the ALGOL Bulletin and offered for publication to other informal bulletins. This working paper is <u>not</u> to be offered to any formal or refereed journal for publication.

c) The editing committee working on this document will take into particular account those weaknesses and deficiencies, if any, discovered in the course of implementation of the language.

Van Wijngaarden was then asked to act as editor, which he accepted. The period between Warsaw and Zandvoort was rather long, too long in the opinion of some members. I have gone into the previous meetings rather in a detailed fashion, because the basic principles were laid down in these early meetings. As the day of final acceptance drew nearer, more and more time was devoted to formal and procedural discussions. But let us first look at some quotations again.

Van Wijng.: If you recall the Warsaw meeting you should remember that I agreed to write the report but under the specific condition that no time pressure will be brought to bear on us. We have incorporated two new features: the Samelson's feature and the overloading. "We" in this context means myself and Messrs. Mailloux and Peck who worked as devils.

Indeed, the complete report was now reworked. The Samelson device was the handing in of parametrizable forms, or lambda forms as they are called in other languages, as actual parameters. The coercions also were invented by that time but they were by no means leak proof yet.

The old-fashioned notation real x now was an extension, a kind of abbreviation for ref real x = loc real, although the syntactic sugar tasted a little bit less sweet in these days. So a ref could be dropped sometimes. But real pi = 3.14 could not be extended. This prompted Seegmüller to ask the following question:

Seegmüller: When we go from strict into extended language ... we drop something in one case but not in the other. Is this not slightly misleading?

Mailloux: It is very simple. You just explain to people that = is a negative reference.

...

Bauer: Why to use the term "generator" and describe its action as creation?

Van Wijng.: It is difficult to find better terms. If you could give them to us we should be happy.

Bauer: The words you use are so ambitious.

Parallelism was discussed to great extent. There were "elementary" actions defined in the report (what now are called "inseparable actions") but pressure was exerted on the editing committee to insert the P and V operations of Dijkstra as the means of synchronization. The discussion was rather inconclusive and the dangers of only giving some quotations from the full discussions are great. Nevertheless I want to quote the following:

Randell: Dijkstra says that taking a value and assigning a value are the only two elementary actions.

Mailloux: We have already agreed to give you p and v.

...

Van Wijng.: ... We shall say we are not ignorant of the problem but the state of art is such that it does not yet permit for inclusion of parallelism in ALGOL (67). But, whatever will be the outcome of the research on parallelism, the concept of elementary action and elementary symbol will be in, so let us let them in.

He was wrong in that statement. For a while the elem symbol stayed in together with the p and v operation, later called up and down operation. It was Niklaus Wirth who transmitted the message that not both concepts could stay in together, although he had left the committee as a member later. As a consequence the elem operation disappeared, but the elem symbol reappeared in a later version, now as the 'n-th element of' symbol.

Wirth: It would be funny to take a parallelism out, but only part of it.

Randell: It is like taking half a tooth out.

All this talk on parallel phrases made some of us invent a nickname for Fraser Duncan. He was called a parallel fraser.
At this moment I recall another anecdote. When planning the Warsaw meeting Bauer asked, why in Warsaw. What can you buy in Warsaw on Saturday. Answer: the same as on Friday. From the Zandvoort meeting I also have the quip:

If the bible had been written like this there would have been many less christians.

In the very beginning of the WG 2.1 on ALGOL there were attempts from the side of IBM to get a unified effort of developing FORTRAN and ALGOL. Later there has been an effort from SHARE, which developed the NPL (later being known as PL/I) to bring this New Programming Language and ALGOL X together. Actually both committees have exchanged observers at some time. McIlroy once attended our meeting as an observer in Baden and I have attended a SHARE meeting on NPL in Hursley. But the principles of designing a language were so far apart that these efforts soon bled to death. Not only the scientific starting points were different, but in particular the commercial viewpoint was different. How could a firm as IBM who felt responsible for the language PL/I put things in the hands of such an irresponsible bunch of scientists. On the other hand it must be said that the selling power of the IFIP is not always what it could or should be. We sometimes made the joke of saying: PL/I for the IBM CCCLX.

At the request of Yoneda there was an added syntactical chart to the document. Yoneda himself produced several fine specimina in his very precise handwriting. One produced by Peck had the motto:

> People who like this sort of thing will find this the sort of thing they like. (Abraham Lincoln).

Speaking about motto's I always regret that one motto has disappeared from the final report, but figured in one of the numerous intermediate versions.

> Yes, from the table of my memory I'll wipe away all trivial fond records. (Hamlet, Shakespeare).

This motto headed the chapter on structured values, formerly called records after the idea of Hoare. The editors apparently thought it unkind to wipe away all fond memory of records.

Another very long year went by before we had the next meeting in Tirrenia, Italy. The editing committee had now grown to 4 people: Van Wijngaarden, Mailloux, Peck and C.H.A. Koster. Koster mainly worked on transput (i.e. Input and Output). Peck became the specialist in syntax and coercion, Mailloux worked out implementation [14], Van Wijngaarden was the party ideologist. In the mean time a "Draft report on the algorithmic language ALGOL 68" (Report MR93 of the Mathematical Centre, Amsterdam) [13] had been mailed in February 1968 as supplement to ALGOL Bulletin 26 to the subscribers of the AB. The Tirrenia meeting would be informal except for the last day, because of the $3\frac{1}{2}$ month rule of Zantvoort. Only so long after the mailing could the meeting be convened to give the proper opportunity to the members to read the revised document. But alas, nobody ever read the papers of anybody else in this committee. (Or is this true in other committees too?) Naur did not believe in committees any more as the stated in BIT [20]:

> A committee is a group of people unwilling to work, organised by other people incapable of doing so to do work which is probably useless.

Well, the editing committee certainly has not been unwilling to do work. If I only measure the height of the stack of iterations of documents I come to some 75 cm. And it may be true that a committee wastes hours, it keeps minutes.

The meeting in Tirrenia was about the last one where really technical matters were discussed. There were some strong objections to the publication of the Draft Report because some copies indeed had penetrated to refereed journals and even some copies were found for sale in a London bookshop. But all this was smoothed out. It was after all only distributed as an ALGOL Bulletin Supplement.

A point of discussion was the description method. Several times other methods of description for the same language were invited but no reports were submitted except for one from Duncan, which reverted to the use of angle brackets. It did not convince the majority that it really was another kind of description, instead of just another notation for the same thing. We often asked ourselves in how far the language to be defined was independent of the method of definition. Would not it be another language if the defining method is completely changed.

The MR93 certainly was difficult for the uninitiated reader. I quote here from a personal letter from Duncan of 25th March, 1968.

> ... In London we have been trying to get to grips with MR93. Landin has a fortnightly seminar, which the other 3 of us [Hill, Russell, Lasky?] usually attend. ... I think it is no exaggeration to say that a widespread opinion is that the document itself is extremely difficult to begin to understand (and unnecessarily so), but that inside it there may well be a good language trying to get out. Maar niemand wil een kat in de zak kopen! [Duncan knew Dutch]

There was growing a good deal of opposition to the document and the language. Here is a quotation from a letter of Dijkstra (undated! but my date is 2nd April, 1968):

> Motto [one of them]: "there are writings which are lovable although ungrammatical, and there are other writings which are extremely grammatical, but are disgusting. This is something that I cannot explain to superficial persons." [from Chang Ch'ao] ...
>
> Thank you for sending me MR93, which has absorbed a considerable fraction of my available mental energy since it is in my possession. [Dijkstra was seriously ill at that time] It must have been very hard work to compose it; alas, it also makes rather grim reading. The docu-

ment turned out like I expected it to be, only much more so.
The more I see of it, the more unhappy I become. I know it is a hard thing to say to an author who has struggled for years, but the proper fate of this document may indeed range from being submitted to minor corrections to being completely rejected. ...

Here is another reaction of H. Bekič of 23rd April, 1968:

> ... My first impression was that it is much richer ... much more complete ... and also more condensed than previous versions. ...
> I cannot help deploring many of the reactions to the Report, even though, in a sense, I share them. It is an amazing question how it can be that a Committee which has charged you to do that work and has had the chance of watching the direction into which it moves and of voting on intermediate results, now produces such reactions; and I think it would be worthwhile to analyse this question from the Minutes or from some more complete private recordings. The main concern seems to be about matters of style, and of inderstandability. Now style is a very important thing, but very difficult to argue about. ...
> ... I for one find it difficult to get a really thorough and connected view of such a big thing like the ever-growing informal definition of PL/I, or our formal definition of it, or now your Report, and others may find themselves in a similar necessity to divide their energies.
> ...

Much of the critique came in directly to the Editor. These letters form an enormous stack together. In the same style as introduced in MR93 using two letter abbreviations as PP for Preliminary Prologue er EE for Ephemeral Epilogue, series of remarks from certain places got abbreviations too. E.g. AA for the Amsterdam Ameliorations, BB for the Brussels Brainstorms, CC for Calgary Cogitations (Peck was in Calgary again), MM for the Munich Meditations, LL for Landin's Laments and even greek letters such as ϕϕ for the Philips Philisophies. The BB's have been issued later as Report R96 from the Manufacture Belge de Lampes et de Matériel Electronique, where four very active members were working: M. Sintzoff, P. Branquart, J. Lewi and P. Wodon. This report alone contains 197 BB's and is 2 cm thick [16].

A few quotations from the Tirrenia meeting:

[1:2] <u>real</u> b = (3.14, 2.78)

Goos: [The above clause] is undefined by the language.

Van Wijng.: It is not.

Goos: Then I can treat it, I can see it easily.

V.d. Poel: So you want to forbid only cases which you cannot see?

Goos: Yes.

Yoneda raised a new point and insisted that unions should be defined in such a way that they are commutative so that <u>union</u> (<u>int</u>, <u>real</u>) would be the same as <u>union</u> (<u>real</u>, <u>int</u>). They also should be accumulative. This has become one of the showcases of what could be done with the syntactic formalism but when you ask me personally, I still find it ugly and too complicated. But as usual, if the editors saw a way to satisfy the wishes of the members expressed in their voting, they tried to do it and they often succeeded.

The struggle for acceptance had begun, we neared completion and the technical content of the meeting went down, the formal matters going up.

Van Wijng.: I have been a long long time in the Algol Committee. I have had bad experience with producing working papers for WG 2.1. People have published what I couldn't publish (Orthogonal design). Therefore it is a fair request of the authors: If you like it, take it; otherwise, we publish. I have not fulfilled my task if you consider (what is not in the Minutes) the talks before closing the Warsaw meeting. This WG has worn out its first editor, Peter Naur. Then it has worn out two authors, Wirth and Hoare. If I understand right, it has worn out now four authors.

...

Bauer: Aad, [Van Wijng.] don't throw away the baby because the shoes don't fit. You want the committee to accept not only the language you have defined but also the peculiar form of description you have chosen for your definition.

...

V.d. Poel: Perhaps this is the last chance for a Committee to design a language.

At the beginning of the North Berwick meeting, I seriously considered to invite a psychologist as an observer to study the behaviour of this very peculiar group of scientists. If ever somebody thought that a language design could be made on reasonable grounds alone, he is mistaken. I have never seen so many emotional arguments being brought in as in this WG.

Gradually a dissident party could be discerned in the group. Ranging from "drop the whole thing" to "it should be more formally defined" the discussions were sometimes very chaotic. When discussing on in and out procedures, we found the appropriate terms: insane and outrageous. I find it very difficult indeed to give a clear account of the very subtle shades of opinions, which were sometimes ventilated in rather fierce attacks in words. The best I can do is still give some literal quotations, but I am aware of the fact that even the selection I had to make could give a partial impression. I can assure you that I found these last two meetings before the final acceptance the most difficult ones.

The last formal resolution of Tirrenia read:

> The authors are invited to undertake to edit a document based on MR93, taking into account the questions and remarks received before, on, and possibly after, this meeting to the best of their power in the time they can afford for this job. This document will be submitted to the members of WG 2.1 before 1st October, 1968. This document will be considered by WG 2.1. Either WG 2.1 accepts this document, i.e. submits it to TC 2 as Report on ALGOL 68, or it rejects it.

The first days of North Berwick were used up in a rather fruitless polling of opinion on the most important topics for the future. Among them were Maintenance of ALGOL 68, self-extending languages, primitives, abandonment of ALGOL 68, operating systems, conversational programming, shared data bases and so on. Many of these terms were only O.K. words and were not defined.

Dijkstra: Condensing of the interest is very interesting and promising but I would recommend to the members a bit of soul-searching to discover the extent to which they were lured by a number of the O.K. words. I am extremely verbally thinking and my thinking can be led astray for days by vague associations caused by O.K. words.

The possibility was discussed to have a minority report going with the document.

Van Wijng.: Is it really necessary to have the minority report? The ALGOL Working Committee prepared documents published in 1958, 1960, 1962 and 1964. On all these occasions there was no one who agreed in every respect with the documents. In many cases the precise formulation of the documents was not even known, but the names were attached. The voting on the Subset was on the verge, the minority was very substantial, yet there was no minority report.

Randell: It would be very nice to believe that the intersection of our opinions is to be published, it is obviously premature to believe that the minority report will be necessary. But the ruling that there is not going to be a minority report is as deplorable as I can imagine. ... There must be a vote in December. Until then the discussion about the minority report is premature.

...

Zemanek: We should take into account the effort undertaken.

Dijkstra: The amount of effort has no bearing on the successfulness. I cannot honestly see why we should take into consideration the amount of efforts put into work. Amount of efforts should bot influence the judgement, should not put pressure on us. I am still using mild expressions.

Zemanek: Sir, I know you think of blackmail. I am not putting any pressure on you.

Van Wijng.: I want to make my personal interpretation of Zemanek's statement. The amount of efforts was put into activity by the request of the members who were kind enough to attend last meetings. This puts some responsibility on the members who requested this effort. This does not put any responsibility on members who showed no interest. I would only like them to continue not showing any interest in the future.

Sometimes the atmosphere was nasty as you see. There was a kind of loss of trust as Randell expressed it.

Bauer: Can we go back to the idea of working parties? ... To me it seems that "primitive" and "self-extending" people could sit together, I do not know about the others. I hope that the Chairman has enough wisdom to help such parties to be created.

V.d. Poel: Do you suggest that these parties submit their results to the whole group or that they should have their own rules?

Bauer: I refuse to give you the answer.

Dijkstra: I am trying to picture such a liberal grouping. The group to which I would be most attracted would be less decided by the subject of the work and more by the attitutes of other members in such party.

Turski: Is it that you do not care what you do as long as you do it with whom you like doing it?

Dijkstra: Certainly not, but what you can achieve depends on the attitude as much as on the subject. I can be better cooperative in the group which is better suited to my slow-wittedness.

As we know now a new Working Group was formed later, called WG 2.3 on Programming tools. In contrast to WG 2.1 this group had not the task of developing ALGOL, that is, a definite language to be used.

Here I come across a Guiding Principle, invented during the coffee breaks, i.e. the Bauer Principle.

Ross: Do I understand that you have simple modules of the language, and the experimental ones?

Van Wijng.: We apply the Bauer Principle: who does not want to use complex facilities, does not pay for them. If the user wants to use them he has to pay a little.

Lindsey, who had written "ALGOL 68 with fewer tears" [22] was one of our new observers at that time and soon afterwards became a member.

Lindsey: ... The built-in operators, like + and -, should be implemented in an efficient manner, not by procedures. ... The operator definitions certainly should not be permitted to be recursive.

...

Van Wijng.: Is it meant that this WG 2.1 is recursive in its decisions in the sense that we may undo decisions on which two years of work were based? If we accept this point of Lindsey we will produce a FORTRAN-like language, by this I mean its intellectual level.

Somewhat later the difficulties of storage administration for the heap were discussed.

Hoare: ... We are still exploring the areas of storage administration and the solutions are yet unknown. ...

V.d. Poel: There is no real problem in it. In the single level store the garbage collection problem is solved now.

Ross: I would dispute this.

At this moment we know for sure that it has been solved!

Another example how different attitudes and frames of thinking were popping up repeatedly was the "assignment operator" as some people called it. This is perhaps true for a typeless language such as LISP with only a built-in dereferencing of one step working uniformly on operands but it is not true in ALGOL 68 where "soft := strong" and "firm + firm".

Hoare: ... Inability to extend the definition of the assignment operator, as you can extend other operators, is responsible for many coercions built into the language.

Van Wijng.: I disagree because := is not an operator at all.

Hoare: I agree that you made things very asymmetric.

That's how life is! The relevant formal resolutions stated that minority reports could be part of any final document produced, but then they must be or have been submitted in writing to all members present at the meeting at which the final document was to be accepted.

That brought us to the last meeting in which ALGOL 68 had to be accepted or dropped. I had indicated my wish to resign as chairman after seven years of office at the end of the Munich meeting. As I stated in my opening word:

V.d. Poel: I am very happy that we returned to Munich. I do not know whether it is symbolic, whether it is the end of our meetings, or the work is endless, cyclic.

As several refinements had been put in between North-Berwick and Munich (two more complete reprintings, labelled MR99 and MR100) there was again quite a lot of technical explaining going on. The case-conformity clause was invented.

Landin: I thought that the case clauses were some sort of nested <u>if</u> clauses!

Van Wijng.: Yes, but you first have to find the value of i [in <u>case</u> i in ...].

Landin: O yes, I see!

...

Van Wijng.: I would like to ask that at least point 2 [on additional clarification asked for and motivations] is continuously on the menu.

Dijkstra: I think I disagree with that.

Van Wijng.: But I want to have the substance matter continuously on the menu.

...

Seegmüller: The idea of hardware language is introduced very vaguely. What is the distinction between the representation language and the hardware language?

Van Wijng.: It depends on your reading equipment.

...

Seegmüller: I would not go as far as this. But I would try to be a bit more precise.

Van Wijng.: Why do not you go, sit in the corner, and make proper wording.

Seegmüller: O.K., I shall try.

At this time the idea of the II, the Informal Introduction to ALGOL 68 [18] was brought up. Lindsey and Van der Meulen had volunteered to undertake such a work. Lindsey made a presentation of the lay-out of this work.

Seegmüller: A part of my suggestion was that the II should be published together with the defining document. I would like to repeat this point.

Lindsey: You will have to wait.

Seegmüller: Then I would rather delay the publication of the Report.

V.d.Meulen: You cannot write the introduction before the Report is closed.

V.d. Poel: There was no commissioning of this work, we are entirely in the hands of the authors of II; when they finish it, it will be published.

Now the negotiations began on the wording of a cover letter for the Report. This took a long time and all controversies were raised again.

Duncan: I am not of the opinion that the document describes a language. Another point is that I do not know why anybody should be interested in my opinion.

He was feeling very low apparently and I know why. I am not going to disclose that piece of information. I also have my professional secrets. Later on description methods, Duncan's against Van Wijngaarden's.

Duncan: The description method [of vW.] failed my tests. Another thing is that if my objections as a member of this Group are not taken, then what a chance do I stand as a member of the public.

V.d. Poel: Many of your objections were taken into consideration.

Van Wijng.: I made improvements according to your suggestions even before I received your letter.

Turski: A clear example of Extra Sensory Perception!

As an intermission to these little fights let me just tell you about another nice procedure which would in one stroke promote ALGOL X into an ALGOL Y. At one time the following procedure was proposed:

<u>proc</u> execute = (<u>string</u> progr): ¢ the string progr is considered as a possible closed clause and elaborated at the textual position of the call ¢;

This procedure could transform a sequence of characters into a closed clause, i.e. a syntactic notion. In other terms, it could invoke the compiler at run time. A simple operating system could now be written as:

<u>do</u> execute (read)

Execute as a program what you have read as a string and read the next program when you are ready. The proposal was not accepted. What a pity!

For the authors, who tried to create a milestone, found that it had become very much a millstone. They had to be careful that it would not become their tombstone.

The Munich meeting had sailed clear of a minority report but in the last half day it still happened. Signed by Dijkstra, Duncan, Garwick, Hoare, Randell, Seegmüller, Turski and Woodger such a minority report was handed in. For the text I have to confer to the ALGOL Bulletin, in which it was published. I rather quote here from the less accessible documents.

The meeting concluded with a number of formal resolutions:

1. Resolved that WG 2.1 recommends to TC 2 to create a working group on Programming Tool Requirements and to reconsider the membership of WG 2.1. This was proposed by Van Wijngaarden [!] and seconded by Dijkstra and taken by 35 in favour, 2 against. The creation of WG 2.3 informally was a fact. In a second resolution Lindsey and Van der Meulen were thanked for their initiative in producing II.
2. Resolved that the Chairman, with the assistence of the Secretary, shall transmit to all members of TC 2 a copy of MR100, together with the text of the agreed Covering Letter. Subject to the approval of TC 2, the authors shall submit copies of MR100, together with the agreed Covering Letter, at least to the following journals: Comm. ACM, The Computer Journal, Numerische Math. [17], Kybernetika, Calcolo, Revue d'AFCET. The authors may introduce all necessary corrections to MR100 before submission and at the proof-reading stage. This last vote was taken with 27 in favour and 2 against (8 abstained).

After this 4 more meetings have been held, now under a new chairman but an old member: Manfred Paul. The membership has changed and the topic has reverted back to very deepgoing technical discussions. Of course some errors have been found, but they were lying very deep and are of no concern to the ordinary programmer. Several long felt desires have been proposed and are readied for inclusion in a Revised Report as stipulated in the Covering Letter. Also a rather full implementation proved many expectations to be true. It is not a big compiler, it is efficient [23].

I shall not go into these years. This is good for another jubilee and for another author. For the next chairman it could be "the only most important case" as he once said in another context. For me it were the "longest 7 years I ever had" to paraphrase another anonymous remark on the longest 5 minutes somebody ever had.

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My name, expressed in double hexadecimal ASCII, is: FIPS PUB

52 2E 57 2E 42 45 4D 45 52 1
R . W . B E M E R

I am a resident of Phoenix, AZ 5-1

County of 13 6-1

(except that our State Highway Department encodes it as 07, so I had better say Maricopa),

Country of US 10

Except that I was married in the BQ (Virgin Islands). 10

I'm in Congressional District 01 (of AZ) 9

and, since it is a populous area, in metropolitan statistical area 6200. 8

I'm pleased to have this opportunity to talk to you, on 19710521, 4

on the subject of problems resulting from lack of conformance to, and dearth of, Federal standards, some of the first of which have just been demonstrated.

In fact, if you add the standards for paper tape and the 9-track, 800 cpi representation of the ASCII Code on magnetic tape, and the most important standard on implementation of ASCII, you have the 10 Federal Information Processing Standards that represent the entire body of agreement since the Brooks Bill, Public Law 89-306, was passed on 1965 October 30.

Of course, many other standards are in various phases of development and submission. Some have been published as draft standards in the Federal Register, such as:

- General Purpose Paper Cards
- Hollerith Punched Card Code
- Rectangular Holes in 12-row Punch Cards
- Subsets of ASCII
- Bit Sequencing for Serial-by-bit Transmission
- Character Structure and Parity for Parallel-by-bit Transmission.
- Interfaces between Data Terminal and Communication Equipment.
- Layout of Forms for OCR Input.

All these are of course available for Federal Agencies to use in procurement contracts, even in advance of actual ratification. The COBOL programming language is not yet even to this step, yet the Department of Defense has adopted the ASNI American National Standards Institute) COBOL as its standard for procurement. Mr. Brooks is very anxious that the National Bureau of Standards set up a

COBOL validation facility for entry into the GSA schedule.

Of course, I could have identified myself further as Social Security number so-and-so, but I don't let any more facilities have that than I am forced to. My friendly bank has never gotten it from me, but I more than half suspect that they already have it. This is under review within ANSI X3, the Committee on Information Processing Standards, but there have been some flaps about this, as you know. Informed estimates are that your Social Security number is used now in at least 200 different Federal Government files.

I could also note that the railroad ships things to ma at 797XXX, courtesy of the Transportion Data Coordinating Committee in Washington, which is sponsored by such organizations as the AAR, the American Trucking Association, and the Transportation Division of the Census Bureau. The XXX is for the last 3 digits of the ZIP Code, but naturally it is unthinkable that the Census Bureau and the Post Office could have figured some way to get together. The Department of Transportation is also against the Post Office, and they want to use the TDCC code, called SPLC (Standard Point Location Code) in transportation flow studies. However, neither of these are Federal Standards. As Joe Cunningham says, by a quirk of law, the President of the United States must sign the Federal Information Processing Standards.

The classic, of course, is ASCII, the original standard signed by Lyndon Johnson. This is not to be taken as trivial, for although IBM fought it for a long time, it is an international standard in many respects. As the ISO Code, it is Recommendation 646 of the International Standards Organization. As Working Alphabet 5, it is effectively replacing the Baudot Code of CCITT (the Consultative), a joint arm of many Departments of State. In the USSR the 7-bit ISO Code is fleshed out to 8-bits, to include the Cyrillic alphabet, and is a standard enforceable by law.

We read recently that Ralph Nader has contended that a GM recall of some cars for alleged design improvements really should have been reported to the Government under the safety laws. So it is with loose interpretations in the Federal Information Processing Standards. Of course we all know, too, that IBM equipment does not use ASCII as an internal code. Nor do any others except the NCR Century and a few more. Now this is certainly not illegal, for the code is billed for "interchange", and indeed this is proper, just as we all think it proper that the Government does not know what goes on in the privacy of our homes.

Putting aside the possible argument of economies if the internal code were to be identical with the transmission code in an era of international networks of computers, let's see what happens in practice that is not covered by any provisions in the Federal Standards, nor indeed in any other, ANSI or ISO. There is such a thing as a collating sequence for a set of characters. It is used for ordering files. The easy way is to make a numerical subtraction of the bit representation of characters treated as numbers, and let that determine the ordering. In ASCII the digits fall below the alphabet; in EBCDIC, the code of the IBM 360 and other equipment, they are high to the alphabet. Thus the order is G3, GB for ASCII, and GB, G3 for EBCDIC.

This difference might be resolved by arbitrarily making a standard collating sequence, couldn't it? No, it couldn't. Order a list of names for a telephone directory according to the numerical sequence of either ASCII or EBCDIC, and you have a mess. It's the problem of upper and lower case. Unfortunately both codes also have controls and graphics intermixed, and this could get sticky, too.

Now let us take the case of an agency trying to comply to the Federal Standard for ASCII. The files must thus be recorded in ASCII for interchange purposes. On the other end of the line, the Department of Defense has decreed COBOL for the programming. Now if we read the COBOL standard to see what it has to say on collating sequence, as applied to the comparison instructions, we find that it is permissive. Use your own, on the machine you have. So the characteristics of the native machine are built into the program by the way in which the programmer (and thus the compiler) uses the known machine logic collating sequence to make decisions and jumps in the program. Thus the data, recorded in ASCII, must be converted to a particular internal code that the programmer depended upon in order to make the program work. Now what happened to all that interchangeability that the Brooks Bill intended for the Government so they could have alternate sources of supply to get better prices?

Some might think this a trivial problem with respect to costs. It is not, for the Air Force has to reorder some 40% of the files that come in from the field. Some might think it can be controlled easily. It can not. IBM decreed that all 360 programs should be code independent, for there is a switch that makes an ASCII machine out of a 360. It did not turn out that way. There is now way to control 5000 programmers, of which 2000 work for subcontractors, unless there is a mechanical software factory which tests all coding to verify such code independence before it is allowed to be entered into the software complement. Some might think that the COBOL standard could be revised to incorporate the ASCII collating sequence, ignoring the upper and lower case difference. It wouldn't work. You would limit the telephone book boys, and the Scandinavians, who happen to work to the same COBOL standard because it is identical to ISO COBOL, and happen also to have 3 extra characters in their alphabet.

I have used this as an example of the inadequacy of the Brooks Bill to produce what it was intended to produce, because such problems were not generally understood at the time of its passage. I do assure you that Congressman Brooks is very aware of the problems. Hearings were held just 2 days ago to see what might be done. My conclusions, to which I hope others can agree, are that standardization in information processing is inherently different from manhole covers, the classic illustration of the standards engineers for many years.

I think that realistically there can be no unique standards by agreement or decree. I certainly don't want a multitude of varying practices.

(in here put my ESCape Registry proposal)

The concept of a coded character set seems to many to be a a little trivial, perhaps too trvial to thextkex be not only the first Federal EEEz Information Processing Standard, but to be established as such by a signed Executive Order from President Johnson. Translate from one code to another, you might say. It only takes a table in the computer store, or a chip.

Yes it does, providing the graphic content is the same. In fact, we made a great effort to bring IBM's EBCDIC code into compatibility with ASCII via the Hollerith Card Code as a bridging mechanism. IBM was to have made some slight modifications for content, except they do not seem to have done it. Example: I have a GE Terminet 300 terminal in my home, which I use to enter and edit text. It is ASCII based, so I am able to use the exclamation point. Only problem is when I get to work and use the IBM 2741 terminal to run off a copy for reproduction, that terminal does not have an exclamation point (nor does Datel), and it prints the "~~cents~~" sign, which is not in the ASCII set content. So al lm y text had to be redone by using the single quote, backspace, and period.

(SLIDE) V (T, ALL WAYS ½

ASSORTED TOPICS

Terminology - same interagency EDP task force (Data mation, 71 May 15) had input to ANSI. FORTRAN - "one of several , etc..." IFIP/ICC. Difficult problem (Negative Fathoms) International (Furippu.fupoppu)

IBM fighting CODASYL Data Base

- o National Decisions require national data (Richardson - information conserves other resources thru improved decisions. Schultz.

  Recognition of data - FAA Compatibility
  - EPA (Aines)
  - Whipple and NASA (Labels)

- o Let IBM do it? for their proportion? de facto anyway? NOT ON YOUR LIFE! CONSIDE THE 660 - 750!

COBOL - level problem - Stan Smith level - degrade - remote compile
- imprimatur
- ordering seq

Instrumentation - not in NBS - REGISTRY (Kogbetlaintz - sin/cos
FAA - 2 10 millisec vs. 16 micro

Registry - date example. Publicit is a part of it.

NASIS - nice goals, no resluts.

The programming language COBOL has ~~pk~~ held ~~axtarge~~x an ~~a~~ important position in Government hopes. ~~The~~ It's development was definitely government nurtured. Charles Philpps, Chairman of the CODASYL Executive committee, was top EDP MAN IN THEZ~~AirzForc~~x Department of Defense. Vice Chairman Joseph Cunningham is the same as the BOB member of the triumvirate. Substantial govenment support in personnel was given ~~firstxtm~~ to CODASYL from 1960 to the present, and to ANSI standardization activities starting in 1963(?). Yet it took unitl 1969(?) to get a COBOL standard (true, it was worldwide).

Despite my pleading at the 1968 Jan meeting of X3, the collating sequence has never been determined for ~~COBOk~~ the characters of the COBOL language and those that it may operate upon.

Collating sequence is the ordering (etc.), ~~and~~ which operates in the COBOL statements IF (GR and LS) (check all this). Althoug a strong ASCII proponent, I would not demand that the binary sequence of t the 128 characters of ASCII be the ordering or collating sequence. The telephone book would look lousy (Example). On the other hand, I certainly do not think that the IBM commercial collaiting dequence should be it, either. And here we must give a little hisstory of IBM sequences.

In 1959 I started to try to striaghten out the various (9) IBM BCD codes, noting that there was no equivalence (Datamation ref) between bonary sequence and ordering sequence there either. As a matter of fa t, the coolating sequence was a device that IBM used to suuport the adoption of EBCDIC ~~aszthezbasi~~x arther than ASCI as the basic code for the 360. A questionnaire was sent out to IBM customers, asking would they prefer to stay with BCD or go to ASCII, which would require a reordering of all their files. Naturally the customers howled, for ~~that~~ that would certainly entail a great deal of expense. So IBM established EBCDIC, which ashas a different collatuign sequence from BCD, and the customers had to do just about as kuch reordering if theyhas gone to ASCII.

In COBOL it is not the ordering part that is so awkward; it is the fact that a program can be written in COBOL which imbeds the logic of any collating sequence! Consider an airaraft part number. In ASCII the digits are lower than the alphabet; in EBCDIC they are higher. In other words, Part No. AA6 iszlowerzinxEBCIDxthat PartzNoxz would precede Part No. A2B in a file ordered on the EBCDIC basis. It would be the converse on an ASCII basis. Now write a COBOL program that says

```
        IF INPUT-PART GREATER THAN CURRENT_PART THEN THIS ELSE
    THAT.
```

Now demand that the file be in ASCII order and produce answers according to the EBCDIC pattern. Chaos!

Is there a simple solution? Certamnly! A simple addition emendation to the standard COBOL thatzsayxxžxThe environment devision shat:

```
COLLATING SEQUENCE IS   { ASCII
                          EBCDIC
                          TABLE      (which erferes to a table defingin
                                      the special ordering.
                          RULE R   } (can go to a special (registerd)
                                      subroutine to define the rules
```

Reading this preface, the COBOL compiler for a particular computer can compile the proper piece of program. If bhe internal code happens to be ASCII, and that sequence is specified, thenthe program is very simple. If it is something it cannot handle at the moment, the compiler yells for help, and says "Build thatnew one in ".

Now let's see how this would work in practice by going back to our COBOL example. As part of the introductory elements of the program, we require a statement "COLLATING SEQUENCE IS .....". Compilers can be fairly smart. If the sequence is recognized as native, it compiles one way, very efficiently. If foreign, it throws in subroutines; slower, perhaps, but correct. The National Bureau of Standards keeps the registry on the permissible collating sequences that compilers should know how to recognize. Only heavy usage gets you on the list, and eventually, as your customers utilize more system measurement devices and see how much your equipment costs them by being only registered and not to the main standard, you are forced to relinquish this and build your replacement equipment to the single standard. Then that registry number is canceled, and compilers notified that they no longer must consider it.

To give an example of the amplification of seemingly trivial divergence, consider the Honeywell RAES (Remote Access Editing System). We use this for all production of documentation, both manuals and programs. Several different types of terminals are connected. Forgetting the differences in transmission rates, troublesome enough in themselves, consider what happens when text or program is entered on one type of terminal and printed from another, a very common occurrence. (In particular, I have a Terminet 300 at home, but like the font on the Datel or IBM 2741 better for production, so I have the output printed at work).

Figure ____ shows the keyboard layouts and what happens when original input for a particular keyboard is printed out on the various terminal types. Note that the Terminet 300 and the Teletype 37 are identical, due to ASCII; the Datel is identical to the IBM 2741 due to IBMs market. We see that the 2741 prints:

		ASCII characters
¢	for	~ and ^
-	for	| and \
(	for	< and { and [
)	for	> and } and]
@	for	`
'	for	@ and '
½	for	!

out

ON 30

OUR CHOICE: ~~RE-EMULATION~~

MARK II CUSTOMER CHOICE

Printing a selected character for many is mandatory due to the 44 key limitation on the IBM terminal. This reminds me of one of my great failures, a special trip to Lexington in 1961 to plead with the typewriter engineers fo use an escapement other than 1, 2, 2, -5 so the keyscould be encoded to ~~maxxh~~ correspond to a 7-bit code. I lost. The engineers said the ~~R~~ Selectric would never be a terminal, anything except a typewriter.

But the last one really hurts in text. To avoid it, one must enter all exclamation points as quote, ~~baska~~ backspace, period.

Curry
VICO
MIKE D.