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From universal project to sunken culture : Algol in France

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Algol was a high-level programming language, defined by American and European mathematicians in the late 1950s. It provoked a wave of debates, projects and counter-projects, and remained lively in academic spheres until the 1970s. This paper focuses on Algol, less as a programming language than as a research program, as an object of circulation and translation, as a decisive step in the building of a new scientific community : computer science or *informatique*. It gives an analysis of the main French actors involved in the global Algol endeavour – small groups of computer scientists who became interested in this project, appropriated it and participated in its evolution, either within academic laboratories, R & D departments of computer companies, users or learned societies. This means grasping each group with its local, particular logic, culture and environment, in order to better understand the overall dynamic and allow comparisons at European or global scale[1].

1 This paper drew much inspiration from the SOFT-EU project group supported by the European Science Foundation, particularly from its memorable meetings in Prague, Grenoble and Leyden, which offered a treasure of stimulating lectures and intense discussions. It is mainly based on archives and primary literature, on interviews with actors from the university and the computer industry, and on a comprehensive census of all doctoral dissertations in computer science defended in France between 1956 and 1973, which I am compiling.

This paper aims at offering an overview of Algol-related events in France, their chronology and their major actors : The people and organizations involved, the motives and evolutions of their action.

How to write a local history of a transnational object ? A global chronological narrative would fit with a conceptual history of Algol – the early reflexions and definitions of a universal Algorithmic Language responding to the needs of numerical analysis, which produced Algol 60 in the late 1950s ; then the collective effort to elaborate concepts and tools, understand the logical and mathematical implications of a formal language, and extend its application field, which led around 1963 to a paradigm (arguably the first paradigm in computer science), rich with results and potential ; then Algol's influence on entire families of programming languages, including the edification of Algol 68, a new project which remained lively throughout the 1970s and provoked its share of debates and counter-projects, contributing decisively to the transformation of "automatic computing" into "computer science" and "software engineering". A perfect case of something which "became history" in both senses of the phrase, as Algol disappeared from the scene, but changed programming forever.

Yet what I am writing here is a history of Algol on French territory. More exactly, as the national framework does not make much sense in this case, an analysis of the main French actors involved in the global Algol endeavour – small groups of computer scientists who became interested in this project, appropriated it and participated in its evolution. This means grasping each group with its local, particular logic, culture and environment, in order to better understand the overall dynamic and allow comparisons at European or global scale.

This approach through successive monographs imposes a few chronological flashbacks, which I hope will not disconcert the reader. We will start with the beginning of the collective project within the French learned society for computing, Afcal, and with the policy of national science agencies which supported it. Then, we will review the Algol-related activities of a computer manufacturer, Bull, and of the main academic laboratories involved in computing in the 1960s : Grenoble, Paris, Nancy, Toulouse, Lille. Finally we will contrast Algol's fading away from the industrial practice in the late 1960s, with the boiling Algol 68 effort and the new paths taken beyond Algol by individuals and groups in the next decade.

The following narratives are guided by four main questions:

- Toward 1960, the French computing « community » was a village of a few hundred people, where almost everyone knew each other. How did Algol arrive, then circulate and spread in this *milieu* ?

- What roles played respectively University computer scientists and the French computer industry in the development and promotion of Algol in France ? Was there, for example, a division of labour between hardware manufacturers and University software experts, or was it rather a *continuum*?

- Like many scientific topics, and unlike some other programming languages, Algol seems to have vanished from the foreground of the computer scene, after a decade of intellectual excitement: Did that happen in France just as it has been told in other countries, or can we observe specific, local variations?

- Meanwhile, and in the longer term, to what extent was Algol a source of inspiration and an instrument in the self-assertion of informatics as a recognized science? From this short survey, it appears that people who had been immersed in the Algol ebullition of the mid-1960s later embraced two distinct, although related, intellectual agendas : Software engineering ; and theoretical computer science.

Note that the beginnings of computing in France were dominated by a crude fact : No stored-program computer was developed in any academic laboratory during the 1950s, contrary to what happened in most industrial countries[2]. It was in private companies (SEA, IBM and Bull) that electronic computers appeared around 1955, along with the first programmers. Academics who learned to program were primarily applied mathematicians who gained access to computing machines, and whose agenda was to promote a new discipline : Numerical analysis, considered trivial, even despicable, by the pure mathematics establishment. However, they could find decisive support from industrialists and other partners outside the University, in the context of the post-war reconstruction, of the economic modernization effort and of the military build-up, either within the Atlantic alliance or with the independant nuclear deterrence program.

A Revelation : Algol in learned societies

Algol was presented in Paris in June 1959 at the Unesco International conference of information processing societies (ICIP) [3], where the Algol-IAL committee hold a meeting and invited computer specialists to join the ACM-GAMM project[4]. In November, a preliminary meeting was organized in Paris by the German subcommittee of the GAMM, attended by 50 people from Western Europe, to select 7 delegates for the international Algol 60 conference. This conference of 13 delegates met in Paris in mid-January 1960, hosted at IBM Europe and at Bull, and specified an improved version, Algol 60. This, with the rapid translation of the Algol 60 report, was the real debut of Algol in France.

A cooperative project such as Algol fitted perfectly the purpose of the recently created Association Française de Calcul (Afcal), the French founding member of IFIP (International Federation for Information Processing), whose *raison d'être* was to foster cooperation between computer specialists from various professional backgrounds, and to integrate them in the international computing community. Typically, the French version of the Algol 60 report[5] was written by three authors : Bernard Vauquois, director of the Center for automatic translation

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2 P. Mounier-Kuhn, *L'Informatique en France, de la seconde guerre mondiale au Plan Calcul. L'émergence d'une science*, Paris, Presses de l'Université Paris-Sorbonne, 2010.

3 GAMM (Gesellschaft für Angewandte Mathematik und Mechanik) is the German learned society in applied mathematics.

4 Algol was presented in two papers, one by two French scientists, J. Poyen & B. Vauquois, "A propos d'un langage universel", the other by Friedrich L. Bauer and Klaus Samelson. "The problem of a common language, especially for scientific numeral work". *Proceedings of the International Conference on Information Processing*, Paris, UNESCO, June 1959. Journal du Congrès, n° 5, http://unesdoc.unesco.org/images/0015/001537/153718fb.pdf.

5 F. Genuys, J. Poyen & B. Vauquois, "Rapport sur le langage algorithmique Algol 60", *Chiffres* n° 3, March 1960, p. 1-44. It was the translation of A. J. Perlis, K. Samelson and other's Algol project, initially published in *Numerische Mathematik* (Bd 1, S. 41, 60, 1959). It preceded Peter Naur, J. W. Backus, F. L. Bauer, J. Green, C. Katz, J. McCarthy, A. J. Perlis, H. Rutishauser, K. Samelson, B. Vauquois, J. H. Wegstein, A. van Wijngaarden, M. Woodger, "Report on the algorithmic language Algol 60", *Communications of the ACM*, v.3 n.5, p. 299-314, May 1960.

(CNRS, Grenoble University), who was the only French co-author of the original Algol 60 report ; François Genuys, a mathematician employed at IBM's European Electronic Computing Institute in Paris, who had created a working group on programming languages within Afcal ; and a young Bull engineer, Jeanne Poyen. Published in the society's journal, *Chiffres,* the report was thus distributed to the 200 members of Afcal, and certainly read by more people.

F. Genuys, a pure mathematician whom IBM France had hired in 1957 to strengthen the interface between its *Institut Européen de Calcul Scientifique* and scientific users, had developed a passion for programming languages ever since he had been exposed to Fortran :

> "Algol had immediately interested me because of its academic flavour — there was even a Bourbaki side in Algol, this idea that mathematics is essentially a formal language !"[6].

He was in charge of a seminar on numerical analysis within Afcal, hosted at the Paris *Institut d'Astrophysique*. In 1960, Genuys shifted this seminar's focus to programming languages. A clear mind and an efficient diplomat, Genuys co-organized the 1960 Algol meetings in Paris and participated in the dissemination of Algol 60 among the French computing scientists[7]. Working at IBM's European Electronic Computing Institute in Paris, Genuys had become familiar for some years with the members of the international committee which supervised this Institute[8], and had friendly contacts with van Wiijngaarden, Bauer and other mathematicians involved in Algol, as well as with John Backus at IBM. From 1962 he represented Afcal in the committees on programming languages of IFIP (TC2) and of the International Standard Organization (ISO/TC97/SC5), both of which included an Algol working group. In the mid-1960s, he managed to obtain financial support from NATO to organize meetings on programming languages.

His seminar attracted physicists, astronomers, logicians, as well as mathematicians interested in programming. Much like the computer itself, Algol served as a common topic, problem, project and playground which gathered various people from different professional environments and diverse countries.

If Algol was hardly mentioned in Afcal's first congress (Grenoble, 1960), it took off during the following years[9]. In October 1961, A. Grasselli et E. J. Cluskey, from Princeton University, presented a modified version of Algol 60 for logical programming, intending to expand its application field[10]. From 1963 on, Algol was a main topic in about 10% of the talks given at Afcal congresses (Afcal changed its name into Afcalti, then Afiro, then Afcet, when it merged

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6 Video interview with François Genuys, Henri Leroy and François Sallé, by Pierre Mounier-Kuhn, January 2008. The Bourbaki usage is to speak of *la mathématique*, singular.

7 F. Genuys, « Commentaire sur le langage Algol », *Chiffres*, 1962, vol 5, n° 1, p. 29-53. This paper was mainly a reflexion on Algol syntax and semantics, making more explicit some concise passages of the original Algol report.

8 The members of the scientific committee were : É. Durand (Toulouse University, chairman), A. Ghizzetti (Rome University), R. Inzinger (TH Vienna), C. Manneback (Brussels), E. Stiefel (TH Zurich), A. Walther (TH Darmstadt) and M. Wilkes (University of Cambridge).

9 Still, no French speaker participated in the sessions on programming languages at the IFIP Congress in 1962, while France was well represented in the mathematical and "Real-Time" sessions (Cicely M. Popplewell (ed.): *Information Processing 1962, Proceedings of IFIP Congress 62*, Munich, August 27-September 1, North-Holland, 1962).

10 A. Grasselli and E.J. Cluskey, "Une version modifiée d'Algol 60 pour la programmation logique", *2e Congrès AFCAL*, oct. 1961, Paris, Gauthier-Villars, 1962, pp. 355-364.

with similar societies devoted to operation research, then control and command). A similar rythm of emergence is observed in the society's journal, *Chiffres*.

As soon as it was presented, Algol was criticized. At the 1961 Afcal congress, a chief programmer from Esso claimed that Algol would interest users if the Algol committee devoted as much care to improving its ease of use as it had cultivated its logical rigor ; and that the efficiency of compilers was less important than their speed, and would become even more secondary as computer prices would drop. In 1963, another Algol objector (from CNRS) explained that the Babel tower of programming languages, however inelegant, responded to practical concerns, and that developing metacompilers to produce programs easier was more useful than creating an Esperanto of computing.

Nevertheless, a working group on Algol was created within Afcalti ("TI" was added for *traitement de l'information*, stressing the society's vocation to cover all fields of data processing). It was initially an informal group, gathering "a few passionates who were sensitive, like me, to the language's beauty and even more to its recursivity[11]". Chaired until 1967 by Louis Bolliet (Grenoble University), it was altogether a meeting point of French Algolists, as they soon called themselves, and the interface with sister societies abroad and with the IFIP TC2 committee on programming languages.

Beside learned societies, international organizations dealing with industrial issues were concerned. In April 1960, a European Computer Manufacturers Association (ECMA) was created by 20 companies, of which eight British and two French (Bull and SEA), along with IBM World Trade Europe. It settled in Geneva the next year to collaborate with the International Organization for Standardization (ISO). Its purpose was to encourage adoption of standard procedures and hardware by the various manufacturers, and to avoid duplication of programming languages studies. Three technical committees were formed, respectively for :

- Input/Output;
- Symbols for flow charts;
- Common programming languages (ECMA TC2). Committees were soon added for Algol (TC5), Cobol and Fortran.

Science policy : supporting the Algol effort

Two organizations devoted to science policy at national level, CNRS and DGRST, launched programs to support research in numerical analysis and the development of Algol software, commencing in 1963. Such coordinated action was facilitated by the fact that most leaders of the young French computing profession were advisers in these bodies' committees.

Within the Centre national de la recherche scientifique (CNRS), in 1963 the appplied mathematics committee prepared a position report asserting, for the first time, the importance of research regarding information processing, "whether numeric or non-numeric". Among the major research themes, it identified programming languages, and the elaboration of "standard programs in Algol". Coincidentally, the CNRS was setting up a new research grant procedure, *Recherches coopératives sur programme* (RCP), to support priority topics by facilitating collaboration

11 Correspondence with F. Genuys, 20 October 2010.

between different teams and to foster nascent scientific communities. Algol was immediately chosen, in 1963, as the theme of an RCP n° 30 ("Etudes d'analyse numérique et de programmation"), supervised by Jean Kuntzmann (Grenoble). The RCP 30 coordinated and sponsored the various works that were being conducted in several academic labs. 150,000 FF were awarded for hardware (a modest sum allowing to rent small machines or computer hours), 15,000 F for travel grants, allowing participants to participate in seminars and meetings ; a supplement was added to pay a few doctoral students and programmers. It led to the publication in 1967 of a collective manual, *Procédures Algol en analyse numérique*, offering a hundred tested procedures and algorithms, to solve current equations used in scientific and technical research[12]. This was essentially making scientific instruments – scientific instruments implemented in symbolic instructions, rather than in mechanical gears or electric circuits. It was in line with the ambition of the Algol project : Developing sound algorithms and studying these particular mathematical objects. Thus the RCP 30 budget *de facto* supported academics who were committed not only to numerical analysis, but also to basic research in programming, and who were beginning to discuss whether it was a new scientific field (see map of French Algol centers in Fig. 6).

Tableau 1. CNRS RCP 30 : Geographical distribution of contributions.

The most committed teams were located in universities with a strong mathematical stand.

Subthemes	**Leader**	Besançon	Clermont	Grenoble	Lille	Nancy	Paris	Toulouse	**Total**
Linear algebra, linear systems	Bonnemoy (Clermont)	1	0	9	2	0	1	0	12
Linear algebra, **Calcul d'éléments propres**	Rigal (Besançon)	4	0	4	0	3	4	0	11
Resolution of algebraic equations	Lagouanelle (Toulouse)	0	0	4	0	1	0	6	11
Integral & differential equations	Pouzet (Lille)	0	0	0	6	0	0	0	6
Integral calculation	Legras (Nancy)	0	0	3	0	7	0	0	10
Approximations	Laurent (Grenoble)	0	0	12	0	0	0	0	12
Probabilities & special functions	Hennequin (Clermont)	0	5	1	0	0	2	0	8
Total		**5**	**5**	**33**	**8**	**11**	**7**	**6**	**76**

Simultaneously in 1963, the Délégation générale à la recherche scientifique et technique (DGRST) launched a program to support computer R & D. The DGRST controlled the state's whole civilian R & D budget, which enjoyed a fast growth under De Gaulle's presidency. It identified priority fields and awarded grants under *Actions concertées*, much inspired by the NSF and the British NRDC models. Computing was recognized in 1962 as a strategically and economically important domain where France was lagging and where academic-industry collaboration should be encouraged. In 1963-1965, the committee of the *Action concertée Calculateurs* secured 17,1 MF, a much higher sum than the CNRS could provide. Of this amount, 25 % were awarded to "Languages and programming" projects, particularly on compilers (theory and development) and to comparative language studies. The main beneficiaries were the academic computing labs at Grenoble, Paris and Toulouse, and the SIA, the software subsidiary of SEMA. The DGRST, like the CNRS, also supported the learned society Afcalti and its journal.

12 RCP 30 (J. Kuntzmann, ed.), *Procédures Algol en analyse numérique*, Editions du CNRS, 1967, 324 p.

The *Action concertée Calculateurs* was an important step toward the recognition of informatics as a discipline as, for the first time, it considered programming as an autonomous research field, branching out of appplied mathematics.

We may add, on the military side, the Direction des recherches et moyens d'essais (DRME), whose grant system was inspired by the US Advanced Research Projects Agency (ARPA). Its main purpose was to foster and coordinate all R & D efforts which could contribute to the development of integrated weapon systems, particularly regarding guided missiles and nuclear deterrence, but also in more exploratory directions. In 1965, a new division for Appplied Mathematics and Informatics centralized the R & D contracts which had been hitherto managed by the different Defense branches, targetting specific problems which looked promising in the long term. Regarding software, DRME sponsored various CAD, artificial intelligence and man-machine communication projects. Algol and software engineering (as we would say now) were supported through a "Generation and automatic correction of programs" budget line, with two contracts for Algol 68 in the late 1960s[13].

Note that no French authority went as far as the German Research Council, which required all computers delivered to German universities to be equipped with "Algol processors".

An early Algol 60 compiler came in spring 1963 with the installation of a Regnecentralen Gier at the French Navy Hull Yard (*Bassin des Carènes*) for hydrodynamic studies. The reason was that the *bassin*'s director, Roger Brard, was a friend of Carl Prohaska, director of the Danish Hull Yard at Lyngby. After translating the technical notes from Danish and reading the Algol report, this Navy plant became a stronghold of Algol in France, and trained people who later spun off to universities.

Bull

The Compagnie des Machines Bull[14], as a punch card machine vendor, had a long experience in servicing its clients — mostly accountants who wanted solutions, not technical problems. Teaching them how to program connexion boards, or wiring those up for the users, had been a sustained investment of Bull for two decades. When it shipped its first electronic calculator in 1952, then its first stored program computer in 1956 (Gamma ET)[15], crude programming tools came along. Bull was familiar with the accounting market, not the scientific clientele, and it was surprised to see dozens of these machines acquired by scientific users. Now, while Bull was glad to sell (or even donate) Gamma calculators to academic centers, its managers did not suspect anything useful could come from the universities. Bull was a company with a culture of industrial secrecy, rather reluctant to co-develop new products with external partners.

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13 DRME contracts n° 67-469, Algorithme permettant une utilisation efficace de la grammaire d'Algol 68, projet de traduction du rapport Algol 68 (1967-1970) ; and 69-745, Analyse des innovations du langage Algol 68 (1969-1972).

14 P. Mounier-Kuhn, (1989) "Bull - A Worldwide Company Born in Europe", *Annals of the History of Computing* vol. 11/4.

15 B. Leclerc, "From Gamma 2 to Gamma E.T.: The Birth of Electronic Computing at Bull," *IEEE Annals of the History of Computing*, vol. 12, no. 1, pp. 5-22.

Only in 1958, a year after a Gamma ET drum calculator had been installed at IMAG, the computing laboratory at the Grenoble University, did Bull give a contract to this lab for designing better programming tools. Then Prof. Vauquois, in the same Grenoble team, developed an assembler for this computer. Vauquois, IMAG and other academics established good contacts with the young engineers and mathematicians who worked as analysts and programmers at Bull's scientific service bureau, the "*Centre National de Calcul Electronique*" (CNCE) — about 50 employees, which was more than any academic computing laboratory toward 1960. The head of the programming staff was Henri Leroy, a Polytechnician who had designed the arithmetic unit of the Gamma 60, then turned to software ; both he and his assistant, François Sallé, along with other analysts at CNCE, were engineers with a strong mathematical training – a mathematical culture which was at the roots of Algol, and made them receptive to this innovation as soon as they were exposed to it.

The *de facto* division of labor which appeared at that time can be summed up as follows:

- The Bull R&D department developed a computer, including basic software.

- Academic computer scientists acquired the computer and improved the software.

- Application programs were designed by clients and by Bull's marketing department, particularly the 'CNCE' service bureau. Users groups fostered close cooperation between client programmers, Bull R & D and academic computer scientists.

In the late 1950s, Bull developed a big universal computer with multiprogramming capabilities, the Gamma 60. Due to the mismanagement of this enormous project and to the lack of experience of what resources and time were needed for software development, the first Gamma 60s were shipped with only a primitive version of the operating system. The machine was not yet on the market when CNCE chief programmers, whose role would be to write application programs on the new machine, realized that no team in the R&D department was really in charge of developing basic software, and persuaded the management to assign them with this task. Only in 1960, with the Algol meetings in Paris and a conference given at Bull by A. Perlis in September, did Bull programmers discover the world of high-level languages and compilers.

To catch up with lost time, a vast programming effort was undertaken to create software for the existing machines and for those under development. Algol became central in Bull's strategy (more precisely in the basic software team's strategy), as the company saw Fortran as an IBM product. This effort took place within Bull and in partnership with universities. Within Bull, Jeanne Poyen, who had participated in translating the Algol 60 report, led a team which specified a scientific language, AP3, combining Algol's mathematical rigor with practical functionnalities.

Two universities equipped with Gamma ETs became software partners of Bull. In Lille, an "APB" symbolic language was developed, combining Algol approach with Bull's AP2 assembler features[16]. It was used on the Gamma ET and disseminated through this machine's user group, then adapted to the faculty's new IBM 1620.

In Grenoble, Bull awarded a contract to IMAG, in October 1961 for various programming languages studies, particularly to write an Algol compiler for the Gamma 60. The latter never

16 P. Bacchus & P. Pouzet. "Autoprogrammation pour calculateur Bull Gamma ET: APB", *Chiffres, Revue Française de Traitement de l'Information*, 1964, n°1, p. 3-14. The journal became then *Revue d'Informatique et de Recherche Opérationnelle*.

became operational, as IMAG finally chose an IBM 7044. Despite this specific failure, the collaboration between Bull and the Grenoble computer scientists evolved into a durable relationship, as we will see later.

It was inside Bull that an Algol compiler, offering a large subset of the language, was developed and completed for the Gamma 60 in December 1962, thus becoming the first Algol compiler made in France[17]. It was used immediately by Bull's circuit designers to improve their CAD algorithms[18]. Although it aimed at counteracting IBM on the big mainframe market for scientific users, it did not become popular among Bull clients, as Algol was unfit for commercial data-processing and left to be desired for I/O control.

Algol also inspired a "C7" language specified for the Gamma 60, using Algol's hierarchy of block structure ; "C7" tricks allowed to process large matrices, for which Algol required too much storage and computing time[19]. A "Mage" programming method was developed on a Bull Gamma ET[20]. Another attempt within Bull was an "Algol P", with off-line read-write files capacities, to expand Algol toward commercial applications, Bull's main market, but it led to inacceptable processing time. A 114-page *Cours de Programmation Algol* for the Gamma 60 and the RCA 301 (built under licence by Bull) was published by the Bull programming school in 1963. Overall, Algol was central in the software culture of many Bull programmers in the mid-1960s[21]. Sallé participated in the Algol 68 committee of Afcalti, until 1966 when he definitely shifted his interest to system development and left his seat to Leroy.

This does not mean that Algol was ever central in the software catalogue of Bull machines, or in the clients' practice. Assembly codes remained dominant throughout the decade for economic reasons, while Cobol became the main high-level language in commercial installations, as Fortran was to scientific users.

Bull's takeover by General Electric in 1964 did not hamper the company's interest in Algol. When GE introduced its large GE600 systems, Bull-GE developed an Algol compiler, considered necessary for the European scientific market ; the compiler written in Algol was simulated on the Gamma 60, then implemented at GE in Phoenix (Arizona)[22] ; it was decisive to convince one of

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17 H. Leroy, "Sur une méthode de compilation et d'exécution des programmes Algol", *3e Congrès AFCALTI*, Paris, Dunod, 1963, pp. 191-197. Leroy headed the 4-person team which developed the compiler. His paper explained that the compiler's general organization was similar to the one presented by E.T. Irons in 1961 in the *Communications of the ACM*, allowing for a speed comparable with Samelson and Bauer's classic method. For the execution of object-programs with recursive procedures, Leroy had adopted Dijkstra'solution implemented on the X1 machine.

18 Correspondance with Claude de Marsac (Bull), 31 March 2007.

19 F. Sallé et J. Newey « Spécification d'un système de programmation et d'utilisation pour un calculateur scientifique de grande ou moyenne puissance. Le système C7 », *3e Congrès AFCALTI*, Paris, Dunod, 1963, pp. 199-206.

20 L. Bosset, "MAGE, A Language Derived from Algol Adapted to Small Machines". *Symbolic Languages in Data Processing*. Gordon and Breach, New York, London, 1962, pp. 473-481.

21 H. Leroy published an "Introduction au langage Algol", *Chiffres*, 1963, vol 6, n° 1, p. 59-73. In a 1963 book, Jeanne Poyen considered that Algol 60 was a base and a model for future universal languages, that it would evolve through international meetings, and give birth to new programming methods (J. & J. Poyen, *Le Langage électronique*, PUF, coll. « Que Sais-je ? », 1963, p. 115-116).

22 R. W. Bemer, "A Politico-Social History of Algol (With a Chronology in the Form of a Log Book)", http://www.softwarepreservation.org/projects/Algol/paper/Bemer-Politico_Social_History_of_Algol.pdf, p. 156.

Bull-GE's first GE600 clients, ASEA in Sweden, which required the delivery of the machine with an Algol ready to use[23].

Grenoble : The Applied Mathematics Institute (IMAG)

The Grenoble University included a faculty of science and a school of electrical engineering, which had required the appointment of a professor in applied mathematics in the late 1940s. Jean Kuntzmann had been trained as an algebraist, but after the war he turned to "more useful mathematics", and he responded to this demand by teaching numerical analysis, by creating a computing service and by assembling a research team on these matters. Beginning with desk machines, he acquired a Bull computer in 1957. Scientific expertise and advanced equipment attracted R & D contracts from clients outside the University, such as Electricité de France, the Air Force, or computer manufacturers like SEA and IBM, later Bull. These contracts, in turn, brought not only money, but new problems, good reputation and a broadened professional network, generating a virtuous circle of resource reinvestment and allowing particularly to pay students as programmers and to hire assistants and researchers among them. The *Institut de Mathématiques Appliquées de Grenoble* (IMAG), 6 research staff in 1958, employed 53 in 1963. This cumulative growth process was observed in other French universities which became strongholds of computer science, such as Toulouse and later Nancy or Lille, but Grenoble remained prominent in software R & D.

Grenoble was also the only French university which had established frequent contacts with the German numerical analysis and computing community. Kuntzmann participated in the large Darmstadt computer conference organized in 1955 by Alwin Walther[24]. Two years later, a smaller Germanic-French meeting gathered in Munich, to discuss about applied maths and computing training, and compare local or national experiences ; Kuntzmann's report advocated for developing education in a promising branch of mathematics, algorithmics[25]. Thus a connexion was established with some of the German-speaking numericians who were weaving the "Algol conspiracy".

The connexion was reinforced with the arrival of Bernard Vauquois. Trained as an astrophysicist in Paris, Vauquois had learned to program on an IBM 650 at IBM France scientific service bureau ; he had devoted his doctoral dissertation (1958) to electromagnetic radiations, but had added a second thesis (which was a requisite for the *doctorat d'état*, to avoid hyperspecialization)

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23 Correspondance with Michel Taine (Bull), 31 March 2007.

24 Fachtagung *Elektronische Rechenmaschinen und Informationsverarbeitung,* Darmstadt, 25-27 October 1955. Hartmut Petzold, « Eine Informatiktagung vor der Gründung der Informatik: Die Darmstädter Konferenz von 1955 », in Rudolf Seising, Menso Folkerts & Ulf Hashagen (eds.), *Form, Zahl, Ordnung. Studien zur Wissenschafts- und Technikgeschichte. Ivo Schneider zum 65. Geburtstag*, Wiesbaden, Franz Steiner Verlag, 2004, p. 759-782. I thank H. Petzold for the names of the few auditors from France.

25 *Colloque sur la formation des ingénieurs et des mathématiciens en analyse numérique sous le point de vue des machines mathématiques / Arbeitstagung über die Ausbildung von Ingenieuren und Mathematikern in numerischer Mathematik unter Berücksichtigung der elektronischen Rechenanlagen*, Mathematisches Institut der TH München, Munich, 27-29 Mai 1957. I write "Germanic" as participants came from Zurich and Vienna as well as from the FRG. The French were G. Brillouët (Nantes), É. Durand (Toulouse), J. Kuntzmann (Grenoble), R. Rind (IBM France), J. Ville (Paris). Among German-speaking participants stood F. Bauer (TH München), J. Heinhold (TH München), K. Strubecker (TH Karlsruhe), R. Inzinger (TH Vienne), R. Sauer (TH München), E. Stiefel (TH Zurich), A. Walther (TH Darmstadt), K. Brokate (IBM Deutschland).

on "*Arithmétisation de la logique et théorie des machine*s". Kuntzmann invited him then to join the University of Grenoble, where he created a Center for automatic translation, with CNRS and military fundings. Thus Vauquois was perhaps the first French academic interested altogether in computer programming, in logic, in algebra and in formal linguistics. This explains his early participation in the Algol 60 committee, and the prompt diffusion of Algol at IMAG. Moreover he spoke English decently, which was not the case of many French scientists then (French and German were common languages in the international maths community). While Vauquois soon turned most of his attention to machine translation of natural languages, which excited his interest in the similitude between translating and compiling processes, he still hold a chair in "electronic computing", participated in Algol meetings and in doctoral jurys of theses on programming languages.

Algol compilers

Algol became the central topic of two research efforts in Grenoble : one to develop compilers, the other to write numerical analysis programs in this language, sponsored by the CNRS ; as we have already given a glimpse of the latter with RCP 30, we will focus on the former.

In October 1961, Kuntzmann assigned Louis Bolliet, an electrical engineer who had become his assistant for programming, to create a research group on languages and programming systems, and to design Algol compilers for the most common computers being installed in France. An ambitious enterprise, as it implied altogether elaborating most of the theoretical bases of this new field, and developing advanced pieces of software which could work efficiently, yet while implementing the whole of Algol as specified in the definition reports, with its full potential… and problems.

The uncompromising intellectual ambition responded to the mathematical culture of Kuntzmann's and Vauquois' circle, while Bolliet's education as an engineer meant that attention would be paid to deadlines and practical results. The stress was put altogether on the completedness of the compiled language, on the systematic use of recursive procedures, and on the immediate integration in the machines' operating systems. Practical constraints were considerable. It took 1 to 1 ½ year for a trained, high-level programmer to write a compiler, then to punch it on cards or paper tapes. A main problem was to pack relatively large programs on the small memory of 2nd-generation computers: A programmer could spend an hour trying to economize a single word in an instruction ! Despite initial expectations, it was impossible to reuse a compiler designed for a specific computer on another. Thus, for each machine model, a compiler had to be written from scratch. Only the grammars could be reused.

In 1962, Bolliet's group gave birth to three teams initially, each specialized in a particular machine, and to a seminar which reviewed and discussed the state of the art in this field. Such a targetted research enterprise propelled Grenoble at the vanguard of French programming. Drawing from recent work on syntaxic analysis and from previous experience on compilers for other languages, the group chose an approach based on memory stacks. In February 1963, IMAG organized a conference on Algol, supported by DGRST, with a hundred participants from the academic world and the industry; Bolliet's team was able to present its first results, spurring emulation in other faculties. A year later, in a keynote lecture at the 3rd conference of the French computing society, Bolliet offered a detailed overview of compiler techniques, presenting particularly the works of Irons, Rutishauser, Perlis, Ershov, Arden, Bauer, Samelson, Grau and

Dijkstra[26] ; this gives us a glimpse of the discussions at the Grenoble seminar. Starting relatively late, the French could take advantage of these Algol pionneers' early experiments and chose among a variety of approaches[27].

A regular flow of theses, reports, and of course operational compilers followed. The first doctoral dissertation on this topic was defended in 1963 (Jean-Loup Baer, *Etude critique et données de compilation du langage Cobol*), comparing Cobol with Algol and criticizing its lack of formal definition. As it was a study in programming, not in applied mathematics (despite its official filing), it can be considered one of the first doctoral dissertations in *Informatique* in France.

A prominent result of this research enterprise was Jean-Claude Boussard's doctoral work[28]. In collaboration with the whole Bolliet team and with IBM France laboratories, it produced an Algol 60 compiler fully integrated in the IBM 7090 and 7044 operating systems, which was put to use in January 1964 in several computing centers, and soon distributed through the SHARE user group[29]. It was also the first *doctorat d'état* in computing science – the *doctorat d'état* being the highest degree in the French University, allowing its possessor to run for full professorship. Boussard immediately seconded Bolliet in the *Programmation & software* course. His bibliography shows that he (and certainly the rest of the group) was aware of the work done by A. P. Ershov on the BESM in USSR, of N. Chomsky on the formal properties of grammars, and of course on the various authors whose work was presented in Bolliet's survey at the Toulouse conference. Bolliet himself wrote his dissertation, *Notation et processus de traduction des langages symboliques,* for a *doctorat d'état* in "applied sciences", defended in 1967.

On the industrial side, Bull subcontracted to IMAG the development of Algol and Cobol compilers (the first one lagged[30], but the second one was duly delivered), and of various scientific software programs for the Gamma 60 ; these contracts amounted to nearly 1 MF in 1961-1964

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26 Louis Bolliet, « L'évolution des techniques de compilation », *3e Congrès de l'AFCALTI* (14-17 mai 1963, Toulouse), Paris, Dunod, 1965, pp. 21-58.

27 This is explicit, for example, in the dissertation of J. Le Palmec (1966), *Étude d'un langage intermédiaire pour la compilation d'Algol 60: application à un calculateur de type microprogrammé, CAE 510*, who adopted Dijkstra's method to design a compiler for a small machine, and compared it with Randell & Russel's implemented simultanously on the KDF9 in Britain, and with other approaches tried in Grenoble.

28 J.-Cl. Boussard, *Etude et réalisation d'un compilateur Algol 60 sur calculateur électronique du type IBM 7090/94 et 7040/44,* Thèse de doctorat ès sciences appliquées, Grenoble, 1964, 380 p. J.-Cl. Boussard, "An Algol Compiler: Construction and Use in Relation to an Elaborate Operating System", *Communications of the ACM*, 1966, vol. 9, n° 3, p. 179-182. Comment in J.-Cl. Boussard, "Le premier compilateur Algol sur grosse machine IBM, intégré au système d'exploitation IBSYS/IBJOB", unpublished, 2008.

29 The Algol compiler for IBM 7090 was completed and running in October 1963, the version for IMAG's new IBM 7044, two months later. Boussard recalls that, given the technology of these machines, it took great efforts to execute compiled programs with a performance not too inferior to what was normally achieved with usual languages (Fortran) : An optimal 1.3 ratio without recursivity.
A linguistic question arose, as Boussard used French word delimiters, instead of the standard English word delimiters. Questioned about this, Boussard observed that the word delimiters or their abbreviations could be used arbitrarily in English or in French, and that it was also technically valid to have a mixture of words in the two languages (Correspondence between M. Lietzke and J.-Cl. Boussard, Sept.-Oct. 1963, reproduced in R. W. Bemer, "A Politico-Social History of Algol (With a Chronology in the Form of a Log Book)", p. 209). The French translation of the Algol report had recommended that English words be used for programming purposes.

30 J. Le Palmec, in his dissertation on the CAE 510 Algol compiler he designed (1966), still mentioned an Algol compiler completed at IMAG for the Bull Gamma 60, and "operational in January 1964".

(equivalent to \$ 200,000)[31]. Designing compilers under contract became a specialty of IMAG, which developed Algol compilers for for different manufacturers' machines (CAB 500, CAE 510, IBM 1130, Philips P 8000). While cashing in revenues, the Grenoble lab took care to draw also novel problems, intellectual challenges and doctoral research topics from these tasks. Working on such a variety of machines, from mini-computers to large mainframes, gave IMAG the opportunity to explore different practices, different technical compromises and software styles.

The IMAG published the first French Algol manual in 1964 [32]. Bolliet's coauthors, Gastinel and Laurent, were numerical analysts, and the book was explicitely aimed at practitioners of scientific calculation, much like the collection of programs produced in RCP 30 under Kuntzmann's direction. Meanwhile, it stressed the fact that Algol was the first attempt to apply automata and formal language theories to programming, offering new possibilities to study and develop languages.

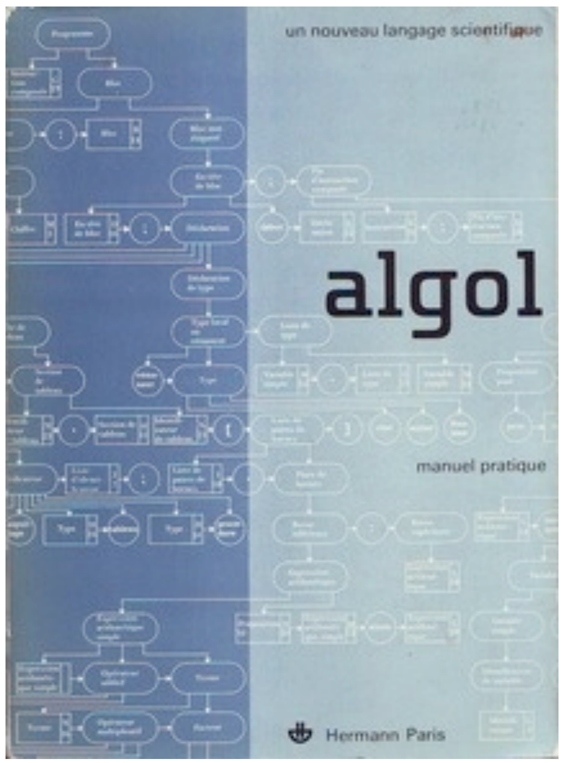

Figure 1. First French book on Algol. L. Bolliet, N. Gastinel, P.-J. Laurent, *Un nouveau langage scientifique : Algol. Manuel pratique*, Paris, Hermann, 1964. The publisher, Hermann, took great care of the book's typography and had special characters designed for printing Algol formulas by the famous Swiss typograph Adrian Frutiger, who named this alphabet "Algol".

31 Correspondence between IMAG (Bolliet, Kuntzmann) and Bull (Sallé, Leroy, Adrien), 1958-1964 (IMAG 150).

32 L. Bolliet, N. Gastinel, P.-J. Laurent, *Un nouveau langage scientifique: Algol. Manuel pratique*, Paris, Hermann, 1964.

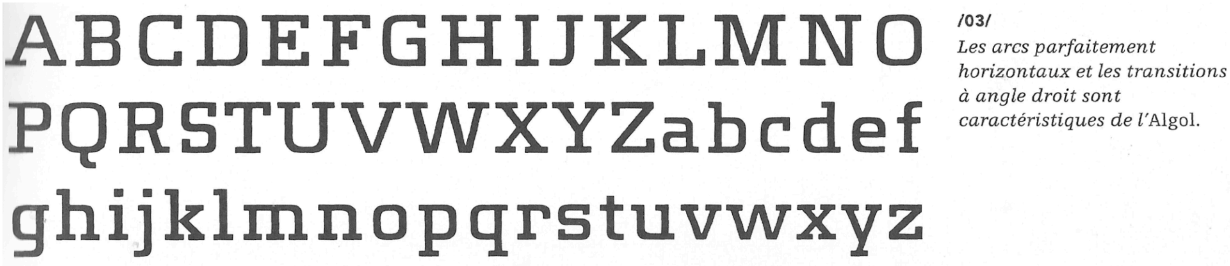

Figure 2. Algol alphabet by A. Frutiger (1964).
(source : Heidrun Sterer & Philipp Stamm (2009), *Adrian Frutiger, Caractères. L'oeuvre complète*, Birkhaüser, Bâle, p. 161).

The Grenoblois began to preach the Algol gospel, influencing computer specialists in other universities ; for example Bolliet gave a seminar in 1964 in Rennes, persuading the audience to adopt the Algol 60 agenda. The team became attractive at international level. An Austrian student, Georg Werner from the Vienna Technische Hochschule, chose Grenoble to write his dissertation on *Etude de la syntaxe d'Algol - Application à la compilation* (1964) ; he developed the CAB 500 Algol compiler and became an IMAG member, then a professor at Lille. An Englishman trained at Oxford University, Michael Griffiths, was invited by Bolliet to work in Grenoble, and later took a chair in Nantes. Grenoble computer scientists became a local community with an international identity.

That Grenoble had become a star in the global Algol constellation was confirmed when it was put in charge of organizing the 6th meeting of the IFIP's Working Group 2.1 on Algol. The group met in October 1965 in St-Pierre-de-Chartreuse, a quiet mountain village above Grenoble. Algol official history recalls that three reports describing more or less complete languages were amongst the contributions, featuring a new technique for language design and definition. In one of the participants' memoirs[33], at this meeting "we had a draft of an excellent and realistic language design which was published in June 1966 as "A Contribution to the Development of Algol", in the *Communications of the ACM*. It was implemented on the IBM/360 and given the title Algol W by its many happy users. It was not only a worthy successor of Algol 60, it was even a worthy predecessor of Pascal." At the same meeting,

> "the Algol committee had placed before it a short, incomplete and rather incomprehensible document describing a different, more ambitious and, to me, a far less attractive language",

which eventually became Algol 68. Yet other participants enthusiastically embraced the Algol 68 project, including a number of Grenoblois such as J.-C. Boussard or L. Trilling.

The next year, a NATO summer school on programming languages was organized in another nearby ski resort, Villard-de-Lans, by F. Genuys (IBM and Afcalti)[34]. Beside the intellectual challenges of the meeting, this conference brought a new international opening to IMAG : A participant was Prof. Pierre Robert, from the University of Montréal, who soon invited junior computer scientists from Grenoble to teach and pursue their post-doctoral research in

33 Tony Hoare, ACM Turing Award lecture, 1980, *The Emperor's Old Clothes*. Full article in *Comm ACM* 24(2), 75-83 (1981), reprinted in *Essays in Computing Science* (Hoare and Jones, eds.), Prentice-Hall 1989..

34 F. Genuys (ed.), *Programming Languages*, Academic Press, 1968.

Montréal[35] ; his computer department was launching a research on operating systems, and welcome the talents trained in Grenoble.

In the mid-1960s indeed, Bolliet's team broadened its research scope to systems, a natural extension of compiler work. It developed Diamag, an Algol conversational, multiple access system[36] which, implemented on the faculty's IBM 7044, allowed simultaneous access to 32 users. Here again, Grenoble was leading, as this was the first operating system developed in a French university[37]. The Diamag project allowed to test these novel concepts on IMAG's mainframe and satellite computers. It trained several doctoral students who devoted their theses to various aspects of the system[38] and produced a number of publications, contributing to the growing flow of Algol literature[39].

Meanwhile, Bolliet had spent a semester at IBM, NY, in 1964, in a team responsible with the development of a *New Programming Language* (PL/1). This experience, added to the Diamag achievement, helped French IBMers convince their hierarchy to establish a joint "Scientific Center" at the Grenoble University in 1967. The center was co-directed by Bolliet, on the University side, and by Jean-Jacques Duby on IBM's side. At the same time, IMAG received the most advanced IBM machine, a 360-67 designed for time-sharing. This made Grenoble the best equipped of all French universities, far ahead even of Toulouse and Paris in terms of computer power and architecture, and enabled it to push its research effort within the international scientific competition.

Reflexions on compilers and programming languages (essentially Algol's would-be successors, like PL/1) remained central in this new team's culture, but other research directions were pursued, particularly virtual machines, virtual memory and other fundamental concepts which were to change computing in the decade to come. Meanwhile, Algol remained essential in IMAG's programming courses until the mid-1970s.

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35 The first *Grenoblois* invited in Montréal were Laurent Trilling (1967-1970), Alain Colmerauer (1967-1970), Jean-Pierre Verjus (1968-1970), Olivier Lecarme (1970-1974). There were also several Swiss from the Lausanne Polytechnicum, who developed exchanges with Rennes and Grenoble.

36 "The Diamag system is an on-line version of Algol which adds a number of language elements to permit communication with the time-sharing system." (Jean Sammet, *Programming Languages: History and Fundamentals*, Prentice Hall 1969, p. 195).

37 For more details on Diamag and on the Grenoblois' spin-off, see Verjus, J. P. (1990), "Programming in Grenoble in the 1960s and those who Flew from the Nest". *Annals of the History of Computing*, 12, 95-101.

38 Among others, J.-P. Verjus, *Étude et réalisation d'un système Algol conversationnel*, Dr.-Eng. thesis, Grenoble, 1968. M. Griffiths, *Analyse déterministe et compilateurs*, doctorat d'état thesis, Grenoble, 1969. M. Griffiths' dissertation on the automation of compiler production was the first *thèse d'état* to be officially labeled *Informatique*, instead of *Sciences appliquées*.

39 Particularly A. Auroux, B. Bellino & L. Bolliet, "Diamag, a Multi-access System for On-line Algol Programming", *Proc. AFIPS*, New York, Spartan Books, 1966 SJCC, vol. 28. L. Siret, M. Bellot, J.-P. Verjus, "DIAMAG 2, système conversationnel à accès multiple", *Revue francaise d'informatique et de recherche opérationnelle*, September 1968, n° 12 (B2), p. 3-44.

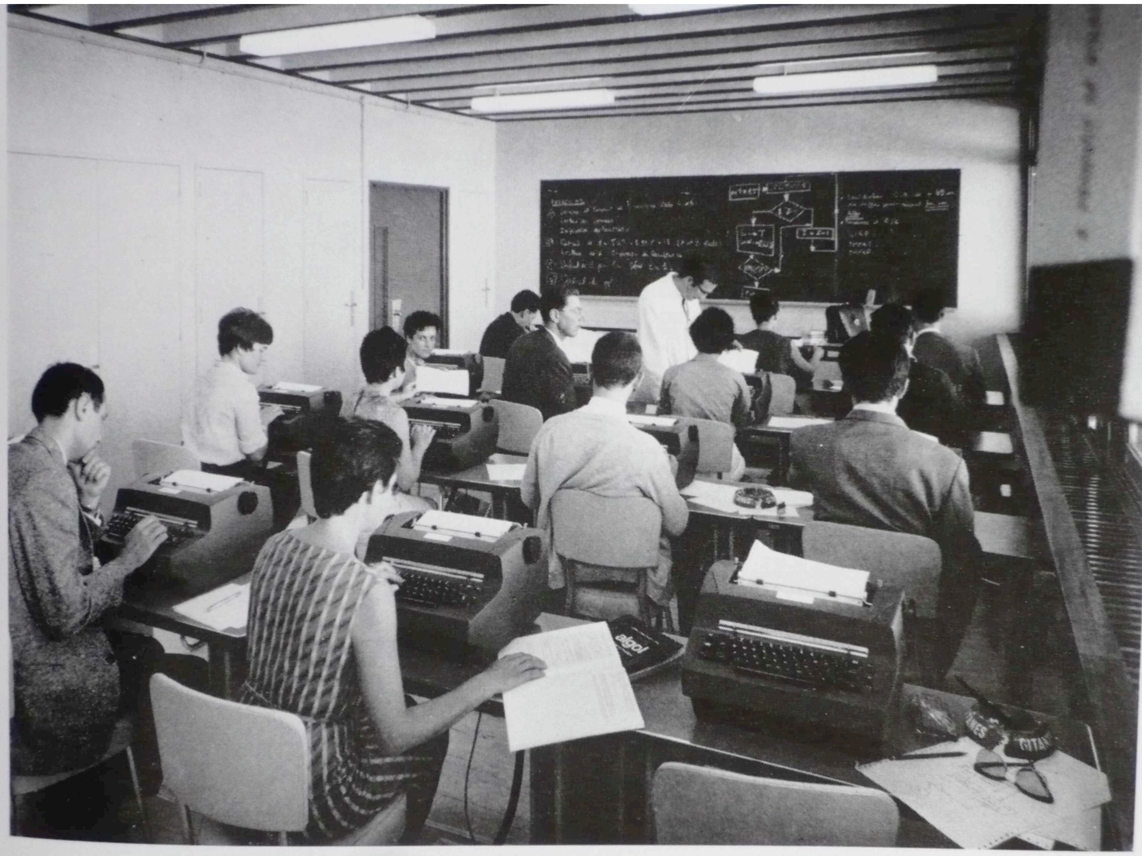

Fig. 4. — Seize étudiants compilent et exécutent simultanément des programmes différents

Figure 3. Toulouse time sharing Algol.
In 1965, a CAE 510 computer was installed at the *Centre d'Informatique* of the University of Toulouse. An Algol compiler and an interpreter were developed on this small machine, along with a time sharing system which allowed 16 students to work on 16 different programs. The system was inaugurated in December 1966, and later adapted to medical applications. Mathematics in Toulouse were not as predominant as they were in Paris, Nancy or Grenoble. Computer scientists were more oriented toward hardware and system development than toward the mathematics and theory of programming. The investment in Algol was aimed mainly at practical purposes : To achieve a working system to teach students programming.

Paris

In Paris, the Institut Blaise-Pascal (IBP) was CNRS' main computing center and computer science laboratory[40]. Its director, René de Possel, hold a chair in numerical analysis at the Faculty of Sciences since 1959. An *Institut de Programmation* for training computer users at all levels was added in 1963.

In the early 1960s, Algol became important in the agenda of IBP's computer scientists. The director of the computing center, Louis Nolin, a philosopher trained in mathematical logic, undertook theoretical research toward a more rigorous definition of Algol syntax, with applications to the compilation and translation of Algol in various machine codes[41]. Nolin was assisted in this research by a young mathematician from Ecole normale supérieure, Maurice Nivat[42]. An algebraist with a strong interest in linguistics, André Lentin, worked on extending Algol to non-numerical data processing.

From 1963, a newcomer in this circle, Marcel-Paul Schützenberger, broadened the perspectives decisively. A very original personality, Schützenberger had been a medical doctor, a statistician and a specialist of information theory, but he was essentially an algebraist. His encounter with linguist guru Noam Chomsky at MIT had led to a seminal paper on the algebraic theory of languages, which happened to provide a powerful tool to describe programming languages. Schützenberger's high intellectual standards attracted researchers who worked on code theory, formal languages, automatas and compilers, etc. Working on Algol had prepared IBP researchers to be receptive to Schützenberger's cross-disciplinary explorations (context-free grammars used in the description of Algol had been also conceptualized by Chomsky). In M. Mahoney's words, Schützenberger brought "the agenda of semantics" to the Paris group. This was particularly obvious in Nivat's doctoral dissertation on the transduction of Chomsky's languages and in the studies he conducted with Nolin[43].

Another newcomer, Jacques Arsac, was, like Vauquois, an astrophysicist whose computing needs had reoriented towards numerical analysis and programming. An inventive mind, he had developed and compiled a language to ease the task of programming on the IBM 650 of the Paris Observatory. When an IBM 1401 was added in 1962, he developed an Algol

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[40] A. Collinot & P.-E. Mounier-Kuhn, « Forteresse ou carrefour : l'Institut Blaise Pascal et la naissance de l'informatique universitaire parisienne », *Revue pour l'histoire du CNRS*, 2011, n° 27/28, p. 85-94.

41 Nolin gave a lecture, on 23rd November 1961, at the Afcal seminar on symbolic languages organized by F. Genuys, and published it later (L. Nolin, « Quelques réflexions sur les langages de programmation », *Chiffres*, 1963, vol 6, n° 1, p. 9-28). He recommended to to build programming languages by following the axiomatic method established in mathematics, as exemplified by Algol. The paper also explained that concrete problems of designing algorithms would be better approached in the light of the reflexions on computability produced by logicians since the 1930s.

42 L. Nolin and M. Nivat, « Sur un procédé de définition de la syntaxe d'Algol », *Publications de l'IBP*, 1963.

43 M. Nivat and L. Nolin, Contribution to the Definition of Algol Semantics. *Proceedings of the IFIP Working Conference on Formal Language Description Languages*. T. B. Steel, Jr. (Ed.), North Holland Publishing Co., Amsterdam, 1966, pp. 148-159. M. Nivat, *Transduction des langages de Chomsky*, Annales de l'Institut Fourier, 18, Grenoble, 1968, p. 339-455.

compiler and a Fortran syntax analyzer, and presented them in Genuys' seminar at Afcalti[44]. Among the audience sat Nolin, who invited Arsac to teach programming at Institut Blaise-Pascal, and soon to become head of the newly created *Institut de Programmation*. In 1965, Arsac was elected full professor at the University of Paris in a *chaire de Programmation*, one of the first chairs in computer science in France. Yet, until then, Arsac had not published anything on Algol, as he considered that his present scientific profile was in numerical analysis (his first book was on Fourier transform) ; teaching programming was just technical education.

Another carrier of Algol into IBP was the Elliott 803 computer, which came in 1962 with a remarkable Algol 60 compiler designed by C. A. R. Hoare in Britain.

The most visible outcome of the Institut Blaise-Pascal's work on Algol was a treaty written by its four leading computer scientists, *Algol, théorie et pratique* (1965)[45]. Published a year after the Grenoble manual, it carried something of a Parisian reply emphasizing the need for a more theoretical approach[46]. More exactly, it was two books within one : The part written by Arsac was in line with his effort toward programmer education, while the three other authors were essentially interested in the algebraic and linguistics implications of the research on Algol – particularly in Nivat's mind, one needed to shift the focus on semantics, not merely on syntax as was implicitely the case in Grenoble, where Nivat was appointed during a few, unhappy years.

The fact that two of the four authors were *Normaliens*, graduates from the highly purist Ecole Normale Supérieure, was a step toward the legitimation of a "computing science" in French academic circles (or possibly toward the authors' academic suicide?).

44 J. Arsac's autobiographical notes, and interview with the author. This Algol compiler was not described in any publication, as Arsac still considered this topic too technical.

45 J. Arsac, A. Lentin, M. Nivat, L. Nolin, *Algol, théorie et pratique*, Paris, Gauthier-Villars, 1965.

46 According to A. Lentin, the Parisian team had not read the Grenoblois' manual, which was not even ordered by the Institut Blaise Pascal's library – another sign of the tension between the Grenoble and Paris computer scientists (author's oral interview with A. Lentin, 6 June 2011). Indeed, the library catalogue of the Paris University which inherited the IBP's library does not contain any reference to the Grenoble book.

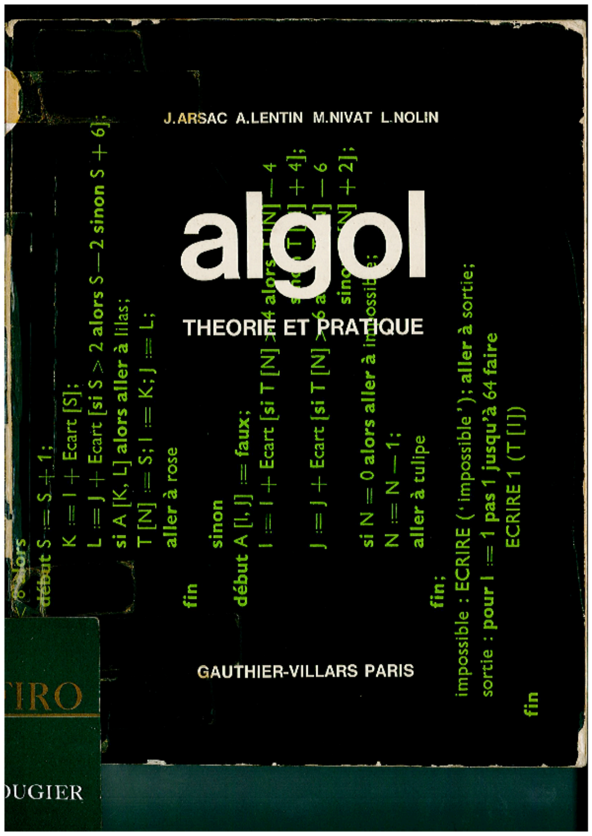

Figure 2. The Paris Algol treaty

Figure 4. The right programming spirit.

In 1967, the Institut de Programmation (IP) was about to move to the new science faculty at Orsay, south from Paris, with its NCR-Elliott 4130 computer. Astérix and Obélix, whose adventures *with the Britons* had just appeared, inspired this cartoon by an IP assistant. Insiders could recognize the silhouettes of an assistant carrying the 4130, and of Prof. Jacques Arsac with a flask of “Algol”, indispensable to give students the true programming spirit.
(drawing by Bernard Robinet, *Progrès et Science*, special issue on Institut de Programmation, 4th quarter 1967).

The Institut Blaise-Pascal annual reports show that, all along the 1960s, Algol and Fortran were the main languages used and taught, with compilers being written for internal use on the many computers installed at the institute. When the IBP developed a time-sharing system for its new IBM/360-40 in 1966 (a way of appropriating IBM technique which was not fully approved by IBMers…), Algol was chosen as the normal programming language for its users, who would type their programs and see them corrected online by a specific syntaxic software :

> “For this reason, Algol (a slightly simplified version) was chosen. The procedure structure of this language makes it particularly well adapted to this kind of organization ; moreover, it fits perfectly with *la logique des choses*, and is in the best tradition of the mathematical language.”

The choice of Algol was also justified by the growing array of algorithms and procedures written in Algol, either within the RCP30, or in the scientific journals, which « become everyday more numerous[47]. » Beside experimenting with Algol and software development, the purpose was to facilitate the users' direct access to the computer, so that IBP computer scientists could devote more time to their own research, instead of serving clients. Nolin himself was designing a new, universal language, ATF, in collaboration with the SEMA software company.

Yet, in the late 1960s, Algol was no longer taught to scientific users from other disciplines, for whom the main languages were Fortran and PL/1 [48] ; it still remained prominent in the "practical programming training" of the Masters in Informatics of the *Institut de Programmation* ; it was also one of the two main languages taught in the more professional-oriented programmer curricula, the other being a list language[49].

While the IBP teams had been immersed in the Algol experience, they were not as involved in the Algol project as their Grenoble or Nancy colleagues[50], and from this experience they soon moved to new research directions.

Arsac had become a leading specialist of programming languages, which made him a frequent member of doctoral jurys in Grenoble and other universities, as well as in Paris ; and, since 1964, he had broadened his scope to operating systems, on which he wrote a book published in 1968. He was also a member of IFIP Education committee (TC3), and participated in IFIP's first computer science curriculum. It was this array of activities which made him realize that computing was an autonomous discipline, "the science of information processing", distinct from mathematics, and deserved full academic recognition[51]. Arsac would devote the rest of his professional life propagating this conviction, along with pursuing research on algorithmics, languages and software reliability.

At the convergence of numerical analysis and programming, algorithmics was becoming a cornerstone in the foundation of computer science – a direct consequence of the Algol project. Nivat, influenced by his own experience and by D. Knuth, started teaching a course on "Mathematics and algorithmics" at the *Institut de programmation* in 1967. From there, the group around Schützenberger, Nivat and Nolin took a path which led it to participate in the transnational construction of a "theoretical computer science" :

> "A major methodological and conceptual turn was the creation of IFIP WG2.2, which addressed the problem of semantics, leading to a profound revision of programming. […] The idea that programs could be seen as mathematical objects was not entirely new ; yet once visibly, clearly worded, it opened new, immense paths to research[52]."

The IFIP WG2.2 met for the first time in 1967, and Nivat attended it in 1969.

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47 CNRS Institut Blaise-Pascal, *Rapport d'Activité 1966*, Comité technique de l'IBP.

48 CNRS Institut Blaise-Pascal, *Rapport d'Activité 1968*, p. 9.

49 In Paris, only two doctoral dissertations mentioning Algol in their titles were prepared, in a late period (toward 1970) ; both were devoted to compiler or system development, and fall roughly in the "software engineering" category.

50 Faculté des Sciences, Institut de Programmation de l'Université de Paris. *Maîtrise d'Informatique ; Diplômes de Programmeur et d'Expert en traitement de l'information*, 1967-1968.

51 J. Arsac, *La Science informatique*, Paris, Dunod, 1970.

52 M. Nivat's interview with P. Mounier-Kuhn, 2009.

In 1970, Schützenberger and Nivat proclaimed the birth of "theoretical computer science" in France, grouping three research fields : Automata and language theory, algorithmic complexity, theory of programming. The new subdiscipline aimed evidently at attracting good mathematicians to computer science, as well as to give it more legitimacy in academic institutions. Young French graduates who had passed Ph.Ds in American universities with DGRST grants joined the movement. Initiated at IRIA, the research institute set up by the Plan Calcul (while the IBP was dissolved in 1969), theoretical computer science soon conquered positions at the university of Paris, where Nivat, Nolin and Schützenberger created in 1972 a laboratory for *Informatique théorique* with CNRS support.

Leagued with other European scientists, Nivat simultaneously tried to persuade the European Economic Community and other international organizations to launch a common scientific policy regarding computer science. A report was written to this end for OECD in 1971[53]. As the project of a "European software institute" failed, Nivat and his friends (Corrado Böhm, etc.) turned to founding a learned society. In January 1972 in Brussels, they created the European Association for Theoretical Computer Science and its journal, *Theoretical Computer Science*, centered on three major themes: Theory of algorithms and complexity, Automata theory and formal languages, Theory of programming. Six months later, the first International Colloquium on Automata, Languages and Programming (ICALP) was held at IRIA.

Nancy

Grenoble and Paris were soon followed by Nancy. In the capital of Lorraine, a professor of applied mathematics, Jean Legras, had created a small computing laboratory equipped with an IBM 650. In late 1962, he came back from a seminar in Grenoble with a copy of the Algol 60 report and news of Bolliet's endeavor to develop compilers. This coincided with the arrival of a mathematician, Claude Pair, who was looking for a topic for his doctoral dissertation, but was interested neither in the abstract Bourbaki views, nor in numerical analysis. Pair, who had learned programming on a Bull computer during his military service at the Atomic Energy Authority, took eagerly on the idea to design an Algol compiler, and found four junior researchers to assist him. The driving force was the intellectual challenge : developing compilation methods, searching universality, testing ideas on recursivity and on the stack principle. Pair and his assistants educated themselves in this field by reading the *Communications of the ACM* and the *Algol Bulletin*, and by attending the seminars of Bolliet in Grenoble and of Genuys, Nivat and Schützenberger in Paris.

The lab's ageing IBM 650 had not enough memory to support such software, but the team found a deal with IBM : They could use an IBM 1620 at the local IBM agency in Metz, 50 km from Nancy, during the night. The 1620 Algol compiler was presented at a conference in Mannheim as « still needing further testing »[54]. It never became fully operational, as the University chose to

53 A. Caracciolo di Forino, S. Michaelson, M. Nivat, M. Schützenberger, *Problèmes et perspectives de la recherche fondamentale. Le cas de l'informatique*, OCDE, 1971, 49 p.

54 Cl. Pair, « Description d'un compilateur Algol », European Region 1620 Users Group, Mannheim, 1965. Pair was invited to present this paper by Prof. van Reeken of the Tilburg Katholieke Hogeschool. He described the few restrictions or modifications brought by his team over the original Algol 60, and the main technical problems : How to program I/Os, how to reduce the required memory size from 60,000 to 40,000 bits, knowing that programmers at the University of Lille had written a 1620 Algol compiler which ran on 20,000 bits only.

buy another computer in 1965. The experience thus gained allowed the laboratory, a few years later, to design a PL/1 and a Snobol compiler, this time under contracts with private companies.

Algol nevertheless became central in the Nancy computer culture. It was taught and used as a standard programming language, at the same level as Fortran, throughout the decade. At least six doctoral dissertations prepared in Nancy from 1964 to 1975 mentioned Algol in their titles, and certainly a dozen were essentially devoted to Algol-related problems, out of a total of 60 doctoral theses in applied mathematics and computer science. This was correlated with a close cooperation with Grenoble. Nancy researchers could go to Grenoble to use IMAG's powerful IBM computers. Pair and Boussard later co-authored several papers and co-edited a book on Algol 68.

Studying Algol 60, its properties, its promises and its shortcomings, led to explore various branches of mathematics which could provide models and help formalize concepts. While Legras himself remained focused on numerical analysis, from 1963 his seminar broadened its program to include discussions on programming languages, on metacompilers, on mathematical logic, on formal grammars, on trees and graph theory[55]. Cl. Pair's doctoral dissertation, defended in 1965, was devoted to the stack concept and its application to syntax analysis. Once a *docteur d'Etat*, Pair was able to attract more students and to explore new research directions, particularly graph theory, which looked promising to foster progress in algorithmics.

This trend to abstraction and theory, which characterized most computer laboratories as computing evolved from a practice to a discipline, was particularly strong in Nancy for three reasons. First, Nancy was, after Paris, "the other capital of Bourbaki", a stronghold of pure mathematics, and even those who were not in the Bourbaki line, like Pair, were altogether stimulated by this intellectual environment and willing to assert the mathematical legitimacy of their field. Second, a team of theoretical linguistics existed in Nancy, which used Legras' computers and favoured discussions on formalization. Thirdly, the Centre de calcul possessed only small computers in the 1960s (a big Gamma 60 was installed at the nearby *Faculté des Lettres* for lexicographic analysis, but it was saturated by the linguists' work, so that the computer scientists had little access to it – a rare case where Humanities had a bigger computer than Sciences) ; hence, unlike their colleagues in other universities, the Nancy computer scientists had not much incentive to develop operating systems, and preferred to reinvest their compiler experience in other directions.

The list of doctoral dissertations supervised by Claude Pair over two decades can be broken up in three categories of topics. About half of them were devoted to computer applications to other fields[56], such as medical data banks or linguistics (including an attempt at developing an *Algol linguistique* – a not very promising path, as there were already languages designed to this need). Half of the remainder addressed problems of compiler or metacompiler design, of program development methodology and of other sofware engineering topics[57]. The last quarter was

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55 A history of the Nancy computer science team was published by Cl. Pair, « CRIN: The History of a Laboratory », *Annals of the History of Computing*, July-Sept. 1990, Volume: 12, n° 3, pp. 159-166.

56 Among these, an engineer at Electricité de France, P. Broise, published a book on *Le Langage Algol. Applications à des Problèmes de Recherche Opérationelle,* Paris, Dunod, 1965, 99 pp.

57 This category included for example the doctoral thesis of J.-P. Finance in 1974 (supervised by Cl. Pair) – one of the ultimate dissertations on Algol 68. J.-P. Finance is now the president of the scientific university of Nancy.

essentially theoretical computer science, a field which Nancy researchers invested in parallel with the Paris group ; Cl. Pair participated in the IFIP WG 2.2 devoted to “Formal Description of Programming Concepts”.

Until the late 1960s, the few academic laboratories centers which had been pionneers in computer science, such as Grenoble, Toulouse, Paris or Nancy, grew internally, with staffs reaching 150 people. From 1967 on, they started to spin off part of the junior researchers and assistants they had trained, who were looking for higher academic positions, while all French universities were now following the move, creating courses in programming and in computer science, thus opening many new teaching positions. In consequence, many computer scientists who had been immersed in Algol projects at the time of their doctorates became professors throughout French universities and engineering schools, bringing with them the Algol culture – if not always Algol itself.

In Rennes, computer science bloomed suddenly toward 1970, as a result of local initiatives combined with political decisions ; no less than eight software specialists who had passed their doctorates in Grenoble, Paris or Nancy, then spent a few years teaching in Montreal or working on Simula with Control Data, received positions at the Rennes university. Their main project was the development of an operating system written in Algol 68 for the big CII computer (SDS Sigma 7) of the faculty. They took on the challenge of designing an Algol 68 compiler[58], which became the topic of 5 doctoral dissertations ; operational in the mid-1970s, the Rennes compiler was brought to similar machines in other universities, and remained widely used until 1981, when Multics machines replaced Plan Calcul computers… and received a new Algol 68 compiler.

Meanwhile, at Bull-GE…

In 1963-1967, as a member of the European Computer Manufacturers Association (ECMA), Bull had participated in the specification of the ECMA standard for a subset of Algol. A small team under the leadership of Henri Leroy developed the base of a compiler for that language. The effort was terminated at the end of 1967, when most Bull-designed machines were killed by GE management. In early 1968, the same team was working on an Algol 68 project under Leroy, to be ready to expand if the green light was given (which eventually never came).

Besides, a major problem was whether to adopt a high-level language to write the next generation operating system. GECOS-III, GE’s present operating system, was still written in assembler, as were IBM’s OS/360, CII’s Siris and even Multics’ kernel. « Finally we decided to use both an assembler and a high-level language for implementation. The language chosen in 1968 was ‘Q’, a dialect of Algol, which did not puzzle us, several Bull engineers having participated in the Algol 60 compiler for the GE 635 in Phoenix and in Sweden. The Q language was finally abandoned in 1970 for HPL, a dialect of PL/1, with which over 85% of GCOS64 was eventually coded[59]. »

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58 Project SAR (Système Algol Rennes) included several particular features: A new compiling method (“by events”, with only one pass on the source text), an original “garbage collector”, a new kind of block (“prolators”). The team also developed a compiler for a subset of Algol 68 (SERA, Sous-Ensemble Rennais d’Algol 68), which was used in Rennes and in Paris to teach programming. These were the only French implementations of Algol 68 actually put into service (correspondence with L. Trilling, 27 September 2010).

59 Correspondance with Jean Bellec, 21 December 2007. Jean Bellec became a project manager of GCOS64, Honeywell-Bull’s major operating system developed in the early 1970s.

Leroy progressively left the industry to teach computer science at the University of Louvain (Belgium), and kept using Algol which he considered "an excellent language for teaching — much better than Pascal, for instance"[60] (a rare opinion, as far as I know). In the interval, Sallé and others had left Bull and gone straight to the newly founded CII, the "national champion" of the Plan Calcul.

The Plan Calcul, CII and Grenoble

The beginning of the Plan Calcul was a corporate battle whose outcome left no room for Algol projects. Two companies, SETI and SEA, had developed computers inspired by Algol concepts, but they ended up on the losing side.

The Société d'électronique et d'automatisme (SEA) was, from its creation in 1948, a computer maker rather than just an electronics company: For its founder, Raymond, who had a double background in electrical engineering and in mathematics, the stored program concept was as important as the computer itself. In the late 1950, the SEA had developed its own programming languages : PAF for its small scientific CAB 500 computer (a language comparable with BASIC), and PAGE for its data-processing CAB 3900 system[61]. An Algol compiler was written in 1963 in Grenoble for the CAB 500 installed at IMAG, while SEA's own engineers were designing the next generation machines' operating systems. In 1963, Raymond and his team began to explore non-von Neumann architectures, based on the stack principle: Axe 2, which never went far beyond the paper-machine stage, was inspired by list languages ; CAB 1500, an Algol stack-machine whose prototype was built in 1966 and used during a few years at IRIA in a research laboratory stuying man/machine communication. Somehow the SEA was comparable with Algol : This visionary company did not have a strong presence on the market, but it played an important part in the education of computer engineers and scientists, and in the conceptual progress in this field.

The Société européenne de traitement de l'information (SETI) would have followed a "hardware only" approach, had it not hired ex-Bull engineers, who had lived through the painful experience of the Gamma 60 and knew the value of software. They designed the Pallas computer, which came in 1965 with a complete catalogue of programming tools and compilers for Algol, Fortran and a home-made data processing language, GEAI. Algol was particularly important in this stack machine, whose chief designer was in love with the Burroughs B 5000, and wrote a book on this kind of architecture[62]. The Pallas did not achieve commercial success beyond a dozen sales to universities and research centers.

Both companies were dismantled and absorbed by CAE to form the new national champion Compagnie internationale pour l'informatique (CII). CAE was a subsidiary of Thomson-CSF which sold computers under licence from TRW and Scientific Data Systems. Its small CAE 510 computer had been shipped in 1964 with almost no software but a poor Fortran, and users had had to write most of the software — Algol compilers were developed at the universities of

60 Video interview with François Genuys, Henri Leroy and François Sallé, January 2008.

61 D. Starynkevitch, "The CAB 500", *IEEE Annals of the History of Computing*, vol. 12/1, 1990.

62 Y. Harrand, *Traitement des files et des listes par l'homme et par la machine,* Paris, Dunod 1967.

Grenoble and Toulouse for this machine. CAE's core expertise was in real-time systems, with priority given to systems reliability and assembler programming. Besides, the Plan Calcul commissioned the new national champion to focus on commercial mainframes, with only marginal attention to the scientific market.

Thus, Algol had not much place in the Plan Calcul. Since 1965, the DGRST "Languages and programming" chapter had shifted to PL/1 compilers and to communication software. And, while CII planned to have Algol compilers on its mainframes like the large CII 10.070 (SDS Sigma 7), Algol developments were easily delayed when the company had to cut spendings in 1968. The priority was to develop the Siris operating systems for the future CII mainframes, aimed at the commercial market.

To achieve this enormous task, the new company had the choice, in principle, between three types of resources. It could subcontract most of the development to SEMA, the leading, expert software firm which was pressing hard to get this big contract, but CII refused to outsource such a vital part of its business. It could collaborate with the universities of Grenoble and Toulouse, or with IRIA, but the systems they were designing were too experimental to be implemented on commercial products. The only realistic option was to develop the Siris OSs in-house, that is to hire or to train hundreds of programmers, and to find seasoned project managers by tapping Bull's human resource.

François Sallé was approched at an 1967 IFIP meeting in New York. He joined CII with several other Bull engineers who had participated in the development of Algol compilers for various Bull or GE machines. They brought with them not only a considerable experience in programming, but also the conviction that "basic software" (monitors, compilers, I/Os, etc.) should be entrusted to a department or direction at a high hierarchical level. Sallé received the *Direction du software de base* at CII; three years later, he also annexed application software, hitherto a part of marketing operations; and, in 1971, he was appointed as head of the whole company's R&D, hardware and software. Sallé's career eloquently revealed how software changed statute, from an ancillary commercial service to a key competence in the company's strategy.

What software should be developed in-house, and what parts could be subcontracted to external partners, was a carefully minded policy. Generally speaking, operating systems, particularly the monitors, were never delegated: They were the realm of Sallé's men. Other parts, such as compilers and some application programs, were either completed at the CII, or subcontracted — some to software companies, some to academic laboratories.

In 1970, the decade-long experience of collaboration between Sallé's team and IMAG was strong enough to allow for a bolder step in Research-Industry relationship. The Plan Calcul decision makers were upset by IMAG's scientific joint venture with IBM (the *Centre Scientifique*), and they imposed the creation of a similar IMAG-CII research center. This center's evolution is another story. Suffice to say that it was the outcome of years of cooperation — not only development contracts, but also scientific meetings, common interests in learned societies, etc. — where Algol had played a prominent part.

At the same time, in the early 1970s, a program was launched with IRIA to develop specific software for and with academic scientists, under a committee chaired by Claude Pair (Nancy). CII had finally realized that scientific clients, while a marginal market, were influent prescriptors and partners to be counted with. This operation produced over the years a catalogue of compilers and translators for Algol W, PL/1, Prolog, LISP and Algol 68, implemented on the high-end CII computers which were now the cores of University computing centers[63].

A 1970 survey found that, in the late 1960s, the great majority of the users were still programming in autocode or in assembler. Only a quarter of the users programmed in Fortran or in Cobol ; PL/1 and Algol remained marginal and represented “less than 5% of the languages employed[64]”.

Afcet, Algol 68 and theoretical computer science.

After several acronym changes, the society became AFCET (Association française pour la cybernétique économique et technique) when it merged with the French society for automatic control.

In 1967, Bolliet transferred his chairmanship of the Algol group to Pair, who supervised its reflexions about Algol 68 until the mid-1970s. Algol 68 was an attractive topic for a minority of computer science teams in Europe, both because of its logical rigor and because its compilation implied new, tricky problems. This new intellectual challenge was addressed through various meetings, seminars and courses (experimental, then regular), and of course practical developments and doctoral works in most laboratories active in programming languages, particularly Grenoble, Nancy, Lille, Rennes and later Paris-Orsay.

The effort coordinated by AFCET can be summed up through four marking publications. The lists of active members and co-authors reveal a European group open to all specialists who could speak French, with experts from the Belgian MBLE, undoubtedly a world leader in compilation, from Amsterdam (Koster), from Britain (Mike Griffiths) and from the francophone part of Switzerland (Giovanni Coray). They also show, to some extent, the rise of a new generation – mostly men who had passed doctorates since the mid-1960s. None of the four Parisians who had co-authored the 1965 Algol treaty participated in the Algol 68 endeavour.

A first introduction to Algol 68, its basic principles and its expressiveness was published in 1969 by Boussard (Grenoble) and Pair (Nancy), along with a description of the language by M. Sintzoff (Brussels)[65]. Using the French terminology approved by AFCET, it recommended readers to look for a more complete description in van Wijngaarden’s and Lindsey’s reports published by the Amsterdam Mathematisch Centrum[66].

In 1969-1970, Boussard and Duby (IMAG and IBM, Grenoble) organized a series of meetings to evaluate Algol 68, with an committee of twenty computer scientists from various academic or industrial backgrounds (14 from France, 4 from other European countries, two American

63 Among others, an Algol compiler was written in Toulouse in 1971 for the University’s CII new 10.070, but it did not become part of CII’s software catalogue.

64 G. Cristini & A. de Lamazière “Le parc français”, *0.1. Informatique-Mensuel*, September 1970, p. 58.

65 J.-Cl. Boussard & Cl. Pair, “Introduction à Algol 68," *Re. Franc. Inf. Rech. Oper.*, 3, No. B-3,. 17-52 (1969). M. Sintzoff, “Introduction à la description d’Algol 68," 3, No. B-3, 3-16.

66 A. van Wijngaarden, B.J. Mailloux, J.E.L. Peck, C.H.A. Koster (1969), and H. Lindsey & S.E. van der Meulen (1969).

IBMers). The purpose was to assess Algol 68 from the various points of view of the informatician community, and to judge the language's practical programming possibilities, on the base of the two Amsterdam reports again and of a few attempts to write programs. The resulting report, published in *Revue d'informatique et de recherche opérationnelle*[67], mentioned heated debates and a few remaining disagreements within the committee, and its conclusion was prudently optimistic : A real programming language and not just an algorithmic language, powerful and well-structured, Algol 68 was a step toward languages which would give programmers improved means of definition, of expression and of checking. The language's actual possibilities for the various branches of informatics remained to be proven, particularly for data processing and management applications. Its success would depend not only on users and manufacturers's support, but also on the coordinate effort to implement it efficiently for a whole range of applications.

Meanwhile, the AFCET Algol group (18 co-authors) translated the Report on the Algorithmic Language Algol 68 edited by A. van Wijngaarden in 1969, and published it in 1972 with a detailed introduction, building on the two papers published in 1969 in *RIRO* [68]. The work was sponsored by two contracts from the Plan Calcul and from the DRME military agency. Such a translation required extreme care and precision: The main difficulty came from the frequent use of English as a formal language in the original report. All ambiguities had to be eliminated, with lexicons to provide French equivalents of English terms, and the same for symbol representations. A whole, standardized language, completely defined with its vocabulary and syntax, had to be translated into a profoundly different language… essentially to give Algol more acceptability on the market. In this regard, Algol was comparable with the nascent European community, with the considerable investments it implied to produce, then to translate common regulations into each country's law and practice.

The Algol 68 manual was published in 1975 by 17 co-authors supervised by P. Bacchus, Cl. Pair and J. André, respectively from Lille, Nancy and Nancy-then-Rennes[69]. Resulting of an enormous work by AFCET's Algol group, through meetings, in-depth discussions and criticism, cross-reading and successive version, it was a masterwork of logical construction and unambiguous expression, as greeted in the preface by F. Genuys – in tune with Algol 68 itself. This thick book was sponsored by the CNRS only, revealing a lack of interest of more user-oriented agencies. Acccording to the publisher, while Algol 60 manuals had sold well, Hermann never recovered the costs of its two Algol 68 books. It was generally viewed as the last salvo from a group of inconditional militants who still considered Algol necessary for the construction of software engineering.

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67 J.-Cl. Boussard & J.- J. Duby (ed.), *Rapport d'évaluation d'Algol 68*, *RIRO*, B.1, 1971, p. 15-106.

68 J., Buffet, P. Arnal, A. Queré, (ed.), *Définition du langage algorithmique Algol 68*, Hermann, 1972. It included the French translation of A. van Wijngaarden, B.J. Mailloux, J.E.L. Peck, C.H.A. Koster (1969), *Report on the Algorithmic Language Algol 68*, MR 101, Mathematisch Centrum, Amsterdam.

69 Groupe Algol de l'AFCET (P. Bacchus, J. André & Cl. Pair, eds.), *Manuel du langage algorithmique Algol 68*, Paris, Hermann, 1975, 492 pp.

Figure 5. Groupe Algol de l'Afcet, *Manuel du langage algorithmique Algol 68*, Paris, Hermann, 1975. The authors came from half a dozen universities in France and Belgium. The three editors (P. Bacchus, J. André, Cl. Pair) were respectively from Lille, Rennes and Nancy, three universities where Algol was still particularly alive in the mid-1970s.

In short, Algol 68 had the merit of having triggered in-depth reflexions on structured programming, data structures, then object languages. It was a systematic exploration of the most advanced concepts, a stimulating research program. However it resulted in a tool which was too complex, with a too formal definition, to be practical – as proven *a contrario* by the success of Pascal, its counter-project.

Laurent Trilling (IMAG), who considered himself the "last of the Mohicans" in the teaching of Algol in France (until 1987), attempted later to analyze the practical unsuccess of Algol 68, in a paper presented at the first History of Computing conference in France. He reviewed objective and subjective factors – the scarcity of powerful machines in French academic centers, the apparent complexity of the language, and also the social and psychological factors such as intellectual fashions in science. One could object that US universities had powerful computers, yet did not take on Algol 68 : Computer power appears to be a necessary, but unsufficient reason. In the early 1970s, Algol 68 was taught in most post-graduate curricula for computer scientists (DEA). This accounts for the number of doctoral dissertations consequently related to this language. It was much less taught at graduate or undergraduate levels for computer users – for example the *Instituts universitaires de technologie* taught Cobol, Fortran to future programmers and analysts, yet soon replaced Algol with Pascal, along with the advent of structured programming methodologies. The two main reasons were that the language was considered too difficult or daunting, and that very few computers offered Algol 68 compilers : it was hardly possible to use the language practically before 1975 [70]. A manual for beginners was only published at the end of the decade, under a collective name[71]. On this long journey, many pilgrims “arrived exhausted on the promised land”[72]. Yet the history of Algol confirms, better than any parabole, that it is the pilgrimage itself, more than the promised land, which improves the pilgrim.

At the same time, Afcet became a tool to promote theoretical computer science, in close relation with the Algol project (for example, logical programming was largely born from W-grammars used by van Wijngaarden to describe Algol 68). The Nancy team was developing research in this field and, from 1971, it initiated an annual summer school in theoretical computer science – in a certain rivalry with the Paris group who organized an Afcet spring school… Open to any specialist who spoke French, it had an international dimension. Throughout the 1970s, Afcet summer schools played an important part in the construction and official recognition of computer science, particularly in the design of new academic curricula and teaching programs. The most prominent result was a book published by a Nancy group under a collective name, *le Livercy*[73] (collective names were adopted at that time to avoid possible stardom benefitting to the editors of a collective book). Thus, created in the mid-1950s to foster a nascent profession and to promote its techniques, less than twenty years later Afcet asserted the development of a new science.

We use categories and group names such as *theoretical computer science, Algol* or *software engineering*, but in fact they were closely interwoven, as shown by the participation of the same people in these different groups. For example, Claude Pair (Nancy) was involved in this whole array of research programs, as was Michel Sintzoff, a Belgian who was a frequent host of Grenoble and Nancy and contributed to launch theoretical research in these universities. If we consider a major innovation in algorithmics and a trajectory beyond Algol, Alain Colmerauer, the inventor of Prolog (PROgrammation LOGique) whose rules are close to W-grammars, was familiar with Algol 68 since his doctoral work in Grenoble[74] ; and the initial Prolog interpreter (1971) was written in W-Algol by Colmerauer’s team spun-off in Marseille in 1971.

Overall, since the early 1960s, French research orientations in these fields were closely related with the evolution of IFIP working groups : First the Technical Committee on Programming Languages (1962) and its emanation the WG 2.1 specialized in the development, specification,

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70 We mentioned the Rennes compiler. Another Algol 68 compiler was developed at the University of Paris-Orsay and implemented on the Univac 1110 series. It could compile the full language, including formats, unions, flexible arrays, recursive modes, parallel computation, etc. Minor restrictions concerned the equivalence recognition of crossed recursive modes, multiple precision and short modes, and scope checking (Daniel Taupin (1977), “The Algol 68 compiler of Paris-XI University (Orsay)”, *ACM SIGPLAN Notices - Proceedings of the Strathclyde Algol 68 conference*, Volume 12, n° 6, June 1977, p. 109-116).

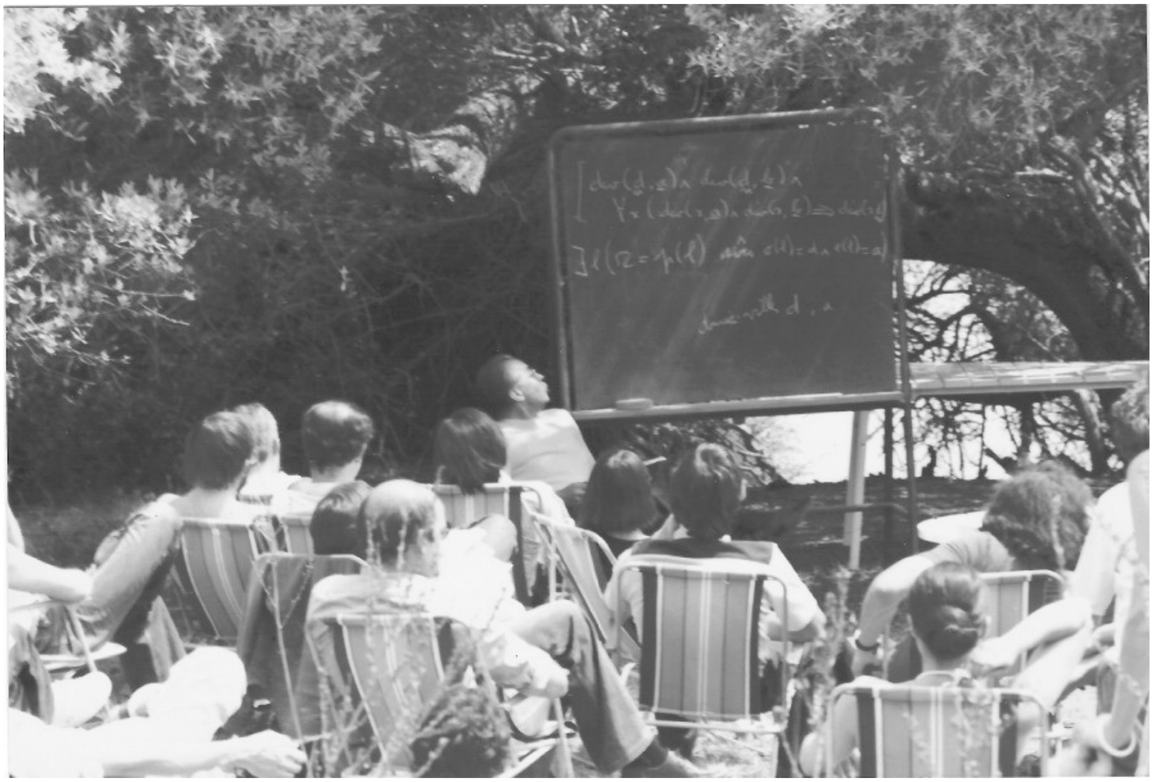
71 Gerbier, *Mes premières constructions de programmes*, Springer, 1979.

72 L. Trilling, “Algo1 68, une culture informatique perdue ?”, *Colloque sur l’histoire de l’informatique en France*, Grenoble, INPG, 1988, Vol. 1, p. 447-453. In a similar vein, see S. G. van der Meulen, “Algol 68 might-have-beens”, *ACM SIGPLAN Notices - Proceedings of the Strathclyde Algol 68 conference*, Volume 12, n° 6, p. 1-18.

73 C. Livercy, *Théorie des programmes*, Paris, Dunod, 1978 ; Livercy was the collective acronym of Jean-Pierre Finance, Monique Grandbastien, Pierre Lescanne, Pierre Marchand, Roger Mohr, Alain Quéré and Jean-Luc Rémy. The book is now online at http://perso.ens-lyon.fr/pierre.lescanne/publications.html.

74 A. Colmerauer (1967) *Précédence, Analyse syntaxique et langages de programmation*, doctorat d’État, Grenoble.

and refinement of Algol" (later renamed "Algorithmic Languages and Calculi") ; then in 1967 the WG 2.2 devoted to "Formal Description of Programming Concepts", soon under the banner of theoretical computer science ; and finally in 1969 the WG 2.3, ("Programming Methodology"), formed with the dissidents of WG 2.1 as its core, after the NATO Conference on Software Engineering at Garmisch.



Cargese conference

Figure 6. Afcet computer science meeting, Cargese, Corsica, May 1978.
The CNRS conference center at Cargese hosted a meeting of ex-Algol 68ers, computer theoreticians, Afcet's Groplan group (devoted to operating systems), and a few members of the nascent *Génie Logiciel* (software engineering) group. The speaker at the blackboard is Claude Pair.
(photo by Jacques André).

Elements for a conclusion

Algol was a mathematicians' project, and in many regards remained firmly rooted in mathematical culture and practices. Meanwhile, Algol played a decisive role in establishing computing as an autonomous science and engineering discipline. Thus, it offers a splendid case of the construction of a new scientific field, through a double process: Branching out of an old discipline, and convergence of various intellectual agendas and individuals from different backgrounds.

Algol, an international project from the start, was soon disseminated among scientists who already had a habit of international contacts, in a political context where international collaboration was encouraged and sponsored in several overlapping frames : The Atlantic alliance of North America and Western Europe, the various European organizations, the informal francophone cluster, and global institutions such as IFIP, which favored East-West contacts to contribute in the *Détente* of the 1960s. It was just natural that "Algol" became one of these communities where participants cared little about their national origins, and just as little about their being "Europeans" or coming from other regions of the world : They simply observed, in the Algol 68 phase, that American colleagues shifted their interest to other topics, while Soviet scientists were fully involved. If the Algol community was not a nation or a transnation, it was certainly a culture[75].

If we summarize the advent of computers in universities as the irruption of big science in the mathematicians' ivory tower, the study of actual practices show a coexistence of large teams and costly equipment working for the industry and the military, assigned to the mass-education of programmers; and of more traditional individual practices, such as the doctoral thesis. Between these two extremes, a range of working modes made a continuum between big and little science. For example, all doctoral dissertations I have consulted acknowledged the contribution of the research team, of the programmers at the computer center, and eventually of the employees of a company which supported the student's work (this is not limited to Algol subjects). Our story is largely a story of committees, of discussion groups, of seminars, of multiple-authors publications: Is this characteristic of big science, or in line with this archetypal collective scientist, Bourbaki?

An alternative view of this collective work appears if we consider that Algol committees gathered people from different, sometimes competing laboratories and companies, to establish a common standard. In this regard, Algol was part of the growing mass of precompetitive R & D on standards in computing (coordinated in Europe by ISO and ECMA), but with a peculiarity: No industrial player in the game had any proprietary standard to impose. Software being not priced until the early 1970s, the market for languages was open and there were many competitors. Users chose ultimately – even if "users' choice" was generally mediated through the teachers and instructors who taught programming languages to the masses of end-users.

Finally, this story, and the rest of the history of computing in France, support the SOFT-EU project's assumption that "the academic habitus was not as unambiguous as the European self-image would have it": While purist academics were the most visible *savants*, hold major power positions in the University and also in the ideological system, eg. in the making of the self-image of Science (particularly of European and French Science vs. US Science), the Science Faculties had in fact hosted technical education and research for long decades, collaborated with the Defense and the industry, moved back and forth between the scientific and economic spheres. Computer scientists were at the forefront of a long struggle to redefine science, trying altogether to gain legitimacy within Mathematics, to recompose them (with new categories such as discrete mathematics) and to build the foundations of a new engineering science whose core object was information structures.

75 L. Trilling, "Algol 68, une culture informatique perdue ?", *Colloque sur l'histoire de l'informatique en France*, Grenoble, INPG, 1988, Vol. 1, p. 447-453.

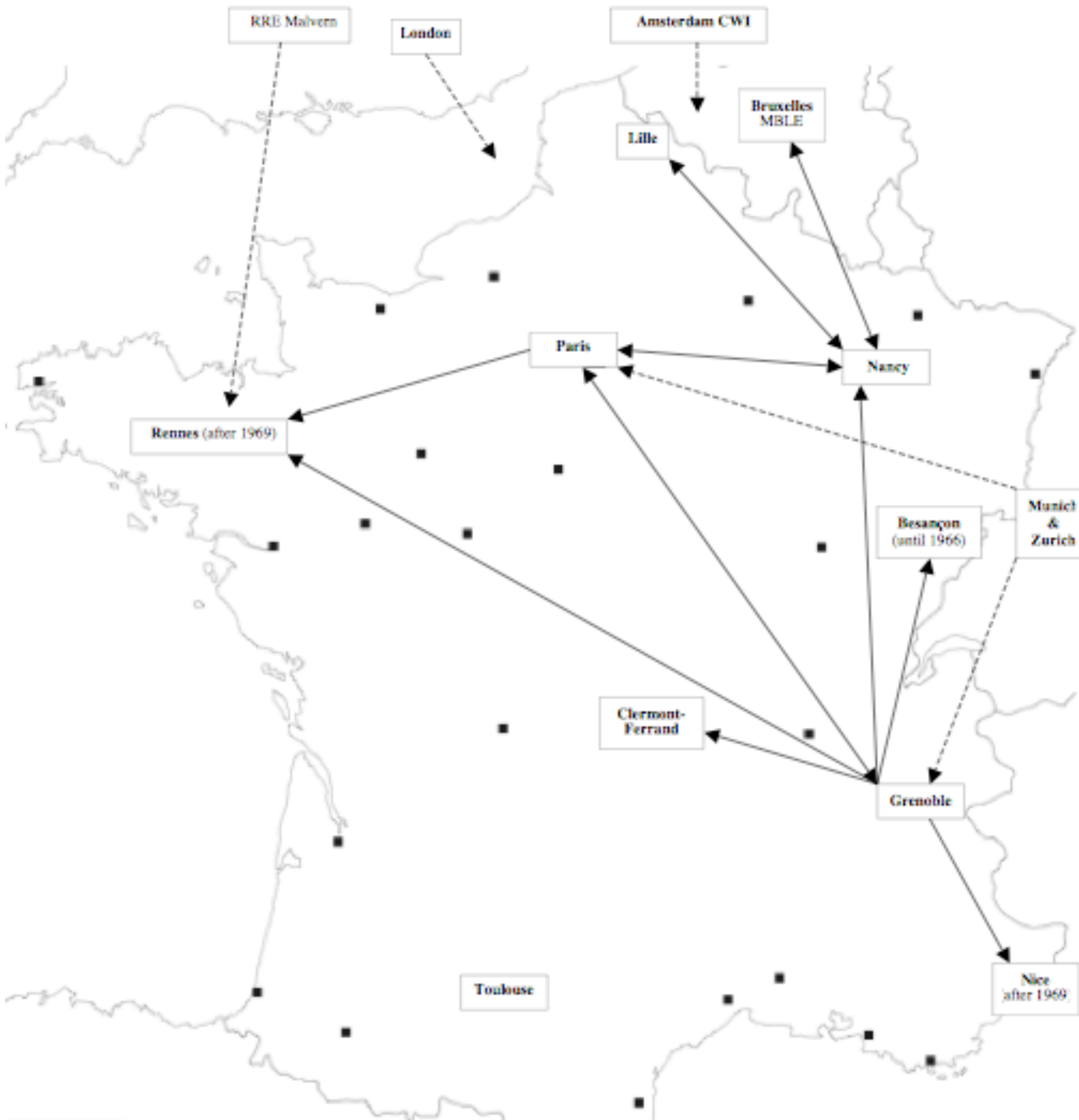


Figure 7. Major Algol research centers, as viewed from France.
The arrows symbolize the main flows of influence and collaboration, which remained at individual or small-team scale.
This map of French-speaking Algol groups differs markedly from a classic map of France, as, for example, major cities like Lyon, Marseille, Strasbourg or Bordeaux are out of the scope.