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**From General Electric to Bull :
A case of managerial knowledge transfer (1956-1970)**

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Abstract

General Electric, the very model of an integrated, multidivisional conglomerate with an advanced management system, ventured into the computer business in the late 1950s. In 1964, it took over the French Bull company, a leading European manufacturer of information-processing machines. Bull had an active educational policy, with an internal school to train its technical and commercial manpower as well as its clients. Its integration in the American multinational resulted in a wave of changes, as General Electric not only introduced novel information technologies, but also spread its highly formalized managerial procedures throughout its European subsidiaries. In turn, Bull contributed to transfer these techniques and bodies of knowledge to other French organizations.

Résumé. De General Electric à Bull : un cas de transfert de connaissances managériales (1956-1970)

General Electric, véritable modèle de conglomérat intégré, multidivisionnel et doté d'un système avancé de gestion, s'est lancée dans l'informatique à la fin des années 1950. En 1964, elle a pris le contrôle de l'entreprise française Bull, principal fabricant européen de machines de traitement de l'information. Bull avait une politique de formation active, grâce à une école interne destinée à son personnel technique et commercial aussi bien qu'à ses clients. Son intégration dans la multinationale américaine aboutit à une vague de changements, car General Electric a non seulement introduit de nouvelles technologies de l'information, mais a aussi diffusé ses propres procédures managériales fortement formalisées dans toutes ses filiales européennes. À son tour, Bull a contribué à transférer ces techniques et toutes sortes de connaissances à d'autres organisations.

Introduction

In 1964, the French Bull company, a leading European (originally Norwegian) manufacturer of information-processing machines, was taken over by General Electric. Bull had an active educational policy, with an internal school to train its technical and commercial manpower as well as its clients. Its integration in the American multinational resulted in a wave of changes, as General Electric spread its highly formalized managerial procedures throughout its European subsidiaries.

This paper will neither tell the corporate history of Bull, which was summarized in earlier publications¹, nor detail the tensions within the GE multinational, which will be analyzed in another article. It focusses on three questions:

- How General Electric (GE) was led to enter the computer business and to acquire European office equipment companies.
- How the largest of these, the French Compagnie des Machines Bull, received and incorporated economic and cognitive resources from GE.
- How this knowledge spread and evolved after GE left the computer industry.

General Electric enters the computer business

The entry of General Electric in the computer business was an opportunistic diversification, beginning in the mid-1950s. Among its ten or so laboratories, since the second world war GE had fostered a laboratory devoted to high-frequency electronic components, a technology pulled mainly by the demand for radars and pushed by advances in physics. In 1956 a group of electronic engineers seized an opportunity to develop computers : The Bank of America posted a request for proposals to manufacture, after a prototype developed by the Stanford Research Institute, a computer system able to read and process checks automatically (this project gave birth to the machine-readable numbers that we still have on checks today). Two years later they formed a GE computer department in Phoenix (Arizona). In a similar manner, the Military Equipment Department in Syracuse (NY) developed a calculator for missile tracking, which in turn engendered another family of powerful computers for military and space applications. In the first half of the 1960s, these efforts resulted in three different computer lines, the 200, 400 and 600 series, each composed of several compatible models, in addition to smaller calculators for industrial process-control².

¹ P. Mounier-Kuhn, "Bull. A Worldwide Company Born in Europe", *Annals of the History of Computing*, 1989, vol. 11/4, p. 279-298. "Product Policies in Two French Computer Firms: SEA and Bull (1948-1964)", *Information Acumen. The Understanding and Use of Knowledge in Modern Business* (Lisa Bud-Frierman, ed.), London, Routledge, 1994, p. 113-135. "French Computer Manufacturers and the Component Industry, 1952-1972", *History and Technology*, 1994, vol. 11, p. 195-216. "L'informatique française : une résistible 'américanisation' (1946-1970)", *L'Américanisation de l'Europe occidentale au XX^e siècle* (D. Barjot et C. Réveillard, dir.), Presses de l'Université Paris-Sorbonne, 2002, p. 207-226.

² On GE, see particularly J.A.N. Lee, "The Rise and Fall of the General Electric Corporation Computer Department", *Annals of the History of Computing*, vol 17, n° 4, 1995, p. 24-45. J.A.N. Lee & George E. Snively, "The Rise and Sale of the GE Computer Department: A Further Look", *IEEE Annals of the History of Computing*, April-June 2000, p. 53-60. H. Oldfield, *King of the Seven Dwarfs. General Electric's Ambiguous Challenge to the Computer Industry*, Los Alamitos, IEEE Press, 1997. G. E. Snively, "General Electric Enters the Computer Business," *Annals of the History of Computing*, 1988,

A high risk investment

How did these bottom-up developments fit in the strategy and managerial policy of the GE Corporation ?

GE's possible investment in computing had been discussed at several instances in the early 1950s, and repeatedly refused by president Ralph Cordiner. His rationale was that IBM was a good client for GE's electric motors and electronic components, and that if GE entered the computer market to compete against IBM, the reprisal would be IBM stopping to buy GE products. This rationale lost part of its weight from 1956 on, because of two events: IBM faced an antitrust action, resulting in a consent decree favouring competitors ; and IBM began to make its own components.

In mid-1956, GE considered acquiring IBM as a way to enter the computer business and to support the ERMA effort. "At that time, as measured by the comparative revenues and net worth of GE and IBM, it would have been a modest acquisition. However, GE's management was incredulous about the market value for the stock of a company with minimum earnings, heavily in debt and which didn't pay a dividend"³.

Moreover, the head of GE's electronics division and the head of GE's Microwave laboratory at Stanford advocated that they would build only a special-purpose machine, not a universal computer which would rival IBM products. While this was true for the Stanford SRI prototype, GE engineers evidently ended up developing universal computers – just like their colleagues in Syracuse. Another argument was put forward : GE was one of IBM's biggest clients and paid huge sums in renting IBM machines ; and the cost of developing computers would be recouped by substituting them for IBM machines in GE data-processing centers.

General Electric was considered a managerial model throughout the US industry, and had even influenced IBM. President Cordiner had profoundly reorganized GE in the early 1950s under the motto of "controlled decentralization" – a system somehow comparable with the German military concept of *Auftragstaktik* or decentralized leadership⁴. He altogether decentralized operational responsibilities toward the different business units, and recentralized strategy and overall resource control. At the top of the corporation, headquarters (often called by their address in Manhattan at 570, Lexington Avenue, NY) concentrated on long-term planning, financial control and the definition of corporate values, personnel policy and managerial procedures.

Each operating department was responsible for a class of products and capable to develop, manufacture and sell them on a competitive market. A department responded hierarchically to a division, itself subordinated to a group. By 1956 the corporation comprized a hundred departments, 22 divisions and 4 major groups.

vol. 10, n° 1, p. 74-78. For a more contextualized view, see J. W. Cortada, *The Computer in the United States. From Laboratory to Market, 1930 to 1960*, M.E. Sharpe, 1993.

³ G. E. Snively, "Separating fact from fiction. A critique of Homer R. Oldfield's book, *King of the Seven Dwarfs*." http://www.smecc.org/snively_corrections_to_king_of_the_seven_dwarfs.htm. Snively was the expert commissioned to analyze IBM as a possible acquisition by GE in mid-1956.

⁴ See the paper by Sven-Erik Grieg-Smith on "Knowledge exchange in organizations" in this issue.

This grand system was completed with horizontal Service Divisions which acted as consultants to the operating units and to the president's office. Among them, the Management Consultation Division developed the written rules to implement the new organization: Guide books for every type of position within the company, procedures for rating employees' performance and results, etc.

These elaborated tools to achieve efficiency through coordination, by monitoring and improving productivity, costs and profits, required a growing corps of executives, a "managerial class" producing and consuming masses of information to keep the increasingly complex and interdependent system running. To meet its own demand for professional managers, GE undertook an immense educational program with help from consultants like Peter Drucker. Systematic collections of case-studies, benchmarks on work efficiency, theories of scientific organization, were assembled and adapted to GE needs in four volumes totalling 3,463 pages: The "Blue Book", GE's management bible⁵. In 1956 GE created its own business school at Crotonville (NY), to indoctrinate executives in the corporate dogma and transform them into "professional managers". The basic belief was that management was a science which could be taught in a classroom and that the resulting "professional managers" were able to manage any business.

Through this vast bureaucracy, GE was essentially ruled by the financial function, which enforced strict control upon all entities. The financial function provided a common language through these heterogenous businesses – nuclear reactors, jet engines, domestic appliances, color television, etc.–, whose economic models and technical cultures were basically different. Ironically, it was in this paragon of managerial control that adventurous engineers "bootlegged" computer development⁶.

Venturing into the computer market was risky, altogether as it was a novel, complex and fast-evolving technology, and as IBM dominated it by far and made huge profits that it could reinvest to curb a competitor. Yet it was tempting: GE was still far bigger than IBM and had considerable resources too ; particularly, GE possessed outstanding capabilities in electronics, which could be further valorized by applying them to the new, fast-growing computer sector. Diversification was inherent to GE's corporate culture and strategy. And GE had perfected the adequate tools to conduct a diversification in any new field, not only through financial control, but also with procedures for managing projects successfully and with its marketing expertise. General Electric essentially applied to the computer business the "scientific" models that had proven successful in other branches.

Market segmentation and product life cycle

GE's three computer lines were incompatible, but overall compatibility was not an issue for computer makers at that time: The technology was so difficult to master that engineers gave priority to optimizing the design of each computer model for a perceived type of clientele.

⁵ GE, *Professional Management in General Electric*, GE (NY), (1953-1959). Book 1. General Electric's growth. 2. General Electric's organization.-- 3. The work of a professional manager. 4. The work of a functional individual contributor.

⁶ The term "bootlegged" is from G. E. Snively, "Separating fact from fiction. A critique of Homer R. Oldfield's book, *King of the Seven Dwarfs*".

An important concern in the definition of products was market segmentation. It was important to ensure that the sales of a product would not impact other products through internal competition. Not very subtly, market segmentation was based more on the size of customers than on their actual use of computers – an approach to segmentation heavily promoted by consulting firms. The business was divided between “Large computers” reserved to *Fortune 500* firms and government agencies, “Medium size computers” and (relatively) “Small computers” for small businesses or units. Thus General Electric was willing to devote one product line to each market segment, and did not mind about designing incompatible families.

Some consideration was given to sub-segmenting the market by industry, but only few products were industry specific: The requirements for a banking transaction system, for instance, are not so different from an airline seat reservation system. The main differences between industry sectors were at the level of application software, which was developed mainly by the clients with some assistance from the vendor.

This set of principles seemed to remain valid, but with some adjustment, after 1964 when the success of the IBM/360 range showed that the initial segmentation between scientific and business computers would eventually fade out.

In each of these market segments, GE applied the concept of product life cycle. This concept was implemented in the early 1960s by General Electric's Apollo support department for the NASA. It dealt with the decision process that allowed a project to progress smoothly. It was based on the early identification of risks and the preplanning of contingency plans to handle malfunctions and technical problems. The life cycle model was extended to commercial products by introducing a “market requirements” phase and measurement ratios, mainly the time necessary to recoup investments and to ensure a return on investment.

At GE a product's life was divided in six phases:

- investigations
- design
- development
- introduction
- production
- termination.

Each of the six phases was under authority of different functions within the firm. Theoretically, Product Planning was the only organization in charge of phase 0, Engineering came in phase 1, Marketing in phase 3, Manufacturing in phase 4. In fact there was some overlapping, as Engineering was involved also in the planning evaluation, and Manufacturing was involved in prototype development. As for the phase 5 (phasing down), it was rarely addressed before the sales curve fell significantly.

Each phase ended with an independent product review (IPR) and with the management's formal decision either to pursue with the product, to reiterate a phase or to abandon the product. An IPR consisted in a meeting of several days, with a presentation of the project team (an informal gathering of all those in charge of the product) to a review board, composed of individuals coming from unrelated departments of the company, sometimes of external experts. It was followed by an intensive session of questions and answers, leading to

a review report which identified the risks. Those risks were rated by their impact on the business: “unacceptable” meant that the project should be killed unless the risk was corrected, “high” meant that the business plan would be seriously impacted, etc. The report was then presented to the project team and to the management. An IPR was an efficient way to detect potential problems and to address them, thus to avoid chain disasters known in Murphy’s law.

A characteristic of computer projects, which involved a combination of hardware and software development with marketing efforts, was the long lead time they involved: Typically from 2 to 3 years in the best cases. Such projects could not be managed through an annual budget timing. The processes involved in the product life cycle ensured altogether a technical control and a financial control over the project, and facilitated communication within the different levels of the company.

This held at least in principle. In fact, the situation of the computer department within GE was always uncomfortable. The available sources reflect mainly the point of view of the computer engineers, who often felt frustrated and misunderstood by top managers who, but with a few exceptions, are described as either uninterested or illiterate regarding the computer business⁷.

GE-Bull negotiations

A succession of business plans gradually recognized the fact that GE was entering the computer business. By 1962, with several computer lines already marketed or under development, GE’s strategists began to look for markets beyond North America.

As soon as July 1962, the group vice-president in charge of Industrial Electronics, Harold Strickland, came to Paris and met with Joseph Callies, the chairman of Compagnie des Machines Bull. Bull was already selling peripherals to the GE computer department, and Strickland suggested to Callies that their companies might negotiate a broader agreement – technical, commercial and financial. Strickland expressed GE’s desire to take a participation in Bull’s capital, “even limited to 20 %”⁸. Needing more information on GE’s technical development and market strategy, Callies sent two Bull engineers in September, who appreciated that GE staff answered questions precisely and talked openly about their projects. Yet Callies had many constraints to consider: Bull had already an American partner, RCA, which provided technical assistance in the form of a licensed computer, and did not threaten to take control of the French company – something which might alarm the French government; another agreement was underway with a French electrical equipment maker, Schneider.

Soon afterwards, NYSE rumors about a possible sale by Sperry-Rand of its Univac computer division to GE made the Bull board rush its recently retired CEO, Georges Vieillard, to New York to check the information. Vieillard met with Sperry-Rand’s vice-president in charge of Univac, Dause L. Bibby, who denied the rumor (Bibby had travelled to Paris the previous year and proposed to sell Univac to Bull, but selling it to the giant GE would be against anti-trust legislation). While in New York, he saw Strickland who confirmed GE’s position: GE was now determined to make a grand entry on the computer market; GE was willing to examine the possibilities left by the Bull-RCA agreement; GE maintained its proposal and, if

⁷ For example J.A.N. Lee, “The Rise and Fall of the General Electric Corporation Computer Department”, and H. Oldfield, *King of the Seven Dwarfs*, *op. cit.*

⁸ G. Vieillard, *L’Affaire Bull*, Paris, Spag-Chaix, 1968, p. 32-33.

an agreement was reached, it would develop Bull's manufacturing in France and its exports abroad, particularly in the United States. Subsequent talks between the lawyers of the two companies made it clear that such an agreement would lead to GE controlling Bull, so the talks ended in November 1962⁹.

GE resumed them one year later. By then, Bull's financial situation had become disastrous. On GE's side, the December 1962 annual review had shown that the 200 line was not achieving the planned sale goals. It became imperative to expand the sales towards the European market, which was now growing faster than the American. A first attempt had been made when GE tried to sell computers through its traditional French licensee, Thomson (the old Compagnie Française Thomson-Houston) ; yet Thomson appeared able to sell GE's process control calculators, not mainframe computers for the business market. This required a specific know-how and sales force, which existed only within established office equipment vendors. GE thus became determined to strike alliances with the two major European office equipment and computer makers: Bull and Olivetti.

In December 1963, GE's treasurer, John D. Lockton came to France and had a three-days talk with Bull top managers in the Paris office of GE's legal adviser for Europe, Richard Klehe of Allen & Co. Back in New York a week later and with the approval of GE's board, he sent a 3-page letter to Joseph Callies, outlining an agreement proposal. Mixing appreciation of Bull's technical and commercial achievements with nicely worded threats, it essentially repeated the 1962 offer, and insisted on guarantees regarding the maintain of R&D and of full employment at Bull factories. A further letter offered to buy Bull stock at the market price to date, about \$ 40 per share. This offer was still subject to a review of the financial problems of Bull, of its plants, products and plans, of the content of the RCA agreement and of other possible questions¹⁰.

Among "other possible questions" there was indeed a stumbling block: the French government's industrial policy. It was far more complex than the usual, simplistic descriptions of an authoritarian "general De Gaulle" punching the table and voicing his opposition against an American takeover of French interests. While American direct investments in Europe were beginning to raise concern about the continent's autonomy, in fact it was French electronics engineers and academics from the industry, the military and the University who had started lobbying, created committees and written reports. They pointed at the widening "technology gap" between Europe and the USA, recommending that the government woke up to this "strategic" problem and gave stronger support to R&D in electronics and automation. The Bull crisis had burst in due time to provide more evidence to their point, and from the summer of 1963 two plans had been set up, under the patronage of the ministries of industry, research and finance, to "save Bull" by associating it with various French electrical equipment conglomerates which had small computer subsidiaries.

To make a long story short, these plans were well on their way in early 1964, when growing doubts about their outcome appeared among the French companies and banks involved. In April 1964, the general meeting of Bull stockholders, led by Vieillard who had carefully maintained contact with GE headquarters and prepared an alternative solution, opposed a takeover by a CSF-CGE consortium (the ancestors of today's Thales and Alcatel) and voted in favour of a partnership with General Electric. Consequently in July, a complex legal arrangement was agreed, whose main aspect was the creation of the Bull-General Electric

⁹ G. Vieillard, *op. cit.*, p. 34.

¹⁰ John D. Lockton letters to Joseph Callies, 18 and 30 December 1963 (File Visites préliminaires GE-Bull, Arch. Hist. Bull, 92Hist-DGE02/7. And G. Vieillard, *L'Affaire Bull*, p. 36-39).

company. The government's meddling, along with the other partners' manoeuvres, had so perfectly fumbled the whole thing and caused Bull's stock plunge on the financial market, that GE was able to buy 51% of the main European computer sales organization at about the same price that it had offered 6 months earlier for a mere 20 % of it¹¹.

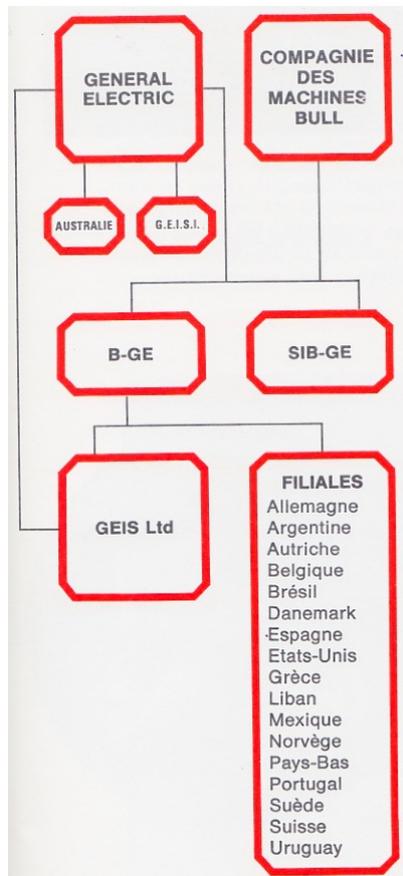


Figure 1. Overall structure of General Electric Information Systems (GEISI) (1964-1970).

Bull-GE: a learning organization

In their overall relationship, GE was clearly a donor, and Bull a receiver. General Electric was perfectly confident that, in addition to its excellent machines, it had an exceptional know-how and a message for humanity, coined in the corporation's slogan, "Progress is our most important product". Indeed the American multinational brought money, technology, managers, and the secrets of efficient organization to its European subsidiaries.

Bull : A receptive company

Despite the differences in size, culture and positions, Bull was essentially receptive to knowledge imported from GE. This can be understood through the history of the company. Bull's corporate culture may be described as **international, provincial, learning and innovative**.

¹¹ J.-P. Brulé, *L'Informatique malade de l'État*, Paris, Les Belles-Lettres, 1993. This book provides a more distanced analysis than G. Vieillard's, *L'Affaire Bull*.

The establishment of Bull in Paris in 1931 had resulted from the encounter of Norwegian patents, Swiss and Belgian capital, and French entrepreneurs and clients. From the start, it had **international** roots and a European identity. Its crucial early years were marked by an exhausting fight to escape takeover attempts by IBM and Remington-Rand, against which Bull found American allies. It soon endeavored to export, building over three decades a vast sales organization, often in partnership with other companies – Wanderer Werke in Germany, Olivetti in Italy, Kamatek in Holland, DeLa Rue in Britain. During the 1950s, Bull had commercial and cross-licence agreements with British Tabulating Machines and with Sperry-Rand-Univac, who consequently did not compete with Bull on the French market, but sold Bull printers and punch-card peripherals in the Commonwealth and North-American markets. On an average, throughout this decade, exports generated between a third and a half of Bull's revenues, which was exceptional among French firms at the time¹².

Bull was also a typically French **provincial** family business. Since the mid-1930s its major stockholders were the Callies family, the owners of the Aussedat paper mills in the remote Savoie region, and related to the Michelin tire makers in Auvergne. The Callies-Aussedat group had gradually taken control of Bull, as a vertical integration step to ensure the sales of paper for punch cards – then a high-tech product. With their Michelin cousins, they had staffed Bull with managers, administrators and production engineers. Devout Christians with families of six children (one of them necessarily a priest, another a military officer), hardworkers who often died at work in their early seventies among piles of accounting analyzes and monthly reports, reserved characters who shunned anything that came close to show-off and did not have a special place on the company's parking lot to park their unobtrusive Citroën, they impregnated Bull with what can be labeled a Catholic ethics of business. Young men of the family were hired by numbers, but only after they had graduated from engineer or business schools and gained experience in companies unrelated to the clan. Like Michelin, Bull was a provincial and international company altogether, as opposed to the Parisian business world. Both companies prided themselves of being free firms thriving on the free international market, avoiding as much as possible the political entanglements and the strings of government contracts.

Like its competitors, Bull was also a **learning** organization. Punch-card machines were complex devices which demanded professional skills to design, to manufacture, to install, to maintain and to use. Therefore the company had developed a whole set of courses to train its workers, technicians, salesmen and field maintenance staff – a considerable part of the business, as electromechanical machinery interacting at high speed with paper and cards was inherently unreliable – and customers would not wait to compute their employees' salaries. In addition, a punch-card machine vendor had to train its clients' operators, from card punchers to programmers. Bull had five internal schools to meet these various needs, employing a corps of instructors and professors, some of whom later wrote influential treatises about information systems analysis or programming methodology¹³.

Bull existed only because it had been able to **innovate** and to produce competitive machines against IBM. It had started with punch-card tabulators and sorters which were faster and

¹² P. Mounier-Kuhn, "Un exportateur dynamique mais vulnérable: la Compagnie des Machines Bull (1948-1964)", *Histoire, Économie et Société*, 1995, n° 4, p. 643-665.

¹³ Jean-Dominique Warnier, *Entraînement à la construction des programmes d'informatique, principes et exercices pratiques*, Paris, Éditions d'Organisation, 1970, etc.

cheaper than those of IBM, then extended and improved these machines continuously. An electronics laboratory established in 1949 had developed a successful programmable calculator, then a stored-program computer – one of the first in history to be sold in more than a hundred units. Much of this effort was based on incremental, shopfloor innovation, as opposed to radical, science-based breakthroughs. “Evolution, not revolution” was a commercial motto of Bull’s as of IBM’s, and the bulk of the clientele – typically accountants in banks and in large administrations – did not ask for more. Bull directors visited the USA once or twice a year, along with one of their engineers, to talk with Thomas Watson at IBM and with other business leaders, and they were informed of novelties such as big, advanced computers or magnetic disks. Yet they tended to reassure themselves, and their staff, by discarding those devices as futuristic bluff or as expensive masterworks which were fit only for the American market.

In the late 1950s, Bull was a profitable, attractive, high-tech, fast-growing company which hired as many qualified persons as it could and was expanding commercially on four continents. The company was a star at the Paris stock exchange, and the American magazine *Fortune* praised it as a symbol of the post-war “French miracle”, along with the Caravelle jetliner¹⁴. Its R&D teams was preparing the next computer generation, by designing a universal computer to compete against the upper-mid range of IBM. This Gamma 60 would incorporate all the new technologies available towards 1960, with an original, multiprogram architecture. After three years it appeared that the development had gone off control, resulting in a machine twice bigger and more expensive than expected, and no operating system to make it work. Two more years of efforts make it reach the market, but by then the Gamma 60 was no longer competitive. Its rental fees hardly covered its development costs, and Bull was still living out of its old punch-card machines and 1st generation calculators. Top executives desperately strived to seek solutions, accepting agreements in the worst possible bargaining position with French or American companies. Meanwhile the R&D teams drew the lessons of the Gamma 60 debacle and developed compact computers which proved successful later – but meant just more investment in the short term.

Knowledge transfers

Through Bull, General Electric meant primarily to acquire a European sales force, then local manufacturing facilities, and only then R&D laboratories which GE planned to restrict to developing peripherals and software. Peripherals were considered less “noble” than central processing units, and software at that time was a part of the after-sales service, without any commercial price of its own.

When General Electric took over, it added to Bull’s basic strategy its “scientific” analysis of the business. Inside each market segment, it was expected that technology progress would lead to successive computer generations. The resulting price reduction for a given computing power would be offset through the growth of new applications required by customers needs. Thus the segmentation by customer size would match a segmentation by price. Overall, it was considered that the computer expenditures would remain proportional to the amount of sales of the customer. When Bull-GE discovered that small businesses would replace their punch-card machines with computers, a new line of “Very Small Computers”, developed in Paris, was added after 1968.

¹⁴ *Fortune*, April 1959, p. 83.

On the Bull side, the perceptions of being taken over by an American company, particularly by General Electric, varied in function of the different professional situations and interests, and evolved over time. To begin with, most Bullists were relieved to escape the “*solution française*”, which they considered neither French nor a solution, as CSF and CGE made process-control computers under American license and did not have the resources necessary to solve Bull’s problems.

For the top management at Bull, the alliance with GE had considerable advantages. In 1964 the General Electric Corp., backed by the Chase Manhattan Bank, was a giant conglomerate with 260,000 employees and a consolidated revenue superior to IBM’s. Thus GE was able altogether to bring the massive investment badly needed by Bull to follow the rapid growth of the computer market and the fast pace of innovation. Yet its computer department was comparable with Bull in size and sales, which let Bullists hope that their “partnership” would not lead to an absorption of the French company.

Commercially, GE was gaining shares on the US computer market, a market considered vital by Bull managers who had constantly sought an American partner to sell their products across the Atlantic.



Figure 2. A powerful GE600 computer installed at Electricité de France (EDF) in the late 1960s.

Technically, GE was perceived as a serious competitor against IBM. Its computer series could compare with the IBM/360 range announced in April 1964. On the bank market, where Bull struggled to maintain its leadership, GE had designed a revolutionary check processing device, Electronic Recording Method of Accounting (ERMA) with the Bank of America. GE’s engineers had developed an Integrated Data Store, the first direct access data base system¹⁵. GE had also pioneered new ways of using computers through sophisticated software, particularly time-sharing and real-time operating systems. Its R&D benefitted from a permanent knowledge transfer from US universities such as Dartmouth and MIT – a research-industry cooperation which was much weaker in France. Bull was to learn and adopt these novelties, and to spread them among European users.

¹⁵ Charles W. Bachman, « The Origin of the Integrated Data Store (IDS): The First Direct-Access DBMS », *IEEE Annals of the History of Computing*, Oct.-Dec. 2009, vol. 31, n° 4, p. 42-54.

GE really internationalized R&D and offered Bull engineers an open door to the American scene, which contrasted with the “closed shop” spirit of the old Bull Cy: Hundreds of R&D engineers from Bull-GE and Olivetti-GE were sent on missions to GE laboratories and plants. They had access to all civilian research at General Electric.

GE’ expertise in time-sharing and remote processing systems led the multinational to develop computer networks. Network systems were both a competitive advantage over IBM which was temporarily lagging in this field, and a revolutionary mean of communication – first internally as productivity tools for programmers, then for clients. In 1967 GE established the first time-sharing service in Europe in its British subsidiary Bull-De La Rue. Terminals were installed in Paris and Rome, allowing for commercial demonstrations. A year later, more time-sharing centres were officially opened in France and in Italy. Electronic mails were exchanged between the Boston and Paris GE development teams from 1971.

Certainly the most important kind of knowledge that Bullists looked up to was GE’s managerial expertise.

American multinationals were impressive to French executives and policymakers. Whatever opinions they had of “American imperialism” or on the necessity to stick to the transatlantic alliance and embrace the American way of life, they generally considered big US companies as models of efficiency – much the way GE meant to be perceived. A growing literature of management manuals, politico-economic essays and newsmagazines in French contributed to spread this image in the French public. American companies were the standard to which the “technology gap” was metered, they had been much studied since the productivity missions within the Marshall plan, they conquered markets and minds. They were altogether models and targets for what European companies should become – French corporations were strongly encouraged by the government and opinion leaders to grow and to merge in order to attain a “critical size”, considered indispensable to survive in the European Common Market then in construction. Emulating American multinationals was an economic and political imperative. In this regard, what best schooling could exist than being integrated in GE?

The very model of a modern, integrated industrial organization¹⁶, GE was indeed considered a veritable business school by the Bullists. All the more as they had to keep a double accounting system to comply with the French and American regulations... A considerable educational effort was set up to integrate the European staff into the US corporation, with courses to teach GE principles and procedures – and, to begin with, the English language in which most French employees were far from fluent.

“We were invaded with a technical and commercial literature in American English. [...] A wave of new technical terms appeared, which did not exist in dictionaries: *debugging, abort, post mortem memory dump, input reader, output writer, BIOS, file and library management, object & source program, linking & scheduling...* Bull-GE soon had to print American-French technical dictionaries [...]. Still more significant, the language of international meetings became English, not without resistance among some French directors. And GE introduced international meetings at all levels¹⁷.”

¹⁶ A. D. Chandler, *The Visible Hand: The Managerial Revolution in American Business*, Cambridge Ma, Harvard University Press, 1977.

¹⁷ Correspondence with Gilbert Nathan, former sales engineer at Bull, 9 July 2001.

Courses were set up in marketing, in industrial strategy, in finance, in communication techniques. Engineers saw the introduction of product planning methods as a “revolution” in development processes. The sudden importance taken by these courses, and even more by the companywide implementation of these methods which left piles of statistical documents, meetings and reports, is obvious from the volume they occupy in Bull’s archives.

“The GE model imposed itself at a moment when the old Bull model was completely devalued. Propaganda tricks from GE, such as “go for improvement” slogans were viewed as gadgets by the technical cadres, but we had an evident need for project management methods, P&L models, etc. The obligation to use English as our work language was a constraint, yet it was well accepted even down the hierarchy. [...] In my own environnement [system development], I felt I was integrated in one of GE’s divisions¹⁸.”

Our description could be extended to Olivetti, but with some qualifications. The memoirs of Marisa Bellisario, chief of Olivetti-GE’s product planning, stress altogether the desire of Olivetti people to learn GE managerial methods, and the difficulties faced by Italian and American executives to adjust their respective companies’ cultures to each other¹⁹.

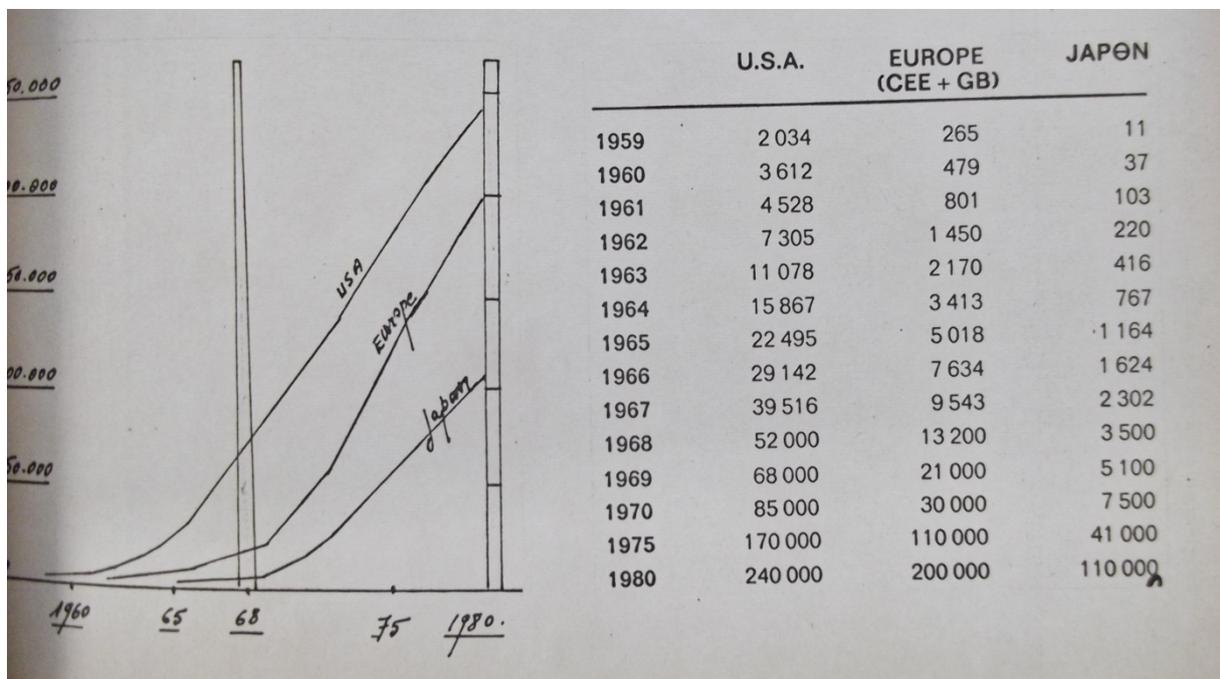


Figure 3. Evolution of the computer market (number of machines) in the USA, Western Europe and Japan, as seen in a market study presented at Bull-GE in 1969. The Bull Historical Archives contain a wealth of internal reports and meeting presentations, which contributed to integrate Bull employees in GE’s global strategy.

Managerial delusion

It turned out that, while GE had no problem financing the cash requirements of the computer business, the surprising success and growth of the computer business led to much larger “paper losses” than initially forecast. This was largely due to the rental system : Most computers were leased, so that their production cost was not recouped before several years. The fastest the market expanded, the more new computers were installed at clients who paid

¹⁸ Correspondence with Jean Bellec, former R&D engineer at Bull, 6 July 2001.

¹⁹ M. Bellisario, *Donna & Top Manager. La mia storia*, Milano, Rizzoli, 1987, p. 14.

only a fraction of the price monthly, the more abyssal were the short term losses. And the market grew even faster in Europe than in North America.

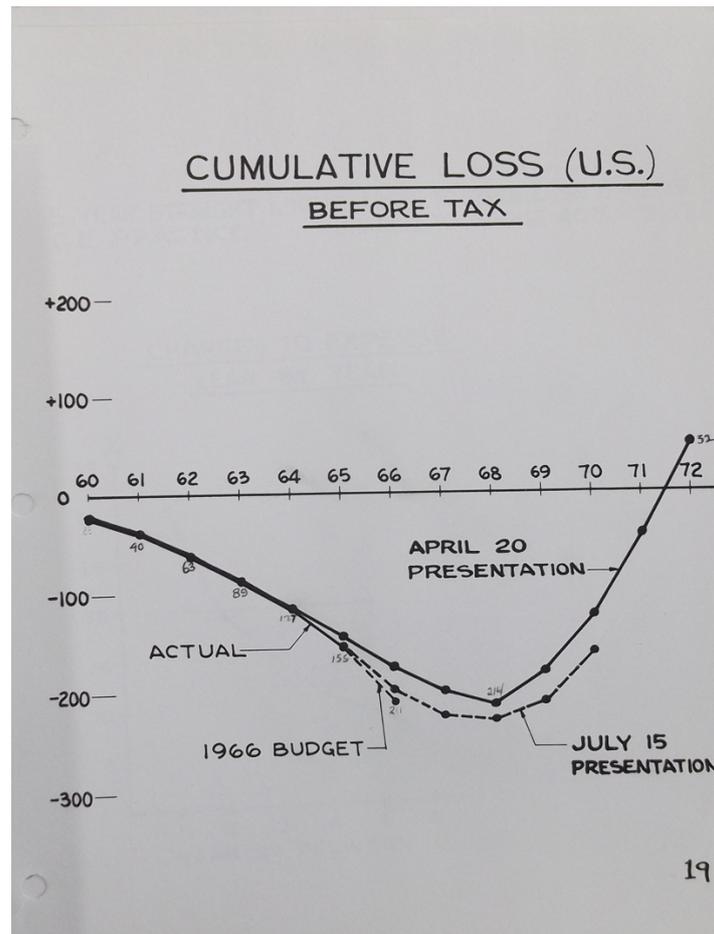


Figure 4. At an internal meeting held in Phoenix (Arizona) in Feb. 1966, GE managers compared the marketing efforts of IBM and GE, explaining GEIS' financial problems. They still found "chinks in the armor" of IBM, giving hope for GE's computer operation to become profitable (Bull Historical Archive).

This financial situation was particularly difficult to justify in a multidivisional, diversified corporation, where other businesses competed for investment. It was further complicated by the fast pace of innovation cycle which required considerable investment in R&D and a careful scheduling of product life cycle. Obviously the GE managerial principles were not enough to face these challenges, and many people within the corporation came to realize it.

In 1969 GE launched a vast project for an Advanced Product Line to replace and unify all its existing computer families – as IBM had done seven years before. Following the rules from the book, GE organized a form of independent product review at top level, a secret meeting in a Florida hotel under the code name *Shangri-La*.

About fifty experts from the multinational planned the development of the new line, dispatched among the American and European units of General Electric Information Systems (GEIS), Bull-GE receiving responsibility for the medium system. Beyond technical developments, *Shangri-La* integrated the planning and marketing considerations in a global vision. The project was then passed on to the financial audit, including a consultation of Diebold and Arthur D. Little. Conclusion : The development of this grand project would take five years – five years of additional losses –, cost about \$ 1 billion, and break even toward 1980. Other reports showed that this sum would be more profitably invested in GE's nuclear

energy or jet engine divisions. GE covered less than 6 % of the world computer market, while most experts agreed that any mainframe vendor needed at least 10 % of the market to compete profitably against IBM. The president of General Electric, Borch, adopted these conclusions and decided to sell the computer business.

The buyer was Honeywell, so that from October 1970 Bull became the major European part of Honeywell Information Systems. The French subsidiary had become profitable in 1969, and would remain so all along the 1970s.

The segmentation model inherited from GE functioned as long as Grosch's law of growing returns on processor power was valid. As the "technical" market expanded in the 1970s, a new segment was identified, for which a new minicomputer line was created. Yet, when large customers started to acquire collections of small or medium computers for specific uses, the validity of the model began to fade. Another factor of change was that the customer business stability no longer exceeded the life duration of a computer system and *a fortiori* of major computer applications. Moreover, this was a time of active external growth, and many mergers had led to problems due to the incompatibility of the computer systems between the merged companies. Mergers normally led to consolidating the units' data-processing facilities, with serious, unanticipated migration problems. Nevertheless the segmentation model established in the mid-1960s remained the basis of the strategy over the next two decades. Even while it was recognized as obsolete, it was not easy to replace.

A cascade transfer process beyond the corporation

In turn, Bull-GE had become an emitter which transferred knowledge towards other companies – technical knowledge, and later managerial knowledge.

Central product planning at GE had assigned Bull-GE and Olivetti-GE with the development of two compatible computers. Both were marketed in autumn 1966 and sales started favourably. Yet in December, GE product planning decided to withdraw the Bull-GE 140 machine, which created internal competition against the GE 400 line.

This stirred resentment among Bull engineers and salesmen. However the 140 ended up metamorphosed rather than killed, as it became two new computers at two different manufacturers:

- In 1967, Bull-GE sold the licence of the 140 to a Czechoslovakian electronics company, Tesla. Tesla took on the manufacturing from the Angers Bull factory, and sold a hundred units under the name "Tesla 200". With a revenue of nearly \$ 13 millions, plus the sales of Bull peripherals which followed, this transfer operation covered largely the development costs of the machine. It was still acceptable for Cocom regulations, given the size and standard technology of the Bull machine.

- In a less direct fashion, the 140's software migrated to the Plan Calcul. Part of the Bull development team in charge of the disk operating system was so shocked by GE' decision that they walked out in disgust and rejoined CII. This was exactly what the Plan Calcul authorities expected – that Bull talents would be soon fed up with the American parent company reducing opportunities in France, and would join the national champion which was developing exciting, advanced systems. Indeed the head of the team, François Sallé, was hired by CII in late 1967 as director of "*software de base*", in charge of all programming R&D,

while other ex-Bullists adapted the 140 disk operating system to CII's midrange computer line. Shipped from October 1968, the new CII machine became a serious competitor to the GE 400s on the French market.

Compared with Bull-GE, CII was essentially an engineers' company with little managerial or commercial culture. While it was supposed to become profitable (which it did by the early 1970s), its R&D expenses being largely covered by government subsidies and its sales benefitting from a preferential procurement policy in public administrations, CII priority was to achieve an over-ambitious computer development program under the Plan Calcul.

Perhaps the only advanced managerial method in use at CII was the Program Evaluation and Review Technique (PERT), a well-known statistical technique for measuring and forecasting progress in projects involving several parallel development tasks, applied as a decision-making tool to optimize resources, control a program and save time in achieving end-objectives. The PERT had been designed within the US Navy in the late 1950s to accelerate the development of Polaris missiles. From the US Navy it was transferred through NATO to the French Marine Nationale, which in turn required its implementation at companies which were participating in the development of nuclear weapon systems. CII was one of them. Not only did CII systematically apply the PERT to all of its computer projects, but it also spread the technique among its clients as CII wrote PERT software programs running on its computers. Perhaps PERT's acceptance in France was also facilitated by the fact that a comparable method was elaborated by SEMA, a French consulting firm specialised in operation research and software development: It fit well with the professional culture of French engineers-mathematicians²⁰.

Despite it used PERT at technical level, CII constantly experienced problems of development delays and of poor coordination between engineering, manufacturing and sales. The arrival of the software team and of salesmen from Bull in 1967 had not brought much of GE's managerial methods, since these had not yet widely impregnated Bull staff, particularly in these fields of the business. It was only in 1972, with a second wave of migrations, that GE-originated concepts and procedures of product life cycle and independent product review, as well as marketing and product planning techniques, made their way to CII²¹. This time they were brought by a sales director and by hardware and computer architecture project managers.

Still, three years later when the Plan Calcul was terminated and CII absorbed into Honeywell-Bull, CII executives discovered what they perceived as a more modern managerial culture, with stricter control and accounting methods, and a more elaborate product planning than had ever been practiced at CII²². GE's knowledge heritage appeared to be long lasting, forming a managerial backbone of the French company throughout its successive avatars.

²⁰ Created in 1958, SEMA applied Prof. Claude Berge's graph theory to develop a « *méthode des potentiels* » comparable with the PERT.

²¹ It can be precisely dated with a first note by an executive just arrived from Bull quality control, M. Demaret, « *Projet de procédures de revues indépendantes de produit* », 20 October 1972, officialized and implemented from January 1973

²² Author's interviews with J.-F. Dubourg, G. Simonet and other former CII executives, 2008.

Conclusion

The formation of Bull-GE in 1964 led GE's computer business to control the international sales organization set up by the French company in the past thirty years. This acquisition ended up being much more costly than originally forecasted. In six years, General Electric injected over 100 million dollars into Bull. A sum that none of the would-be partners involved in the short lived *solution française* was able or willing to pay. This observation leads us to reevaluate the takeover of Bull by GE, which was considered a national disaster among governmental spheres in the mid-1960s : With the distance of time, and knowing that a few years later GE left the computer business, this takeover appears as a real economic salvation.

It appears even more so if we take into account the massive transfer of knowledge from GE to Bull. As we mentioned already, GE was somewhat of a corporate business school for its executives and engineers, a teaching and learning organization which was particularly welcome by Bullists who had just experienced the drawbacks of an outdated management.

The diffusion of managerial doctrines and tools spread beyond GE computer business (GEIS), particularly through the professional mobility of executives: Concepts and methods as essential in the computer industry as Product Cycle and Independant Product Review, which had been transferred from GE to Bull, were later passed on from Bull to CII and to other companies which hired Bull-GE engineers. Thus, a local or central managerial culture became gradually global – sometimes clashing with particular corporate cultures or economic models related to new high-tech firms.



Figure 5. Beside the direct investments in its European computer operations and the education in managerial techniques, GE's major contribution was the development of early digital networks.