Diffusing Electronic Computing Savoir-Faire in the Belgian Technological Periphery, c1945-c1960

Sandra Mols, Marie d'Udekem-Gevers
Faculté d'Informatique & CITA
FUNDP, Namur

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1. Researching Belgian Computing

Research Programme on BCH

- Collecting primary sources
- Oral history methods
- Highlighting:
  - Relations with the Anglo-Saxon world and European neighbours
  - Belgian specificities

Methodology:

- Reliance on oral history
- Lack of archives, literature

Content:

- Some results on the Machine Mathématique IRSIA-FNRS, 1950-1960
- Reflections on the emergence of a Belgian indigenous culture in electronic computing

Particularities

- Empirical emphasis
- Programme under way, hence incompleteness of results on many issues

2. Locality and Technological Diffusion

2.1. Useful literatures and concepts

- Economics of technological innovation; Computing cultures of computing; Data processing histories
- Trajectory literature: ‘Computer regime’; ‘Technological trajectory’
- Centre-vs.-periphery analysis
- Deconstruction of the Nation

2.2. Locality and Technological Appropriation

- As in e.g. Jankovic, Jordan and Lynch
- To reconstruct Belgian computing history without judging these developments by comparing with advanced locations such as the UK or US
- Going beyond the American-centredness

3.1. Reconstructing R&D in post-war Belgium

Post-war reconstruction

New world order:

Cold War (politically)

Big Science (R&D)

Transnational collaboration & American assistance:

Plans Galopin (1942-1945), Benelux (1943), Marshall Plan (1947), CECA (1951), CEE & Euratom (1958)

Social modernisation of the Belgian society:

Women's right to vote (1949); Linguistic tensions; Popularisation of higher education; 'Rêve Americain'

Rise of science and technology in society

Triple-helix collaborations towards repair of the industry and R&D:

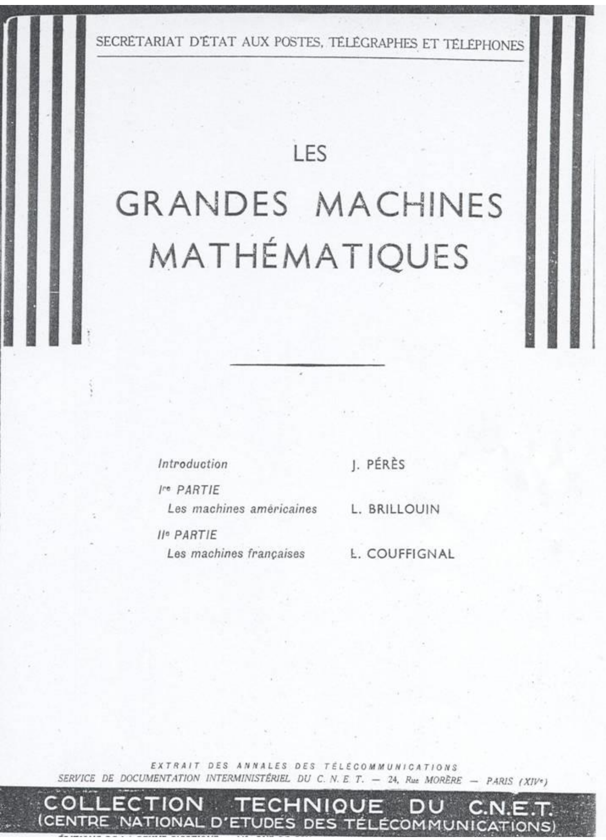
- 1944-1946: IRSIA; Industrial research centres
- 1947: IIPN (IISN 1951), Associations de Recherche Industrielle, MBLE turns towards electronics; funding towards universities
- 1952: CEAN (Mol CEN 1956)
- 1957: Commission Nationale des Sciences
- 1958: Euratom, Expo 58, Centre d'Electronique Appliquée
- 1959: Ministère de la Politique Scientifique

Quantitative rise of R&D in post-war Belgium: + 50% of research establishments, + 50 % of university staff, + 75 % of research positions (UNESCO reports of 1965)

“Shortly after the end of the second world war several European countries of the continent – in particular the Netherlands – became interested in the construction and use of computers. To keep up pace with its neighbours Belgium urgently needed a similar research program.”

Jacques Loeckx, 2007

3.2. Yearning for Anglo-Saxon Electronic Computing


SECRÉTARIAT D'ÉTAT AUX POSTES, TÉLÉGRAPHES ET TÉLÉPHONES

LES

GRANDES MACHINES MATHÉMATIQUES

Introduction	J. PÉRÈS
I^re PARTIE	
Les machines américaines	L. BRILLOUIN
II^e PARTIE	
Les machines françaises	L. COUFFIGNAL

EXTRAIT DES ANNALES DES TÉLÉCOMMUNICATIONS

SERVICE DE DOCUMENTATION INTERMINISTÉRIEL DU C. N. E. T. — 24, Rue MORÈRE — PARIS (XIV^e)

COLLECTION TECHNIQUE DU C.N.E.T.

(CENTRE NATIONAL D'ETUDES DES TÉLÉCOMMUNICATIONS)

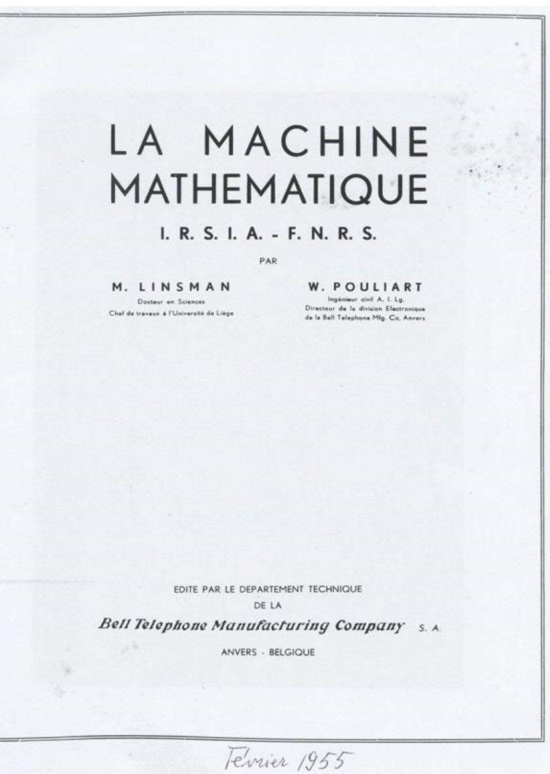
Through participating to:

- **The American support for recovery:** plan Marshall, development of R&D supporting offices (e.g. the IRSIA)
- **Computing conferences in the US**, e.g. the 1947 Harvard Symposium on Large Scale Digital Computing Machinery, held in January 1947 at the Harvard University Computation Laboratory

Reading and writing reports on Anglo-Saxon R&D, e.g.:

- C. Manneback, L. Brillouin, *Les machines mathématiques aux Etats-Unis*, 1947
- J. Pérès, L. Brillouin, L. Couffignal, *Les grandes machines mathématiques*, 1948.
- H. Rutishauser, A. Speiser, E. Stiefel, *Programmgesteuerte digitale Rechengeräte (elektronische Rechenmaschinen),* 1951

3.3. Towards the Machine Mathématique IRSIA-FNRS, 1948-1955


LA MACHINE MATHEMATIQUE

I. R. S. I. A. - F. N. R. S.

PAR

M. LINSMAN
Docteur en Sciences
Chef de travaux à l'Université de Liège

W. POULIART
Ingénieur civil A. I. Lg.
Directeur de la division Electronique de la Bell Telephone Mfg. Co, Anvers

EDITE PAR LE DEPARTEMENT TECHNIQUE DE LA
Bell Telephone Manufacturing Company S. A.
ANVERS - BELGIQUE

Février 1955

Initiators: The IRSIA and the FNRS

Technical expertise by Bell Telephone Mfg Co, at Antwerp, a telecommunications company close close to the Régie des Télégraphes et Téléphones and expert in electronics (transistor of 1947)

Later technical development also by the Comité d'Etudes et d'Exploitation des Calculateurs Electroniques (CECE) from 1955

Leading to 2 electronic digital computing machines

The Machine mathématique IRSIA-FNRS (1951-1962)

The First National City Bank Machine (1952[?]-?)

1955 political gloss on aims :

1. The development of scientific research in Belgium
2. Encouraging Belgian industries towards new, modern, forefront, activities
3. Promoting the interest for modern developments of automatism

3.3. The Machine IRSIA-FNRS: Chronology

1947: Manneback's stay in the US and report

1950: Suggestion by Henry, director of the IRSIA, of a research programme on electronic computing

1951: Launch by the IRSIA and FNRS of the Machine Mathématique IRSIA-FNRS project; Committee of academics to oversee the project; Technical assistance of Bell Telephone Mfg Co, Antwerp

1951-1955: Work on the Machine IRSIA-FNRS at Antwerp
Leadership by W. Pouliart and V. Belevitch, Bell, and M. Linsman, Université de Liège

February-March 1955: Inauguration of a 17-racks prototype of the MIF using a simplified arithmetic
Comité d'Etudes et d'Exploitation des Calculateurs Electroniques (CECE)
February-September 1955: experimental use and study of the prototype
Late 1955: Dismantling and extension of the prototype towards the full machine

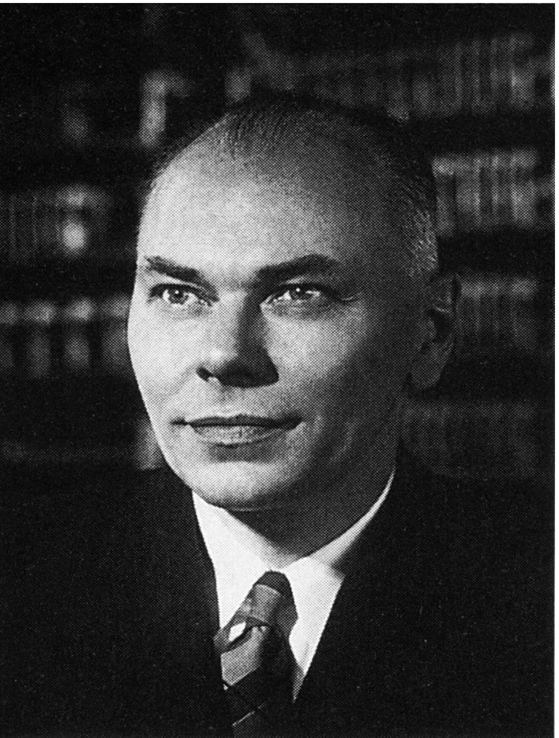
Late 1956: Completion and testing of the full-size Machine IRSIA-FNRS
CECE: ca 8 staff, testing and writing up of routines; first uses on clients' problems

Early 1957: check and correction of routines; regular operations (Institut météorologique, FN, universities, …)

Late 1957: Relocation of the MIF to the Brussels Institut National de Statistiques

Late 1962: Closing of the CECE; Scrapping of the Machine IRSIA-FNRS

3.4. Building Up on Harvard Expertise in Electronic Computing



The Machine IRSIA-FNRS was the result of a collaborative endeavour between Belgian engineers and American experts in electronic digital technology, through:

- Linsman and Pouliart's long sojourn in Aiken's laboratories, at Harvard, before conception of the design of the Machine IRSIA-FNRS

- Regular consultancy visits by Aiken to Antwerp during the design stages of the Machine IRSIA-FNRS

Collaboration that led to a design of the Machine Mathématique IRSIA-FNRS being partly mimicked on the designs of the 1952 Harvard Mark IV

Source: *Cahiers de Science et Vie*, Hors-série 36, p.30.

4. The Machine Mathématique IRSIA-FNRS: A Technical Visit

4.1.Definition in modern terminology

- **Stored-program** ‘universal scientific digital computer’

- Design: ‘Harvard architecture’,
  - e.g. physically **separate storage for instructions and data**,
  - Origin in the guidance by Howard Aiken

- Architecture distinct from the von Neumann architecture, with instructions and data in the same storage

4.2. Architecture

1. Storage

1.1. Low-speed memory: Six periphery memories **on magnetic tapes**

1.2. Medium-speed memory : Central memory on **two magnetic drums**

1.3. High-speed memory: Two electronic technologies

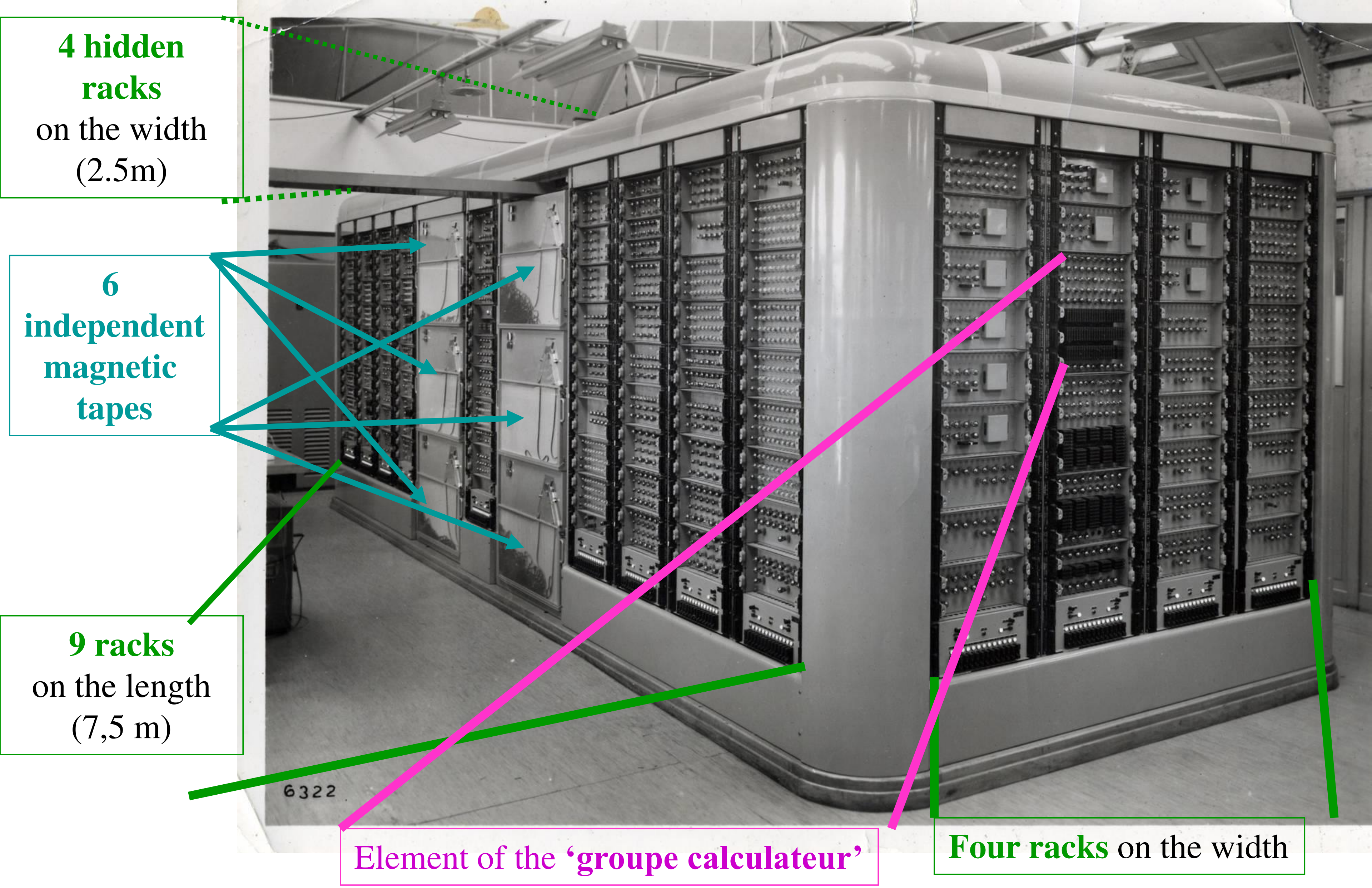
- Racks of **gas tubes** (/cold cathode tubes) used e.g. towards asynchroneous transfers between drums and tapes
- Racks of flips-flops made of triodes, vacuum tubes with high heat release and chronic reliability issues

2. 'Groupe calculateur'/arithmetic unit : in charge of arithmetic operations; **floating & fixed-**point arithmetic device

3. 'Circuits de commande'/control unit: Distributing in the machine the orders given by the program

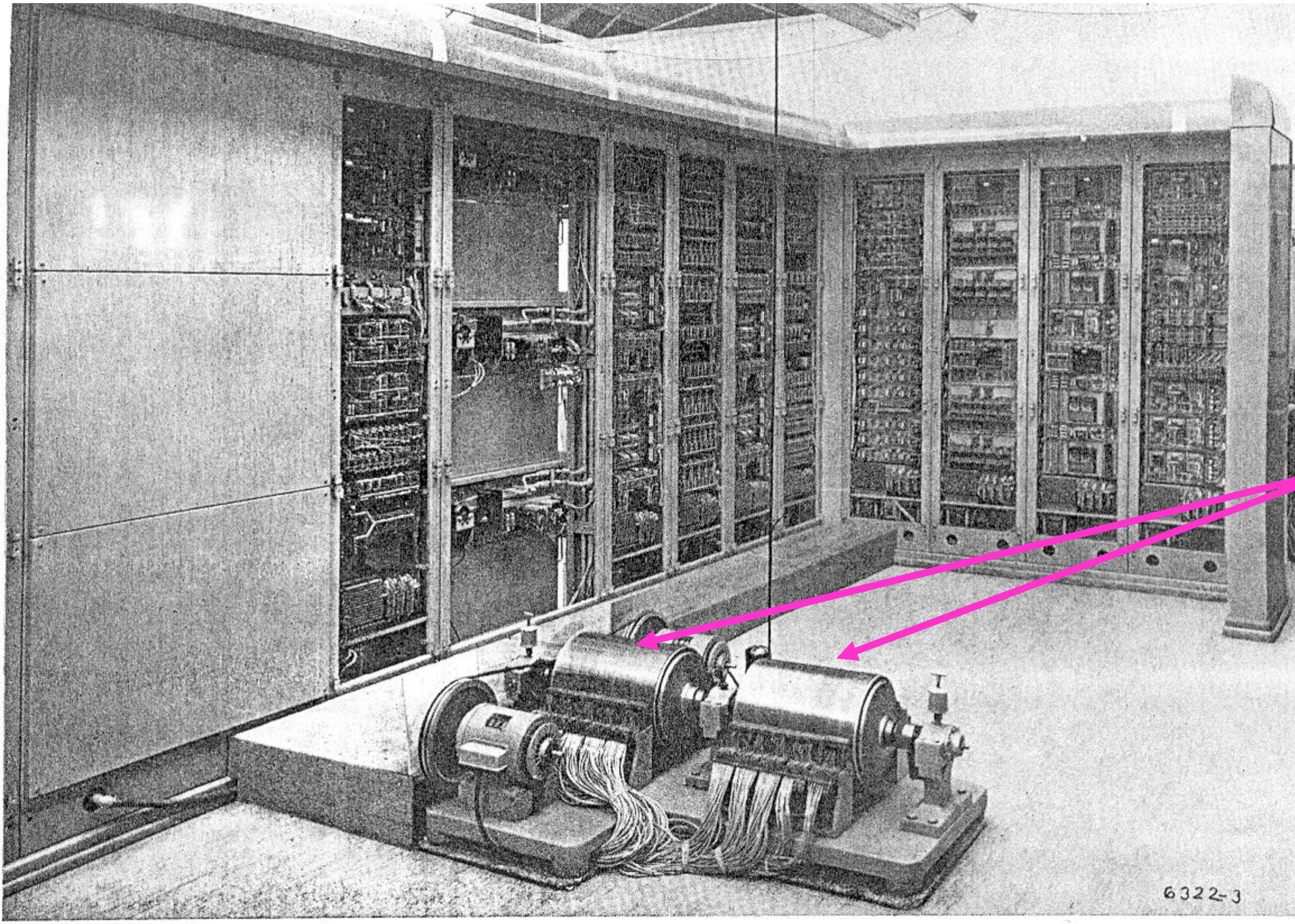
4. Keyboard: towards input of instructions and data on the magnetic tapes

5. Electric printer: towards output



Front view of the 17-racks prototype of the Machine Mathématique IRSIA-FNRS, c. January 1955

Courtesy N. Rouche



Central memory:
2 magnetic drums

One for numbers
One for instructions

Back view of the 17-racks prototype of the Machine Mathématique IRSIA FNRS

Courtesy: N.Rouche

Developing Indigenous Machine Know-How

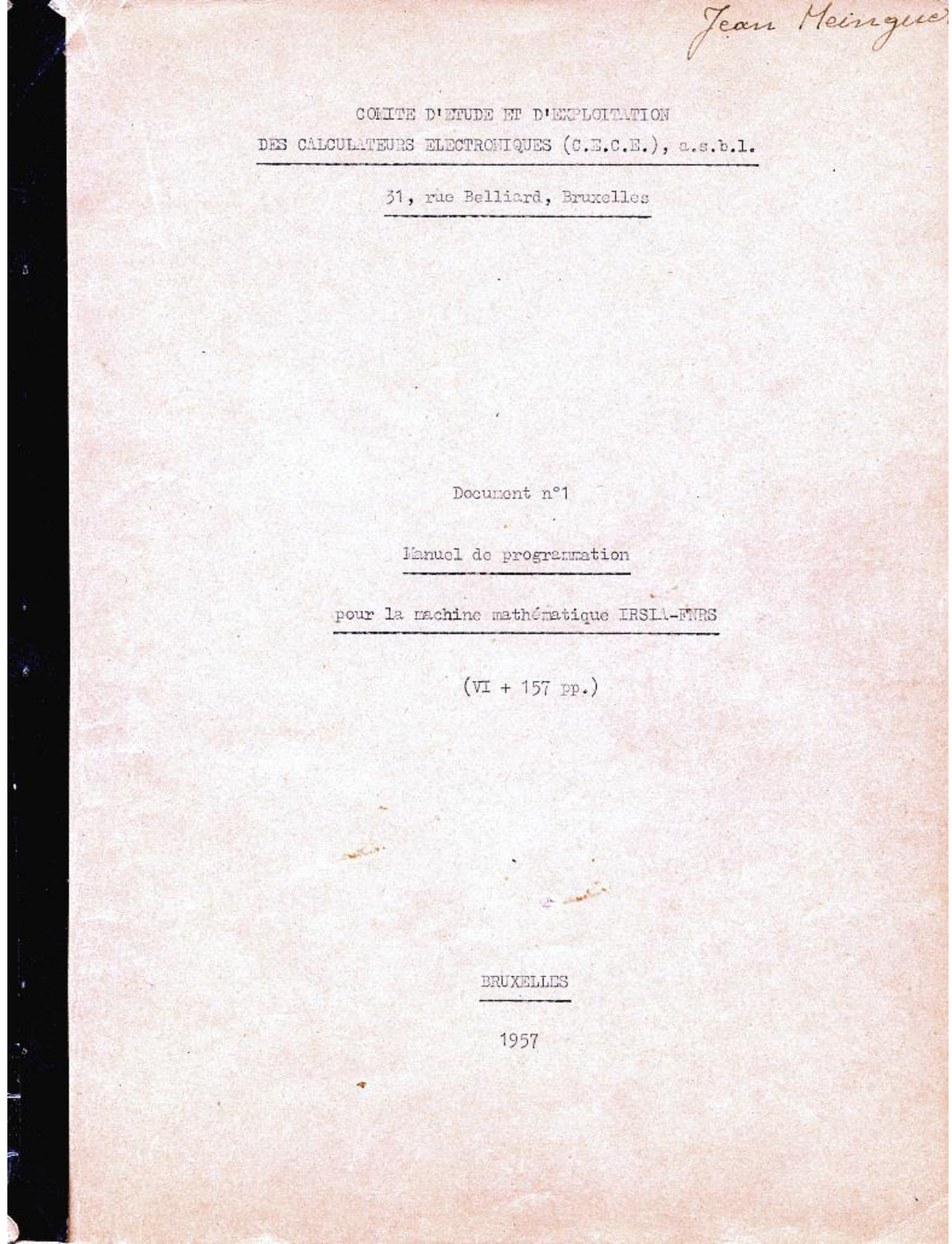
- **Towards indigenous advanced know-how in electronic computing**
  - By e.g. by Fosséprez
  - Examples:
    - Magnetic tape storage system
    - Magnetic drum technology
    - Racks of gas tube
  - Linsman & Pouliart's showing-off comments, 1955: "organes dont la conception différencie nettement la machine IRSIA FNRS des autres."

- **Ferrite core research towards magnetic storage**
  - From Dec. 1952 research by Rouche
  - Research using expensive US-imported samples
  - Considered by Bell as too expensive and interrupted
  - Rouche's later comment: "On a raté le coche."

Claude Fosséprez

4.3. Programming

Jean Meinguet


Jean Meinguet

COMITE D'ETUDE ET D'EXPLOITATION

DES CALCULATEURS ELECTRONIQUES (C.E.C.E.), a.s.b.l.

31, rue Belliard, Bruxelles

Document n°1

Manuel de programmation

pour la machine mathématique IRSIA-FNRS

(VI + 157 pp.)

BRUXELLES

1957

« Code » = « système de notations » [used in a program]:

 here used vocabulary: only **digits**

« [Regular] Code » ← « Pseudocode » (shorter and easier)

« Translation »

« Code » = « système de notations » [used in a program]:

 here used vocabulary: only **digits**

« [Regular] Code » ← « Pseudocode » (shorter and ***easier***)

« Translation »

« One instruction word comprises two separate orders »

« Each order comprises
- ✓ one operation prefix (5 digits) followed by
- ✓ an address (4 digits) »

« A pseudo-order is made up of
- ✓ a two digit prefix ***possibly*** followed by
- ✓ a four digit address and
- ✓ an index digit»

Ex.: first line of the Transfert program
0015 90000 0006 54000 0000

← Ex.: first 2 lines of the T pseudoprogram
90 0006
54

! « Programmation à simple adresse »

Definition in modern terminology

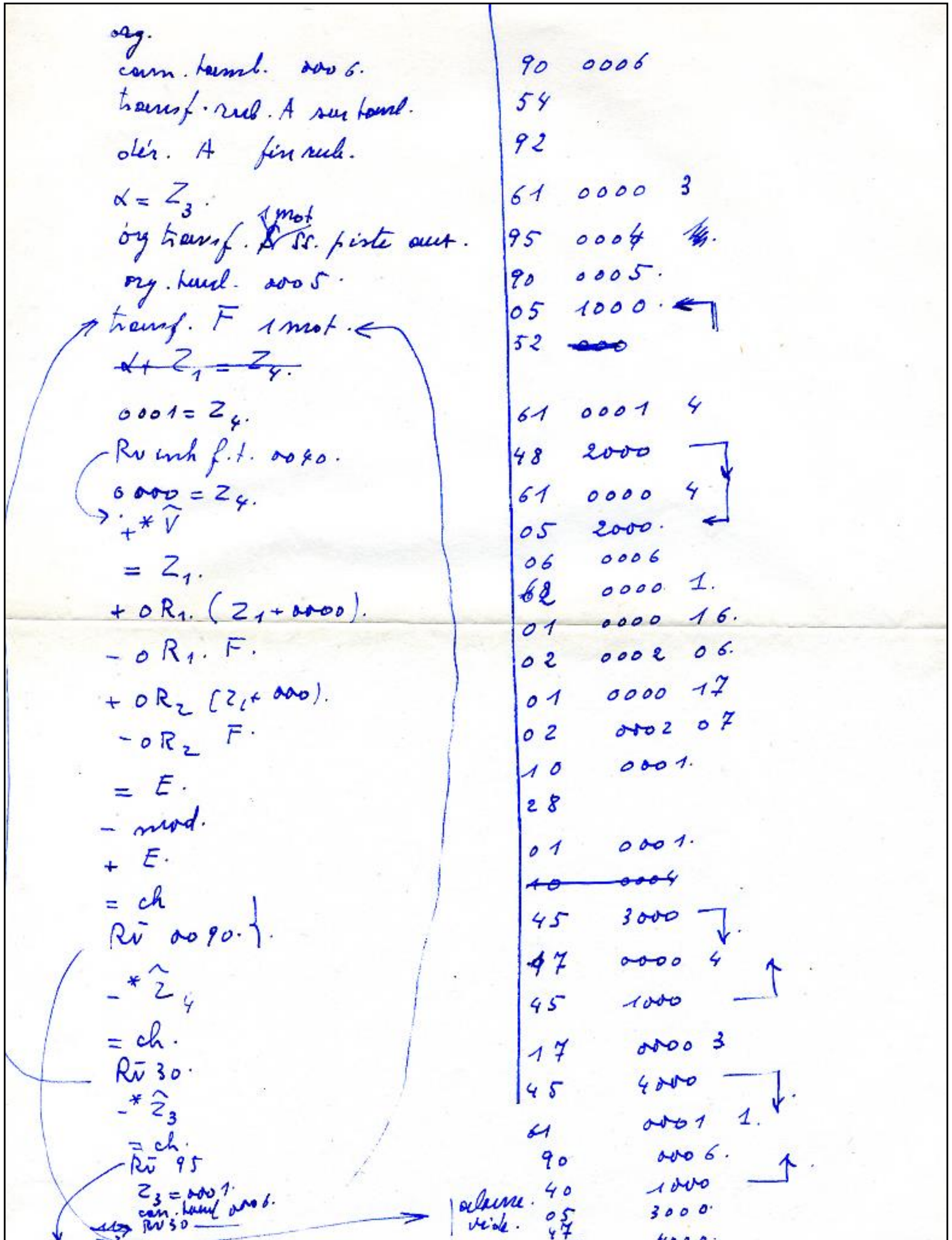
« [Regular] Code »

« Pseudocode »

= digital machine languages

Programming implied intimate knowledge of the HW of the machine, i.e.

- to optimise and manage the use of the various storage systems (registers, drums, tapes)
- to optimise the organisation of the data stored on drums and the tapes,
- ...



Programming sheet by Jean Meinguet

• Right column: sequence of lines (orders) of a program/ « codage/coding » in pseudocode

• Left column: « notes » meaning of each code line in a language mixing French and mathematical notations

Which programs?

1. Routines

1.1. used by each program

- « programme initial de transfert [du ruban vers le tambour] »
- « Programme final d'impression »
- « translation routine » (if pseudocode)

1.2. called by some programs

- Ex. : elementary functions (inverse, inverse square root, sin x, log x, …)

N.B. Some routines stored on magnetic tape and others "in permanence on the drum"

2. Programs for the resolution of scientific problems

- From 1955: experimental exploitation, for instance towards Bessel functions for the Ecole Royale Militaire

- From late March 1957: Regular operations towards problems submitted by the Institut météorologique, the FN, Universities, Commission des tuyauteries

5. Appropriating Anglo-Saxon Computing Know-How, 1950-60

5.1. A continuous exposure to problems to solve locally

While designing the components of the machine along the lines decided

With making the machine calculate

- by the elaboration and storing of numerical analysis routines on the magnetic drums
- by stopping the machine falling into failures due to chronic problems
  due to triodes' heating effects
  - When cold in the morning, the machine worked about 10 times slower
  - If at optimum temperature:
    - Uncomfortable temperature for users
    - Rising unreliability effects from triodes
    - Dilatation effects in the drums and scratching of the magnetic coating

Situations:

- Daily basis
- e.g. at the inauguration by King Baudouin in Feb. 1955
  Water spread throughout to cool the machine room and rise reliability
  And still malfunctioning of the machine and fake demonstration out of a pre-prepared result tape

5.2. Developing Indigenous Know-How

Towards indigenous advanced know-how in electronic computing

- By e.g. by Fosséprez
- Examples:
  - Magnetic tape storage system
  - Magnetic drum technology
  - Racks of gas tube
  - Ferrite core research towards magnetic storage

Incremental learning process through:

- Exposure to technical problems with making and using the machine
- Participation to conferences, ex. Paris conference on automatism in 1956
- An up-to-date library in electronic computing and related fields
- The emergence of groups of skilled researchers capable of
  - Technical independence
  - With the tacit knowledge for the reading, interpretation and use of the literature

Claude Fosséprez

Staff at work in the room of the Machine Mathématique IRSIA FNRS, [c.1955] among which André Thijs and André Fisher
Source: Nicolas Rouche

5.3. Contributing at Anglo-Saxon levels of quality?

Via the 1955- CECE

Programming and technical machine issues

- See e.g. the 1957 *Manuel de programmation*, and 1958 *Pseudocode Manual*
- Development of programming practices similar to those developed in the UK
- Similarities to be found re: the elaboration of routines and of the pseudocode, esp. with contemporary Cambridge and Manchester practices (micro-programming, autocodes)

Numerical analysis

- *Development of know-how with the treatment of numerical algorithms, esp. as regards to error management:*
  - by contacts with the ETH
  - and readings on Anglo-Saxon developments

- Sample publications:
  - V. Belevitch, F. Storrer, "Le calcul numérique des fonctions élémentaires dans la machine IRSIA-FNRS," *Bull.Acad. Roy. Belg.*, XLII, 1956, pp. 543-578
  - CECE, *Document Nr 3: La résolution des problèmes d'algèbre linéaire sur la calculatrice IRSIA-FNRS*, Brussels, CECE, 1958;
  - CECE, *Document Nr 6: Eigenvalues and eigenvectors of symmetrical matrices by Lanczos method*, Brussels, CECE, 1960.

6. Closing comments