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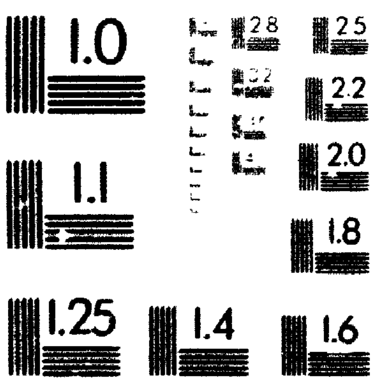

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THE TRANSATLANTIC DISCURSIVE REGIME AND FRENCH POLICY IN INFORMATION AND COMPUTER TECHNOLOGY: 1945-1981

by
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acceptance of the thesis,

THE TRANSATLANTIC DISCURSIVE REGIME AND FRENCH POLICY IN INFORMATION AND COMPUTER TECHNOLOGY: 1945-1981

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Chair, Department of Political Science

Thesis Supervisor

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Carleton University
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ABSTRACT

This thesis explains the French inability to develop an autonomous information and computer technology (ICT) industry as a result of the participation of the French industry and policy makers in a transatlantic discursive regime. I define the concept of discursive regime to mean not only a set of transatlantic international norms and procedures or the congruence of views between sectors of the member governments of the regime. This concept also includes disputes and divergences of interest and emphasizes the role of the agents in the formation and transformation of regimes. The emphasis on agents however did not entail a rejection of the concept of structure but implies a simultaneous occurrence of structure and agency in the formation of historical events within a *universe of political discourse*. Thus, I use the concept of *universe of political discourse* to show competing discourses in the analysis of internal ICT policy-making both in the US and France and the concept of *discursive regime* as an alternative methodological framework to neo-realism, liberal regime theory and the neo-Gramscian approach to international relations.

Using these concepts, I argue that from 1946 onwards, with respect to ICT, the US Air Force leadership within the US military establishment was the critical force that linked the military sphere to science, technology and industry within the US universe of political discourse in ICT. The mode of this linkage was provided by the US Air Force's perceptions and priorities of air power and air defense that created a technological dynamism in information and computer technology. Moreover, I show that the US Air Force structured the transatlantic space militarily, scientifically and technologically through NATO and the OECD. In keeping with this argument I demonstrate how in the period 1945-1965, NATO priorities in defense and the OECD science and user orientation in computer policy were internalized by French decision-makers. I show that during this period, France's universe of political discourse in ICT adopted an Atlantic orientation by choosing American computers in order to respond to the NATO concern with inter-operability. As the French military and telecommunications authorities had chosen IBM computers, this choice motivated French electronics companies to seek alliances with American interests, in order to survive within the French defense procurement market.

In 1968, when the French *Délégation à la recherche scientifique et technique* (DGRST) formulated a plan to oppose NATO and OECD policies and to create a European industrial specificity in electronics, computer and telecommunications, this plan failed. This failure was due to the fact that while the plan of the DGRST depended on the EEC member countries' political willingness to challenge American views within NATO and the OECD, EEC member countries and their firms felt that their interests were better served within NATO and the OECD, rather within a DGRST-led fortress Europe. The European resistance to the DGRST plan strengthened the relationships between the French and US ICT industries in the period 1974-1981.

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CHRONOLOGY

1944

- Roosevelt began to consider air power not only as an *ad hoc* solution to be used in the course of a war, but, as a diplomatic tool

1946

- The US Army Air Force (AAF) Air Force created the Scientific Advisory Board (SAB)
- SAB members received Air Staff briefings on AAF research and development plans and recommendations about air defense.

1947

The French Air Force created the *Société d'Electronique et d'Automatisme* to develop specialization in analog and digital computations and industrial automation.

1949

- The Soviet Union detonated its atomic bomb.
- George Vally (MIT) proposed to Theodore von Karman, Chaiman of the SAB that a study of air defense systems be undertaken.
- SAB created the Air Defense Systems Engineering Committee (ADSEC), with Valley as chairman
- Creation of NATO.
- NATO established a transatlantic Military Production and Supply Board (MPSB)

1950

- Jay W. Forrester of MIT's Digital Computer Laboratory (DCL) invented the random-access core memory as a replacement of the current but limiting technology of cathode-ray-tube (CRT) storage

1951

- "Project Charles" was established at MIT for short-term investigation of air defense problems
- First life demonstration of automatic aircraft interception using Whirlwind computer.
- "Project Lincoln" was established at MIT as air defense laboratory.
- The Air Defense Research and Development Command (ARDC) took responsibility to administer "Project Lincoln".
- MIT's Digital computer laboratory was associated to Project Lincoln.
- NATO abolished the transatlantic Military Production and Supply Board (MPSB) and the Atlantic Council established a Standardization Policy and Coordination Policy Committee and a Military Standardization Agency.
- The French company SEA manufactured its CUBA computer, a cathode-ray tube-based machine

1952

- Name "Project Lincoln" was changed to "Lincoln Laboratory".
- Plans for the "Cape Cod System", the prototype for the SAGE system was established
- Lincoln Laboratory considered several manufacturers to build the SAGE computer.
- IBM was awarded a subcontract by Lincoln Laboratory.
- The French company, SEA produced its first computer, the *Fisaugraphe* that was ordered by the French Air Force for military communications.

1953

- In France, the French company BULL introduced the *Gamma 3* at the same time as IBM entered the electronic computer industry, and a little after the British firms FERRENTI and ENGLISH ELECTRIC. The *Gamma 3* was in fact a response to the IBM 604 computer.

1954

- IBM received contract to manufacture two computer prototypes: the XD-1 and XD-2.
- The Cape Cad System was fully operational
- The Air Force awarded to IBM the first production contract for SAGE computer called the AN-FSQ-7
- The Air Material Command (AMC) established the Air Defense Engineering Service (ADES) with Western Electric company involved in the ADES management.

1955

- IBM installed at Lincoln Laboratory a simplex version of the AN-FSQ-7 computer
- In France, SEA built the CAB 2000 computer for aircraft interception.

1956

- IBM announced the development of TX-0 an experimental transistorized computer.
- In France SEA built a scientific and management version of the CAB 2000.

1957

- US Air Force began weapon integration and integrated space research in its policy.
- The US government created the National Aeronautic and Space Administration (NASA)
- The French *Direction de la Recherche et des Moyens d'Essais* (DRME) of the French Armed Service and the French Air Force financed research done by an SEA team for a machine that used new magnetic techniques.
- SEA built DOROTHEE a germanium-based computer that failed to fulfill the F . Air Force' s specification.
- The French company BULL's *Gamma 3* computer and its modified version the *Gamma Extension Tambour* (ET) were used unsuccessfully by the *Institut Blaise-Pascal* of the CNRS, the University of Grenoble and the nuclear center of Marcoule.
- When *Electricité de France* (EdF) required digital computer for replacement of its analog machines, *Intertechnique* bought a production license from the American company *Thomson Ramo Wooldridge* (TRW) to build transistorized digital computers

1958

- The US Air Force formed the Stever Committee that redefined the Air Force's role as responsible for the military uses of space.
- The US Government created the Advanced Research Projects Agency
- In France, IBM-France built two PACA II computers for French air defense and CAPAC I computer as a missile guidance system.
- CSF also established an alliance with TRW and create a subsidiary: the *Compagnie Générale des Semi-conducteurs* (COSEM).

1959

- In France, the IBM 370 computer series replaced the CAPAC I and II computer in French air defense.

1961

-In the US, the Air Research and Development Command and the Air Material Command were terminated and replaced respectively by the Air Force System Command (AFSC) and the Air Force Logistics Command (AFLC). The AFSC had the mission to forecast the USAF's requirements in five to ten years and assess the deficiencies of national defense policy, military strategy, and inter-service relationships. Furthermore, it had the task of making suggestions on the improvement of US defense from emerging scientific discoveries and undertaking an Air Force-wide program review, named *Project Forecast*

- The French government created the Permanent Electronics Commission of the Plan (COPEP). COPEP was a platform of discussion of French policy in electronics. It regrouped members of the

DGRST, DRME, CNET, CCRST and the *Commissariat Général du Plan* who dealt specifically with electronics. Its mandate was to propose a policy for the expansion of the electronics industry during the next ten years and to elaborate procurement policy.

1962

- The US World Wide Military Command and Control System (WWMCCS) that concentrated both nuclear and conventional forces in the hands of Strategic Air Command (SAC) became operational.
- The beginning of the French Fourth Plan.

1963

- The SAGE system was fully deployed in 23 air-defense sectors: 22 in the United States and one in Canada.
- First OECD conference on science policy.
- The French *Quatre* and *Hexagone* computer development programs.

1964

-GENERAL ELECTRIC took over the French computer company BULL

1966

- The French *Plan Calcul* computer development program

1967

- The American company HONEYWELL took over the French computer company BULL
- NATO placed increased emphasis on the utilization of national military and PT&T networks for greater flexibility in NATO defense and to create a NATO Integrated Communications Systems (NICS)

1968

- Third OECD Conference on science policy
- The Second phase of the French *Plan Calcul*
- Under the influence of the US Department of Commerce, NATO and the OECD, inter-operability between the computers that run the PT&T of member countries was abolished in favor of *Compatibility in Manufacture and Supply Services* to upgrade NATO telecommunication networks and to establish a civilian transatlantic data-processing network: the Integrated Management and Information System (IMIS).

1969

- Beginning of PREST negotiations, the French-led European data-processing and telecommunications initiative.

1973

- The French company CII, the German company SIEMENS and the Dutch company PHILIPS agreed to create a European data processing consortium called UNIDATA. From the French perspective, the consortium's primary objective was to create an industrial entity that by 1980 would be second to IBM in the world computer industry. UNIDATA was abolished the same year it was created.

1975

- The government decided to merge CII with HONEYWELL BULL. The newly created company was known as CII-HB. According to this arrangement, CII-HB sold to the French government machines manufactured by the US company HONEYWELL INFORMATION SYSTEM under CII-HB label.

1979

- The French Ministry of PT&T built its remotely-controlled data-processing system, TRANSPAC, that became operational in 1979. The Commission of the European Communities used TRANSPAC technology to built EURONET. These networks were administered by the nine EEC member countries' PT&T ministries, were interconnected among themselves and with American networks TYMNET, TELENET and GENERAL ELECTRIC MARK III to form an Integrated Management and Information System.
- MATRA a French owed missile company created MATRA HARRIS SEMI-CONDUCTEURS a 51% - 49 % joint-venture with HARRIS, an American Company. After this alliance, HARRIS transferred its Complementary Metal Oxide Semiconductor-Conductor (CMOS) technology to MATRA HARRIS SEMI-CONDUCTEURS.

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Chapter One

INTRODUCTION

After 25 years of attempting to develop a competitive computer industry, the French government became convinced towards the end of the 1970s that France's information and computer technology (ICT) industry would be incapable of autonomous development. This change of policy is not the subject of this thesis. Rather, through an archival investigation of French electronics policy during the period 1962 -1981, I seek to explain why France could not develop an autonomous ICT, despite projects such as the *Quatre Axes, Hexagones,* the *Plan Calcul* and UNIDATA, the French-initiated pan-European computer development program.

In a time when dialog between international relations perspectives and when interdisciplinary research is encouraged in almost all academic curricula, I find the subject of this thesis theoretically and methodologically fruitful for several reasons. First of all, since post-World War II, the sector of information and computer technology (ICT) is where both the development of means of destruction and the hope for better human life converge. Second, ICT is a sector where defense, science, technology and industrial policies are closely related. Third, ICT is also where competition and cooperation between nations go hand in hand. While my research tracks these issues of international concern, my choice of France is also theoretically and methodologically motivated. The role played by France in the ICT sector can be described as both competitive and cooperative in defense, science, technology and industry within a hegemonic context dominated by the United States, which problematizes main IR theories and opens dialog between them.

With these concerns in mind, in what follows, I review several analyses of the French failure to develop an independent ICT industry. Each of these analyses is related to the notion of power and to one of the major theories in international relations (IR): realism, neo-realism, regime theory and neo-Gramscian approach to IR. While the merits of each of these analyses are considered, they are also criticized for their tendency to present a simplistic view of the French policy.

1.0 REVIEW OF LITERATURE

Among the French ICT projects, the best known is the *Plan Calcul*, which is portrayed as as an initiative, representing the French discourse of independence. Those who argue from this point of view maintain that French ICT policy during the period 1965-1974 was in effect a nationalistic industrial policy whose objective was to achieve technological independence *vis-à-vis* the then dominant U.S. computer industry and its flagship International Business Machines (IBM). This version of the French discourse of independence in ICT was articulated in particular by realists and neo-realists. Raymond Aron for example argued that:

> of primary concern to Europeans is the theory that the American superiority in research and development tends to be cumulative. It builds on itself and tends to increase because the mass of resources which can be devoted to research is greater as the over-all national and corporate resources are greater. Therefore, the nation which has the research leadership has a good

> chance to increase it even further . Whether the theory of U.S. cumulative superiority is true is uncertain. What is important at least many Europeans fear that it is true. And many are obsessed by the thought that in 10 or 20 years the majority of large European firms will be dominated by multinational companies with American dominance.[1]

Although many French and other Europeans believe in the American technological domination of Europe, the evidence presented in this thesis shows that contrary to what would have been expected from "nationalist" French government during the period of the *Plan Calcul*, the French government did not take steps to overcome this domination. Instead, French policy makers chose to base their computer industry on American technology and allowed GENERAL ELECTRIC, an American firm to take over France's first computer maker, the *Compagnie des Machines Bull*. This fact however was of little importance to a realist such as Raymond Aron who believed that the unequal distribution of power resources among states favored the United States and would necessarily motivate countries such as France to overcome it. What is important in Aron's argument is that both US technological superiority and the alleged European scientific and technological weakness are given by the post-World War II structure of inter-state relations. The argument suggests, moreover, that given the state of anarchy in the international system, it is only natural that some countries would react against American technological superiority by attempting to shift the balance of technological power to their advantage.

In keeping with the realist understanding of international relations, Robert Gilpin also argued that European governments were less concerned with economic profitability in their science and technology policy than with politics understood as

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[1] R. Aron, The General Electric Forum, Vol. 9, No. 2, April-June 1966, p. 16.

struggle for power. This was how in the 1960s, realists interpreted the European concern over their technological gap vis-à-vis the United States. According to Gilpin:

> ... what is at issue for France and Europe is their political position vis-à-vis the Great Powers and their capacity for long-term national independence. Whereas beginning in the latter century control over petroleum resources became essential once naval ships shifted from sail to diesel, so today an independent aerospace and electronics industry along with the supporting sciences has become crucial for a nation to enjoy diplomatic and military freedom of action.[2]

Through their notion of structural power struggle, realists and neo-realists such as Raymond Aron and Robert Gilpin claimed that the distribution of power was the main aspect of the 1960s transatlantic technological gap debate. As Stefano Guzzini points out, such explanations identify the contenders (here the US and Western Europe), "...their diverging interests and intentions, the open and tacit clash of wills and prevailing outcome... This allows the power of the actor to be assessed not only for the power confrontation in question but also for future ones".[3] Despite much archival evidence to the contrary, this realist framework was used by John Zysman to interpret the French ICT policy in the 1960s. He maintains that:

> ...Whether the state's economic return on investment in the increasing use of computers, process-control production and numerically controlled machine tools would have been higher than its return on investment in the support of a financially and technically independent French computer industry was a question left undiscussed. The notion of national self sufficiency and technological glory was... unquestioned value. The government intervened to achieve the political goal of technological independence, not an economic goal, however defined.[4]

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[2] R. Gilpin, France in the Age of Scientific State, Princeton N. J., Princeton University Press, p. 76.

[3] S. Guzzini, "Structural power: the limit of neorealist power analysis", International Organization. Vol. 47, No.3, 1993, pp. 448-449.

[4] J. Zysman, Political Strategies for Industrial Order. State, Market, and Industry in France. Berkeley, Los Angeles and London, University of California Press, 1977, pp. 73-74.

For Zysman, there was no doubt that the *Plan Calcul,* the 1966 French computer policy was about developing an independent computer industry free from American interests. The author states that:

> ...whatever the exact events which prompted this concern, the logic justifying government support [to the French electronics industry] is clear: an independent electronics industry consisting of firms controlled by French capital and independent from American technology is required for a French military and economic independence...[5]

A decade after Zysman's book, in 1987, E. A. Koloddziej maintained that the *Plan Calcul's* objective was to create a "new line of computers with no relation to American technology."[6] In the same vein T. R. Howell *et al* have asserted that: "The French government implemented a number of programs in the 1960s and 1970s to promote the development of an indigenous semiconductor capability."[7] As recently as 1991, C. Le Bolloc'h Puges has argued that the objective of the *Plan Calcul* was to build an independent national computer industry free from American influence.[8]

Since French electronics policy was understood by realists and neo-realists as a struggle for independence, the lack of an independent French computer industry in the late sixties was seen to be an effect of the international structure of power relations that placed limits on French ambition for independence. In 1968, just after the first phase of the *Plan Calcul,* Robert Gilpin argued that:

> There is an irony in the efforts of French to play a greater role in industrial R and D - namely that the United States, the world's foremost free enterprise nation is forcing traditionally *dirigeant* France to socialize the basic resources of the modern economy - scientific R-D. In a situation where an economy, two thirds of whose firms are relatively small (a total work

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[5] Idem, 74.

[6] E. A. Koloddziej, Making and Marketing Arms: The French Experience and Its Implications for International System, Princeton, Princeton University Press, 1987 p. 230

[7] T. R. Howell *et al*. The Microelectronics Race, Boulder and London, Westview Press, 1988, p.169.

[8] C. Le Bolloc'h-Puges argues the contrary in La politique industrielle Francaise dans l'électronique, Paris, L'harmattan, 1991, p. 11. However his book is not based on primary documents.

force of less than 1,200) is competing in a world market with industrial giants...[9]

Having maintained that during the first phase of the *Plan Calcul* the French implemented a policy of technological independence vis-à-vis the United States, the author argued that the problems encountered by this policy were the result of US hegemony. Pierre Maillet who worked for a Common European Market technology policy against American multinationals, took a similar position in arguing for UNIDATA, the attempt to build a European computer company through the alliance of CII, PHILIPS and SIEMENS. A European policy in ICT he wrote, was justified because international information technology was dominated by the United States and therefore a country of France's size was incapable of developing alone a national electronics industry capable of competing against IBM.[10]

While the purpose of the *Plan Calcul* was explained in terms of a struggle for power within the international system, the end of the second phase of the *Plan Calcul* and the abandonment of UNIDATA were accounted for in terms of a choice-theoretical approach to power. In this approach, the unequal distribution of power is not the main criterion for the explanation of policy outcomes. The choice-theoretical approach to power stresses the importance of power resources in cases of international concern within an "issue area" or a "regime" "asymmetrical interdependency", vulnerability, resources and potential power can be analyzed. It emphasizes a country's capacity to bargain via stratagem in order to influence changes in the regime. This approach was implicitly adopted by Zysman to explain the change in direction of the French ICT

[9] R. Gilpin, op. cit., pp. 332-333.
[10] P. Maillet, «L'hexagone peut-il contenir toute la technologie moderne», in I. Chapelle & C Ponsard, La capacité de concurrence de l'industrie française, Paris - Montréal, Bordas, 1971, p 83.

policy towards the end of the 1970s. The author focused on the French government's will to bargain with multinationals in order to influence the structure of the international electronics industry.

Zysman's argument is that since France was in a situation of "asymmetrical interdependency" with the United States in the "issue area" of electronics, French decision-makers towards the end of the 1970s finally understood that:

> War against the multinationals simply because they are foreign entities no longer seems necessary or possible. Furthermore, the limits on power of the of the state to intervene in an international industry are more clearly understood. Yet the possibilities of state action are also accurately perceived. Seemingly, the French feel able to minimize the problems and take advantage of the opportunities the multinationals represent. The policy began to evolve under Pompidou and seems to have crystallized under Giscard. It is reported to be as much a response to events as an explicit shift in direction.[11]

It is important to note that this argument not only emphasizes the normative influence of the liberal trade regime and technological change but also a bureaucratic learning from or reaction to "previous policy" implying the autonomy of government from social and political pressures[12]. In a similar line of argument that combines the influence of international norms, technological change and bureaucratic learning, John Ardagh wrote in the early 1980s that:

> Today the French Government reluctantly accepts that full national independence in the electronics field is not possible, since American techniques are so far ahead. So the government is operating a dual policy: the work of CSF and the other purely French firms is promoted for all it is worth and mergers are encouraged; but the Bull take-over is also allowed, and IBM is encouraged to build its strength in France[13].

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[11] J. Zysman, «The French State in the International Economy», International Organization, Vol.31, No.4, 1977, p.869.

[12] Policy change as bureaucratic learning process is perspective developed by P. Sacks "The Structure and the Asymmetrical Society", Comparative Politics, Vol 12, April 1980, p. 356. See also M. Weir and T. Skocpol, "State Structures and the Possibility and the Possibility for 'Keynesian' Responses to the Great Depression in Sweeden, Britain and United States", in P. Evans *et al*, Bringing the State Back In, New York, Free Press, 1985, p.119.

[13] J. Ardagh, The New French Revolution, New York and Evanston, 1981, p. 45.

Despite the US active efforts to liberalize international electronics trade between the late 1960s and late 1970s, Zysman and Ardagh seem to argue that in the 1970s, the power resources of the United States were not as important as the norms of the international liberal trade regime supported by the latter. Thus, after a time-lag that can be situated between the mid 1940s and mid-1970s, the liberal trade regime itself became a source of inducement that acted independently from US power to influence French decision-makers' change of policy.

This focus on external variables is used by Brand and Durousset to describe the internationalization of the French computer industry as a shift from a logic of investment and production in the post-war era to a strategy that inserted the French computer industry into the international electronics market. Brand and Durousset argue that:

> *La contrainte externe constitue un déterminant de plus en plus pressant à l'intervention de l'État... Les contraintes externes auxquelles il faut ajouter la rapidité des progrès techniques expliquent que la priorité à l'expansion devienne l'objectif majeur ... et dominent la politique industrielle pendant les dernières années de la présidence du Général de Gaulle (jusqu'en 1969) et celle de la présidence de GeorgesPompidou.*[14]

All these analyses would have made sense if the French government had **implemented** a policy of **independence** in the electronics sector. Instead, and despite the persistence of the discourse of independence in France and the bureaucratic and social confrontation over how to carry out this policy, the actual outcome was always a policy of **interdependence** that took into account the US technological leadership and the interests of American multinationals in France. This, I argue was the

[14] D. Brand & M. Durousset, La France, histoire et politiques économiques depuis 1914, Paris, Éditons Sirey, 1991.

case during the *Quatre Axes* and the *Hexagone* computer development programs and during the two phases of the *Plan Calcul.*

However, despite these practices of interdependence, the French discourse of political independence persisted. This is why, in contradistinction to the above views, French neo-Marxists have explained the gap between the French discourse of independence and the state of the French industrial and technological dependency in terms of ideology and transatlantic class relations. Like the neo-Gramscians who view transatlantic relations in terms of class alliances, Alain Joxe[15] argued that French pretense to military independence *vis-à-vis* the US (which included a policy for an independent ICT industry) was a bourgeois ideological deception whose purpose was to build a class consensus that favored the creation of a modern military industry to the economic interests of the French bourgeoisie.[16] This analysis contains four interrelated assumptions: (1) since the end of World War II, the investment of governments in defense industries in the western world was a way to stop the decreasing rate of profit in the general economy (2) the French struggle for military equality with the US hid a bourgeois political consensus on both sides of the Atlantic, (3) true inequality is not amongst nations but between classes across the Atlantic and finally (4) what really matters are transatlantic class relations and alliances implicating objective class interests within the capitalist mode of production.

While for Joxe and J.-P. Belligand French industrial policy of the 1960s was never about independence, those participating in the development of the *Plan Calcul*, such as André Danzin claim that the inability of the former to deliver on its promise was

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[15] A. Joxe, "Atlantism et crise de l'État", In N. Poulantzas (ed), La crise de L'État, Paris, P.U.F., 1978, pp. 298-348.

[16] For another reference concerning neo-Marxist argument see J.-P. Balligand, "Defense nucleaire et hegemonie politique", Les Temps Modernes, No.378, Jan. 1978.

due to an internal factor: the French failure to understand that information technology was a major tool for the modernization of France. Danzin has recently stated, for example, that:

> *Je ne crois pas que l'on puisse attribuer à autre chose qu'à un manque de préparation globale de la société française à comprendre que le traitement de l'information allait devenir l'outil majeur de la modernisation du pays ou par défaut la raison principale de la chute de la competitivite de nos industries et de nos services.*[17]

According to this institutionalist approach to policy making, the lack of understanding of the importance of ICT to the future of the global economy led the French private electronic companies such as the *Compagnie Générale d'Électricité* and THOMSON to resist government initiatives during the 1960s and 1970s.[18]

While each of the above accounts is not entirely false, they remain partial accounts of the French industrial policy in electronics and are based on a misunderstanding of French discourse of independence. As Gordon has pointed out, this understanding "...[t]ends to take independence and grandeur literally and professes to see international stature and total freedom of action as the goal of the French in and of themselves."[19]

Against this extreme interpretation of the French discourse of independence some authors argue that the Gaullist perspective was not so much a denial of the reciprocity of external relations but was primarily a discourse meant to mobilize French

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[17] A. Danzin, "Électronique et informatique", in Institut Charles de Gaulle, De Gaulle en son siecle. Tome III Moderniser la France, La Documentation Française, Actes des Journées Internationales tenus a l'UNESCO Paris, 19-24 novembre 1990, p.738.

[18] According to Liliane Bensahel et al: *«Les résultats du Plan Calcul ne furent a la hauteur des espérances... parce que Thomson et CGE ne se sont pas vraiment investis ... du fait même de leur conflit interne et Thomson n'a pas eu une politique ambitieuse en matiére de composants»* L. Bensahel, J. Fontanel, M. Vigezzi, L'économie contemporaine de la France, Grenoble, Presse Universitaire de Grenoble, 1989, p. 120. A similar stance is maintained by B. Esambert Pompidou, capitaine d'industrie, Paris, Éditions Odile Jacob, 1994, pp. 177-178.

[19] P. H. Gordon, A Certain Idea of France. French Security Policy and the Gaullist Legacy, Princeton N. J. , Princeton University Press, 1990, p.18.

people in support of government's modernization policy at the wake of World War II[20]. Thus Gordon maintains that "Independence for de Gaulle was part of an overall strategy for insuring French interest in what de Gaulle believed to be an environment hostile or at least indifferent to those interests. But it was not the belief that national isolation was possible in the modern world."[21]

Just as neo-realists tend to exaggerate the extremist tendency of the French discourse of independence, authors like Gordon tend to downgrade it and promote a moderate view. But the French policy process in ICT expresses two tendencies: what could be considered as the extreme version of political independence represented by the French Delegation for Scientific and Technical Research (DGRST) and to a lesser extent by the Ministry of Science and the interdependent moderate view that was carried out by the French military and telecommunication authorities such as the *Comité de Coordination des Télécommunications* (CCT) and the *Direction Générale des Télécommunications* (DGT). Therefore, if one is interested in describing the policy process, it is necessary to consider both tendencies and to show why the vision of technological interdependence always won over the other. As Peter Hall has shown for a comparable situation, an accurate policy analysis should take into account the arguments of the competing tendencies and "...[t]heir positional advantages within a broader institutional framework, ... the ancillary resources they can command in the relevant conflicts, and [the] exogenous factors affecting the power of one set of actors to impose its paradigm over others."[22]

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[20] S. Hoffmann, Decline or Renewal. France since the 1930s, New York, Viking Press 1974 and J. Lacouture, De Gaulle. Vol. 2. Le politique, Paris, Editions du Seuil, 1985.
[21] P. Gordon, op. cit., p.21.
[22] P. A. Hall, «Policy Paradigms, Social Learning, and the State. The Case of Economic Policymaking in Britain», Comparative Politics, Vol. 25, No.3, April 1993, p. 280.

Successive French governments clearly had choices that ranged from complete independence to dependence on American computer technology. From amongst these choices, they chose a particular kind of interdependence, one which resulted in a reliance on American computer technology in order to build endogenous industrial capacities for nuclear and aerospace capabilities. The forces shaping this choice were not only those of power as neo-realists argue or technological change and liberalization of trade as regime theorists argue. Nor were they simply transatlantic class interests as neo-Gramscians would argue or reducible to the resistence of CGE and THOMSON to the DGRST perspective of technological independence as institutionalists have claimed. US post-War technological superiority, technological change, international pressure towards the liberalization of technological trade and transatlantic industrial alliances contributed to the lack of an independent French computer industry. By privileging one factor over the others, each of the above perspectives presented a simplistic view of a complex reality.

To avoid simplification and in order to offer a more comprehensive account, I propose to show how the forces that shaped the French choice in ICT were organized through the "hegemony" of a particular "discursive regime" upon which the development of post-World War II information and computer technology was founded. The concept of "hegemonic discursive regime" will enable me to show how different forces such as those expressed in military relations, industrial alliances and political ideas and doctrines interacted with each other to shape the French choice for asymmetrical technological interdependency with the United States.

This approach challenges both the neo-realist position that post-war technological change did not alter the state of anarchy in the "international system", and regime theory which holds that there are "international imperatives of science and technology" that reduce the autonomy of states and force them towards cooperation. Against the general wisdom that maintains that change in international relations occurs as technological innovations come into use, I believe that the concepts of hegemony and regime, both combined with the Foucauldian notion of discourse, will enable us to sustain the argument that it was international political and military changes of the mid-1940s that changed computer technology and drew French policy making and electronics industry into a "transatlantic discursive regime". While the elements of the post-war hegemonic discursive regime originated in the United States, it was their understanding by French policy makers and other Europeans that prevented France and Europe from having an autonomous computer industry and defeated the extremist tendency of the French discourse of independence.

My demonstration has five steps. First, I show the limits of dominant International Relations theories to explain the failure of French policy to develop an ICT industry. Second, I demonstrate how the concepts of "hegemony" and "regime" when they are used within Foucault's notion of discourse allow an alternative explanation to emerge. That explanation begins with the way in which World War II created a new perspective on the "role of government in science and technology" according to which western nations' "air power" and "air defense" were conceived and built through a particular use of computers. I move on to show how these ideas and practices were institutionalized through the role of NATO and the OECD to form a "hegemonic discursive regime" in the Western World after the mid-1950s. Third, I demonstrate how computers as we know them today embody not only inter-state power relations but also incarnate perceptions and priorities on various subjects such as science, technology, defense and economic development within the American-dominated hegemonic discursive regime. Fourth, I demonstrate how the formation of this hegemonic discursive regime affected French policy choices in the computer industry in the period 1945-1968. Finally, I show how change in this hegemonic discursive regime made French electronics industry even more dependent on the US and prevented the DGRST from restructuring the European electronics industry in accordance with its view of technological independence.

1.1 THEORETICAL AND METHODOLOGICAL BACKGROUND

The international political and social context that shaped the French choice for interdependency was composed of relationships of force, a number of constraints and opportunities and political ideas and ideologies within the transatlantic space. As the above review of the French debate illustrated each of the perspectives presented explains one aspect of this international context but as J. G. Ruggie puts it "...[b]y discounting or ignoring altogether the integrity of those domains of social life that its premises do not encompass..."[23]

The objective of this section is to show the limits of neo-realism, regime theory and the neo-Gramcian perspective and to draw out the methodological insights that each of these approaches can provide in order to build the concept of "hegemonic discursive regime". This is not eclecticism but a theoretical attempt to bring together the concept of "hegemony", "discourse" and "regime" for the methodological purpose of stressing the importance of military force, on which international norms and procedures for standard practice are based and within which French political and industrial actors confronted

[23] J. G. Ruggie, "Territoriality and beyond: problematizing modernity in international relations", International Organization, Vol. 47, No.1, Winter 1993, p.169.

each other in the determination of French choices in information and computer technology.

The first part of this section argues that adherence to American views by Western European countries was far more important than American material capabilities because it was the basis upon which these countries used military concepts, objects such as computers and components standards of American origins and thereby maintained American scientific, technological and industrial hegemony despite the decline of American material capabilities. Since this European use of American concepts, objects and standards suggests an inter-state order, it leads me in this section to take issue with the anarchic view of the international system held by neo-realists and allows me to lay the groundwork for understanding the role that international organizations such as NATO and the OECD played in shaping transatlantic defense and technological relations.

The second part of this section argues that international integration and regime theories regard technological change as an independent variable and overlook the power relations embedded in these changes. The political is stressed in contradistinction to a tendency towards technological determinism in this literature. Part three shows the limits of the neo-Gramscian approach to transatlantic relations. Here, I point out that the central difficulty of this perspective lays in its class and economic reductionism. This critique will lead me to favor Foucault's concept of discourse and Giddens' notions of structure and agency within which I use the concepts of regime and hegemony and from which I draw my historical and political methodology for the description of the hegemonic discursive regime and its determination of French perceptions and priorities on scientific and technological matters.

1.1.1 *The Limit of Neo-realism and Post-Worl ! War II Technological Change*

Despite the divergence of opinion regarding the nature of post-war US/Western Europe relations, there is a fundamental convergence across all the perspectives: the description of these relations as hegemonic power relations dominated by US military and economic capabilities. Essential to this view is the concept of hegemony defined as the supremacy of the US within a transatlantic context characterized by an unequal distribution of material capacities including economic preponderance and military force. This concentration of capabilities made America the hegemon because it provided military defense and economic welfare to the Western European countries.[24]

In neo-realist theory, stability, cooperation and peace within the transatlantic zone are due to the concentration of military and economic resources in the hands of the United States. For neo-realists, post-World War II US hegemony enabled American governments to promote liberal economic policies and interdependence through which countries in the area maximized economic gains. According to neo-realists, in the early 1960s, when US power resources were exhausted, cooperation and interdependence were simultaneously disrupted because the US no longer had the material capability to promote international economic policies.[25]

Consequently, the disappearance of the economic advantage gained by European countries made the hegemony's coercive nature more obvious. That was the

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[24] See Fred Block, The Origin of International Economic Disorder: A Study of the United States Monetary Policy from World War II to the Present, Berkeley, CA., University of California Press, 1977; Robert Gilpin, US Power and the Multinational Corporation, London, Macmillan, 1976; Stephen Krasner, Defending the National Interest of US Foreign Policy, Princeton, N.J., Princeton University Press, 1978; Robert O. Keohane, After Hegemony: Cooperation and Discord in the World Political Economy, Princeton N.J., Princeton University Press, 1984.

[25] R. Gilpin, War and Change in International Politics, Princeton, NJ. Princeton University Press, 1981, p. 129.

phenomenon that led to a sudden division of Europeans between those who supported American hegemony and free riders. The lexicial meaning of the word *free ride* is obtaining something without paying the usual cost or devoting the equivalent effort. In neo-realism in international relations, *free ride* means getting the benefits of an international system without paying membership cost, that is having others paying for the benefit received. Beyond this lexical meaning however, neo-realists use this term in relation to a perceived context of hegemonic decline. In such a context according to neo-realists certain nonhegemonic countries within an international system do not cooperate to maintain the system and rather manifest the will to break away. In this sense, according C. Kindleberger, the *free ride* is not a reaction to the decline of American capability *per se*, but to a system that is no longer economically beneficial and reduced to its coercive nature. Thus, a country can be categorized as a free rider when it manifests the will and/or is capable of breaking away from a system that is reduced to its coercive features. Such a phenomenon occurs when the hegemon is facing a relative decline of its economic capabilities and consequently cannot afford international economic liberal policy.[26]

It is obvious that this theory was shaped by American foreign policy problems (the Vietnam War, the fear of a break-up of NATO) of the 1960s. Consequently, the 1966 French withdrawal from NATO appeared to neo-realists as opportunistic behavior. However, seen from the French perspective, the neo-realist model appears historically short-sighted.[27] Through their thesis of "free-riding", American neo-

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[26] Ch. Kindelberger, "Systems of Economic organizations", In D. Calleo (ed), Money and the Coming World Order, pp.15-20, Ch. Kindelberger, «Dominance and Leadership in the International Economy: Exploitation, Public Goods and Free Riders», International Studies Quaterly, Vol.25, June 1981, pp.242-54, Ch. Kindelberger, "Hierarchy Versus Inertial Cooperation", International Organization, Vol.40, Autumn 1986, pp841-848.

[27] According to C. Duradin

realists ignore France's preoccupation with political independence as they see only opportunism and thanklessness in the French attitude *vis-à-vis* the United States. The main problem with the free riding thesis is that the French/US confrontation predated the 1960s and it is a conflict between divergent ideologies: international liberalism presented by the US versus French nationalism towards the US since the end of World War I.

However, despite the presence of nationalism in France, nationalistic forces could not halt cooperation between US and France. Indeed, when General de Gaulle withdrew France from NATO, the French government could do no better than to opt for American defense technology and air defense structure. The neo-realist emphasis on a power struggle between nations has led many to overlook other countries' incapacity to challenge America and US capabilities to shape priorities and perceptions on crucial issues such as defense and technology. Thus, despite the fact that the reconstruction of Japan and Europe was desired and financially supported by the United States, the neo-realists' "zero-sum game" approach to International Relations (IR) has led them to believe that the economic revival of the allies represents the "relative" decline of the US economy. They project that this relative decline will inevitably lead to weakness in US military capabilities and to the inescapable break-up of the world order.

In this respect, R. Gilpin has forecast a series of interrelated factors that will inevitably reduce American technological dynamism and prevent the diffusion of

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> *La France et les États-Unis entretiennent un étrange dialogue fait de solidarité et de compétition. En 1918, puis en 1945, l'affirmation de la puissance américaine oblige les doctrinaires et les hommes politiques à redéfinir l'identité française dont l'universalisme messianique se heurte à celui de l'Amérique. [C'est une confrontation entre deux idéalismes] qui d'ailleurs n'empêcha pas] un accord profond qui motive des engagements solidaires et une même appréciation des menaces antidémocratiques s'associ [ant] dans la longue durée des crises du XX siècles, à un désaccord qui se répète.*

C. Duradin, La France contre l'Amérique, Paris, Presses Universitaires de France, 1994, p.6.

technical innovations in the armaments industry.[28] He maintains that the decline of productive capital in favor of finance capital in the American economy will, in the long run, prevent the US government from financing its military capabilities. This would add to the US burden in European defense by deepening the US economic and financial crisis[29]. Gilpin has argued further that American foreign investment was among the principal causes of American economic and military decline since it undermined US competitiveness by giving away advanced American technologies and enhancing the economic power of America's potential challengers.

This attack against international interdependence is not only biased because it is tilted towards US isolationist forces but also because it is weakly argued. There is no doubt that the spread of American money and technology over the old continent allowed for a quick economic recovery that otherwise would have been difficult. However, this recovery was not at the expense of American economic strength or a blow to the world economic order. Quite the contrary. In Europe, American companies gained lucrative contracts through which American technological norms became international standards influencing practices in European industries especially those related to communication and computer technologies.[30] As neo-realists themselves recognize:

> Nations seeking major-power standing in the world have to pursue technological objectives selected by the two superpowers. Either through research or purchase they must match American and Russian ballistics, missiles, fighter bombers, attack submarines and main battle tanks...

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[28] Idem p. 179. This guns or butter dilemma has been raised by many authors: L. Freedman, "Order and Disorder in the New World", Foreign Affairs, Vol. 71, No.1, 1992; P. Kennedy, The Rise and the Fall of Great Powers. London, Heyman, 1988.

[29] Robert Gilpin, War and Change in World Politics, Cambridge, Cambridge University Press, 1981, p. 157-66.

[30] G. Wackermann, Les pôles technologiques, Notes et études documentaires, La Documentation Française, No. 4948, 1992-3, p. 10.

Even when nations lack such ambitions, they apparently cannot afford to ignore the technological priorities of the superpowers, especially those of the United States, because of the commercial by-products that are associated with military research[31].

This statement recognizes that all countries do not face the same problems with technological change since they do not have equal capacities to orchestrate technological change in their favor but this does not mean anarchy. In Western Europe for example, NATO and the OECD acted to reduce technological gap between member-countries and shaped their perceptions and priorities on the use of American communications and data-processing technologies. Although the structuring role played by NATO and the OECD belies the anarchy of the international system depicted by neo-realists, the latter still assume that: "Far-reaching changes in domestics politics may take place but these will matter little. As long as relations among states are recognized as competitive interactions among sovereign units within anarchy, the laws governing these relations remain the same regardless of unit changes."[32]

While US technological leadership in the transatlantic zone led countries in this geographic area to pursue the same economic, military and social goals, neo-realists continue to insist on anarchy. As they are keen to maintain the anarchic aspect of the "international system", they overlook the impact of technology on this "system" and claim that there are no "international imperatives of technology" that change the fundamental characteristics of IR. In particular, they assume despite technology the

[31] H. M. Sapolski, «Science, Technology and Military Policy», in I. Spiegel-Rösing and D. de Sola Price, Science, Technology and Society A Cross-Disciplinary Perspective, London & Beverly Hills, Sage Publications, 1977, p.444. See also R. Giplin, France in the Age of the Scientific State, Princeton, Princeton University Press, 1968.

[32] J. A. Caporaso, "Has Europe Changed ? Neorealism, Institutions, and Domestic Politics", in R. J. Jackson (ed) Europe in Transition. The Management of Security After the Cold War, Praeger, 1990, p.19.

behavior of states can still be accounted for in terms of the conventional focus of the territorial nation-state.[33]

On this basis, neo-realists maintain that technological change in weapons systems makes states feel greater insecurity and this feeling increases the anarchic structure of inter-state system. Neo-realists argue as if technology is an exogenous variable to inter-state relations and has no effect on them. Therefore they overlook the progressive decline in the salience of national territory which is exemplified by the rise of powerful transnational actors such as multinational corporations and international organizations such as NATO and the OECD.

The neo-realists' historical short-sightness and their devotion to anarchy led regime theorists to challenge these neo-realist notions. For regime theorists the notion of regime implies:

> Implicit or explicit principles, norms, rules and decision-making procedures around which actors' expectation converge in a given area of international relations. Principles are beliefs of fact, causation and rectitude. Norms are standards of behavior defined in terms of rights and obligations. Rules are specific prescription of actions. Decision-making procedures are prevailing practices for making and implementing collective choice.[34]

It is in terms of regimes that John Ruggie explains the functioning of multilateral rules and procedures governing the regulation of many areas of international concern such as the oceans, space and telecommunications, money, trade and health.[35]

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[33] H. R. Nau, "Collective Response to R&D Problems in Western Europe", International Organization, 29, No.3, Summer 1975, p.1.

[34] S. D. Krasner, "Structural Causes and Regimes. Consequences, Regimes as Intervening Variables", in S. D. Krasner, International Regimes, Ithaca, N. Y., Cornell University Press, 1983, p.2.

[35] J. G. Ruggie, "International Regimes, Transaction and Change --- embedded Liberalism in the Post-War Economic Order", International Organisation, Vol 6, 1982.

Along the same lines, Robert Keohane and Joseph Nye[36] advanced the notion of "complex interdependence" to describe the increased integration between post-war western economies. For Keohane and Nye, domains of "complex interdependence" function under a set of rules and procedures. More importantly, the future of such regimes, they argue, is not necessarily tied to the existence of a hegemon but to member-countries' perception of a communality of interest. Thus in contrast to neo-realists who argue that regimes are only a reflection of American hegemony and that, consequently, they would not survive American hegemonic decline, regime theorists maintain that even with the decline of American material capabilities, the international order that emerged from W.W.II will last. Central to this argument is the assumption that international rules and procedures are not only maintained by a hegemon but are also carried out as a result of a common international liberal spirit described by J. Ruggie as "embedded liberalism" and defined as a belief that the domestic welfare is dependent upon the liberalization of the international economy and hence peaceful relations between states.

Consequently, whereas most[37] neo-realists believe that a hegemon is necessary to keep anarchy at bay, regime theorists believe that the development of modern capitalism makes the role of a hegemon unnecessary for co-operation. Even in a situation of hegemonic decline, sovereign states constrained by problems resulting from the requirements of capitalist development have no choice but to cooperate. This

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36 R. O Koehane and J. S. Nye, "Two Cheers for Multilaterism", Foreign Policy, No. 60, 1985

37 With the exception of Robert Gilpin who does not think that the reduction of American material capabilities would necessarily result in a collapse of the international economic order. R Gilpin "The Richness of the Tradition of Political Realism", International Organisation, Vol 38, 1984, pp. 295-296.

requirement for co-operation perpetuates international norms that had been originally imposed by a hegemon.

Despite this divergence, like neo-realists, international regime theorists also believe that technological change is exogenous to the system of International Relations. Science and technology are not components of international political processes but intervene from without to undermine the territorial aspect of international relations. For regime and international integration theorists, while science and technology have a great impact on the international distribution of military and economic power among states, they also generate global problems such as the rising cost of weapons systems and scientific equipment, pollution and arms control. These phenomena lead inevitably to international cooperation.[38] The basic assumption here is that science and technology are prime agents of international change as they lead inevitably towards the obsolescence of state sovereignty.[39] In other words, there are "international imperatives of technology" that limit state sovereignty and make international organizations more preponderant than states in resolving global problems created by technological change.

This position parallels the view expressed by international organizations such as the OECD who claim more authority at the expense of national governments. However, while it is not clear whether this convergence of views describes reality or represents an ideology that advocates international integration and the creation of regimes, it is obvious that it overlooks the power relations (between US and Western Europe) that

[38] E. B. Skolonikoff, The International Imperative of Technology, Berkeley, Institute of International Study, University of California, 1972.
[39] B. Schroeder-Gudehus, "Science, Technology and Foreign Policy", In I. Spiegel-Rösing and D. de Sola Price, Science, Technology and Society A Cross-Disciplinary Perspective, London & Beverly Hills, Sage Publications, 1977, p.481.

are embodied in technological change. When this theory is used to explain France's inability to develop an independent computer industry, it points to technological changes and overlooks not only US capacity to orchestrate technological change through its weapons programs but also its ability to force these changes on other countries by shaping their priorities and perceptions on issues related to the use of science and technology. In fact, in order to make their case for greater international integration and the emergence of international regimes, international integration and regime theorists, although they recognize that there are differences in 'sensitivity and vulnerability' between countries in various domains of international concern, do not take into account these differences in the formation and transformation of regimes.[40]

Despite these problems, in comparison to the neo-realist concepts of power/hegemony, the notion of regime has descriptive power. However, in order to be analytically more useful and to explain change, the notion of regime has to give theoretical ascendancy to differences in vulnerability between countries within a regime, the contradictions that this vulnerability generates and the role of these contradictions in both the formation and transformation of regimes. In this sense, the neo-Gramscian concept of hegemony is more useful. Although the proponents of this concept do not argue in terms of regime, their concept of hegemony allows one to conceive of "regimes" in terms of hegemony, implying not only the communality of interests between countries, but also their inequality, vulnerability, and most importantly class interests and international alliances, the role of political ideas, perceptions, priorities, opportunities and constraints during the formation and transformation of hegemonic regimes.

40 J. F Keeley, "Towards a Foucauldian Analysis of International Regimes", International Organization, Vol. 44, No.1, Winter 1990.

1.1.2 *The Limits of the neo-Gramscian Concept of Hegemony and its Analytical Usefulness in the Understanding of International Regimes*

Fundamental to Gramsci's thought is the idea that hegemony in one country is not the result of coercion but an effect of consent built upon the intellectual and moral leadership of a "historical bloc". The notion of "historical bloc" is used to describe the convergence of different social and political forces under the leadership of the most economically preeminent social class. When this notion of hegemony is applied to IR, one country's economic power, albeit a requisite, is itself insufficient to determine the formation of an international 'historical bloc'. Economic power must be complemented by political leadership. Thus, for an international 'historical bloc' to emerge, economically-dominant social classes have to make sacrifices for the benefit of the nonhegemonic groups.

For neo-Gramscians as well as for Gramsci, social and political struggle followed by political arrangements always precede changes in the economy. For them:

> An appropriate political initiative is always necessary to liberate the economic thrust from the dead weight of traditional policies - i.e. to change the political direction of certain forces which have to be absorbed if a new, homogenous politico-economic bloc, without internal contradictions, is to be successfully formed.[41]

Gramsci claims that his view is an alternative to classical Marxism's economic and technological determinism within which political struggle has no theoretical status. For Gramsci, Marxism can be an instrument for social change only when political struggle is given theoretical ascendancy. Fundamental here is the view that what

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[41] R. Cox, "Gramsci, Hegemony and International Relations: An Essay in Method", Millennium: Journal of International Studies, Vol. 10, No.2, 1983, p.168.

characterizes western liberal societies is not so much the structure of their economics but political and social processes that maintain hegemony.

Consequently, Gramsci argues that desired changes through social and political struggle are possible only within these processes. This view stems from the author's definition of civil society as a two-headed structure of power. One part is constituted by the state's coercive apparatuses such as public administration, legal institutions, and military and para-military forces. The other part is formed by civil society's institutions such as political parties, factories, unions, churches and universities. Hegemony is created and maintained through the institutions of civil society that enforce ideological conformity and produce consent. In return, these civil institutions are seconded by the state's coercive apparatuses.[42]

Cox draws his view of post-war transatlantic relations from the above definition of civil society. Similar to the Gramscian model of civil society, for Cox:

> World hegemony is ... a social structure, an economic structure, and a political structure and it cannot be simply one of these things but must be all three. World hegemony, furthermore, is expressed in universal norms, institutions, and mechanisms which lay down general rules for the behavior of states and for those forces of civil society that act across national boundaries - rules which support the dominant mode of production.[43]

How do these three structures work together to display the Gramscian concept of hegemony on the world stage? Like neo-realists, Cox also believes that the post-war transatlantic political structure is dominated by the concentration of military and economic capabilities within the US. Unlike neo-realists however, Cox maintains that material capabilities (which he defines as "power overt") are only one aspect of

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42 A. Gramsci, Selections from the Prison Notebooks of Antonio Gramsci, op. cit., p.12.
43 R. Cox, op. cit., p.171-172.

international hegemony. Besides material capabilities, he identifies the power of the ideas underlying the

> ...broad-based political consensus in the Atlantic states which in effect served to generate the ethico-political concepts of civilization which cemented the bloc. The concepts of liberty, modernity, affluence, welfare... were fused into a concept of 'the west'...the bloc's foundations were forged in a balance between the material forces of national and transnational capital, organized labor and the state[44].

This is what neo-Gramscians call the social structure, also depicted as the "framework of thought" or the "power covert".[45] For Stephen Gill and David Law the power covert represents the normative aspect of structural power and hegemony[46] which allows them to establish the task "...[o]f finding the new transnational bloc and the way its (neoliberal) discourse and practice suborn dependent classes and pre-empt their opposition."[47] For them, this level of power has a tremendous importance in the workings of the transatlantic hegemony because it sets the horizon for the subjects' perception of the possible. Like the Gramscian two-headed structure of civil society, Cox, Gill and Law's international power structure is defined by "power overt" and "power covert". The effective combination of both serves to maintain and reproduce social and political norms that perpetuate the mode of production.[48]

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[44] S. Gill, American Hegemony and the Trilateral Commission, Cambridge, Cambridge University Press, 1990, p.49.
[45] Robert W. Cox , "Social Forces, States and World Order", Millennium: Journal of International Studies, Vol. 10, No.2, 1981 and "Gramsci, Hegemony and International Relations: An Essay in Method", Millennium: Journal of International Studies, Vol. 10, No.2, 1983 pp. 162-175.

[46] S. Gill and D. Law, The Global Political Economy, New York, Harvester, 1988 and «Global Hegemony and the Structural Power of Capital», International Studies Quaterly, No. 33, December 1989, pp. 475-499.
[47] J. F Keeley, "Towards a Foucauldian Analysis of International Regimes", op. cit., p.464.
[48] S. Gill, op cit, p. 73

Cox's application of Gramscian ideas makes hegemony in international relations a power structure of interstate relations that includes transnational forces. Thus, a hegemonic world order is:

> ...not an order directly expressing the interest of one state but an order that most other states could find compatible with their interests, given their different levels of power and lesser ability to change the order... The concept of world order is founded not only upon the regulation of inter-state conflict, but also upon a globally conceived civil society...[49]

For Gill, the idea of "global civil society" stems from American plans after W.W. I to shape Western European economic and political development in a direction complementary to that of America. This he argues continued through the Marshall Plan, the formation of NATO and the international organizations and regimes of the Bretton Woods system that mobilized social forces within Europe and the United States.[50] For him, these forces propagated a "New Deal" at the Atlantic level by creating an "Atlantic multinational bloc". The questions that come to mind are: Was American military-industrial policy after the mid-1940s similar to that of the 1930s? What was the role of the US and NATO military strategy in the formation of this multinational bloc? To what extent did NATO represent the interests of the "New Deal" forces? What was the social composition and dominant features of this "Atlantic multinational bloc" and most importantly was this multinational bloc homogeneous as the neo-Gramscians tend to suggest? While the answer to such questions involves empirical investigation, for neo-Gramscians the answer is given by the Marxist theory of the capitalist mode of production. Within this theory, post-war Western military, scientific and technological changes were all indistinguishably attempts "to increase the rate of productivity

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[49] R. Cox, op. cit. p. 45.

[50] S. Gill, op cit. p.126.

growth" and therefore represent the interest of the transatlantic bourgeoisie.[51] In other words, the capitalist mode of production determines military policy and technological development through the state effort to correct the falling profit [52] and to increase capital productivity. While the relationship between military policy and the falling rate of profit has been rarely submitted to empirical investigation,[53] for classical Marxists, neo-Gramscians and neo-Marxists in general, military expenditures since the beginning of capitalism have always signified an attempt to overcome economic crisis.[54] Speaking of US military expenditure during president Ronald Reagan's era, Gill argued that:

> This was a renewal of the early role of the Pentagon as the major agency in American 'military-industrial' policy...the key worry for the United States was whether this policy was the most efficient way to raise its rate of productivity growth which had been declining relative to that of its major economic competitors during the 1970s. In the hope that it was, the Reagan

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[51] Ibid. p.14.

[52] At the heart of classical Marxist view on technological change is the dynamism of capitalism which according to them generates competitive pressure on firms to improve their process of production as to overcome the tendency of failing rate of profit. According to Marx and Engels:

> The bourgeoisie cannot exist without constantly revolutionising the means of production, and thereby the relation of production and with the whole relations of society... constant revolutionising of production, uninterrupted disturbance of all social conditions, everlasting uncertainty distinguish the bourgeois epoch from earlier one [K. Marx & F. Engels, Communist Manifesto, London 1848, Cited by C. Freemen, «Economics of Research and Development» In In I. Spiegel-Rösing and D. de Sola Price, Science, Technology and Society A Cross-Disciplinary Perspective, op. cit., p. 241.

[53] G. Adams, "Les dépenses de défense: bienfait ou hemorragie pour l'économie américaine", In Groupe de Recherche et d'information sur la Paix (GRIP), Momento Defense-Desarmement, GRIP 1988, pp. 165-169.

[54] See G. Sen, "The Economics of US Defense: The Military-industrial Complex and Ne: -marxist Economic Theories Reconsidered" Millenium : Journal of International Studies, Vol. 15, No.2,1987. PP. 179-194. K. Robin & G. Frisvold, "Reagan's New Economic Agenda: The Military and the Market", Capital & Class, No.26, Summer 1985, J. Lovering "The Atlantic Arms Economy: Towards a Military Regime of Accumulation", Capital & Class, No.33, Winter 1987, PP. 129-153, G. Georgiou, "The Political Economy of Military Expenditure", Capital & Class, Spring, No. 19, 1983, pp. 183-204.

> administration poured enormous funds into scientific education and basic research...[55]

This is the neo-Gramscian view of the American Strategic Defense Initiative (SDI). It implies that the military has no autonomy from the economic sphere. In effect, this economic determinism prevents the neo-Gramscian framework from seeing the way in which military concerns affect the economy and orient technological development. Thus, since the economy determines military policy, other social actors and their concerns such as the Pentagon and its concern with air and space defense have no political significance outside the management of the economy. While these concerns were at the root of many changes especially in the computer and telecommunications sectors they are overlooked not only by neo-Gramscians but by neo-Marxists in general.

Despite the neo-Gramscian economic reductionism of military policy, I believe that the neo-Gramscian perspective still has useful methodological insights. As Gill put it, their framework stresses change because their concepts of hegemony and power combines both agency and structure thus avoiding analysis in terms of abstract structuralism.[56] For Gill, "Structures are not simply categories invented by theorists, rather they are aggregates of responses to given, historically specific conditions. They involve habits, expectations and anticipation that is how people conceive and act upon "the limits of the possible".[57]

This definition of structure renders the notion of regime, as defined by Krasner, compatible with the neo-Gramscian concept of hegemony. It is not my aim here to deny

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[55] S. Gill, American Hegemony and the Trilateral Commission, Cambridge, Cambridge University Press, 1990, p.83.
[56] Ibid, p. 231.
[57] Idem, p.231.

ideological and epistemological differences between concepts but to describe the way they are compatible and how they can compensate each others' weaknesses. In particular Gill's definition of structures as involving habits, expectations and anticipation according to which actors perceive 'the limits of the possible' is similar to Krasner's "...implicit or explicit principles, norms, rules and decision-making procedures around which actors' expectation converge in a given area of international relations". Most importantly, both integrate the neo-realist notion of power as based on the predominant country's military and economic capabilities and believe in (to borrow Lukes' terminology) the significance of "indirect" power: defined by the notion of "power covert" in the neo-Gramscian framework and seen as "implicit rules" within the liberal notion of regime. The similarity however goes beyond definition. In both theories there is a same lack of clarity. What is referred to as indirect or implicit power seems very important but neither theory describes it and it is possible that liberal regime theorists and neo-Gramscians believe that such power resists description.

Indeed, while both perspectives reinforce each others' strengths they also increase each others' weakness. A hegemonic regime where the elements of "power covert" or "implicit rules" are so strong, leaves us with a sense of status quo rather than with a capacity to understand the role of the subject during the formation and transformation of hegemonic regimes. Moreover, such a regime is unable to explain why a country such as France that is at the center of the transatlantic hegemonic regime has always produced a discourse of political independence while concomitantly participating in the transatlantic hegemonic regime. It is for this reason that I believe the Foucauldian notion of discourse and Giddens' notion of "structure and agency" provide useful tools with which to reformulate the concepts of regime and hegemony. In such a reformulation, it will appear that a hegemonic discursive regime is not a rigid set of rules, norms and ideologies that determine behavior but rather describes a reality of conduct that is situated between a norms-following international system and subjects' interpretations and uses of these rules according to their own interests.

1.1.3 *Foucault, Giddens and the notion of hegemonic discursive regime*

Much of Foucault's work was in the history of ideas. He sought to determine how in a given period in history certain thoughts and practices were possible rather than others.[58] The concept of discourse for instance refers to a set of statements produced within the framework of institutions that constrain enunciation. Ultimately, these enunciations are inscribed in a framework that fixes historical, intellectual and social practices. In Foucault's notion of hegemonic discourse every practice is an exercise within a context of power relations implying norms and procedures that separate normal and abnormal practices and give meaning to statements. This definition of practice is complementary to Giddens' notion of context that according to the author "cannot be treated as merely the 'environment' or background of [practice]. *The context of interaction is in some degree shaped and organised as an integral part of that interaction...*"[59] Following both authors, it is possible to argue that a ***hegemonic discursive regime*** is "a body of...historical rules, always determined in the time and space that have defined a given period, and for a given social, economic, geographical or linguistic area, the conditions of operation of the enunciative function."[60] Unlike

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[58] M. Foucault, The Archaelogy of Knowledge. The Discourse on Language. New York, San Francisco and London, Harper & Row, p. 29, p.171.
[59] A. Giddens, Central Problems in Social Theory. Action, Structure and Contradiction in Social Analysis. London, Macmillan Press, 1979, p.83.
[60] Ibid., p.117

neo-Gramscians who seek to determine how hegemony prevents opposition or regime theorists who only see convergence of views and interests, with Foucault it is possible to see that resistance to rules, contests and divergent interpretations of dominant doctrine are parts of the institution-building process during the formation and transformation of hegemonic discursive regimes. By including resistance, contests and divergence in opinion and interests, it becomes possible to see the dual purpose of a regime's norms and rules of procedures: first the fulfillment of common objectives and second the prevention of possible deviance that derives from subjects' use and interpretation of the dominant discourse. Under certain conditions of power struggle, deviance could exhaust the hegemonic discursive regime or certain of its elements.[61] Unlike the neo-Gramscian notion of hegemony that sees only congruence and unlike the liberal notion of regime that recognizes only the willingness to cooperate within a regime, the notion of *hegemonic discursive regime* includes opposition to regime as constituent of it. According to Keeley (who also uses the Foucauldian notion of discourse) :

> First are actors who accept and cooperate willingly within it. Their disputes may be technical or over relative positions. Although they accept both the hegemonic discourse and its apparatus, their discourse could unintentionally erode the regime...Second are true free riders...These may erode the regime, reduce its capability , or produce dispute over burden-sharing, but wise parasites do not destroy their hosts. These two groups are community members who accept the legitimacy of the order. Third are deviants and rebels, who challenge the order on the basis of subjugated or alternative knowledge and alternative networks of relations but who are contained within the regime's community and thus are pressured to follow its dictates. They differ from true free-riders in that they want to break up from the order...Fourth are outsiders and other communities organized in other public space...They are also targets for regime expansion.[62]

[61] See M. J. Shapiro, G. M. Bonham and D. Heradstveit "A Discursive Practices Approach to Collective Decision-Making", International Studies Quaterly, December 1988, Vol.32, pp.379-419 and J. F. Keely, op. cit. p.97.

[62] J. F. Keeley, op. cit., p. 97.

The only problem with this typology is Keeley's confining of the notion of "actor" to states, which seem to be the sole actors in the "international system". This position is in contradiction with regime theorists' argument that the states are not the only significant actors in the international system and to the neo-Marxist point that the state is not a monolithic actor. Despite this problem, Keeley's typology brings important methodological insights since it opens the way to conceiving of a variety of positions and behaviors within a *hegemonic discursive regime*, including different positions and behaviors in each member-country of the regime.

Foucault also argues that subjects have a reflexive capacity that enables them to formulate judgment from their positions and interests in different social spheres that is irreducible to the dynamic of the capitalist mode of production. Since the economy is not the only site that determines the subject, the latter is an individual in varying positions defined by its role within different social spheres. In this thesis these "spheres" are the military, scientific, technological and industrial domains that are involved in the creation of event such the digital computer. Consequently, the concept of *hegemonic discursive regime* as used in this thesis refers to a set of statements that are drawn out from subjects' understanding of practices within the military, scientific, technological and industrial spheres. While this concept does not imply that these spheres are reducible to each others, it means that practices in these spheres are accounted for and revealed through statements expressing different beliefs. These beliefs are not necessarily coherent and cohesive with each other. Coherence and cohesiveness are guaranteed within a hegemonic discursive regime by the dominant force that provides goals to the regime and a mode of association between beliefs. For example, for the military to be associated with science and influence technological development and industrial production, we need a strategic alliance (between subjects in these spheres of activities) that itself in policy-making practice would result from political struggle between contending views and interests.

In the above sense, what makes a hegemonic discursive regime a process of change is not its economic and technological content but the interaction between the subjects' beliefs and actions involving moments of reflexivity. As Anthony Giddens maintains, this reflexive moment is "called into being in discourse that breaks into the flow of actions which constitute the day-to-day activity of human subjects. Such a moment is involved even in the constitution of 'an' action or of 'an act' from the *durée* of lived-through experience."[63] According to Giddens again, the moment of reflexivity implies that "action" or "agency" is "... a *continuous flow of conduct* involving intervention [that cannot] be fully elucidated...outside the context of *historically located modes of activity*."[64]

In keeping with this definition of agency, the concept of discourse does not refer only to formal rules and procedures or ideas and ideologies. It is not the linguistic interface of practices but the interdependence between beliefs and actions. Such interaction is deployed in an international context in the form of a hegemonic *discursive regime* whose cohesiveness, change or demise is not determined by the economy or technology but by the interaction between human subjects that create historical events. Foucault's notion of discourse and Giddens' definition of action make the structuralist attempt to penetrate below the level of subjects' belief and action useless.[65] According to Foucault, this methodological position implies that

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[63] A. Giddens, Central Problems in Social Theory. Action, Structure and Contradiction in Social Analysis, London, Macmillan Press, 1979, p. 55.
[64] Ibid., pp.55-56.
[65] Giddens' critique is addressed to both Parsons' and Althussers' notions of actors: "Parsons via the action framework of reference and Althusser through his 'theoretical anti-humanism' - each reaches a

> ...we must renounce two linked, but opposite themes. The first involves a wish that it should never be possible to assign, in the order of discourse, the irruption of real events; that beyond any apparent beginning - so secret and so fundamental that it can never be quite grasped in itself... To this theme is connected another according to which... The manifest discourse ... is really no more than the repressive presence of what it does not say; and this 'not said' is a hollow that undermines from within all that is said.[66]

In the same line of argument, Giddens also rejects "the methodological tactics of beginning analyses by discounting agents' reasons for their actions... in order to discover the real stimuli to their activity, of which they are ignorant. Such a stance ... is one with strongly-defined and potentially offensive political implications. It implies a *derogation of the lay actor.*"[67] In other words, "Discourse must not be referred to the distant presence of the origin, but treated as and when it occurs".[68] Therefore, in the case of this thesis, there is little need to refer to the dynamic of the economy in order to understand discursive events or changes within military policy, science policy or computer technology policy. What is important in turn, is the search for the particular power relation, the strategic alliance or more practically the project that associates these domains and encodes them politically in a cohesive fashion to form a regime. Power here is a relational concept that is related to human agency and operates as a transformative capacity through the use of resources that are generated by the structure of domination within a regime. In the case of transformation of regime, it is again this human agency that creates new events, gives new meanings to regime's elements or creates new ones.

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position in which subject is controlled by object. Parsons' actors are cultural dopes, but Althussers' agents are structural dopes of even more stunning mediocrity", A. Giddens, op. cit., p.52.

66 M. Foucault, The Archaelogy of Knowledge. The Discourse on Language, op. cit. p.25.

67 A. Giddens, op. cit., p.71.

68 Idem p.25

The refusal of external determination of discourse and the focus on the subjects' action within a given structure of power relation form for this thesis the epistemological ground on which I justify my use of "evenemential" or epochal[69] and experiential methodological approaches. In political science the material that is the candidate for such approaches are public utterances that can be located in policy promulgation, policy report, official letters and notes, books and articles describing doctrines, goals, perceptions, experiences and actions. According to F. Müge Göçek:

> The evenemential approach problematizes the event ... by focusing on sources of evidence often embedded in public discourse to historically reconstruct the structure and agency involved in the event. The experiential approach explains patterns in history through the interpretation, typically utilizing sources of evidence located,...in the...discourse to illuminate the role of agency.[70]

In contradistinction to the liberal notion of regime, the concept of *hegemonic discursive regime* based on epochal and experiential methodological approaches "...introduces a sense of reflexivity that takes into account both the social structure and human agency in the formation of events."[71] Because structure and agency occur simultaneously in the formation of events, Jane Jenson argues there is no need to privilege structural analysis over "agency-centered arguments" or to take the opposite methodological stand. She maintains that

> History is a set of arrangements experienced by each actor as the constraints within which actions occurs. Yet if actors are endowed with the ability to act...then their actions must be seen as creative of the different histories

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[69] As F. Müge Göçek put it "*evenemential* is the anglicization of the French word *evenementiel*, a concept coined by Lucien Lefebvre but theoretically articulated by Fernand Braudel." F. Müge Göçek, "Whither Historical Sociology", Historical Methods, Vol. 28, N°2, Spring 1995, p. 16. See also W. Sewell "How classes are made: Critical Reflexion on E.P. Thomson's Theory of Working Class Formation", in H. Kaye & McClelland (eds), E. P. Thompson Political Perspective, London: Polity Press, 1990.

[70] F. Müge Göçek, "Whither Historical Sociology", op. cit. p. 107-108.

[71] Ibid

> which they live. Thus focusing of the politics of actions is as important as structural analysis; neither can be abandoned [72]

In this sense, it is not only actions that matters. Also of equal importance is the capacity of an actor to account for its action or in other words its reflexive capacity that obliges the analyst to think both in terms of struct re and agency. In sociology, as Giddens maintains, the methodological insight of such assumption is that the concept of structure does not imply a model posited by the analyst but rather a recognition of "the existence of: (a) knowledge... of how things are to be done (said, written), of the part of social actors; (b) social practices organized through the recursive mobilisation of that knowledge; (c) capabilities that the production of those practices presupposes."[73] In a policy-making context, following Jenson, such knowledge constitutes a "[u]niverse of socially constructed meaning resulting from political struggle"[74]. This is what Jenson defined as the "universe of political discourse", a concept implying a relation of unequal power and where "[t]he parameters of political action are established by the process of limiting the set of actors...the range of issues considered within the realm of political debate; the policy alternative considered feasible for implementation."[75]

The concept of *universe of political discourse* and that of hegemonic discursive regime are closely related since both refer to hegemonically constructed norms and procedures of interaction that give meaning to a variety of issues and at the same time constrain and enable political action. However, differences between international and

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[72] J. Jenson, "Ideas, Space and Time in Canadian Political Economy", Studies in Political Economy, (36), 1991, pp. 49-50.
[73] A. Giddens, Central Problems in Social Theory, Action, Structure and Contradiction in Social Analysis, op. cit., p.64.
[74] J. Jenson "Gender and Reproduction: Or, Babies and the State", Studies in Political Economy, (20) Summer 1986, pp. 25-26.
[75] Ibid., p. 26.

national levels of action lead me to return to the concept of hegemonic discursive regime here. International relations, norms and procedures are subject to both international and national levels of mediation and this make them less rigid than the norms and procedures of social interactions within a nation. For instance, at the international level, despite the structure of domination that makes the US, the hegemon, international norms and procedures are negotiated through international political institutions such as NATO and the OECD that have less power of decision and sanction on member countries than the power of sanction that national institutions have on their citizens. For example, in accordance with a defense policy that requires certain types of computers, the US government can induce and ultimately oblige company such as IBM to build these computers. However, although the US is dominant within NATO, the latter as representing a coalition amongst sovereign states cannot oblige the French government to buy these computers. Although US defense and technology policy influenced the formation of transatlantic norms and procedures, the latter still had to be negotiated within each sovereign nation's social fabric and internal power struggle. For example, when France adopted US defense and computer policy, the latter were translated through French "national interest" that itself was socially constructed since its meaning depends upon internal unequal power relation and political struggle between institutions. Indeed, despite French participation in NATO's military communications structure, the French government decided to build its own computers, albeit with American technology. This is to say two things. First, an exact replica of international norms and procedures from a national context to another is hardly possible given the difference in member countries social fabric that makes the boundaries of inter-state interactions more flexible than those of interactions between the citizens of a nation. The concept of *hegemonic discursive regime* is not only compatible with the concept of *universe of political discourse* but, given the interaction between national and international factors in policy-making, these two concepts are complementary. Thus, while the concept of *hegemonic discursive regime* will determine the international context of the parameters of national policy making, the methodological insights provided by the concept of the *universe of political discourse* i. e. the inequality of power between the group of actors on which is based the construction of the universe of meaning will be used to show how these parameters are negotiated though internal power struggle.

Having specified the problems that makes the use of the concept of *hegemonic discursive regime* necessary, before explaining its use in this thesis it is indispensable to eliminate the redundancy that it contains. I therefore drop the notion of hegemony, because in my discussion of the liberal notion of regime and the neo-Gramscian concept of hegemony, I reached the conclusion that the former implies the latter. However, as I argued before, if a regime is conceived of in terms of hegemony, it becomes difficult to understand the divergence of interests amongst participants, the inequality of power in the formation of norms and procedures and to elucidate the simultaneous occurence of structure and agency in the formation of events. For this reason, I keep the notion of discourse which implies reflexivity and Giddens' and Jenson's view of simultaneous occurrence of structure and agency in the formation of historical events.

Given this conclusion, first, for this thesis, the concept of *discursive regime* in the area of Information and Computer Technology refers to a number of policy statements specifying beliefs, goals and decisions such as those involved in defense, science, technology and industry and actions that are the implementation of these decisions. Second, I argue that the digital computers as we know them today are shaped by agency represented by the US Air Force that imposed its doctrine of air power and its priority of air defense on US military establishment. It should be noted that there is no theoretical reason to start my analysis by the role played by the US Air F orce in the development of digital computing. The reason is rather historical; that is because the US Air Force was the first institution that saw digital computing as the best way to deploy its military strategy. Third, the forces that shaped the French choice for asymmetrical interdependency in the area of electronics are not only those of power in neo-realist terms or only implicit and explicit norms as regime theorists would argue or solely the economy as neo-Gramscians maintain. While all these forces were present in different spheres, I argue that they were organized by the US Air Force through NATO and the OECD to form a transatlantic discursive regime that shaped the French choice in ICT through internal power struggle. My fourth assertion is that the successive French governments in the period 1945-1981 never adopted a policy of technological independence with regard to the computer industry, despite the French Ministry of Science and the French Delegation for Scientific and Technical Research (DGRST)'s will to do so.

As I argue that the transatlantic *discursive regime* originated first in the US military sphere, the statements and enunciations of Chapter Two are drawn from testimonies by air power advocates during the formation of air power. In order to analyze the relationships between "air power" as a notion implying a military belief and "digital computer" as a resultant of an action according to this belief, the corpus of this chapter is completed by books produced by the US Air Force Historical Division and the Smithsonian Institute Press. I use these primary and secondary sources to determine how the notion of "air power" came to dominate American military strategy and laid down a knowledge of how to build an air defense system. From these sources, I also show how the late 1940s conception of air defense influenced computer technology and finally demonstrate how the notion of air power, air defense and computer technology evolved in tandem in the formation of a *discursive regime* in the realm of information technology in the US. I analyze the Air Force's strategic representation through the relationships of "air power", "nuclear deterrence", "massive retaliation" and "real-time". This representation had geopolitical implications (the collapse of the inside and outside, the global and the local) that would allow the Air Force to impose its ideas on internal US military decision-making regarding the atomic bomb and to monitor events of military importance worldwide. To show how this representation became a discourse, I demonstrate the way the Air Force's strategic views were translated into institutional mechanisms, decisions and actions within the US universe of political discourse in ICT.

The discursive line (or in French *le trait discursif*) that I draw from these secondary and primary sources can be summarized as follow: The need to prevent an atomic war in the late 1940s implied the primacy of "air power" that emerged as the first discursive element of the regime . This first element implied a second: the centralization of military offense and defense structure. As the Air Force became the most important arm of nuclear deterrence, in the late 1940s, it associated the realm of science and technology to the military according to its own views. This was because the development of air power required the establishment of ***permanent*** rather than ***ad hoc*** scientific and technical research institutions whose work evolved in relation to changes in defense objectives beginning from the mid-1950s. The establishment of permanent scientific and technological public institutions in peacetime and under the supervision of the Air Force was the origin of the third discursive element: a science policy based on the forecasts and predictions of defense requirements in the future that was implemented in the early 1960s. The articulation of these three discursive elements directly affected the shape of the Semi-Automatic Ground Environment (SAGE) air defense system and its digital computers in the late 1950s. In order to show this, I use testimonies provided in the *Annals of the History of Computing* by US engineers who built the SAGE system. I show that the construction of the SAGE digital computer was an expression of the primacy of the Air Force's view. Important here is my assumption that technological artifacts such as the SAGE digital computers that became the paradigm for the global computer industry did not originate outside defense policy to determine US defense strategy. Rather, the SAGE computers emerged from within the structure of unequal power relation within the US defense decision-making process and thus embodied this power relation. This is why this chapter establishes the relationships between military concepts such as: "air-power", "air defense" and "centralization of commands" and technological notions such as "digital processing", "time sharing" and "real-time" computing (in the late 1950s) in the formation of US universe of political discourse in ICT. I show in other words that, the SAGE system was thus built according to the requirements of air-defense which materialized the centralization military of command structures by the means of digital / real-time computers that had "time sharing" capability. The building of this capability structured the change in the computer industry from "batch processing" and analog techniques to "time-sharing" practices and digital techniques. The relationship between these elements reveal a particular mode of association between the military, scientific, technological and industrial sectors related to ICT.

In summary, the elements of the US *universe of political discourse* in ICT that later influenced the formation of the transatlantic *discursive regime* can be divided into two categories. Some are general guidelines originating in the United States after the war and became a basis for policy practice at the transatlantic level: (1) a "big science" element involving research and development in major scientific fields such as nuclear energy, aerodynamics, electromagnetic radiation techniques, electronics and space research, (2) a military-oriented science policy which implied (3) a permanent rather than *ad hoc* interaction between government officials and scientists and (4) a link between defense policy and science policy objectives. The other elements were specific to the computer industry: the government role in forcing technological change in the computer industry from analog to the digital, the fusion between the computer and telecommunications sectors, the use of standard digital computers in the areas of transatlantic defense and telecommunications and the common transatlantic military and economic interest in achieving standardization of electronic components and inter-operability between the computer systems of different national origins and finally the emergence of middle-sized general purpose computers in the mid-1960s. During the period analyzed by this thesis, these discursive elements of the regime constituted an ensemble of knowledge applied by actors during their interactions and expressed their capabilities to enact processes in the military, scientific, technological and industrial spheres related to information and computer technology.

Chapter Three shows how these elements were transmitted by the US Air Force in Europe via the OECD and NATO. I seek to determine how problems related to defense, science, technology and industry were perceived and prioritized by both organizations. This analysis will show that the same elements that emerged from the US military, scientific and technological spheres formed the transatlantic discursive regime during the 1960s. Between the late 1940s and the late 1950s, the Pentagon and NATO diffused American electronic standards in ICT to Europe through a general framework that expressed the need for transatlantic rationalization, standardization and interoperability in military procurement. This framework was accepted by Western European governments and was carried out through industrial alliances between US and European firms.

While the liberal regime theorists would argue that this was the dynamic of technology at work, the neo-Gramscians would view this as an attempt to increase the rate of profit. My argument is that this framework was not an effect of an economic or technological dynamic. It was rather a result of an interaction between actors in the military, scientific, technological and industrial spheres under the leadership of the US Air Force. This interaction formed the transatlantic discursive regime. The latter was not a rigid set of ideologies and rules but only a general framework of guiding principles susceptible to change given its various interpretations by the regime's participants. Indeed, by the end of the 1950s, after the reconstruction of Western European defense industries, a political dispute about Western Europe's "technological gap" *vis-à-vis* the US emerged within the transatlantic discursive regime. This dispute ended the processe of standardization and rationalization and created a controversy over interoperability. While, for the US, interoperability meant that American equipment would be common to all members of the Alliance, for the European members, it meant compatibility between equipment of different national origin. For the Europeans, after post-World War II reconstruction and the consequent dependence on US money and technology, the objective of interoperability was to favor more interdependent technological relations between the two sides of the Atlantic. In the early 1960s, these conflicting interests were mediated through the OECD where the American way of managing science and technology was diffused and through NATO where inter-operability between military equipment of different origins was encouraged. Thus, through the concept of *discursive regime* it is possible to show that the inequality in military, technological and industrial capabilities between the US and Western European countries provoked resistance to standardization and led to a transformation from transatlantic standardization and European dependence to interoperability and interdependence between the two sides of the Atlantic.

Chapter Four shows how this regime transformation led to the development of an interdependent computer industry in France. Here is where the typology laid down by Keeley and Jenson's view of a socially constructed universe of meaning and her idea of power struggle during policy formation enter the analysis. In this chapter, I appropriate Keeley's typology not to oppose France to the US but to describe the variety of actors, their positions and alliances within the French policy process. I specify how French institutional actors and firms during their interaction in the pre-*Plan Calcul* policy process (1962-1965) used transatlantic discursive elements to account for their conducts, to enact policy and to oppose each others' views. I show that the French office of the Prime Minister, the Ministry of Science and the General Delegate for Scientific and Technical Research's argument for an independent computer industry was based on their use of two discursive elements: "big science" and the role of government in forcing technological change on firms. These institutional actors did not support the idea that the French computer sector should depend on the military or that it should be fused with the telecommunications sector. They wanted an independent and market-oriented computer industry. This position made them allies of the *Compagnie des machines Bull* (CMB), the first French computer maker that itself was the ally of the Radio Corporation of America (RCA). On the opposing side, was the *Comité de Coordination des Télécommunications* (CCT), the *Commissariat générale du Plan* , the *Comité permanent pour l'électronique du Plan* (COPEP) , the *Direction de la Recherche et des Moyens d'Essai* (DRME) and the *Délégation ministérielle pour l'armement*

(DMA). These technical institutions also supported the idea that the government should force technological change in the industry, but, in addition, they advocated interdependence which implied the use of American digital computers and American electronics components in the areas of defense and telecommunications in order to achieve transatlantic inter-operability, to build particle accelerators, an aerospace industry and an independent French nuclear force (*force de frappe*). Their industrial allies in this debate were the *Société d'Electronique et Automatisme* (created by an air force engineer in 1947), the *Compagnie des téléphonies sans fil* (CSF), the *Compagnie Générale d'Électricité* (CGE), the *Compagnie des Compteurs* (CdC) whose respective American allies were Thompson Ramo Woolridge (TRW), Scientific Data System (SDS) and Packard Bell. During the struggle this set of institutional actors and their industrial allies were better positioned than the office of the Prime Minister, the Ministry of Science and the DGRST. This was because military independence and telecommunications were more important presidential priority (in post-war France) than the idea of technological independence and they thus targeted equipment development and not basic research[76]. It was according to this equipment development policy that the outcome of the debate between the two sets of institutional actors was decided in favor of telecommunications and defense.

Chapter Five shows that the *Plan Calcul* was the outcome of this struggle. It describes French developments during the *Plan Calcul* and its aftermath. The corpus of this chapter is constituted of letters and notes collected from French contemporary archives. This corpus is completed by testimonies produced during two colloquiums

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76 According to P. Cohendet and A. Lebeau in the French nuclear, telecommunications and space policy although some research was included, the French government's effort was essentially on equipment development. P. Cohendet and A. Lebeau, Choix strategiques et grands programmes civils, Paris, Economica 1987, p.9.

([in 1989 and 1990] on the history of the French computer industry) organized by academics, civil servants and industrial leaders who participated in the first phase of the French *Plan Calcul* (1966-1968). It shows that the meaning of French political independence was not autarky as neo-realists argue but rather the freedom to use American technologies without restriction. The development of French political independence by means of technological interdependence was in conformity with the early 1960s OECD science policy and NATO inter-operability requirements. The military and telecommunication orientation that made French industry depend on US research won over the nationalistic perspective that sought to develop French integrated circuits. .

Chapter Six demonstrates that although the French and generally other Europeans acted within the framework of asymmetrical interdependence with the United States, their efforts to achieve interoperability between different computer systems ended in a greater incompatibility between telecommunications equipment. Consequently, in the late 1960s, NATO set new communications requirements and questioned the practice of interoperability. These new requirements re-opened the disputes over the European "technological gap" that threatened to erode the capabilities of the transatlantic discursive regime to cope with the issue of electronics, computers and telecommunications. On this occasion, nationalistic forces in France (within the DGRST) came forward with a proposition to liberate not only the French but the entire Western European electronics, computers and telecommunications sectors from American interests. Thus, these forces questioned NATO and the OECD's roles and proposed that the EEC was the best framework for Europeans to build their technological and industrial identity separate from the US. Here, again, the process did not reflect the neo-realist free-riding hypothesis since, among these actors, only the

DGRST and its associate the *Comité Consultatif pour la Recherche Scientifique et Technique* (CCRST) wanted to break free from the transatlantic ICT regime. In effect, the other French institutional actors in defense and telecommunications pursued cooperation with the American government and companies. European member-states of the EEC and their companies also rejected on different economic, technological and political grounds the idea of a European technological fortress. Consequently, in order to enable the regime to cope with NATO requirements and French nationalism, the elements of the transatlantic discursive regime were re-arranged into a new fashion to allow for the formulation of a new policy. In 1968 under the influence of the US Department of Commerce, NATO and the OECD, the "big science" discursive element was replaced by a more socially and economically-oriented science policy, government as principal agent of technological change was replaced by multinationals. Furthermore, inter-operability was abolished in favor of *Compatibility in Manufacture and Supply Services* to upgrade NATO telecommunication networks and to establish a civilian transatlantic data-processing network: the Integrated Management and Information System (IMIS). This was the new regime within which France's ICT policy evolved in the period 1974 -1982. Even within this new context the French government maintained interdependence. Despite American pressures towards the liberalization of electronics trade, the French government was still present in the industry. But rather than building an independent ICT industry the French government adopted a triple strategy: First it maintained national control over an important segment of the industry; second it encouraged the formation of alliances between French electronics firms and American electronic components producers and later adapted the DGRST nationalism to a common European policy in electronics.

Chapter Two

THE EMERGENCE OF THE DISCURSIVE REGIME AND ITS CHANGE OVER TIME

2.0 INTRODUCTION

Having argued in the previous chapter that the military, the technological and the economic are interdependent spheres of activity, I went on to claim that it is important to investigate how all these spheres were interconnected in a given power relation and formed the elements of the discursive regime in the US. I maintained that the discursive regime in ICT that originated in the US represented a particular association of the military, technological and industrial spheres under the US Air Force's leadership within the US military establishment. Rather than overlooking the military and taking into account only the technological, as liberal regime theorists do, or the economic sphere, like the neo-Gramscians, the concept of discursive regime has the advantage of showing how the US Air Force associated the military, science and technology and laid down the discursive elements that emerged from this association to form a universe of political discourse in ICT in the United States.

To show the US Air Force leadership within US military establishment, I first describe the struggle between US military services over military strategy in the 1920s and early 1940s. In analyzing this period, I found 1944 to be a turning point in US military history both in terms of military thinking and technological practice. After two decades of controversy between the Army and the Navy on one side and the Air Force on the other, over the use of airplanes in military operations, in 1944, the Air Force took over US military policy and imposed air power as the *de facto* US military doctrine replacing the earlier concept of naval-power. The consequence of this change was profound for the relationships between military policy and scientific research. Scientists were no longer subservient to military needs and became equal partners of military strategists. They were used not only to fulfill daily logistics requirements but also to help define military strategy and to *predict* future military needs.

The second part of this chapter is concerned with the relationship between science, technology and air power in the US between 1944 and 1963. Although inter service conflicts over budgetary resources were important in this period, I argue that it would be simplistic to view the whole process in terms of this dispute. Besides the interdepartmental struggle over resources, there was also a confrontation over how to manage scientific and technical resources in peacetime for current and future US defense. This confrontation divided the US armed forces establishment into those who favored the emphasis on day-to-day requirements and those who preferred greater focus on future military preparedness. It was a confrontation between an emphasis on basic research versus a focus on development which ended in the early sixties with the creation of two institutions, the Air Force System Command (AFSC) and the Air Force Logistics Command (AFLC). Together, both organisms integrated forecast research with development objectives within the framework of *Project Forecast* that linked American science policy to foreign policy.

From the 1960s on, the AFSC and AFLC monitored research and development programs not only in the US but also in Europe through scientific and technical organizations attached to NATO and the OECD: the European Office of Scientific Research (EOSR) created in 1952, the Advisory Group for Aeronautical Research and

Development (AGARD) created in 1954 and, in 1962, four years after the creation of the OECD in 1958, the OECD's Directorates of Scientific and Technical Research were also set. This was the context for post-war electronic development in the United States and in Europe.

2.1 THE POST WORLD WAR I AIR POWER DOCTRINE AND THE DEBATE OVER US DEFENSE ORGANIZATION

As Clausewitz says tactics are about how battles are fought. But where, why and when is a matter for strategists and political decision-makers to decide.[77] However, in the real world, by the late 1890s, this clear-cut distinction had been blurred by the notion that a nation could wage and win a war only if it had "command of the air" using dirigibles.[78] This implied that a victory could be decided in the first engagement by aerial means and that, therefore, there was no need for surface forces to meet in the initial engagement. This is an anonymous rule whose origins are unknown.

It is, however, important to note that this axiom was not determined by change in military aeronautics which was inexistent at the time.[79] It emerged before airplanes for strategic deployment were developed and therefore it was autonomous from the

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[77] C. von Clausewitz, On War, Book Three: Of Strategy in General, New York, Penguin, 1968. According M. De Landa, "While tactics seek to integrate men and weapons in order to win single battles, strategy seeks to integrate battles together to win entire wars." M. De Landa, War in the Age of Intelligent Machines, Cambridge, MA and London, UK, The MIT Press, 1991, p. 83

[78] L. Kennet, A History of Strategic Bombing, New York, 1982.

[79] According to L. Kennet:

> The popular literature of the late nineteenth century because of its scientific and futuristic elements, had more than a casual relationship to the dawn of air power and, more particularly, to perceptions of that power... When the armed airship did finally appear, it was already familiar to popular mind. Not only was the weapon expected, but its role and functions had already been envisoned ... Here a certain "fantasy factor" operated, so when airships and airplanes appeared, extravagant and impossible things would sometime be expected of them [L. Kennet, op. cit., p.8.]

economic and technological spheres. In the early twentieth century, this axiom influenced many changes in the design of battleships, the dispersion of troops on the battlefield and new standards for the construction of fortresses. It was thought that during a war, the main work could be achieved "in the air and the arrival of an aerial fleet over the enemy"'s stronghold would conclude the battle in favor of the force that engaged the first aerial strike.[80]

Since then, air power advocates have considered the yet-to-be developed strategic airplanes as decisive weapons. In practice however, during World War I, airplanes offered only tactical support for ground troops in reconnoitering the enemy's position and their airborne guns and bombs were engaged against surface forces to stop the advances of the enemy. From these practices, the concepts of "close support" and "interdiction" emerged to describe aircraft deployment in military operations. This tactical exclusivity of the use of aircraft did not last long. Soon after the end of World War I, the late XIXth century view of airplanes as strategic means and decisive weapons re-emerged. According to Paret *et al.*,

> By the end of the war, spurred on largely by the German raids over England, yet another vision arose - that of aircraft operating independently of armies and navies. The task of such forces would be to attack targets far removed from the battle lines, with the aim of destroying essential elements of the enemy's capability to wage war by bombing his factories, transportation hubs, and centers of government.[81]

Although unsuccessful in terms of battle decisiveness, the German raids of World War I paved the way for a controversial new air power doctrine. As stated by a British air squadron leader in 1927, the air power doctrine contained five principles: (i) it was impossible for the navy to prevent raids at every point and there were immense

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[80]P. Paret *et al*, Makers of Modern Strategy, Princeton, N.J., Princeton University Press, 1986, p. 627.
[81] Ibid., p.628.

advantages to be gained by continual offensive in the air against enemy aircraft, (ii) air superiority was an essential preliminary for either naval or military operations, (iii) the maintenance of air superiority was essential to the success of subsequent military operations, (iv) air-power in defense have both naval and military advantages, (v) given air superiority it was thought possible for landing operations to be undertaken with a smaller naval and army forces.[82]

The doubt generated by this argument lay in the fact that airplanes had never achieved such primacy in wartime. Moreover, the development of aircraft was still in its infancy. As pointed out by the same author,

> How effective aircraft can be against various types of vessels has yet to be determined. Certain experiments have been made since 1918, but the reports available are somewhat meager and live on in an unhappy state of uncertainty. At all events there seems too little in the way of definite material on which to base a satisfactory conclusion.[83]

Despite these widely-recognized problems, in the United States, throughout the 1920s, a group of air commanders ceaselessly promoted air power as a determinant factor in modern warfare, claiming that fighter and bomber planes could destroy any battleship and a nation needed only airplanes for defense against foreign invasion. They assumed moreover that airplanes could guarantee rapid victory and that it was therefore unnecessary for surface forces to meet in battle. Through strategic bombing, these airmen argued, an enemy nation could be defeated before its army reached the battlefield. These views challenged all military experience and, for this reason, they were unacceptable to the US military establishment.[84]

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82 Squadron Leader, (the author did not give its name) Basic Principles of Air Warfare, Aldersshot, Gale and Polder Ltd, Wellington Work, 1927, p.84. This is a rare document that gave a critical of view on air power in the late 1920s.

83 Ibid.

84 This doctrinal divide on the use of airplanes became the focus of an ideological struggle between the forces of change and those of inertia in the US military establishment. The socio-political

By the end of the 1920s, when the US War Department disputed these claims, General Mitchell (an air commander) straightforwardly advocated the separation of the Air Force from the Army and engaged in an effort to rally public opinion in order to oblige the government to respond to his demand. The result of this unconventional political action was the opposite of what might have been expected: Mitchell and his followers, instead of gaining power, lost credibility in the eyes of the General Staff of the United States Army and General Mitchell was obliged to retire after a court-marshal.[85]

In this struggle between the Air Force and the rest of the US military establishment, the former had neither the status nor the resources to impose its ideas. Despite these disadvantages, Mitchell's forced retirement had limited success in eradicating the air power discourse; the statement of the decisiveness of air power survived General Mitchell's retirement.

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aspect of this situation has been thoroughly described by Brigadier General William Mitchell who stated that:

> The armed services of a nation are the most conservative elements in its all make-up... The tradition among all the armed services is much older than any government. more conservative than any government department, and more sure to build on a foundation that they are certain of, rather than to take any chance of a making a mistake. As they have changed so little in their methods and ways of conducting war for so many centuries, they always look back to find a precedent for every thing that is done....*in the development of air power, one has to look ahead and not backward and figure out what is going to happen, not so much what has happened. That is why the older services have been psychologically unfit to develop this new arm to the fullest extent practicable with the method and means at hand* [my emphasis]

Brig. General William Mitchell, «The Development of Air Power», Excerpts from William Mitchells Winged Defense: The Development and Possibilities of Modern Air Power- Economic and Military. G.P. Putnam Curtis publishing Co., 1925. Reprinted in E. M. Emme, The Impact of Air Power: National Security and World Politics, Princeton, N.J., Toronto, New York and London, D. Van Nostran Inc., 1959, p.174.

85 J. S. Underwood, The Wings of Democracy: The Influence of Air Power on the Roosevelt Administration, 1933-1941, Texas, A & M University Press, 1991, pp. 3-4.

In 1933, when Franklin D. Roosevelt became president of the United States, he inherited this situation.[86] Other air power advocates maintained that air power had defensive as well as offensive potential that could not be fully exploited if airplanes were envisaged merely in terms of support to surface troops (navy and army elements). They proposed the creation of a unified General Headquaters (GHQ) for the Air Force that would plan scenarios and pre-emptive air strikes at the heartland of the enemy country in order to stop the arrival of men and material on US shores. Assumed in this reque:.t was the ability of a potential enemy to build an air capability similar to one envisioned by US air power advocates. To avoid placing the United States at a disadvantage, the US government, they argued, should support the construction of a strong and well-structured air system (defensive and offensive) in an integrated chain of command. These demands were again rejected by the General Staff[87]. In fact, air power advocates faced not only the US military establishment's opposition, but also, an entire military discourse and technical deployment that, until then, had maintained de-centralized defensive and offensive commands. The next section will describe the

86 Three other generals: Oscar Westover; Henry H. Arnold and Frank Andrews engaged in a renewed effort to convince the General Staff and the Roosevelt Administration that the Army Air Force (AAF) was no longer separatist and was willing to elaborate deployment concepts for the use of airplanes in concert with the other forces. Despite their conciliatory tone, the generals still believed that military aircraft could achieve decisive outcomes in war. Based on this assumption, they requested that air power decision-making centers previously divided among the various ground commanders be concentrated in one General Headquarters (GHQ). J. F. Shiner, Foulois and the US Army Air Corps: 1931-1935, Washington DC, USAF, Office of Air Force History, 1983, p. vii.

87 The rejection of the air defense system was on the ground that in the mid-1930s,

> ...no type of airplane has been developed capable of crossing the Atlantic or Pacific with an effective load, attacking successfully our vital areas, and returning to its bases....
>
> The "air invasion of the United States" and the "air defense of the United States" are conceptions of those who fail to realize the inherent limitations of aviation and to consider ocean barriers. Aircraft in sufficient numbers to threaten serious damage can be brought against us only in conjunction with sea forces or with land forces which must be met by forces identical in nature and equally capable of prolonged effort

J. F. Shiner, Foulois and the US Army Air Corps: 1931-1935, op. cit., p. 5.

use of calculating machines in this technical deployment after World War I in order to show how this deployment did not favor the emergence of digital computers.

POST-WORLD WAR I U.S. AIR DEFENSE AND THE USE OF CALCULATING MACHINES IN TACTICAL AIR POWER

I suggested in Chapter One that computers as we know them since 1957 were a result of the particular discursive regime that originated in US military sphere, after the air power discourse became dominant. In order to appreciate the role of of air power, it is necessary to describe military calculating machines used before the 1950s. In the United States, until 1944, different machines were conceived for special purposes: shipcraft and aircraft stabilization; ballistic firing tables calculation; aircraft homing and almost none for communications. These computers reflected the de-centralized command structure mentioned above.

Despite repeated demands by air power advocates, during and after Word War II, Army and Navy establishments maintained the Air Force and air defense systems within a tactical deployment that ignored claims for an integrated chain of command. According to this tactical deployment, several Ground Controlled Interception sites were located in the US and abroad. Within US territory, these sites were under US Army control and consisted of one or two search radars, a heigth-finder radar, and ground-to-air and air-to-ground communications systems[88] designed and manufactured by Bell Labs and the MIT Radiation Laboratory.[89]

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[88] M. M. Astrahan and J. F. Jacobs, «History of the Design of SAGE Computer - The AN/FSQ-7», Annals of the History of Computing, Vol.5, N°4, October 1983, p. 340.

[89] C. Towns "From Radar Bombing Systems to the Masers", in F. Nebeker *et al*. Sparks of Genius: Portraits of Electrical Engineering Excellence, New York, IEEE Press, 1994, p.69.

At the heart of each of these systems was an analog calculating machine that processed radar data that were communicated by voice telephone to tactical airpilots who performed interception and interdiction.[90] In Europe, each US Army detachment was accompanied by a Tactical Air Command whose mission was to provide air defense in forward sectors.[91] In this setting, airborne radar units provided with calculating machines completed the air defense picture. However, these radar units[92] were incapable of performing any mission other than "homing", a concept that described the direction of aircraft moving in on their targets.[93]

In 1941, TRW company designed, built and tested a system that combined radar and mechanical analog techniques in a bombing system. This machine was called the Norden Optical Bombsight. It operated only under certain conditions: day light, clear weather, and little danger from antiaircraft fire or enemy fighter-aircraft[94]. When the United States entered the Second World War, harnessing computers for the Navy and the Army air defense became even more important because the Germans dominated the air and the allies were deficient in antiaircraft fire control. Although their guns could

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90 C. R. Wieser, Loc cit., p. 363.

91 Tactical Air Command missions consisted of offensive operations against enemy ground troops and installations in the immediate tactical area, and other offensive operations in close co operation with friendly ground units, Ibid., pp. 229-230.

92 Tactical Air Command aircraft were almost entirely fighters and fighter-bombers. Each detachment went into the fighting with a radar organization composed of three Forward Director Posts that had five Ground Observation Posts each. The latter reported by radio telephone to a Net Control Station common to the group of five. The Net Control Station then phoned pertinent information to the Forward Director Post. The tactical radar was mainly deployed at forward sites. Operators at these sites reported air activities to the Fighter Control Center which was located at the forward TAC headquarters. The latter are occupied jointly by Army ground officers who controlled airborne fighters See L. N. Ridenour, Radar System Engineering, New York and London, McGraw-Hill, 1947, pp 229-230

93 During the Second World War, homing was tactically an important function, both in the attack on shipping by aircraft and in the interception of hostile aircraft by defending fighters. The first operationally successful homing of aircraft on a surface-vessel was done by the British Air-to-Surface Vessels a computer-aided radar, the Mark II during World War II. A counterpart of this equipment was developed in the United States by Harvard University for the Army and the Navy, Idem, p. 196

94 C. Towns, op. cit., p.68.

shoot the German planes, the mechanical directors of their antiaircraft guns were slow in comparison to the speed of these planes.[95]

The solution to this problem was the construction of a simulator for predicting how far ahead of a fast-moving plane the gunner had to aim in order to have the trajectories of his antiaircraft missile and the enemy plane intersect. This job of prediction was taken over by a servomechanism, a feedback-based device which automatically kept the radar antenna aimed at the target as the plane maneuvered.[96] Instead of technological determinism, what we have here is the influence of war operations on electronics and not the reverse. Under this influence, the field of calculating machine was linked to the military as the domain of electronics became important for air defense. This linkage was not in accordance with the Air Force's view on centralization of commands but in conformity with the then dominant military establishment that favored the development of analog technique and maintained a decentralized air defense command structure. In the mid-1930s to increase the accuracy of their own fighters and bombers, the Navy and the Army chose to develop an electronic bomb system composed of electrical analog computers and radar devices.[97]

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[95] J. Rajman. "Early Research on Computer at RCA", In Metropolis, N et al. A History of Computing in the Twentieth Century. Academic Press, 1980, p. 465.

[96] M. De Landa, op. cit., pp. 42-43.

[97] According to C. Towns the bombing radar worked as follows:

> ...the bombardier identified the image of the target on the cathode-ray screen of the radar set, moved a set of cross-hairs to cover the image, and then kept the cross-hairs on the image as the plane approached the target; an analog computer took as input such things as altitude of the airplane, ground speed, winds and ballistics of the bomb, and gave output in the form of a needle showing the pilot which way to turn and an indication to the bombardier when to release the bomb.

C. Towns, op. cit., p.69.

On the Command of the sea side, since 1920, the Navy had used the "Sperry Fire Control systems". This system was the basis for the development of computerized information and control systems long before the above-mentioned computer developments of World War II. According to Thomas P. Hughes:

> The Sperry gunfire-control system...placed an analog computer, the "battle-tracer", in the gunnery officer control room. The "battle tracer" automatically received information about the ship course from the compass, the ship's speed from revolution counters of the propeller shafts, the targets bearing and range from sighting devices aloft, and then combined these with other information about the ocean currents. The output from the analog computer consisted of a small ship model that moved along a chart continuously showing the ship's position, and an arm extending from the ship model that continuously marked on the chart the enemy, or target, ship position.[98]

In 1935, the Navy initiated a computer development program to address the cryptoanalysis problem of decoding enemy communications. This development was the foundation of present-day electronics intelligence. Between 1935 and 1943 under the combined sea and army leadership many computer development projects were initiated. Among these, in 1937, Howard Aiken, then instructor in the Physics Department at Harvard, convinced IBM to develop an Automatic Sequence Controlled Calculator.[99] IBM built the machine ordered by Aiken in 1943 and released it to Harvard under the name of Harvard Mark I to undertake the still-classified US Navy work.[100] During the war, army operators considered again that the mechanical directors were too slow and the large number of cathode tubes required made the machine impractical for use in the field.[101]

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98 T. P. Huges, American Genesis: A Century of Invention and Technological Enthousiasm, Penguin Books, 1989, p.136.

99 Another major computer project was undertaken at Radio Corporation of America through the Franklin Arsenal in Philadelphia in 1939. A. W. Burks, "From ENIAC to the Stored-Program Computers", In Metropolis, N. op. cit., p. 314.

100 B. Randell, (ed), The Origin of Digital Computers, Selected Papers, Berlin, Heidelberg and New York, Springer-Varlag, 1970, p.187.

101 J. Rajman, op. cit., p.467

The military discourse and the technological practice described above were not hospitable for the development of later computer devices such as the Central Processor Units, "flip-flop" technology, "real-time" and "time-sharing" techniques because these devices and techniques required the centralization of command structure which was not a priority before World War II. In other words, the political momentum that would bring the discourse of centralization of command and the integration of weapon systems into play had yet to emerge. As a matter of fact, any technology policy that moved in this direction was blocked by the Navy and Army Material Commands who saw no need for such changes in the US military structure. Even after the war when the US military budget was under pressure from a public that saw no need for developing or even maintaining defense facilities, the alternative organizational design promoted by airmen was seen by Army and Navy supporters as the Air Force's attempt to monopolize scarce peacetime defense resources .

2.3 THE CENTRALIZATION OF COMMANDS

Despite Navy and Army conservatism, in strategic thinking the Air Force's view gained momentum for three reasons. First, in addition to reconnoitering, transportation and air cover, the US AAF participated in daylight high-altitude strategic precision bombing against German and Japanese strategic assets. This use proved the strategic value of the Air Force to the Roosevelt Administration and by 1944, Roosevelt began to consider air power not only as an *ad hoc* solution to be used in the course of a war, but, also as a diplomatic tool. According to Underwood "Roosevelt changed from a man wanting to ban bombers and aerial bombardment into a man willing to bomb civilian populations."[102] Second, at the end of World War II, the atomic strike against Hiroshima and Nagasaki further asserted the strategic value of air power. As a consequence, the AAF saw its resources increased by the construction of five thousand more planes[103]. At this moment, the Air Force circle considered that

> ... a home base from which war through the air can be carried directly, by passing overseas bases and supply lines. This elimination of distant bases and ground and sea forces will enable the U.S. to provide superior air force for direct intercontinental offensive.[104]

This statement synthesized the technological infrastructure of the emerging centralization of command concept that entailed the building of new offensive and defensive electronic systems and their integration under the command of the Air Force GHQ. It also implied a centralization of war decision-making centers for the purpose of the maximization of certainty at the top of the new strategic command and the minimization of decision-making errors which the Air Force viewed as considerable in the case of a de-centralized command structure. Technically, although the war ended, the Air Force wanted not only the maintenance of the US air defense facilities, but also the responsibility for their modernization according to its own strategic priorities and command structure. According to Astrahan and Jacobs: "Following the Allied victory,

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102 J. S. Underwood, op. cit., p. 3.

103 However, this increase was not a recognition of the Air Force as a "force in being" meaning an arm independent of the tactical requirements of other services. From the air power advocates' point of view, the establishment of an air "force in being", required not only an improvised increase of air resources, but, also a firm public commitment to air power as a strategic asset and a transformation of the entire US military fabric. According to A. P. De Seversky (an air power advocate):

> Mr. Roosevelt's fifty thousand planes merely amounted to a belated admission that modern armies and navies need the air weapons along with their guns, tanks, torpedoes and other standard equipment. He was not building air power but simply reinforcing our surface strength. Long-range aircraft... were tabooed and the rest were "behind the bulk of the Navy program, behind battleships, behind tanks, behind trucks and a host of other war items on the list of armament priorities [A. P. De Seversky, Air Power, Key to Survival, New York, Simon and Schuster, 1950, pp.30-31.)

104 Ibid., p.59.

the most powerful air forces were in the hands of the allies including Russia. There seemed no justification for the expense of maintaining the radar sites established during the war, and support eroded."[105]

Third, despite public concern over the military budget, the vacuum created by the demobilization of American military forces and the Roosevelt Administration's strategic option of massive atomic retaliation delivered by air-power, made the future of the Air Force look better than ever. It became evident that in the case of a surprise attack against US territory, the Air Force would have the primary mission of undertaking retaliatory measures against the enemy by using the most advanced strategic weapon system at hand, the atomic bomb.[106] Herein lay the convergence between air power and American defense policy.[107]

It was widely believed that foreign policy, like military policy, backed by suitable air power must seek to serve the security and the welfare of the people of the United States.[108] While such discourse highlights the realist concept of power, it also reflected the social hegemony of the Air Force that began to gather momentum in order to impose its warfare paradigm on the other forces. As observed by Underwood: after the war "The atomic diplomacy practiced by the United States was only an updated version of a foreign policy based on the application of air power."[109] Since the

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105 M. M. Astrahan and J. F. Jacobs, "History of the Design of SAGE Computer - The AN/FSQ-7", Annals of the History of Computing, Vol.5, N°4, October 1983, p. 340.
106 General Thomas S. Power, "Strategic Air Command and the Ballistic Missiles", In in E. M. Emme, The Impact of Air Power: National Security and World Politics, Princeton, N.J. Toronto, New York & London, 1959, p.436.
107 D. MacIssac, "Voice From the Central Blue: The Air Power Theorist", In P. Paret, Makers of Modern Strategy: From Machiavelli to the Nuclear Age, op. cit., p.641.
108 An address by the Under Secretary of the Air Force before the World Affairs Council of Northern California J. H. Douglas "Air Power and Foreign Policy", October 14, 1946. Reprinted in E. M. Emme, The Impact of Air Power: National Security and World Politics, op. cit., pp. 801-803.
109 J. S. Underwood, op. cit., p. 5.

discourse on air power was an old web of ideas (such as "air superiority" and "decisiveness") that was adapted to the atomic context and internalized the later concepts such as "deterrence" and "massive retaliation"[110], it is important to note that it was not atomic technology that changed air power but the latter that became associated with the US Air Force's momentum. Indeed, the AAF General Chief of Staff, had happily stated that:

> The influence of atomic energy on air power can be stated very simply. It has made air power all-important. Air power provides not only the best present means of striking an enemy with atomic bombs, but also the best available protection against the misuse of atomic explosives.[111]

Although he did not explain how a misuse of atomic bombs could be averted by air power, one cannot miss in this statement the Air Force's will to subsume the atomic deterrence policy under its own strategic discourse. In the post-war context where avoiding military confrontation between major powers became the diplomatic priority, the pre-World War II Navy doctrine, the *Command of the Sea* seemed outdated. The importance of air power rested on the atomic deterrence policy that changed the role of the Air Force from a decisive means to win a war, into a deterrent arm that prevented atomic confrontation.[112] As one air power advocate wrote in 1945: "Thus far, the chief purpose of our military establishment has been to win wars. From now on its chief

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110 Reinforcing air power became a guarantee of the command of the air (in peace as well as wartime) and the essential means of the policy of deterrence. As a consequence, deterrence through massive and indiscriminate atomic retaliations, became morally more acceptable than the tactical doctrine that saved civilian populations from air bombardment

111 General H. H. Arnold, "Air Power and the Future", op. cit. p.309.

112 Even before the Russians exploded their atomic bomb, preventing an atomic war, became the chief national interest for two related reasons. First, it seemed to be common sense that the devastation of an atomic war would not spare the American continent. Second, the US' decisive implications in both World Wars ended its immunity from foreign wars. In effect, American airmen used this argument to make their case. They pointed out that despite Germany, Japan and Italy's effort to maintain American neutrality in both wars, these nations found American military power used decisively against them. Therefore, in the next conflict, no aggressor could avoid the United States as a first target. [The War Reports of General of the Army George C. Marshall, General of the Army H.H. Arnold and Fleet Admiral Ernest J. King, Philadelphia, J. B. Lippincott, 1947, p.415.]

purpose must be to avert them. It can have no other purpose."[113] This analysis led another air power advocate to stress that:

> Atomic explosives only heightened the danger of foreign aggression and underscored the crucial role of air power in modern warfare. Surprise attacks using nuclear weapons were not unthinkable, and science could offer no umbrella against this eventuality. If only one missile carrying bomb penetrated a nation's air defenses, immense destruction will ensue. The answer... lay in a powerful offense which deterred aggression. Offense aerial systems must give U.S. air forces the capability of reaching remote targets quickly and striking them at maximum impact; attaining air superiority over any region of the world; and landing, in short order, large contingents of men and equipment at any trouble spot. Over her own territory, America must establish total air superiority, and erect a network of highly sophisticated warning and homing devices to detect incoming forces.[114]

In keeping with the new atomic strategy the traditional concepts of defense and offense, tactics and strategy[115] were fused into a notion of "massive retaliation" that bridged the gap between individual tactical engagements and decisive military actions and thus brought together the concepts of "air power", "atomic deterrence", "strategy" and "tactics" from which a new military procedure emerged i. e. the ability to operate in real-time.

Before the end of World War II, "real-time" procedure existed in the modeling of the complex dynamic motion of a missile and aircraft systems and in the mechanical director of tactical air defense. With the Air Force's momentum, however, "real-time" has a strategic meaning. It referred to the strategic use of speed in order "to see, to

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113 B. Brodie, The Absolute Weapon, New York 1946.

114 T. von Karman Science, the Key to Air Supremacy (Volume one of Toward New Horizons) 15 Decembre 1944, pp. xix-xxiii.

115 Right after the war, such statements were common amongst air-power advocates even outside the United States. In 1946, a British lieutenant commander of the Royal Air Force reached similar conclusions: «The only defense against the weapon of the future is to prevent them of ever being used. In other words the problem is political and not military at all. *A country 's armed forces can no longer defend it: the most they can promise is the destruction of the attacker* » [C. Clarke, «The Rocket and the Future of Warfare», Royal Air Force Quaterly, Vol 17, No.2, March 1946, p. 63.]

hear, to perceive, and, thus to conceive"[116] of a global military situation beyond the limits of human senses. In other words, it was the way to operate in an ever-decreasing time-frame between an attack, responsive military decisions and their implementation. In the mid-1940s, maximizing the outcome of such a process was not yet a possibility provided by technology but was rather a representation of war-making by the US Air Force who associated "air power" with "atomic deterrence". The notion of real-time as a central element of the emerging discursive regime had an effect not only on electronics but also on international relations. From the geo-political point of view as observed by Paul Virilio:

> The question no longer entails relations of what is global in respect of what is local, or what is transnational and what is national but above all concerns this sudden "temporal commutation" in whose flickering disappear not only the difference of inside and outside and the expanse of political territories, but also the "before" and the "after" of duration... for the sake of the ***real instant*** over which, **finally no one has control**. To be convinced of this shift we need only observe today's inextricable problems of geostrategy in view of the impossibility of clearly distinguishing *offense* from *defense*. Instantaneous and multipolar strategy has been deployed in what military experts call "preemptive" strikes.[117]

Unlike Paul Virilio I do not think that *real time* or *real instant* is a thing - that is beyond human control - that makes political territories disappear. As we have seen with respect to military strategy, the notion of real time stemmed from the US Air Force's will to associate the atomic bomb to its strategic priorities. Thus, without the notion of "air power" and related deployment concepts within the nuclear context, it is impossible to understand the geo-political meaning of "real time". Real-time was a political construct that meant for the control of military decision-making by the US Air Force within the universe of political discourse in the United States and the monitoring of

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[116] P. Virilio, "The Third Interval. A Critical Transition", In V. Andermatt Conley (ed.), Rethinking Technology, Minneapolis and London, University of Minnesota Press, 1993, p.5

[117] Ibid., p.10

military events abroad. It is a concept implying an exercise of power and control. According to the General Staff AAF,

> Detailed and moment-by-moment knowledge of all aspects of civilian and military activities within the territory of an enemy or a potential enemy is essential to sound planning in time of peace or war. Continuous knowledge of potential enemies, covering their entire political, social, industrial, scientific, and military life is also necessary to provide warning to impending danger. Strategic air warfare can be neither soundly planned nor efficiently executed without a continuous flow of detailed knowledge of this kind.[118]

Intelligence was an essential military practice even before the Cold War. But, from the Air Force's point of view, it was not to be conceived within the age-old Army and Navy experiences. Since the Army and the Navy's conceptions of war-making were outdated according to the Air Force, so was their intelligence practice. New intelligence had the function of predicting oncoming inter-state conflicts and putting US military capability ahead of other nations' war techniques. Predicting conflicts supposed not only the assessment of potential enemies' capabilities and weaknesses but also supposed new scientific and technical measures that broke with previous Navy and Army technological orthodoxy.[119] More than the requirement of centralization of

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[118] General H. H. Arnold, "Air Power and the Future", op. cit, pp. 308-309. and S.F. Wells Jr., «A Minuteman Tradition», The Wilson Quarterly, Vol.3, No.2, Spring 1979, pp.109-124.

[119] According to the General Staff AAF:

> National safety would be endangered by an air force whose doctrines and techniques are tied solely to the equipment and processes of the moment. Present equipment is but a step in progress, and any air force which does not keep its doctrines ahead of its equipment and its vision far into the future, can only delude the nation into a false sense of security.
> ...our concept of the implements of air power should not be confined to manned vehicles. Controlled or directed robots will be of increasing importance, and although they probably will never preclude some form of human guidance, reliance upon direct manual skills in pilotage will gradually decrease.

The Third Report to the Secretary of War by the Commanding General of the Army Air Force, General Henry H. Arnold, November 12, 1945. These words can also be found in Theodore Van Kàrmàn, The Wind and Beyond: Theodore von Kàrmàn, Pioneer in Aviation and Pathfinder in Space, Boston Little commands and the technological measure that would deploy this centralization, it was this role of prediction that linked science to the military in the late 1940s. Again it was not scientists that influenced military policy as Robert Gilpin and John Schmand[120] suggest but the military that linked science to their strategy.

In 1949, the Soviets' explosion of their first atomic device ended the US atomic monopoly and gave further credence to the Air Force. It became essential that missile technology and air power develop in tandem. This prospect gave relevance to the 1944 Air Force "strategy for applying the new technologies - such as pilotless aircraft - to the battlefield to institute a three-tiered typology of weaponry: human directed, electronically assisted, and purely automatic."[121] This strategy was the basis for the Air Force's views on a science policy that would be designed to harness electromagnetic radiation techniques (for radars), aerodynamics, propulsion technology, and electronics[122]. These techniques were meant to set up new devices for control,

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Brown, 1967 and M. H. Gorn, The Universal Man: Theodore von Kàrmàn's Life in Aeronautics, Washington, D.C. & London, England, Smithsonian Institution Press, 1992, p. 116.

120 R. Gilpin France in the Age of the Scientific State, op. cit, and J. Schmand, "Towards a Theory of Scientific State: Administrative versus Scientific State" In Szyliowicz, J. C. (ed), Technology and International Affairs, New York, Preager, 1981.

121 M. H. Corn, op. cit., pp. 36-37.

122 The Air Force's idea to apply these new technologies to warfare was based on the experiments carried out by European military research. In 1944, the AAF Scientific Advisory Board (SAB) formed a crew to travel to Europe with the mission "...to learn from the most advanced aeronautical ideas generated during the wartime research and project [them] to the future." SAB's intention was to continue the development of the technological achievements of German research in pilotless aircraft and guided missiles. Its interest was to develop further the calculations that had been completed by the Germans for a transoceanic missile, the wind tunnel test, ballistics computations, and the V-2 experiments.

During its European journey, the delegation reviewed the advances in jet propelled aircraft, guided missiles, radar, television equipment, fuels, material and explosives in laboratories at Teddington and Franborough, U. K. In France and in Belgium, it visited the National Aeronautical Laboratories and coastal launch sites of robot bombs. The visit to Holland permitted the SAB delegation to acknowledge Philips Corporation's advancement in radar research. However, most important were visits to Germany (Aaechen, Metz and Strasbourg), Switzerland (the Zurich Institute), Sweden, Finland, Poland and Italy that «all offered the fruits of German science, either in German laboratories or in facilities directed by Germans abroad.» See M. H Corn, op. cit., pp. 21, 27 28 communication, detection, warning and intelligence for a new strategic deployment. It is striking to see that what was earlier an idea (strategic bombing) of a controversial moral and military value, became, after 1945, not only the official US military doctrine but also the expression of US foreign policy. What is also impressive is the convergence between air power and science policy. This convergence rehabilitated the previously immoral practice of strategic bombing and paved the way for the Air Force's technological projections and speculations on future wars.

2.4 SCIENCE AND THE AIR FORCE STRATEGIC DISCOURSE

As I argued in Chapter One, the notion of discourse itself refers to the relationship between a belief or a representation and actions. So far, however, I have only analyzed the Air Force's strategic representation through the relationships of "air power", "nuclear deterrence", "massive retaliation" and "real-time". As we have seen, this representation had geopolitical implications (the collapse of the inside and outside, the global and the local) that would allow the Air Force to impose its ideas on internal US military decision-making regarding the atomic bomb and to monitor events of military importance worldwide. To show how this representation became a discourse, it is necessary to demonstrate the way the Air Force's strategic views were translated into institutional mechanisms, decisions and actions. This is where the role of the US Air Force in setting post-war US science and technology policy becomes important to the formation of the universe of political discourse in ICT in the Unites States and the formation of the transatlantic discursive regime later in the early 1960s.

Until World War II, US government support of science was carried out on an *ad hoc* basis. According to A. King: "The history of American scientific institutions has consisted essentially of the creation at (or after) the outbreak of each war of a new central body with co-ordinating, advisory, and research functions."[123] In conformity with this practice, in 1940, the armed forces created the National Defense Research Committee (NDRC) to sponsor research for military purposes. The NDRC had no laboratories of its own. Its work was done through contracts with university and industry laboratories. This sporadic government concern with science began to change in 1941, when the NDRC was dissolved for being too much confined to military research and was replaced by a new organism, the Office of Scientific Research and Development (OSRD). It was thought in the White House that broader and more independent research was necessary for "greater prosperity, better health for the people, more security from the enemies (or power to attack them), and enhanced national prestige."[124] Despite this broad awareness, throughout World War II, the OSRD integrated research and development in a way that reflected the preoccupation of the military establishment. Again according to Alexander King "The OSRD, in which research and technology were organically united, [ensured] the total mobilization of science for the war, its correlation with military thinking and with engineering development and production."[125]

After the war, on February 1946, when the commanding general of the Air Force retired, General Spaatz his replacement created the Scientific Advisory Board (SAB). The creation of SAB[126] was the first institutional attempt to link scientific research to the AAF's ceaseless ambition to impose its vision on US defense policy.

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123 A. King, Science and Policy, The International Stimulus, Oxford, Oxford University Press, 1974, p.5.
124 Ibid., p.viii
125 Idem, p.8.
126 The AAF's Scientific Advisory Board should not be confused with the New deal's Science Advisory Board (SAB).

While the AAF was increasingly showing an exaggerated trust in the efficacy of science in military matters, it did not see the role of science as restricted to the development of hardware. Science was envisaged as part of a new military practice whose objective was not to wage wars, but to avert them. As pointed out by Dr. James Doolittle (an influential military SAB member):

> **It is far better to keep out of war than to win a war. If we permit a potential enemy to get ahead of us technologically ... that is the surest way to start a war.** I feel that the time has come to make some sacrifice from today's continuing emergencies in order to prepare for tomorrow's eventualities - jar loose some funds, some competent personnel from daily requirements in order to pr 'pare for tomorrow's requirements[127]

Beyond daily logistical requirements, science and technology were called upon to project American defense policy and technological practice into the future.[128] In this

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[127] Cited in T. Sturn, The USAF Scientific Advisory Board: Its First Twenty Years: 1944-1964, USAF Historical Divison Liaison Office, US Government Printing Office, 1967, p.9.

[128] After the war, the above-mentioned military doctrinal crisis was also reflected in American science policy. The centralization of US science policy symbolized by the OSRD was also questioned by the AAF. In 1944, the AAF created its own Scientific Advisory Group (SAG), an office attached to the commanding General of the AAF (H. Arnold). SAG was headed by a military deputy, Colonel Frederic E. Glanzberg and a scientific chief adviser, Dr. Theodore von Kàrmàn. The SAG board received directives directly from the commanding general of the AAF and the latter was informed by the board of new scientific developments on a regular basis. The objective of SAG was not only to enlist scientists to work for the AAF, but also to familiarize air officers with science. It was admitted in the AAF circles that:

> Scientific results cannot be used efficiently by soldiers who have no understanding of them, and, scientists cannot produce results useful for warfare without an understanding of military operations.
>
> The Air Force leadership has the task of creating and maintaining a climate of mutual respect and cooperation between the scientists and military planners

Within this framework, the SAG board presented to the commanding general of the Air Force proposals for special studies, evaluated long-term research plans and advised the general on institutional aspects of military technology. During the two years of the SAG existence, this small circle nominated members, drafted policy, and appointed *ad hoc* panels Thirty experts sat on five panels: aircraft and propulsion; missile guidance; fuels, explosives, and nuclear power; radar, communications and weather; and aeromedicine. The scientific deputy (von Kàrmàn) controlled the working of these groups through quarterly meetings of an executive board comprised of himself and six other vice-chairs. [M. H. Gorn, The Universal Man. Theodore von Kàrmàn's Life in Aeronautic, op. cit., p.118.]. See also T. Sturn, The USAF Scientific Advisory Board: Its First Twenty Years: 1944-1964, op cit.

setting of science policy, the Air Force had many tasks: (1) the responsibility for ensuring that the US was prepared to wage effective air warfare; (2) enlistment of scientific talent and industry to foster air power on new scientific and technical basis; (3) recruitment and training of personnel who had understanding of scientific facts in order **"to produce and use equipment which was more advanced than that used by any other nation"** (4) development of existing facilities and creation of new ones that would enable the AAF to undertake its own research and to make such facilities available for scientists and industry working on Air Force problems.[129] Industries had always participated in war effort but the US Air Force ambition was not only mobilization but the establishment of a permanent industrial base.

SAB was thus the institution that translated the Air Force's representation of air defense and offense into political decision. In a 1946 meeting, SAB members received Air Staff briefings on AAF research and development plans. Before any Soviet nuclear threat was felt, two of these recommendations concerned air defense and AAF responsibility on systems affecting Air Force operations. According to General Spaatz, since the building of air defense would be an expensive operation, he wanted a system

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129 For the White House, it was not clear whether military research should be placed under the OSRD or be merged with military services. Vannevar Bush, the Director of the OSRD, was the first to give his advice on the issue. In November 1944, few days after the AAF created the SAG, President Roosevelt asked Bush to recommend to him a federal science policy for peacetime. In his report, *Science, the Endless Frontier* (1945), Bush proposed that military research be under civilian control. He argued that although the military themselves should be engaged in scientific research, their activities should be limited to improving existing weapons and nothing more. He further suggested that civilian control of military research be undertaken through a "National Science Foundation", an organization that he proposed to promote US na ional interests in science.

Although Bush recommended that the AAF undertake its own research, von Karman, the SAG civilian chief scientific adviser, interpreted Bush's proposal as if *Science, the Endless Frontier* had claimed that, basic research was not of the AAF's business. This attitude, according to Komons was due to the fact that Bush had not been specific as to the extent to which the AAF's

> ... research would be permitted or the areas it would be conducted in. And his assurances notwithstanding, Bush was never able to dispel the feeling in the AAF that he meant to place all military research under civilian control.

that first met current requirements "**...but yet flexible enough to allow continuous upgrading in step with the latest technical advances.**"[130] This statement clarified the intention to build permanent relationships between the military and industry to ensure military industrial readiness in peacetime. The key word was "flexibility". There was no doubt that the would-be air defense system was conceived to deal with present danger. However, dealing with present danger was not the most important characteristic of the Air Force's concept of air defense in the mid-1940s. The envisioned system was also meant to be erected against potential enemies and weapons. This was indeed a break with the pre-World War II intermittent pattern of relationships between defense, scientific research and the industry.[131]

In 1948 when the Air force became an independent service from the Army and after two years of struggle between White House scientific advisers and the Air Force on the role of the latter in scientific and technical research, in 1950 with the agreement of the White House, the Air Force created the Air Research and Development Command. This organization was endowed with a separate budget devoted entirely to Air Force's research and development problems. The Air Research and Development Command conducted its relations with US academic research and industry through the Air Force Office of Scientific Research (AFOSR) created in 1950 and placed under the command of Colonel Oliver Haywood who replaced Dr. Theodore von Kàrmàn as chief scientific adviser to General Staff US Air Force (USAF).[132]

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130 T. Sturn, op. cit., p.21.

131 General Vandenberg who replaced General Spaatz in 1949, pointed out that "The Air Force has no tradition or any inhibition because we are a new department and we would like to start off research and development on the proper foot and I think with the advice and assistance of [the SAB], we should be able to do that", Excerpts, Minute of SAB Study Group Meeting, 11 July 1949.

132 T. Sturm, op. cit., pp.19-25.

In order to assert the independence of scientific research from USAF logistic problems, the new orientation faced opposition from within the USAF. For Haywood, basic research was not manageable within a framework of *a priori* planning or need. As reported by Komons[133], Haywood said that: "one could not sit down and logically construct a program and go out and requisition the research he wanted done. In point of fact this was the way the Air Force was accustomed to doing things". The head of the AFSOR felt that, even if scientific research was sponsored by the military, from an ethical point of view, it should not be subservient to military requirements. The task of science was to wrestle with the unknown within a defined but yet broad field of inquiry. It was according to this perspective that Haywood organized the AFOSR to reflect basic scientific disciplines: Chemistry, Mathematics, Solid State Physics and Mechanics.

2.5 THE BUILDING OF THE SAGE SYSTEM

So far, I have described the Air Force's representation of air defense and analyzed the importance of the notion of "real time" as a new operative procedure whose meaning was given by the Air Force's strategic view. Furthermore, I have also analyzed the relationships between this representation and the institutional setting of the Air Force's science policy machinery which was meant to translate this representation into practice. In what follows, I will show how the Air Force association of the military, technological, scientific and industrial spheres influenced changes in computer

[133] N. A. Komons, Science and the Air Force: A History of the Air Force Office of Scientific Research, Arlington, Virginia, Office of Aerospace, Historical Division Office of Information, Office of Aeroapce Reasearch. US Government Priting Office, 1964, p.4

technology in the early 1950s. My argument is that while the resources devoted to build the Semi-Automatic Ground Environment (SAGE) system was the demonstration of the US Air Force's hegemony within the US universe of polical discourse in ICT, the extension of this system to Europe (the NATO Air Defense Ground Environment [NADGE]) and worldwide (World Wide Military Command and Control System) symbolized the US economic and military power within the transatlantic discursive regime. This force became the basis for the merger between computer and telecommunications and the foundation of the transatlantic industrial alliances in ICT during the late 1950s and early 1960s.

The restructuring of the American air defense system was concomitant with change in military discourse. The Electronics Panel of the SAB did not wait until the Soviets exploded their atomic device and certainly not until the completion of the science policy framework before launching a project for air defense. As mentioned earlier, it was in 1946, during a SAB meeting, that the SAB Electronics Panel was briefed by the General Staff AAF, about the general characteristics of a new air defense system to be designed according to the Air Force requirement for "real time" capability. However, despite this Air Force plan, the White House and the Pentagon thought that "It was doubtful that anyone, including the Russians, would dare launch an air attack so long as the Strategic Air Command retained its overwhelming nuclear retaliatory capability..."[134] This doubt delayed the building of a new air defense system according to Air Force requirements.

The lack of an immediate military threat was not the sole reason for the rejection of the Air Force air defense project. In addition, in the mid-1940s, most of the

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[134] Memo, Major General T. F. Walkowicz to SAB chairman and Military Director, 10 November 1948, quoted by Komons, op. cit., p.33

Pentagon's computer procurement was dominated by the Navy ballistic missile programs. The Navy, through the Office of Naval Research (ONR) and the Navy Bureau of Aeronautics funded many analog computer programs for modeling guided missile prototypes.[135]

In 1949, when the US atomic monopoly disappeared with the explosion of the Soviet atomic device, the Air Force's long-standing demand for a new air defense began to make sense to the Pentagon and the White House. The Soviet atomic explosion was the exogenous factor of US inter-service struggle and became an event that favored the power position of the Air Force which began to effectively impose its air defense paradigm. As a consequence of this event, the Air Force pressed harder for new air defense system. "First, however, it needed a sound plan of action, and... asked the SAB to help draw up such a Plan"[136]. In 1949, in conformity with this recommendation, the SAB constituted the Air Defense System Engineering Committee (ADSEC) with the mission to develop equipment and techniques so as to produce effective air defense for a minimum dollar investment. Dr. George E. Valley who was a member of the SAB Electronics panel became ADSEC chairman. As air defense problems became increasingly urgent, in 1950, Dr. Valley became the chairman of both ADSEC and the SAB Electronics Panel.

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135 Among these were the *Typhoon* and the *Cyclone* computer projects that were carried out respectively by Reeves Instrument Corporation and Radio Corporation of America (RCA). These projects «...involved the development of large analog computing facilities and were intended primarily for the study of guided weapons and to model in-flight characteristics of high-speed aircraft» J.S. Small «Engineering, Technology and Design: the Post-Second World War Development of Electronic Analogue Computers», History and Technology, Vol.11, No.1, 1994, p.37 and A. Karen and B. Loveman, «Large-Problem Solutions at Project Cyclone», Instrument and Automation, No.29, 1956, pp. 78-83

136 Memo, Major General T. F. Walkowicz to SAB chairman and Military Director, 10 November 1948, quoted by Komons, op. cit., p.33

When the Air Force's ideas on centralization of command and air defense became entrenched in the reasoning of Pentagon commanders and White House officials in 1949, the ADSEC undertook a selection process to identify scientific institutions dealing with computing. This selection process was limited to institutions that understood the air-power strategic doctrine as a new framework for air-defense engineering. By that point however, there was little opposition to the air-power strategic doctrine among scientists. Scientists who had been given the role of implementing the Air Force program, were the same as those in charge of the most important scientific and engineering institutions.[137]

Although not yet developed, the idea of using digital techniques for combat purposes already existed but it began to grow stronger relative to other techniques when the Air Force started pressing for a real-time air defense system.[138] In 1947, one year after the Air Force's air defense briefing to SAB members, Crawford who was

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137 Robert Bright a former SAGE chief engineer recalled the degree of consensus that then reigned amongst scientists and engineers, claiming that it was generally believed that «this is in the national interest; this is the kind of thing we ought to do.» H. S. Tropp (Moderator), H. D. Benington, R. Bright, R. P. Crago, R. R. Everett, J. W. Forrester, J. V. Harrington, J. F. Jacobs, A. L. Shiely, N. H. Taylor and C. R. Wieser, "Perspective of SAGE: Discussion", Annals of the History of Computing, Vol. 5, N° 4, October 1983, p. 381. In a same vein, Shiely (Bright's college) maintained that, it was "... a national perception of the emergency need for an improved air-defense system; there wasn't any argument...There was an understanding at the topmost part of the government that the need was urgent" Ibid, p.380.

138 The diffusion of the Air Force's electronic ideas was not automatic. It was channelled through interpersonal communication. After the end of World War II, Forrester (then a researcher at MIT) for example, had thought of leaving MIT and starting a company to develop servomechanisms. His friend Gordon Brown informed him that there were possibilities for more challenging projects. After this discussion, Brown provided Forrester with a project for an aircraft stability and control analyzer that was the first step towards SAGE. The aircraft analyzer was meant to be an analog computer but, Perry Crawford (who then worked for the Special Devices Center of the US Navy and later at IBM) attracted both Forrester and Brown's attention to three technical possibilities: (1) a digital computer; (2) the mechanical Harvard Mark 1 computer and (3) the ENIAC computer. Among these three possibilities, Crawford insisted that only a digital computer could overcome the difficulties of data handling and bookkeeping presented by analog computation. In air-surveillance, analog computers could neither select accurate information from inaccurate, nor could they resolve the problem of repetition during the aircraft tracking and hand over process. Later these problems would be resolved through digital computation which made possible the technique of "data fusion".

working at MIT's Digital Computer Laboratory (DCL) pushed the "... idea of combat information and control with digital computers, well before any high-speed, general purpose, reliable computer had even functioned."[139] Again, this was not the influence of a scientist on military affairs but an example of a technological choice that was driven by a military concern. Indeed, on December 1950, the Chairman of the Air Defense System Engineering Committee proposed that MIT create an air-defense laboratory to work on air-defense R&D. The SAB accepted this proposal and formed a special steering committee for what was termed "Project Charles". In 1951, Project Charles endorsed the concept of a computer-based system and a laboratory for this purpose was established at MIT under the rubric of the Lincoln Project. In the same year, the steering committee for Project Charles presented to the SAB's Electronics Panel a proposal for the electronic aspects of weapon integration to bring into play the fusion between offense and defense and tactics and strategy. This proposal consisted of a system that connected many low-range radars on the basis of which a continuous and "real time" picture of the sky would become possible.

It is important to note that the Air Force's notion of real-time computing was not yet technically possible. As we have seen, it was different from the engineering notion of real-time modeling and tactical calculation of aircraft interception. It was a notion that implied centralization of command, control and intelligence. Its realization (which surpassed the capacity of analog computers) opened a dialogue between those designing computers and the Air Force. The handling of radar data in "real-time" required the Air Defense System Engineering Committee (ADSEC) to sponsor research for new computer techniques and applications. In 1951, the MIT Digital Computer

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[139] Ibid., p. 376.

Laboratory (DCL) and the Air Force Cambridge Research Laboratory (CRL) whose specialty was data communication, carried out the engineering implementation of the ADSEC program. Both DCL and CRL's work was based on the "Whirlwind computer originally developed in the late 1940s by MIT's Digital Computer Laboratory as a computer for a Navy flight trainer and airplane stability trainer."[140] The work of both teams demonstrated that a "real-time" control of flying military devices by digital computer was possible. This experiment became a testbed for the air-defense system design.[141]

The Air Force's requirements for accuracy, speed and readiness in the interception of flying objects became an incentive for another invention in data storage techniques.

> In 1950 Jay W. Forrester (of DCL) invented the random-access core memory as a replacement of the current but limiting technology of cathode-ray tube (CRT) storage. Compared to the cathode-ray in Whirlwind, the core memory doubled the operating speed, quadrupled the input data rate, increased the mean time to failure from two hours to two weeks, and reduced the maintenance time from four hours a day to two hours a week.[142]

This random-access core memory was made of ferrite. It "had an access time on the order of 10 microseconds, less than that of cathode tubes."[143] Following this experiment, in the Spring of 1952, ADSEC was dissolved and replaced by the merger between the DCL and the CRL. The two labs created the Lincoln Laboratory at MIT

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[140] J. F. Jacobs, "SAGE Overview", Annals of the History of Computing, Vol.5, No.4, October 1983, p.325

[141] K. C. Redmond & Smith, T. H., Project Whirlwind, The History of a Pioneer Computer, Bedford, Mass., Digital Press, 1980 and "Lessons From Project Whirlwind", IEEE Spectrum, Vol.14, No.10, October, 1977.

[142] J. F. Jacobs, op. cit., p. 324.

[143] R. J. Chapuis and A. E. Joel, Electronics, Computers and Telephone Switching, A Book of Technological History as Volume 2: 1960-1985 of "100 Years of Telephone Switching, Studies in Telecommunications Vol 13, Amsterdam, New York and Oxford, North Holland Publishing Company, 1990, p.98.

that replaced the Lincoln Project. After this merger, the Whirlwind computer project became part of the Lincoln's experimental air-defense system that was called the ***Cape Cod System***. This system consisted of three separated centers of operation: (1) a control center at the Barta Building in Cambridge, Mass., where the Whirlwind computer was housed; (2) an experimental long-range radar on Cape Cod at South Truro, Mass. and; (3) a number of short-range radars called "gap fillers". The control center contained computer-controlled operating stations and was provided with ultrahigh frequency ground-to-air communications systems.

The network can be described as composed of several cathode ray tube consoles connected to one central computer processor. It translated the Air Force's requirement for a centralized chain of command into several command stations: tracking, scanning and surveillance. These stations communicated data to each other in real-time through a single high speed computer. This type of computing was indeed an innovation. With the arrival of high speed, random-access core memory, the computer had the ability to handle masses and various types of data swiftly, interactively and simultaneously. In other words the computers are used here more as sorting and collating than as calculating machines.[144]

The other characteristic that differentiated the *Cape Cod* experimental computer from the other systems used in military computing, was its "time sharing" capacity as opposed to the "batch processing" of the analog computers where computing jobs were executed in sequence because the programs were fed separately and operated in sequence. Given the simultaneity of many operations during the process of interception, the long turnaround time of batch processing disqualified analog

[144] D. J. Morris, Communication for Command and Control System, Pergamon Press, International Series on System and Control, Vol. 5, 1982, p. 15.

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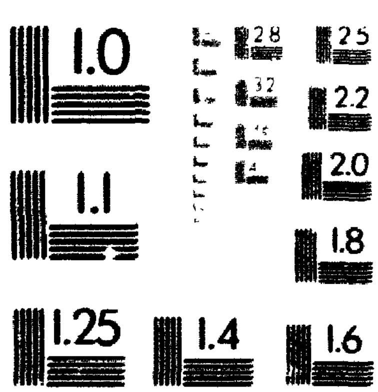
PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT



PRECISION℠ RESOLUTION TARGETS

computers for real-time air defense operations. The *Cape Cod* experiment on the Whirlwind I computer circumvented this difficulty by allowing a process where "... programs should be able to run simultaneously without being affected by another. Each user can have a continuous run with the computer, thus viewing the computer as exclusively his and not being bothered by queues or by delays."[145]

The high speed capacity of the random access memory gave the impression that the Whirlwind functioned continuously despite responding simultaneously to multiple commands. In reality, however, the computer was interrupted each time a different command was addressed to it through a station which technically used only a slice of the central processor time.[146] While time-sharing supposed the simultaneity of procedures such as tracking, control and surveillance of flying objects, real-time meant the maximum speed possible of these simultaneous procedures. In 1952, when it became clear that these two combat capabilities were feasible through a Central Processor Unit (CPU), a new era in computing emerged: the beginning of the merger between telecommunications and computers. It became henceforth possible through a computer to track while scanning flying objects and to processing data collected from these procedures in real-time.

After the association of science with the military, this was how the domain of electronics was enroled to serve the Air Force strategic purpose. As the military, scientific and electronics domains became interdependent, what remained was the integration of the electronic industry in order to translate the Air Force's strategic representation into a reality. Here too the point is not that the military acted to solve a

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145 Ibid.,

146 Idem, p.15.

problem of productivity within electronics industry as neo-Gramscians would argue but rather to fulfill their own strategic ambition. It was in the pursuit of this ambition that the members of Project Charles recommended the search for an industrial contractor in order to turn the *Cape Cod* experiments into an operational machine. A team from the Lincoln Laboratory was created to discuss with the Air Research and Development Command (ADRC) and Air Defense Command (ADC)'s personnel the restructuring of the air defense and the selection of the most appropriate computer manufacturer.[147]

After a meeting in 1952, members of the Lincoln Laboratory, the ARDC and ADC formed the Whirlwind II project, the initial name of the SAGE system. The Whirlwind II team argued that present and future problems of the US air defense can be summarized as a problems of data handling capabilities, including facilities for communication, filtering, storage, control and display. Accordingly, they agreed that:

> A system that can maintain a complete and up to date picture of the air and ground situation over a wide area of the country; that can control modern weapons rapidly and accurately; and can present filtered pictures of the air and weapons situations to the air force personnel's who conduct the air battle [was required].[148]

Moreover, they asked themselves whether the central machine should use transistors, magnetic-core memory or vacuum tubes. Given the state of emergency created by the new Soviet atomic capability and the non-readiness of transistor technology, the Whirlwind II group opted in 1952 for a magnetic core for the CPU and a vacuum tube technology for the input and output peripherals. They also decided that the system would be built in a way that future changes in these components should

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147 This team was composed of: Jay W. Forrester, head of the Lincoln Laboratory and director of DCL. Robert A. Everett associate of these two laboratories, Robert Wieser leader of the Cape Cod System design and ; Norman H. Taylor chief engineer of Lincoln Laboratory.

148 R. R. Everett, C. A. Zraket, and H. D. Benington, "SAGE --- A Data-processing System for Air Defense", Annals of the History of Computing, Vol.5, No.4, October, 1983.

involve only "...a few hours a year of unavailability of the operating system»[149]. After this agreement, the Whirlwind II group started the process of selecting commercial manufacturers to produce the system."[150]

It should be noted that the CPU was the artifact that was designed to be consistent with the Air Force's representation of defense. Further changes of this device set the trajectory of technological development in the computer industry. Here came the role of International Business Machine (IBM). In contrast to neo-Marxian argument, this company did not structure these changes but rather was able to accommodate itself to them in order to take on the role of the prime contractor for air defense.[151] In order to understand why IBM won the prime contract, recall that criteria such as size and experience in computer manufacturing were not as important as a company's ability to accomodate the emerging discursive regime. The company learned about the air defense system as a revolutionary idea and understood the power structure within the air-defense program management. Such an attitude prevented IBM from affecting a technological orthodoxy that would have disqualified it from a leadership position in the construction of the system.

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149 J. F. Jacobs, op. cit., p.327.

150 During this process, according to chief of the ARDC (Albert R. Sheily). "Part of our job in New York was ... to isolate the experts who were certain they knew how the job could be done by different approaches and who also were completely convinced that the SAGE system would never work" [R. R. Everett, C. A. Zraket, and H. D. Benington, op. cit., p. 379.]

151 A review of the SAGE system shows, indeed, that many American electronics companies contributed to its development. IBM designed, manufactured, and installed the AN/FSQ-7 combat direction-center and the test equipment. Western Electric Company Inc. furnished the management service and constructed the center's buildings with the assistance of Bell Telephone Laboratories as subcontractor. Burroughs Corporation took care of the logistics support for AN/FST-2 data coordination and transmission sets. The System Development Corporation (SDC) (until recently a division of Rand Corporation) assisted Lincoln Laboratory in the preparation of the master computer program and its adaptation to combat direction centers Ibid., pp. 331-332.

Indeed, if the Lincoln Whirlwind II group had considered criteria such as the size of a company and its experience with computer manufacturing, then companies such as Remington Rand (Univac in 1949[152]) should have been chosen. Likewise, if experience in communication technology had been an important criterion, the University of Michigan had already developed a competing system, the Air Defense Integrated System (ADIS), and, as mentioned before, RCA had become specialized in military communications and air defense system devices long before any other computer company. Finally, in terms of size, in the early fifties there was little difference between IBM and other companies such as BURROUGHS, RCA, HONEYWELL, G.E.[153], CDC[154], and NCR([155])[156].

The irrelevance of these criteria for the choice of the prime contractor suggests that military problems structured the change in the computer industry and not the latter's attempt to increase the rate of its profit through innovation. In the beginning, it was not even evident that the change from analog to digital computing would be profitable to computer makers and communications leaders. In effect, Bell Laboratories and the University of Michigan proposed systems that went against the Lincoln Laboratory's concept of the digital real-time computer.

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152 Univac was, in the early sixties, "the computer division of Sperry Rand, the first company to enter the computer industry. In the forties, the two computer pioneers of the University of Pennsylvania, J. P. Eckert and J. W. Mauchley, founded the Eckert-Mauchley Co. In 1949, this small firm was acquired by Remington Rand [...] During the three years following the introduction of the UNIVAC I computer in 1951, Remington Rand enjoyed a virtual monopoly, which was soon to be put in question by IBM". In OECD (Directorate for Scientific Affairs), Gaps in Technology Between Member Countries, Revised Draft Report on the Electronic Computer, Paris, August 12, 1968, p. 71.

153 G.E. = General Electric.

154 C.D.C. = Control Data Corporation

155 N.C.R = National Cash Register

156 In United States the pioneering companies in the ealy fifties such as Remington Rand (UNIVAC), Burroughs, RCA, NCR, were like IBM specialized in office machinery. RCA, was specialized in communications and consumer electronics, Honeywell was in scientific instruments and Philco was in consumer electronics and electronics components. Ibid., p.70.

Once these criteria are put aside, IBM's own strategy emerges as an important factor in the Lincoln Whirlwind II group's choice. IBM's willingness to accomodate the new established military-based discourse was a useful strategy for a 'late comer' that had no particular advantage in computers. Thus, the economic aspect of computer development became finally part of the universe of political discourse in ICT where IBM emerged as the dominant firm. The technological choice having been made, the Whirlwind II group was organized along the lines of the major computer subsystems to be developed: "an arithmetic-element section, drum-design section, and so forth... the IBM team organized itself in a similar pattern."[157]

Moreover, IBM management knew that the Lincoln Laboratory was the leading party in the inception of the program and that, consequently, any initiative or concept that contradicted the Lincoln Laboratory's understanding of air defense would have decreased IBM's chances of participating in the development of the air-defense system. In return, the mimicry of the Lincoln Laboratory's research organization by IBM enhanced the chance of getting the first contract. Moreover, Lincoln Laboratory was the only channel through which the Air Force communicated its air defense engineering specifications. It had also conceived of the air defense design and was the only body that evaluated contracts. IBM's early understanding of this reality led the company to put aside its own computer techniques and to learn about techniques developed in the Lincoln Lab.[158]

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157 M. M. Astrahan and J.F. Jacobs, "History of the Design of the SAGE computer - the AN/FSQ7", Journal of the History of Computing, Vol.5, No.4, 1983, p.344.
158 H. S. Tropp (Moderator), H. D. Benington, R. Bright, R. P. Crago, R. R. Everett, J. W. Forrester, J. V. Harrington, J. F. Jacobs, A. L. Shiely, N. H. Taylor and C. R. Wieser, "Perspective of SAGE: Discussion", Annals of the History of Computing, Vol. 5, N° 4, October 1983.

Besides this initial compromise, IBM did not passively await the Lincoln Whirlwind II group's final decision. The company made an effort to anticipate and meet the Committee's as yet unknown selection criteria. According to Forrester, the director of the Lincoln Laboratory:

> The IBM management committee really threw their resources into the program without restraint As an example, when it came time to schedule production, there was no air force contract yet for the machines. If IBM was to meet the schedule, there had to be a factory. IBM went ahead and started building a factory before the air force had signed a contract. No doubt IBM could built typewriters in the building if the contract did not come along, but, nevertheless, they built a factory specially for the SAGE computers on their own initiative.[159]

Thus, when the Lincoln laboratory set up a team[160] to find the most capable computer manufacturer to improve the Cape Cod System for the next generation of air-defense, three companies were considered: two divisions of the Remington Rand group and IBM. The team assessed the contributions of each company in several computer components: tubes, storage systems, circuits, hardware packaging, and magnetic type units. It also evaluated the production organization of each company, the quality of assembly work and the training capability. Last but not the least, was each company's proximity to MIT. In the end, IBM was selected.[161]

On September 1952, IBM won a six-month study subcontract issued by the Lincoln Laboratory.[162] Following this, in January 1953, a first meeting between Lincoln Laboratory and IBM members took place at Hartford. Jay Forrester, the

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159 Idem. p.386.

160 The team was constituted by the MIT Lincoln Laboratory. Its members were:Jay W. Forrester, head of Lincoln Division 6 and director of Digital Computer Laboratory (DCL), Robert R. Everett, associate director of Division 6 and director of DCL; C. Robert Wieser, leader of the Cape Cod System Design; and Norman H. Taylor chief engineer of the division. See M. M. Astrahan and J. F. Jacobs, "History of the Design of SAGE Computer - The AN/FSQ-7", Annals of the History of Computing, Vol.5, N 4, October 1983, p.343.

161 Ibid., p. 344.

162 Idem. p. 344.

Lincoln speaker during that meeting "...stated that none of the existing computers, including Whirlwind I, the IBM 701 were suitable. Because of the nature of the problem, specialized peripheral [equipment] were required..."[163]

> J. F Jacobs of Lincoln presented the arguments for choosing vacuum tubes for the arithmetic and control unit. It was too early for transistors and magnetic core were too slow H. D Ross of IBM reported some tentative arithmetic element decisions,... and the use of flip-flop instead of pulse regenerator used in the IBM 701.[164]

The IBM 701 regenerator, like all analog devices, was an amplifier "which receives weak signals and delivers corresponding stronger signals without reshaping waveforms."[165] On the other hand, a flip-flop is a circuit used to construct one-bit storage "delay line memories". This term refers to the computer components showing the property of storing a signal for a time interval before they transfer the signal to its out-put line[166]. These delay line memories allowed "information obtained from radar antenna sweeps to be stored so as to display a readily intelligible picture of the scanned data on a cathode ray screen."[167] This was because data were converted into "bit" (*Binary digIT*), a digit in binary notation that represented information in a sequence of 0s and 1s. It is still the smallest unit of storage. Thus, digitization, also called bit processing "became the common denominator of telecommunication and computer technology..."[168] and the standard for automatic data processing.

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163 Idem, p.332

164 Idem, p.335.

165 Cambridge Dictionary of Science and Technology, op. cit., p.757

166 Delay line memory components were made of a column of mercury, a quartz plate, or length of nickel wire, in which impressed sonic signals travelled at a finite speed. See Cambridge Dictionary of Science and Technology, op. cit., p.235.

167 R. J. Chapuis and A. E. Joel, Electronics, Computers and Telephone Switching, A Book of Technological History as Volume 2: 1960-1985 of "100 Years of Telephone Switching, op. cit. pp 91-92.

168 Ibid, p.114. Flip-flop techniques were at the core of digitization. According to Chapuis and Joel : «it was thus possible in a stream of pulses to store a datum which for its further retrieval was shuttled back and forth between the delay input and output; (in layman's term this process my may be

On the basis of this digital technique, IBM proposed several logical designs for the computer including "dual arithmetic elements for simultaneous processing of X and Y coordinates of tracking data, and an interrupt scheme for operating in-put out-put equipment simultaneously with programming execution."[169] Following this, in 1953, a permanent office, Project Grind was formed by members from Lincoln Laboratory and IBM so as to confront different views until appropriate solutions to each technical problem was found. Both teams broached many technical problems including the management of radar inputs, video-mapper, and slowed-down video input. On this basis, in April 1953, IBM received the prime contract to design the SAGE computer.[170]

Once IBM became the prime contractor, its relationship to the Lincoln Laboratory became conflictual. The bone of contention was the eventual computer trade mark. Although the basis for the common design was the Lincoln Laboratory Whirlwind I computer, a dispute emerged between IBM and MIT over the identification of the computer prototype for the new air-defense system. Lincoln Laboratory wanted the prototype to bear its name, but IBM resisted. In the end, both IBM and MIT declined to give their names to the machine. What was supposed to be the Whirlwind II

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likened to the way long distance swimmers perform their laps in an Olympic pool» [R. J. Chapuis and A. E. Joel, op. cit., p.92.]

[169] M. M. Astrahan and J. F. Jacobs, op. cit., p. 345

[170] Idem, p.344. Since designing the computer was only one task among many that the system required, it was possible for Lincoln Laboratory to exclude the University of Michigan (who did not accept its initial concept) but not the electronics companies whose experience was necessary to build the entire system. According to Robert Bright (one of the SAGE architects):

> At that time Bell Laboratories and Western Electric were involved in a study of continental air defense, called naturally the CADS project. In May 1955 General N. F. Twinings wrote to N. J. Kelly president of Bell Laboratories, saying 'Take a look at what Lincoln's doing, we were already phasing out the University of Michigan, and we want you to make the management and the implementation of SAGE. [Idem, p. 381.]

as the successor for the Cap Cod Whirlwind I (from Lincoln Laboratory's perspective), was given an Air Force number: AN/FSQ.[171]

As can be seen, at this stage of the process, it was easier for IBM to challenge the Lincoln Laboratory's authority rather than that of the Air Force. Likewise, since the technical solution were now in place, and the Air Force needed a manufacturer and not a researcher, it was also easier for the Air Force to deal with a profit-making enterprise such as IBM rather than with scientists who had previously challenged the very relevance of the air-power strategic doctrine and had joined the Air Force electronic program simply because they had lost their struggle for the tactical use of air-power on political grounds. Based on this mutual interest between the Air Force and IBM, the latter received a contract to build two computer prototype systems, XD-1 and XD-2. XD-1 was to replace the Whirlwind I in Cape Cod system and XD-2 was produced to provide the test for SAGE at Poughkeepsie[172]. Following this, the first production contract was awarded to IBM in February 1954[173] and the system declared operational July 1, 1958. In the years, following 1958, IBM built 24 FSQ-7s and 3 FSQ-8s that were deployed along the northern perimeter, in the east and west coasts of the United States[174].

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[171] Idem. p. 381.

[172] Idem. p. 346-347.

[173] In 1955 when the United States announced the launching of a satellite as part of its International Geophysical Year (IGY) contribution, a University of Michigan cosmic-ray physicist approached the Air Force and suggested that the latter might be interested in placing a satellite in orbit for strategic purpose. This proposal was rejected by the Air Research and Development Command which was reluctant to take on another project while its ballistic missile program was in its critical stage. In the end, the Office of Naval Research (ONR) took over the satellite program (Project Vanguard) and showed the White House the military advantage of having an artificial satellite orbiting on earth. However, considering the slowness with which the military reacted to the issue, it became obvious to many that the Russians would launch their satellite before the Navy

[174] Idem. p. 347.

The total SAGE system comprised 23 centers, 3 combat centers and 1 programming center. Each center was duplicated. There were, in total, 54 Central Processor Units (CPUs). As described by its designers, SAGE,

> The Semi-Automatic Ground Environment ... is a large scale, electronic air-surveillance and weapon control system and is composed of three groups of facilities: those required to process and to transmit surveillance data and weapon's data from data-gathering sources to data processing centers; data processing centers where data are evaluated and developed into an air situation and where weapons-guidance order are generated; and communication facilities to transmit data to weapons to command levels, to adjacent centers...SAGE uses very large digital computing system to process nation-wide air defense data. Sage is a real time control system, a real time communication system, and real-time management information system.[175]

[175] R. R. Everett, C. A. Zraket, and H. D. Benington, "SAGE --- A Data-processing System for Air Defense", op. cit., p.331.

TABLE. 1

SAGE COMPUTERS
Whirlwind: Developed as a high speed, parallel, synchronous digital computer for a variety of application
Whirlwind II: Developed for use in the air-defense system. Initial name of the SAGE computer prototype.
AN/FSQ-7: (1954) (also FSQ-7, Q-7) Air Force nomenclature for the production version of Whirlwind II. This computer served as the active element at the sector level in the SAGE direction centers.
XD-1, XD-2: (1955) Single computer prototypes of the AN/FSQ-7. One was installed at IBM's Poughkeepsie location, the other at Lincoln laboratory.
TX-0: (1956) Experimental, transistorized next-generation computer system used to develop new techniques to replace AN/FSQ-7 vacuum tube technology.
AN/FSQ-32 (1957): Proposed transistorized replacement for the AN/FSQ-7. A single model was built and installed at Strategic Air Command Headquarters
AN/FST-1 (1958):Radar data processing and transmitting equipment employing so-called slowed down video technique. Designed by Lincoln Division 2 and Lewyt Corporation for the gap-filler radars
AN/FST-2 (1963): Radar data-processing and transmitting equipment which converted analog radar signal to a digital format. Also reduced clutter and performed beam splitting. Designed by Lincoln Division 2 and built by Burroughs Corporation for the SAGE system

Sources: J. F. Jacobs, "SAGE Overview", Annals of the History of Computing, op. cit.

To summarize the FSQ-7 was the device that materialized the Air Force representation of air defense and centralization of command. It was composed of 70 frames containing 60,000 vacuum tubes that handled (input and output) data. The central computer was supplied with information from all sector computer and buffered by the magnetic drums of input/output equipment. Finally, a real-time clock (an electronic unit which kept track of the date and the time of the day in a special register that can accessed by the programmer) was incorporated in the FSQ-7 and four magnetic tapes were connected to it to simulate input and to summarize output in digital forms.[176]

[176] Ibid.

2.6 INTEGRATION OF WEAPONS, THE OUTER SPACE ERA AND THE FORMATION OF THE *PROJECT FORECAST*

In 1957, the Air Force set up a military team, the Air Defense System Integration Division (ADSID) that dealt with problems regarding integration of weapons and the modification of the SAGE system. Accordingly, the vacuum tube AN/FSQ-7 computer was replaced by the AN/FSQ-32 transistorized machine. That same year the Soviets launched Sputnik. As a response, the White House decided to automate radar sites and direction centers. Automation was provided by the Back-Up Interceptor Control (BUIC) system. For the Air Force and the Pentagon, while this improvement was in conformity with the discourse on the integration of weapon systems, it was still inadequate to the challenge posed by Sputnik for two reasons. On the one hand, the launching of Sputnik demonstrated the greater Soviet mastery of rocket science and a huge step forward in space technology which rendered the newly built SAGE system obsolete. On the other, the launching of Sputnik was not all negative; it opened up "space' (in fact "outer space") which became the new horizon for the projection of the US air power and military diplomacy. Indeed, in 1957, the word "space" was integrated into the universe of political discourse in ICT. Consequently, real-time command, control, communication, intelligence, reconnaissance and surveillance would not only depend on the development of the computer but also on satellite technology. Henceforward, the Air Force's ideas concerning weapons integration would be linked to the development of satellites, space platforms, and space-flight vehicles programs.[177]

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[177] L. Brown, USAF Historical Division Study, An Air Force History of Space Activity 1949-1959, Washington DC, US Government Printing Office, 1962, pp. 10-12.

It was under these circumstances that the AFOSR launched the Far Side project, a program to fire a rocket towards the moon. After many trials the project proved unsuccessful. This led to the creation of the National Aeronautic and Space Administration (NASA) in 1957. With the formation of NASA, the Air Force was evicted from space research and consequently began questioning its entire management of scientific research. The Air Force high command considered that its ambition to evolve doctrinally along with the latest scientific discoveries had been shown to be seriously flawed by its incapacity to predict the eventual usefulness of outer space for military purposes. What was evident here, was the Air Force's will to link this domain to its own concerns. Indeed, when the Air Force insisted on the exploitation of outer space for military purposes, it met strong opposition from the US scientific community, including the Air Force Scientific Advisory Board (SAB). They considered the Air Force's space ambition too futuristic. SAB members defended an approach that stressed the pursuit of general survey of aeronautical and astronomical trends as opposed to the narrow and purely technical interest shown in the Air Force's space projection.[178]

On this occasion, civilian scientists from the Scientific Advisory Group (SAB), the National Academy of Science (NAS) and the Air Research and Development

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178 For the SAB's civilian members, "While there is no doubt that the era of space flight with its many military and civilian implications is at hand, it will be a long time before the foot soldier, the boat, the airplane vanish completely from the "surface" of the earth" [M. Gorn, The Universal Man, op. cit., p. 142.] For them, satellites and other space systems should only be considered from reconnaissance and communications point of view, and, they should not be *given more importance* than the regular air power problems: strategic warfare, air defense, tactical warfare and logistics. Against this new orthodoxy, the Air Force General Staff took an opposite position: all traditional air power problems should be envisaged in a space perspective. One SAB member said, «I think we will have a tough job to convince the Air Force that they are still interested in wings, turbojets and such things. They have apparently decided to become a Space Force» [Memo T. von Karman to members the 1958 study group, May 1958 National Academy of Science. Quoted by M. Gorn, op. cit., p. 78]

Command (ARDC) formed a coalition against the Air Force's quest for space leadership. They issued a report that

> ...recommended the Air Force strongly support pure research on the matter of space exploration. This would have two major benefits. It would provide the Air Force with new information applicable to space flight and, at the same time, ready the Air Force to assume what would appear to be its logical future mission of performing space logistics analogous to the Navy's logistics capability in bringing scientific data back from the Antarctic.[179]

The Air Force refused such a role, and, in 1958 formed another committee, the Stever Committee, that redefined the Air Force's role as responsible for the military uses of space. This committee suggested immediate action on several points :

> (1) Obtain a massive first generation IRBM and ICBM capability as soon as possible. (2) Establish a vigorous program to develop second generation IRBM's and ICBM's having certain and fast reaction to Russian attack. (3) Accelerate the development of reconnaissance satellites. (4) Establish a vigorous space program with the immediate goal of landing on the moon. (5) Obtain as soon as possible an ICBM early warning system. (6). Pursue an active research program on anti-ICBM problems. The critical elements are decoy discrimination and radar tracking. When these problems are solved, a strong anti-ICBM missile system should be started.[180]

This statement articulated the relevance of outer space to defense, and convinced SAB members. Consequently SAB was re-organized in nine panels to reflect these new areas of interest. The Aeromedical Research Panel became the Aeromedical/Biosciences Panels. The Aircraft Panel changed to Aerospace Vehicles, indicating the interest in all manned vehicles, astronomical as well as aeronautical. Explosives and Armaments turned into the Guidance and Control Panel.[181] It became clear that the problem was not so much the individual mastering of each of these fields but their convergence and

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179 The report was prepared by the SAB committee and forwarded by Dr. Doolittle (ARDC director) who sent it to the of Chief of Staff of the US Air Force, T.D. White. Dr. Doolittle "Report of the SAB Ad Hoc Committee on Advanced Weapons Technology and Environment", 9 October 1957. Cited by L. Brown, USAF Historical Division Study, An Air Force History of Space Activity 1949-1959, op. cit., p. 24.

180 Dr. J. D. Doolittle "Space Technology" memo to General T. D. White, Chief of Staff US Air Force, 9 Decembre 1957.

181 Fuel and Propulsion became the Propulsion Panel, the Communications and Electronics Panel was transformed into the Electronics Panel which reflected both preoccupations.

development in tandem to harness outer space for military use. Accordingly, research management within the Air Research and Development Command was restructured in an interdisciplinary fashion. In 1958, the Aerospace Vehicles, Guidance and Control, and Nuclear and Propulsion Panels were combined to form the Air and Space Weapon Systems Division. The Electronics Panel was transformed into the Communication and Information Handling Division. Besides these panels, in 1958, a special Space Technology Panel was formed from the representative of the USAF, Advanced Research Projects Agency, and the newly created (1957) National Aeronautic and Space Administration.

Two years later, in 1960, it became clear that all major ICBMs in operation or under development were about as effective as science could make them and their further improvement depended only on the work of operations officers and site engineers. This was not the case, however, of military space programs such as satellite reconnaissance, warning, interception and manned vehicles. To better integrate weapon systems in the new space era, a closer relationship and a more extensive exchange of ideas between the Space Technology Panel and the Electronic Panels was required. Furthermore, the General Staff USAF was also convinced that it was necessary that the entire acquisition phases of weapon systems (development, procurement and production) be made the responsibility of a single command. It was for this purpose that, in January 1961, the Air Force Systems Command (AFSC) was created. The SAB and AFSC leaderships agreed to reduce SAB membership and created several System Divisions (SDs). As a result in 1961, the Air Research and Development Command and the Air Material

Command were terminated and replaced respectively by the Air Force System Command (AFSC) and the Air Force Logistics Command (AFLC).[182]

Now, as the emphasis was on operational problems, the AFSC had the mission to forecast the USAF's requirements in five to ten years and assess the deficiencies of national defense policy, military strategy, and inter-service relationships. Furthermore, it had the task of making suggestions on the improvement of US defense from emerging scientific discoveries and undertaking an Air Force-wide program review, named *Project Forecast.* As described by Gorn, "*Project Forecast* treated Technology; Threat; Policy and Military Considerations; Capabilities; Costing; and Analysis, Evaluation and Synthesis."[183]

While technology panels were concerned with almost all imaginable scientific breakthroughs, members of the Threat Panel were assigned to assess the potential and existing weapon systems of hostile countries. Unlike previous practices, the Policy Committee in the early 1960s selected research programs on the basis of US foreign policy imperatives, whereas the Capability committee translated all research programs (which passed through the Threat and Policy panels) into weapon systems. Finally, the Analysis, Evaluation, and Synthesis committees did the cost-effectiveness analysis based on data supplied by the Cost Committee[184].

Each System Division had the mission to make its program compatible with the Air Force's space programs: unmanned satellites; space weapons, and manned satellites. These satellites were to increase the accuracy of the already existing functions of the SAGE system: electronic reconnaissance and surveillance; communications;

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[182] M. Gorn, The Universal Man, op. cit., p.96.
[183] Ibid. p.99.
[184] Idem. p.102.

control; navigation and positioning. The Electronic Reconnaissance and Surveillance satellites were used primarily to pinpoint enemy air and missile defense radars and to determine their range and signal characteristics. The information they provided was used in planning strategic bomber penetration of enemy defenses and erection of electronic countermeasures (ECMs) such as jamming devices and electronic counter-counter measures (ECCMs) carried by aircraft[185].

As can be seen, in this picture, computers were the main tool for the centralization of commands structures. In 1962, they operationalized the World Wide Military Command and Control System (WWMCCS) which concentrated both nuclear and conventional forces in the hands of Strategic Air Command (SAC). With the emergence of satellite communications technology, SAC reached its maximum offensive potential. The importance of satellite communication lay in its greater real-time communication capabilities in comparison with ground installations. Satellites made it possible to operate an effective centralized control over vast territories and forces. This was indeed a greater centralization than the SAGE network of ground relay communication systems had provided[186].

In 1965, the USAF established its Manned Orbiting Stations (MOS) program with the objective of placing a small orbiting station in space for military reconnaissance, surveillance and observation[187]. From then, until the SDI was announced (1982) no major policy on space defense was developed. In lieu of such a policy, it was the air power based nuclear deterrence policy that through a constant

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[185] North Atlantic Assembly, Scientific and Technical Committee, Information Document on The Technology of Military Space Systems, London, International Secreatariat, 1982, p.11.
[186] Ibid., p.9.
[187] Idem, p.22

upgrading of space system capabilities became the *de facto* space doctrine.[188] In 1966, the United States Strategic Defense Satellite Communications Systems (DSCS) was created to handle Worldwide Command and Control (WCC) of United States military forces. Subsequently, to meet the defense communications requirements of the Alliance, NATO began the development of a satellite communications system (SATCOM) in 1967. The SAGE and the NAGDE computer terminals were thus connected to these satellites to form an integrated communication network that provided intelligence and information communication services to all NATO member countries, as well as Command and Control for all NATO land, sea and air forces.[189] This greater centralization of commands created a problem of flexibility, manpower and compatibility between systems. As Manuel De Landa observed:

> ...the greater the increase in the information flow needed to run the operation... the more uncertain the final results. Far from solving this problem, the computers ended compounding it by producing their endless streams of information. What was needed was a means to interface humans and computers so that they would amplify each other's strength: instead of taking people out of the loop, computers had to be combined with people into synergistic whole.[190]

The problem of interaction between humans and machines was the first problem faced by the centralization of commands. This problem would become common to all NATO members and would be addressed in transatlantic terms when all the elements of the US universe of political discourse in ICT will be diffused through NATO interoperability requirements, transatlantic industrial alliances and OECD science policy in ICT.

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188 Idem, p.23
189 Idem p.11
190 D. De Landa, op. cit., p. 80. See also E. Feigenbaum and P. McCorduck, The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World, New York, Signet, 1984, p.274.

2.7 CONCLUSION

Through my analysis of the relationships between the Air Force's representation of military strategy and actions undertaken to build the ground and space communication environment, I have been able to show how the Air Force became hegemonic and what its discourse was. This analysis demonstrated that ideas, political struggle, science and technology have all evolved in tandem since the mid-1940s in the formation and transformation of this discursive regime. From the mid-1940s until the early 1960s, this new discursive regime drew its legitimacy not from the age-old Clausewitzian military discourse, but, essentially from an air power-based military diplomacy that became the mode of association between the military, science, technology and industry in the field of Information and Computer technology. The interdependence between foreign policy, air power, military policy and science policy was symbolized by the institutionalization of the practice of forecasting.

The institutionalization of this practice of forecasting became the structure that integrated American air defense and science policy. Within this framework, American science policy became primarily concerned with changing air defense problems while the latter became scientifically and technically oriented. In this interdependent relationship between science and the military, subsequent redefinitions of air defense problems were not based on traditional military rules but in line with the advancement of sciences whose orientation and internal dynamics were themselves heavily influenced by foreign policy and military affairs . It was within this complex and dense set of relations that the SAGE system was constructed. The SAGE was the event that symbolized the so-called post-war electronics revolution and represented new priorities on military command communication and control arising from specific mission objectives of delivering and intercepting means of destruction. It was a system that fulfilled those objectives in the most optimum way.

The emphasis I have placed on the US Air Force's needs for digital computation is not based on the assumption that before the advent of the Strategic Air Command, the idea of digital computing did not exist. Rather, the aim was to show that this idea became a technological and industrial reality only within the discursive regime created by the Air Force. Only then did the digital computer became the core device for Strategic Air Command and dramatically oriented computer industry towards telecommunications in United States and Europe.

Chapter Three

THE NATO & O.E.C.D. DISCOURSE ON SCIENCE POLICY IN THE 1950S AND 1960S

3.0 INTRODUCTION

This chapter demonstrates how the elements of the US discursive regime in ICT were transmitted from the United States to Western Europe and affected the choices that were made in Europe with respect to computers and their development. I argue that the hegemony of this regime in Europe was not only determined by US technological superiority and military force. Beyond this, there was also the power of ideas such as interoperability and standardization developed by the Pentagon and adopted by NATO. These became the framework for transatlantic industrial alliances during the late 1950s and early 1960s. US military force and technological superiority shaped the transatlantic discursive regime in ICT once the European members of the regime formulated their military, scientific and technological priorities in accordance with the priorities defined with the US universe of political discourse.

The influence of the US universe of political discourse in ICT on the transatlantic zone was diffused through notions such as rationalization, standardization, and interoperability which reflected all three dimensions of power emphasized separately by neo-realists, liberal regime theorists and neo-Gramscians. First, was the dimension of force represented by US technological and military force and emphasized by neo-realists. This force became the basis for the development of rules and procedures represented by the notions of rationalization, standardization and interoperability. The emergence of these rules and procedures is what the liberal regime theory depicts as a regime. However, such rules and procedures did not stand by themselves they were supported by transnational social forces within the military, scientific, technological and industrial spheres bounded by the hegemonic priority of achieving real time and time-sharing devices for military command, control, communication and intelligence. These forces, their common interests and representations is the aspect of power emphasized by the neo-Gramscian concept of hegemony.

Among the three perspectives, the neo-Gramscian perspective is the most comprehensive because it takes into account the relationship of force, economic interests and the role of ideas in the hegemonic formation. However, like the liberal perspective on regimes, it has the tendency to see more congruence of view and overlooks contests and contradictions within the hegemonic formation. I developed the concept of hegemonic discursive regime in order to show that contradictions and contests are key factors in the formation and transformation of regimes. For example, in ICT towards the end of the 1950s, the Pentagon-NATO doctrine of standardization which was the result of the immediate post-war US economic and technological strength was contested by Europeans as the latter rebuilt their industries . This contest undermined the practice of standardization and the policy of transatlantic rationalization of military procurement and limited the transatlantic discursive regime to the notion of interoperability. The latter meant: "The ability of systems, units or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together."[191] Interoperability was thus a modified version of standardization but in return itself became controversial because it meant from the American point of view the «commonalty of equipment types and often implied that it was US equipment which should be common»[192] while for the Europeans and specially the French, the term meant the ability of systems of different national origins to operate together. Towards the end of the 1960s this divergence of views resulted into the notion of specialization and rationalization. These terms structured the debate on computer policy both within NATO and the OECD.

This chapter shows that controversies and disputes do not imply the absence of hegemony. They imply instead that US operational concepts such as Command, Control, Communication and Intelligence became hegemonic and structured the debate within the Western Alliance. Here, NATO and the OECD played respectively technical and normative roles. These organizations not only reflected the power of the United States as neo-realists argue, and the power of implicit and explicit norms as liberal regime theorists would maintain but also the dominant view of the most dynamic elements of transnational capital and certain sections of the governments as neo-Gramscians believe. This chapter suggests that NATO and the OECD harboured congruent views as well as contradictions between social forces at the national and international levels. In keeping with the concept of discursive regimes, I will highlight not only the willingness to cooperate , but, also contradictions implying political and

191 See T. Taylor, Defense, Technology and International Integration, London, Frances Pinter, 1982, p.9. Also Dictionary of United States Military Terms for Joint Usage, Joint Chief of Staff, JCS Pub.1, Washington, D.C. 1 Dec., 1964, p.133.

192 T. Taylor, op. cit., p. 8.

technical disputes that are at the heart of the formation and transformation of the transatlantic discursive regime.

3.1 NATO AND THE EMERGENCE OF THE NOTION OF INTEROPERABILITY

The first attempt by NATO to transmit in Europe the elements of the US universe of political discourse in ICT was the creation in November 1949 of a transatlantic Military Production and Supply Board (MPSB). MPSB's role was "the promotion of more effective methods of procuring military equipment and the standardization of parts and end products of military equipment."[193] In 1951 the Atlantic Council established a Standardization Policy and Coordination Policy Committee and a Military Standardization Agency. There was no doubt that in the beginning one cannot speak of interdependence but rather of dependence implied by the notion of standardization. This term as defined by the Pentagon and adopted by NATO, meant:

> The process by which member nations achieve the closest practicable cooperation among forces; the most efficient use of research, development and production resources; and agree to adopt on the broadest possible basis the use of (a) common or compatible operational, administrative, and logistic procedures; (b) common or compatible technical procedures and criteria; (c) common, compatible, or interchangeable supplies, components, weapons or equipment; and (d) common or compatible tactical doctrine with corresponding organizational compatibility.[194]

This definition supposed not only a transatlantic agreement on engineering standards of military equipment and components compatibility but also a congruence of views on basic tactical concepts and strategic procedures such as those involving the

[193] NATO Standardization: Political, Economic and Military Issues for Congress. Report for the House International Relations Committee by the Congressional Research Service, 29 March 1977, Washington DC, US GPO, p. 50.
[194] Rationalization / Standardization within NATO. Fourth Report to the Congress by the Secretary of Defense, Jan. 1978 cited by T. Taylor, op. cit., p. 8.

implementation of "massive retaliation" and the Command, Control and Communication processes described in Chapter Two. Between 1949 and 1957 this transatlantic process of standardization was facilitated by the "...*de facto* commonality of weapons which stemmed from dependence on American aid"[195] under the 1949 NATO provision of the Mutual Defense Assistance Program. These eight years of transatlantic standardization reflected the US economic, military and technological force and European dependency. There was no debate among the allies because the process was a "one-way" flow of military goods from the US to Western Europe. Second, there was no resistance on the issue of standardization because Western Europe needed to rebuild its military forces and was indeed assisted by the US as the latter established in Europe many "...production centers...and the allies received the output of these centers as aid."[196]

It was within this context of European dependency that US Air Force concepts began to materialize in Europe and NATO emerged as the institutional mechanism through which the US Air Force transmitted its science policy to Europe[197]. Indeed, in

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195 T. Taylor, op. cit., p.18.

196 Idem, p.20.

197 It is well known that NATO is an alliance and organization devoted to defense tasks. However, less well known is the fact that the defense organization is also engaged in scientific activities for non-military purposes and indeed it is rarely asked why NATO is involved, for example, in science policy. Those who have studied NATO's science policy commitments simply cite Article 2 of the Treaty as sufficient reason for NATO involvement. The latter stipulates:

> The Parties will contribute toward the further development of peaceful and friendly international relations by strengthening their free institutions, by bringing about a better understanding of the principles upon which these institutions are founded, and by promoting conditions of stability and well-being. They will seek to eliminate conflict in their international economic policies and will encourage economic collaboration between any or all of them.

Nothing in this article says that NATO should be involved in scientific activities. However given what has been said so far, the necessity of NATO implication seems fairly straightforward. Since the US military structure was dominated by the USAF and since the US military dominated NATO, this organization's technical problems were indistinguishable from USAF's problems. Given these parameters, it should come as no surprise that the USAF was the first institution to start building a

1950, just one year after the creation of NATO, Theodore von Kàrmàn, the architect of the USAF science policy, undertook the reform of European science policy. He suggested in particular the creation of a scientific advisory group for NATO. With the approval of General Vandenberg, von Kàrmàn traveled to Europe in the summer of 1950 to study the state of aeronautics in a number of Western European countries. Upon his return to the Pentagon, he solicited the Chief of Staff's support for a permanent, international committee of scientists to harness European and North American science for common defense. The following February, twelve nations were invited to send representatives to Washington, D.C. to discuss the idea. Eight countries sent scientists who quickly drafted a proposal for the NATO Advisory Group or Aeronautical Research and Development (AGARD). They recommended that AGARD act as a clearinghouse for European technical information relating to aeronautics and as an advisory group to NATO governments on how European science could be employed in the interest of the Atlantic Alliance.[198]

In this context, the AFOSR recommended the creation of an European office under the command of the Air Research and Development Command to which the AFOSR was responsible. Following this recommendation, in 1952, the European office was established in Brussels, Belgium.[199] The European Office worked under the supervision of the AFOSR. It was mainly a procurement and monitoring office that had neither a research program nor research funds of its own. Its task was to evaluate European research proposals and send them to the AFOSR (in the US) who reviewed

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coherent transatlantic science policy. A. King op. cit and J. Touscoz, La coopération scientifique internationale, Paris, Éditions Techniques et Économiques 1973.

[198] T. von Kàrmàn Wind and Beyond, op. cit, pp. 325-329.

[199] ARDC Historical Division, History of the Air Force Research and Development Command, Arlington, US Government Printing Office, 1956, Vol. I, p.210.

them to see if they fitted the Air Research and Development Command's research programs[200]. Following the creation of the European office, the Electronics and Communications panel of the Air Research and Development Command established an electronic technical laboratory under NATO. This laboratory was staffed by European scientists whose task was to develop an integrated control and warning system. It was felt that the lack of such a system (and poor communication generally) within NATO minimized the US Air Force's contribution to European defense.[201]

In 1957 after the launching of Sputnik, the North Atlantic Council created the NATO Scientific Committee chaired by the NATO General Secretary Scientific Advisor[202]. From its inception, the NATO Scientific Committee worked under the authority of the Organization's General Secretary who chaired and assumed the responsibility of implementing NATO's decisions. The General Secretary also chaired NATO's International Secretary composed of an Executive Secretary and four Divisions each chaired by a vice-Secretary General: Political Affairs; Economic and Financial Affairs; Production, Logistics and Infrastructures and Scientific Affair.[203]

NATO vice-General Secretary had many functions. He advised the NATO Council on scientific problems related to the organization, chaired and administered the Scientific Committee's work and meetings, and assumed the function of a liaison between NATO's military and civilian authorities. Furthermore, he was also in permanent contact with member countries' administrations in charge of elaboration of

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200 ARDC General Order N°48, August 1952. Quoted by N. A. Komons, op. cit., p. 33

201 Ibid., p.73.

202 This measure was taken after the recommendations formulated by several working groups the *Committe of three Ministers* - G. Martino (Italy), H. Lange (Norway), L.B. Pearson (Canada), the *Working Group* chaired by Dr. Koepfli (United States) and the *Committee of NATO Members of Parliament* (1957) OCDE, La coopération scientifique internationale, op. cit., p 76

203 Ibid., p.74.

policies for other international scientific bodies whose work interested NATO.[204] Such organizations included the OECD Scientific Committee and the European Council, the European Nuclear Energy Agency (ENEA) and the European Military Co-ordination Communication Committee (EMCCC) which was composed of two subcommittees: the European Long Lines Agency (ELLA) and the European Radio Frequency Agency (ERFA).[205]

A distinction should be made between NATO's Scientific Affairs and NATO's Scientific Committee. While the vice-Secretary General for Scientific Affairs had both internal as well as external roles in NATO, the Scientific Committee had only an internal role. It brought scientific and technical matters regarding the Alliance before the NATO Council. Its recommendations always concerned national scientific and technical programs and direct actions to be engaged by NATO in support of these national programs. It also recommended to the NATO Council support for other international organizations whose activities interested the members of the Alliance or favored the development of their scientific potential. Decisions regarding NATO Scientific Committee's recommendations were always taken in unanimity by the Council members.[206]

NATO's research was clearly divided into civilian and military programs. In the civilian chapter, NATO sponsored scientific fellowships in all scientific disciplines and summer study programs in selected areas, notably in mathematics, astronomy, chemistry, physics and other applied sciences. It also gave subsidies to civilian

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204 Idem

205 Premier Ministre - Comité de Coordination des Télécommunication, Documentation méthodique Fascicule 1, 3° Édition, Mars 1963, p.15.

206 OTAN Documentation sur l'Organization du Traité de l'Atlantic Nord, Service de l'information Paris, 1962; Rapport sur le développement de la science occidentale, Fondation Universitaire Bruxelles, 1960.

research in oceanography, operational research, meteorology and radiometeorology and electronics.[207] Most of NATO's military research was sponsored by AGARD which depended on the NATO Permanent Group and various Technical Groups composed of experts from member-countries forming several committees: Aeronautical medicine; Space; combustion and propulsion; Aerodynamics; Fluids Dynamics and Structures and Materials.[208]

The NATO Military Committee and Permanent Group played a role (similar to Project Forecast's Military Group [See Appendix I]) in advising the NATO General Secretary. While the NATO Council of Committees was the counterpart of the Project Forecast's Ad Hoc Consultant Group, NATO Scientific Affairs had a similar role to the US Forecast's Technology and Capability Panels. Similarly, Project Forecast's Policy and Military Consideration, Cost, Analysis, Evaluation and Synthesis functions were undertaken respectively within NATO, by the Organization's Political Affairs, Financial and Economic Affairs, Production, Logistics and Infrastructure Committees.

NATO's various Committees applied the appropriate measures taken by the Council. From a science policy point view, these committees were intended to contribute to the homogenization of NATO-members' armament procurement policy. Their role was to promote the adoption of common armament standards and the rationalization of armament production. As defined by the Pentagon the term rationalization describes

> any action that increases the effectiveness of Allied forces through more efficient or effective use of defense resources committed to the Alliance. Rationalization includes consolidation, reassignment of national priorities to Alliance needs, standardization, specialization, mutual support, improved

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207 Ibid.
208 Idem

> inter-operability or greater co-operation. Rationalization applies to both weapons/material resources and non weapons military matters.[209]

Rationalization implied the subordination of national priorities to NATO objectives and the co-ordination of research and development.[210]

There is no doubt that this regime of standardization and rationalization was favored by the US economic and military power. However, from the liberal regime theory, these standardization and rationalization rules and procedures should have become autonomous from US power. This was not the case despite many changes in computer and telecommunications technology. Standardization ended soon after European industries recovered from war damage and consequently the problem of incompatibility between weapons systems of different national origins emerged. This was not a technical problem but a political issue that cannot be explained by the neo-realist notion of free-riding because the US was not in economic decline. The problem of incompatibility was a political problem of a different nature. It was a problem within the transatlantic discursive regime that brought to the fore the problem of vulnerability of Western European states vis-à-vis US technological and military superiority. In 1959, while the United States sought standardization as the optimal solution for more equitable "burden-sharing" and better defense the other allies felt that standardization was less urgent than the danger of US technological and economic dominance. It was within this context of conflicting interests that interoperability became for the European a term that did not include standardization whereas for the US Congress "the greatest degree of interoperability can be achieved through standardization. Standardization

209 Rationalization / Standardization within NATO, op. cit., p.129.

210 Report, 5th Meeting of the Members of European Parliament and the US Congress, 17-24 March 1974, US Government Printing Office, Washington DC, 1974, p.10.

itself concerns equipment and other matters - such as training and doctrine. Interoperability is an aspect of standardization not an alternative to it."[211]

Despite this disagreement, the European notion of interoperability prevailed. It became a half-way compromise that took into account the common defense procedures such as command, control and communication and the European countries' desire to protect their industries from the US large defense corporations.[212] In military communications sector, for instance, the word interoperability implied not only the commonalty of equipment but "the capacity of units using different equipment types to exchange comprehensible messages."[213] Inter-operability could thus be achieved through different end products but with common subsystems. It implied some technological dependency but not total dominance of the European defense market by American companies.

This compromise was not without ambiguity. It was still not clear how to achieve technical inter-operability leading to a compatibility of equipment without standardization of components. This ambiguity, far from implying the stagnation of the transatlantic discursive regime, shows that different interpretations and contradictory interests led to the transformation of transatlantic relations. This transformation was institutionalized in 1958 by the abolition of the NATO Production and Supply Board, the Standardization Policy and Coordination Committee and the Defense Production Committee and their replacement by the Conference of National Armament Directors within NATO. As this transformation reflected a shift from dependence to

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211 Idem, p. 10.

212 Robert Rhodes James, "Standardization and Common Production of Weapons in NATO", Defense Technology and the Western Alliance, No.3, London Institute for Strategic Studies, 1967.

213 Report, 5th Meeting of the Members of European Parliament and the US Congress, 17-24 March 1974, op. cit., p.10.

interdependence, from 1958 onwards, NATO was no longer a mere reflection of American power nor simply an organization that functioned according to autonomous rules and procedures. Moreover, it certainly did not represent a congruence of member-states' views in all domains. NATO became one among other institutional mechanisms of the transatlantic discursive regime and the latter a process where convergence of views and interests coexisted with divergence. This contradictory aspect of NATO was represented on the one hand by the wide acceptance on both sides of the Atlantic of doctrinal notions such massive retaliation, command, control and communication and on the other by the varying interpretations and positions represented by the vague notion of interoperability.

3. 2 INTEROPERABILITY AND THE BUILDING OF THE NADGE SYSTEM

Neither the change in computer and telecommunications achieved in the United States nor the Soviet launch of Sputnik were enough to reduce national differences. Although for the European members of NATO, building the NATO Air Defense Ground Environment (NADGE) system meant that they had to adapt their air defense to the SAGE system[214] and its development[215], they nevertheless had to maintain autonomous tactical command and industrial infrastructure.

214 After 1958, the political alliance that linked NATO member countries was technically reinforced by the extension of the SAGE system to Canada, through the NORAD Cheyenne Mountain Complex (CMC) for primary warning purposes. The CMC air-defense system organizational structure was composed of the Air Defense Operation Center (ADOC), Aerospace Defense Intelligence Center (ADIC) and NORAD Command Post (NCP). ADOC obtained attack warning, track and other information from seven Regional Operations Control Centers (ROCCs) located in Greenland, Iceland and in the United States. NPC provided attack warnings and assessments not only to the U.S. National Command Authorities (NCA), the National Military Command System (NMCS) and the U.S. Strategic Air Command (SAC), but also to the Canadian government and to all U.S. allies. See F. L. Gertcher and W. J. Weida, Beyond Deterrence: The Political Economy of Nuclear Weapons, Boulder, San Francisco and London, Westview Press, 1990, p. 109. Also see B. Blair, Strategic Command and

The NADGE system can be described as a network composed of all NATO member-countries' military communication systems. Each country has its own Air Defense Ground Environment (ADGE) system. The sum of the parts is still known as NATO Air Defense Ground Environment (NADGE). The system functioned in its early days through "...the use of modulated signals over limited bandwidth telephone lines (a technique dating back to the growth of telegraphy..."[216] under the control of different organizations both nationally and internationally. Nationally, data was exchanged between the strategic command under the authority of the national air forces and the tactical deployments belonging to different military services: air forces; navies and armies. Internationally, in the case of France, the exchange was between NATO Air-Defense Ground Environment and the French *Système de Traitement des Informations de Défense Aérienne* (STRIDA)[217], a French version of Air Defense Ground Environment.

As described by P. A. Kennedy, NATO command, control and communication structure is composed of several (developed differently) mobile and static systems.

Control: Redefining the Nuclear Threat, Washington DC, Brookings Institution 1985, «NORAD Profile», Defense Electronics Magazine, and the «Military Balance, 1985/86», Air Force Magazine, Air Force Association, February 1986.

215 France was linked to U.S. electronic command through NATO Air Defense Ground Environment (NADGE). The organism that manages all European military communication systems is the European Military Coordinations Committee (EMCCC). See Comité de Coordination des Télécommunications (CCT), Documention méthodique, Fascicule I: Organization, 3ième Édition mars 1963, p.15.

216 D. F. Bird, "International Standards in Military Communications", International Conference, Advances in Command, Control and Communication Systems: Theory and Application, Organized by: the Computing and Control Division of Institution of Electrical Engineers, in association with: the British Computer Society; Institute of Mathematic and its Applications; Institute of Measurement and Control; Institute of Physics and Institution of Electronic and Radio Engineers. Venue: Bournemouth International Conference Centre, 16-18 April 1985, p.106

217 A full description of the French system had been made by D. Coulmy (D.M.A/D.T.C.A - Service Technique des Télécommunications de l'air- France) "Organisation du STRIDA. Système de Traitement des Informations de Défense Aérienne", In North Atlantic Treaty Organization - Advisory Group for Aerospace Research and Development (AGARD), AGARD Conference Proceedings No. 149 on Real Time Computer Based Systems, Athens, Greece, 27-31 May 1974.

Each of these systems, had "...a degree of autonomy with regard to information handling, and varying in support from being entirely manual to possessing a high degree of automated assistance."[218] The political disagreement between the allies, the technological differences of their military communication systems and the immediate NATO operational requirements have forced NADGE to operate since the beginning, according to the capability of its lowest and common denominator.[219] In other words the NADGE system was adapted to the political divergence between the allies through the accommodation of US technological power to European technological vulnerability.

Nevertheless, all national systems were required to evolve towards Automatic Data Processing (ADP) in order to communicate data digitally. In consequence, the evolution towards this fixed objective transformed the political solution of inter-operability into a technical problem. The challenge for the emerging transatlantic discursive regime was how to reduce political divergence among its participants. In the early 1960s, interoperability within NATO circles was no longer a notion that highlighted the technological vulnerability of Western Europe vis-à-vis the US but became a problem of interconnecting computers of different national origins through the medium of data transmission. Through interoperability it became possible to introduce the US Air Force's notion of real-time and time-sharing into Europe. The European effort to achieve real time and time sharing system raised the issue of computers inter-working or in other words the ability of computers to exchange data digitally within the system and across its interconnections. The requirement of digital communication meant that the technical problems that the Lincoln Laboratory had dealt

[218] P. A. Kennedy "Command and Control in the International Arena", International Conference. Advances in Command, Control and Communication Systems: Theory and Application, op. cit., p. 164.
[219] Ibid

with during the building of the SAGE were transferred to the US military allies. Western European electronic firms too had to shift their priorities in computers from batch processing to time-sharing. As in the case of SAGE, digital time-sharing computers would allow Western European air-defense systems to operate a network of communications circuits where information in a form of pulse trains, speech and vision were converted into a suitable form through the process of "data fusion".[220] This was to enable Western European communication systems to gain many technical advantages such as fostering telecommunication systems that are immune to noise and exchanging electronic information through the technique of switching.[221]

Through the above NATO military communications requirements, Western European countries entered the era of digital communication and time-sharing computing. Immediately after the construction of the SAGE system, in 1959, the IBM World Trade Corporation began several laboratory and field experiments on switched and military communication lines for construction of new data transmission systems in

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220 According to G.B. Wilson:

> If there are 100 aircraft in the area concerned then, in the end, the Command and Control System should ideally have 100 comprehensive and accurate reports - one of each aircraft. Of course if we have twenty sensors we could conceively start off with twenty reports on each aircraft and the problem faced would be in reducing the 2000 possible reports to just the 100 which the system should finish up with. [...] **It is this process which is given the blanket description of "data fusion**... (I emphasize) (G. B. Wilson «Some Aspects of Data Fusion», International Conference, Advances in Command, Control and Communication Systems: Theory and Application, op. cit., p.99.)

221 In telecommunication engineering switching is "The provision of point-to-point connections between constantly changing sources of information and their intended recipients". A switching system is particularly important where an interconnection communication system such as the NATO NADGE is composed of different communication systems as described above. See P. M. B. Walker, CBE, FRSE, Cambridge Dictionary of Science and Technology, Cambridge University Press, third edition 1992, p. 249.

Western Europe.[222] The company conducted these experiments "...with the strong support of government communications laboratories and agencies [in] Switzerland, Holland, France, England, Germany, Sweden, and Norway..."[223] Here again we have a case of military leading and IBM following. This was, in part, how IBM transformed its US monopoly into a transatlantic monopoly. The need to achieve technical interoperability within the context of asymmetrical interdependence became the basis for many transatlantic industrial alliances.

3.3 IBM MONOPOLY AND TRANSATLANTIC INDUSTRIAL ALLIANCES IN THE COMPUTER SECTOR

This section shows that the transatlantic discursive regime in ICT was not simply maintained by US power or only by the rules and technical procedures of the policy of interoperability. Of crucial importance in this regime were also the American firms-dominated and militarily-encoded innovation process in the electronics industry. Overlooking the importance of these two factors in the global dynamic of the industry led many misleading analyses at the time. For example, according to an OECD Group of Experts' report:

> The history of the computer industry can be divided into three stages the period before 1950s can be described as the "pre-industrial stage", the second period from 1950 to 1960 is characterized by the pre-eminence of the first generation of computers (with vacuum tubes), the third period from around 1960...is that of solid state technology (i.e. transistors and later integrated circuits)...In the pre-industrial period, Germany, the United Kingdom and the United States appear to have been more or less at the same technological level, even if the United States has had a much wider influence on other countries. The second period - roughly the 1950s - is marked by the

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222 E. Hopner, "Phase Reversal Data Transmission System for Switched and Private Telephone Line Applications", IBM Journal of Research and Development, Vol. 5, N°2, April 1961, p. 93.
223 Ibid., p. 103.

> disappearance of Germany in the group of technological leaders. The third period only one country remains: the United States.[224]

This historiography itself is not problematic. What is debatable is the Group of Experts' analysis of the disparity between the major countries. According to the same report the computer industry does not "confirm the picture offered by several other advanced industries, whereby the technological leadership of certain European countries in the initial stages of an industry is lost as soon as the industry expands beyond a certain level of size and technological complexity."[225] The difference according to the report lies in

> ...the fact that computers form complex systems, rather than individual products. What the customer is interested in is the quality and performance of the system as a whole, not in that of any single component of the system...Furthermore the process of system innovation is continuous: a particular computer is regularly upgraded and the later computers of any type usually have higher performance than the earlier ones of the same type.[226]

The OECD report does not explain why the US was the only country in the "third stage" of the industry's history nor why the innovation process was continuous rather than discontinuous. One could argue like Raymond Aron that the computer industry shows that "American superiority in research and development was cumulative. It builds on itself and tends to increase because the mass of the resources which can be devoted to research is greater as the overall national and corporate resources are greater." Although this realist explanation is right from the descriptive point of view, it is still analytically partial since the principle cause of American technological superiority cannot be at the same time greater American R&D resources

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224 OECD - Directorate for Scientific Affairs, Gap in Technology between Member Countries. Revised Draft Report on the Electronic Computer Sector, DAS/SPR/68.22 Restricted, Paris 12th August, 1968, p.37.
225 Ibid
226 Idem, p.39.

capacity. As an alternative to this circular explanation, this thesis suggests that beneath US resource capacity lies the Air Force's practices that structured the computer industry according to the US air defense system whose upgrading required incremental technological changes. As I noted earlier, the air defense system was made flexible enough to allow continuous change. In effect, between the late 1950s and early 1960s changes in the computer technology evolved in tandem with changes in the US air defense system. This explains why the US was predominant in the computer industry and the latter's process of innovation was not discontinuous but rather continuous as it occurred within a computing paradigm formed by the military requirements of the transatlantic discursive regime.

As Table. 1 (Chapter Two) showed, IBM and other firms were the industrial agents of this discursive regime but they were not the major agents for structuring change in the computer industry. Although IBM dominated Air Force procurement of computers, other computer manufacturers were not excluded from total US defense procurement. However, as Table 2 shows that until the late 1960s, defense procurement was an important market for IBM.

TABLE 2: "Share of Department of Defense markets and share of the total computer market of the main manufacturers in the United States (number of installation)"

Name of the firm	D.O.D market in 1965	Total U.S. computer market	
		in 1962	in 1967
IBM	45.1%	65.8%	50%
UNIVAC	14.6%	8.7%	12.1%
NCR	14.2%	1.7%	10.8%
RCA	8.3%	1.6%	2.5%
CDC	5.5%	2.0%	4.7%
BURROUGHS	2.9%	2.2%	4.2%
GE	1.8%	1.1%	2.4%
HONEYWELL	1.2%	0.6%	4.6%
ALL OTHERS	6.4%	16.3%	8.7%
TOTAL	100%	100%	100%

Sources: R. Weber, O.E.C.D (original from the Inventory of Automatic Data Processing Installed in the Department of Defense). Statistical Index. Cited by O.E.C.D, op. cit., p.102.

Most of these computers were not installed by the Department of Defense (DOD) for communication purposes. DOD used computers as scientific instruments, tools for office management and in other weapon systems: bombers, fighter aircraft and artillery. Table 3 shows that other companies responded to the DOD's other computation needs.[227]

227 According to the U.S. National Bureau of Standards:

> In July 1964, the Government was using directly approximately 1,767 computers. In addition, approximately 2,000 computers are used by the Department of Defense as components of weapons systems and other classified purposes. Also approximately 2,000 computers are used by cost-reimbusement contractors for Government at Government expense. Thus the number of computers whose use is financed by the Federal Government is more than 30% of the estimated national total of 22,000 computers. The estimated total fiscal year 1965 annual operating cost for all computers by the Government is approximately $ 3 billion, or roughly 3% of the Federal Budget.

Table 3: Share of each company of the DOD market as percentage of the overall US Computer market: 1962.

Companies	Number of computers operated by DOD	Percentage purchased
IBM	628	34%
UNIVAC	204	62%
NCR	198	2%
RCA	116	60%
CDC	77	83%
BURROUGHS	41	46%
GE	25	24%
HONEYWELL	16	56%
OTHERS	89	80%
TOTAL	1,394	42% (Average)

Sources: R. Weber, op. cit.

Nevertheless, despite the lack of information regarding the types of computers and their ability to inter-work, IBM clearly dominated not only the military communications market but also overall defense procurement. Furthermore, the above table also indicates that the US government was able to afford many types of computers from different companies. The military use of computers gave a monopoly to IBM and influenced the worldwide demand for American digital computers for both military and civilian uses. In 1965, projected use of digital computers in telecommunication included:

> ...controlling switched systems either in the capacity of automatically storing and forwarding messages or operating automatic telephone exchanges. In addition, there [were] many other functions in a communication system which can be improved or made feasible by the use of [digital] computers. Automatic alternate routing in telephone systems, automatic maintenance, transmission quality monitoring and control are but a few.[228]

House of Representative Representative Current Activities of NBS Related to Computer Science, Hearing before the Sub-Committee of the Committee on Governement Operation, 89th Congress, 1st Session, March 31, 1965.

[228] M. C. Andrew, "On Communications and Data Processing: A Foreward", IBM Journal of Research and Development, Vol. 9, N°1, July 1965, p.227.

Table. 4 shows that with exception of the British market IBM dominated not only the U.S. market, but also those of France, Germany, Holland and Belgium.

TABLE 4: IBM dominance in the major Western European computer industries in 1962.

	France 1962		U.K 1962		Germany 1962		Holland 1962		Belgium 1962	
Name of firm	Nbr.	%	Nbr.	%	Nbr.	%	Nbr.	%	Nbr	%
Bull/GE	140	49.1	3	1.0	16	2.9	12	17.4	19	26.8
Burroughs	--	--	3	1.0	--	--	--	--	4	5.6
CDC	--	--	--	--	1	*	--	--	--	--
Eurocomp.	--	--	--	--	15	2.7	--	--	--	--
Facit	--	--	--	--	1	*	--	--	--	--
IBM	**139**	**48.8**	**56**	**17.9**	**341**	**62.2**	**34**	**49.3**	**37**	**52.2**
ICT-Ferranti	5	1.8	119	38.2	6	1.1	1	1.5	1	1.4
ITT	--	--	--	--	--	--	9	13.0	3	4.2
M.C. Ferta	--	--	--	--	--	--	1	1.5	--	--
Monroe	--	--	1	0.3	--	--	--	--	--	--
NCR/Elliottt	1	0.3	69	22.1	15	2.7	--	--	2	2.8
Philips- Electrologica	--	--	--	--	10	1.8	8	11.6	--	--
Sperry-Rand	--	--	--	--	42	7.7	4	5.8	4	5.6
SEA	1	0.3	--	--	--	--	--	--	--	--
Siemens	--	--	--	--	26	4.7	--	--	--	--
STC	--	--	--	--	2	*	--	--	--	--
Telefunkun	--	--	--	--	2	*	--	--	--	--
Zuse	--	--	--	--	64	11.7	--	--	--	--
Total	285	100	312	100	548	100	69	100	71	100

Table 5 indicates the presence of the U.S. electronic companies in Europe during the "third stage" of the history of the computer industry. This presence not only illustrates the dominance of US technology but the European acceptance of discursive elements such as real-time, time-sharing, electronic command and control, fusion between computers and telecommunications not under the policy of interoperability. It was under this policy of interoperability which meant asymmetrical interdependency in ICT that transatlantic industrial alliances were formed through licensing (Table 5) in order to allow western Europe to contribute to the building of the NADGE system and also to fill the gap of European private business computation needs.

Table 5: European companies with a manufacturing license in 1962

Name of Firm	Country of Operation	Name of Licensor
AEG-Telefunken	GERMANY	GE
BULL-GE	FRANCE	GE
BURROUGHS	UNITED KINGDOM	BURROUGHS
CAE	FRANCE	SDS
ENGLISH ELECTRIC	UNITED KINGDOM	RCA
ELLIOT AUTOMATION	UNITED KINGDOM	THOMPSON
GEC	UNITED KINGDOM	TRW SDS
HITACHI	JAPAN	RCA
HONEYWELL	UNITED KINGDOM	HONEYWELL
IBM	UNITED KINGDOM	IBM
--	FRANCE, UNITED KINGDOM	IBM
--	CANADA, JAPAN, SWEDEN	IBM
--	GERMANY, ITALY	IBM
SIEMENS	GERMANY	RCA

In accordance with this trend of cooperation between US and European firms, the 1962 *Instruments, Electronics and Automation Exhibition* in London was dominated by the theme of data transmission, not only for the military but also for business. As had been the case for the military, "Manager, accountants, and administrators have found their speed of working naturally tied to the speed of their information links to other places. These links are found to be...inadequate."[229] It was not immediately evident to the general public that these high speed data transmission capabilities were trully justified. As noted in the *British Communications and*

[229] "Data Transmission - Too Little or Too Much", British Communications & Electronics, Vol. 9, No.6, June 1962, p.411.

Electronics' editorial: "Perhaps commercial industry is to be mesmerized by what has been accurately and dramatically described as digital-data-hypnosis: a desire for data without knowing what do with it."[230]

This civilian urge for the digital computer indicates the spill over of military concepts such as "real-time" and "time sharing" over the civilian industrial sphere. Like their military counterparts, business leaders also wanted to use speed in order to overcome the limitation of distance. Like US military communications systems that used ground installations as well as satellites, the owners of the civilian intercontinental system also wanted to develop a system that would "ensure communication between automatic networks of substantially different design on either side of the Atlantic."[231] This diverted Western European interests from special-purpose analog computers and oriented science and industry towards general-purpose digital computers.[232]

As a result of this tendency towards the increased used of general-purpose computers, in October 1961, the *Conseil Consultatif International Telegraphique et Telephonique* (CCITT)[233] "Special Study Group A" met in Geneva and reached an agreement on the standardization of transmission channels, of parameters for data

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230 Ibid., p. 411.

231 R. J. Chapuis and A. E. Joel, Electronics, Computers and Telephone Switching. A Book of Technological History as Volume 2: 1960-1985 of 100 Years of Telephone Switching, op. cit. p.454.

232 This does not mean that the analog computer do not have any advantage over the digital computer. Analog computers were very useful for scientific observation and inquiries because one of its main advantages is the ease with which it can alter the time scale of events in a system, so that they may speeded up or slowed down for more convenient observation. It had also been used successfully as a simulator for testing automatic pilots. But the technique is known as being very limited in terms of calculation accuracy and does not have the speed necessary for automatic data transmission in real-time. See E. Lloyd Thomas, "Analog Computation", British Communications and Electronics, Vol. 5, N° 5, May 1958, p.349 and p. 358. Other proponents of the analog computer have written that "...there has been a tendency to forget about analog computers and to overlook the progress they have been making...the digital computer as it stands, in spite of its undoubted superiority in many cases, still has long way to go before it can surpass the analog device in all applications" R.B. Quarmby "Electronic Analogue Computing: Survey of Modern Techniques", Wirless World, March 1954, pp.113-118

233 CCITT is a United Nations established committee in Geneva for tariffs, technical standards and conformity in order to facilitate international telecommunications.

modem equipment in telephone type circuits and for operating procedures. It should be noted that this standardization was only about modems that allowed inter-operability and did not concern the machines that run each national system. However, here again business telecommunications like their military counterparts had to face the same problem of interaction between humans and computers. The conception of the interface between data transmission and data processing was introduced and defined, with CCITT accepting responsibility for the channels and modems within the interfaces[234]. An interim transatlantic communication system was built in 1963 to provide semi-automatic service between New York and London and between New York and Frankfurt. As in the case of military communications the interim system was a

> ...compromise between American technologies and trends and those in favor at the time in Europe. Simplicity of design was the guiding principle both to ensure rapid decision making and to facilitate physical construction of the terminals of the system, whose main features were:
> - line signaling to afford two-way circuit operation...
> - multifrequency code (MFC) inter register signaling using only MFC signals in the forward direction to transmit the address signals (digits of the called number)[235].

The transatlantic orientation of the European ICT industry in the early 1960s as described in Table 5, was not entirely the result of the re-organization of Western European civilian and military communication systems. Restructuring of the post-war economies and industrial production in Europe also required the use of computers. In industry, computers were to be used to solve a number of problems ranging from animal breeding and managing automobile factories to oil refining.[236] In government

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[234] R. J. Chapuis and A. E. Joel, Electronics, Computers and Telephone Switching, A Book of Technological History as Volume 2: 1960-1985 of 100 Years of Telephone Switching, p.411.
[235] Idem, pp.454-455.
[236] "The Use of Computers for Optimal Planning", British Communications and Electronics, Vol. 6, N°11, November 1959, pp. 776-778.

policy, computers were considered as tools to implement government economic, social and military decisions in "optimum ways".[237]

Since computers had to be used everywhere, the transatlantic standardization/interoperability debate in ICT had spread from the military sphere to the economy. Consequently, the European problem with inter-operability and the technological gap vis-à-vis the US became even more acute. In order to overcome this gap, transatlantic industrial alliances and licensing were insufficient since Europeans had also to generate an internal dynamic that would allow them to appropriate American techniques for their own use. Here the US practice of "big science" such as those in nuclear energy, electronics and space research became an example and a solution to Europe's scientific and technical relative weakness. In effect, Allied governments felt that science had an important role in the development and defense of their communities. These governments considered that henceforth, all policy objectives should be associated with the progress of science. Governments thus had an important role both in financing science and technology and in promoting international co-operation. International co-operation was, therefore, considered the most efficient means of attaining national and international political objectives which ranged from social, cultural and economic development to defense policy.[238] That was the context within which the OECD played a crucial role in carrying American science policy to Western Europe.

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237 « Comment of the Month: Policy-Making by Computer», British Communications and Electronics, Vol. 4, N° 3, March 1957, p. 137.
238 OCDE, La coopération scientifique internationale, Paris, OCDE, 1964, p.20

3.4 THE OECD SCIENCE POLICY DISCOURSE AND ITS USER POLICY

In the early 1960s the OECD presented the interest of government in science as a new phenomenon. It claimed that the political and economic dimensions of science had appeared only after World War II when political and economic institutions in United States felt that they needed scientific information related to their problems. This was an effort to present American scientific and industrial practices during and after the World War II as a model for the post-war Western European scientific and industrial policies. The OECD suggested the creation of purpose-oriented scientific and technical organizations, the establishment of teams for operational research and the creation of technical and economic consulting groups. These measures, according to the OECD, would help governments in general and military services in particular to understand the implications of science in their decision-making. Moreover, they would contribute to a more adequate transfer of scientific information to users without scientific knowledge.[239]

Since historians[240] tell us already that government use of science dates back many centuries, there is no need to debate the universal truth of the OECD's discourse but to seek for its relative meaning within the emerging transatlantic discursive regime. I argue that through a "new" science policy, the OECD General Secretary incited

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[239] O C.D.E. Direction des Affaires Scientifiques, «Conférence ministérielle sur la science, 3 et 4 octobre 1963. Chapitre II de l'ordre du jour - "domaines speciaux" sur le transfert et l'utilisation de la connaissance: note sur la communication scientifique», op. cit. p. 7.

[240] In effect since the "Urstaat" (this concept refers to the model of government established by the first known city-state: the Mesopotamian city of Ur in 2000 B.C.) "The search for a more rational approach to nature laid the foundation for several sciences: astronomy, algebra, and geometry. Significantly Greek mathematics and astronomy drew their early inspiration from the Oriental Near East and they reached their climax under Euclid, Heron, and Ptolomey..." K. A. Wittfogel, Oriental Despotism,a Comparative Study of Total Power, New Haven and London, Yale University Press, 1957, p. 195.

Western European countries to imitate the American discourse and practice of big science. The effect of imitation was not the emergence of a scientifically and technically stronger Europe but a Western Europe that was engaged in an asymmetrical interdependency with the United States. This was because all European "big science" projects such as those regarding space and nuclear programs required the most advanced American computers. Consequently, although the words interoperability and standardization did not appear in the OECD General Secretary's early utterances, through a user policy - as opposed to an industrial policy of manufacturing computers - the General Secretary articulated the logic of the Pentagon-NATO position that had favored transatlantic standardization rather than interoperability between computers of different national origins.

3.4.1 *The OECD Science Policy Framework*

The emergence of the OECD science policy was concomitant with the Pentagon-NATO effort to standardize allied weapons procurement. Indeed the US Air Force's initiative to form the AGARD had been preceded by a demand from Westein European countries who wished to benefit from American scientific and technical research in all areas of economic and military interest. It was within this context that the former OEEC along with NATO became involved in the reform of the Western European countries' science policy. As Alexander King the former Director of the OECD Scientific Affairs noted in 1965:

> The origins of scientific activity in the Organization can be traced to early Marshall Plan days in 1949, when the Council of the Organization European Economic Co-operation (OEEC) set up its Working Party No.3 on Scientific and Technical Information. The Working Party was charged with considering the potential inherent in new technological ideas at a moment when

> European industry was being re-equipped mainly with traditional plant and machinery.[241]

Although not strictly within its mandate, the OEEC initiated a number of productivity studies, launched specialized discussions on productivity measurement in particular sectors and arranged for the transfer of technology from the United States to Europe. In 1950 recommendations were made through the OEEC Council to the constituent governments advocating the establishment of a national productivity center in each country. These centers were created and sustained with the aid of US funds. As a result, the European Productivity Agency was established as an organ of the OEEC, and operations began in all member-countries.[242]

This was the beginning of the formation of a science policy for all OEEC member-countries that took a decade to accomplish. In 1959 at the OEEC a first approach was made towards understanding governments' concern with science. Thus, defense matters and economic issues were linked through NATO and OEEC's concerns in an integrated fashion. The overlap between the two international bodies was made clear in 1959, when the General Secretary of the OEEC asked Mr. Dana Wilgress, formerly Canadian Ambassador to OEEC and NATO, to start a study of scientific organization and of major problems relating to science in member countries. Specifically Wilgress was asked:

> 1. to discuss with governmental, scientific, and industrial leaders the measures already taken, or planned, to increase the scientific and technical resources in each Member country;
> 2. to make those in high authority aware of the importance that scientific research and technological development was likely to have on the future economy; and

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241 Alexander King (Director for O.E.C.D. Scientific Affairs), «Science in the OECD», in Mesthene, E. G., op. cit., p. 17.

242 Ibid., pp. 17-18.

3. to propose measures at the national or international level that would increase technological resources and favor establishment of common action for their more **rational use** [*my emphasis*][243].

The key word in this statement is again rationalization. This recommendation was issued in 1959 the year after it was realized that the objective of rationalization had become difficult to achieve within the military sphere as European members of NATO sought equality with the United States. Thus, the rationalization debate was widened to cover the civilian scientific and technical sphere. It was during the dispute over NATO standardization that Mr. Wilgress' undertook his study of science policy. Among of his many observations he stressed that:

> [T]he full implications of the scientific revolution have not yet sunk into the consciousness of large section of the population of Western European countries...they loath to scrap their traditions. In particular they are reluctant to adapt their educational systems to the needs of science and technology.[244]

That was a clear indication that European scientific and academic traditions would have to adapt to the new policy practices developed in the United States for the management of defense programs.[245] The OECD's Scientific Affairs Committee echoed this position when it asserted that

> Certainly, in the advanced countries at least, scientific agriculture for example is an old story...What is relatively new is the idea that government policies in *every* field are in principle at least subject to improvement and refinement by the impact of science, and that some cannot be adequate to their purposes unless they explicitly and deliberately take account of that impact in their form. The clearest case is that of military policy whose adequacy since World War II has been largely determined by what goes on in.

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243 This and the three following questions are from Dana Wilgress, Cooperation in Scientific and Technical Research, OEEC, Paris, 1960.

244 Idem.

245 It was the transposition of American way of industrial management in Western Europe. This system is described by G. E. Bugos as the way in which

> The American military-industrial complex of the 1950s was dramatically restructured around 'program management' a set of organizational techniques used to dictate to engineers the timely completion of one weapon system...

G. E. Bugos, "Manufacturing certainty: Testing and Program Management for the F-4 Phantom II", Social Studies of Science, N°23, 1993, p. 265.

and is likely to issue from, the laboratory and the engineering shop[246]. (My emphasis)

This statement expressed a suggestion to European member countries of NATO and the OECD to build their technological capacity by imitating American "big science" practice. It was recognized that even though military, space and atomic research do not have direct impact on the economy, they could stimulate research of economic interest. It was recognized in the agenda of the OECD ministerial meeting on science on October 1963 that:

> *Comme on l'a montré dans le RAPPORT DE BASE, les ressources engagées dans la recherche scientifique représentent aujourd'hui de 1 à 3% du PNB dans les pays les plus avancés de l'OCDE. Mais une bonne parties est consacrée à des objectifs de recherche militaire, spatiale et autre, sans rapport direct avec l'économie civile, encore qu'elle puisse souvent la stimuler.*[247]

The economic rationality of government involvement in science and technology as NATO and the Pentagon wanted, was abandoned by the OECD Scientific Affairs Committee in favour of a more balanced perspective that recognized that governments' interests in science and technology responded not only to economic problems but to social and cultural development, military objectives and international political prestige. According to this view, these objectives were not contradictory to each other since a country's military and political power was based on its economic and industrial capability. The OECD agenda admitted that scientific research in all domains would be coordinated with research oriented towards economic growth.

> *Il se peut que la part du lion soit attribuée à des fins militaires ou de prestige politique, au détriment de la croissance économique. Pourtant, les activités de recherche répondent à des considérations nombreuses et complexes, non seulement de caractère économique, mais aussi d'ordre social, culturel, militaire et politique; et toute politique de recherche et développement*

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246 Ministers Talk About Science. A Summary Review of the First Ministerial Meeting on Science October 1963, op. cit., p. 30.

247 CAC 77/321 Box 729. - , OCDE Document de synthèse. Chapitre III de l'ordre du jour. Science et croissance économique, CMS -30 10/63 Diffusion Restreinte, Paris le 3 septembre 1963, p. 1.

scientifiques doit trouver un juste milieu entre tous ces objectifs. La façon d'atteindre cet équilibre variera selon les nécessités politiques et sociales et la valeur politique qui lui sera accordée. Mais en dernière analyse, toute puissance militaire et politique est fondée sur la puissance économique et industrielle, et c'est là une raison de plus pour accorder une priorité élevée à la recherche orientée vers la croissance économique.[248]

This statement reflected the contradictory nature of the emerging transatlantic discursive regime on science and technology because it shows the difficulty of reconciling the military mission and political prestige of scientific research and technological development on the one hand and the economic profitability of R&D and international cooperation on the other. Consequently, rather than representing an autonomous institutional mechanism in the liberal sense of the concept of "regime", the OECD became a site for inter-state dispute, a focus for both contradictions and consensus-building.[249]

Unlike the abolished NATO standardization office and the OEEC which represented the Pentagon view and unquestioned US power, the OECD Council was rather similar to the NATO Conference of National Armament Directors. It was constituted by the representatives of all the member-countries.[250] The OECD council was evidence that after ten years of transatlantic cooperation, it was still difficult for autonomous rules and procedures to emerge within the transatlantic discursive regime. Indeed, far from representing a supra-national body or an institution that represented a transatlantic social hegemony, the OECD council constituted a forum that represented

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248 Ibid. p.2

249 The convention that created the OECD was signed on December 14, 1960, by twenty countries who sought to transform the Organization for European Economic Co-operation (OEEC) into a new Organization comprising the members of OEEC and Canada and the United States. These twenty members formed the basis of the OECD that was composed of a Council, an Executive Committee, a Budgetary Committee and several Specialized Committees supported by Specialized Organisms such as the European Nuclear Energy Agency (ENEA); the Development Center and the Secretary.

250 The members of the Council held meetings once a year and one session per week among the permanent representatives.

conflicting views and interests in science. Science and technology were not considered only as factors that would favor international integration and harmony between nations but also as integral to state power and national prestige. In one of the minutes of the OECD ministerial conference on science, one can read:

> *Puisque la puissance, le développement et le prestige des pays se mesurent aujourd'hui en partie au succès qu'ils remportent dans les sciences et les techniques, un rang éminent dans ce domaine devient de plus en plus un objectif national important ... de là le rôle croissant que joue l'État dans les affaires scientifiques...*[251]

Given the diverging national interests in science, the OECD's role was limited to resolving problems related to the costs and benefits of international cooperation and the harmonization of national policies.

> *En l'absence d'une autorité politique supranationale, il ne peut y avoir de politique internationale dans le même sens où il y a des politiques scientifiques nationales. Néanmoins, il existe un système de relations scientifiques qui soulève des problèmes de politique relatif au coût de la et au profit de la coopération scientifique internationale, ainsi qu'à ses instruments. Ces problèmes sont communs à plusieurs pays, en dépit des différences que peuvent présenter leurs politiques nationales en ce qui concerne les affaires scientifiques, et l'objectif d'efforts mutuels pour les résoudre est d'atteindre une harmonisation plus grande du système des relations scientifiques internationales .*[252]

Unlike the early NATO rationalization policy that was supposed to manage member-countries' use of scientific and technical resources, OECD harmonization policy of the early sixties echoed the NATO interoperability debate. Although it was supposed to establish a "code of conduct" that would guide national policies, the OECD conference simply recognized national specificity and the conflict of interests between member-countries. It was agreed that:

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[251] Centre des Archives Contemporains- Fontainebleau- France (hereafter CAC). CAC 77/321 Box 729. - , OCDE Document de synthèse. Chapitre I de l'ordre du jour. Problème de politique scientifique nationale. CMS-28 10/63 Diffusion Restreinte. Paris le 3 septembre 1963, p.1.

[252] CAC 77/321 Box 729. - , OCDE Document de synthèse. Chapitre II de l'ordre du jour. Problème de politique scientifique internationale. CMS -29 10/63 Diffusion Restreinte. Paris le 3 septembre 1963, p.1.

La confrontation des politiques nationales peut à son tour conduire à une certaine harmonisation des politiques. Par certains de ses aspects, une politique nationale peut heurter celles des autres pays, de telle façon qu'une sorte de "code des bons usages" finissent par s'imposer, qui, même s'il n'a pas force de loi, pourra servir à orienter les politiques nationales [253].

This role of comparison of national policies was supervised by an Executive Council constituted by ten member-countries representatives[254] and several Specialized Committees. These committee included two Scientific Affairs Subcommittees: the *Committee of Scientific and Technical Personnel* and the *Committee of Scientific Research*.To make sure that this comparison did not overlook the political and cultural differences in favor of technical efficiency and economic rationality, member-countries were represented in each of these subcommittees. They met two to three times a year.

Under the heading of specialized organizations, the Development Center had the mandate to build data bases from inquiries on member-countries regarding industrial development and general economic policies and to make these data available to the less developed countries. All specialized organizations and the Specialized Secretary worked for the General Secretary who was assisted by two vice-Secretary Generals. The most important specialized organization that issued doctrine and policy guidline concerning science and technology was the *Directorate of Scientific Affairs* (DAS). It was constituted of four *Divisions*: Forecast and Development; Scientific and Technical Personnel; Basic Studies and Scientific Research to which was attached the Central Service for International Co-operation in Scientific Research. It had no decision-making power.

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253 CAC 77/321 Box 729. - , OCDE Document de synthèse, Chapitre III de l'ordre du jour, Science et croissance économique, CMS -30 10/63 Diffusion Restreinte, Paris le 3 septembre 1963, p.7.

254 These representatives were nominated annually by the Council. They normally met once a week. The Budgetary Committee which was composed of all member-countries representatives met only when necessary.

The *Council* was the highest level where general as well as administrative decisions were taken. It laid down general statements in the form of policy that oriented the specialized bodies' analysis and advice. The Council functioned by *decisions* that member-countries have the obligation to implen..t, by *agreements* with member-countries and non-member-countries, by *recommendations* submitted to members, non-member-governments or to other international organizations and finally by *resolutions* regarding the continuation of the OECD's works or relating to quest of information from member-countries. These acts, whatever their denomination (*decisions, agreements, recommendations* or *resolutions*) were taken unanimously. However, there were exceptions, especially when the *Council* unanimously adopted different procedures for special cases or a member-country decided to abstain or to stand aside of an action.

The *Executive Committee* studied issues in connection with general policy and built consensus around initiatives, before such initiatives reached the *Council.* While the executive had no decision-making power, it could be asked by the *Council* to undertake an action or to assure the co-ordination between several initiatives. The *Council* and the *Executive Committee* order the *Specialized Committees* and their Group of Experts to undertake research and studies. However, these specialized committees were also allowed to carry out actions without the permission of the two boards, as long as their chairman felt that such activities fell withi. .heir competence and were for the interest for the OECD members. As we shall see later, this flexibility would give a leverage to the United States to influence the debate on science policy in the mid-1960s.

3.4.2 *The role of the OECD 's Committee of Scientific Affairs*

The Scientific Committee had the task of facilitating the development and harmonization of member-governments' science policies and promoting research at international scale. It was in this sense that it issued a document entitled Science and the Policies of Governments[255] that served as a background to the first OECD Ministerial Meeting on science[256] in 1963. This meeting had to determine the institutional framework guiding states' decision-making regarding scientific and technical issues. In this first OECD ministerial meeting on science, Théo Lefèvre the Prime Minister of Belgium argued that:

> ...whatever the structures adopted, there are essential functions they must fill as means of preparing the ground for decision and for co-ordination of effort. **Among these, the information function emerges as crucial because it is fundamental to all policy-making in the modern sense of the term.**[257] (I emphasize)

The objective of this ministerial meeting was to forge an institutional model that would be effective in each member country. This required, first, a consensus on the concept of science policy. Consequently, the OECD ministers agreed to make an intellectual distinction between "policy for science" and "science for policy". The two categories were considered as constitutive of the concept of science policy. OECD officials did not claim originality for this definition; they recognized that they had drawn on the model of the relationships between American scientists and defense

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255 OECD, Science and the Policies of Governments, Paris, OECD, September, 1963.
256 Idem, p. 28.
257 T. Lefèvre (Prime Minister of Belgium), "The Ministerial Meeting on Science", in Emmanual G. Mesthene, (ed) Ministers Talk About Science. A Summary Review of the First Ministerial Meeting on Science October 1963, Paris, OECD 1965.p. 16.

officials.[258] They claimed that this definition could help change the pattern of action in scientific affairs.[259]

At the time, it was widely agreed that Europe's problem was not a lack of scientific information but how to transmit the latter to the users. Therefore, building an adequate communication system for transferring scientific knowledge to sectors such as industry, government and the military was becoming increasingly important. The purpose underlying such position was to bring European scientific and technical research into alignment with the US policy model described above, i. e. the functional relationships between scientific and technical research to government policy objectives and industrial programs described in the US *Project Forecast*. The implementation of this model in Europe was meant to help European policy-makers in their decisions regarding science. Consequently, the OECD Scientific Affairs Committee suggested that the objective of European science policy should not be focused on producing new knowledge but on communicating already existing scientific information to non-scientists. This was because the OECD's Scientific Committee believed that European scientists (like their American counterparts in the immediate period after the war) did not have the experience required to recognize the form that the results of their work would take when applied to industrial problems and they were often not aware of the fact that their inquiries could be of interest in resolving industrial and military issues. Therefore, establishing communication channels between scientists and non-scientists was to be the priority of European science policy.[260]

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258 The first OECD report cites the Bulletin for Atomic Scientists, November 1962, p. 44.
259 Hunter Dupree, Science in the Federal Government, Cambridge, 1957, pp. 1-2.
260 O.C.D.E. Direction des Affaires Scientifiques, «Conférence ministérielle sur la science, 3 et 4 octobre 1963. Chapitre II de l'ordre du jour - "domaines speciaux" sur le transfert et l'utilisation de la connaissance: note sur la communication scientifique», op. cit. p. 3.

The similarity between the views of the OECD's Scientific Committee and the Air Force's mid-1950s criticism of US civilian scientists is here obvious. However, subsuming scientists completely to industry was at the time a very controversial issue as the US experience had shown. Intellectual freedom and governmental objectives were not easily reconciled. The OECD moderated this concern by adjusting its notion of intellectual freedom to the situation. It stressed that

> There is no necessary conflict between the need for policy and the intellectual autonomy of the scientist, especially so long as researchs are more numerous then the possibilities of implementing them, and so long as the scientists themselves, through their advice to policy-makers can discourage unwarranted compromises with scientific worth. Many scientists nevertheless realise that the complex organisations and diverse skills required by modern scientific work **imply some modifications of traditional views of academic freedom.**[261] (I emphasize)

Changing the meaning of scientific freedom was necessary to allow government control over scientific workers, but was not sufficient to include Europe's scientific and technological practice within the emerging transatlantic discursive regime. Government control without international norms and procedures albeit flexible could create scientific and technological nationalism. In order to prevent such a trend, what was also needed was a transatlantic common "language" through which scientists could overcome differences in attitudes and values arising from different ways of envisaging scientific and technical problems. In this respect, the stated OECD objective was the creation of a transatlantic community spirit that was considered the condition for establishing a system of norms and procedures that would allow the use of new machines and systems such as mechanized records of scientific information. For this purpose, the first step was the elaboration of an information system that used

[261] OECD, Science and the Policies of Governments. The Implication of Science and Technology for National and International Affairs. Report of the Secretary-General's ad hoc group on science policy, Paris, 1961, p. 161.

simultaneously men and machines. From the OECD's perspective, the human factor in this system and its efficient use implied that social science techniques must be associated with methods of logic and automatic calculation already embedded in new comp. ter techniques.[262] As we have seen, the problem of interaction between humans and machines was generated within the US centralization of military commands that created a scarcity in manpower to monitor the computer systems. With the OECD interest in computers, this problem became a civilian issue.

Computers became the objective as well as the means of scientific information exchange. The OECD and NATO sought the improvement of the existing means and methods of communication, viz. electronic computers and to a lesser extent punched cards computer systems.[263] Electronic computers were to be used in many tasks: basic research in information science; library science; creation of new information systems; promotion, support and use of specialized numerical information services; supplying technical information to industry and finally training engineers and scientists to use scientific information efficiently. According to the OECD, fostering these fields should be the target of national science and information policies. Thus, national science policy became the management by government of institutions of scientific and technical information.[264] One year after the first ministerial meeting on science, in 1964, at the US suggestion, the OECD created a Working Group on Scientific and Technical Information. Between 1964 and 1966 the Working Group studied three sectors: (1) the

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[262] OCDE. Direction des Affaires Scientifiques, "Conférence ministérielle sur la science, 3 et 4 octobre 1963. Chapitre II de l'ordre du jour - "domaines speciaux" sur le transfert et l'utilisation de la connaissance: note sur la communication scientifique", p. 4.

[263] Idem, p. 8.

[264] O.C.D.E. Groupe sur l'information scientifique et technique, «L'information scientifique et technique et la politique des gouvernments», Diffusion restrainte, DAS/CSI/67.42, Paris, le 16 juin 1967, AnnexeI, «Information et politique - definition de quelques concepts», p.17.

possibility of automating member countries' bibliographic systems in the sector of chemistry; the extension to Europe of the American Medical Library and Automatized Research System (MEDLARS) and (3) the economy of information.[265]

3.4.2 *The OECD Science Policy and Inter-State Confrontation over Information Technology*

In order to balance American influence which always tended to overlook the political vulnerability of its European allies and presented their technological gaps as simply a technical problem, many efforts were made to avoid the autonomization of the regime's institutional machinery. As we have seen, in order to include the problem of European vulnerability in science and technology, NATO created the Conference of National Armaments Directors that replaced NATO standardization office. Similarly, within the OECD, the power of decision was not given to the OECD General Secretary but to the OECD Council.

Despite all these efforts however, the American tendency to present the issue of science policy as an economic and technical problem persisted. This tendency pushed the autonomization of the OECD machinery. In effect, in 1964, the US National Science Foundation constituted an *ad hoc group* that wrote a report that recommended the OECD create a centralized international institute of technology that would elaborate and administer OECD science policy. This institute was to be an alternative to the prevalent OECD machinery that was influenced by member-countries' political concern with science. The reason advanced by the National Science Foundation was that

265 RE 130, Box 11, File 740, Délégation Générale à la Recherche Scientifique et Technique (DGRST) J. D'Olier, "Rapport sur l'activité du Groupe de Travail "DOCUMENTATION" de l'OCDE", p. 17.

although member-countries spent considerable resources on R&D, they lacked the necessary information in order to make rational political and economic choice. In 1962 the *ad hoc* group stated that:

> *Il faudrait encourager la création d'un institut central qui réunirait et classerait des données à l'intention des autorités chargées d'élaborer la politique de recherche et d'en administrer la mise en œuvre.*
>
> *Le groupe ad hoc est favorable a ce que l'OCDE poursuive ses fonctions de liaison et de "centre de communications" et qu'elle stimule les activités opérationnelles dans les organisations nationales et internationales, mais il considère que l'Organisation ne devrait pas prendre en charge des activités opérationnelles ni jouer un rôle de service, à moins que qu'il soit nettement établi que sans ces activités en question, les programmes des pays Membres en matière d'information scientifique et technique ne pourrait être exécutés de façon satisfaisante .*[266]

In 1967, the OECD Secretary General accepted the National Science Foundation proposal to recognize the need for a transatlantic rationalization of the use of scientific and technical information. A note by the OECD Secretary General stressed that:

> *...l'information scientifique et technique représente des investissements publics et privés substantiels; de plus, le fait que tout le monde ait immédiatement accès a cette information constitue un des principaux facteurs du progrès scientifique, économique et social. Le volume d'informations disponibles augmente à une cadence telle qu'aucun pays ne peut espérer longtemps, assurer seul, des moyens d'information suffisants dans tous les domaines. Une certaine action internationale a déjà été entreprise: cette orientation est souhaitable et nécessaire, elle doit être encouragée et accélérée.*[267]

After the Secretary General's recognition of the need to rationalize, it committed itself to propose to the OECD Council the creation of a transatlantic network of computers to enable the storage and the retrieval of scientific and technical information.

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[266] CAC 77/321 Box 928. OCDE - Direction des Affaires Scientifiques, Comité de la Recherche Scientifique. Rôle de l'OCDE dans le domaine de l'information scientifique et technique. Note d'orientation politique pour le Comité de la Recherche Scientifique. SR (62) 25 Diffusion Restreinte. Paris le 24 septembre 1962, p. 11.

[267] OCDE - Groupe sur la politique de l'information scientifique - L'information scientifique et technique et la politique des gouvernements. DAS/CSI/67.42. Diffusion restreinte. Paris le 16 juin 1967, p.1. Copies of this document were sent to national delegates of the OECD Council.

Thus, after it had been defeated within NATO, in 1967, the policy of rationalization re-emerged within the OECD and became the General Secretary's doctrine. As we have seen earlier rationalization implied standardization. Starting from 1967, both notions began to replace interoperability in the transatlantic discursive regime. For the OECD Secretary General, European members of the organization, rather than worrying about their technological domination by the United States, should make the effort to follow US trends in sectors such as time-shared systems, systems for simulation and quantitative management methods and computer-assisted engineering. The Secretary General stated that:

> *Personne ne voudrait affirmer que les "écarts technologiques" que l'on constate actuellement, ont pour seule cause un manque d'information; de même fournir davantage d'information n'est pas une panacée. Mais, sans aucun doute, un flux continuel d'idées nouvelles aiderait à surmonter la résistance à l'innovation que l'on rencontre dans beaucoup d'entreprises* [...] *Il appartient aux gouvernements de saisir les opportunités et de profiter des avantages économiques que le coopération internationales peut leur offrir.*[268]

This statement indicates that the economic benefit of using American scientific and technical information systems outweighed the construction of independent national information systems. The Secretary General argued that although Europe was not as advanced in computer techniques as the United States, European governments should not ignore the interests of European companies in time-shared systems. They should encourage the modernization of telecommunications systems in order to foster adequate transmission lines for time-shared systems and find a way to overcome problems related to the cost and technical complexity of the emerging systems. This analysis was based on a survey made in 1966 by the consulting company, Arthur D. Little, who also

268 Ibid., p. 2.

advised Europeans to merge computer and telecommunications in order to participate in the American information revolution. The report stated that:

> We already have in the United States a network of data transmission and data processing equipment set up by Western Union which will be used by service companies to operate the programs and to maintain the files they will make available on a subscription basis. Perhaps a situation is developing rather like that in the telephone industry. Here, there are three levels of firms. First, there is the manufacturer of telephone instruments, switching equipment, cables, and the like. Second there is the telephone company , which purchases this equipment as needed to provide telephone services to a geographic area. Third there are many firms often small, that offer services based on their own use of the telephone company facilities.[269]

Although the structuring of European telecommunications system in accordance with above analysis would increase the influence of American computer manufacturers in Europe, according to the OECD Secretary General, Europe would still benefit from such structuring. The Secretary General stressed that:

> it would be a mistake to consider the computer industry simply in terms of output and growth rates, however impressive the figures may be. This industry should be considered in the broader framework of what has been called the information revolution, which will probably prove to be as significant, if it is not more, than the industrial revolution of the 19th century and one of its outcomes, the communications revolution of the 20th century.[270]

For the Secretary General, European countries should take note of the fact that the computer industry is not only a manufacturer of equipment but it is also a service-provider concerned with the utilization and processing of information in the broadest sense. Moreover, the General Secretary stated that computers, like steel, are "input" to all other industrie , 'but unlike steel they penetrate not only the manufacturing sectors but also the service industry, e. g., banking, insurance, education, health, civil service.

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[269] RE 130, Box 11, File 254.74, ARTHUR D. LITTLE INC - Frederic G. Withington «The Impact of Advancing Computer Technology», p.7.

[270] OECD - Directorate for Scientific Affairs - Experts Group on Electronic Computers, Gaps in Technology Between Member Countries, (note by the Secretary] DAS/SPR/68.3 Restricted , Paris, 9th January, 1968, p.1.

They are at the heart of the management and decision-making processes.[271] On the question how could all countries benefit from this industry given their unequal technological strength, the General Secretary's answer was: a knowledge of how to manufacture computers could not be translated into strength in the industry if the society as a whole did not express a demand for high-speed information processing and there are no companies to satisfy this demand. In other words, a country could not enter the information revolution without a demand for information processing. For the Secretary General "[T]his explains to some extent the pioneering role of the United States as far as the market expansion is concerned, and the relatively more modest results achieved by Germany or the United Kingdom in spite of their technological capability."[272] In short, for the Secretary General, the growth of the computer industry could be described by the dynamic of demand-pull rather by technology-push.The Secretary General stressed that:

> Although computers are considered as a part of the electronics industry the first firms to enter the industry and to become the leaders were not electronics firms (except in the United Kingdom and in Japan) but were active in other sectors, mainly office machinery. The fact that many electronic firms missed out computers, at least at the beginning, appears to be largely a question of management. When considering management as a factor in disparities in the computer industry, one has to look essentially at individual firms. Case studies of firms such as Univac, Bull, Zuse or LEO show that failure did not lie in the lack of technology capabilities, but rather in insufficient awareness of what the market required, bad service to customer or insufficient marketing effort.[273]

This analysis misses the fact that the nature of the demands for high-speed data processing did not emerge from a change in the economy or from individual companies' ingenuity but rather it was a phenomenon emanating from the US Air Force. Moreover, IBM did not structure these demands but was rather able to

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271 Ibid., p. 2.
272 Idem, p. 3.
273 Idem, p.8.

commercially translate those military techniques such as real-time and time-sharing. The company dominated the world market within the transatlantic context of American military leadership that defined NATO communication requirements according to American technological priorities, perceptions and capabilities. To recognize that the "technological gap" was the effect of this leadership would be to put into a question NATO's communications structure or at least US leadership within this organization. This was why the Secretary General overestimated the management failure of European individual firms. The note states that:

> Technological gaps in the semiconductor industry appear to have affected non-American firms only as far the third generation of computers are concerned...Although this may have affected the competitive position of some firms, the effects should not be overestimated; components account for only a fraction of the total cost of a computer system; moreover the type of components which are used are of little interest to the customer to the extent that the service is good. And a good service can be obtained by using faster transistors for instance, or by incorporating characteristics which are typical of many third generation machines (rather than by simply using integrated circuits). The problem as far as the gaps are concerned, lies more in the risks inherent to any single source of supply.[274]

This perspective was not the doctrine of the entire OECD Council which at the time was divided into two lines of thought. The first line was maintained by France, the United Kingdom and Japan who felt it was necessary to build strength in the computer industry.[275] They considered the industry for its own sake and were only secondarily preoccupied with respect to its stimulus on other industries. The second position was maintained by the United States who argued that it was more important to stimulate the use of computers and that a national computer industry was not

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274 Idem p.10.

275 Although I am not sure about the different positions within the United Kingdom and Japan, in France, the position that sought strength in the computer industry did not represent all the French sectors concerned with the computer industry. This was rather the position held by the French ministry of science and the DGRST who always defended industrial nationalism while the French telecommunications authority, the *Commissariat Générale du Plan* and the Armed forces favored a user policy. I will come to this point in the following chapter.

indispensable. This divergence shows that the transatlantic discursive regime in ICT did not reflect the neo-Gramscian notion of international hegemony since the acceptance of interoperability did not prevent French, British and Japanese representatives in the OECD Council from seeking a better share in the transatlantic computer market.

Although the Secretary General said that the OECD was not in a position to decide in favor of either of these views, it nevertheless suggested a form of transatlantic specialization that tended to favor the American position. It argued that since "...the number of firms which were financially and technologically in a position to [innovate in the industry] is extremely small. One possible solution would be to concentrate on the fields where IBM is weak or absent."[276] But in the mid-1960s, IBM was the strongest both in computer hardware and general purpose programming[277]. With the introduction of IBM 360 computer series, IBM was able to produce a whole range of compatible general-purpose computers and not only one medium-sized commercial computer. The only sector that IBM could not entirely cover was the field of special purpose programming. In effect, the OECD Secretary General's policy of specialization and utilization was clear recognition of IBM's monopoly both in equipment and general purpose programming. Had this approach to specialization been adopted by all OECD member countries, the aborted Pentagon-NATO standardization approach would have become the policy doctrine of the transatlantic information regime

276 Idem, p.7.

277 It was considered that the cost of developing general purpose programs which the manufacturer must provide with the machine was approximately equal to the cost of the machine itself. With the increase in program complexity and the decrease in computer costs, it was clear that the expense of developing the programs would become the largest component of the cost in computer manufacture.

and consequently, the utilization / manufacturing debate would have been resolved in favor of the above mentioned American view.[278]

In France, the most articulate opposition to the Secretary General's position came from the French *Délégation Générale à la Recherche Scientifique* (DGRST). The DGRST accused the OECD of attempting to establish American electronic systems in Europe which would have negative economic, cultural and political impacts. While the DGRST agreed that European users would have easy access to sophisticated American systems and abundant scientific and technical information, the DGRST argued that the extensive use of American systems and scientific information would result in a *de facto* recognition of an American monopoly in the diffusion of scientific and technical information. From the DGRST's perspective, this monopoly implied the hegemony of an information system whose centers of decision were located in United States. Furthermore, if allowed, this hegemony would result inevitably in the use of English as the only scientific language. Given these political, economic and cultural disadvantages, the DGRST cast doubt on whether the French use of American systems was less expensive than an effort to develop a purely national system.[279]

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278 For the OECD General Secretary, the future of the computer industry (understood globally as both equipment manufacturer and service-provider) lay in programming. It argued that, in the United States, knowledge in programming was increasing and the business managers both in the United States and Europe would be provided with improving tools for forcasting the results of their decisions and for investing their firms' resources so as to obtain the maximum possible return for the minimum possible costs. Similarly, the OECD advised that, like their American counterparts, European industrial firms and engineering schools should experiment with the use of computers to design products. As the scarcity and cost of engineering increased and firms in the United States merged to be in a better position to make the use of expensive equipment, European firms should be familiar with computer-aided design as a practical possibility. According to the OECD analysis, although at one time Europe seemed to suffer less than the United States because more programmers were available at lower cost, the postion has tended to become reversed because insufficient efforts were made in Europe to train new programmers. OECD - Directorate for Scientific Affairs - Experts Group on Electronic Computers, op cit.

279 The Delegation's report reads:

From the DGRST's perspective, the cost of French participation in American information systems should not only be measured in economic terms but also in terms of political and cultural vulnerability vis-à-vis the US. Such analysis incited neo-realists such as Zysman to argue that the French state intervened during the *Plan Calcul* to achieve "self sufficiency" and "technological glory" not an economic goal. This was a misrepresentation of the French technological nationalism for two reasons. First, technological nationalism was not the position of all participants in French electronics policy. Second, even if one left aside the other participants and considered only the DGRST, such extremism cannot be found. The DGRST position was more nuanced and expressed a dilemma rather than the suggestion that sought to France ought to break away from the transatlantic regime. The terms of this dilemma were as follows: either France participates and runs the risk of being disadvantaged or does not participate and also runs the risk of being marginalized in the transatlantic regime. Until the mid-1960s, on no occasion did the delegation advise French separation from the transatlantic information regime.[280] This hardly illustrates a policy of *grandeur* or a desire to leave the regime. It is, rather, a legitimate sense of dilemma that prompted the Delegation to propose a solution that excluded separation and promoted autonomy inside the regime. The DGRST policy of autonomy combined both inter-operability (or "normalisation" in French terms) and the OECD specialization approach in order to allow France's technological participation in certain areas of the emerging international telecommunication regime. In this respect, the DGRST argued that:

> *Il n'est pas possible de répondre trop négativement aux offres américaines présentées par l'O.C.D.E. car l'apport fourni par les États-Unis en cette matière est trop considérable. Il est sans doute possible de préserver une certaine autonomie...Mais cela nécessiterait que soit en France un effort qui puisse nous hisser au moins dans certains secteurs au niveau technique des centres américains, de manière à proposer notre part des contributions en nature (et non pas en argent) au système international.* [281]

This is only one example of many statements that illustrate that the French discourse of independence was more nuanced than described by neo-realists and

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> *L'activité de l'O.C.D.E. vise sans aucun doute à organiser en Europe des têtes de pont des systèmes de documentation américains avec le corollaire que cela implique:*
> *- Accès facile des usagers européens aux services de documentation américains avec toute leur richesse.*
> *- Reconnaissance par les divers pays européens d'un monopole de fait pour la diffusion de l'information scientifique et technique en faveur d'un système dont les centres de décisions seront situés outre Atlantique.*
> *- Emploi de l'Anglais comme seule langue de travail en matière d'indexation documentaire, étant bien entendu que les documents destinés aux utilisateurs seront traduits dans diverses langues nationales (avec le retard inévitable que cette opération comporte).*
> *Le coût de ce système est théoriquement le moins élevé...mais en fait il n'est pas sûr que la participation à un tel système soit moins onéreuse que le développement d'un effort purement national au niveau nécessaire pour un obtenir un résultat équivalent .*

RE 130, Box 11, File 740, Délégation Générale à la Recherche Scientifique et Technique (DGRST) J. D'Olier, «Rapport sur l'activité du Groupe de Travail "DOCUMENTATION" de l'OCDE», op. cit., p.4

280 In the DGRST's terms *"ou bien participer et courir le risque que les mécanismes de coopération proposés ne nous soit pas favorables ou soit dépourvus d'efficacité ou bien ne pas participer et courir le risque de rester à l'écart d'un système de coopération qui a quelque chance de bien fonctionner"*. Ibid, p.3

281 Idem, p.6.

expresses real dilemmas that the neo-Gramscian concept of hegemony does not recognize. It is a moderate sense of nationalism that illustrates the theory of regime presented in this thesis. It would be fair to say that France was part of a regime that was dependent on US economic and military forces but not immune from political disputes.

3.5 CONCLUSION

In describing NATO and OECD science policy through both organizations' structures and functions, this chapter has also traced the emergence of the transatlantic discursive regime. After 1949, the elements of this regime emerged from the military, scientific, technological and industrial spheres. Between 1949 and 1959, within this regime, member governments of NATO and the OECD expressed congruent views on issues related to defense, science, technology and the industry. This congruence was the product of US military and technological superiority and Western Europe's dependence on American money and technology. After ten years and the reconstruction of the European defense industry, instead of maintaining autonomy from member governments' particular interests or simply representing US military and technological superiority as respectively liberal regime theorists and neo-realits would expect, NATO entered a period of disputes. Consequently, NATO bodies such as the Military Production and Supply Board (MPSB), the Standardization Policy and Coordination Policy Committee and the Military Standardization Agency were abolished and replaced by NATO Conference of National Armament Directors. This organization did not represent the neo-Gramscian concept of hegemony but highlighted member governments' diverging interests in ICT. As a result of this change, the standardization process ended and was replaced by the vague notion of interoperability that symbolized the confrontation between the will of the European members of NATO to develop more interdependent relations with the United States and the latter's ambition to impose its user policy in ICT through the OECD General Secretary. It was within this context that the French choices in ICT policy took shape.

Chapter Four

THE PRE-PLAN CALCUL: THE FRENCH DEBATE ON INTERDEPENDENCE

4.0 INTRODUCTION

This chapter is based on French contemporary archives on computer and information technology, testimonies produced by participants in the early 1960s French decisions in ICT, and some descriptions and accounts by French historians. I use this variety of sources to analyse how the elements of the transatlantic discursive regime shaped France's choice with regard to computers and electronics. I show that, as a NATO member, the French government subscribed to US military policy and hence French territory was an integral part of NATO's Air Defense Ground Environment. Within the OECD, the French government accepted the new definition of science policy with it emphasis on the development and use of a transatlantic scientific and technical information systems. France's participation in these two international bodies created the context within which France's electronics and computer sectors from the late 1950s onward became increasingly structured by the transatlantic regime's military priorities. As I have already shown, the transatlantic regime did not represent a harmonious congruence of member governments' views or a set of rigid rules and procedures independent from US economic and military force. I have, moreover, demonstrated that the European feeling of vulnerability accounted for the transformation of this regime from the policy of Rationalization, Standardization and Interoperability (1949-1959) to a framework that emphasized only Interoperability (1959-1967).

This analysis of French computer policy will show that a diversity of views existed not only at the transatlantic level but also within the French government whose position at the inter-state level was determined by the most influential institutions within the French universe of political discourse in ICT. During the French Fourth Plan (1962-1964) there was unquestioned agreement between all bureaucracies and industrial actors that France should maintain its political and military independence and that American electronic technology was necessary to build France's air defense, nuclear research and electronic scientific and technical information system. There was, however, disagreement within the French universe of political discourse on how to defend French political independence. For the Ministry of Scientific Research, the DGRST and private companies such as BULL and the *Societé d'Électronique et d'Automatisme* (SEA), the priority was the use of American knowledge to build national strength in the manufacture of electronic components. This position was in contradiction to that of the *Commissariat Générale du Plan* , the *Commission Permanente de l'Électronique du Plan* (COPEP), the *Comité de Coordination des Telecommunications* (CCT), the *Direction de la Recherche des Moyens d'Essai* (DRME) and the *Compagnie de téléphonie sans fil* . For these institutions, the policy of independence should first emphasize the use of American technologies in developing important sectors such as air defense, nuclear energy and telecommunication systems.

Unlike those (for example Zysman) who believe that the notions of "technological glory" and "self sufficiency" were unquestionable and the benefits of using American techniques left undiscussed, this chapter will show that it was the user/maker dilemma that structured the French debate over the computer development programs of the Fourth Plan. Although these programs gave no industrial results, they were an occasion for French decision-makers and industrial leaders to confront their positions by using the elements of the transatlantic discursive regime. As a result of this confrontation, the Ministry of Scientific Research and the DGRST's approach to industrial autonomy was sacrificed for the CNET, CCT, COPEP and the DRME user approach. In short, military and nuclear independence became a more powerful motivation than the necessity to foster an industrial independence in the electronics industry. This choice was the continuation of the late 1950s French government purchases of IBM equipment to the disadvantage of the national computer producers: the *Compagnie des Machines Bull* (CMB) and the *Société d'Électronique et d'Automatisme* (SEA). Moreover, the French government sought American participation in its computer development programs. The failure of both companies and the French electronics sector generally to supply French air defense and nuclear programs with digital electronic equipment pushed all companies to seek alliances with American interests in order to survive within the French market.

The first section of this chapter discusses the different positions of the principal actors and shows how they internalized the notions of digitization and the fusion between computers and telecommunications. It will appear that orienting the French policy towards either a user or a manufacturing policy required the restructuring of the French computer and electronics industry given French technological backwardness and BULL's financial problems. Since BULL was the major French computer maker, helping this company became a major preoccupation for all French bureaucracies. The second section deals with the 1950s military industrial alliances and demonstrates that these alliances were not motivated by the problem of productivity in the French electronics industry but concerned the building of French air defense system. The third section discusses the French policy of interdependence during the Fourth Plan electronics research programs. It shows that the objective of these programs was not technological independence but to familiarize French researchers with American advances in electronics. Section five argues that the *Quatre Axes* and *Hexagone* computer development programs were formulated to conform with NATO interoperability requirements and OECD user policies. Thus these programs maintained the French electronics industry within the transatlantic discursive regime. Within this regime, complete independence was not the objective of all French bureaucracies. However, a conflict revolved around forms of interdependence and pitted different companies and institutions against each other. The choice of military and nuclear independence made BULL unwilling to be militarized. This analysis concludes that the French firms subsequently strengthened their links to US industry in order to fulfill their perception of market needs and military procurement.

4.1 THE PRINCIPAL INSTITUTIONAL ACTORS IN FRENCH ELECTRONICS POLICY-MAKING

Before the 1960s, one of the key government institutions dealing with information technology was the *Comité de Coordination des Télécommunications* (CCT) created by government decree in 1945. The CCT was a military organization. Its permanent personnel were one secretary general, one chief engineer and three military officers from the Army, Navy and Air Force. Although its mission was to co-ordinate the interests of different French state institutions in telecommunications, this committee waited more than ten years before becoming directly implicated in issues related to computers. This delay was not unusual given that in 1945, even in the United States, there was no computer development policy and that NATO's AGARD was not yet in place. Moreover, the OECD did not establish its science policy program until the early 1960s.

In 1954, after it was felt within the AGARD circle that the poor communications systems of the European members of NATO reduced the US Air Force's contribution to European defense, the Prime Minister Pierre Mendes-France established the Secretary of Scientific Research. The same year, he created a Commission on "calculators" in which the CCT was a major participant.[282] This commission was headed by General Bergeron (from the French Air Force) who started his mandate with a discussion on the need to train specialists in new techniques related to computers and to assess French policy in this domain.[283] This commission was created within the context of standardization, at a time where the commonalty of American equipment was unquestioned by the European members of NATO.

Within this context, on October 11, 1956, the *Commission Calculateurs* gave the CCT several missions including supervising research in electronics, advising the Minister of National Defense on military telecommunications, and organizing civilian and military telecommunications. Moreover, CCT and the Directorate General of Telecommunications (DGT) of the Ministry of the PTT organized the standardization of electronic components in telecommunication equipment through their laboratory the

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282 It should be noted that *calculateur* is a French word for computer. The use of the word is not innocent; it expresses the idea of a computer that is not a business machine but a scientific instrument French policy-makers and analysts still refer to large computers as *calculateurs de grande puissance*.

283 G. Ramuni, "Entre recherche fondamentale et developpement industriel: l'action de la DGRST en faveur du developpement des calculateurs electroniques", Conservatoire des arts et metier, Deuxième colloque sur l'histoire de l'informatique en France, P. Chatelin et P-E Mounier-Khun (eds) Paris, 24, 25, 26, avril 1990, p. 337.

Centre National d'Études en Télécommunications (CNET). Towards the end of the 1950s, most of the CNET's research "[a]ssignments were... aimed at solving outstanding problems in the French network severely damaged by the war. Priority was given to the trunk service, to restoration of its network of long-distance routes and to its expansion."[284]

The concern of the French electronics policy was the building of a real-time communication system according to US component standards and in conformity with the transatlantic regime's doctrine of rationalization, standardization and interoperability. Within this regime which was as yet unquestioned by France, between 1945 and 1958 the CCT and DGT worked in coordination with NATO telecommunications organizations that included the European Military Communication Coordination Committee (EMCCC) and its subcommittees, the European Long Lines Agency (ELLA) and the European Radio Frequency Agency (ERFA). During this period, CNET research was applied mostly in the field of transmission: studies on radio relay links and on multiplexing[285]. Given the backwardness of the French electronics sector, electronic switching[286] remained for CNET "[a] field of activity which was reduced to a very minor role: mainly studies leading to the development of electromechanical systems with very low capacity."[287] In terms of research for more

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[284] R. J. Chapuis and A. E. Joel, Electronics, Computers and Telephone Switching. A Book of Technological History as Volume 2: 1960-1985 of 100 Years of Telephone Switching, op. cit. p.218

[285] Multiplexing is a digital telecommunications procedure using one channel for several messages through a time-division multiplex system. The latter allows multiplex digital transmission after the process of measuring at regular intervals the level of varying (analog) waveforms in order to convert them into a suitable digital form. Cambridge Dictionary of Science and Technology, op. cit., pp. 592, 782 and 783.

[286] In telecommunications, this is "[t]he provision of point-to-point connection between constantly changing sources of information and their intended recipients", Cambridge Dictionary of Science and Technology, op. cit., p.876.

[287] Idem. p.218.

complex systems such as time-division multiplexing, CNET engineers were reduced to keeping abreast with what was being done in the United States. Thus, they conducted only theoretical studies of the principles of electrical logic circuits that had emerged in the computer industry at IBM and in telecommunications at Bell Laboratories in the mid-1950s[288].

While CNET engineers were still incapable of building an adequate telecommunication system, at the transatlantic level, France was among the countries that sought interdependent relations with the United States and for this reason it refused standardization and argued only for interoperability. However the technical interoperability required by a more interdependent relation with the US maintained CNET engineers in a weak position in the development of modern electronics. To overcome such weakness characteristic of many French industrial sectors and to strengthen French domestic manufacturing capacity, at the end of the 1950s General de Gaulle's government gave a high priority to scientific research.[289] This government instituted the co-ordination of different ministries' scientific research and co-operation between scientists and the government executive. The same year, the government Order in Council of 1958 created a supreme body for science policy, the *Committee of Ministers for Scientific and Technical Research* (CIMRST). The Committee was assisted by the *Advisory Committee for Scientific and Technical Research*(CCRST). The activities of the CIMRST and the CCRST were coordinated by a secretariat headed by a General Delegate who also was a Prime Ministerial appointee. Later in 1961, members of this secretarial office became members of the *Commissariat Général du*

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288 Idem

289 G. Ramuni, "Entre recherche fondamentale et developpement industriel: l'action de la DGRST en faveur du developpement des calculateurs electroniques»", op. cit., p. 337.

Plan.[290] These two committees had a joint secretariat that was in fact a standing body responsible for investigation and synthesis: the *General Delegation for Scientific and Technical Research* (DGRST) that was also created in 1958.[291]

According to the terms of Order in Council No.58.1144, the chairman of the DGRST worked also in liaison with the *Commissaire Général du Plan.* While the *Secretariat for Scientific Research and Atomic and Space Questions,* the *General Delegation for Scientific and Technical Research* (DGRST) and the *Commissariat Génér ile du Plan*'s concern was with technical development. The 1958 Order in Council No.58.1144 was modified in 1960 and 1961 to enable the DGRST to undertake synthesis, evaluation and analysis similar to that of the US *Project Forecast.*.[292]

In this setting, military research had its own institutions: the *Committee for Scientific Action for Defense* (CASD) and *Directorate for Research and Experiment* (DRME) created in 1958 by Order in Council which set the terms of reference under which both organisms have functioned. Generally their role was to forecast "... in co-operation with Defense Staffs, the perspectives opened up by science in order to determine the lines of research to be pursued and then to carry out such research in a sufficiently disinterested manner."[293] This was not the emergence of a "scientific state" as R. Gilpin and J. Schmand would have us believe. It represented the French military's attempt to orient the field of science to their own objectives. Thus, even in France, the mode of association between the military and science was provided by the transatlantic discourse on "big science" that shaped the French policy process along the

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290 Idem, pp. 337-8

291 OECD, Country Reports on the Organization of Scientific Research: France., Paris, OECD, 1964.

292 OECD, Review of National Science Policy: France, op. cit., p.21.

293 Ibid., p. 3.

lines of the US Project Forecast. In effect, CASD and the DRME, (just like the US Air Force Office of Scientific Research (AFOSR)) were established by the French Ministry of Defense to "identify and intensify pioneer work likely to guide the nation's armaments policy in the long term."[294]. It is worthwhile mentioning that both CASD and DRME's work was not so much concerned with the immediate logistic requirements of the French Armed Services. These requirements were taken over by the *Delegation Ministerielle pour l'Armement* (DMA). In this sense, the DMA's role was similar to that of the US Air Force Logistics Command (AFLC).

The supreme organ of French science policy, the *Committee of Ministers for Scientific and Technical Research* (CIMRST), was chaired by the head of government himself, the Prime Minister. Thus, when I use the term "government", I refer directly to the Prime Minister and its council of ministers, the executive power including the *Secretary of State for Scientific Research and Atomic and Space Questions* and ten other ministers whose heads were responsible for government scientific research in: Education, Defense, Finance and Economic Affairs, Industry and Commerce, Agriculture, Public Health and Population, Post and Telecommunications, Public Works, Foreign Affairs and Co-operation.

While the chairman of the DGRST was both a member and a *Rapporteur* to the CIMRST, the chairman of the *Advisory Group for Scientific and Technical Research* (CCRST)' s role was merely to advise the CIMRST. Thus, the CIMRST was the highest decision-making body for all government scientific and technical research. According to the terms of reference in the 1958 Order in Council, CIMRST had the responsibility of submitting

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294 Ibid.

> ... proposals to the Government for the development of scientific and technical research and in the light of the Plan (for economic and social development) [and] draft programmes for equipment and reallocation of resources, particularly the credits to be appropriated to the various Ministers under the national budgets[295].

It is also worthwhile noting that the *Advisory Group* (CCRST) 's decisions were not subject to majority rule by the CIMRST. CCRST's decisions were rejected or accepted by the Prime Minister who in turn presented them to the Council of Ministers and the Parliament for final decision. The CCRST's advice concerned all research programs covered by the period of the Plan and gave guidelines for the government's budgetary and general policy in scientific and technical matters.

However, CCRST advice did not concern the armed services, telecommunications and atomic energy sectors. Government subsidies to these sectors did not fall under the normal budget. Telecommunications, atomic energy and other military procurement were subsidized under the category of extra-budgetary expenditures. In this sense they were outside the control of the CIMRST, CCRST and DGRST, which were constrained to civilian matters. Since the French electronics policy was heavily influenced by military considerations, the separation between normal budget and extra-budgetary expenditure put the military-oriented institutions such as the DRME, CADS, CCT, CNET and DMA in an advantaged position.[296] The power advantage of these institutions derived not only from their military orientation. They also benefited from their direct relation with the French presidency, whose military scientific advisers had influence on not only public laboratories such as CNET but also on private companies such as the *Companie de Téléphonie Sans Fils* (CSF),

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295 This is an OECD's translation of the Order in Council No.58.1144. OECD, Review of National Science Policy: France, op. cit., p.21.

296 P. Fred, "Le rôle de la DGRST", Nouvelle frontière, N°8, 1964, p.42.

Electricité de France (EdF), the *Compagnie Générale d'Électricité* (CGE), the *Compagnie Européenne d'Automatisme* (CEA) and the *Société d'Électronique et d'Automatisme* (SEA).

4.2 THE 1950S FRENCH MILITARY INDUSTRIAL ALLIANCES IN THE ELECTRONICS SECTOR

The French military's attempt to link the domain of science to their objectives was accomplished concomitantly with their intervention in the electronic industry. This intervention was not motivated by a wish to increase the productivity rate of this industry, as Marxists might suggest, but rather was induced by telecommunications problems created within the transatlantic discursive regime. Here the discursive elements such the fusion between computers and telecommunications and digitization played a considerable role in shaping the French universe of political discourse in ICT and creating industrial alliances between American and French firms.

In effect, the French private sectors' entry into modern electronics was also through defense. In coordination with the efforts made within the public laboratory, CNET and under the Air Force advice, SEA was created in 1947 to develop specialization in analog and digital computations and industrial automation. SEA's first digital computer, the *Fisaugraphe* ordered by the French Air Force in the late 1940s for telecommunications, was produced in 1952. It was the French version of the Whirlwind experimental air defense computer. However, unlike the Whirlwind, the *Fisaugraphe* was not a stored-program computer as French had yet to master ferrite. The *Fisaugraphe*'s central processor unit was simply made of vacuum tubes. Despite its archaism, this machine was proudly presented in 1952 in Paris at the *Salon du Progrès* as the most up-to-date French calculator.[297]

In 1955, three years after the construction of the *Fisaugraphe*, the SEA built the CAB 2000, an interception device that was capable of 'hash coding', a data processing technique through which a machine such as the CAB 2000 generated meaningless numbers from coded data items. The following year, in 1956, SEA built a scientific and management version of the CAB 2000. In 1957 the French Armed Services and the French Air Force financed research done by an SEA team for a machine that used new magnetic techniques. In 1958, SEA manufactured the CAB 3018, a flight simulator for MATRA (a publicly owned missile company). The CAB 3018 failed to meet the specifications of the French air defense. In 1960, SEA manufactured its first general-purpose computer, the CAB 3030. This machine was not ordered by the military but was produced under a contract from the *Comptoir des Produits Sidérurgiques*.[298]

Military telecommunications were not the only reason for the French military to intervene in the electronic industry. The other motivation was their project to build a domestic nuclear capability. This was not so much a project for technological glory or nuclear self-sufficiency but an attempt to foster political independence in defense decision-making while French territory was still part of NATO military structure. The move towards nuclear autonomy was undertaken by INTERTECHNIQUE an affiliate of Dassault, the French aeronautic firm. Originally, INTERTECHNIQUE was established to provide the French aeronautics industry with equipment that could not be found in France. In 1955, however, when the Ministry of National Defense estimated

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[297] F. H. Raymond, "Une aventure qui termine mal: la SEA", In P. Chatelibn (eds), Colloque sur L'histoire de l'Informatique en France, Vol. 2, Grenoble 3-4-5 mai 1988, p. 375.
[298] Ibid. pp.378-379.

that the growth of the aeronautic industry was about to stagnate.[299] it advised INTERTECHNIQUE's headquarters to shift interest from aeronautics to nuclear technology. Thus, in 1956 the company began to specialize in nuclear instruments. This specialization brought INTERTECHNIQUE into the field of digital processing techniques. In 1957, when EdF required digital computer for replacement of its analog machines, INTERTECHNIQUE bought a production license from the American company THOMSON RAMO WOOLRIDGE (TRW) to build transistorized digital computers.[300]

The failure of SEA to supply the French Air Force with suitable digital computers and Dassault's withdrawal from the nuclear instruments sector opened the computer sector to CSF.[301] In 1958, CSF also established an alliance with TRW and created a subsidiary: the *Compagnie Générale des Semi-conducteurs* (COSEM). Moreover, in 1959, the CSF was allied with INTERTECHNIQUE to create the *Compagnie Européenne d'Automatisme* (CEA). The alliance between CSF and TRW was encouraged by the French military because the French air defense needed time-sharing and real-time military communication systems that used transistors and the latter were not available in France. CSF justified this alliance by referring to the objective of developing Central Processor Units similar to those used in the SAGE

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[299] O. Darrieult, "Intertechnique: Une voie française en informatique", P. Chatelin and P. E. Mounier Khun, Deuxième Colloque sur l'Histoire de l'Informatique en France, Paris, 24 25 26 avril 1990, p.74

[300] INTERTECHNIQUE involvement in the emerging French nuclear sector did not please Marcell Dassault, the owner of the Dassault aerospace company. As consequence, Marcel Dassault withdrew his participation from INTERTECHNIQUE's capital Ibid

[301] Throughout the 1950s, CSF was the prime defense contractor. It accumulated 25% of the industry turnover in 1960. Half of the company's revenues came from its sale of military equipment which constituted 57% of its export. While R&D played a major role in the company's dynamism, most of it was for military purposes. The company was larger than Bull, had diversified electronics firms whose main activity was in professional electronics but was not specialized in computers. Ibid

system in order to enable France to follow the development of NATO's NADGE system. With its alliance with TRW, CSF was convinced that it would be able to fulfill NATO electronic components standards. It stated that:

> *L'objectif essentiel concerne les performances en commutation. On s'efforcera, dans les limites exprimés ci-dessus, de caractériser le type exact d'élément conforme* ***aux listes guides NATO existantes ou à venir,*** *en vue de pouvoir étudier l'utilisation du transistor proposé au domaine militaire. Cet effort comprend: le développement technologique et électrique d'un transistor de commutation rapide de moyen courant, spécifié et présentant des garanties de fiabilité ... l'étude et la réalisation technologique de transistors de commutation capables de répondre aux impératifs de performance et de prix nécessités par la nouvelle génération de calculateurs.*[302] [emphasis in original]

Although CSF was not familiar with computers, its research department was confident that its experience in electronic switches and commutations would enable it to contribute to French air defense. Their confidence was bolstered by the fact that the computers needed to fulfill NATO inter-operability requirements were not electromechanical office machines or analog scientific machines in which BULL, the first French computer maker, was specialized. Pierre Schouler the technical director of the *Companie des Semiconductors* (TRW and CSF joint-venture), maintained that:

> *Les calculateurs modernes sont équipés de mémoires principales à grande capacité (8192 adresses par exemple)dont la lecture s'effectue suivant le principe de la coïncidence; le temps de cycle de fonctionnement de ces mémoires est compris entre 5 µs et 7 µs. Les calculateurs de l'avenir devront être équipés de mémoires principales fonctionnant avec un temps de cycle n'excédant pas 2 µs.* ***Il n'existe pas à l'heure actuelle un fabricant en France de tores de ferrite suffisamment rapides pour remplir cette condition, et dont le courant de commande soit compatible avec une électronique associée de prix acceptable***[303]. [my emphasis]

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302 CAC, 77/321, Article 720, Compagnie Générale des Semiconducteurs St-Egreve (Isère), Declaration d'intention. Etude de diodes silicium de commutation pour calculateurs, Avril 1964, p.2.
303 Ibid., p.6

The last sentence of this statement is not true because there was IBM-France which, since the mid-1950s, worked for the French air defense.[304] Inspired by its parent company, IBM-USA, in 1959 IBM-France created a military division and developed indigenously, a germanium-based transistor with which it manufactured a series of equipment for all three armed services. It built the first generation of computers that were used in the *Système de Traitement des Informations de Défense Aérienne* (STRIDA), the CAPAC II and III. These digital computers were connected to radars and performed air surveillance and fire control. With these computers, it was possible for the STRIDA to be part of NATO air defense network, the NADGE system. Moreover, IBM-France also built the PACA computer for missile guidance for the French Navy and the BGEa computer as a shipborne version of PACA.[305]

As Table 10 shows, IBM computers dominated French military procurement. French companies' incompetence in new components made IBM-France the only company able to satisfy defense demands. Between 1959 and 1965, the IBM 370 computer series replaced the STRIDA generation: the CAPAC I and II. The IBM 370 computer was not only used for air defense. The French Navy also used IBM 370 versions in the MASURCA Mk II armament system, in several frigates and incorporated them into COLBERT, a French mainbattle navy ship.[306]

IBM dominance was not only in military communications. French nuclear scientists also utilized IBM computers. After experimenting with FERRENTI's

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304 Although this company is an IBM-USA subsidiary, the company was registered in France since 1924 as a French company. It was the only company that was able to supply French defense with digital computers, without a co-operation agreement with a foreign partner

305 O. Darrieult, "Intertechnique: Une voie française en informatique", P. Chatelin and P. E. Mounier Khun, Deuxième Colloque sur l'Histoire de l'Informatique en France, Paris, 24 - 25 - 26 avril 1990 p.87

306 Ibid., p.87

Mercury computer and attempting to use the BULL Gamma 60 computer, the *Direction des Applications Militaires* and the civilian department, both sections of the *Commissariat d'Énergie Atomique* (CEA) bought several versions of IBM computers. This decision was motivated by the inability of the French computer industry to cope with the new military environment within which French defense policy evolved by following US practice.[307]

If we take from Table 10, only the computers ordered, quantitatively, the division between IBM (20), LCT (8), SAGEM (12), CAE (51) favored the French constructor, CAE and not IBM. However, the RW 130 and 133 computers were not built with French technology. These computers were built under license from the American company TRW, and, from 1965 the IBM-France CAPAC III replaced the CAE RW 130 computers (33 machines) in missile guidance. This change left CAE-TRW products only in submarines. As a result of this change, in 1965, IBM-France dominated the French military market not only in communications but also in missile guidance with its CAPAC III series which were replaced in 1975 the IBM 370 series.[308]

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[307] A. Amouyal, "Les début de l'informatique au Commissariat de l'energie Atomique", In P. Chatelin et P.E. Mounier Khun (eds), Deuxième colloque sur l'Informtique en France, op. cit., pp.11-25.
[308] H. Boucher, "L'informatique dans la défense", op. cit., p.87.

Table 10: Digital computers used by French defense between 1951 - 1965.

Date	Name of computer	Company	Technology	Mission	Status
1951	CUBA	SEA	Tubes	Simulator	In study
1953	SABA	SEA	Tubes	Simulator	In study
1953	DTL	LCA	Tubes	Torpido - Fire control	In study
1954	CAB 3018	SEA	Tubes	Air navigation computer	In study
1956	DORETHEE	SEA	Germanium	Artillery fire control	In study
1956	**PACA I**	**IBM France**	**Germanium**	**Simulator**	**In study**
1957	DORETHEE	SEA	Germanium	Missile guidance sytem	Protype
1958	**PACA II**	**IBM France**	**Germanium**	**STRIDA Communications**	**2 ordered**
1958	**CAPAC I**	**IBM France**	**Germanium**	**Missile guidance system**	**In study**
1958	CAB 3118	SEA	Tubes	Artillery fire control	In study
1959	**CITAC I**	**IBM France**	**Germanium**	**STRIDA Communications**	Prototype
1959	**CAPAC II**	**IBM France**	**Germanium**	**STRIDA Communications**	Prototype
1960	**BGAe**	**IBM France**	**Germanium**	**Missile guidance system**	**8 ordered**
1960	**CAPAC II**	**IBM France**	**Germanium**	**STRIDA Communications**	**Series**
1961		LCT	Germanium	ICBM (Missile detection)	8 ordered
1962		SAGEM	Silicium	ICBM (Missile detection)	6 ordered
1962		CROUZET	Integrated circuits	Airborne computer	In study
1962	**CITAC II**	**IBM France**	**Germanium**	**Artillery**	**10 ordered**
1963	**CAPAC III**	**IBM France**	**Germanium**	**STRIDA Communications**	**prototyp.**
1963	**CAPAC III**	**IBM France**	**Germanium**	**STRIDA Communications**	**In study**
1963	RW130	CAE	Germanium	Missile guidance system	33 ordered
1963	RW133	CAE	Germanium	Submarine shipborne	18 ordered
1964		SAGEM	Silicium	ICBM Missile detection	6 ordered
1964		SAGEM	Silicium	Airborne computer	In study
1964	**SERPEL**	**IBM France**	**IBM-360**	**Simulator**	**In study**
1964	**SITERE**	**IBM France**	**IBM-360**	**Simulator**	**In study**
1965	**CAPAC III**	**IBM France**	**Germanium**	**RADIAN (Missile)**	**Series**
1965	**CAPAC III**	**IBM France**	**Germanium**	**ICBM Detection**	**In study**

Reference: H. Boucher, "L'informatique dans la défense", in Colloque sur l'histoire de l'informatique en France, op. cit., p.95.

Besides CSF, SEA, CEA and IBM-France there were also *Signaux et Entreprises Electriques*; the *Companie Générale d'Électricité* (CGE), *Companie des Compteurs* (CdC), *Compagnie Française Thomson Huston* (CFTH) and *Alsacienne de Construction Mécanique* that all with the exception of BULL contributed to French defense electronics[309]. However, these companies were unfamiliar with computer

[309] R. A. Mallet, Apercus de l'électronique française, Cédit de l'Ouest 1954.

architecture and new computer components, especially transistors. Given their technological incompetence, they proposed that in order to contribute to the new French defense they should be associated with American companies specialized in the field.[310] By 1962, the CGE had chosen a license from the American company, Scientific Data System (SDS), to participate in the French nuclear program and the *Compagnie des Compteurs* also bought a license from the American company PACKARD BELL. While all of these French electromechanical companies sought to introduce themselves on modern computing through American licenses, only BULL remained aside.[311]

Since 1931, BULL's activities were under the jurisdiction of the *Service des Machines de Précision* of the *Ministère de la Production Industrielle et du Commerce*. By 1935, it had built 60 mechanic calculators and with these machines it conquered 15% of the French market. It surpassed SAMAS[312] and became the main IBM competitor in France. In the years following the Great Depression, BULL gained market share in Belgium, Switzerland, Italy and the Scandinavian countries. Unlike IBM whose European subsidiaries had their own factories, BULL's production was centralized in France. Until the late 1940s, with its own mechanical techniques the company was the largest French producer of office equipment. With its 385 machines installed, BULL surpassed IBM in the French market.[313]

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310 "Fiche à l'attention de Monsieur le Minsitre d'État", op. cit, p.86

311 H. Boucher, "L'informatique dans la défense", op. cit., p.88.

312 SAMAS is for *Société Anonyme des Machines à Statistiques* created in 1923. It distributed the equipment of Accounting and Tabulating Machine, a subsidiary of the British company Powers Accounting Machines Co., itself created in 1911 in the United States by James Power.

313 P. E. Mounier-Khun, "Bull: 70 ans de traitement de l'information", Deuxième colloque sur l'Informatique en France, Conservatoire des Arts et Métiers, Paris, 24 - 25 - 26 avril 1990, pp.273-284.

In the early 1950s, the French Ministry of Industry and Commerce protected[314] BULL's French market from foreign suppliers by imposing import quotas on IBM while BULL signed an agreement with REMINGTON (an American company) to distribute BULL's machines in the US. In 1948, as the use of mechanical techniques for calculators matured, BULL sent a team of engineers to the United States to review new breakthroughS in electronics. In 1951, upon their return from the US, these engineers built the *Gamma 2*. This machine was based on germanium and used delay line techniques for stored programs[315]. During that period, the company acquired from REMINGTON-RAND UNIVAC the magnetic amplifier technology at the same time as the latter replaced that technology with a transistor. In 1953, BULL introduced the *Gamma 3* at the same time as IBM entered the electronic computer industry, and a little after the British firms FERRENTI and ENGLISH ELECTRIC. The *Gamma 3* was in fact a response to the IBM 604 computer. The success of the *Gamma 3* of which 1,200 were made, was at the origin of the company's rapid growth between 1953 and 1958. During that time BULL had more than 45% of the French government computer market and this without direct financial help from the government.[316] In 1957 the *Gamma 3* and its modified version the *Gamma Extension Tambour* (ET) were used unsuccessfully by the *Institut Blaise-Pascal* of the CNRS, the University of Grenoble and the nuclear center of Marcoule.[317] In 1960 when BULL's contract with REMINGTON RAND UNIVAC ended, it stood alone in its confrontation with IBM.

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[314] A. J. J. Bothelho, "The State and The Political Construction of Informatics in France and Brazil", In P. Chatelin et P.E. Mounier Khun (eds), Deuxième colloque sur l'Informatique en France, Conservatoire des Arts et Métiers, Paris, 24 - 25 - 26 avril 1990, p.11.

[315] B. Leclerc, "Gamma 3 et Gamma ET de Bull: Du Calculateur à l'Ordinateur",In P. Chatelin et P.E. Mounier Khun (eds), Deuxième colloque sur l'Informtique en France, op. cit., p.175.

[316] OECD (Directorate of Scientific Affairs), Gap in Technology Between Member Countries, op. cit., p.73

[317] P. E. Mounier-Khun, op. cit., p. 290.

This was the situation where BULL had been obliged to buy an RCA license to manufacture and commercialize the 304 RCA computer model under the name of «Gamma 30».[318]

The completion of the SAGE system and its many technical breakthroughs described in the Chapter Two hurt BULL in the French scientific, military and industrial automation market. As French military and nuclear scientists began to look towards the US for new equipment, BULL's share of the French market began to decline. Moreover, the company was heavily indebted and it was also unable to sell its products in both French and international markets. This was due to both market and technical failures of the company's latest product the «Gamma 60». In spite of the machine's technical sophistication, it could not generate enough turnover to cover its research and development costs. In addition, the «Gamma 60» contained several technical shortcomings that were intolerable, considering the machine's high cost. Furthermore, while the absorption of the high production cost of the machine required a large market, the «Gamma 60» was designed for a restricted use: scientific calculation. Along with these difficulties, the structure of the Gamma 60 was not flexible and that did not allow the customer to use it for purposes other than those designed by the company. BULL itself was unable to convert it for purposes other than for the one initially designed.[319]

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[318] B. Leclerc, "Le Gamma 60: une aventure humaine et technologique", in P. Chatelin (ed) Colloque sur l'histoire de l'informatique en France, Grenoble 3-4-5 Mai 1988, pp. 293 - 7

[319] C.A.C 77/321 Box No. 995, "Fiche à l'attention de Monsieur le Ministre d'État", June 8, 1964, pp.1-2

4.3 THE FRENCH POLICY OF INTERDEPENDENCE AND THE FOURTH PLAN'S ELECTRONIC AND COMPUTER DEVELOPMENT PROGRAMS

One year after the Semi-Automatic Ground Environment system was declared operational in the United States in 1959, and while the French and other Europeans were questioning the Pentagon-NATO standardization policy, the twelve members of the CCRST wrote a number of reports about the state of several scientific disciplines in France. Among these reports was one written by A. Lichnerowicz and entitled *Calcul effectif.*[320] The starting point of Linchnerowicz's assessment was the observation that numeric calculus had changed qualitatively the conduct of fundamental and applied research. This analysis led him to plead for the creation of a national calculus center. Linchnerowicz believed the center would fulfill several tasks: training; the diffusion of new techniques and the production of scientific computers. Furthermore, he felt the center could perform industrial and commercial activities like any other private enterprise.[321]

Several problems beset Lichnerowicz' s project. First was the lack of French specialists in the new computer techniques. Second was the resistance from the *Conseil des ministres* led by the finance minister, who were reluctant to create a new research structure. This was also a concern stemming from the Education Ministry which saw the creation of the calculus center as an encroachment.[322] Given these obstacles, the center was not established. However, the idea to develop an endogenous computation capability remained among the government's primary concerns. In 1961, during the preparation for the Fourth Plan, among the several issues debated within the French

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320 A. Lichnerowicz "Calcul effectif", Archives National (thereafter AN) AN/87/0401/142 115/ R48
321 Ibid. See also G. Ramuni, op. cit. p. 339.
322 Ibid.

government was again the state of the national electronics industry. On this occasion, the government decided to intervene by establishing new research structures designed especially for the development of electronics. The objective was co-ordination of the different government departments' research efforts in electronics.[323]

Accordingly, an order-in-council of March 27, 1961, created the Permanent Electronics Commission of the Plan (COPEP). COPEP was a platform of discussion of French policy in electronics. It regrouped members of the DGRST, DRME, CNET, CCRST and the *Commissariat Général du Plan* who dealt specifically with electronics. Its mandate was to propose a policy for the expansion of the electronics industry during the next ten years and to elaborate procurement policy. Although it translated different governmental concerns over electronics, it was chaired by a military officer Admiral Congé appointed as COPEP president. Mr. Lescop (the director of the *Département des industries mécaniques et électriques du Ministère de l'industrie*) was appointed vice-president[324]. COPEP designed the electronics policy of the Fourth Plan.

The lack of co-operation between the French computer and telecommunication sectors was pointed out by COPEP members as the major structural weakness of the French computer and electronics industry. The first COPEP report[325] dated August 10, 1961, pointed to the technological backwardness of the French electronics industry and to the need for special government policy in this sector. It proposed greater use of electronics components in the manufacturing of any type of computer. Furthermore, COPEP advised that, in the future, the government should include in its modernization

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[323] Idem.

[324] G. Ramouni op. cit., 340.

[325] C.O.P.E.P. «Proposition d'une action spéciale en faveur de l'élecronique», 10 août 1961, No. 61-12/ C.O.P.E.P.

program a computer development initiative for the purpose of translation and documentation[326].

During the same year, the DGRST proposed three kinds of government action: (1) direct intervention through offers of research contracts to national companies; (2) government direct financing of research for the equipment that it orders or (3) company's self-financing that would link the ratio of its research expenditure to the volume of its sale of equipment to the government. The DGRST was particularly in favor of this last approach. To guarantee the success of this approach, it excluded offshore procurement of electronic equipment[327], favored "concerted action" measures that would co-ordinate and orient electronic research (public institutes[328] and private companies) with a nationwide electronic procurement program in the government and private sectors. Following these suggestions, on October 10, 1961, on the COPEP suggestion, the government adopted an "Electronic Concerted Actions" and an electronic components research budget.[329]

Although the DGRST's plan favored protectionism it was not clear that COPEP "Electronic concerted actions" would follow the DGRST. From the COPEP point of view, these "concerted actions" were not meant to overcome dependency on US research. It was a training program to familiarize French engineers with the latest

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326 Ibid.

327 The D.G.R.S.T. maintained then that the recent C.N.R.S. decision to procure the I.B.M. 7054 computers for its scientific centers must be blocked because such an offshore procurement practice would constitute a loss of opportunity for French companies. See Premier Ministre/D.G.R.S.T. "Projet de rapport du Délégué Général à la Recherche Scientifique et Technique à Monsieur le Premier Ministre", N°IN/47/NC, op. cit., p.5

328 These are:the Conseil national de recherche scientifique (C.N.R.S.); the Conseil national des études en télécommunication (C.N.E.T.), the Commissariat d'énergie atomique (C.E.A.) and Électricité de France (E.d.F).

329 Premier Ministre/D.G.R.S.T. "Projet de rapport du Délégué Général a la Recherche Scientifique et Technique à Monsieur le Premier Ministre", N°IN/47/NC, op. cit. p.6

American advances in the sector. There was a serious contradiction between a user policy and manufacturing perspective that opposed COPEP and the DGRST. From the beginning, the DGRST industrial policy was in a difficult position. While modern computers used semiconductors, there was no research in this sector undertaken either by French private companies or public institutes. The reason was the military oriented public institutions had no intention of reinventing the wheel. Their priority was to equip French air defense and nuclear research with real time and digital equipment.

The dominant French bureaucracies did not wait until the 1970s to realize that war against American multinationals was not possible. Back in the early 19[illegible]s, they understood the limits of their power to challenge the transatlantic regime. Even as they sought interdependence within the framework of transatlantic interoperability, in 1962, a document - produced jointly by the *Commissariat Générale du Plan*, the CCT, the Prime Minister Office, the Ministry of Education, Ministry of the Armed Forces, the Bureau of the Chief of Staffs and the *Chargé de Mission à la Présidence* - stated clearly that there was no reason to worry about the presence of foreign electronics companies on French soil. Their presence could in the future favor the French balance of payments:

> *Il n'y a pas raison de s'alarmer du nombre et de la puissance des industries étrangère installées en France, dans le mesure où quelques firmes contrôlées par nos propres capitaux peuvent parvenir à atteindre elles aussi un niveau valable de compétition technique. Cette situation est déjà et deviendra au cours des prochaines années un élément favorable de notre balance commerciale comportant parfois des entrées invisibles importantes, tel que par exemple le marché intérieur international d'IBM.*[330]

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[330] CAC 77321 Box 719, Lemerle (Commissaire au Plan), Amiral Conge (President du Comité de Coordination des télécommunications, Delmont (Chargé de Mission auprès du Premier Ministre), Aigrain (Directeur Général de l'Enseignement Supérieur - Ministère de l'Education) Sallebert (Conseiller techniques au Minstère des Armées), Loste et Daniau (Chargé de Mission à la présidence), Commandant Franchet (Etat major particulier à l'Elysée), Dossier Calculateur, Fiche sur les calculateurs et les appareils de traitement de l'information Paris, 2 avril 1961, p. 3.

Unlike the DGRST, not only were these actors not protectionist, they also saw the benefit of a user policy developed by the OECD Secretary General. They understood that national self-sufficiency was not the option and it was wise to use American computers in defense, industrial organization, public administration and scientific research. They stressed that:

> *Bien que le marché des calculateurs soit un de ceux qui se developpe les plus rapidement, ce n'est pas son volume financier qui retient l'attention, mais l'incidence que les appareils et les techniques nouvelles de traitement de l'information auront de plus en plus sur l'ensemble des activites nationales (défense, organisation industrielle, administration, recherche, etc.)*[331]

The similarity between this analysis and the view of the OECD Secretary General is striking. The French actors who were responsible for military procurement, telecommunications and nuclear energy although previously having contested the NATO rationalization discourse, towards the mid-1960s, tended to agree with the OECD Secretary General's specialization approach. They maintained that the French electronics industry could compete internationally by developing expertise in areas where IBM was absent or weak. They argued that:

> *...la position de la société IBM est exceptionnelle puisqu'elle fabrique les 3/4 des calculateurs vendus dans le monde. Cette position est cependant loin de décourager toute concurrence. En effet, IBM se doit de couvrir avec une gamme de matériel homogènes, toute la variété des besoins. C'est pourquoi il est facile, à condition de limiter ses ambitions à un "créneau" relativement modeste dans la variété des tailles ou des utilisations, de faire mieux qu'IBM, et pas plus cher.*[332]

Moreover, in conformity with the OECD General Secretary's user approach, COPEP members emphasized that the modernization of French electronics depended not on technology push but on demand pull. In other words, the French industry could

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[331] Ibid., p.1.
[332] Idem, p.2.

not innovate if there was no demand for high quality and sophisticated information processing. The same document asserted that:

> *il est vrai que c'est la miniaturisation des composants électroniques qui a permis le développement des calculateurs, ce sont ces derniers qui constituent déjà le principal débouche pour les semi-conducteurs...Leur part en valeur etait superieure au tiers en 1960 et elle devrait s'accroitre de beaucoup dans l'avenir*[333]

It could be argued that this convergence of views between sectors of the French government and the US National Science Foundation and the alliances between French and American companies represent a hegemony in the neo-Gramscian sense or the fact that the French government did not reject the user approach shows the effectiveness of a regime in the liberal sense. However, where both theories see only transatlantic cohesion, we detect contradiction. Thus, it was the above-mentioned actors' concern with their country's technological and political vulnerability vis-à-vis the United States that led them to take what they believed to be scientific and technological measures needed to avoid subjecting their independent nuclear and military policy to an eventual US technological embargo.

The joint document cited above asserted that:

> *Il . est important de voir se maintenir dans notre pays quelques groupes libres vis-a-vis des capitaux d'Outre Atlantique. Située a la pointe du progres technique, l'industrie des composants des calculateurs (comme d'ailleurs l'industrie des composants électroniques) doit être en mesure de nous mettre a l'abris des "embargos"...de certains composants électroniques.* ***Il n'est d'ailleurs pas besoin pour éviter ces "interdits" de fabriquer effectivement tous les matériels visés, mais d'être capables de le faire dans le cas échéant à des prix plus élevés et dans des délais pas trop longs. Il suffit que l'effet d'un éventuel "embargo" ne soit pas réellement déterminant pour que le risque soit écarte*** [334] [my emphasis]

[333] Idem, p 1
[334] Idem, p 3

Despite COPEP's policy of interdependence and under the fear of an eventual American embargo, that the Fourth Plan's research program was oriented towards five basic research areas: (1) Solid State Physics that was concerned with research on material in order to develop knowledge on magnetism, supraconductivity and ferroelectricity, (2) semiconductor and microelectronics that also dealt with material, (3) quantum electronics that emphasized research on lasers and their use in telecommunications, (4) plasma physics for application in radioelectricity and (5) dependability of components for definition of methods and launching of eventual pilot factories.[335] The government allocated 65 million FF to basic research programs. It should be noted that this amount did not aim to produce equipment but to familiarize French researchers with American advances.

Table. 6: Research in electronic components during the IV° Plan

Discipline	Number of contracts	Number of new and renewed contracts	Value of contracts in millions New French Francs	Percentage
SOLID PHYSICS	69	95	26.2	38.9
SEMI-CONDUCTORS	53	77	18.2	27
QUANTUM ELECTRONICS	35	41	8.8	13
PLASMAS	22	33	5.3	7.8
DEPENDABILITY	34	38	9	13.3
TOTALS	213	284	67.5	100

Sources: CAC/77 321/729 D.G.R.S.T / Comité de l'electronique. "Rapport d'activité du IV° Plan", N° FR/17/ RP

335 CAC/77321/729, D.G.R.S.T. Comité de l'Electronique, Rapport d'activité du IV° Plan, N° FR/17/RP not dated, p. 1

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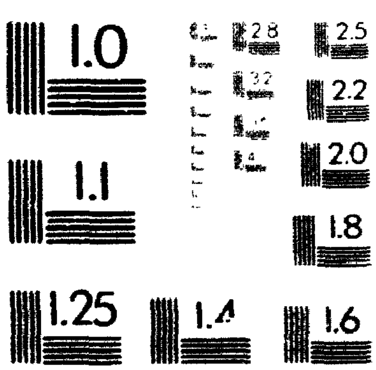
PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT



PRECISION℠ RESOLUTION TARGETS

The institutions that took part in these research programs were the Air Force laboratory, (the Service de *Traitement et de Transmission Aérienne* (STTAe)) the Ministry of telecommunications through CNET and the *Ministère d'État chargé de la recherche scientifique et des questions atomiques et spatiales* through the *Commission de l'Énergie Atomique* (CEA). Since this research was about military procurement, telecommunications and nuclear energy, the DGRST was excluded. It was the DRME that took the leading role in coordinating and supervising this program. A report on the activities of the Fourth Plan described that:

> *C'est surtout avec la Direction des recherches et des moyens d'essais (D.R.M.E.) que les liens ont été les plus étroits, car les programmes du Comité de l'Électronique et de la DRME sont fortement imbriqués, et une coordination constantes a été nécessaire, et facilement réalisée par la presence dans le comité et dans chacune de ses commissions de représentants qualifiés de D.R.M.E.* [336]

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336 Ibid., p. 2.

Table. 7: The result of the Fourth Plan Research Program

RESEARCH FIELD	SECTOR AND APPLICATION	STAGE OF PROGRESS
SOLID PHYSICS (1)Thin Magnetic Layers (C.E.N.G - L.M.T.)	Fast digital memories for computers	Laboratory fabrication in L.M.T (AT&T affiliate)
(2)Twined Magnetic Layers (C.N.R.S. - Grenoble)	Computer memories for non-destructive reading	currently studied in S.E.A
(3)Inductor (C.S.F)	Coil with high magnetic field	laboratory fabrication in C.S.F
(4)Ionic Probe	Chemical analysis and isotopic	Development realized by CAMERA
(5)Superconductor coils (Institut d'Électronique d'Orsey)	High precision magnetic resonance tuning	laboratory fabrication
(6)Ferrite (C.N.R.S. Believue)	Inductance with high coefficient of over-voltage	Current development in L.M.T.
(7)Preparation of In Bs of High Purity	Infrared detection in micro-material 0.1 to 2 mm	manufacturing in series
(8) Study on titanium (L.C.C.)	Realization of plates for integrated circuits	Industrial development made by RADIOTECHNIQUE (PHILIPS affiliate)
SEMICONDUCTORS (9)Study on semiconductors by X ray (Lang methods) (Science Faculty of Orsey)	General use in micro-electronics	Laboratory experiences
(10)Epitaxy on silicon (RADIOTECHNIQUE)	General use in electronics	Laboratory preparation
(11)Epitaxy on silicon (L.T.T)	Basic research	No industrial development in the foreseeable future
(12)General research on epitaxy	Very important technology in electronics	Industrial patent deposited - Development was underway (C.S.F)
(13)Methods of preparing As Ga. mono-crystals (Science Faculty of Montpellier) and Research in semiconductors (C.N.R.S. Grenoble)	General use in micro-electronics	Laboratory development
(14)Transistor with metal-semiconductor interface (Montpellier faculty of Science)	General use in micro-electronics Possibility of realization of diodes matrix tunnel for calculators	Laboratory Development
(15)Helicon waves (E.N.S.)	Basic research	Development was too far

Table 7 continued

(16)Passivization of semiconductors contrivances - Stabilization of MOs Structures (C.S.F. and S.E.S.C.O)	Very important technology for electronic	Patent was deposited Development was under way at C.S.F. and S.E.S.C.O
(17)Micro-fabrication by ionic bombardment (Orsey Faculty of Science)	Very important technology in micro-electronics	Laboratory experiences
Quantum Electronic (18)Millimetric Masers (Grenoble Science Faculty and ALCATEL)	Telecommunications	Laboratory fabrication at ALCATEL
Gas Laser C.G.E. - C.S.F.	Diverse applications	Current development in C.G.E. & C.S.F. laboratories
(19)Parametric amplifier in light strip	Possibility of realization of millemetric lasers	No foreseeable industrial development
(20)Diode lasers of Ga. As and P Ga. As (C.S.F.)	Diverse applications	Laboratory fabrication at C.S.F.
(22)Photocatodes for Progressive tubes waves (C.S.F.)	Telecommunications	Fabrication in C.S.F. laboratories
(23)Study on the structure of Si and Sb band (Ecole Polytechnique)	Possibility of realizing millimetric lasers	No foreseeable industrial development
Plasma (24)Magnetism of Plasmas (Ecole Polytechnique)	Experiences in plasma physics	Laboratory experiences
(25)Artatron tube (C.S.F.)	Telecommunications	Industrial development realized by C.S.F.
(26) Cold emission cathode (C.S.F.)	Diverse	Fabrication in C.S.F laboratories
(27) Ceramic-metal tubes (C.N.A.M- C.F.I..)	Realization of cold alkaline and stable plasmas	Fabrication in the CNAM and CFTH laboratories

Sources: CAC/77 321/729 D.G.R.S.T/Comité de l'électronique, « Rapport d'activité du IV Plan», N FR/17/ RP. PP. 13-15.

As Table. 7 shows, the only French computer maker that was included in the DRME research program was SEA. The program was dominated by CSF and included many scientific institutions. In conformity with the view that sought to include foreign firms as part of the French technological system, ITT and PHILIPS also participated in this program through their respective French affiliates, RADIOTECHNIQUE and LMT. While PHILIPS' participation showed the will of French government to encourage European cooperation, the government invited IT&T to participate in order to benefit from the latter's expertise in satellite and airborne computers.

In compliance with the policy that sought to anticipate the effects of an eventual American embargo on components, the military did not seek to manufacture semiconductor components but to enhance the country's research capacity. This approach was opposed by the DGRST who wanted research leading to industrial development.[337] The DRME replied that the original objective of the Fourth Plan electronics program was not about manufacturing components but the development of new relationships between universities and industries in order to facilitate the circulation of ideas and to familiarize scientists with industrial problems. According to the DRME, such a policy served two purposes: first, it prepared the nation against an eventual American embargo and second, it adopted a user policy that would enable French scientists and industry eventually to develop specialization in certain areas of electronics. The DRME stated that the objective was to guarantee a rapid circulation of ideas, to orient the research of certain university researchers towards industrial problems and to help scientists and engineers to find new solutions to their problems.[338]

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337 According to an assessment made by the DGRST :

> *Si l'on considère maintenant les résultats détaillés des programmes de recherche, en raison de la nature même du programme, les plus intéressants n'aboutissent pas en général à des produits spectaculaires...des très nombreuses études qui pourrait aboutir à des applications intéressantes ne sont pas encore exploitées par suite de l'absence d'une aide au développement efficace, susceptible de prendre la suite du Comité de l'électronique. Cet effet a été très sensible en fin de Plan ...*

CAC/77321/729. D.G.R.S.T - Comité de l'Electronique «Rapport d'activité du IV° Plan», op. cit., p.3

338 Idem

From the DGRST's point of view, not only did the entire Fourth Plan electronics program fail to take into consideration the concerns of industry [339] but the research undertaken was not even original. The delegation stressed that:

> *..à l'origine de cette constatation, c'est le manque d'imagination manifeste généralement par les chercheurs. Il est en effet regrettable de constater que toutes les propositions d'études soumises au Comite, à part quelques très rares exceptions, s'inscrivaient dans un programme public. Or ce programme, par son essence même, ne peut être original. Il est necessaire que les scientifiques prennent conscience de ce fait et essaient d'y remedier dans les années à venir.*[340]

This statement is not only a criticism of the DRME but also of the OECD Secretary General's approach to science policy whose implementation by the DRME during the Fourth Plan prevented France from making an original contribution in the international electronics industry. As a result French industry's competitive position in the international electronic market would be hurt. "*...il faut reconnaître que l'action concertée n'a pas apporté une solution à tous les problèmes. En effet,... elle n'a pas pu assurer le développement des produits ou matériaux nécessaires à la prospérité de nos industries en face de la concurrence internationale.*"[341]

In short, whether the Fourth Plan's electronics research program was a success or a failure depended on the objectives of each camp. For the military-dominated sectors of the government, the research policy of the Fourth Plan was a success, in part, because it was conceived as a complementary action to the efforts undertaken by the French electronics industry through the components production contracts with

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339 According to the DGRST: "*Un autre reproche qui pourrait être fait a l'action concertee, est d'avoir "trop intéressé" certains secteurs d'activité scientifique. On peut constater en effet que les directives du Comité, jointes à celles de la D.R.M.E., on a pratiquement orienté toutes les recherches dans certains domaines, au point que le quasi totalité des publications relatives à ces sujets proviennent des contrats passés par ces deux organismes. Le cas de l'électronique est particulierement frappant* Idem, p.18.

340 Idem, p.19.

341 Idem, p.18.

American firms. This policy was also a success because the modesty of the research program prevented a higher financial waste than the DGRST industrial initiatives could have otherwise risked. Moreover, while the Fourth Plan complied with the transatlantic regime's user policy, it also secured France's military program from the effects of an eventual American technological embargo.

From the DGRST's position, however, the program was a failure because, while in the United States research in electronics was increasingly moving towards the use of semiconductor elements such as silicon, French electronics researchers were still using metals (ferrite) to develop electronic circuits. Moreover, according to the DGRST, although the OECD suggested greater industrial orientation for scientific research, most of the Fourth Plan's research results were far behind development and industrial production. They remained either theoretical or at a laboratory stage.[342]

In short, if there was a failure, it was the DGRST's incapacity to impose its views on the universe of the French political discourse in ICT. This fundamental failure of the DGRST's initiatives was reinforced the Delegation's lack of a credible industrial ally within the French industrial structure. The only company that could have supported the DGRST position was BULL, but the latter was in financial turmoil. Consequently, even the Minister of Science who was the traditional DGRST ally was reluctant to support the DGRST's industrial initiatives during the Fourth Plan. It was for this reason that the civilian dimension of the Fourth Plan's electronic policy was limited to user policy and university research in programming. A note addressed to the Prime Minister by the Minister of Science underlined that:

> *J'ai fait différer jusqu'ici l'exécution d'une partie importante du programme de recherche de la Délégation à la Recherche Scientifique Technique dans le*

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342 Idem. p.18

> *domaine des calculateurs électroniques, en raison des incertitudes introduites par l'affaire BULL. Seules ont été poursuivies cette année, des mesures à caractère universitaire portant principalement sur le traitement de l'information. Étant donné les derniers développements de l'affaire BULL, il me paraît qu'il n'y a pas lieu de tarder davantage à définir ce que pourrait être notre programme de recherche dans le domaine des calculateurs* [343]

According to the Minister of Science, he was the one who postponed the DGRST's manufacturing program. From what has been said so far, it is clear the Minister of State had overestimated his power since it was the *Comité de l'Electronique* that was dominated by the military (and within which the DGRST was in a minority) that postponed the DGRST's industrial plan. Moreover, BULL's financial problems were not the only issue since CSF faced the same problems. It will be seen in the following section that it was BULL's participation in military policy program that caused difficulties for the DGRST's industrial perspective. BULL was not willing to work for French defense and for this reason, the Minister of state's financial rescue plan to save BULL was opposed by CSF and its military allies. In order to show this, we now discuss the two computer development programs of the Fourth Plan: the *Quatre Axes* and *Hexagone* initiatives, both of which were aborted before implementation.

4.4 THE QUATRE AXES AND THE HEXAGONE

It should be noted that, for the military-dominated French bureaucracies, a policy to manufacture computer components in France for an independent French computer industry was not an option. Competing immediately against IBM in large

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[343] CAC 77/321 Box 729, Gaston Palewski, le Ministre d'État chargé à la Recherche Scientifique et des Questions Atomiques et Spatiales "Le Ministre d'État à Monsieur le Premier Ministre Object Recherche Scientifique. Action concertée dans le domaine des calculateurs électroniques ", Paris le 25. 7. 1964, p. 1.

systems or middle-sized computers was obviously unrealistic. The only possibility was an interdependent development program based on licensing agreements with US companies. This approach would allow French industry to manufacture and sell products different from those of their American licensors at the same time as it complied with military demands of interdependence and NATO requirements for interoperability. In terms of civilian technological interdependence, this was also the case of BULL's technological agreements with UNIVAC and RCA. This choice made sense within the context of the science policy designed by the OECD in the early sixties. In other words the aim of French computer policy was not so much commercial success; it was to enable French electronics firms to absorb advanced component techniques developed in the United States in order to keep a substantial protected share in the internal market. Thus, the only way to attain this objective, or so it was perceived, was to re-orient the entire French computer industry from special-purpose analog machines to general-purpose digital computers. However, the question was: who among the companies and group of companies would carry out this project: the military and their industrial allies such as CSF and CGE or BULL and the DGRST? Moreover, even if BULL were integrated into French policy whose purpose would the company serves: the development of marketable computers as the DGRST wanted or a complement to the off-shore-oriented military procurement policy as the DRME and its institutional allies required? These were the questions whose debate during the Fourth Plan (1962-1964) blocked the implementation of two computer development programs.

4.4.1 *The Quatre Axes Computer Development Program*

Despite differences in approach between the DGRST and the other institutional actors, a compromise was reached in 1962 to include BULL in the *Quatre Axes* computer development program. As its name indicates, this program was to foster co operation among French electronic and computer companies through four research and development projects. (1) The development of an embedded general-purpose computer (*Calculateur universel embarquée*[344]) that was meant to bring together the *Compagnie de téléphonie sans fil* (CSF) and BULL; (2) research on digital computer structures that was designed to ally the *Societé d'Electronique et d'Automatique* (SEA) and BULL; (3) research on a hybrid computer that COPEP gave to SEA and; (4) study of the possibility of manufacturing a scientific computer that was also meant by COPEP to bring BULL and the SEA into a partnership.[345]

As can be seen, BULL was central to the *Quatre Axes* program. However, as CSF alleged, the implementation of this program was hampered by BULL's debts. COPEP and CSF were thus confronted with the following dilemma. Either they leave out BULL and lose its experience with computers in which case, the company would likely fall into foreign hands, or they keep BULL in and seek a satisfactory solution to its financial problems. However, this solution would have taken funds from the Fifth Plan electronics research program. For the CSF, keeping BULL as an important participant in the national electronic policy would cripple the *Quatre Axes* program because BULL was not committed to defense work. To avoid this, the CSF refused to

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[344] This was a machine to be incorporated in a navy ship or aircraft

[345] C.A.C. 77/321 Box 995. "Le délégué général à Monsieur le Ministre d'État chargé de la recherche scientifique et des questions atomiques. Objet: cacalatrices électroniques. P.J un projet de lettre à Monsieur le Ministre des Postes et télécommunication", p.1.

work with BULL and formed a new partnership with the *Compagnie Européenne d'Automatisme* (CEA).[346]

For different reasons, both BULL and SEA refused to be committed to CSF/COPEP's *Quatre Axes* plan. They felt the program had little to do with their business: office automation and general-purpose computers. They believed that in shifting their priority to the program, they ran the risk of becoming subcontractors of the main defense electronic supplier: CSF.[347] Given BULL's and SEA's resistance to the *Quatre Axes* ' orientation, the DGRST (whose role was to study market and technological trends in the computer industry at the global level in order to suggest a long-term development approach) reiterated that government policy should revitalize the computer industry and include computer makers such as BULL and SEA. The DGRST's position was opposed by an alliance of COPEP, the Department of Telecommunications, CSF and the Armed Services. While the DGRST's concern was the development of a national computer industry on a market basis, the association of BULL and SEA as major partners in French electronics development also echoed the worldwide trend of electronics development. According to the DGRST, the future of electronics depended on the growth of a general-purpose middle-sized computer industry rather than on heavy, specialized equipment such those in telecommunications and defense.[348]

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[346] Which should not be confused with the *Commissariat d'Énergie Atomique*. The capital of the *Compagnie Européenne d électronique et d'automatime* (CEA) was held in 1963 by Thomson 40%; C.S.F. 40%; Kali Saint Thérèse 11%; Intertechnique 9%.See C.A.C. 77/321 Box 995 op. cit., footnote no.2.

[347] Idem, p.20.

[348] J. W. Cortada, Before the Computer: I.B.M., N.C.R., Bourroughs, & Remington Rand and the Industry They Created 1865-1957, Princeton, N.J. Princeton University Press, 1993.

The DGRST perspective alienated the CSF and its subsidiaries because, as mentioned earlier, there was no commonality of interest or structural integration between the computer makers and defense and telecommunications suppliers in France. For the CSF, French independence in electronics meant the reinforcement and the protection of the French telecommunications interests that only marginally included French computer makers. For the computer manufacturers, effective policy that decreased dependency would mean connecting electronics development to computer manufacturing.

Despite their soundness from an economic point view, the DGRST's suggestions encountered opposition not only from the CSF but also a reaction from the CSF's customers, the military and the CCT members who constituted the majority in COPEP. The Department of the Armed Services and the CCT wrote a COPEP report that recommended the pursuit of a defense-oriented electronics development strategy. This opposition ended the *Quatre Axes* program in 1963. To replace the *Quatre Axes* program, the majority in COPEP agreed in 1963 that France should concentrate its resources in seven areas: 1) large defense and data processing systems including sophisticated missiles and military aerospace equipment; 2) electronic telephone centers; 3) satellite telecommunication systems; 4) large nuclear particle accelerators; 5) training on new computers; 6) scientific instruments such as measurement apparatus and medical electronic; and finally 7) consumer electronics especially items such as color TV.[349]

This option was in conformity with the user policy supported by both NATO and the OECD. However, it was far from the research on and development of

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[349] «Réponse au questionnaire du 17 Juin 1964 du Groupe de travail "Recherche Normalisation, Qualité"», op. cit., p. 20.

techniques essential for general-purpose computers. Instead of being a strategy for making computers, all these programs tended towards the use of components and computers produced by American companies. In return, even though this strategy was not of interest to BULL and the SEA, given the CCT's predictions that computers and communications sectors would merge, the implementation of the above program required the building of an alliance that would merge both companies with the telecommunications and defense suppliers, CSF and CGE.

4.4.2 *THE HEXAGONE PROGRAM*

As the parties could not agree on the *Quatre Axes* program, of the end of 1963, CSF presented a new program to the COPEP: the *Hexagone* computer development program. As its name suggests, the *Hexagone* proposal covered six research projects: (1) research and development for a scientific and military computer for the CEA; (2) a project for a business management computer for BULL; (3) research on advanced computer environment and structure for the *Société d'Analyse et de conception de système* (SACS). [The latter had been created by CSF and the *Société d'Étude et des Mathématiques Appliquées* (S.M.A.) in 1963]; (4) manufacturing of peripheral equipment for Bull (5) advanced techniques for the SEA and BULL and finally; (6) research on specialized electronic components for computers for CSF. In sum, CSF would do research and BULL would be confined to the development of middle-sized computers that required less R&D expenditure, as the company already had a licensing agreement with RCA for the production of the Gamma 30.[350]

[350] Ibid, p.2.

Like the *Quatre Axes*, the *Hexagone* program pitted those interested in telecommunications and military technologies (the majority of the COPEP members minus DGRST) against those (the DGRST, the Ministry responsible for Scientific Research and Nuclear and Space Questions) who favored a general purpose computer orientation. In this confrontation, while the former prefered the import of licenses and the production of components domestically, the latter favored national computer manufacture and a blockade against IBM as a first stage towards the structural reinforcement of the national electronics industry. In other words, this program too suffered from an interlocking series of refusals.

The distribution of the research funds amongst the companies gave CSF and its subsidiaries the most important research tasks. The uneven distribution of research contracts caused SEA to boycott the entire *Hexagone* initiative. The SEA refused to accept the *Hexagone* plan claiming it had not been consulted by CSF. As a consequence, the "advanced techniques" initiative that was meant to force BULL to co-operate with the SEA was abolished. Although BULL for its part accepted its minor status in the program, the company refused a partnership with SEA as it was already engaged in a process to foster an alliance with GENERAL ELECTRIC which objected BULL's taking on the SEA as a partner.[351]

The *Hexagone* program had the same fate as the *Quatre Axes*; it was terminated in 1963 before it accomplished any of its objectives. Following the termination of the *Hexagone* program, all industrial parties (excluding the CSF because of the competition against the CGE in the telephone industry) and the DGRST tried to integrate the CGE into a new national project. The possibility of associating the CGE led the head of the

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[351] C.A.C -77/321 Box 991, «Note sur l'industrie française des calculateurs électroniques», 1963, p 1

CSF's research department, Mr. A. Danzin to claim that associating the CGE with the project would cause further delay. According to Danzin, it would be necessary to redefine all the contracts and that would cause financial losses for his company. Danzin reminded the DGRST that his company had already refused other government contracts because of its involvement in the project. To limit the damages for CSF, Danzin asked the General Delegate for financial support for his company's share in the program. This share was composed of three research contracts: (1) material improvement: the expected sum from the DGRST was 250000 FF; (2) semiconductors (especially diodes for high speed commutation) 300000 F.F. and; (3) transistors for high speed: 300000 FF All these activities were oriented towards developing specialized equipment.[352] The government did not approve CSF's request.

4.4.3 *THE ALTERNATIVE TO HEXAGONE*

Although the Office of the Prime Minister agreed in principle with the CSF's plan, it disliked the prospect of starting any project without BULL. For the Prime Minister, it remained essential to find a way to associate BULL with the project. In a note on January 1963, the Minister of State responsible for Scientific Research and Nuclear and Spatial Questions argued that despite the errors made by BULL, the company was still important for French electronics policy.[353] He reasoned as follows. First, computers were used mainly in business management and government

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[352] C.A.C. - 77/321 Box 995 A. Danzin, «Action concertée calculatrice», Note to the General delegate of the D.G.R.S.T., No. 5913 - Danzin/Y.B., 1963.
[353] C.A.C - 77/ 321 Box 995. Projet remis au ministre d'Etat. Le Ministre d'Etat chargé à la recherche scientifique et des questions atomiques et spatiales à Monsieur le Premier Ministre, «Objet: Accord Bull-General Electric», 24 janvier 1963, p. 2

bureaucracies (one type of computer). In a lesser number, they were used for scientific research, artillery, civilian and defense telecommunications and industrial processes. In sum, these different uses defined four types of computer. However, the Minister believed that the existence of four types of computer did not mean that there were four different research and development problems in manufacturing them. There was one problem that lay at the very heart of the computer industry: spare parts were common to all types of computers and this was true even in the case of computer peripherals. Moreover, the interest in the digital computer (in comparison with the analog machine) lay in its flexibility. Given these two industrial characteristics, the Minister argued that there was no such thing as a general-purpose computer since a company could build a variety of machines by making small changes in any type. In this view, the policy in computers should concentrate its research efforts on the flexible scientific and business machines. This, the Minister felt was the practice that had allowed IBM to decrease its production costs and enlarge its market share. For the Minister, IBM had occasionally modified an entire business machine to fulfill other tasks either scientific calculation, defense or telecommunications.[354]

Considering what was written in Chapter Two, this interpretation is wrong. IBM did not modify its business machine to fulfill the US Air Force's requirements in the SAGE system. For example, the IBM 701 regenerator was abandoned for a flip-flop technology developed by the Lincoln Laboratory. In reality the Minister's plea for a flexible business and scientific machines simply echoed the DGRST's suggestion for the manufacture of marketable computers and its support for BULL. The Minister of Scientific Research claimed that unless a company had the same commercial network as

[354] Ibid., p.3

the one BULL had, its competitive strategy in Europe would be doomed to failure. Moreover, the Minister predicted that despite BULL's economic and technological failures with the GAMMA 60, its middle-sized machines, including those manufactured under RCA license and IBM's business computers would hold the market until 1967. It was further predicted that until 1970, IBM will hold a monopoly over largest computers.[355] The Minister's option for the period of 1967-68 was to orient French companies towards the manufacturing and marketing of middle-sized machines and the continuation of the different services related to them. According to the Minister this option was strategically necessary even if it required French electronics companies to seek technological agreements with IBM and other large American computer companies. Two years were considered sufficient to prepare French industry for international competition.[356]

In a meeting[357] held in December of 1963, the Minister presented his option before the Electronics Committee of the Plan. It was an option that clearly favored BULL and its technological agreements with RCA as well as an eventual relation with IBM that BULL considered as a potential ally. The minister justified his position by pointing to French dependence vis-à-vis foreign governments, the systematic French use of American research that led to the scarcity of specialized French mathematicians, and, finally the existence of an IBM monopoly in France and worldwide.[358]

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[355] Idem, p.4.
[356] Idem, p.5.
[357] Were present, MM. de SAINT LEGIER, TOUSSAINT and the Colonel BRUNO for the Ministery of scientific research and Nuclear and Spatial issues, General LEVEQUE and M. MAGNEN for the D.M.A., Professors MALAVARD and AIGRAIN, Mr. NATTA and Captain CHARVET for the D.R.M.E and finally Mr. GUIYESS for the DGRST
[358] CAC-77/321/991, Le Ministre d'Etat chargé de la recherche scientifique et des questions atomiques et spatiales par délégation le directeur de cabinet René de SAINT LEGIER, Compte-rendu confidentiel, Paris le 2 avril 1963, p.2.

The choice option was not one of absolute independence or autarky. The best option was an interdependent development policy based on American technology which focused mainly on BULL having the potential to manufacture general-purpose computers. In this sense, the Ministry of Scientific Research's perception of French interdependence in electronics differed markedly from that of the Armed Services and COPEP whose choice was military and special-purpose machinery and who had opted for the CSF as the main partner. Military opposition to the Ministry of the Scientific Research was expressed in the same meeting by General Lévèque who voiced his concern about French political independence in relation to the agreements that BULL had contracted with RCA and the other technological deals the company was about to sign with IBM. These agreements were different from the ones between CSF and TRW because in the BULL case the contract appeared more like a takeover. Contrary to General Lévèque, Mr. Saint Legier (a DGRST member who was also a member of the COPEP) argued that the agreements signed between RCA and BULL would not limit the latter's freedom of action. He maintained the same opinion concerning the cross-licensing agreement that BULL intended to sign with IBM.[359]

The meeting as a whole recommended the company work with SEA despite BULL's refusal. A partnership between BULL and SEA would assure that the former would not fall entirely into foreign hands and it was the guarantee of military support. According to the DRME, an agreement between SEA and BULL would allow the latter's middle-sized machines to be used for artillery and telecommunications. Along with the CNES, the DRME also agreed to maintain the long-term scientific computer project that was meant (in the *Hexagone* program) to be manufactured in co-operation

359 Ibid., p. 2.

by BULL and SEA. In both cases the DRME agreed to help both companies financially and guaranteed purchase orders.[360] BULL's acceptance of the military proposal would expand military support to other BULL's machines. Even though all participants agreed that French industry should be able to manufacture scientific computers, the military felt they could not secure the market for the entire output. Instead, they were willing to buy 50% of the machines produced on condition that BULL work with the SEA and present to the DRME a concrete research and manufacturing proposal.[361]

On these conditions, the DRME agreed to solve BULL's problems and make this company a key element in the national industrial policy with CSF. What remained ambiguous, however, was the degree to which the solution entailed a market or a defense equipment orientation and to what extent this solution would change the existing relationships between American computer producers and French scientific and business users. In this regard, most French government departments and research institutes were unwilling to sacrifice their immediate needs for American computers to a long-term national research policy in electronics in favor of BULL. This unwillingness illustrates just how far the OECD user policy had penetrated French computing practice. Such an influence was diffcult to reverse by a political decision that took into account only the military and industrial interests and neglected the users and French financial interests. Indeed, in November 1963, a commission[362] constituted by the CCT suggested an end to the government blockade (which had begun earlier the same

[360] Idem, p. 2-3
[361] Idem, p.3
[362] Members of this commission: Admiral CONGE; General Engineer TREVE (of the Interior Ministry); Colonel FERRÉ (of the Army); and Mr. BOCQUET of the Public Services. CAC-77/321/991 A. MARECHAL "Note à l'attention du Ministre d'Etat. Objet: calculatrice", N° 08673, 21 novembre 1963, p.1.

year) of the different government computer purchases. It maintained that if the government continued to blockade the different departments' computer procurement program, then it should be ready to run several risks. First, according to the CCT, the blockade might severely damage the organization of national defense and hamper the modernization process within other public services. Second, the blockade might also cause a loss of opportunity to companies that would produce the needed items.[363] As an alternative, the CCT suggested that the government lift the blockade and allow departments to purchase freely the scientific computers that they needed. The CCT believed that machines such as scientific computers were economically unimportant because of their restricted use and that the builders of this type of machinery were enterprises such IBM-France that were partially the property of French capital.[364]

On display here was the view that buying IBM computers would help maintain IBM-France's capacity in electronic components. It was clear that French financial interests and the demand for American computers for telecommunications systems pressured the CCT into this policy. As a result, the Commission suggested the abolition of the blockade of the purchase of middle-sized general-purpose computers. The latter was to take two forms depending on whether the contracts were signed and blocked or were about to be completed. In the first case, the Commission argued that it was unnecessary to abolish the choices that had already been made by the government departments. Otherwise, any other option would cause additional costs and delays that would slow the overall modernization program. In the case of the second type of contract, the commission suggested that, first, the government should prevent any

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363 CAC-77/321 Box 991, Annex to the MARECHAL's Note. "Avant projet à Monsieur DELMONT par le Comité de Coordination des Télécommunications", p. 1.
364 Idem, p.1.

company, including French companies from gaining a monopoly. Second, the government should seek to "respect by all means", the compatibility criteria for the materials that the CCT needed to construct an integrated information system that would allow transatlantic interoperability. These criteria had to be defined through "subjective" methods established within each department. The commission added that each government department or research institute should envisage its purchases of computers within an integrated automatic management system that would function under the direct control of the commission of Data Processing and Transmission[365]. The emphasis on compatibility was to be accompanied by announcements for competitive bids and followed by definitions of technical criteria that allow several technical choices. It was according to these choices that the Commission of Data Processing and Transmission's role became the diffusion of technical information regarding different solutions available in the international telecommunications market, the study of compatibility conditions of different equipment and language programs and finally the study of technical specifications and methods of different data transmission networks.[366]

This debate and these choices illustrate the pervasiveness of transatlantic discursive elements such as digitization and interoperability among French computer users and financial interests who chose technical efficiency over technological self-sufficiency and caused the "volte-face" of the Ministry of Scientific Research, Nuclear and Space Questions. Instead of supporting the DGRST, the Ministry argued for a reduction in emphasis on research in computer components and a focus on problems regarding external links of computer systems and their use from a distance. It was an

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365 Idem, p. 2.
366 Idem, p. 2.

option that brought a new major player into French policy: The *Compagnie Française Thomson Houston* (CFTH hereafter THOMSON). The inclusion of THOMSON as a major player was motivated by two reasons: its experience with computer peripherals and its financial strength that was important at a time when CSF itself was in a financial turmoil. CSF's financial problems had been kept secret until then. Later these problems would be one of the factors that hindered the research programs of the *Plan Cacul* . This problem will be dealt with in the following chapter.

For now, it is important to indicate that the inclusion of THOMSON in the policy process had military approval because the company was not only a defense supplier (it was specialized in the manufacture of peripheral computer equipment) but also was controlled by French capital.[367] This association between THOMSON and CSF was justified by BULL's takeover by GENERAL ELECTRIC in 1964. Before this takeover, BULL had accumulated a financial loss of 200 million FF. When this amount was added to the company's long-term loan of 450 million FF, its financial liabilities constituted 12% of its total turnover. It was then predicted that the company's overall deficit would grow by 60 million FF each year starting from 1964.[368]

In 1964, the Ministry of Scientific Research considered two ways of helping BULL. The first option was to accord preference to BULL in all research and procurement contracts related to government electronics plans. The total value of this procurement would be equivalent or superior to the money needed to solve BULL's financial problems. In this option, the BULL «Gamma 40» computer would be chosen for university laboratories and public research centers. The second alternative was a

367 Although it was among defense supplier, until the mid-1960s Thomson was only indirectly involved in the national electronic policy through its subsidiary CEA that had become the CSF associate in the *Hexagone* Idem, p.2

368 Ibid., p.3.

straight subsidy of 1 billion FF in the form of a loan that would allow BULL to pursue its current activities.[369] Opposition to this rescue plan was voiced by the *Commissaire Général au Plan* for whom both solutions implied that the government should revise its Fifth Plan electronic policy in favor of BULL. The revision would entail a special appropriation on the 1965 electronic plan and a delay that would not be profitable to BULL. While the company was in desperate need of financial help, the rescue program was creating further delays due to the definition of the contracts involved.[370]

On January 1964, the Planning Commissioner gathered representatives from BULL, CGE and CSF in order to find a solution (based on an agreement between these companies) and begin research and development needed by the computer industry. On February 15, 1964, the *Banque de Paris* (now *Banque Nationale de Paris*), the Bank of the Netherlands and the *Credit National* signed an agreement in order to increase BULL's capital. In return, as BULL's share-holders these banks were to retain 2/3 of the seats on the financially troubled company's board. In April 14 and May 12, 1964 the government confirmed that agreement but BULL rejected this offer on the basis that it was in need not only of money but also of an industrial partner that had experience with computers.[371]

BULL went on to find its own solution signing three agreements with industrial partners: first with RCA and then with SEA, SCHNEIDER and GENERAL

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369 Thus the government considered:
- increasing Bull's capital by providing the company with 210 million FF guaranteed by two other unnamed electronic companies and banks;
- guaranteeing 5 years of government contracts equal to 150 million FF;
- according a loan guarantee equivalent of 650 millions FF
This subsidy was equivalent to 1 billion FF that approximated the total of the company's liabilities.

370 C.A.C. 77/321 Box.995, D.G.R.S.T., "Fiche sur le règlement de l'affaire Bull", not dated.

371 F. H. Raymond, "Le Plan Calcul" in Colloque sur l' histoire de l'informatique, Chatelin, P. (ed), Grenoble, May 3-4-5, 1988, p.395.

ELECTRIC. These agreements would have given GENERAL ELECTRIC a 20% share in BULL's capital. The government thus rejected this deal. In April 9, 1964, the government rejected yet another agreement with GENERAL ELECTRIC. Finally GENERAL ELECTRIC and BULL reached a solution that the Governme ' ratified in the General Assembly in November 12, 1964. Under the terms of this agreement the government authorized a modification of BULL's financial structure to create three new companies: BULL-GENERAL ELECTRIC (BULL 49%, GENERAL ELECTRIC 51%); S.I.B.G.E. (Societé Industrielle BULL GENERAL ELECTRIC between BULL 51% and GENERAL ELECTRIC 49%) and *Société de Promotion Commercial* between BULL 51% and GENERAL ELECTRIC 49%.[372]

Despite the complexity of the BULL-GENERAL ELECTRIC financial structure, the deal between the two companies was perceived by the French military more as a takeover than as an association involving two equal partners. Although the deal was in conformity with the French policy that encouraged the establishment of foreign companies in France, the acceptance of BULL as a key partner in the formation of French electronics policy, it was felt would increase French political vulnerability vis-à-vis the US government. Consequently, BULL was excluded from the coming Fifth Plan's electronics program and THOMSON took its place.

The equal partnership between CSF and the American TRW would provide France with electronics components required by CSF, and THOMSON would provide the French government with special equipment and software. On the basis of this deal, the Minister of State for Scientific Research and Atomic and Space Questions argued for more research in programming, languages and generally everything connected with

[372] Idem

the use of software technology. For the Minister, these research programs were to be considered either as a mid-term program for assembling modular sets of computers or as a long-term initiative that would deal generally with problems related to the use of computers.[373]

The Ministry of State for Scientific Research's "volte face" indicates the pervasiveness in France of the transatlantic regime's specialization policy. It reversed the Ministry's previous industrial nationalism and it shows that for this Ministry, participation in the transatlantic regime could also be beneficial to civilian interests such as those related to scientific research and to the financial sector which helds shares in IBM-France. As part of this new policy, the Ministry of Scientific Research created the Joint Scientific Computer Committee (within the DGRST) to which the head of the DRME was appointed president and from which the French computer manufacturers such BULL and SEA were excluded. According to the Ministry of Scientific Research, this decision was made to avoid conflict of interest in the computer procurement policy.[374]

Consequently, on December 1964, the Department of the Armed Services issued a technical memo on computer procurement as the basis upon which companies' proposals were to be evaluated. According to the memo, the largest and sophisticated computers would be manufactured only on a small scale as the greatest demand was for less technically efficient machines. Consequently, the Armed Services proposed that evaluators reject projects involving highly sophisticated computers and consider only projects for middle-sized general-purpose machines[375].

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[373] Idem, p.2

[374] CAC-77/321/991, M. Palewski "Decision", Paris November 19, 1964, p.1.

[375] CAC-77/321/ 991, Secret confidentiel. Ministère des Armées, Delegation Ministerielle pour l'armement, Direction des Recherches et des Moyens d'Essai, Sous-direction des Recherches

Further evaluation criteria were elaborated according to which the memory of the type of computers retained should be compatible with IBM middle-sized machine and combine two sorts of processors: one for speed commutation (of 2 microseconds speed) and another economic processor (of 6 to 10 microseconds speed). While the *Ministère des armées* did not require that these two processors function simultaneously,[376] it held that the selected computer must be flexible in the sense that the alternative use of one of the two processors should not involve changes in the software program. The builder of the machine should make the technical effort necessary to enable the machine to function alternatively with these two types of processors.[377] The Department of the Armed Services believed that this flexibility would allow the French industry to fulfill defense as well as civilian needs for computers as early as 1968.[378]

It was in part the strong appeal for digital and general-purpose computers that resulted in this agreement that would have been impossible without a concession made by the DRME who still did not believe that a general-purpose middle-sized computer could be of military use. Indeed, contrary to the Department of Scientific Research, the DRME still maintained that there was no unique solution to the problems presented by the different types of computers even within the military sector; making a missile

Techniques, Division Equipements Mesures, "Caractéristiques générales d'un ensemble de calcul universel", N° 244 MA/DMA/DRME/EQM, Paris 29 Octobre 1964, p. 1.

376 Ibid., p. 2.

377 Idem., p. 3.

378 C.A.C. 77/321, Box 995, Ministère des armées -- Delegation ministerielle pour l'armement - Direction des Recherches et des Moyens d'Essais -- Sous-direction des recherches techniques Division Equipements - Mesure, « Ensemble de calcul universel. Presentation générale», Secret confidentiel, N° 265 /MA/DMA/DRME/EQM, November 12, 1964, p.2

director was held to be different from the construction of a shipborne or an airborne computer.[379]

Beyond this technical disagreement, both departments (the DRME and the Ministry of Scientific Research) agreed that the problem of the French electronics and computer industries was the lack of a French industrial partner as large as the giant American companies such as IBM and GENERAL ELECTRIC. According to both departments, this problem was due to the absence of vertical integration in the French electronics industry. The success of multinationals such as Philips and IBM exemplified the need for a merging of the French telecommunications and computer companies to foster a division of labor.[380]

As the DGRST's option for the middle-sized digital computer began to gain ground in the Office of the Prime Minister, for the DRME this option was a short-term choice that was meant to contribute to a long-term strategy comprising five advanced research programs in materials development.[381] In compliance with its policy to counter an eventual American embargo, the DRME suggested more governmental help for the companies who wanted to acquire knowledge in electronics but this did not mean helping to manufacture or to market competitive semiconductor components.[382] Moreover, it suggested that the French industry should not emphasize the knowledge

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379 Ibid., p.2

380 Ibid., p.2

381 First was research in discreet components (for resistance and ability: diodes transistors and inductors) that would be assembled in two different ways: either by printing or in faggots (as in the case of RCA circuits assembling method). The second program was the manufacture of micro-lengths like those of IBM and the mastering of deposited circuit techniques. As we have seen earlier, until 1964, private companies could not complete the feasibility of manufacturing semiconductor.

382 IBM microlengths were obtained through passivisation of active elements by glass capsuling protection method. These passive components where deposited through "silk screen printing" process and the active components are added to them. In the United States, the industrial strategy that permitted the realization of deposited passive elements was the vertical integration among the computers manufacurers and components makers.

of only one technique. According to the DRME, the industry should master different processes and techniques such as the capsulation of active electronic elements and their connection as well as miniaturization and other assembling methods.[383]

Considering the fact that the development of circuit technologies depended on the needs expressed by computer users, the DRME took care to point out the following difficulties. It noted that those who insisted that French industry must produce its own integrated circuits, should know that if they preferred to use added capsulated active elements, the development of these components takes one year and production follows in 18 months or two years. If the industry choice was "protected non-capsulated active elements", production can be brought on line in a shorter period of a year or 18 months. However, the DRME warned that circuits that are manufactured by this method will not be militarily dependable.[384]

Furthermore, the DRME also recommended that French industry master the "void atomization process" for the manufacturing of the passive elements to which (as in the case of IBM's microprocessors) the active components were added. Finally, it suggested research in different physical and chemical processes for the manufacturing of integrated circuits: epitaxy; diffusion; atomization; cathodic projection on several or in one silicon bloc. As shown in Table. 7, in 1964, the CSF and RADIOTECHNIQUE (a PHILIP subsidiary) already had laboratory experiments in these fields. The DRME felt that to take this laboratory experience into the manufacturing stage would require

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[383] CAC 77/321 , Box 995. Ministère des armées -- Delegation ministerielle pour l'armement Direction des recherches et des moyens d'essais -- Sous-direction des recherches techniques Division Equipements - Mesure, "Ensemble de calcul Universel. Présentation générale", Secret confidentiel. N 265 /MA/DMA/DRME/EQM November 12, 1964, p.2

[384] C.A.C. 77/ 321, Box 995. Ministère des Armées -- Direction des recherches et des moyens d'essais -- Sous-direction des recherches techniques -- Direction equipement et mesure "Note d'information sur la technologie des composants en France", N° 257/MA/DMA/DMRE/EQM, Paris 7 novembre 1964, p 1

considerable public financial support.[385] If the government agreed on such support, both the DMA and the DRME felt that such support should begin as soon as 1965 and sustain THOMSON-CSF's effort in the sector.[386]

These suggestions indicate that despite their compromise on general-purpose computers, both the DRME and DMA still favored the THOMSON-CSF military and special purpose-oriented industrial strategy that conformed specialization. As expected, both the DGRST and the Ministry of Scientific Research voiced their disagreement. In 1964, they issued a report declaring that future development in the electronics industry lay not in specialized electronics needs such as those in military and telecommunications. They pointed out the fact that the computer market absorbed 40% of semiconductor production (mainly transistors and diodes) which had became the basis of modern electronics. Moreover, it was estimated that the semiconductor production for general-purpose computers would occupy 2/3 of the electronics market in 1970.[387]

In France, the DGRST and the Ministry of Science estimated that business and general-purpose computers occupied 4/5 of the total market. Based on these two estimates, they argued that although the development of this type of computer had previously benefited from military funds in the United States, even in the US this sort of funding in 1964 was insufficient to support the increasing research and development costs required by this emerging industry. Finally, at odds with both the DMA and the

[385] Ibid., p.1.

[386] CAC 77/321 Box 995, Ministère des armées -- Delegation ministerielle pour l'armement -- Direction des recherches et des moyens d'essais -- Sous-direction des recherches techniques - Division Equipements - Mesure, « Ensemble de calcul Universel. Presentation générale», Secret confidentiel, N° 265 /MA/DMA/DRME/EQM, november 12, 1964, p.2

[387] CAC - 77/ 321 / 995 Projet remis au ministre d'Etat. Le Ministre d'Etat chargé à la recherche scientifique et des questions atomiques et spatiales à Monsieur le Premier Ministre, "Objet: Accord Bull-General Electric", op. cit., p.4.

DRME, the DGRST and the Ministry of Science maintained that an industry supported only by military subsidies was economically artificial[388]. For the Ministry of Scientific Research, policy for the components sector should respond to civilian market needs and not conform to *a priori* criteria such as those defined by the *Ministère des armées* and the CCT.[389]

On December, 1964, under the supervision of the DRME,[390] the government electronics policy-makers (military and civilian) and private enterprise's representatives re-examined the state of the French electronic industry. They corroborated the OECD and COPEP's previous analyses by confirming the importance of the use of computers and asserted that the number of computers installed in a given country was an indicator of its «development level» in the same way as a country's energy consumption per capita[391]. The analogy between the national use of computers and energy consumption per capita was not neutral. It underlined the conflict of interest between the field of energy conversion (electrotechnique) and computer components research. In the early 1960s the two fields were not separated in policy-making and budget appropriations. Companies such *Electricité de France* (EdF) and the CGE were specialized in high electric frequencies, inductors and superconductors. These companies feared that the increasing importance that the government accorded to electronics would be translated into losses for them. However, in France at the end of 1964, in terms of economic

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388 Ibid., p.4.
389 Idem, p.4.
390 Were present: Professor MARÉCHAL; (D.G.R.S.T); Professor AIGRAIN (the scientist director of the D.R.M.E) and industry representatives from C.S.F; C.G.E; C.d.C; S.E.A and E.M.D
391 Minitère des Armées - Délégation Ministerielle pour l'Armement and Premier Ministre - D.G.R.S.T "Rapport sur les resultat des contrats de definition calculateur". Secret Confidentiel, September 30, 1965, p.1.

importance, the ratio in the use of electronics and electrotechniques was 3 to 1 in favor of electronics.[392]

All these analyses did not convince French policy-makers and firms to agree on a single project. With BULL already in American hands and the US Department of State's declaration of an embargo on the delivery of a Control Data Corporation 6600 computer for French nuclear program, the French government was finally forced into deploying its anti-embargo strategy. It was a show of French bargaining power within the transatlantic discursive regime however and not an attempt to break France free from this regime or a change of the French universe of political discourse in ICT towards a unilateral industrial policy. Under the initiative of the Ministry of National Defense, according to Boucher, on December 1964:

> *Le Groupe de Travail Calculateurs est formalisé à la demande du Général Lévèque adjoint au DMA, en vue de dresser un bilan de l'informatique de Défense et de proposer un plan de 5 ans. Il y a là, sous la présidence de Carpentier, Senguillet (DMA), Cremieux (STTA)... et un invité Olivier (DGRST) qui assure la liaison avec la recherche civile*[393]

The *Groupe de Travail Calculateurs* was thus a military group that was motivated by French military logistics and nuclear research problems. The *Groupe de Travail Calculateurs* was constituted by members of the *Délégation Ministerielle pour l'Armement* (DMA) the logistics command of the Ministry of National Defense and logistics Command of the Air Force, the *Service de Traitement et Transmission Aérien* (STTA). The primary purpose of this group was to show to the US State Department that France could counter the embargo.

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[392] See A. Roux "La recherche dans les industries electriques et electroniques: son financement en France et à l'étranger", Conference au groupe X Electriciens, Paris 3 novembre 1965.
[393] H. Boucher "L'informatique dans la défense", op. cit., p.88.

This was the context of the Fifth Plan's electronics program the *Plan Calcul*. In its beginning the plan appeared to illustrate a "volte face" away from the military, that is the actors who were in line with the transatlantic discursive regime and opposed industrial nationalism within the French policy process. However, as will be seen in the following chapter, this was only a show of bargaining power within the transatlantic discursive regime and did not represent a fundamental change in the practices of the Fourth Plan.

4.5 CONCLUSION

The purpose of this chapter was to show how the elements of the transatlantic discursive regime shaped French policy choices. I argued that digitization was an important element of the transatlantic discursive regime, not because it was driven by technological change but because it was a discourse that crystallized both the belief in the command of the air as the best military strategy to avoid war and the resources to materialize this belief. In France, after the SEA's failure to provide French air defense with suitable digital computers, the French military maintained a user policy, scientific training programs and excluded the manufacture of French electronics components from their policy objective in conformity with the OECD General Secretary user and specialization policy. Within NATO, the French military like their American counterparts required digital computers but unlike the American electronics industry, the French electronics industry was unable to supply French defense with digital computers. Consequently, from the late 1950s onwards, BULL's privileged position in the French market was undermined by the French Air Force and nuclear scientists that began to turn towards American computer technology.

In addition, there was a also a rivalry between BULL and CSF. CSF was afraid of market competition from BULL. This was the basis for CSF's accusation that BULL's relationships to RCA was more dependent than its own foreign relations with TRW. By this accusation, CSF's strategy was to solidify its relations to the military while keeping BULL marginalized. Therefore, the accusation was more trumped-up than real.

Despite the French military's participation within NATO defense, their need for American technology, they opposed standardization and opted for interoperability. Thus, the boundaries of the French universe of political discourse in ICT were defined by interoperability and independent defense and nuclear programs. Within these boundaries, American firms such as TRW, GENERAL-ELECTRIC and SCIENTIFIC DATA SYSTEM built partnerships respectively with CSF, BULL and CGE. While these American firms hoped for economic gain from their alliances with French companies, the French expected to achieve economic, technological, military and political objectives. Moreover, by moving to a more general purpose machines, the government avoided a situation in which it could be at the mercy of a single supplier who could have charged the government high price and made high profits. Economically, the French presidency and the military believed that American investment in the French electronics industry could help strengthen French electronics industrial base and, in the long run could decrease the French balance of payment problems. Politically, the French military hoped that the alliance between American firms and French-owned companies could enhance French technological potential and preserve France's control over its defense policy within the transatlantic regime.

This perspective was opposed by the Ministry of Scientific Research and the DGRST for whom a user policy should be limited to licensing with the French industry developing and marketing its own computers. Within these parameters that I have analyzed the struggle of the DGRST and the Ministry of Scientific Research on one side and COPEP, CCT, CNET, DRME on the other. This struggle was resolved during the Fourth Plan in favor of the latter group which blocked the DGRST industrial plans, the *Quatre Axes* and *Hexagone* computer development programs.

Chapter Five

THE PLAN CALCUL AND ITS AFTERMATH

5. 0 INTRODUCTION

The *Plan Calcul* has often been presented as the French reaction to the US State Department's refusal to allow France to purchase a CDC (Control Data Corporation) 6600 computer for the French military nuclear program.[394] In 1965, an editorial in *Le Monde* presented the plan as a nationalistic industrial policy.[395] More than two decades later, in 1987 E. A. Koloddziej steadfastly maintained that the *Plan Calcul's* objective was to create a "new line of computers with no relation to American technology."[396] As recently as 1991, C. Le Bolloc'h-Puges similarly argued that the objective of the *Plan Calcul* was to build an independent national computer industry free from American influence.[397]

In contrast to these neo-realist interpretations of French policy, P. Mounier-Khun has maintained that, during the *Plan Calcul*, CGE and THOMSON-CSF decided

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394 This was how the *Plan Calcul* was presented to the French public. See also J. Tricot, "Histoire de l'informatique -1960-1974: l'irrestible ascension de l'ordinateur de série", Science et Vie, N°744, Septembre 1979 and Ch. Rollin, "Les Français n'ont pas la tête informatique", L'informatique professionnelle, N°11, mars 1983.

395 C.A.C. 77/321 Box 1002, Le Monde, "Enjeu et chance du Plan Calcul", 23 novembre 1966, p1.

396 E. A. Kolodziej, Making and Marketing Arms: The French Experience and Its Implications for the International System, Princeton, Princeton University Press, 1987 p. 230.

397 C. Le Bolloc'h-Puges La politique industrielle Française dans l'électronique, Paris, L'Harmattan, 1991, p. 11. However his book is not based in any archives or government document.

to develop incompatible computer series based on American licenses. Even for Mounier-Khun, this choice is difficult to understand, given the French government's discourse on independence from the US.[398] Given the procurement choices made in the Fourth Plan and the CCT, the DRME and the COPEP's concern with telecommunications and nuclear research, the decision in favour of American licenses is less contradictory than it appears. French nuclear research and military policy were already connected to American technology.

The sources of this chapter are drawn mostly from French contemporary archives. These primary sources show that the above opinions are based on a misunderstanding of the French discourse of political independence. In all documents, independence in the ICT sector did not imply a break in Franco-American industrial relations but the freedom to use American technology without restriction. As one observer put it, this policy of independence did not imply autarky, but *"l'indépendance au stade des décisions et de l'utilisation."*[399] This independence at the level of decision and use did not constitute an industrial policy that aimed to compete with the United States in the computer sector. Rather, it emphasized the freedom to use American data-processing techniques in order to develop other sectors such as nuclear weapons, the space industry, military and commercial aircraft in conformity with the doctrine of "big science". In this sense, the *Plan Calcul* was the Fifth Plan's continuation of the Fourth Plan's user orientation. This approach conformed to the early 1960s OECD user policy with its recommendation that European governments not attempt to develop computer

398 P.-E. Mounier Khun, "Les constructeurs d'ordinateurs face à l'industrie des composants", Colloque: Le défi électronique d'après guerre - une perspective historique, op. cit.
399 CAC 77/321, Box 1002, G. Aranda, "Le Plan Calcul va reposer sur la CGE, la CSF et Schneider", Entreprise, N°13, Octobre 1966, p. 15.

industries equal to the US or promote research in components manufacturing and develop an application-software policy rather than a policy to develop computer-system software.

It is worthwhile to remind the reader here that whereas the development of computer-system software in the 1960s implied research in semiconductors, application-software entailed the use of American computers for the development of software that adapted computer-system software or general-purpose programs to special tasks ranging from the processing of scientific data to military communications. Applications-software was thus different from computer-system software that controls the computer system's performance. It was against the wishes of the DGRST that, during the first phase of the *Plan Calcul* , the military, the telecommunications sector and nuclear interests in France adopted an application-software program and rejected integrated electronics and computer development. This decision represented a choice for American technology in order to stay abreast with the American practice of endlessly improving military equipment not because of any immediate military threat but to apply the latest scientific discoveries and technical innovations. This policy increased French dependency on American semiconductors and integrated circuits which was in direct contradiction with the DGRST's policy that favored components development.

Contrary to Gilpin, Zysman and Kolodziej who have presented the *Plan Calcul* as a free riding practice and French neo-Marxists who explain the Plan as an attempt to build a military-industrial complex in favor of the French bourgeoisie, this chapter shows how the *Plan Calcul* conformed to American doctrines such as "big science" and the OECD user and specialization policy that were accepted by the French military within their framework of political independence. The companies' lack of interest in collaborating with each other and BULL's resistance to military projects will show that the French framework of political independence was not determined by the industry but by the military who attempted, with difficulty, to draw the industry into their project.

Using the DGRST's internal archives, the first section shows that the French reaction to the American embargo did not introduce any major change when compared to the Fourth Plan. The second section describes the DGRST's nationalistic position. Section three describes the *Plan Calcul* as presented to the general public showing that in the policy statement of the *Plan Calcul*, the government took account of both the DGRST and military concerns. Section Four shows by examining the *Plan Calcul* 's budget that the government did not give priority to the DGRST's industrial nationalism and favored a military orientation compatible with participation in transatlantic discursive regime.

5.1. THE REACTION TO THE US EMBARGO AND THE RESTRUCTURING OF THE FRENCH ELECTRONICS INDUSTRY

As a reaction to the US embargo in 1965, the French Minister of Defense declared that the principle of political, military and economic independence required France to build its own electronics industry.[400] To fulfill this objective, the DMA asked the DRME and the DGRST to formulate with French industry a plan for the industrial development of several types of computer within the spirit of the terminated *Hexagone* program.[401] In 1965, the DRME and the DGRST received three computer development

[400] C.A.C. 77/321, Box. 995, Ministère des Armées - Délégation Ministerielle pour l'Armement et Premier Ministre - D.G.R.S.T "Rapport sur les resultats des contrats de definition calculateur". Secret Confidentiel, September 30, 1965, p.1.
[401] Ibid

proposals from four different companies: the CSF, the CGE, the SETI (a *Compagnie des Compteurs*' sub-company) and the SEA.[402]

The proposals submitted by the *Compagnie de téléphonie Sans Fil* (CSF) and the *Compagnie Générale d'Électricité* (CGE) was industrial project that would mobilize all French system builders and peripheral equipment producers. Each of these companies would assemble a modular set of computers based on American, German and British expertise. Although the CSF had opposed earlier a role for CGE in government planning for the electronics industry, given the need to strengthen French bargaining power, the *Ministère des armées* pushed both companies into forming a joint-venture, CITEC (*Compagnie Européenne pour l'Informatique et les Techniques Electriques*).[403]

Despite the climate of hostility between the US State Department and the French presidency, during tne preparation of the *Plan Calcul*, transatlantic interoperability, reliance on American components and a user approach were still prevalent in the French universe of political discourse in ICT and appeared in the companies' proposals. Thus the CITEC proposal consisted in the development of a series of three class «M» compatible computers: «M 1»; «M 2»; «M 3» which were designed to be compatible with the IBM 360 series from 360-30 to 360-65. CITEC projected the manufacture of these machines in co-operation with several other European electronic companies. The consortium offered the British company ICL a 40% share in the manufacture of the compatible computers. In return, ICL would release a license without fees on

402 Idem, p. 2.

403 CITEC was a common holding (a merger between the *Compagnie Européenne d'Automatisme Électronique* part of the CSF and the *Compagnie Européenne de Calculateurs Industriels* of CGE group) in which each company detained 50% of the capital. When CSF and CGE constituted CITEC, they gained the right to exploit licences from two American companies: SCIENTIFIC DATA SYSTEM and THOMSON-RAMO WOOLRIDGE. F. H. Raymond, "Le Plan Calcul", op. cit., p.395.

peripheral equipment technology to CITEC. At the same time, CITEC was seeking co-operation and agreements with three other companies: the German TELEFUNKEN; the American companies BUNKER-RAMO and SCIENTIFIC DATA SYSTEM[404]. CITEC had also proposed that a smaller computer: the «M 0» be assembled in two versions: a 'real time' and an office-automation type. The consortium foresaw sales of 290 «M 0s»; 360 units of «M 1»; as well as 93 units of «M 2» and 25 of «M 3»[405].

With the exception of the «M 3», the research program presented by the consortium was limited to the assembling of the machines and did not include the production of the required electronics components. Thus, for the smaller and middle-size machines, the consortium selected «DTL» FAIRCHILD integrated circuits. The criteria for this choice were the military dependability of the circuits and their decreasing cost in comparison to hybrid circuits. The choice of FAIRCHILD circuits was a reversal of policy when compared to the *Hexagone* program which had been designed to promote the domestic manufacture of components. Moreover, in order to enable the industry to comply with the Department of the Armed Services' dependability and normalization requirements, CITEC proposed a specific design for the «M 3» circuits. However, even these circuits were to be of American origin.[406]

The SETI (the CdC subsidiary) proposal also consisted of three types of machines: «A 1» a small-sized computer for industrial process; «B 2» a general-purpose computer; «C 3» a large scientific computer. SETI proposed an overall turnover of 500 machines during the period of 1968-1972. Contrary to CITEC's

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404 Ministère des Armées - Délégation Ministerielle pour l'Armement - Premier Ministre D.G.R.S.T « Rapport sur les resultats des contrats de definition calculateur», Secret Confidentiel, op. cit. pp. 4-5.
405 Ibid., p. 3
406 Idem, p. 3

proposals. SETI machines were neither compatible with each other (each SETI computer required a distinct software[407]) nor with IBM computers. Despite their high level of sophistication they did not respond to the criteria of internal and external compatibility established by the Armed Services and the CCT. Instead of using integrated circuits, SETI had chosen to provide its computers with hybrid circuits[408].

In order to gain the government's financial support, the SEA proposed two compatible large-sized computers. The company estimated that it could sell and rent 950 of these machines in France and Europe. SEA's choice of components for these computers was based on the speed of the processors, their miniaturized size and availability on the French market in 1965. These criteria led the company to adopt RADIOTECHNIQUE hybrid circuits because the manufacture of the latter did not require a large investment. RADIOTECHNIQUE hybrid circuits cost the same as the integrated circuits manufactured in the United States in 1965[409]. However, SEA's choice of circuits did not take into account two important factors. First, although the price of hybrid circuits reached its lowest point in 1965, the price of integrated circuits was expected to decrease further given the improvements in production technique. Second, the hybrid circuits were considered less militarily dependable than integrated circuits.[410]

The criteria established by the DMA for the selection of the best computer proposal were specially designed for the CITEC consortium. Since the latter was composed of the largest French firms, it best represented the French government's willingness to bargain with the US government. Thus, not surprisingly, CITEC's

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[407] Idem. p.9.
[408] Idem. p. 13
[409] Idem. p. 13
[410] Idem. p.14.

proposal was in compliance with the Defense department policy of fostering an alliance between French electronic companies and using American component parts compatible with IBM machines. Moreover, the criteria of internal and external compatibility of the CITEC's computers were in line with the Armed Services' option of using circuits that were made in the United States or by American subsidiaries present in French territory. As expected, the DMA, the DRME and the CCT agreed to choose the CITEC's proposal and reject the others. Consequently, perhaps knowing that the choice had been made in advance to favor defense suppliers, BULL did not present a proposal. BULL'S choice signified the failure of the Ministry of State for Scientific Research to impose its market-oriented development policy.[411] Thus, despite THOMSON-CSF and CGE's lack of experience in the computer market, the departments of Defense and Telecommunications banked on them to improve the condition of the French electronics industry, believing, further, that CITEC would break the IBM monopoly as early as 1968.[412]

On this occasion, the DMA, on the behalf of the military logistics, maintained that although the CITEC choice would fulfill French civilian and military communications programs and, despite the fact that SETI's proposals were rejected, the DMA did not consider excluding the latter from the national strategy; instead, it urged SETI to merge with the CITEC consortium. Although it was agreed that this strategy would benefit from the high technical quality of the SETI team, the aim was also to convert SETI engineers and computer scientists from special-purpose analog computation to general-purpose digital computation. For this purpose, the DMA

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411 Idem.
412 Idem. p. 26

convinced the DGRST that any government support to CITEC should be contingent upon a successful merger between CITEC and SETI.[413]

Moreover, the rejection of the SETI and SEA proposals meant that developing a French computer was not a priority in the militarily-dominated French universe of political discourse in ICT. Rather, the priority was the vertical integration of the French-owned companies. The problem of vertical integration was not specific to the electronic industry. In the same years, as Lynn Mytelka has observed with regard to the textile industry, because of a profit squeeze, the government in collaboration with large and middle-sized firms moved to eliminate marginal textile firms and to promote mergers and takeovers within the industry. This policy was known as "*assainissement*".[414] Accordingly, the DRME undertook to promote complementary lines of research on magnetic discs, the improvement of the «magnetic reel unwinder» and the study of visual display devices which would involved companies other than the ones selected to manufacture of the computers retained in the selection process. The DRME thus requested the *Compagnie des Compteurs* (CdC) seek a technological agreement with the US company DATA PRODUCTS. In addition, the DRME agreed that if the technological agreement between CITEC and the British company ICL was confirmed, research to improve printers and card punching devices would be financed jointly by the French government and ICL.[415]

In agreement with the Ministry of the Plan, the DRME also decided to orient French research in electronics towards upstream computer technology in order to prepare French electronics companies for the upcoming 1972 computer generation. The

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413 Idem, p. 26

414 L. K. Mytelka, "In Search of a Partner: The State and the Textile Industry in France", In S. Cohen and P. Gourevitch, France in Troubled World Economy, Butterworths, 1982, p. 132.

415 Idem, p.27.

object here was not to fill the technological gap that separated France from the United States but simply to make French electronics industry aware of research undertaken in the United States. This policy was referred to as the technological watchfulness policy or controlled backwardness (*politique de la veille technologique ou de retard contrôlé*) It was designed as a complement to the user policy, as it was a safeguard against an eventual American embargo.[416] For this purpose, in 1965 the DRME undertook a number of "concerted actions on calculators" through the Scientific Committee. These "concerted actions" had two research aspects: «Action A» and «Action B». Action A was a long-term theoretical research on computers that was divided in three sections: a) "technology and machine structure" which meant to follow new development in electronics; b) language and programming and; c) use of machines oriented towards numerical analysis, operational research, management and other sectors particularly medical research and hospital management. Action B was simply the CITEC proposals mentioned above. They were also labeled as "concerted actions" because they were meant to be controlled by the DGRST and DRME.[417]

Despite the previous DGRST resistance to aligning the computer sector with defense and telecommunications, the DRME insisted that the state should increase its research effort in order to establish no later than 1970 a modern telecommunications network that would allow for the use of remote-controlled computers. For that purpose, the DRME was committed to encouraging extensive use of French telecommunications facilities by French electronics companies in order to acquire the

[416] RE130/11/250 Commissariat Général du Plan / Commission Permanente de l'Electronique / Groupe de Travail ELECTRONIQUE de la Commission des INDUSTRIES DE TRANSFORMATION, "Réponse au questionnaire du 17 Juin 1964 du Groupe de travail "Recherche, Normalisation, Qualité" de la Commission des Industries de Transformation du Vème Plan", op. cit.
[417]This Scientific Committee acted as a scientific adviser to the Telecommunication Coordination Committee (C.C.T).

technology that facilitated the use of computers from a distance.[418] As the French presidency still opposed transatlantic standardization, the DRME's computer policy was designed within the framework of interoperability that would allow the transatlantic normalization of the assembled electronic materials needed for telecommunication systems. According to the *Commissariat Général du Plan*, although the normalization of electronics equipment would lead to an increase of product prices by pushing certain customers to adopt strict equipment specifications, it still had many advantages. First, it would help to unify the methods used to measure electronics equipment performance. Second, even if the lack of a large market for intermediary electronic components[419] might contribute to an increase in cost, generally established norms could draw out a large series of components that would serve to absorb production costs. Third, normalization had the advantage of simplifying the maintenance problems related to sophisticated equipment.[420]

All state departments concerned with the use of computers defined technical problems that would preoccupy the French electronics industry. Again these problems were connected to the use of computers rather their manufacture. Thus, instead of fostering independence at the upstream level of electronics research, the strategy pushed French efforts towards the downstream level related to the use of computers: problems of communication between machines and between men and machines. It was an effort to normalize the use of computers. This normalization process was not

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418 Idem, p.29.

419 The term intermediary components is used here to refer to the electronic components that are between high performance and consumer electronics.

420 RE 130/11/ 253.77, *Les archives de Madame Martin*. Commissariat Générale du Plan, Commission des Industries de Transformation, Groupe de Travail Électronique, Vème Plan, "Réponse aux questionnaire. Recherche Normalisation Qualité. Normalisation des materiels electroniques assemblés", Paris 15 février 1965, p.3.

according to the evolution of French research. It was carried out in accordance with the rapid technical change in the U.S. that demanded endless revision and updating of the technical characteristics of computers. At the downstream level, normalization was concerned with international terminology, letters and coding systems, automatic recognition of objects, input and output devices (punched cards and magnetic bands), language of programming, data transmission, constitution of messages, speed of data transmission and mode of transmission, vocabulary and finally interconnection between computers.[421] These norms also show the influence of NATO's rationalization policy whose objective was to increase compatibility and to avoid waste of resources.

By seeking to apply these norms to French computer assembling, the DRME's proposal for the Fifth Plan sought two economic objectives. The first was to decrease computer prices and ease the procurement process of electric and electronic component parts. The second objective was to stabilize the general technical characteristics of computers. The *Commissariat Général du Plan* also agreed that the adoption of IBM models would facilitate interconnection and interchangeability between machines.[422] All these arrangements were meant to be the policy of the Fifth Plan (1966-1970). In contrast to the Fourth Plan, and given the political necessity to counter the American embargo, the policy was designed to assemble computers but not integrated circuits.

421 Idem, "Annexe I: Normalisation des calculateurs électroniques", p.1.
422 Ibid, p.2.

5.2 THE DGRST'S POSITION DURING THE PREPARATION FOR THE FIFTH PLAN (1966-1970)

The above plan presented by the Ministry of the Plan and the military-dominated institutional actors was a mid-way between a strict user policy and a manufacturing program. It was opposed by the DGRST which presented two separate propositions: one for electronics development and the other for computers. These two propositions represented the DGRST's political strategy to emphasize domestic electronics research and to link the latter to endogenous computer development.

5.2.1. *The DGRST 's Electronics Development Policy Proposal*

The American embargo was an event that radicalized the DGRST's position. However, like the earlier DGRST position, this radicalism failed because it broke with CITEC's bargaining strategy within the regime. Unlike the CCT, CNET, COPEP, DRME and DMA who agreed to import American integrated circuits during the Fifth Plan, for the DGRST the reliance on American integrated circuits as adopted by the CITEC was not only an insufficient response to the American embargo, but also hindered French industrial development. The DGRST's *Commission Calculateurs Developpement* reported that:

> *Qu'il s'agissent de détection ou de mesure, de transmission de l'information et de calcul, de restitution de l'information traité et de contrôle ou de régulation de processus divers, les nouvelles possibilités offerte à l'homme par les progrès de l'électronique sont à la base d'une mutation de la vie économique et sociale. [...] Sans doute les techniques et les nouveaux outils - notamment les calculateurs - sur lesquels s'appuie cette mutation peuvent-ils être importés.* ***Mais s'agissant d'un secteur d'une haute technicité et de l'un des plus importants, renoncer à développer un effort français dans ce domaine reviendrai pour***

> ***la France à abandonner le peloton de tête des pays développés-dont les progrès sont assis sur la valorisation de la matière grise de leur ressortissants - pour se contenter des domaines qui exigent un médiocre potentiel intellectuel***[423] [my emphasis]

This was a clear rejection by the DGRST of the transatlantic user doctrine. From the DGRST's perspective, this doctrine would only aggravate the structural weakness of French industry by reducing it to the status of subcontractor for large American electronics companies. Consequently, such a status would weaken French political independence in decision-making related to the use of American technology. In short, from the DGRST's point of view, even if independence was restricted to freedom in defense decision-making, France could not afford to surrender the manufacturing of components.[424]

This view implied a postponement of the modernization of French defense equipment and suggested that the Department of National Defense cease its off-shore procurement of computer technology and integrated circuits. It was an attempt by the DGRST to convince the French military that independence in defense decision-making depended on a healthy national industrial base that was capable of producing modern electronics components for defense as well as for civilian uses. According to the DGRST:

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423 C.A.C./ 81401, Box 136. Premier Ministre - D.G.R.S.T, "Rapport intérimaire de la commission calculateurs developpement", Confidentiel, I.065.PD/VP , p.2.

424 The DGRST stated that:

> *C'est donc bien au niveau de la conception et de la construction d'ensembles complets que se pose le problème d'une industrie indépendante du calcul de notre pays. Malgré les dispositions naturelles qu'on trouve chez nous pour les opérations abstraites et la logique mathématique, le développement de vastes sociétés de software n'apporterait pas la solution, à supposer d'ailleurs que ces dernières puissent survivre sans accepter de s'inféoder à des groupes étrangers. Le software n'est au surplus pas brevetable.* Ibid., p.3.

Du point de vue militaire... il est souhaitable que soient implantés en France, des moyens d'études sains et solides basés sur une industrie électronique capable de vivre par ses propres moyens; car la part du militaire dans le marché du traitement de l'information est chez nous trop faible pour soutenir à elle seule les développements nécessaires, si elle n'est pas étayée sur un marché civil large et stable.[425]

Thus, against the transatlantic regime's conventional wisdom that counted multinational subsidiaries as part of the host country's industrial base, the DGRST believed that the construction of a French national electronics industrial base should not be based on foreign subsidiaries whose decision-making centers were located outside France. For this reason, they could not promote French military independence.[426] For the DGRST, even though the development of an autonomous French electronics industry that could compete with IBM remained a risky and ambitious project, it was precisely this risk that justified an unconditional governmental financial aid to national companies. This help was not to be linked to an immediate commercial success of the French industry, but was to prepare the latter for an European collaboration. The DGRST stressed that:

...le développement particulier d'une industrie française de calcul électronique n'exclut pas une certaine coopération à l'échelle européenne. Bien au

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[425] Idem, p.3.

[426] The Delegation emphasized that:

> *que la présence en France d'usines et laboratoires d'IBM, **comme de Bull-General Electric**, ne suffit pas à répondre aux besoins que satisferait le développement d'une indusnrie nationale de calcul: **l'assistance puissante qu'apportent à ces firmes les laboratoires de recherche américains, notamment dans le domaine de pointe et dans les recherches qui préparent les prochaines générations de machines, diminue singulièrement l'impact qu'on peut attendre d'une telle industrie en recherche fondamentale comme en recherche appliquée; d'autre part le pouvoir de négociation dont notre pays peut souhaiter disposer n'est pas suffisamment assuré par la collaboration que des Français apportent à ces firmes**.* [my emphasis] Idem, p.4.

contraire, et sous réserve que le partage des tâches et des marchés s'effectue dans des conditions telles que notre pays conserve sa part des effets bénéfiques attendus d'une telle entreprise, cette coopération est indispensable.

Mais les firmes françaises sur lesquelles l'État s'appuiera pour développer son action ne seront en état de négocier ce partage dans des conditions satisfaisantes que si elles ont en main l'atout que constitue la décision délibérée du Gouvernement de développer une importante industrie de calcul et de lui apporter son appui.[427]

As a complement to the CITEC and the DRME/DMA policy proposals mentioned above, the DGRST added a policy that targeted the production of active and passive components.[428] What the DGRST defined as active components were primarily semiconductors and memory and secondarily, connective-materials and electrical switches on which the dependability of circuits and memories depended. The reasons advanced by the DGRST to support the development of circuit manufacturing capabilities were also economical because the major part of the cost of a computer was not programming or assembly but rather the price of the active and passive components. In other words, the DMA-DRME/CITEC proposals to procure components from American producers should be reconsidered. The DGRST suggested that CNET, the *Délégation Ministérielle pour l'Armement* (DMA), THOMSON-CSF and Radiotechnique join efforts in building a French components industry. For the DGRST:

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[427] Idem, p.5.

[428] According to the DGRST:

> *la Commission calculateurs [of the DGRST] a pensé que cette action de développement devrait être située dans un cadre plus large et s'est attaquée a esquisser ce que devrait les actions, intimement liées à la première, concernant le développement des composants électroniques et celui de certains types de périphériques. Elle tient donc à souligner que si les recommandations du présent rapport relatives aux calculateurs proprement dits résultent d'études déjà fouillées, grâce aux initiatives de la DMA...celles concernant les composants pour calculateurs n'ont pu bénéficier de la même procédure et appellerait, quant aux marchés à passer, des études précises .* Idem, p.5.

> *Grâce au dynamisme des entreprises et à une action persévérante des Pouvoir Publics menée depuis 1960 (Délégation Générale à la Recherche, Délégation Ministérielle pour l'Armement, C.N.E.T., ...), notre pays se trouve posséder plusieurs sociétés dont les trois C.S.F., SESCO et Radiotechnique, malgré des chiffres d'affaires encore insuffisants, seraient susceptibles de parvenir à la taille critique d'ici 1970 moyennant une aide au développement et une concentration des moyens.*[429]

What appears in this statement as praise of the DMA, CNET, and THOMSON-CSF was rather a criticism of the late 1950s and early 1960s defense procurement of American computers and CSF and THOMSON's reluctance to produce integrated circuits and modern computer memories. Both previous practices and recent proposals were considered by the DGRST as a hindrance to French political independence as they relied too heavily upon American integrated circuits. From the DGRST's point of view, only a policy of national solidarity that connected public procurement to industrial policy would overcome the structural weakness of the French electronics industry. The DGRST justified such an approach by the fact that semiconductor materials and computer memories required large investments both in terms of research and production and because international competition imposed low prices that created further difficulty for the French industry. In the DGRST's analysis, both realities made the cost of entry into the sector too high for an individual French company. The Delegation argued that:

> *...seules des entreprises de grande taille peuvent en fait construire des composants électroniques et que le chiffre d'affaire minimum annuel doit atteindre le milliard de francs par an pour pouvoir amortir les frais d'études et les investissements (les recherches et le développement se monteraient dans ce cas à 5 ou 7%, et les frais de lancement industriel à 10 ou 15% environ du chiffre d'affaires; ce sont là des taux qu'on ne peut guère dépassé si l'on veut tenir les prix de vente) [...] d'une donc d'une industrie aux investissements élevés qui ne peut produire que des grandes séries* [430].

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[429] Idem, p.17.
[430] Idem, p.16.

This statement used the OECD's analysis of the computer industry but contradicted the Organization's conclusion that discouraged Europeans from building their own strength in the components sector. According to the DGRST, however, given the size of the French computer market and the previous military choice of IBM computers, it was no longer possible to connect the development of the French components sector to computer manufacturing:

> *Il n'est plus possible de lier rigidement le développement en France des composants électroniques à celui d'une série de calculateurs. Le domaine des composants est en effet beaucoup plus large et les calculateurs envisagés ... ne saurait constituer avant de longues années un débouché suffisant pour un fournisseur de composants quel qu'il soit.*
>
> *Il est d'ailleurs difficile de tracer une frontière précise entre les composants pour calculateurs et les autres; la zone de recouvrement est vaste.* [431]

Knowing that much of French components production was in cathode tubes that was dominated by CSF and CGE and the latter were reluctant to be directly involved in integrated circuits production, the DGRST's analysis implied a shift in emphasis from the manufacture of cathode tubes to integrated circuits. As Tables 11 and 12 show, the Delegation advised the Prime Minister that a five-year plan that allocated 175 million FF for the development of memories and integrated circuits for computers and only 65 million FF for tubes was the way of the future.

Table. 11: DGRST's Proposal for the Development of Integrated Circuits and Computer Memories (million FF)

Components for computer	1966	1967	1968	1969	1970	Total
Cost of development	35	45	40	30	25	175
including market study	10	12	10	10	8	50
and reimbursable subsidies	10	13	10	10	7	50

Sources: C.A.C./ 81401, Box 136. Premier Ministre - D.G.R.S.T. "Rapport intérimaire de la commission calculateurs developpement", Confidentiel, I.065.PD/VP, 1965, p.17

431 Idem, p. 17.

Table. 12: DGRST Proposal for the Development of Cathode tubes

Component for other use	1966	1967	1968	1969	1970	Total
Cost of development	10	15	15	15	10	65
Including market study	3	5	5	5	2	20
and reimbursable subsidies	3	5	5	5	2	20

Sources: C.A.C./ 81401, Box 136. Premier Ministre - D.G.R.S.T. "Rapport intérimaire de la commission calculateurs développment", Confidentiel, I.065.PD/VP, p.17.

The development cost of computer memories and integrated circuits predicted by the DGRST was 175 million FF. According to the DGRST, 1/3 of this amount should be provided by THOMSON and CSF companies because they already benefitted from extra-budgetary research expenses which included military equipment and telecommunications devices. The remaining 2/3 should be supplied by the government as an aid to RADIOTECHNIQUE:

> *Le montant des frais de développement prévus est de 175 millions pour les composants directement utiles aux calculateurs. Pour tenir compte du fait que Thomson-CSF ne pourra pas bénéficier que d'une aide plus réduite de la part du gouvernement français, le montant total à prévoir pour cette aide serait ici inférieur aux deux tiers et ne devrait pas dépasser 100 millions...*[432]

This proposal stepped on the interests of defense suppliers such as THOMSON, CSF, the *Compagnie Générale d'Électricité* (CGE) and *Electricité de France* (EdF) as their research had nothing to do with semiconductors. Moreover, while the DGRST emphasized semiconductor components, French public research institutions such as the *Comité National d'Étude en Télécommunications* (CNET), the *Commission d'Énergie Atomique* (CEA), the *Centre National d'Étude Spatiales* (CNES) and the DRME did not develop components other than those related to their uses. They absorbed almost all public resources thereby depriving the sector of

[432] Idem, p18.

general-purpose semiconductors of necessary funds. According to Ambroise Roux (the head of the CGE):

> *La CNET et CEA, ces organismes excellents travaillent en étroite liaison avec l'Industrie, mais leurs préoccupations sont très précises: si leur action est très efficace, elle s'exerce dans un domaine limité. Ces organismes n'ont, aussi bien, jamais prétendu avoir une compétence générale pour encourager la recherche dans son ensemble...* ***Venaient ensuite les Militaires qui dépensaient beaucoup d'argent. Mais leur rôle ... n'était pas toujours efficace dans le domaine de la recherche. Finançant peu la recherche de base, ayant surtout des préoccupations à court terme, il ne donnait pas à la recherche industrielle un impulsion très coordonnée.*** [433] [my emphasis]

It was for these reasons that the DGRST suggested a shift in emphasis from military and specialized electronics tubes to semiconductor materials. If adopted by the government, such a change would redress the imbalance between the DGRST and the other research organizations' (CNET, CEA, DRME and CNES) share in the control of government expenditure in electronics research.[434]

Moreover, the adoption of this proposal would have initiated a major change that could have jeopardized the French military view of political independence that was limited to freedom in defense policy within the transatlantic regime. Given the American influence on the French military and the objective integration between the French and American electronics industries, it is hard to explain the DGRST's difficulties simply as internal bureaucratic struggle. As it was impossible for the French military to develop a different defense policy than the one provided by the American model; it also became difficult for French industry to develop a national semiconductor manufacturing capabilities. In effect, given the French companies' relative

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[433] A. Roux, "La recherche dans les industries électriques et électroniques en France et à l'étranger". This paper was given in a conference on Novembre 1965, before the *Groupe X Electroniciens* and reprinted in Premier Ministre - DGRST Le Progrès Scientifique, N°96, Mai 1966, pp.16-17.

[434] As an example of this imbalance, it was noted that in 1965, while the DGRST controlled only 17 million Francs for electronics research the DRME administered 126 million Francs and the *Centre National d'Étude Spatiales* (CNES) 174 million Francs. Ibid., p.20.

backwardness in research, they were unsure of their ability to develop a product that would satisfy the French military's reliability requirement that followed American standards. Consequently, while entering the semiconductor industry required the French to foster a vertical integration between components producers and computer manufacturers, French companies had no interest in such integration as they competed with each other in other sectors and profited from the manufacturing of tubes and electric superconductor materials while importing semiconductors from the United States.[435] The only sector that the companies could agree on was the sector of application-software and computer peripherals but these sectors played a minor role in the DGRST's option.

5.2.2 *The DGRST's Computer Development Strategy*

While the DGRST's electronics policy proposal involved all French companies, its computer development policy was rather restrictive. Contrary to the CITEC/DMA-DRME agreement presented, the DGRST insisted that the government should support only the development of compatible computers and help only successful companies. It maintained that:

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435 As the DGSRT recognized:

> *L'une des difficultés d'un accord entre les trois CSF, CGE, et SCHNEIDER réside probablement dans le fait qu'ils sont à la fois fabricant de calculateurs et d'automatismes industriels. Un terrain d'entente devra sans doute être trouvé aussi pour les automatismes, mais ces derniers ont des ramifications profondes dans un trop grand nombre d'industries d'équipements pour qu'ils puissent faire l'objet d'accords dans le court délais.*

C.A.C./ 81401, Box 136, Premier Ministre - D.G.R.S.T, "Rapport intérimaire de la commission calculateurs développement", op. cit., p. 23.

*Lors de la passation du contrat préliminaire, **et sous réserve que les résultats de celui-ci fussent satisfaisants**.*
Deux sources de financement avaient eté jugées possible à cet effet:
- d'une part des marchés d'étude passés par les ministères interessés aux applications des calculateurs, pour un montant égal au tiers du coût du développement.
- d'autre part des subventions portant sur la moitié des frais de developpment non couverts par les marchés (soit un tiers du coût total). [436]

In conformity with this position, the DGRST proposed a budget of 225 million FF for the manufacturing of a French series of computers. As Table. 14 shows, this budget included 75 million FF of ministerial subsidies for the material they would order and 75 million FF in reimbursable loans to companies. For the Delegation, this budget would be sufficient to favor the emergence of a national computer manufacturer and to finance a vertical integration of components manufacturers, software producers and large systems assemblers.

Table. 14: The DGRST's Research and Development Budget Proposal for the Development of French Compatible Computers

Years	1966	1967	1968	1969	1970	Total
R&D costs	45	60	75	35	10	225
Including public subsidies	15	20	25	12	3	75
Including reimbursable Government loans to companies	15	20	25	11	4	75

Reference: Premier Ministre - D.G.R.S.T. "Rapport intérimaire de la commission calculateur développment", Confidentiel, 1.065.PD/VP CAC/ 81401, Box 136, p.13.

The irony was that while questioning the appropriateness of the American defense model for France, the DGRST pressed hard to implement the American model of vertical integration epitomized by IBM, in order to create a national computer

436 C.A.C./ 81401, Box 136. Premier Ministre - D.G.R.S.T. "Rapport intérimaire de la commission calculateurs developpement", Secret confidentiel, op. cit., p.13.

manufacturer "champion". However, just as French military requirements surpassed French industrial capabilities in comparison with the billion of dollars of American expenditure, French financing also lagged behind the DGRST's ambition. The DGRST's ambition became even more unrealistic when combined with the declaration that the budget would be justified only if it was executed jointly with a financial supplement for a more sophisticated computer series marketable by 1972.[437] As Table 15 shows, this supplement was also a five-year program. If adopted, it would have cost both government and industry 160 million FF of research to build a large computer system for the EEC market. As a supplementary budget, it was portrayed as a French contribution to European cooperation programs whose terms were yet to be defined.

Table 15: A supplementary budget proposal to prepare French industry for European collaboration

Years	1966	1967	1968	1969	1970	Total
Large computer	3	6	21	60	40	160
Departmental subsidies	1	2	7	20	20	50
Governmental loans	1	2	7	20	20	50

Reference: C.A.C./ 81401, Box 136, Premier Ministre - D.G.R.S.T, "Rapport intérimaire de la commission calculateur développment", Confidentiel, I.065.PD/VP, p.14

To summarize, the DGRST's plans totaled 685 million Francs (the total of Tables 11, 12, 13, 14, 15). As Table 16 shows, the 1968 plan would have cost 225 million FF. By 1970 the development of computers for the European market would have take 160 million FF, while 175 million FF would be allocated to components research and 60 million FF for peripheral equipment.

437 The Delegation argued that: "*le développement d'une serie de calculateurs vendables dès 1968 n'a de sens que s'il en est suivi par une seconde opération visant à construire un matériel plus évolué en vue d'une échéance 1972.* ", Idem, p.14.

Table. 16: Total Cost of the DGRST's Proposal

	1966	1967	1968	1969	1970	Total
(1) Mid-term plan for computer	45	60	75	35	10	225
(2) Long-term plan	3	6	21	60	70	160
(3) Components	25	45	45	35	25	175
(4) Peripherals	12	13	12	12	11	60
(5) Tubes	10	15	15	15	10	65
(5) Total of each year	95	139	168	157	126	685

Reference: C.A.C./ 81401, Box 136, Premier Ministre - D.G.R.S.T. «Rapport intérimaire de la commission calculateur développment», Confidentiel, I.065.PD/VP, p.16.

As Table. 17 indicates, the total cost of this five-year program was to be shared between the government (62%) and the industry (38%). While the government would have been the major contributor, its subsidies were to be controlled by the DGRST in lieu of the CNES, the CNET and the DRME (the space, telecommunications and defense research institute).

Table. 17: Proposed Governmental Participation in the DGRST Five-Year Program

Years	1966	1967	1968	1969	1970	Total
Mid-term plan	30	40	50	23	7	150
Long-term plan	2	4	14	40	40	100
Components	20	25	20	20	15	100
Peripheral	8	8	8	8	8	40
Tubes	6	10	10	10	4	40
Total	66	87	102	101	74	430

Reference: C.A.C./ 81401, Box 136, Premier Ministre - D.G.R.S.T. "Rapport intérimaire de la commission calculateur développment", Confidentiel, I.065.PD/VP, p.17.

For the DGRST, if the government agreed on this proposal, there would be no need to develop components outside this program. In fact, the DGRST called for the demise of a DRME, CNES and CNET's role in the Fifth Plan by stating that:

> ***Il ne paraît pas souhaitable de développer ailleurs des programmes de composants*** *... Au risque de quelques duplications, génératrices d'ailleurs de compétition, il semble d'autre part difficile de ne pas soutenir les deux groupes, si ceux-ci restent seuls en présence. Une*

> ***spécialisation qui consisterait par exemple à orienter Radiotechnique vers les mémoires et Thomson-CSF vers les circuits intégrés mériterait en tout état de cause attention...*** [I emphasize].[438]

In conclusion, the DGRST's five-year plan differed sharply from the equipment policy of the other institutions. It was a nationalistic industrial policy that called upon both French defense discourse and technological practice to break with the influence of the transatlantic discursive regime. It was clear from the DGRST's analysis and suggestions that only such a policy could guarantee independence in defense decision-making:

> *... le présent rapport est conçu, pour l'essentiel, dans l'hypothèse* ***d'une politique de développement proprement français,*** *afin de permettre au gouvernement de prendre position. Mais sitôt son accord et son appui acquis, des négociations devraient être entreprises, ou poursuivies, avec d'importantes firmes européennes... Il ne s'agit donc, au stade actuel, que d'un programme en quelque sorte provisionnel, destiné à permettre au Gouvernement de prendre parti sur l'opportunité de l'opération qui lui est proposée, et sur les conditions - notamment de restructuration industrielle - auxquelles est suspendu son appui.* [439] [Emphasis in the text]

Given the minor position of the DGRST within the French institutions, the Delegation recognized that it could not build a national rival for IBM and as it could not accept total technological dependence, it became an early (1965) advocate of trans-European alliances and programs. As we shall see, this five-year program would not gain full governmental support not because it opposed the interests of the nuclear, telecommunications and space sectors but because it questioned the very basis of French defense policy: the procurement of American integrated circuits. Since the Delegation had no power of budgetary decision, its analysis and suggestions remained wishful thinking. As mentioned earlier, it could only suggest policy to the Prime

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438 Idem. p.22.
439 Idem. p.5.

Minister's Office and the latter, in spite of its sympathy for the DGRST's perspective on industrial independence, had no authority over National Defense. According to the constitution defense fell within the jurisdiction of President of the Republic, whose immediate retinue still believed that the strengths of the American computer industry rested on the endless change in military-oriented application-software.

5.3 THE MILITARY POSITION ON APPLICATION-SOFTWARE DEVELOPMENT

Given the divergence between the military-oriented application-software policy and the DGRST's insistence on electronics, in 1966, Mr. F. H. Raymond (a member of the *Service Technique Aéronautique* [STAé] a French Air Force office) presented the military's arguments against the DGRST's position to President Charles de Gaulle in the following terms. The information processing industry was not a branch of electronics because it produced massively electronic components that were specific and characterized by their high quality and dependability. This industry was also different by the nature of its commercial operations that are international by definition. In the long run it will be a key factor in the conception of a variety of capital goods.[440]

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440 According to Raymond:

> .. *L'informatique n'est pas une branche de l'électronique. Elle en diffère par la nécessité de produire des composants électroniques spécifiques performants et de très grande fiabilité, en très grande quantité et à terme en production de masse;*
>
> *Elle diffère par la nature des actions commerciales propres à assurer une diffusion croissante de produits informatiques dans un marché international, international par les besoins et les fournisseurs.*
>
> *A terme l'informatique sera une des clés (de la production et de la conception) des biens d'équipements de toutes natures.*

This was the French Air Force's argument in 1966, specified by Raymond in 1988 in a conference on the history of French electronics in 1988. F.H. Raymond, "Le Plan Calcul", Colloque sur l'informatique en France, Grenoble 3-4-5 Mai 1988, op. cit. p. 387.

This argument was based on US experience in the building of the SAGE system which had revealed many computer application problems specific to American defense policy. As we have seen, through the resolution of these problems, several advances in electronics had been accomplished and US companies had come to dominate the world's electronics industry. For the French Air Force, although in the mid-1960s, application-software was economically less important than electronics, in the future the growth of the whole information processing industry would depend on it. According to Raymond:

> *Nous sommes, en informatique, dans un domaine non majeur mais singulièrement dynamique et de façons diverses pluridisciplinaires.*
> *Il faut des physiciens, des technologues, des ingénieurs et des informaticiens possédant une solide culture mathématique. Les Français sont doués pour cela et* ***toute action en faveur de l'informatique devrait être capable de susciter de nouvelles vocations dont notre économie bénéficiera à terme...***
> ***À terme l'informatique sera une des clés (de la production et de la conception) des bien d'équipement de toutes natures***
> *Si notre pays n'acquiert pas la maîtrise de l'informatique, cela conduira à une frustration grave des Universitaires pour lesquels disposer et dominer l'usage d'outils de calculs de plus en plus puissants est nécessaire au succès de leurs recherches*. [441] [my emphasis]

To argue as Raymond did for a policy to develop software capabilities, was not an argument against manufacturing of components capabilities. Nevertheless, the dilemma was where to start. In this analysis, the American experience with the SAGE system was the example and the OECD user policy was the doctrine. The paradigm was not technologically induced or forced by the United States. It was based on the tacit acceptance of the transatlantic discursive regime. It was a view that was not limited to air defense engineers such as Raymond. The head of the CSF's research department, Mr. André Danzin maintained a similar view. For the latter, it was the change in the mode of information processing that determined change in electronics and not the other

[441] Idem, p.388.

way around. This could be seen where new modes of information processing, transmission and electronic commutation converged within digitization by borrowing massive know-how from software engineering.

> *Ce n'est pas l'informatique qui a besoin de l'électronique mais c'est l'inverse. On le voit bien aujourd'hui où les modes de traitement, de transmission et de commutation converge dans le mode numérique et fond des larges emprunts au logiciel. On eu ainsi écourté la fastidieuse controverse sur la primauté de l'analogique qui a retardé certaines stratégies de choix techniques en électronique*[442].

Danzin's example buried in the quote was also the MIT Lincoln Laboratory's experience with the SAGE system. The issue that divided the DGRST and the French Air Force thus was not a question of budgetary resources but a conflict of ideas bounded by the same concern for French political independence and structured around questions such as what should come first, military autonomy or technological independence. On what should be based the dynamic of industrial development; application-software or electronics? For the DGRST, French strategy should be based on the develop of electronics, for the French Air Force and THOMSON-CSF, prority should be given to application-software.

In Danzin's view :

> *...seule l'informatique pouvait fournir aux composants électroniques des objectifs associant à la fois la demande de pointe et la série de production. Et c'est par dérivation de ces productions que sont nés les composants utilisés massivement et à bas prix par les matériels électroniques d'usage domestiques. Pour les composants, l'ensemble... Informatique et Télécommunications forme le tronc commun nécessaire à l'inspiration techniques et à l'amortissement des frais de lancement et des équipements qui font de cette industrie de la microminiature une industrie lourde en perpétuel état d'anticipation* [443].

As we can see from this statement, the fight between the two institutions went beyond bureaucratic struggles and highlighted the contradiction between the

[442] Idem, p.390.
[443] Idem, p.390.

requirements of military defense as represented by the Air Force and the role of industrial development carried out by the DGRST. Each group of actors argued from the framework of its function not only within the French universe of political discourse but inside the global framework of the transatlantic discursive regime within which the DGRST was always doubly disadvantaged. Not only did the latter have no power of decision within the French universe of political discourse, but it also lacked a credible industrial ally. For both reasons the DGRST was never a serious threat to the transatlantic discursive regime and its antagonism towards IBM although popular amongst neo-realists and in media circles, was never backed by a credible budgetary decision.

Technological self-sufficiency and national glory did not count for much in the French debates. From an economic point of view, not only was an effort to gain a market share in France or in Europe in the sector of general-purpose computing (already dominated by IBM) considered risky but it was also seen as strategically wrong. In conformity with the OECD specialization doctrine, Danzin invited French industry and government to seek new applications that would orient the development of French electronics and to abandon the competition against IBM. He maintained the same argument in 1988 that:

> *Au lieu de mener certes une guerre, non pas contre quelque chose ou quelqu'un mais "pour" le développement de l'informatique sous toutes ses formes,* ***pour*** *la promotion des applications,* ***pour*** *la participation des utilisateurs,* ***pour*** *la réussite d'une originalité française en profitant de la diversité des solutions et des applications que favoriserait la mobilité du domaine, on a cru utile de mener une guerre* ***contre*** *les multinationales américaines et particulièrement contre la plus forte d'entre elles. Cette optique a sous-tendu le choix des objectifs techniques et commerciaux et bien entendu les choix des structures.*
> *[...] 15 ans de lutte contre les plus grands producteurs mondiaux de composants m'avaient appris qu'en innovation technique la pire des manières d'engager la compétition en position de faiblesse est d'accepter le terrain de l'adversaire et de se servir des mêmes armes que lui, ce que tous les militaires*

> *le savent bien. Mais à l'époque, évoquer une situation de faiblesse était faire preuve d'un pessimisme condamnable* .[444] [emphasis in the text]

Although this was a hindsight evaluation of the decision taken during the *Plan Calcul*, it reflected the CSF and generally the telecommunications and military's position as it existed then. Danzin's analysis was, however, misleading because it implied that the *Plan Calcul* was exclusively an electronics development policy and was implemented according to the DGRST's concern with semiconductors. As we shall see in the next section, the *Plan Calcul* was neither exclusively a components development policy nor solely an application-software development program. It was an attempt to reconcile both concerns.

5.4 THE PLAN CALCUL: ITS OBJECTIVES AND INDUSTRIAL BASE

5.4.1 *Objectives*

In 1966, when the French parliament adopted the *Plan Calcul* as the policy for the Fifth Plan, it tried to reconcile two opposing views. This reconciliation resulted in a plan that was a combination of an application-software program and an electronic development policy. It had four main objectives: 1) fostering a French company capable of developing, producing and commercializing a range of general-purpose computers, 2) strengthening the French electronics components sector, 3) building a computer peripheral equipment industry, and 4) assuring a harmonious and dynamic development of consulting services dealing with issues related to the computer

444 Idem, p.391.

industry.[445] It was also agreed that, by 1970, companies involved in the *Plan Calcul* had to produce four types of computer P0, P1, P2, P3.

• P1 was considered the basic design for the entire series. It was a middle-sized machine for both management and scientific calculation;

• P0 was a light version of P1 also designed for management and scientific calculation;

• P2 was a general-purpose computer for a wide range of activities including the military.

• P3 was simply a large computer already commercialized by the CITEC[446].

The 1970 timetable was also a compromise between the DGRST's schedule (1972) and the DMA-DRME's deadline (1968) for French industry to manufacture its first computers under the framework of the *Plan Calcul*. All these machines were meant to be compatible with each other. They did not represent a new line of computers because they were meant to be compatible with the IBM 360 series (30, 50 and 65). Moreover, THOMSON, the CSF, and the CGE had agreed with the department of the Armed Services to produce military versions of the P0 and P2 computers. The military versions of these two computers were named respectively P0M and P2M.

As advised by both the DGRST and the military (the DMA and the DRME) the *Plan Calcul* had also sought to prepare French industry for a second generation of computers after the «P» series. This second generation of computers would eventually be built in cooperation with European partners. The group of companies that would carry out this program also had the mission to:

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445 C.A.C. 77/321 Box 1002, D.G.R.S.T., "Lancement du Plan Calcul", Le Progrès scientifique, N°102, novembre 1966, p.1.

446 Pierre Audin Conseil "Le Plan Calcul français 1966-1975", In Colloque sur l'informatique en France, op. cit., p. 21

- supply French industry with accurate information regarding technical and economic choices;
- enable French industry to maintain control over its industrial policy;
- prepare French industry to convert its «P» range of computers to larger machines.

Furthermore, in July 1966, the Prime Minister nominated a delegate under its jurisdiction . This delegate would have the mission to:

- supervise the implementation of the *Plan Calcul*;
- associate as many French national companies as possible in the program;
- coordinate computer procurement in the public and para-public sectors;
- create an institute under its supervision for application-software and automation[447].

All these functions were already being undertaken by the *Commission Permanente de l'Électronique du Plan* (COPEP). However, the government decision to create a new delegation for application-software and automation constituted a change because it separated research in electronics from the sector of industrial application. The change became official by decree N° 66-756 of October 8, 1966 that created the *Délégation à l'informatique* and the *Institut National de Recherche en Informatique et en Automatique* (INRIA) attached to the DGRST and separated from COPEP[448]. While the *Délégation à l'informatique* would work in coordination with the DGRST, INRIA and COPEP would advise the government in application-software and electronics repectively. In this new framework, COPEP would deal with electronics development in civilian and military communications and space research while the INRIA would

[447] C.A.C. 77/321 Box 1002, Editorial, "Lancement du Plan Calcul", Le Progrès scientifique, N° 102, 1966.
[448] Journal Officiel, Octobre 11, 1966.

coordinate private and public research efforts in application-software for both the national and European markets.[449]

5.4.2 *Industrial Structure*

In keeping with this plan, in 1966 the government urged the CGE and the CSF (the members of the CITEC holding) to merge with SEA (which itself became a SCHNEIDER group subcompany) and made their financial support conditional on this. Accordingly CSF and CGE accepted the merger of the SEA with CITEC to comply with this demand. The SCHNEIDER Group's subsidiary was known for its competence in application software. By merging this company with CITEC, the *Ministère des armées* (whose objective was to build its bargaining power against the US) prevented SEA's engineers from joining American companies. In April 1967, the *Compagnie Internationale pour l'Informatique* (CII) was formed as a merger of C.A.E. (CITEC's subsidiary), SEA (the SCHNEIDER subsidiary) and the *Société pour l'Étude et la Réalisation des Procédés Électroniques* (ANALAC).[450] After the creation of the CII, THOMSON merged with the CSF to constitute one company under the composite name of THOMSON-CSF.[451]

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449 C.A.C. 77/321, Box 1002. G. Aranda, "Le Plan Calcul va reposer sur la C.G.E., la C.S.F. et Schneider", Entreprise, N°13, Octobre 1966, p.15.

450 RE 130 Box 11, Centre des Hauts Études de l'Armement - Section "Armement" - «La compagnie Internationale pour l'Informatique "C.I.I."», Quatrième Session 1967-1968, p.5.

451 When GENERAL ELECTRIC started to give up its assets in BULL to HONEYWELL the government considered it an opportunity to nationalize BULL. However the headquarters of this company rejected the government offer. It argued that France would not accomplish its information technology objectives without the help of American companies. Following this, BULL-GENERAL ELECTRIC became HONEYWELL-BULL. F.H. Raymond, «Le Plan Calcul», op. cit., p.87.

It is worth recalling that the CII was not a merger between THOMSON-CSF, the CGE and SCHNEIDER. It was a financial holding created by these three companies to undertake the *Plan Calcul*. The three firms' traditional activities such as general-public electronics (THOMSON-CSF), industrial automation (SCHNEIDER and CGE), electric super-conductivity (the CGE) and telephony (the CGE and Thomson-CSF) remained separate. Despite the *Plan Calcul*, the three private companies continued to compete with each other while co-ordinating their role in the government plan through the CII.

5.5 THE IMPLEMENTATION OF THE PLAN CALCUL

Given the companies' initial resistance to the DGRST's proposal and the struggle between the DGRST and other institutions over policy orientation, it is legitimate to ask what was the real meaning of the *Plan Calcul* ? The answer to this question requires a comparison between the DGRST's previously mentioned budget proposal and the final budget authorization for the *Plan Calcul* in the *Délégation à l'informatique*'s budget. Such a comparison will show which of the two contending perspectives (the DGRST's perspective [see Table 16] or the military view) won financial approval.

This comparison will reveal that companies' research expenditure was smaller than the amount the DGRST proposed as the THOMSON-CSF contribution in the *Plan Calcul* and the latter was less important than the DGRST's initial proposal. In comparing the real expenditure of the *Plan Calcul* to the government's extra-budgetary expenditure in electronics, it will also appears that the military and the telecommunications authorities maintained their user policy of learning about the edge of American integrated circuits techniques, understanding what they could do, without involving themselves in research and development for marketable electronic circuits. It will become visible that the *Plan Calcul* reinforced the choice made during the Fourth Plan: *La politique de veille technologique et de retard contrôlé* in conformity with the French normalization policy and in line with the OECD Secretary General's user/specialization doctrine.

5.5.1 *Comparison between the DGRST's proposal and the Plan Calcul's budget authorization*

As Table 18 shows, the *Plan Calcul*'s budget fell short in comparison to the amount proposed by the DGRST. Instead of spending 685 million Francs (FF) as the DGRST had advised (Table 16) the government allocated only 573.75 million FF. This amount did not represent the amount paid for the *Plan Calcul*, because in the French budgeting there is always a difference between budget authorization and budget outlay. In fact, as Table 19 shows, the government spent only a total of 524.1 million FF in concerted actions, urgent and exceptional operations and complementary coordinated actions including the *Plan Calcul*. Moreover, as Table. 20 illustrates, only 16% was allocated to semiconductors. Thus, whereas the DGRST emphasized semiconductors for computers and de-emphasized electronics research for other uses, the government authorized the opposite expenditure pattern.

Table. 18: Budget of the *Délégué à l'informatique* 1966-1970
(in million FF)

	1966	1967	1968	1969	1970	Total	%
(1) Computer budget	10.4	69.6	107.4	110.4	94.5	393.3	68.5
(2) Peripheral equipment		9.6	21	31.7	24.5	86.8	15.5
(3) Electro. components		11	4.7	21.1	23	59.8	10.5
(4) Software budget				1.5	4	5.5	0.5
(5) Specific actions		0.15	4.4	8	8.3	20.85	3.5
(6) Computer science Committee				1	8	9	1.5
Totals	10.4	90.35	137.5	174.3	162.3	573.75	100

Reference: C.A.C. 810401 Box 188. "*Budget 1971 - Informatique - Plan Calcul Institut de Recherche en Informatique et en Automatique* (I.R.I.A.)"

The computer budget of the *Délégation à l'informatique* included research, design, manufacturing and marketing of computer systems retained in the *Plan Calcul*. While this budget represented 68.5% of the sum administred by the *Délégation à l'informatique*, it may suggest that the CII was designing its integrated circuits. However, this was not the case because, the company was only assembling these circuits with other bought-in components which were put into plastic boxes and attaching monitors and keyboards. Thus, while the official software budget represented only 0.5 % of expenditure, 68.5% of the budget was mainly in application-software meant to be used in IBM's proprietary operating system. Moreover, although it might appear that the DGRST had won against the military this was not the case as there were other amounts - the extra-budgetary expenditures devoted to electronics that - neither the DGRST nor the *Délégation à l'informatique* controlled. Table 19 shows that the total amount devoted to electronics was 524.1 million FF. Within this amount, the electronics budget of the *Délégation à l'informatique* was in fact 10% less than predicted - 54 million instead of 59 million.

Table 19: Electronic research budget 1966 - 1969 (in million francs)

Budget subcategories	1966	1967	1968	1969	Total
Concerted Actions	83.3	115	119.5	120.5	438.3
Urgent and exceptional operations	17.9	23.6	17	21.6	80.1
Complementary Coordinated Actions				5.7	5.7
Total	101.2	138.6	136.5	147.8	524.1

Reference: CAC. 810401 Box 256. Ministère du d'veloppement - D.G.R.S.T. Affaires Scientifiques et Techniques, "Composants et circuits miniaturisés 24ième reunion", Confidentiel, N° AST/81/AD/762/CCM., p. 2.

Table 20: The microelectronic component budget within the global electronics research budget 1965-1969

	1965	1966	1967	1968	1969	Total
(1)Microelectronic Budget		16	21	22	19	54
(2) Global Electronic Research		101.2	138.6	136.5	147.8	524.1
(3) Percentage		15.8 %	15.15%	16.11%	12.8%	10. 3 %

Reference: CAC. 810401 Box 256. Ministère du développement - D.G.R.S.T. Affaire scientifique et technique, "Composants et circuits miniaturisés 24ième reunion", Confidentiel, op. cit.

Obviously, despite the conciliatory proposal initially adopted by the French parliament, the government, under the powerful influence of institutions such as the military, the *Commissariat Général du Plan* , COPEP, CCT and their industrial allies Thomson/CSF and CGE), overlooked the DGRST's advice that electronics research should not be dealt with outside of the *Plan Calcul* through extra-budgetary expenditures. As we shall see in the next section, the amount devoted to electronics research in telecommunications and aeronautic in these extra-budgetary expenditures was more important than the amount devoted in the *Plan Calcul.*

5.5.2 *Comparison between the microelectronic budget and companies' expenditures*

Although the above figures fell below the DGRST's proposal, they still do not show the effective research expenditures by firms. Further information on micro-electronics research shows that between 1966 and 1970 total expenditures were not 54 millions FF as Table 20 suggests, but only 32 million FF (Table 21) which were not in the Plan Calcul, but in the extra-budgetary expenditures. Of this amount, THOMSON-CSF and their affiliates (SESCO[452] and COSEM[453]) received 39% and the CNET laboratory 17%[454]. This concentration of research funds in THOMSON-CSF raised DGRST protests; the Delegation's policy of providing public help to the entire industry had not been respected. Indeed, in a note in one of the DGRST's files, one can read the following complaint:

> *Rien de tout cela n'a été réalisé. Le Plan Composants n'est qu'une opération de sauvetage destiné à secourir la firme X, [C.S.F.] exactement au moment où le déficit de cette compagnie - dû à des erreurs de gestion - est devenu catastrophique.*[455]

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452 S.E.S.C.O. is for *Société Européenne des Semi-Conducteurs*. This company was created by THOMSON and supported financially by GENERAL ELECTRIC in 1961. Its mission was to produce numerical calculation devices and radar systems for the French Air Force.

453 C.O.S.E.M. is for *Companie générale des semi-conducteurs*. This company was created in January 1960 by the merger between the semiconductor department of the C.S.F. with the *Société Alsacienne de Construction Mécanique*.

454 C.A.C. 77/321 Box 1448. Les archibes de Monsieur Dumesmil. D.G.R.S.T., "Action Concertée Composants et Circuits Microminiaturisés", In Aide à la recherche. Rapport d'activité 1968. Nomenclature des contracts et statistiques. Confidentiel. Mai 1969.

455 Note cited by J. Zysman, L'industrie française entre l'État et le marché, Paris, Bonnel 1982, p.173. Zysman's view have been reported by P.-E. Mounier-Khun, "Les constructeurs d'ordinateurs face à l'industrie des composants", op. cit. Mounier-Khun and Zysman claim that the micro-electronic budget was used by THOMSON to absorb C.S.F. and eliminate the deficit of this company.

Table 21: Each company's share in the 1966/1968 micro-electronic budget

Company name	Contrac' _lue in F.F.	Percentage
C.S.F.	6.159.977	19%
S.E.S.C.O (THOMSON)	2.536.141	8%
R.T.C. (PHILIPS)	5.121.000	16%
C.G.E.	1.911.379	6%
C.F.T.H. (THOMSON)	1.975.048	6%
C.O.S.E.M. (C.S.F.)	2.022.800	6.25%
C.N.R.S.	618.000	2%
S.M.E.R.S.	400.000	1.25%
A.D.F.A.C.	307.000	1%
C.E.A.	960.040	3%
C.E.N.G.	568.000	2%
L.T.T.	351.700	1%
S.I.L.E.C.	2.741.023	8.5%
C.N.E.T.	5.500.000	17%
L.C.C. - C.I.C.E.	485.000	1.5%
C.E.R.C.O.	176.400	0.5%
L.E.P.	200.000	0.6%
Lille Faculty of Science	70.000	*
Toulouse Fac. of science	157.000	0.5%
Grenoble Fac. of Science	371.780	1%
S.E.F.R	85.000	*
Total	32.384.209.	100%

* Less than half percent.

Sources: C.A.C. 77/321 Box 1448. Mr Dumesmil's Archives. D.G.R.S.T.«Action Concertée Composants et Circuits Microminiaturisés», In Aide à la recherche. Rapport d'activités 1968. Nomenclature des contracts et statistiques. Confidentiel. Mai 1969, pp. 4.3 - 4.10.

The reason for this concentration of expenditure in the THOMSON-CSF and CNET laboratories (56%) was not the CSF's deficit and its merger with THOMSON. According to a report ordered by a non-partisan parliamentary committee, THOMSON-CSF and the CNET were the most favored groups in the distribution of government research funds: (*Enveloppe recherche* and *Hors Enveloppe Recherche*[456]), because neither the military nor industry was in favor of manufacturing domestic integrated

456 C.A.C. 810401 Box 190. "Rapport Dugas: Electronique, Informatique, Télécommunications: Electronique: la dispersion des actions", op. cit.

circuits. In fact, in 1966, when the most dependable circuits were silicon-based[457], the CSF continued to provide its equipment with magnetic core memory. After the announcement of the *Plan Calcul*, the CSF's components producers, COSEM abandoned the development of magnetic core memory and turned to the American company TEXAS INSTRUMENTS for procurement of integrated circuits despite the *Plan Calcul* policy.[458]

The national neglect of integrated circuits research continued until the late 1960s. In 1969, when it became clear to the French aeronautics industry that even in specialized products such as airborne and missile computers, tubes and magnetic core memory were no longer dependable, THOMSON-CSF asked the government for further subsidies to switch from the manufacturing of low capacitative loads Emitter Coupled Logic (ECL) to the production of Transistor-*Transistor Logic* (T2L) circuits, the computer logic circuits that consisted of two or more directly interconnected transistors intended to drive capacitative loads[459] at high rates. Despite many trials, THOMSON-CSF's T2L circuits were proven ineffective. This failure led the Air Force to oppose government funds for T2L research. As civilian and military aeronautics shared the same research budget, the Air Force feared that such allocations would be taken from its equipment budget. Instead of spending more money on trials, the Air

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457 Braun, E. and Macdonald, S., Revolution in Miniature: The History and Impact of Semiconductor Electronics, Cambridge, Cambridge University Press, 1978.

458 Electronique Actualités, 5 Janvier 1966.

459 In digital computer techniques, while a **load** refers to the transfer of a program or/and data in a form of an electric stream from a **backing store** (a secondary storage usually made up of a combination of magnetic disk, drum or tape) to a main computer memory, the word capacitative is an attribute of a component that may be vacuum tube, fused ceramic, paper (waxed or oiled) mica, glass, plastic foil that has the capacity to deliver an electric quantity under specified conditions. In electronics engineering these materials are also formally called **capacitors** or **condensers**.

Force advised THOMSON-CSF to compare the dependability of its products with the same material already produced in the United States.[460]

As Pierre Audin Conseil (a French consulting company) noted concerning THOMSON-CSF's failure to produce the T2L circuits:

> *La mise en œuvre a été très longue...car elle a constitué pour la SESCOSEM* (the THOMSON-CSF's semiconductor research department) *en l'apprentissage de la technologie des circuits intégrés ... c'est donc au cours de cette période que les difficultés les plus nombreuses et les plus importantes ont été rencontrées...il est très rapidement apparu que, pour des raisons logistiques (taille de l'usine, importance du noyau de recherches), la SOSCOSEM ne peut pas tout faire.*[461]

The size of THOMSON-CSF's research laboratory SESCOSEM was not the only factor that prevented the company from producing the T2L circuits. A further hindrance was the Air Force's and the PT&T's reluctance to allot the necessary funds for the domestic production of these circuits. As we shall see in the next subsection, these government departments were concerned with application-software rather than encouraging the development of a French semiconductor industry.

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[460] C.A.C. 77/321 Box 1539. Premier Ministre - D.G.R.S.T. - Direction des Affaires Scientifiques "Comité Composants et Circuits Microminiaturisés. Procès-verbal de la reunion du 2 juin 1969. (10ème reunion)" DAS/ARD/81/AD - 467/CCM/D49/, P.3.
[461] Pierre Audin Conseil "Le Plan Calcul français: 1966-1974", In Chatelin, P. (ed), Colloque sur l'histoire de l'informatique en France, Vol.1, Grenoble 3-4-5, mai 1988, p.35.

5.5.3A *comparison between government expenditure in equipment and the Plan Calcul*

The non-partisan parliamentary committee report mentioned above also revealed that total expenditures between 1966 and 1969 did not reflect the equilibrium between application-software and integrated circuits research agreed on in the *Plan Calcul*. This was because the Ministry of PT&T, the Air Force and the CNES bought their integrated circuits from the US and oriented their research to application-software. The parliamentary committee discovered that only 15% of total expenditures were allocated to research while 16% were destined to equipment development. Thus, in spite of the DGRST's suggestions and the *Plan Calcul* agreement, equipment purchases were not postponed for the benefit of research in semiconductors; the government devoted 69% of its funds to application-software and hardware for civil and military telecommunications and space.

Table 22: Total information and computer research budget 1966-1969
(in million of francs)

	1966		1967		1968		1969		Total	
Programs	M.F *	%	M.F.	%	M.F.	%	M.F.	%	M.F.	%
Development subsidies	59	13.7	122	15.9	150	16.6	147	17	478	16
Aerospace & PTT research	360	83.5	543	70.7	596	65.8	543	63	2042	69
Plan Calcul	12	2.8	103	13.4	160	17.6	174	20	449	15
Total	431	100	768	100	906	100	864	100	2969	100

* M.F.= million francs

Reference: RE 130 Box 15, 559 (5). "Premier questionaire de la Commission des Affaires culturelles familiales et sociales de l'Assemblée Nationale sur les perspectives budgetaires de 1970 - Ministère du développement industriel et scientifique". Paragraph. "L'aide au développement, la recherche spatiale, le Plan Calcul", p.3.

This parliamentary budget assessment[462] confirmed that 2. 042 million Francs was allocated to the PT&T and Armed Services research and equipment purchases. Here, again, the French government followed early OECD advice that limited the primary role of government to the modernization of telecommunication lines because the French telephone system was amongst the worst in the industrialized world. Following this policy and instead of participating in the formal *Plan calcul* as announced, private companies (mostly THOMSON-CSF and CGE) received over one third (720 millions francs) of these extra-budgetary research expenses.[463]

Table 23: Electronic budget outside the research portfolio

Companies' participation on their funds	650 millions
Government research contracts undertaken by industry	720 millions
Research associated to equipment procurement	300 millions
Public laboratories research	400 millions
Total	2 070 millions

Sources: C.A.C.810401 Box 190. "Rapport Dugas: Electronique, Informatique, Télécommunications: Electronique: la dispersion des actions", p. 3.

Leaving aside the firm's own expenditure of 650 MF, this table shows that the government spent 1420 million francs in extra-budgetary expenses (*Hors enveloppe recherche*). Given the size of these expenses in comparison with the *Plan Calcul* (524.1 MF), one cannot overlook the fact that these expenditures represented the real policy of

[462] C.A.C. 810401 Box 190. "Rapport Dugas: Electronique, Informatique, Telecommunications: Electronique: la dispersion des actions", p. 3.

[463] It should be noted that the French research budget was not only heavily oriented to military telecommunication and aerospace programs but it was also highly concentrated: THOMSON group alone received 1000 millions French Francs (more than 1/3 of the total "hors enveloppe research budget"). It should also be noticed that this company's interest was not computers and it supplied most of the government equipment orders while fighting with C.G.E. group to gain monopoly over the telephone sector. C.A.C. 810401 Box 190. «Rapport Dugas: Electronique, Informatique, Telecommunications: Electronique: la dispersion des actions», op. cit.

the Fifth Plan. Considering the *Plan Calcul* 's limited budget, it is now possible to assert that the *Plan Calcul* was just a demonstration of the French bargaining power to counter the American embargo and it had little impact on the practice of the Fourth Plan. In fact, the CII did not produce the «P» computer series. Instead of committing their resources to manufacturing the «P» series in 1970 as agreed in the *Plan Calcul*, in 1968, THOMSON-CSF and CGE produced the 10.000 computer series (10, 20, and 70) for military use. Moreover, as these computers were not manufactured with French integrated circuits, their prototypes were not even produced in France. They were imported from the United States.[464] Mounier-Khun has recently revealed that the 10.000 series were nothing less than the American computers SIGMA 2 and 7 of the American company SCIENTIFIC DATA SYSTEMS (SDS).[465] The choice of American technology was proof that the French Armed Forces were not interested in French digital technology nor in French integrated circuits; they addressed only their demands for analog machines to French industry. The French company ANALAC produced many analog computers for the French Navy, Army and Air forces.

Thus, contrary to the plan drawn up by the DGRST, the 10.000 series was adopted by the CII as the basis for a future generation, the IRIS system. The *Délégation à l'informatique* accepted this decision which in turn changed the schedule of the entire five-year program. As a result, in 1968 the CII's engineers modified the 10.000 series to fill the public order while at the same time undertaking research for

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464 P.-E. Mounier Khun, «Les constructeurs d'ordinateurs face à l'industrie des composants», Colloque: Le défi electronique d'après guerre - une perspective historique, CHRST - La Villette 27-28 mai 1993, p. 21.

465 In 1968, the government agreed with the CII that these computers could be developed further to satisfy the three French armed services' (Air Force, Navy and Army) computation needs in the future. See the technical description of these computers in O1- Informatique, N°.5, 1966. Cited in P.-E. Mounier-Khun, op. cit, p.21

two distinct operating systems (SIRIS 3 and SIRIS 8) for the coming IRIS computer.[466] Moreover, the *Délégation à l'informatique* also authorized THOMSON-CSF to create a computer peripheral equipment program different from the one agreed upon in *Plan Calcul* but financed by the latter. Here again, the decision was taken in contradistinction to the *Plan Calcul*; while the development of truly French equipment required a large amount of money, time and research , the THOMSON-CSF's program for peripheral equipment was based on the American company DATA PRODUCTS' magnetic materials.[467]

These arrangements excluded the *Compagnie des Compteurs* (the subsidiary of the *Compagnie Générale d'Électricité* (CGE)), from the manufacture of peripheral equipment and gave greater control to THOMSON-CSF. At the time the new arrangements did not provoke CGE because it followed an agreement between CGE and THOMSON-CSF that established a division of labor in the electronics and telecommunication sectors between the two companies. The agreement was referred to as *Le YALTA de l'Électronique*. According to Michel Barré who was then the CII's chief executive:

> *Cet accord, négocié au cours du premier semestre 1969 et auquel j'ai participé, aboutit en effet à la détermination d'une frontière; cette frontière reconnaissait le leadership de chacune des sociétés sur un certain nombre de domaines; la C.G.E. obtenait le leadership auquel elle tenait essentiellement, à savoir celui de l'industrie de téléphone, la Thomson-CSF renonçait à toute ambition dans ce domaine et, par contre, assumait le pilotage de l'informatique de la C.I.I.*
>
> *Cet accord est communément connu sous le non de "YALTA DE L'ÉLECTRONIQUE .*[468]

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466 M. Barré, «La Compagnie Internationale pour l'Informatique dans le cadre du Plan Calcul», In Chatelin, P. (ed), Colloque sur l'histoire de l'informatique en France, op. cit., pp. 89-90.
467 Ibid. p. 90.
468 Idem. p.87.

These alliances and the agreement between THOMSON-CSF and CGE continued the user policy but did not fulfill the expectation that the establishment of American firms in France would improve the French balance of payments and increase French technological capacity. In addition, they proved to be devastating for the policy of interoperability and interdependence.

5.6 FRENCH INDUSTRY'S SHARE IN THE FRENCH MARKET

In 1967 purchases by the Armed Services, the Department of Post Telegraph and Telecommunications (PT&T) and other government bureaucracies accounted for nearly 50% (Table. 24) of total French computer production.[469]

Table 24: Share of each armed service in the total military computer market 1966-1967

Armed service	1966 % of the total French computer production	1967 % of the total French computer production
Air Force	22.6	16.2
Navy	11.2	12.9
Army	8.3	8.9
Public civil service	6.2	8.9
Total	49.3	46.9

Reference: Re 130 Box 11 File 254 . 21. Centre des Hautes Études de l'Armement - Section "Armement" . "La Compagnie Internationale pour l'Informatique (C.I.I.)", p.2

This material was sold by the CII under American license and was mostly for telecommunications and aeronautics. Aeronautics devices included ground equipment for aircraft navigation and landing; airborne radioelectric equipment for navigation,

469 RE 130 Box 11 File 254 . 21. Centre des Hautes Études de l'Armement - Section "Armement" , «La Compagnie Internationale pour l'Informatique "C.I.I."», op. cit.

communications, detection; and automated test and maintenance equipment. French industry was particularly successful in ground equipment partly because the government helped the industry but mostly because the standards for equipment were set by the International Civil Aviation Organization (ICAO). To maintain international interoperability between aircraft ground control equipment, ICAO's standards changed slowly thus taking into consideration the uneven development of the different countries' electronics industry. In military airborne equipment, French industry was also successful in the internal market because the government protected this sector from imports.[470]

However, this success in military equipment had no spin-off in the civilian airborne electronics equipment sector. According to COPEP's assessment in 1969:

> *Pour les matériels bord civils*[471], *l'industrie française est pratiquement absente aussi bien en France que sur le marché mondial. Elle se trouve en effet en concurrence directe avec l'industrie américaine qui occupe une position dominante dans ce domaine. Les raisons principales de cette absence sont les suivantes: les compagnies aériennes ont une tendance naturelle à s'adresser aux fabricants qu'ils ont déjà éprouvés, c'est-à-dire* COLLINS, BENDIX, SPERRY...[472]

According to COPEP, because of the strong American competitive position in civilian aeronautics, French firms were totally absent from this sector. COPEP stated that : "*On constate que l'industrie française est enfermée dans un cercle vicieux "n'a pas vendue..., n'est pas connue...n'est pas demandée ne vend pas et l'on comprend qu'elle se demande comment amorcer la pompe et qu'elle requiert l'aide de l'État.*"[473] This

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470 RE 130 Box 10, Commissariat Général du Plan - Commission de l'Electronique du Plan - Comité du VIième Plan - Electronique, Informatique et Industrie de Télécommunications - Cellule d'action ponctuelle "Equipements Electroniques Automatiques, "Projet de rapport sur les options", N/ Réf.:69/428/ C.O.P.E.P./ JMT., Paris le 20 novembre 1969, PP. 1-2.

471 *Matériels bord civils* is a French term for civilian airborne equipment.

472 Ibid., p.3.

473 Idem, p.3.

statement represented a denunciation of interoperability and a surge of industrial nationalism within COPEP. It was a reversal of position by an institution that had previously stood against industrial nationalism and pleaded for interdependence within the transatlantic discursive regime. In effect, COPEP blamed the weakness of French industry not only on American companies' strong position in the sector, but, also on the American government's influence on the definition of airborne equipment standards. COPEP argued that:

> *Il ne faut pas oublier que dans ce domaine, outre la concurrence directe exercée par les États-Unis,* ***existe une contrainte au niveau de la définition des équipements; contrainte qui n'a été pleinement mise en lumière en France qu'assez tardivement*** .
> *Alors que pour les matériels sol/bord, les compagnies aériennes ont été amenées,* ***pour assurer l'interchangeabilité des matériels, à définir des caractéristiques beaucoup plus précises et contraignantes (formes, dimensions, nature des informations, câblage types).*** [474] [my emphasis]

This statement indicates the failure of the French struggle for interoperability within the transatlantic discursive regime and shows that even specialization was not possible. COPEP blamed the US government's greater power to influence technological changes. The *Commission du Plan* stated further that:

> ***Ces caractéristiques connues sous le terme de recommandation ARINC sont défini par un organisme international ou l'influence américaine est prépondérante, tant au niveau compagnie qu'au niveau industrie Électronique.*** *Ces recommandations ARINC évoluent assez vite, au fur et à mesure des progrès technologiques en particulier, ce qui peut mettre l'industrie française dans une situation de faiblesse si elle ne suit pas, ou ne peut pas suivre assez tôt cette évolution*[475].

While the *Commission du Plan* was blaming the weakness of the French industry on American influence in the definition of international equipment standards, it

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[474] Idem, p.3.
[475] Idem, p.3.

overlooked its own responsibility notably the lack of interest in semiconductor materials that led THOMSON-CSF to manufacture tubes and magnetic core memory and the tendency of CGE, COPEP, DRME, CNET and CNES to continue to favor specialization in application-software. As Table 25 shows, France imported 40% of its semiconductors.

Table 25: Imports as a percentage of internal consumption (1) in the main components-producing countries (1966)

Country	Components sector	Passive components	Active components: Tubes	Active components: Semiconductors
United States (2)	43%	4.3%	7.2%	3.2%
United Kingdom	13	10.1	18.3	
France	**22.4**	**18.0**	**19.9**	**40.6**
Germany		n.a.	n.a	n.a
Japan	4.4	3.5	2.1	5.7
Netherlands	n.a	n.a	n.a	n.a
Italy	n.a	40.5	n.a.	20.5

Sources: CAC 77/ 321, Box 1417, OECD - Group of Experts on Electronic Components, GAP in Technology Between Member Countries, Draft Report (note by the Secretary), DAS/SPR/ 68.1, Paris 9 January, 1969, p.15.

(1) Internal consumption = output - export + import.
(2) Data for USA are based from shipment for 1969.

The French balance of payments in semiconductor products with the US was in deficit. As Table. 26 shows, in 1969, while France imported 12.3 million dollars of semiconductors, it exported only 1.8 million dollars to the US. As one OECD group of expert commented, "France has a large military market for electronic equipment; this market calls for highly sophisticated components which had to meet exacting technical performance specifications. A large proportion of these advanced components (in particular semiconductors) have to be imported from the United States."[476] Such

[476] CAC 77/ 321, Box 1417, OECD - Group of Experts on Electronic Components, GAP in Technology Between Member Countries, Draft Report (note by the Secretary), DAS/SPR/ 68.1, Paris 9 January, 1968, p. 30.

practices highlight the fact that French defense equipment requirement evolved not according to the French internal industrial capacity but according to US technological change. The French trade imbalance was thus an undesired consequence of following the transatlantic notion of big science which did not fulfill the French expectation of technological interdependence according to the doctrine of specialization promulgated by the OECD.

Table 26: The US balance of trade in tubes and semiconductors with major components producing countries in 1969 in $ million.

Semiconductors	UK	France	Germany	N'lands	Japan
US exports to	13.7	12.3	5.8	3.0	7.2
US import from	0.6	1.8	0.4	3.5	7.4
Balance	+13.1	+10.5	+5.4	0.5	0.2

Tubes	UK	France	Germany	N'lands	Japan
US exports to	3.7	3.4	3.2	1.1	1.4
US import from	6.2	0.9	2.2	8.8	21.9
Balance	-2.5	+2.5	+1.0	7.7	20.5

Sources: CAC 77/ 321, Box 1417, OECD - Group of Experts on Electronic Components, GAP in Technology Between Member Countries, op. cit., p.30.

The French balance of payments in tubes was hardly better, despite increased efforts during the Fifth Plan to improve the state of the French industry in the sector. France still showed a deficit in the more sophisticated tubes used in hyper-frequency, satellites, radar, electronics countermeasure, nuclear accelerator and telecommunications equipment.[477] As a result, by 1969, if all the sectors are taken into consideration, over 50% of French electronics consumption was controlled by

[477] RE130 Box 10 files 560 to 567, Commissariat Générale du Plan Comité du VI Plan 'Electronique, Informatique et Industrie des Télécommunications', N/Ref 69/445/COPEP/ LMT/ AB, Paris le 26 novembre 1969, p.2.

American companies such as IBM, HONEYWELL-BULL, ITT, MOTOROLA and TEXAS INSTRUMENTS who accounted for 90% of foreign investment in the French electronics industry.[478] This percentage was even higher in the specialized equipment sectors of airborne equipment, space and nuclear devices.[479]

Instead of strengthening the French industrial structure and diminishing France's negative balance of payments in electronics products, the arrival of American companies created interdependence between foreign subsidiaries established in France and their parent companies abroad. This was because the international division of labor in electronics shifted from one of multiple competitors producing diversified goods[480] to one in which a few multinational corporations became dominant globally. While it was still possible for countries to manufacture different types of equipment despite the change from magnetic core memory to integrated circuits as much as they did during the change from tubes to magnetic technology, in the late 1960s NATO concern over the flexibility of military communications systems caused American companies to centralize their production and to diffuse NATO and Pentagon standards. This influence was reinforced by the discursive regime within the OECD. In 1968, an OECD report on the electronic computer sector thus emphasized that "standardization was particularly important in the case of an international company...the products of all

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[478] O.E.C.D. - Directorate for Scientific Affairs, Gaps in Technology Between Member Countries, Revised Draft Report on the Electronic Computer Sector, DAS/SPR/68.22. Restricted, Paris, 12th August, 1968, p.54.

[479] C.A.C. 810401 Box 190. «Rapport Dugas: Electronique, Informatique, Telecommunications: Electronique: la dispersion des actions», op. cit.

[480] The situation was different in the late 1950s when each foreign subsidiary was engaged in different computer systems. This was the case of two companies I.T.T. and Ferranti. I.T.T.'s German subsidiary, Standard Elektrik Lorenz (S.E.L.) developed the ER 56 computer on its own, while its British subsidiary developed Standard Telephone and Cables, did the same for the Zebra computer. Similarly, Ferranti Packard, Ferranti's Canadian subsidiary developed the FP 6000 computer Ibid., pp.59-60.

the subsidiaries must be up to the standards of the very best of the parent company. Second rate technology, low tolerances or imprecise interfaces simply defeat an international organization of production."[481]

The practice of centralized, standardized production was not the result of technical change but the implementation of the NATO discourse on *Compatibility in Manufacture and Supply Service* in the American multinational's management and industrial practices that tended to replace interdependence between nations by multinational monopolies. While this practice had the potential to enhance military communications capabilities and the performamce of the PT&Ts, it hurt countries such as France that counted on interdependence to maintain freedom in defense decision-making, to improve its trade balance and save to its electronic industry from complete disappearance.

During the 1968 bilateral negotiations between France and the United States within the GATT framework, the United States argued that the decrease of European trade barriers on value-added products would allow for an increase in trade between the two continents and incite European companies to develop their own competitive products. The French government opposed this view, arguing that free trade on finished products should be limited in favor of more exchanges in technology and capital. This position was maintained by the DGRST because it believed that:

> *Lorsque l'importation des produits étrangers porte trop exclusivement sur des produits avancés elle coûte cher en devises et stérilise les productions nationales correspondantes qui ne peuvent se maintenir et prospérer faute de débouchés. Aussi la division internationale du travail sur le plan international*

[481] Idem.

> *implique des échanges des marchandises entre pays mais aussi des échanges des capitaux et des techniques.*[482]

While a free-trade policy was the best way for the United States to narrow the European technological gap, for the French government and the DGRST, the control of high technology products was still the best option. According to the DGRST, the imposition of tariff barriers on American electrical and electronic products would increase trade on both sides of the Atlantic by obliging American companies to release licenses and *know-how* to French companies. French national companies as well as American-owned companies in France would then be in a position to develop products that they could export to other countries. This would improve the French electronics balance of payment vis-à-vis the United States. The DGRST document cited above, states that:

> *La venue de capitaux américains en Europe ne devrait pas être sensiblement ralentie par le désarmement douanier car vue les caractéristiques particulières du Marché Européen les entreprises américaines installées en Europe seront toujours mieux placées pour répondre aux besoins du Marché européen que les entreprises qui exporteront directement d'Outre Atlantique. Aussi les techniques qui seront protégées en Europe par des brevets couvriront le plus souvent des productions effectuées en Europe même sous contrôle américain.*[483]

Not only were American multinationals reluctant to cooperate, but the DGRST felt that the US government had increased pressure to impose American standards on military airborne electronic devices and telecommunications equipment through NATO. As a reaction to the trade imbalance and the DGRST's desire to develop French electronics production during the Sixth Plan, the French government tried to form a common EEC policy in the sector against US companies.

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482 C.A.C. 820254, Box: 170, File: 541 DGRST, "Coopération scientifique et technique internationale: Le dialogue avec les États-Unis dans le cadre du G.A.T.T.", Document N° D.G.R.S.T 1.387/PG/VP, December 1st, 1966, p.8.
483 Idem, p.8.

5.7 THE SIXTH PLAN'S ELECTRONICS POLICY (1968-1972)

The Sixth Plan's electronics plan was not a continuation of the *Plan Calcul* but an attempt to correct errors made during the Fifth Plan. During the formulation of the Sixth Plan, the *Commissariat Général du Plan* reconsidered the DGRST's option to develop the French semiconductor sector and questioned the choice of specialized military communications and nuclear equipment based on American components. According to the *Commissariat Général du Plan's* assessment:

> *L'idée centrale du VIè Plan... est "l'impératif industriel", afin d'accélérer l'adaptation des structures productives de l'économie française à la compétition internationale. Cette stratégie d'ensemble s'accompagne toujours d'objectifs précis d'équipement publics (y compris dans le secteur des PT&T)*[484]

In 1969, in accordance with this industrial option, the *Commissariat Général du Plan* began to seriously consider the advice offered by the DGRST in particular the development of truly French computers with French semiconductors. They surmised that French electronics research should not be in the category of extra-budgetary expenses but integrated into the plan of developing marketable computers. The *Commissariat Général du Plan* clearly stipulated that the Sixth Electronic Plan should break with the past and reinforce French research in electronics in order to support the telecommunications, aerospace and automation sectors and to gain a share in the growing European data-processing and telecommunications market.

> *Les objectifs du VI° Plan ne doivent pas être chiffrés par une simple extrapolation des efforts passés, mais en considérant les deux buts qui ont été assignés aux industries électroniques, informatique et des télécommunications, pour les prochaines années. Ceux-ci comprennent:*

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[484] This account of the VIth Plan was found on a report about the VIIIth Plan. Rt: 130 Box 19 File 0742, Premier Ministre - Commissariat Générale du Plan, "Programmes d'action prioritaire du VIII° Plan", Paris, le 21 novembre 1979, p.2.

- d'une part, la nécessité de répondre aux principaux besoins de l'économie - téléphone, automatisme, etc...
- la volonté de renforcer les positions des sociétés et de favoriser leurs activités sur les marchés extérieurs[485]

This was a big change in comparison to the Fourth and Fifth p'ans. Military research for e˅ample, was to be de-emphasized and the Sixth Plan would enable French industry to export military and civilian products to foreign markets. This would require three actions:

- créer des ressources de financement civiles, venant relayer les crédits militaires et destinés à étayer les actions de reconversion et de diversification d'activités nécessaires, en particulier dans le domaine des biens d'équipement.
- mettre en place des procédures ...permettant de financer des matériels militaires et civils exportables. Ceci est d'autant plus fondamental qu'il existe un potentiel technique de haute valeur, dont l'avenir n'est pas assurer par la demande militaire et civile intérieures
- la volonté de renforcer les positions des sociétés françaises et de favoriser leurs activités sur les marchés extérieurs. Il faut donc définir et pouvoir financer des matériels disposant de larges marchés internationaux et souvent différents de ceux utilisés par les armées françaises .[486]

The new export-oriented industrial policy required the domestic manufacture of electronic components in order to reduce dependence on American components. The *Commission du Plan* declared that:

Trois types d'activité doivent être considérés...:
- les composants (composants discrets, circuits intégrés, tubes, lasers, mémoire);
- les systèmes ou appareillages, construits à l'aide de ces composants (calculateurs, satellites...);
- les systèmes conçus à partir de ces produits (systèmes d'automatisme, systèmes de mesure, réseaux de traitement de l'information, systèmes de télécommunications)
...les systèmes: plus que par le passé, il convient de porter l'attention sur l'aspect «systèmes»: les plus grands progrès sont à attendre dans la conception - hardware et software intégrés - et l'exploitation des grands systèmes informatiques des réseaux de transmission de données, des réseaux de

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[485] CAC 77/321, File 340, "Electronique, Informatique et Télécommunications" Chapitre VII, in Rapport Final de la Commission de la Recherche, N° 5666, p.249.
[486] Ibid., p.259.

télécommunications - systèmes de commande hiérarchisée, les systèmes de détection et de navigation, etc. ... [my emphasis][487]

The *Commission du Plan* also advised that considering the decrease of the French military effort, in the components sector, the weakness of French industry and the global crisis of the western world's components industry, French research efforts in military equipment, space and telecommunications sectors should be oriented towards export. It maintained that:

> *... sous peine de compromettre irrémédiablement l'avenir de l'industrie électronique française, la mise en place d'**une action finalisée composants** devait figuré au premier plan... cette action sera menée en liaison étroite avec le travail de recherche des universitaires physiciens du CNRS et englobe donc l'ensemble des efforts des industriels intéressés, comme des administrateurs concernés (Délégation à l'informatique, DGRST - action concertées et développement - DIMILEC, CNET, Armees, CNRS) elle sera mise en avant dans le rapport du Commissaire du Plan.*[488][my emphasis]

Contrary to the practice of the Fifth Plan, the Sixth Plan's electronics procurement policy would no longer be open to American suppliers as the government would use its equipment budget to support national industrial development. As Table 26 shows, the Sixth Plan electronics budget totaled 1.585 million FF including 965 million FF for research in components and 520 million FF for equipment development. In comparison with the Fifth Plan, this budget oriented French industry towards research on semiconductors. While research in components constituted nearly 61% of the total budget, research on semiconductors constituted nearly 60% of research in components.

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487 Idem. p.250.
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Table 26: The electronics budget of the Sixth Plan (1968-1972)

Themes	Type of components	Programs						
		CNES	CNET	CEA	ID(1)	CA(2)	D(3)	CNRS
Components	- Passive components.................. 40		Extra budge-tary Expen -ses 150					
	- Tubes........................ 90							
	- Lasers.......................................20							
	° Semiconductors including:							
	- Material and Technology............125							
	- optoelectronics.......................... 50							
	- C.A.D.............. 50							
	- Power elements..........................70							
	- Hybrid circuits...........................30							
	- Hyperfrequency microelectronics..120							
	-Integrated circuits.......................150							
	° Memory.................................220							
	°Total......................................965							
	Including: Extra-budgetary expenses.............150	55	150	130	155	205	250	20
Equipment		CEA	CNRS	Space	CA		Development	
	°Aeronautic including airborne and ground equipment......155							
	°Medical and ocean....................135							
	°Measurement.............................120							
	°Radiology.................................60							
	°Electronic oceanography................35							
	Total...........................520	30	15	155	95		35	
Nuclear Electronics		CEA 80						

(1) Industrial development, (2) Concerted Actions, (3)Development.
Sources: CAC 77/321, File 340, "Electronique, Informatique et Télécommunications" Chapitre VII, in Rapport Final de la Commission de la Recherche, N° 5666, p.263.

This budget was issued after many analyses and suggestions made by the DGRST. As we saw in Chapter Four, during the Fifth Plan, the DGRST's position in terms of research in components did not receive budgetary approval. The DGRST's suggestions started to make sense only after the Fifth Plan's catastrophic results in terms of balance of payments vis-à-vis the US. The export orientation of the Sixth Plan did not target the US but the EEC. However, given the trade protectionism then prevalent among the EEC countries, the DGRST was convinced that French penetration of the European market could not be accomplished without a common research and co-production programs. Thus since 1965, the DGRST had been engaged in an attempt to form a European framework for cooperation in scientific and technical research.

This Sixth Plan electronic policy and the DGRST's European strategy depended on the agreement between THOMSON-CSF and CGE, which accorded the former the computer sector and the latter the telecommunications sector: the "YALTA Accord" mentioned above. This agreement did not succeed for three main reasons. First was NATO's new concerns with the flexibility of its telecommunication networks (we come to this point later). From the technological point of view, the telecommunications and computers sector had become less distinguishable than they had been in the late 1950s. This technological change was strongly supported by NATO and ended the agreement between THOMSON-CSF and CGE. Second, THOMSON-CSF did not succeed commercially in the sector of general-purpose computers because of international competition. Third, the US, NATO and the OECD posed a new problem of compatibility between civilian and military communications equipment. All this meant further difficulties for the DGRST in its attempt to implement its European strategy.

5.8 CONCLUSION

This chapter demonstrated that the *Plan Calcul* was not a decision to build a different line of computers nor was it a nationalistic industrial policy. The DGRST's ideas and suggestions did not convince the military and the PT&T that a components-based policy was better than an application-software orientation. As a result, the *Plan*

Calcul was little more than the continuation of procurement choices made during the Fourth Plan that structurally linked the French electronics industry to American interests and entrenched the French universe of political discourse in ICT in an American technological orientation. This orientation was the reason why the CNET, the DRME and the CNES did not postpone their equipment procurements as the DGRST requested. Although these institutions did not purchase their equipment from the US, they prioritized the purchase of American integrated circuits over national manufacturing. This practice drained funds away from the *Plan Calcul* in favor of the extra-budgetary expenses. Following the example set by government budgetary behavior, THOMSON-CSF and the CGE had also participated in these extra budgetary expenses rather than following the DGRST's industrial policy.

Given the huge difference between the extra-budgetary electronics expense and the *Plan Calcul* budget, one cannot maintain that the *Plan Calcul* as proposed by the DGRST failed. It is fairer to say that the DGRST option was never implemented. Consequently, the computers that the CII was supposed to produce were abandoned in favor of the individual companies' industrial plan, the production of the 10000 series.

As we shall see in the following chapter, the French government and industry's reluctance to implement the DGRST's ideas would change due to change in NATO practice and the OECD's discourse that called into a question the practice of compatibility between telecommunication equipment of different national origins and promoted international standardization. It was this discursive change from interoperability to standardization that revived nationalism within the French universe of political discourse in ICT. The French government considered standardi ation as having many negative effects on French independence: in particular, it had the potential to reduce the freedom of France to use American technology. Rather than importing licenses to produce the equipment they needed, the French would be obliged to import the equipment they required from the United States. Such a change would reduce France's freedom to decide about its military policy and increase its trade deficit with the United States. This was the context of the second phase of the *Plan Calcul*.

Chapter Six

THE CHANGE OF THE TRANSATLANTIC DISCURSIVE REGIME AND THE FRENCH-INITIATED EUROPEAN RESEARCH POLICY

6.0 INTRODUCTION

This chapter is also based on a variety of sources, primary as well as secondary. First are Institut of Electrical and Electronic Engineering (IEEE) documents that explain changes in military communications in the late 1960s. Second are French and European Economic Community official documents found in French contemporary archives. These documents are completed by testimonies produced by people who participated in decision-making to explain French choices between the late 1960s and early 1980s. I use these documents to argue that what became known as phase two of the *Plan Calcul* (the *Deuxième Convention du Plan Calcul*) neither confirmed previous policy nor aimed to overcome French dependency on US technology. The *Deuxième Convention du Plan Calcul* was a French political maneuver designed to oppose the NATO and OECD standardization program, and to reduce France's deficit in its trade in electronic products with the US, all in a changing economic climate characterized by the increasing international role of US multinational corporations. Moreover, in the face of of American resistance, the *Deuxième Convention du Plan Calcul* would have created a European electronic conglomerate UNIDATA and European electronics standards to exclude American from France and the European market.

Both the *Deuxième Convention du Plan Calcul* and UNIDATA failed because the US, NATO and the OECD pushed hard to convince Italy, Germany and the Netherlands that their best interest lay in transatlantic integration and telecommunications standardization and not in the French-led European data-processing and telecommunications initiative represented by the EEC PREST in 1969. The failure of the French programs was also due to the US, NATO and the OECD's science policy of the late 1960s. In accordance with their standardization programs, the US and both international organizations elaborated a new discourse on the international division of technological labor that gave the US the role of provider of basic scientific and technical innovation and Western Europe the role of secondary innovation.

Because it points out the inadequacy of both neo-realism and liberal regime theory, the following description has important theoretical insights for the analysis of the transatlantic relationships between the late 1960s and early 1970s. Evidence in NATO and OECD documents related to ICT shows that, although transatlantic relations during this period were unstable, this instability was not due simply to the American hegemonic decline. Rather it is illustrative of change in the transatlantic discursive regime. This change was represented in the ICT sector, by the replacement of the practice of inter-operability between equipment of different national origins in favor of standardization. Although standardization called for greater transatlantic integration of the national telecommunication systems, it was not determined by technological change as both international integration and regime theories would have us believe. I will demonstrate that standardization was imposed by NATO's requirement for greater flexibility for its telecommunications networks. As this need for flexibility was based on the Pentagon and NASA electronic components standards, its implementation across the Atlantic strengthened the American technological domination of Europe rather than weakening US hegemony.

As my analysis challenges the thesis of the hegemonic decline in the sector of ICT, it also questions the neo-realist hypothesis of free riding. While neo-realists would have interpreted France's opposition to NATO and OECD programs of standardization as an effect of the US hegemonic decline[489] and therefore a free ride. data from the French Ministry of Research show that French antagonism to NATO and the OECD was not to challenge US technological supremacy or to disrupt the transatlantic process of technological integration. Behind France's opposition to NATO and OECD programs there was an attempt to maintain interoperability and interdependence.

This chapter has seven sections. Section One describes NATO and the OECD policy in telecommunications and their standardization program. Section Two presents the DGSRT European strategy and the formation of the PREST cooperative project in data-processing and telecommunications, while Section Three analyses the European governments' negative reaction to the DGRST's strategy. Section Four describes the US, NATO, and the OECD reaction to the PREST initiatives and Section Five presents NATO and the OECD's alternative to PREST. Section Six describes the effect of NATO and the OECD's effect on the formulation of UNIDATA, the French-led European consortium and explains its failure. Finally Section Seven analyses the effect of the transatlantic discursive regime of the French electronics policy in the period 1973-1982.

489 Neo-realists also argued France was willing to counter US influence in Europe.

6.1 TRANSATLANTIC COMMUNICATIONS AND NATO AND THE OECD POLICY IN TELECOMMUNICATIONS

When the first transatlantic military communications system, the NADGE system, was set up in the early 1960s, it functioned according to its lowest technical common denominator. What this meant is that between the 1960s and early 1970s, compatibility requirements between national systems were arranged hierarchically: the SAGE system was at the top and other national systems were connected to it. With this procedure, it was possible to interconnect incompatible systems by supplying them with special interface devices despite the economic cost and the poor quality of messages transmitted.[490]

The transatlantic interconnection between incompatible communications systems however was about to be questioned. In 1967, NATO placed increased emphasis on the utilization of national military and PT&T networks for greater flexibility in NATO defense and to create a NATO Integrated Communications Systems (NICS). Connection between national military transmissions and civilian-switched networks was required to enhance inter-operability for better survivability, flexibility, management and control of the Alliance's military operations. The overall NATO objective was to provide NICS with capabilities comparable to the US Defense Communication Systems (DCS).[491] Thus "[m]any of the Alliance members were in the process of upgrading their own defense military communications systems. These

[490] G. Wallenstein "Internationalization of Telecommunications Systems Development" In IEEE International Conference on Communications, Seattle Center, Seattle, Washington, June 11-12, 1973. See also G. Wallenstein "International Communications, Where Cooperation is the Message", Telecommunications Journal, Vol.9, No 6, June 1972

[491] G.D. Hongoroni, F. J. Powers and L. K. Wentz, "Management and Control of Interconnected Communications Network", IEEE Military Communications Conference, Washington DC, October 31 to November 2, 1983, p.41

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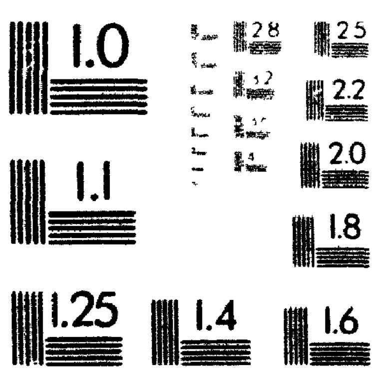
PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT



PRECISION[SM] RESOLUTION TARGETS

systems were being implemented as grid networks relying on a mix of military owned and PTT transmission facilities..."[492]

In order to convert inter-operability between different national systems into fully standardized interfaces, two alternatives were available to member countries: either the exchange of messages on switch-to-switch basis or sharing the US military communications systems. However, both solutions had to overcome many problems related to interoperability. These included: (1) the difference between types of communications subsystems (terrestrial and satellite systems); (2) the complexity of interconnecting analog and digital systems; (3) the difficulty of connecting digital systems of different standards; (4) problems arising from the differences between conversion techniques from analog to digital and from digital to analog (5) the inequality between system bit rates and (6) the difficulty of achieving common interface parameters and standards.[493] These problems emerged directly from the US Air Force's linking of space technology to their framework of centralization of command structures. This would be effective only if the European allies would commit themselves to the modernization of their PT&T and military communications systems. Thus, flexibility became an element of the transatlantic discursive regime by linking civilian to military communications and structuring the debate over the growth of the global electronics industry.

From the OECD's point of view, all these problems could be resolved by an international agreement on common digital communication standards, for as the US experience showed, the generalization of digital terminals was inexpensive and very practical when communication of data to and from the computers was accomplished

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[492] Ibid. p.41.
[493] Idem. p.42

simply through numerical commands. According to an OECD analysis in 1968, in comparison to a analog system, the digital "... dial is a very economical and flexible means for the transmission of limited amount of information to the computer from the operator."[494]

Indeed, in the late 1960s, the replacement of analog telephone systems by the digital exchange was considered a necessary step towards the international growth of the emerging international data processing industry. American companies such as IBM, AT&T and IT&T became concerned that the expediency of developing special devices to connect analog telephone systems to digital systems was not economical. For them, this practice would cause a delay in "... the expansion of international services, increase their operating cost, and contribute to the progressive degradation of message quality..."[495]

For this reason, the US government and companies recommended the International Telecommunications Union (ITU) to revise the notion of compatibility in terms of: (1) "compatibility in operations"; (2) "Compatibility in Manufacture and Supply Service" and (3) "International Compatibility". *Compatibility in Operations* simply meant the ability of different communication systems to function together as components of a single telecommunication system. It implied also the existence of a single organization with control over the manufacture, supply and maintenance of equipment installed at all points of the system. An example of this was the SAGE system that worked as a self-sufficient isolated system.

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[494] OECD - Directorate for Scientific Affairs Gap in Technology Between Member Countries, op. cit., p. 148.
[495] G. Wallenstein "International Communications, Where Cooperation is the Message", op. cit. pp.365-366.

Compatibility in Manufacture and Supply (CMS) *Service* signified that the requirement of compatibility defined above could be satisfied by several manufacturing companies in the sector. However this required that the companies agree on interchangeable telecommunications parts and common test procedures and these would be imposed by a company or a government agency depending upon national context. In the US for example, BELL imposed both requirements on its components suppliers. In France between 1958 and 1969 (as we saw in Chapter Four) in accordance with the directives of NATO, the *Comité de Coordination des Télécommunications* (CCT) established standards for national companies so that the latter were able to offer the PT&T and the *Système de Traitement des Informations de Défense Aérienne* (STRIDA) compatible equipment units. *Compatibility in Manufacture and Supply* had an economic advantage because it allowed a supplier and a buyer economic gain from scale production.

As far as individual countries were concerned, these two concepts of compatibility were unproblematic. In the international arena, however, during the late 1960s and early 1970s, because of the French trade deficit in the sector vis-à-vis the US, the transatlantic implementation of *Compatibility in Operation* and *Compatibility in Manufacture and Supply* created a controversy between France and the United States, particularly in the sector of data communications . While the French government wanted the US companies to produce the equipment that France needed in France, US companies preferred to export these products from the US to France. As the interoperability practice of the 1950s and 1960s gave way to full standardization towards the end of the 1960s, so too, since the norms were the same, the products became so, at least as far as core technology was concerned. Consequently, within the transatlantic discursive regime, interoperability became an aspect of standardization not an alternative to it. Such a view was promoted through the active role of NATO, the OECD and the *International Electrotechnical Commission* , the affiliate of the Geneva based International Standards Organization (ISO). Through the notion of *Compatibility in Manufacture and Supply Service* (CMS), these organizations pushed the standardization process beyond core technology to include equipment. The ISO asserted that:

> *Il convient à ce propos d'éviter les questions trop vastes comportant des éléments n'ayant pas les mêmes degrés de stabilité pour normaliser des sujets plus restreints dont on comptait une plus grande permanence. De plus, dès qu'une matière apparaissait normalisable, il était indispensable d'entreprendre sa normalisation le plus tôt possible ... Cela veut dire: dès qu'un type d'appareil commence à être industrialiser. C'est ainsi par exemple qu'il faut s'intéresser aux appareils à semi-conducteurs de préférence aux appareils à tubes.*[496]

This change from interoperability to standardization revived the DGRST's industrial nationalism.

6.2 THE DGRST'S EUROPEAN STRATEGY AND THE FORMATION OF THE PREST COOPERATION PROJECT IN DATA-PROCESSING

Though the DGRST's anti-American industrial nationalism was always an element in government decision-making, given the French military power within institutional structure and its explicit acceptance of interdependence within the transatlantic discursive regime, the DGRST position was always marginal. Interdependence allowed France and each country of the Atlantic Alliance to produce telecommunications equipment according to its national specifications and not according to transatlantic standards. It was within the framework of this transatlantic interdependency that the French military could protect half of the French computer

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[496] RE 130. Box 11 File 25077. Bulletin d'information ANRT "Normalisation. Commission Electronique Internationale", p.49.

industry (50%) from US interests. They advised the government to set aside the DGRST anti-Americanism and kept pace with the American military-oriented scientific and technological practice.

While the DGRST anti-Americanism did not affect national budgetary decisions and equipment procurement until the Sixth Plan, it continued on the margins of the French universe of political discourse in ICT. Earlier in 1965, when the DGRST was elaborating the first *Plan Calcul*, it was mandated by the *Conseil Consultatif à la Recherche Scientifique et Technique* (CCRST) to negotiate a common research policy with government representatives of the five other EEC member countries in order to overcome the European technological gap vis-à-vis the United States and to counter that country's dominance in information and space technology in Europe. A note by the French government dated March 4, 1965 stated that a common European scientific and technical research policy was needed to update the Rome Treaty (the legal foundation of the EEC) as the latter did not mention the possibility of European cooperation in science and technology. The note stressed that: "*...le Traité de Rome ne prévoit à ce sujet aucune procédure précise. Il est vrai que sa signature a eu lieu avant* ***que l'humanité ne soit entrée dans l'ère spatiale.***" [497][my emphasis]

Since internal policy-making process in science and technology was dominated by the military who accepted explicitly asymmetrical interdependency within the transatlantic discursive regime, the DGRST sought to export its anti-Americanism to the EEC level. For the Delegation, to compete economically against the US, Europe needed big scientific projects such as the US military and space programs. The note indicated that:

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[497] "Note du Gouvernement français", in Ministère du Développement Industriel et Scientifique - DGRST, Le Progrès scientifique, N° 164, juin-juillet 1973, Annexe I, p.32

> *La methode américaine qui consiste, grâce à l'importance des credits alloués a l'espace et aux commandes militaires, à entraîner la presque totalite des travaux scientifiques outre-Atlantique et laisse penser que tout pays industriellement avancé à intérêt à se créer des thèmes d'aboutissement de son effort de recherche pour polariser les efforts de plusieurs secteurs de recherche et dominer son économie.*[498]

In 1967, when NATO and the OECD began their transatlantic standardization maneuvers, the DGRST initiated a countervailing motion to modify the Treaty of Rome and recommended that the European Commission press hard for the creation of an EEC group for Scientific and Technical Research Policy (PREST). That same year, the PREST group was created and the DGRST chairman, Professor Maréchal was appointed PREST president. In 1968, when it became obvious that the French *Plan Calcul* would not give the expected commercial results, Mr. Maréchal led PREST to propose seven areas for cooperation between EEC members: Data Processing (including the manufacture of a large European computer); Telecommunications; Development of Transport; Oceanography; Metallurgy; Pollution Control and Meteorology.[499]

On January 15, 1969, the specialized group "Informatique" of the PREST met in Brussels with delegates from the EEC member countries to decide on a method for implementing the PREST programs. The president of the PREST specialized group "Informatique" proposed that there be coordination between the Telecommunications and Data Processing projects and asked member countries' delegates to propose a list of the participant companies in a large European computer project. According to Mr

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[498] RE 130, Box 30, File 7152, CCRST, "Rapport au Comité interministérielle sur la préparation du budget 1967".

[499] RE130, Box 30, File 7153, "Projet de loi de Finances pour 1969 - Document Annexe: La recherche scientifique et technique en 1968", p.17.

Aigrain (who became the DGRST's head and the French chairman of the PREST group "Informatique"):

> *- Une coordination avec le groupe "Telecommunications" a ete reconnue indispensable, certains problèmes pouvant être traites dans des groupes communs; [...] le projet de grande calculatrice a fait l'objet d'un bref echange de vue au groupe central, la discussion a porte sur le caractere et la signification d'une liste des entreprises susceptibles de participer à la realisation d'une telle machine;* ***la liste qui sera présenté au Conseil comprendra des sociétés véritablement européenne et non pas les filiales européennes de sociétés d'Outre Atlantique et pourra être étendue aux sociétés des tiers européens*** [500] [my emphasis]

The EEC member-countries were invited to favor products that would be manufactured through cooperation between European countries. In return, companies admitted into the projects would be exclusively European enterprises and not European affiliates of American companies. The EEC Commission agreed and suggested that cooperation between member countries in these sectors should result in the manufacturing of industrial products as a way to accomplish a "high technology common market". Mr Toulemon (the EEC General Director of Industrial Affairs) stated that:

> *La Commission a le très vif souci de voir la coopération au niveau de la recherche aboutir à des résultats industriels, ceci implique une réalisation effective du marché commun pour les produits de technologie avancée faisant bénéficier ces industries de pointe de l'élargissement des marchés dont elles ont encore plus besoin que les industries traditionnelles* [501]

To make the emerging European telecommunications and data processing market equally profitable to all EEC countries, rules other than competition were needed to maintain interdependence and to counter the emerging multinational monopolies in ICT. The EEC Commission opted for the concept of "just return" as a

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[500] CAC 820254, Box 158, file 507, Commission des Communautés Européennes Directions Générales III et VII - Groupe PREST - Groupe Spécialisé "Informatique", "Projet de compte rendu de la cinquième reunion (15 Janvier 1969)", 2.021/III/69-F, Bruxelles, le 22 janvier 1969, p.2

[501] Ibid., p3.

way of allowing each country to profit according to its investment in the common research projects across all areas of cooperation as opposed to within each area of common research. According to Mr. Toulemon :

> *Une préférence raisonnable doit être accordée par tous les États participant aux produits résultant des coopérations.* ***En ce qui concerne le "juste retour", les États n'accordent de préférence que dans la mesure où les industries sont associées aux productions en cause.*** [...] *Il convient de trouver des garanties pour tous les États quant à l'équilibre des retombés industrielles; cet équilibre ne pourrait être parfait; toutefois sur l'ensemble des secteurs de coopération, les compensations ainsi réalisées apporteraient un très grand progrès par rapport à la situation actuelle où l'on s'efforce e rechercher le "juste retour" dans chaque secteur, ce qui est la négation même de l'efficacité et fait perdre les avantages résultant de l'elargissement du marché.*[502] [my emphasis]

Moreover, under the French *Délégué à l'informatique*'s , ·ure, the EEC Commission decided that all training initiatives of the EEC countries in data processing be coordinated within the framework of an EEC European Institute of Computer Science and not within the OECD International Institute of Technology or the NATO International Institute of Computer Science.[503] According to a note by the French *Délégué à l'informatique*:

> *L'Institut Européen d'Informatique de la CEE émane du groupe spécialisé informatique pour la coopération scientifique et la délégation française a joué un rôle moteur dans sa définition. Au moment où des positions de principe vont devoir être arrêtées à Bruxelles...* ***la France pratique une sorte de politique de chaise vide*** *à l'égard des travaux [de l'OCDE et de l'OTAN] qui avancent avec des vicissitudes diverses* [504] [my emphasis]

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[502] Idem, p.2

[503] On NATO and OECD initiatives to create two separated data-processing institutes see CAC 820254, Box 157, File 506, Commission des Communautés Européennes - Direction générale de la recherche et de la technologie (DG XII), "Note pour le groupe de travail "Politique de la recherche scientifique". 5.095/XII/69 F, Bruxelles, le 26 fevrier 1969.

[504] CAC 820254, Box 157, File 506, Le Délégué à l'informatique "Note pour le Ministre. Objet: Comparaison des différents projets d'instituts internationaux", MA/944/JJ - 69-2445/Inform, Paris le le· ·· ·pvembre 1969, p.2.

Mr. Allègre, the *Délégué à l'informatique* felt that France should push for the creation of an EEC computer science institute because such an institute would be the only organization where American influence would be minor. In Mr. Allègre's words:

> *Il s'agit du seul institut à vocation réellement européenne et dans lequel l'influence américaine sera donc à priori faible. On peut espérer qu'il contribue efficacement à la prise de conscience de sa propre existence par l'informatique*[505].

Decreasing American influence in the European electronics market was felt by the DGRST to be a necessary step towards the creation of a European identity in electronics and a basis for an European division of labor within the framework of the PREST. According to a PREST document produced on March 1969: "*Dans sa situation actuelle, l'industrie européenne de l'informatique doit faire face à deux problèmes majeures: son existence même doit être assurée, son développement assuré.*"[506]

Contrary to the US, NATO and OECD efforts in the late 1960s that promulgated transatlantic integration of data-processing and communications systems, the PREST special group "Informatique" sought to foster integration between the EEC members' industries because it felt that the future of European industry was endangered by the expansion of American firms in Europe. For the PREST special group "Informatique", European governments and firms should act to secure the mid-term future of their industries and formulate a long-term program that would guarantee Europe a position of leadership in the international electronics industry. The document stated that:

> *Il n'est pas exagéré de dire qu'actuellement l'avenir des firmes européennes n'est pas assuré en raison de l'importance de la place prise par les firmes*

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505 Ibid., p.6.

506 CAC 820254, Box 158, file 507, Commission des Communautés Europeennes - Direction générale des affaires industrielles - Direction Générale Recherche et Technologie - Groupe de la Politique de la Recherche Scientifique et Technique - "Rapport du Groupe Specialisé "Informatique"", Doc. No. 4445 /III/ 69-F- REV.2, Bruxelles, le 5 mars 1969, p.3.

etrangeres sur le marché. Face à cette situation, la réaction des firmes et des gouvernements devrait être d'assurer l'avenir à moyen terme et de viser plus haut en prenant les dispositions nécessaires pour jouer un rôle mondial à long terme.[507]

For the PREST group, the guarantee of world leadership for the European electronics industry implied the promotion of industrial programs equal to the US military and space programs and required EEC member countries' cooperation in three main areas: industrial policy, research and training and development policy. The purpose of an industrial policy in electronics was to create EEC policy instruments in the sector and to enable European firms to reconquer the share of the European market that they had lost to American companies. Such a policy also required inducing European firms to produce common products such as large and high speed data-processing and communications systems. The document reiterated that:

> *Il semble que ce projet peut être celui de la construction réalisée en commun au niveau européen de système à grande puissance de traitement de l'information et de stockage de données...Ce projet aurait une fonction d'entraînement telle qu'il conditionnerait l'avenir de l'informatique européenne tant au niveau des composants qu'à celui des périphériques, reseaux de télécommunications et réalisation de software de base avancé.*[508]

According to the PREST group, cooperation in research and training was the only way to prepare Europe for the 1980s generation of data-processing and communications equipment and to overcome the European technological gap and dependence vis-à-vis the US. The document maintained that:

> *La politique de promotion de la recherche et de formation est étroitement liée à la réussite du projet principal, il est en effet évident que seul l'aboutissement de recherches fondamentales permettra de réaliser les systèmes avancés des années 1980; et un résultat ne peut être atteint que par une action énergique sur la formation des spécialistes de l'informatique notamment au niveau le plus élevé.*

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507 Ibid., p.3
508 Ibid., pp 3-4

C'est la poursuite de ces deux objectifs qui a conduit le groupe a proposer la creation d'un "Institut Europeen d'Informatique et de Technologie[509]

Industrially the PREST initiative involved two programs. The first was to build a computer comparable to the largest American computer in 1975:

Un projet à moyen terme viserait a realiser pour la periode 1975 un ordinateur comparable aux plus grandes machines des U.S.A. Cet ordinateur pourrait être une machine haut de gamme par rapport aux unites moins puissante que les différents constructeurs europeens produiront a la même epoque.[510]

The second initiative was a long-term program that targeted the production of a large computer system in 1980:

Un projet à long terme visant a realiser pour la "periode 1980" un systeme de traitement de l'information de très grande puissance et capacite. Ce projet devrait être ambitieux et reposer sur les techniques et les concepts les plus avancés qui seront disponible à l'époque. Il comporte de ce fait, dès maintenant un très grand effort de recherche et de développement, et suppose pour l'époque de son achèvement l'existence d'un réseau de transmission de données à distance, assez étendu[511]

Like the French Sixth Plan components policy, both PREST mid- and long-term projects were to be carried out concomitantly with research in Large Scale Integration chips.[512] The PREST special group "Informatique" suggested that research in this sector be based on the characteristics of the telecommunications and data-processing systems commonly defined by the PREST "Telecommunications" group and national PT&T organizations. This way, instead of following NATO and the OECD's standardization concerns, the EEC could impose its own components standards on its market. PREST emphasized that:

L'évolution technologique prévisible dans le domaine des grands systemes de traitement de l'information fait apparaître que la conception des

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509 Ibid. p.4
510 Ibid. p.8
511 Ibid. p.9.
512 Large integration chips are those containing many thousands of logic gates

composants (LSI et mémoire) et des périphériques (en particulier mémoire de masse) sera de plus en plus liée à la conception du système lui-même...
Le groupe spécialisé "Télécommunications" propose la création d'un certificat européen de conformité des composants; cette création demande une entente entre les différentes organisations nationales existantes. Cette action de normalisation permettrait d'entreprendre à l'échelle européenne les études de fiabilité [I emphasize][513]

Moreover, the PREST "telecommunications" group sought to integrate the EEC national telecommunications systems through the common development and use of a large data storage and retrieval system in three ways:

le premier, d'ordre commercial: répondre à la demande qui se développera en Europe dans les années à venir sur le marché de cette catégorie, qui autrement sera acquis à des productions non Européennes;
le deuxième d'ordre technologique: favoriser la création d'une technologie européenne très avancée avant un entraînement sur l'ensemble du domaine de l'informatique et permettant la ***formation d'un potentiel européen autonome.***
le troisième, d'ordre industriel: faciliter la transformation de la structure de l'industrie européenne de l'informatique et la mise en place d'une industrie ayant une envergure suffisante pour assumer la compétition sur le plan mondial.[514] [my emphasis]

As interdependence became difficult to maintain in the face of NATO and OECD standardization programs, these three objectives constituted the DGRST's initiative to create deliberate incompatibility between US and EEC telecommunications systems. They required direct inter-governmental intervention that would induce European firms to form an European industrial structure autonomous from US technological and industrial orientation. The PREST Special Group "Informatique" maintained that:

Les structures industrielles nécessaires à l'Europe ne se développeront pas tout seules, si un objectif ne leur est pas assigné, et si les États

[513] CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Direction generale des affaires industrielles - Direction Générale Recherche et Technologie - Goupe de la Politique de la Recherche Scientifique et Technique - "Rapport du Groupe Specialisé "Informatique"", op. cit. pp.11-12
[514] CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Groupe Specialise Informatique, «Rapport d'avancement des travaux du Groupe Spécialisé "Informatique"», Doc 18 269/III/69-F Confidentiel, Bruxelles, le 3 octobre 1969, p.17.

n'interviennent pas financièrement. Cet objectif industriel de restructuration d'une partie de l'industrie électronique est considéré comme prépondérant sous cet aspect. L'action sera renforcée par ses effets importants sur les

n'interviennent pas financièrement. Cet objectif industriel de restructuration d'une partie de l'industrie électronique est considéré comme prépondérant sous cet aspect. L'action sera renforcée par ses effets importants sur les
branches en amont et en aval.[515]

Thus, under the DGRST influence, the PREST Group "Informatique" threatened to deliberately create incompatibility between American and European products by proposing to the European Economic Community (EEC) countries the development of European electronic standards that differentiated European from American products. This policy was accompanied by a French proposal of a common European common procurement policy that, if adopted, would have favored European products to the disadvantage of American companies. For the DGRST:

> *L'industrialisation et la commercialisation des composants nouveaux demandent un nouveau délai. Un pays qui s'installerait dans l'importation de composants électronique admettrait de tarir l'essentiel des sources de son inspiration dans le progrès technique pour tout ce qui concerne l'électronique, l'automatique et l'informatique. Une industrie de l'électronique basée sur l'achat de ses composants à des concurrents, éventuellement installés sur le territoire, assisterait à un contrôle inadmissible de ses prix et de sa qualité.*[516]

The French initiative was a direct attack on NATO's standardization effort and would not be effective without the cooperation of Germany, the UK, Belgium and the Netherlands which all relied on collaboration with American firms to enhance their military communications systems and their PT&T's capabilities to meet the NICS' digital standards.[517]

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515 Ibid., p.18.

516 DGRST- "Rapport au Comité Interministériel de la recherche scientifique et technique", Paris 1968, pp. 49-50.

517 G.D. Hongoroni, F. J. Powers and L. K. Wentz, "Management and Control of Interconnected Communications Network", op. cit., p.42

6.3 THE EUROPEAN GOVERNMENTS' REACTION TO THE PREST PROGRAMS

The transatlantic confrontation that the DGRST sought did not receive EEC approval because of its political, military, economic and industrial consequences. Politically the EEC feared American protectionist retaliation not only in the electronics trade but also in other trade. Moreover, the majority of the EEC countries were not convinced that the PREST initiatives would serve their industrial development better than the prevailing American-dominated relations in electronics and communications.

6.3.1 *The French position*

Under the PREST proposal the *Compagnie Internationale d'Informatique* (CII), the French national "champion" would be the main French firm involved in joint computer development. The French delegation to PREST agreed with the CII on the need for a common EEC project to manufacture a large computer. The CII argued that quota system that would share the conception and design of the machine between six different national companies would cause inefficiency. For the CII, it was thus preferable to choose a single prime contractor that would associate with five other companies in the manufacturing of components and peripherals, a position articulated by the French industrial delegate to PREST.[518]

518 According to the French industrial delegate to PREST:
Il est prudent de viser une machine puissante, se plaçant dans une perspective de longue échéance; pour sa réalisation, une solution à six participants présentera quelques difficultés; de l'avis de la CII il est nécessaire qu'un maître d'œuvre unique soit désigné; on pourrait concevoir que certaines entreprises

Moreover, for the French and Belgian delegations to guarantee commercial success for such an operation, the EEC member governments needed the formulation of a "Buy European Act" that would privilege European products.[519] A "Buy European Act" required an agreement on criteria that defined a European firm. According to the French definition, a European firm was a company that had its headquarters in EEC territory. Its owners had to be European residents and nationals of one of the European Communities. The definition further stipulated that the European owners must possess at least 75% of the capital and the presidency of this company and its administration must be at least 75% European. Moreover, innovation within the firm must be supported for the most part by research centers located in the European Community. Finally production lines must be located in Europe.[520] Clearly this extreme definition

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> *reçoivent la maîtrise d'œuvre et associent d'autres entreprises à leur effort, notamment les composants et les terminaux.*

CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Groupe Spécial "Recherche Scientifique et Technique" - Groupe Spécialisé "Informatique", "Projet de compte-rendu de la troisième reunion (23 janvier 1968)", EUR/C/426/1/68-f, TF 54/Rev.1, Bruxelles le 26 janvier 1968, p.4.

519 The two delegations argued that:

> *...un "Buy European Act" se trouve à la base de toute initiative de Communauté technologique. Il s'agit d'une fidélité aux matériels européens pour les matériels qui ont été développés en commun, dans un cadre international, avec des accords entre industries qui satisfont toutes les parties* Ibid., p.23.

520 As reported in an EEC note:

> *La délégation française propose la définition suivante:*
> *Seraient réputées ressortissantes de la Communauté:*
> *I. D'une part, les entreprises satisfaisant (elles-mêmes, et leurs maisons mères en de sociétés filiales) aux critères suivants:*
> *A- Le centre de décision doit être situé dans la communauté.*
> *Ceci implique que résident dans la Communauté et soient ressortissants de la Communauté:*
> *a) Les propriétaires du capital (pour 75% au moins)*

of a European firm represented the European extension of the DGRST's position on interdependence which sought to establish intergovernmental European control over the activities of European firms in order prevent the change of the transatlantic discursive regime from interoperability to standardization.

6.3.2 *The Italian and Dutch positions*

The Italian delegation accepted the French proposal in principle but insisted on five points: (1) the PREST group should seek the ways and means to associate the United Kingdom in the project; (2) at odds with the French, the Italian government and industry felt that the project should be financed by EEC funds and the large computer should be manufactured by an European consortium formed by private firms in the European Community[521]. (3) From the economic and technological points of view, the Italians and Dutch thought that the definition of the large computer should take into account existing techniques rather than making a technical breakthrough search that might be economically disastrous. Both the Italian and Dutch delegations maintained that:

> *...il convient de préciser les définitions notamment pour la grande calculatrice et de tenir compte de l'évolution récente de la technique...on a indiqué que*

> *b) Le Président du Conseil d'Administration*
> *c) Les Administrateurs et le Directeur Général (pour 75% au moins du nombre total des personnes)*
> *d) Le personnel dirigeant (pour 75% au moins)*
> *B) L'innovation doit être soutenu par des centres de recherche situés dans la Communauté (pour la majeure partie de l'effectif)*
> *C) Les chaînes de production doivent être situées dans la Communauté (pour une part importante du chiffre d'affaires)*
> *D) En cas de litige soulevé dans l'appréciation du cas d'une Société relativement aux critères ci-dessus, il ne peut y avoir d'arbitrage ultime que politique (arbitrage du Conseil des Ministres de la Communauté.* Idem, p.27.

[521] Idem, p.5.

> *l'on pensait à des performances beaucoup plus importantes que celles des machines actuelles, par contre l'étude de marché parle de IBM 360/65; il conviendrait de préciser les notions à cet égard.*[522]

(4) As for not breaking with the emerging transatlantic standardization criteria, the Italians thought that the OECD's work in this sector should not be ignored.[523] (5) Regarding the definition of a European firm, the Italian delegation argued that the French definition was too narrow and could harm the interest of European firms in sectors other than electronics. According to Italy:

> *...l'on ne peut traiter ce problème au niveau du secteur. Il s'agit d'un problème horizontal. Par ailleurs, il faut prendre en considération, les problèmes des filiales des sociétés européennes installées dans les pays tiers et constater que leur statut peut être le même que celui des firmes américaines installées en Europe* .[524]

6.3.3*The Belgian position*

The Belgians did not approve the French position on the grounds that it would establish a monopoly for CII. For Belgium, the idea was not simply to manufacture a common product but to offer European alternative to the IBM World Trade's division of labor in the computer industry[525]. Moreover, they argued that replacement of IBM World Trade by a large European firm in Europe would not result in the unification of the European research and production potential. According to these concerns, the Belgian delegation defended a strict quota system and declared that:

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[522] CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Directions Générales III et VII - Groupe PREST - Groupe Spécialisé "Informatique" "Projet de compte rendu de la cinquième reunion (15 Janvier 1969)", op. cit., pp.4-5.

[523] Ibid., p.5.

[524] CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Groupe Spécial "Recherche Scientifique et Technique" - Groupe Spécialisé "Informatique", "Projet de compte-rendu de la troisième reunion (23 janvier 1968)", op. cit., p.29.

[525] Ibid. pp. 7-8.

> *La société commune doit être, avant tout, un bureau d'étude et l'organe de commandement de l'opération. Pour réaliser la construction graduelle de structures européennes, ce qui est nouveau doit être fait dans le cadre commun. Cette délégation ne peut se déclarer d'accord avec la proposition de la C.I.I....*
>
> *En outre, on ne voit pas pourquoi il faudrait privilégier deux membres du consortium en leur faisant partager la maîtrise d'œuvre au détriment des autres. Les cinq firmes (CII, AEG-Telefunken, Siemens, Philips et Olivetti) qui pourrait participer à l'entreprise sont suffisamment comparables en dimensions et niveau technique, pour qu'un tel système ne s'impose pas.*[526]

Moreover, like the French who believed in the importance of US foreign investment in their economy, the Belgian delegation argued that from an economic and industrial point of view, Belgium could not prevent the implantation of American firms on its territory; the country needed American investment for its industrial development. It maintained that:

> *...les initiatives belges et européennes sont si faibles, que l'économie belge ne peut freiner l'implantation des firmes américaines. Les entreprises qui ont reçu des aides gouvernementales et qui sont devenues technologiquement fortes tout en restant financièrement faibles, ont été absorbé les premières par les capitaux américains. Le gouvernement belge souhaite... la création de sociétés européennes qui trouveront dans des programmes communautaires le même appui technologique que les firmes américaines dans leurs programmes nationaux*[527].

According to the Belgians, Europe could benefit by allowing the installation of American firms in Europe and by supporting its own industry.

6.3.4 *The German position*

The German delegation had three objections: (1) any EEC project in information technology should reflect NATO and OECD concerns, (2) collaboration was necessary only in products that a single European firm could not manufacture and, (3) while it

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[526] Idem, p.7.
[527] Idem, p.26.

was necessary to investigate all types of machines, the PREST group should draw the line between what was possible and what was technically and economically unrealistic.[528] On all three points the German position was compatible with the Italian and Dutch argument. The three opposed PREST by expressing the fear that should the Americans retaliate, they would hurt European commercial interests in other industrial sectors.[529] The German position was bolstered by the Italian delegation who feared that a big project such as the one France proposed would jeopardize efforts to undertake smaller initiatives that was already underway through NATO and the OECD, such as the standardization of computer interfaces. For the Italians, it was imperative to undertake a careful market study before starting any other big project or fundamental research program in computer science. Moreover, if Europeans were to opt for a big project or any other initiatives different from the ones already started within the OECD and NATO, these initiatives would have to be agreed upon within the framework of these two international bodies. All three countries went on to point out that the French large computer project was unrealistic because European companies were not able to produce such a computer and there was no market for such a machine.[530]

6.3.5 *European companies' response to the PREST programs*

Interviews with CII, SIEMENS and PHILIPS undertaken by the Commission of European Communities revealed that each company's response to the PREST

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528 CAC 820254, Box 158, file 507, Commission des Communautés Européennes - Directions Générales III et VII - Groupe PREST - Groupe Spécialisé "Informatique" "Projet de compte rendu de la cinquième reunion (15 Janvier 1969)", op. cit., p.15.

529 Idem, p.28.

530 Ibid., p.3-6.

program reflected its government's position. The CII, according to the DGRST perspective, thought the project should be ambitious enough to attract as many European scientists and companies as possible. Furthermore, in order to come to the market with a world class and original product by 1980, it would be necessary to go beyond the existing computer concepts. According to the CII spokesperson:

> *Le chemin à poursuivre pourrait par exemple consister en une première étape de trois ans aboutissant à une machine sans prétention commerciale mais destiner à fixer les idées des participants...c'est dans une deuxième phase beaucoup plus longue que serait obtenu le produit industriel... On peut ainsi concevoir de créer de véritables Bell-labs européens*[531]

For PHILIPS and SIEMENS, an eleven-year program was simply too long. Both companies were in favor of a classic design for a machine that would be marketable by 1975. SIEMENS in particular, in conformity with the transatlantic concept of *Compatibility in Manufacture and Supply Service*, opposed a radical computer design as it would exacerbate the problem of compatibility between different manufacturers' designs. The company even suggested a licensing agreement with either CONTROL DATA or BURROUGHS as both had significant experience with large scientific computers.[532]

Moreover, for both the German and Dutch companies, developing a large European computer would not only create transatlantic incompatibility and a trade war between the United States and the EEC, but also an economic and technological risk for European companies involved in the initiative. This was because, since the mid-1960s, the computer sector was driven by a shift to miniaturization that was coupled with a new set of demands largely oriented by Cold War military discourse and the

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531 The reporter, Mr. ALLÈGRE was not even sure if the CII representative expressed the unanimous opinion of his company. Ibid., p. 2.

532 Idem, p. 3.

technological practice of the space race with the Soviet Union. In return, as outer space became associated with the transatlantic discursive regime in ICT, it led to a new class of digital computers very different from the early 1960s installations represented by the IBM 360. From mid-1960s on, as opposed to the mid-1950s, the requirement for lighter airborne digital computers imposed by the space race, necessitated a new way of manufacturing electronics components technically termed photolithography.[533] Thanks to photolithography American companies such as FAIRCHILD and TEXAS INSTRUMENTS were able to reduce and mass-produce computer chips, and, to replace transistors and magnetic core in the computer's processor and memory. As a result of this technical change, companies such as COMPUTER CONTROL COMPANY (later a division of HONEYWELL), INTERDATA (later a division of PERKIN-ELMER), VARIAN DATA MACHINES (later a division of SPERRY UNIVAC) and IBM made computers that were smaller in size, cheaper and as fast as the mainframes of the late 1950s and early 1960s. Consequently, the civilian and military aerospace equipment that had used analog special devices began to use digital computers. American computer companies and components producers demonstrated that electronic digital computers reached a level of performance and reliability that surpassed analog machines. Henceforth, it became possible for aerospace engineers to use the power of digital computers while keeping down the size and the weight of their machinery.[534]

In conclusion, the manufacturing of a large and expensive European computer with different components standards from those that were emerging in the US would

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533 Photolithography is a method of manufacturing computer components that is similar to newspaper printing.

534 P. A. Kidwell and P. E. Ceruzzi, Landmarks in Digital Computing: A Smithsonian Pictoral History, op. cit., pp. 73-79.

not only hamper the transatlantic standardization agenda, but, would also prove to be unprofitable to companies such as SIEMENS and PHILIPS that had planned to benefit technologically from the US, through their governments' role in NATO telecommunications restructuring.

6.4 THE US, NATO AND OECD REACTION TO THE PREST INITIATIVES

The DGRST's hostility towards American electronics companies not only contradicted NATO's inter-operability objectives but was also in opposition to the OECD's policy of international scientific cooperation. As one OECD document stressed:

> *Si...un certain degré de compétition nationale est une incitation à la qualité, du moins les pays de l'OCDE devraient-ils renoncer à se faire concurrence et adopter pour les équipements de grande taille une orientation plus internationale. C'est d'abord nécessaire si l'on veut retirer le maximum de profit des investissements scientifique nationaux. Une planification internationale de grands équipements apparaît donc de plus en plus désirable en particulier, il faut renforcer la coopération internationale dans certains domines déterminés en particulier ceux qui exigent des équipements lourds ou des systèmes d'observation intégrés.*[535]

Even though France had a lot to gain in promoting a transatlantic cooperation in the data communications sector, it was reluctant to do so because such cooperation was against its trade interests. As we have seen, during the regime of interoperability the more France adopted transatlantic norms, the more American companies invaded the French electronics market and the less French industry was able to compete internationally. The contention between US companies and the French government was not in the sector of general-purpose computers that French had abandoned to IBM and GENERAL ELECTRIC, but in the sector of professional electronics equipment such as

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535 RE 130. Box 5, File 550, OCDE - Conseil, "Rapport du groupe special du Sécretaire Général sur les nouveaux concepts des politiques de la science". Diffusion restrainte, Paris 13 avril 1971, p.90.

those used in space, telecommunications and aeronautics where France had chosen to develop a national specialization.

As the user policy adopted jointly by COPEP, the DRME, the CNET and the CNES did not pay off, COPEP changed its perspective on electronics policy. It abandoned its early 1960s promotion of IBM compatibility and began jointly with the DGRST to seek European electronic standards through the PREST programs. The Americans indirectly attacked the PREST initiatives on two fronts: through NATO by pressuring for the standardization of military electronics equipment and through the OCED by questioning the relevance of the 1960s science policy that linked industrial development to military research. From the OECD's perspective, developed at the 1968 Third Conference on science policy, what had been good for military programs of the sixties was no longer useful for industrial development and economic growth. This new discourse on science policy was strongly supported by (the then) US President, R. Nixon, who took the lead in proposing a huge civilian research program on water and air pollution, urban traffic control, drug abuse control, education, health and welfare. With these projects, tne US president pushed for creation in 1968 (within NATO) of the Committee on the Challenge for Modern Society (CCMS). All these new areas of research required American computers.

While countries such as France were being pressured by the OECD and NATO to spend more money on the management of the above issues, NATO was also pressuring member-countries to standardize military equipment. The combined policies of both organizations meant that defense preparedness could no longer serve as an excuse for protecting an uncompetitive industrial sector nor as a defense for the proposition that military research was necessary for industrial development. Such an argument entailed the end of technological "interdependency" as the OECD began simultaneously to promote the belief that multinational corporations were the best way to economic and industrial development. The members of the Group of Experts[536] of the OECD Directorate for Scientific Affairs indirectly compared the PREST large computer initiative to large European countries' industrial policy in the steel sector in the XIXth century. According to an OECD report: "If one considers the future rather than the past, computer usage is of particular importance, both in terms of technology and industry."[537]

As we have seen, the importance of the use of computers for economic and industrial growth was not new in OECD discourse. The organization had maintained such a view since the early sixties. However, even though this was not new, it acquired new meaning during the confrontation between the emerging multinational-based trade and current licensing-based interdependence. This new user policy promoted multinationals as the engines of growth and sought to discourage governments from intervening in the computer industry. For the OECD General Secretary, NATO and the US, governments were no longer required to bridge the "technological gap" between the US and Western Europe. They considered government

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536 The Chairman of this group was the Mr. F. J. M. Laver from the British Ministry of Technology. The experts were Dr. F.P. Brooks (University of North California), Mr. L. Castelli-Avolio (from the Italian *Ministerio di Recerca Scientifica*), Mr. R. Curnow (University of Sussex) and Dr. R.E. Murphy from the American Quantum Science Corporation (Palo Alto California). It should be noted that the majority of this group of experts was composed by Americans and British who articulated the US Department of Commerce and the British Ministry of Technology's common view that favored transatlantic *Compatibility in Manufacture and Supply Service* or in other words standardization. This view did not took into account the French and Japanese perspective of interdependence represented during the debate among the OECD national *rapporteurs*.

The sector rapporteurs were: Dr. H. Raiman from the Austrian Calculus Center [*Rechenzentrum Graz*], Mr. R.F. Linden from the Canadian Department of Commerce, Mr. Pierre Audoin from the French *Délégation à l'informatique*, Dr. M. Wessling from the German *Zentralverband der Electrotechnischen industrie*, Mrs. S. Totani and K.Wakasone from the Japanese Minsitry of International Trade and Industry, Mr. G. Lindstrom, from the Sweedish *Saab AB*, Mr. D.V. Davey, the British Ministry of Technology and Mr. S.A Pettingill US Department of Commerce.

537 O.E.C.D. - Directorate for Scientific Affairs. Gaps in Technology Between Member Countries. Revised Draft Report on the Electronic Computer Sector, op. cit., p.64.

intervention to be not only a hindrance to global standardization, but also an obstacle to international growth of the computer industry. According to the US representative in the OECD Council:

> All countries will need to have access to the latest computer hardware and supporting software to maintain their economic and cultural growth at optimum rates. **It is more important to have the knowledge of how to use computers than to know how to make them, since the former stimulates the development of the entire economy, while the latter concerns the growth of the only one industry.**[538] [my emphasis]

In fact, there was no evidence to show that a national computer development program slowed down the use of the computers since the French defense and national telecommunications authorities adopted a user policy during the 1960s and sought to develop specialization in the professional equipment used in defense, telecommunications and aeronautics. But, due to American companies' competitive strength both in the sector of specialized equipment and general purpose computers and because of the small size of the French professional electronics market, the French industry was not able to compete internationally. As we have seen, the reliance on American companies did not reinforce the innovative capacity of French industry. For Mr. Pierre Audoin,[539] (the French representative in the OECD Group of Experts in electronic computers) it was impossible to develop an innovative capacity in the user sector without strength both in the components and computer sector. This was the DGRST's traditional position that had been now brought inside the OECD at a time when US electronics companies were pushing for greater trade liberalization.

For the US (represented by the US Department of Commerce) and the OECD Directorate for Scientific Affairs, American subsidiaries did contribute to the innovative

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538 Idem, p. 65.

539 In 1968 Mr. Audoin also worked for the French the *Délégation a l'informatique*.

capability of the country in which they were located. For them, innovation did not only imply the introduction of a new product into the market but also:

> the considerable development work underlying a new product. Even when the product is not marketed the development work has been done and the capability is there... [American] subsidiaries are the national innovative capability of [the country in which they are located] in the sense that they form a group of specialists capable of developing if not always a complete system at least some parts of it.[540]

The OECD Directorate for Scientific Affairs further stressed that economics was not the only measure "whereby governments should assess the computer industry."[541] However, if countries insisted that the economic yardstick was important, the organization still considered that the benefit of American subsidiaries in Europe was a two-way street. The report underlined, for example, that many of IBM's share-holders were European and predicted that the company would move increasingly in this direction[542]. The final point of the OECD analysis was to prove that the investment of American companies in Europe should not be viewed within "...[t]he framework of competition between the United States on the one hand, and other countries on the other. The fact is that these investments are essential aspect of the competition between American companies themselves."[543]

From the French government perspective the problem was not multinationals' investments but the change of the transatlantic discursive regime that promoted standardization and did not take into account the French government's worry about the effect of standardization in terms of political vulnerability. In France, the problem was

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540 Idem, pp. 60-61

541 Idem, p.61.

542 Idem, p.61

543 Idem, p.58.

that French electronics industry still needed state support.[544] However, if such support was envisaged within the early 1960s formula of interoperability, it could stop the standardization process required by American firms, NATO and the OECD Group of Experts.

For American firms, NATO, the OECD Directorate of Scientific Affairs and the OECD Science Policy Committee whose majority members were all interested in standardization, state intervention in the industry was the major problem and finding a new role for the member governments was the solution. In effect, the American practice of "big science" that served the model for the transatlantic discursive regime's science policy doctrine was about to be replaced by another doctrine that emphasized the social usefulness and the economic profitability of scientific research. During the Third OECD Ministerial Meeting on Science policy which took place in 1968, the OECD Science Policy Committee made an effort to draw a line that would separate the role of governments and multinational corporations in scientific and technical research. It suggested that whereas multinational corporations should maintain their hold on the market, governments should concentrate their efforts on scientific issues related to social and environmental problems. After the meeting, the OECD Science Policy Committee created a subcommittee whose objective was to establish procedures in Europe for selecting and financing several multidisciplinary research programs: computers and education; materials research; brain and behavioral research.[545]

Despite French opposition, the OECD Committee on Science Policy created a Computer Science Committee with missions in the following sectors: automated data

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544 F. H. Raymond, "Note confidentiel sur le Plan Calcul", 9 juillet 1968. Reproduced in Colloque sur l'Histoire de l'informatique en France, op. cit., pp 404-406.

545 O.E.C.D, "Troisième Conférence Ministérielle sur la Science" PRESS / A (60) Annexe C, 12 mars 1968.

banks; interaction between computers and telecommunications; trair.'‹‹ of computer scientists; inquiries on the utilization of computer systems; control of the efficacy of advanced information systems and supervision of the potentialities of computer science in the management of urban and suburban environments.[546]

Here the OECD Expert Group on Science Policy presided over by the American Harvey Brook,[547] was of crucial importance. This Group and the OECD General Secretary delegitimized the French argument that EEC countries would not be competitive unless they copied the American model of large military and space programs. First, according to the General Secretary, it was not true that significant industrial development could only be accomplished through military, space or nuclear programs.[548] Although there was no doubt that military and space programs had contributed to the development of important industrial sectors such as jet aircraft, computers and integrated circuits, there was no proof that these sectors would have not developed without the military urgency of the Cold War and the disdain for economic profitability that the Cold War implied.[549]

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546 These objectives were reported in O.E.C.D.- Comité de la politique scientifique, Problèmes et perspectives de la recherche fondamentale dans certains domaines scientifiques. Rapport synthèse. Note du President. SP (71) 28, Barème 2, Diffusion restreinte. Paris, le 4 octobre 1971, p. 9.

547 The other members were: John B. Adams (General Director of the Program 300 GeV of the European Center of Nuclear Research, Geneva-Meyrin, Switzerland), Umberto Colombo (Research Director, Montecatini, Milan Italy), Michel Crozier (Director of the *Centre de Sociologie des Organisations*), Carl Keysen (Director of the Institute of Advanced Studies, Princeton New Jersey, USA), Thorkil Kristensen (Director of the Institute for Development Research, Copenhagen Danmark), Saburo Okita (President of the Japenese Economic Center) and Carl F. von Weizsäker (Director of the Max-Plank Institute). These people constitute the OECD General Secretary Special Group on the New Concepts of Science Polic':s.

548 O.E.C.D.- Comité de la politique scientifique, Problèmes et perspectives de la recherche fondamentale dans certains domaines scientifiques. Rapport synthèse. Note du President. op. cit. p.33.

549 The statement clearly underlines that:

> *Nul ne mit en doute l'intérêt des produits découlant directement des technologies militaires et spatiales tels que l'avion à réaction, les ordinateurs et les circuits intégrés, bien que même dans ce domaine, on s'interrogeât sur le rôle à attribuer respectivement aux investissements en R-D directement effectués par l'État et à la demande induite portant sur les produits en*

Without referring directly to the PREST programs, the OECD group of Experts rejected them on the ground that it was not only futile but also unfair to launch cooperative research programs and use them against the commercial interests of the program partners. These experts stressed that:

> *Il est vain (et c'est même beaucoup d'argent dépensé pour rien) de lancer un programme de recherche en coopération s'il est envisagé ou utilisé comme un instrument de compétition aux dépens des autres partenaires. La définition des activités devraient être une entreprise véritablement commune, faute de quoi la coopération se contredit elle-même.*[550]

According to the OECD General Secretary, big research programs (such as the one proposed by France within the PREST) were always dominated by military, nuclear, and space ambitions. They were always related to defense or simply undertaken for national prestige and thus lacked social and economic goals. The consequence of such activities was always an unbalanced use of R&D resources at the expense of other sectors such as education and training that would contribute to social and economic development.[551]

Finally, the OECD Secretary General incited member countries to avoid trade wars through big research programs such as the one proposed by France. Instead, it suggested that member-countries of both the OECD and EEC follow the spirit of the OECD Third Conference on science policy that established that disparities in R&D expenditures between countries do not themselves generate economic inequalities. As

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> *question. C'est un fait historique que ces produits ont été mis au point sous l'impulsion des considérations militaires, mais il serait difficile de prouver la thèse selon laquelle ils n'auraient absolument pas pu l'être sans le sentiment d'urgence provoqué par les besoins militaires et le dédain des préoccupations de rentabilité économique dont il s'accompagne.*

Idem, p.32.

550 RE 130 Box 15. file 550. O.E.C.D. Conseil: Rapport du groupe special du Sécrétaire Général sur les nouveaux concepts des politiques de la science. Science croissance et société: une nouvelle perspective. Diffusion restreinte. C (71) 71. Barème 1. Paris le 13 avril 1971, p.40.

551 Ibid., pp.35-36.

we can see, the OECD returned to its original statement of the early 1960s to argue that economic disparities are generated by factors such as: the availability of capital; budgeting policy; attitude; spirit of enterprise; marketing; education; culture and national psychology. From this perspective, a nation could innovate technologically and prosper economically and socially through intelligent use of foreign technologies. While these technologies could be referred to as secondary or imported innovations, to be useful they still required a high level of technical education and training.[552] This doctrine was a central component of the emerging transatlantic discursive regime. Its function was to counter the need for Large European initiative to develop technology of its own and thus it thwarted the efforts by the DGRST through a PREST industrial and technology policy to create transatlantic incompatibility between telecommunications systems.

While invalidating the role of government in industrial affairs, the OECD Directorate for Scientific Affairs suggested that member countries should not be preoccupied by the creation of a competitive European computer or electronics industry. This function should be left to the private sector while governments resolved other problems such as the deterioration of the ecological environment, the pollution of the air and the oceans, and the use of space technologies, all of which required international regulation, control, distribution of resources and the use of expensive technology.[553]

While the issue of US technological domination was still pending, the OECD argued that cooperation between governments could bridge the "technological gap"

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552 Idem, p.32.

553 This opinion was based on study made by E.B. Skolnikoff. The International Imperatives of Technology - The Implications of Technology For The Future Development of International Organisations. European Center of Carnegie Dotation, Geneva March 1970. Cited by the O.E.C.D., op. cit., p.41.

between countries. This argument could be summarized as follow: due to the increasing cost of high technology products, even in the areas of marketable products, competition within the market between private companies would require political cooperation between governments as only the latter could guarantee investment and economic growth. The organization predicted that by the year 2000, every aspect of social, economic and political life in most advanced societies would be computerized. In the meantime and until 1985, international political cooperation in technology was required to assure the diffusion of other intermediary products that would appear in the following order: (1) non-rigid computer memory, (2) the incorporation of software into the hardware, (3) portable computers with large memory capacity; (4) voice command of the computer; (5) laser memories and the transmission of data through laser signals, (6) miniaturized memories of huge processing capacity to be used in office machinery; (7) use of computers in education.[554]

These were the predictions that again restrained member governments to the promotion of a transatlantic user policy. While there was no guarantee that electronics will necessarily evolve towards these directions, it is possible to argue that these predictions represented the investment trends in US electronics firms whose trade ambition worried the DGRST. Here, because the OECD Secretary General's predictions seemed like a conscious political action articulating American and European firms' trade interests, US Department of Commerce's views and NATO telecommunications priorities, it is possible to argue partially in terms of the neo-

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554 These predictions were based on a study done by Parkins and Williams, Science Journal, October 1967, p.52. Cited in the R. Pipe report: O.C.D.E.- Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème., Diffusion restreinte, DAS/SPR/72.20 (1ère Révision), Paris, le 19 septembre 1972, p.14.

Gramscian approach to international hegemony. However, this hegemony was not without its difficulties. In order to legitimate the new discourse within the OECD Council of Ministers and NATO Conference of National Armament Directors, these interests and priorities, however powerful, still needed the consent of countries such as France. The OECD Secreatary General's suggestion was thus an effort to enable the regime to cope with the DGRST's attempt to establish a separate European standards system[555] as opposed to NASA components standards and NATO new requirements.

As the usefulness of the predicted techniques was not immediately evident to the OECD member-governments, Harvey Brooks and the Groups of Experts sought to demonstrate how member nations could directly benefit from them in their daily activities. The Groups of Experts maintained that by 1995 the use of these innovations by member governments' bureaucracies would facilitate numbers of administrative tasks. New, powerful and low cost minicomputers would be used in different areas in the following order: 1) computer aided control of urban traffic, 2) computer aided control in large hospitals, 3) computer aided teaching, 4) computer aided aircraft take-off and landing, 5) electronic recording of scientific advances, 6) computers for diagnosis, 7) electronic recording of workers' incomes and automated transmission of

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555 This American pressure was felt by the Commission of the European Communities which issued a memo asserting that:

> *Les États-Unis paraissent s'inquiéter de l'action qu'entreprennent les pays européens en vue d'une STANDARDIZATION À L'ÉCHELLE EUROPÉENNE DES COMPOSANTS ÉLECTRONIQUES. Ils viennent de présenter à la commission internationale, qui groupe tous les pays industriels du monde une proposition d'harmonisation sur le plan mondial des normes electriques et en particulier des composants électroniques...* (Emphasis in the texte). [RE 130 Box 11, File 25377. Recherche et technologie Bulletin edité par les Services de presse et d'information de la Commission des Communautés Européennes. No.12269/X/70-F, Bruxelles le 20 juillet 1970, No.63]

these data to income tax authorities, 8) computer-aided home learning, 9) computers would be used as same extent as telephones and TVs in all homes.[556]

As a confidential note by the CII president (addressed to the French presidency) stresses, these predicted uses of computers themselves have no power or tendency to constrain or to orient the French policy towards determined objectives. However (according to this note) they reflected American electronics companies' long-term investments[557] for which Western Europe was evidently an important market. This was why the US and the OECD Directorate for the Scientific Affairs were keen to convince European governments on the importance of orienting their science policies towards training and use of new computer techniques. For this same purpose, the OECD created a Computer Science Committee whose role was the sponsorship of an international forum of discussion on standardization within American industrial norms, research and investment trends, while the US Department of Commerce was engaged in an effort to monitor European standardization discussion within the framework of the EEC.[558] According to the Russel Report:

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556 These predictions were based on research done by E. Schich in Transaction, February 1970; reproduced in Congressional Record, February 26, 1970, p. E-1393. Cited by O.C.D.E.- Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème., op. cit., p. 14.

557 The noted stresses that: "*L'observation des efforts continus accomplis aux USA conduit à un dignostic objectif: il est trop tard pour gagner le pari du Plan Calcul dans une perspective de court et moyen termes. Mais on doit opposer à cette position que les événements ne sont pas déterministes et que pas à pas des actions convergentes accomplies dans un climat de foi retrouvée et éclairée peuvent les infléchir dans un sens progressivement favorables...*" F. H. Raymond «Note confidentiel sur le Plan Calcul», op. cit., p.404.

558 The EEC Commission's note cited above indicates that: « *La naissance d'un label européen risque de leur faire ombrage [...] Ceci explique que les États-Unis aient demandé à participer aux travaux du CECC. Cette participation a été jusqu'ici écartée (elle aurait entraîné immédiatement celle du Japon et peut être d'autres pays...). Mais le CECC est convenu de tenir périodiquement les États-Unis informés de l'avancement de ses travaux»* RE 130 Box 11, File 25377. Recherche et technologie Bulletin edité par es Services de presse et d'information de la Commission des Communautés Européennes, op. cit., p. 2.

> *Le choix ou la création d'un forum de discussion doit tenir compte de plusieurs facteurs, comprenant la capacité ou l' expérience acquise dans ce domaine d'activité, la participation de ceux des pays dont les objectifs impliquent une contribution pertinente aux questions débattues et une participation gouvernementale au niveau le plus propre à permettre des réactions significatives à l' égard des propositions avancées. L'organisation institutionnelle de l'O.C.D.E. présente les garanties nécessaires des satisfactions des critères précédents,* ***ce qui n'est pas le cas des Nations Unies ou du Conseil de l'Europe.***[559] [my emphasis]

The Group of Experts of the OECD Directorate of Scientific Affairs felt that the OECD was the only international body that was able to promote inter-governmental discussion of ICT, and that multinational firms' activities were necessary for technical development and economic growth.

6.5 THE FRENCH REPLY TO THE OECD

Although the PREST program was in difficulty, the OECD still had reasons to fear European protectionism in DGRST's opposition to NATO and OECD standardization programs. In 1969, at the DGRST's request, the European Coordination Committee for Electromechanical Norms (CENEL), the European Electronics Components Committee (ECC) and the European Free Trade Association (EFTA) sought to develop a European system of electronics standards that would stand for rationalization of production and efficient use of European industrial resources.[560]

For the Americans and the OECD officials, although this agreement was more inclusive than the PREST programs, it was still worrisome because it was not clear

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559 O.C.D.E.- Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème., op. cit., p.167.

560 CAC/820254 Box 166 file 520. Coopération Européenne dans le domaine de la recherche scientifique et technique COST- Secretariat. "Compte-rendu de la réunion du Groupe d'Experts "Informatique" du 20 novembre 1970 à Bruxelles", 20 292/III/XII/70 -F, COST/82/F/70, Bruxelles, le 30 novembre 1970, p.2.

whether it was inclusive or exclusive of American products. Moreover, if the system was to be inclusive they wondered about the price of joining a system which they had not participated in building.[561] American apprehension of the European standardization program was justified because the Europeans themselves did not agree on the purpose of their program. For the French, for instance, the *raison d'être* of the system was to create and protect a European electronics industry. The Germans saw the system as the way to promote compatibility between products of different origins. For the British, the final purpose of the initiative was the liberalization of international trade in the industry. In 1969, none of these perspectives dominated, establishing an uncertainty that called into question the OECD's technological forecast upon which the predictions of the 1980s global electronics market were based.

In the end, the early 1960s enthusiasm about Western Europe/US interdependency gave way to European ambiguity vis-à-vis the US and faltering opinions about Europe's own industrial future.[562] It was a situation that provoked American worries about the possible emergence of a commercially hostile Western

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561 This concern was reported in an EC bulletin in 1969. The document stated that the development of European standards was worrisome to American electronics components producers. Before the European willingness to develop common electronic components standards, American companies always had manufactured their components according to NASA and US Department of Defense specifications and sold them successfully in Europe as the most space and militarily dependable. The possible emergence of European standards was seen as a threat by American electronic producers. RE 130, Box 11, File 253. 77, Recherche et Technologie. "Les États-Unis paraissent s'inquiéter de l'action qu'entreprennent les pays européens en vue d'une STANDARDISATION À L'ÉCHELLE EUROPÉENNE DES COMPOSANTS ÉLECTRONIQUES", Bulletin édité par les services de presse de la Commission des Communautés Européennes, Reproduction autorisée, N° 63, Bruxelles, le 20 juillet 1970, Annexe I.

562 EEC member-countries did not agree on the goal of the French initiative or on the EEC as the unique framework for cooperation. This was the context where NATO and the OECD created respectively the International Institute of Computer Science and the International Institute of Technology to counterbalance the EEC European Institute of Computer Science. CAC 8200254, Box 160, file 509, Commission des Communautés Européennes -- Direction Générale de la Science et de la Technologie (D.G. XII) "Note pour le groupe de travail "Politique de la Recherche Scientifique et Technique: Examen comparatif des projets de création d'instituts européens de recherche ou de formation dans les domaines de l'informatique et du management", 5.0995/XII/69F, Bruxelles, le 26 février 1969.

Europe. The likely rise of an unfriendly climate within the Atlantic alliance led the British government to distinguish its position from France and to confirm its Atlantic loyalty. For the British government, in contradistinction to French policy, the European standardization program had three purposes: (1) to bring together different electronics specifications that guaranteed quality of products, (2) to make the system of standards cover civilian and military electronic products and (3) to take necessary measures that ensured in due time, the procedures and the general terms of a system that would also be applicable to other industries.[563]

From the British point of view, although it was important to experiment with the European system of standards within a limited number of countries, there was no doubt that the system was meant to include all industrial countries.[564] Consequently, there was no reason to conclude that this European experiment was about to create a European system of standards that would exclude countries in other continents or to establish a European fortress. Quite the contrary, the Foreign Office made it clear to both American and French governments that:

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563 This is from a note sent to the American Embassy in London and to the French Committee of Coordination of Telecommunication, by the British Foreign Office. CAC/8200254 Box 166 file 520, Premier Ministre -- Comité de Coordination des Télécommunications (C.C.T.) -- Comité des Composants Électroniques -- Sécretariat Permanent, "Traduction de la note adressée le 16 mai 1969 par le Foreign Office à l'Ambassade des États-Unis à Londres", N° 253/C.C.T. /B. E., Paris, le 13 juin 1969, p. 1.

564 The reason was in order to see if the principles of the system and its proceeding practices are sound. For this reason only, according to the Foreign Office, it was appropriate to implement it first in Western Europe where the condition of its trial seemed favorable. Ibid., p. 2.

> *On n'a jamais eu l'intention de rendre obligatoires les spécifications harmonisées et il n'y aura pas d'obligation légale pour les acheteurs publics ou privés de se fournir des composants fabriqués en accord avec les dispositions du système*[565]

The British view of European standardization granted latitude to all membergovernments of both NATO and the OECD (including the US). It also suggested that member countries of both organizations could press ahead at their own pace, to modify the system or to stay out and join in later. The challenge for the DGRST was how such a non-compulsory standards system would fulfill the aim of Europe's technological and industrial autonomy vis-à-vis the United States, particularly if the latter took part in the elaboration of the program. This question provoked an immediate response from the French government who considered European standardization as a means among others (such as industrial, research and training policies at the European level) to create a European electronics industry with goals (the promotion of interdependence) different from that of American multinationals (standardization). In a directive distributed to all French administrators concerned with the European standardization, the French Prime Minister's Bureau of European Economic Cooperation stated that:

> *l'objectif principal doit être de réunir les conditions de nature à permettre l'existence d'abord, le développement ensuite, d'une véritable industrie européenne de l'informatique. Cette "dominante industrielle" a marqué les travaux et toutes les propositions du groupe spécialisé.*
> ***-une politique industrielle ne saurait s'appliquer qu'à des sociétés réellement européennes, et non à celles juridiquement européennes au sens de l'article 58 du Traité de Rome. Il n'a jamais été question de faire participer à ces opérations IBM-France ou toute autre filiale européenne de société américaine*** [I emphasize][566]

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[565] Idem, p. 2.

[566] CAC/8200254 Box 183, File 525, Premier Ministre - Comité Interministériel pour les Questions de Coopération Économique Européenne -- Secretariat Générale -- "Politique de la Recherche

6.6 NATO AND THE OECD'S ALTERNATIVE

As expected, the NATO and OECD reaction was, to say the least, a stalwart response to defend the transatlantic concept of *Compatibility in Manufacture and Supply Services* which meant maintaining and strengthening the structural connections that linked the Western European computer industry to US research and technical development. Both organizations' riposte to the DGRST was an aggressive discourse against the very idea of a European industrial identity. They claimed that international cooperation should not be a substitute for national effort. Moreover, the organization recognized that multinational companies could create difficulties when their goals did not match the social and economic policy of the host country. However, despite this possible contradiction, there was no doubt that multinational firms had made purely national economic and social policy obsolete. Consequently, rather than taking a hostile stand against multinational enterprises, the OECD Directorate for Scientific Affairs maintained that countries should envision their policies within the ongoing process of global economic integration and international harmonization of different national legal systems for competition and patenting procedures as opposed to the French policy of building a "fortress" Western Europe.[567]

Such a solution required the participation of the US government and multinational companies in European industrial policy and restated the need to continue

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Scientifique et Technique de la C.E.E. -- Informatique: Note résumant les travaux du groupe spécialisé de Bruxelles", MA/MVB N°CE/7073, Paris le 17 juin 1969, p. 1.

567 RE 130 Box 15. file 550. O.E.C.D. Conseil: Rapport du groupe special du Sécrétaire Général sur les nouveaux concepts des politiques de la science. Science croissance et société: une nouvelle perspective. Diffusion restreinte. op. cit., p. 84-92.

the transatlantic process of technical, economic and industrial integration. The OECD Secretary General not only denied the existence of a European identity in the electronics industry, but also suggested that without US participation in the European industrial projects, Europeans themselves were incapable of success. This allegation, based on the delay of programs such as EURATOM, the European Launcher Development Organization and the European Space Research Organization (ESRO) underlined the effect of divergent national options being inaccurate, lacking a disposition to act towards common objectives, and generating real technical problems and incompetence that often led to errors in decision-making. The Group of Experts on Science Policy's report stressed that:

> *Aux difficultés inhérentes à toutes les entreprises de recherche, l'action gouvernementale a ses obstacles et ses contraintes propres. Ce qui au niveau national passerait pour une erreur de direction, de gestion ou de prévoyance, sera considéré comme une conséquence de divergence de vues entre partenaires touchant soit les objectifs et les programmes, soient le partage équitables des risques et des avantages. En ce sens les retards subis par des initiatives scientifiques et techniques concertés comme certains programmes de la Communauté Européenne de l'Énergie Atomique (EURATOM) du Centre Européen pour la Mise au point et la Construction des Engins Spatiaux (CECLES) ou de l'Organisation Européenne de Recherches Spatiales (CERES) représente essentiellement le contrecoup des options divergentes prises par les politiques scientifiques au niveau national; soit impuissante, soit de mauvaise volonté, ...* ***les difficultés politiques peuvent quelquefois servir d'écran ou de prétexte pour masquer des erreurs techniques.*** [I emphasize][568]

More than ever, in 1969, the OECD's endeavour became an effort to present the European "technological gap" as merely a management problem and equipment gap related to the European lack of appropriate prediction and forecast techniques. Henceforth, according to the Organization, the reasonable solution was the elaboration of new education, training, research and management programs as opposed to the French policy of regional confrontation and hostility towards American multinational

568 Ibid., p.38.

corporations. It was for this purpose that, in a meeting held in Maastricht June 6, 1969, the OECD Scientific Information Committee created its International Institute of Technology for research and advanced management training for member countries citizens. The tasks of the Institute consisted of:

1. elaborating teaching methods and techniques devised to solve complex problems related to decision-making in technical innovation;

2. developing appropriate methods that facilitated the transition from scientific discovery to technical application in industrial production;

3. teaching prediction techniques in order to provide data for decision-making for regulation of existing techniques and elaboration of new technical development projects.[569]

These new projects indicate that the OECD had failed to diffuse the US Air Force practices of prediction and forcasting among the European members of the Organization. As a complement to the OECD projects, in 1969 NATO Advisory Group for Aeronautical Research and Development (AGARD) also laid down a program in advanced software research devoted to the problem of automatic storage and retrieval of information. In detail, the AGARD program consisted of: (1) establishing procedures for machine reading of texts that would be taped in standard forms; (2) fostering procedures for computer "time-sharing"; (3) producing software for display techniques and rapid printing. NATO considered these projects as complementary to member governments' education and training programs in computer science in order to fill the

[569] C.A.C. 8200254, Box 160, file 509, Le Délégué à l'Informatique "Note pour le Ministre: Comparaison des différents projets internationaux", Annex I op. cit.

gap between users and the sophisticated third generation of computers that was to be provided by American suppliers.[570]

AGARD considered this program as a way to enable European scientists to automatically store and retrieve scientific and technical information and to exchange information with US researchers. Although the purpose of this project was scientific and technical in nature, it could also be viewed as a political action to strengthen the regime by tilting the European telecommunications system towards American standards. The 1969 AGARD software program was a step forward in the changing transatlantic discursive regime in computer technology in the sense that NATO was again acting jointly with the OECD to engulf European civilian computing practices within the transatlantic process of industrial integration. The exchange of scientific and technical information between Western Europe and the United States was not the final end; it was simply a means to a bigger automatic exchange program. It was the model for setting up an integrated general purpose telecomputing services across the Atlantic for remote and real time exchange of stock market data; instant information on industrial production; real time banking operations; real time communication of data between multinational corporations and their affiliates and exchange of files between governments in Europe ana across the Atlantic. It was a huge program rivaling the French initiated PREST programs. Once again, NATO and the OECD advised Europeans a policy of computer use rather than fostering manufacturing capacity. As Mr. Neufeld (an IBM representative in an OECD meeting in 1969) indicated:

> *En résumé j'aimerai indiquer que en tant que constructeurs de calculateurs nous pensons pouvoir offrir dès maintenant les aides nécessaires pour établir et développer les systèmes d'information à des fins de gestion. Pour saisir l'aspect fondamental des systèmes d'information à des fin de gestion il faut*

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570 Idem, p.5.

comprendre qu'il s'agit des problèmes de gestion et non la construction des calculateurs. L'objectif de ces systèmes est de fournir l'information à une vitesse susceptible de permettre au spécialiste de la gestion de prendre des décisions stratégiques en vue de la planification future[571]

In 1969, the first trial of this program was an exchange of data between NASA computers and the ESRO Documentation Service. This experiment was proudly described within the AGARD circle as:

...one of the first ventures of the kind where the agency receiving the machine system, i. e. ESRO/ELDO, is also responsible for the provision of machine input to the system operated by the supplying agency i.e., NASA. This...indicated the enormous advantages which could be gained if greater standardization in this area could be achieved.[572]

In conformity with the new OECD science policy doctrine that narrowly defined the technological gap between the US and Europe as being an equipment gap and by closely following the NASA lead in the electronic storage and retrieval of information, the ESRO/ELDO Space Documentation service expressed the need for remote visual display consoles in order to directly interrogate computer files. Mr. Gass, the OECD Directorate of Scientific Affairs vice director stated that:

À propos de l'étude sur l'écart technologique, ... l'un des principaux problèmes s'est révélé être la gestion, non pas au sens habituel du terme mais comme signifiant l'aptitude à intégrer les technologies nouvelles dans des systèmes de gestion.[573]

The OECD Directorate for Scientific Affairs pressed member countries to install visual display consoles at strategic points through the ESRO/ELDO network by the end

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[571] CAC 77/321, File 1415, O.E.C.D. - Direction des Affaires Scientifiques, "Utilisation des calculateurs dans les pays membres - Reunion du sous-groupe d'expert sur les systèmes d'information à des fin de gestion", DAS/SPR/69.48, Paris le 9 août 1969, p.1.

[572] RE 130, Box 19, File 740, Office of Naval Research (O.N.R.), "The Storage and Retrival of Information - - A User--Supplier Dialogue, An AGARD Symposium, 18 -- 20 June 1968", op. cit., p.11

[573] CAC 77/321, File 1415, OECD - Direction des Affaires Scientifiques, "Utilisation des calculateurs dans les pays membres - Reunion du sous-groupe d'expert sur les systèmes d'information à des fins de gestion", op. cit.

of the year 1969.[574] With this, the Directorate sought not simply the setting of standards for input and output devices, but also the establishment of multilaterally standardized alphanumeric patterns in order to provide the means for computers to recognize each others written characters across the Atlantic.[575]

Thus, rather than building two different systems, one exclusively European and another between the US and Europe, NATO, the OECD, the US and the United Kingdom opted for the *Compatibility in Manufacture and Supply Services* based on an unique standards system. They proposed a new program that had been formulated in terms of two operating concepts: the "Total Information System" and the "Integrated Management Information Systems". These two concepts were proposed by NATO and the OECD as an alternative to the PREST teleprocessing projects. In effect, the concept of "Total Information System" refered to a general purpose telecomputing service that would automatically connect across Europe and the Atlantic, newspapers editing houses, telecommunications systems, governments, industries and banks[576].

The project for an "Integrated Management and Information System" (IMIS) replicated, in business terms, the US Air Force discourse on integration of weapons and centralization of military commands of the US military World Wide Command and Communications System (WWCCS). Four main reasons led NATO and the OECD to

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574 Ibid. p.11

575 Character recognition is a technique for automatic identification of alphanumeric symbols; it is a subset of pattern recognition. The latter can be defined as a technique for automatic identification of a given arrangement which is known to belong to one of infinite classes -- missile site on a photograph, tumor in an X-ray, resistor symbol on circuit diagram -- and replaces visual inspection which is a physically exhausting task, prone to errors. RE 130, Box 19, File 740, Office of Naval Research (O.N.R.), "The Storage and Retrival of Information - - A User--Supplier Dialogue, An AGARD Symposium, 18-20 June 1968" op. cit. p.6.

576 RE 130, Box 14, File 555, OCDE - Comité de la politique scientifique, "Problèmes et perspectives de la recherche fondamentale: le cas de l'informatique - note du Secretariat", Diffusion restreinte, SP (71) 25, Barème 2, Paris, le 23 septembre 1971, p.7.

plead for a business replica of the WWCCS: (1) The upgrading of NATO communications to fulfill the requirements of the new NATO Integrated Command Systems (NICS) needed national companies' participation as well as intergovernmental cooperation. (2) Companies' participation and intergovernmental transatlantic agreement was difficult in the absence of a transatlantic civilian communications network project that forced American companies and European firms to operationalize the concept of *Compatibility in Manufacture and Supply Services.* Without such a project, sooner or later it would be easier for the DGRST to create a separate European civilian communications standards that could jeopardize NATO communications flexibility program. (3) Thus, a transatlantic Integrated Management and Information System was seen by both organizations' committees as a way to create a modern transatlantic civilian teleprocessing network between Europe and the United States for the benefit of the former. (4) NATO and the OECD considered the project for an Integrated Management and Information System (IMIS) as essential for the improvement of multinational business operations and military communications as NATO needed the PT&T systems in order to enhance the flexibility of its communications capabilities. In addition, American multinationals wanted to install a transatlantic communications system that handled, stored, processed and retrieved useful data for decision-making across the Atlantic. Thus, the IMIS was not only the business replica of the military communications systems, it was also conceived to facilitate the transatlantic standardization of electronics components through the implementation by companies of *Compatibility in Manufacture and Supply Services.*[577]

[577] RE 130, Box 14, File 740, O.C.D.E - Comité de la politique scientifique, "Rapport du groupe ad hoc sur l'Information, Ordinateurs et les Communications", Diffusion restreinte, Barème 2, Paris le 25 juin 1971, p.12.

As we can see, this concept was not driven by technological change but by NATO and the OECD political action designed to save the regime. In this sense it was an interface between American multinationals' pressure for standardization and the science policy doctrine that confined the role of government to computer utilization. In 1971, a letter sent by the US Department of Commerce to the OECD Directorate of Scientific Affairs asserted that:

> The mandate of the Expert Group on Computer Utilization as defined by the CSP is stated in paragraph 20 of the secretariat's background paper, SP (70) 6:
> (i) to assist Member countries in the formulation of computer usage policies;
> (ii) the exchange of information on usage, concepts and concrete experience of computerized information system;
> (iii) to prepare standardized guidelines for collection of data on computer usage, based on national survey;
> It would more valuable to have the Expert Group focus its attention on topics that pertain much more directly to questions of policy *i. e.* question that are faced now and soon be faced by most member governments. Some examples of such questions are:
> 1) what should be government response to ever increasing request for individual computers?
> 2) what action can and should government take to broaden the base of individuals skilled in using the computer either for research or management purposes?
> 3) what should be the government's role in stimulating and regulating the growth of data communication networks. To what extent should it attempt to integrate the components, computers, communication and content? Should be there international standardization and integration? [578]

Following the 1968 Third OECD Conference on science policy, these questions clearly stated a US position that dismissed the French concern over European industrial autonomy and became the OECD's guideline on standardization. As Mr. J. R. Whitehead, the Canadian head of the OECD Science Policy Committee, put it:

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[578] CAC 77/321 File. 1415, H. Hofner "Proposed Direction for the CPS Program on Computer utilisation", December 1971. This letter was written as the American National Bureau of Standards' reaction to the 1971 R. Pipe report: OCDE - Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème, op. cit.

1) The new information systems that assembled communications systems and computers were becoming very large and extremely expensive.

2) These systems were developing and would continue to do so in several sites outside the government defense, economic, social and science policies.

3) Several and yet unknown private and government social and economic activities would depend increasingly on these information networks;

4) Last but not least, given this forecast, all countries were constrained to develop compatible communication networks [579].

Through these four points the OECD Science Policy Committee underlined that it was economically inefficient to build a system based on large computers when minicomputers were available to offer an inexpensive solution. The Committee advised member countries to adopt standardized products as a guarantee for technical efficiency and economic growth of an industry that could be profitable to all.[580] The use of the NASA electronics components standards was, for the Organization, the only guarantee of technical efficiency and market expansion.[581]

For the Directorate for Scientific Affairs and the US government what was required at the transatlantic level was not compatibility but standardization. In this regard, compatibility was different from standardization. While the former sought the inter-working between equipment of different origins and allowed procurement preferences in favor of national companies, the latter meant literally the adoption of

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579 Ibid., p. 2.

580 R. Pipe report: O.C.D.E.- Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème., Diffusion restreinte, DAS/SPR/72.20 (1ère Révision), Paris, le 19 septembre 1972, p. 166.

581 This demand was undertaken simultaneously with an agressive publicity of American electronic components as the most dependable in weapon system and aerospace equipment. RE 130, Box 11, File 253. 77, Recherche et Technologie, "Les États-Unis paraissent s'inquiéter de l'action qu'entreprennent les pays européens en vue d'une STANDARDISATION À L'ÉCHELLE EUROPÉENNE DES COMPOSANTS ÉLECTRONIQUES", op. cit.

identical products and thus undermined public procurement preferences in favor of national or regional companies. In 1972 the OECD issued a report that maintained that:

> *Les liaisons et les réseaux d'informatique vont se développer, et sans doute à un rythme rapide, entre les pays d'Europe et entre les États-Unis et le Canada; 2. Les actions entreprises indépendamment pour la construction de ces systèmes par les gouvernements et les utilisateurs privés de l'informatique aboutissent à la divergence des techniques, des qualités de données et de compatibilité. Si ces implications sont claires et succinctes, les mesures nécessaires pour assurer l'harmonisation ne le sont pas moins.* ***L'adoption d'une normalisation internationale, si désirable se heurte à l'absence d'accord général concernant le forum le plus favorable à la réalisation de ces objectifs.***[582] [my emphasis]

It now appears that American firms, the US Department of Commerce's trade interests, NATO and the OECD Directorate of Scientific Affairs standardization program proposed the linkage between issues such as military telecommunications, transatlantic civilian-data processing, electronics trade, user-oriented science policy to assure the stability of the transatlantic discursive regime and to minimise the effect of the DGRST-initiated PREST programs. The issues-linkage contributed later in 1973 to the abortion to the DGRST-initiated European industrial consortium, UNIDATA. The Germans (SIEMENS) and Dutch (PHILIPS) who were the potential partners of the French company the CII in the formation of UNIDATA had in fact accepted the new elements of the transatlantic discursive regime, notably the importance of standardization, the Integrated Maganagement and Information System and the new user policy that emphasized the social uselfulness and economic profitability of scientific research. This happened because unlike France, neither Germany nor Holland had the pretense of an independent military policy.

[582] R. Pipe report: OCDE - Direction des affaires scientifiques - Groupe Informatique -, Pour une politique de l'informatique au niveau des gouvernements centraux: Développement des bases des données et dimensions internationales de ce problème., op. cit., p. 167.

As the result of this incompatibility between French autonomous defense policy on one hand and Holland and Germany's interest in NATO on the other, on December 1969, the EEC negotiations on PREST programs were suspended because the French representative in the EEC refused the inclusion of North America in the development of a European standards system. A note by the French Ministry of Industrial and Scientific Development stated that:

> *Les travaux sont suspendus depuis le début de 1969 parce que les partenaires européens refusaient d'aller au-delà des engagements pris dans le Traité de Rome, tant que ne sera pas réglé le problème de l'entrée éventuelle de la GB au sein de la Communauté*.[583]

In fact, beyond the difficulty represented by the French attempt to modify the Treaty of Rome, the problem was the lack of a market for a European large computer which itself was due to Germany's, Italy's, Belgium's and the Netherlands' refusal to approve the PREST programs since their involvment in the transatlantic program of upgrading military communications and PT&T systems in accordance with NATO's concerns[584]. However, despite the rejection of the PREST programs, the DGRST remained convinced the programs could be carried out at the company level and through a common electronics procurement policy for rebuilding the European PT&T systems. This strategy was the reason for the creation of the UNIDATA conglomerate which was from the DGRST's perspective an effort to bring into play at firm level what had been difficult to instigate at the inter-governmental European level.

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583 Ibid., p. 17.

584 The DGRST's hostile attitude towards US interests was incomprehensible to the other EEC members because, in the past decade, France had built its military communications and PT&T systems with the help of IBM and according to NATO standards. Moreover, although the DGRST was hostile to US multinationals, the French government did not take action to bring BULL into the PREST program despite GENERAL ELECTRIC's decision to abandon its share in Bull's capital. Instead, the government allowed GENERAL ELECTRIC to hand over its BULL share to HONEYWELL.

6.7 THE SECOND CONVENTION OF THE PLAN CALCUL AND THE CREATION OF UNIDATA

6.7.1 *The second phase of the Plan Calcul*

On August 1971, the second phase of the *Plan Calcul*, a five-year program covering the period 1971-1975 was adopted. Accordingly, an agreement between the government (including the Ministry of Science and Industrial Development, the Ministry of the Economy and Finances and the Ministry of National Defense) and industry (including THOMSON-CSF, CGE, financial and industrial holding respectively FININFOR and CII) was signed.[585] This agreement consisted of six points[586]: (1) The CII was again committed to mastering the manufacturing of the following products: general-purpose computers, peripheral equipment and mass computer memory, computer terminals and software. (2) The company was to be the cornerstone of the French electronics research but was excluded from the military and specialized equipment sector as the French military still did not agree on the DGRST approach. It was agreed that the company's research should be closely related to the development of computers. (3) Contrary to the first *Plan Calcul*, the second phase of the *Plan Calcul* had no precise R&D objectives because the CII was awaiting an agreement yet to be signed with SIEMENS and PHILIPS to create a joint company which would be known as UNIDATA. (4) It was agreed that, considering the international nature of the data-processing industry and the large financial resources required by the CII in order to take part in this industry, it was necessary that the CII

585 P. Audoin Conceil "Le Plan Calcul 1966-74", op. cit., p.22.
586 Ibid., pp.22-25.

conclude an international agreement with other European companies before 1973. Most importantly, this agreement was expected to increase the range of computers to be produced by the CII, diversify the market for its products and be profitable to the other companies without resulting in a loss of the CII's national character. This point of the agreement implied also that any international cooperative project involving the CII and other companies should favor primarily the participation of European companies. If non-European companies were interested in concluding a joint-venture with the CII, their role should be minor. Furthermore, in any deal the CII would have to maintain leadership of the research, development and commercialization of a large series of products. CII leadership in France as well as in Europe was considered necessary to provide the French economy with a world class information processing industry. (5) The fifth point concerned the promotion of CII products. The government and industry settled on a procurement policy that obliged the French public administration and the CII parent companies (THOMSON-CSF and CGE) to give priority to CII products if the latter were technically or commercially competitive. (6) On the basis of the five measures, THOMSON-CSF and the CGE were committed through their common financial holding FININFOR to increase CII's capital by 27 million FF in the period 1972-1973 and the government guaranteed a minimum of 604 million FF for R&D and a loan of 224 million FF to CII.[587]

The problem with this program was that in 1971, the state support for the CII was no longer secure because the DGRST was incapable of imposing its view at the European level. According to M. Barré (who was then the CII president):

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[587] Idem

La situation reste confuse et je commence à avoir des inquiétudes sur la suite des opérations: la CII se trouve dans une situation ridicule; elle est engagé selon les directives du Plan Calcul dans une voie européenne; elle a constitué une Association qui s'est fixée un travail en commun; le travail a été entrepris; les dépenses prévisibles on été signalées au gouvernement : aucune des conséquences financières de cette politique voulue et approuvée par le gouvernement ne paraît être pris en compte.[588]

To succeed in the 1970s competitive environment, CII (the THOMSON-CSF and the *Compagnie Générale d'Électricité* (CGE) common firm) needed state support in order to widen its commercial network and to strengthen its research. In 1972, it requested an increase of its government allocation from 217 million FF (in 1970) to 342.4 millions FF.[589] In the absence of a European standardization program, the CCRST (the French scientific and technical research consultative body) a former DGRST ally felt that there was no need either to increase the CII funds or to augment the *Plan Calcul* resources. According to a CCRST note:

Cette augmentation considérable de moyens exprimait des craintes particulières:
la prise en charge par l'État des frais de lancement de la CII et l'aide à l'expansion commerciale de cette compagnie;
...l'intérêt de constituer sans tarder des équipes étoffées pour lesquelles l'encadrement est déjà en place afin d'atteindre son plein rendement dès 1973.
En dépit de ces arguments...le CCRST a écarté sans les examiner à fond les demandes de crédits destinés à soutenir le lancement de la CII et son expansion à l'étranger qu'il a jugé irrecevables...
Compte tenu de l'incertitude qui pèse à l'heure actuelle sur l'industrie française de l'électronique...la CCRST estime raisonnable de maintenir au même niveau qu'en 1971 les crédits destinés sur les recherches en "hardware". Il souhaite qu'un bilan précis soit fait de l'exécution du Plan calcul aux termes des cinq années fixées pour la convention entre l'État et la CII .[590]

As Table 27 shows, on the CCRST's "volte face", instead of increasing the CII capital, the government decided to merge this company with BULL (which became the

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588 M. Barré, "La Compagnie Internationale pour l'informatique dans le cadre du Plan calcul", op. cit. p.98.
589 CAC 810401, Box 188, IRIA "Demande de budget" avril 1971, p.1.
590 CAC 810401 Box 188. CCRST "Budget 1972: Informatique, Plan Calcul, IRIA", p.1.

property of the American company Honeywell in 1969) and reduced the *Plan Calcul* annual funds.

Table 27: The Plan Calcul budget for 1972

Program	Total budget for the VIth Plan	Endowment 1971	Budget demand for 1972	CCRST approval
-Computer		136	144	137
including: CII		(133)	(140)	(133)
and minicomputer		(3)	(4)	(4)
-Peripheral	} 780	20	20	20
-Input equip.		6	8	8
-Components	155	23	45	31.5
-Software	70	10	10	10
-Specific action	85	11	20	10
- Research in computer science	80	11	20	10
-European action	0	0	58.4	0
-Commercial expansion of the CII	0	0	12	0
Total	1.170	217	342	227

Source: CAC 810401 Box 188 CCRST «Budget 1972: informatique, Plan Calcul, IRIA», p.4.

In conformity with this change, the government decided to cut the second *Plan Calcul* budget by 415 million FF. Rather than allocating 1.585 million FF (see Table. 26), it agreed only on 1.170 million FF that would include the development of telecommunications and space equipment, new materials, aircraft engines and helicopters.[591] This budget reduction symbolized the return to the previous decade's

[591] CAC 810401, Box 190, CCRST, "Première propositions du CC pour une relance de la recherche scientifique en France", mars 1973.

discourse on interdependence that linked the French electronics industry to American advances in electronics. In practice, the French *Institut de Recherche en Informatique et en Automatique* (IRIA) established several research partnerships with American research institutes such as the Massachusetts Institute of Technology, Harvard University, the University of Michigan, the National Science Foundation (NSF), the National Bureau of Standards (NBS) and the Defense Advanced Research Project Agency (DARPA). This new wave of Franco-American cooperation concerned digital control, numerical analysis, artificial intelligence, software, electronic components standardization and data-processing network.[592]

The lack of intergovernmental European agreement on the PREST programs ended the hope of THOMSON-CSF to establish an internal monopoly in computer procurement and put into question the agreement between THOMSON-CSF and CGE, *le YALTA de l'Électronique* . As a consequence, the French government not only ended the DGRST's attempt to counter US industrial interests in France but also accepted the OECD's role in the international standardization of teleprocessing equipment.[593] Following the OECD's advice, the French government became concerned about the French industry's role in the new multinational-oriented transatlantic division of labor. Instead of following the DGRST in the struggle against US firms, the CCRST advised that France catch up with Japan, Germany and England.

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592 CAC 820250, Box 320, Ministère du développement industriel et scientifique - DGRST - le Délégué Général - la Délégation à l'informatique, "Coopération franco-américaine dans le domaine de l'informatique: relations franco-américaines en informatique premier semestre 1973", No. 3186, Paris le 28 mai, 1973, p.1.

593 A note by the French representative in the OECD computer science subcommittee (Mr. Michel Delamarre stated that: *"I existe bien sûr plusieurs organismes de type international s'occupant d'informatique, mais à mon sens l'OCDE est l'organisme qui offre la plus large tribune pour les pays développés."* C.A.C. 77/321 File. 1415 M. Delamarre "La Conférence des Ministres de la Science à L'OCDE les 24-25 juin 1975: le problème de l'informatique", p.2.

This was the context of the formation and the failure of the European consortium UNIDATA in which the CII participated with the German company SIEMENS and the Dutch company PHILIPS.

6.7.2 *The formation of UNIDATA*

Two years after the above agreement, in 1973, the CII, SIEMENS and PHILIPS agreed to create a European data processing consortium called UNIDATA. From the French perspective, the consortium's primary objective was to create an industrial entity that by 1980 would be second to IBM in the world computer industry. To attain this objective, these companies agreed on: (1) the management of the consortium (2) the ways and means of cooperation between the three companies and (3) the role of each individual company in the transitory period between 1973 and the co-production of the first UNIDATA computer.

To present an alternative to IBM's World Trade monopoly, the companies created the UNIDATA council, a decision-making body that took initiatives on behalf of all three companies and three operational units located in France, the Netherlands and Germany. These units were to implement UNIDATA policies in trade and technology. Moreover, each national company controlled 100% of the industrial plant and 80 % of the marketing offices located on its national soil, plus 33% of each of the three management offices located in Germany, Holland and France and less than 49% of total UNIDATA financial holdings.[594]

[594] Idem, p.32.

If the management of UNIDATA thoroughly reflected the French concern with the national control of their industry, the agreement on technology was another story: the three companies were not able to develop an alternative to the transatlantic discursive regime of standardization. They reached an agreement on Central Processor Units for large computers, peripheral equipment and software but they were incapable of agreeing on electronic components and the equipment to be used for special applications such as military and civilian telecommunications, air traffic control and industrial automation. The lack of agreement in these sectors underlined the fact that France was still not ready to digitize its professional applications according to transatlantic standards, and the exclusion of components indicated that Germany and the Netherlands preferred transatlantic standardization instead of building European separate standards.

Despite this cleavage, the three companies committed themselves to produce six different computers called the "X" series. These computers were to be different in power and storage capacity and ranged from X0 to X5. X0 was to be developed by PHILIPS, X1 and X3 by SIEMENS, X2, X4 and X5 by the French company, CII.[595] They were all meant to be compatible with each others, with the CII's operating systems (the SIRIS 2 and SIRIS 8) and with IBM machines[596] and this revealed how the formulation of UNIDATA was affected by the changing transatlantic discursive regime from interoperability to standardization. Rather than being a common European industrial strategy, the UNIDATA agreement simply highlighted the regime of standardization that gained ground in Germany and the Netherlands and the

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595 Idem, p.33.

596 M. Barré, "La Compagnie International pour l'informatique dans le cadre du Plan calcul", op. cit., p.96.

Europeanism that was still the domain of the DGRST. In practice as the French company, the CII, had chosen a large computer series; SIEMENS and PHILIPS' chose to produce minicomputers. Given this lack of common production objectives, the three companies preferred to protect their shares in their national markets from each others with products that involved American technology rather than manufacturing common products that would have promoted the European components industry. Furthermore, the terms of production-sharing agreement as promulgated by the DGRST was not respected; SIEMENS sought to manufacture its UNIDATA share, the X1 and X2 computers as competitors against the French IRIS series and the German company TELEFUNKEN projected developing a large computer in order to compete with UNIDATA X5 series[597]. As UNIDATA excluded European agreement on European system of components standards, it imposed IBM compatibility.[598]

There is no doubt that the cleavage between companies was a reflection of opposition between Germany and Holland on one side and France on the other on the issue of standardization. However, this opposition is hardly explainable by the traditional neo-realist notion of contradiction between national interests. It indicates rather the impossibility of maintaining the old practice of interdependence in ICT within a discursive space already dominated by the preponderant trade practice of American multinationals that dissipated national technological specificity in ICT and promoted transatlantic standardization. Moreover, although the implementation of a transatlantic system of standards was literally a diffusion of American component standards in Europe, it does not indicate a transatlantic integration process determined by technological change since the latter was itself originated in NATO's requirement of

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[597] Idem, p.99.
[598] Ibid., p.97.

telecommunications flexibility. In fact, as Germany and the Netherlands had chosen American components standards, the rationale of their choice was not determined by technology but by their participation in NATO and OECD standardization process that in return gave UNIDATA a transatlantic content and thereby opened the French telecommunications market to the American-influenced German and Dutch companies.

As a result of the transatlantic discursive regime's influence on the shape of UNIDATA, the French Minister of PT&T decided to include THOMSON-CSF in the telecommunications sector despite the *YALTA de l'Électronique* that restricted THOMSON-CSF to computers and the *Compagnie Générale d'Électricité* (CGE) to telecommunications. The Minister of PT&T argued that it was abnormal that the first French electronics company was excluded from the telecommunications sector while the latter was becoming all electronics. CGE was thus doubly disadvantaged; it not only had to share the French telecommunications market with THOMSON-CSF but also with PHILIPS whose production of minicomputers within UNIDATA allowed it to participate in the French market.[599]

While the Sixth Plan ended in 1972, UNIDATA partners were still incapable of reaching a final production-sharing agreement until 1974. In 1974, in the middle of Seventh Plan that started in 1972 the government ended the whole *Plan Calcul* and in the following year, in 1975 the French government decided to terminate UNIDATA negotiations. The termination of both programs caused the abolition of the *Délégation à l'informatique*. With these events the episode of interoperability ended and the new era of transatlantic standardization began in the French electronics policy.

[599] M. Barré, "La Compagnie International pour l'informatique dans le cadre du Plan calcul", op. cit., p.97.

Although this era is referred to in the literature as the epoch of liberalism[600] in the French electronic policy, it is more accurate to describe it as the era of transatlantic standardization since the government was still involved in the industry; only the attempt to create a separate European system of standards was abolished. In May 12, 1975 the government decided to create a new company: the CII-HONEYWELL BULL (CII-HB) as a result of a merger between the *Companie Internationale pour l'Informatique* (CII) and HONEYWELL-BULL. The CGE and the government obtained a majority share (53%) in HONEYWELL-BULL, 50% of the new company's (CII-HB) capital and 25% of HONEYWELL's share in BULL. This financial structure was not an indication of liberalism, but was in conformity with the early 1960s French policy that made mandatory the national control of the French electronics sector by French national capital. In return, in the period 1975-1979, 50% of French government procurement of electronic equipment were attributed to HONEYWELL. According to this arrangement, CII-HB would sell to the French government machines manufactured by the US company HONEYWELL INFORMATION SYSTEM under CII-HB label.[601]

This change in government policy was not determined by a bureaucratic adaptation reacting against "previous policy" as institutionalists such as P. Sack and T. Skocpol would argue.[602] The merger between CII and HONEYWELL represented a disapproval of the DGRST's European initiatives and a recognition that full national

600 C. Le Bolloc'h-Puges argues the contrary in La politique industrielle Française dans l'électronique, op. cit.

601 Assemblée Nationale - Seconde session ordinaire de 1974-1975, "Proposition de loi relative à la création d'une compagnie nationale de l'informatique", N°1857, Annexe n°3, le 28 juillet 1975. Reproduced in Colloque sur l'informatique en France, op. cit., p.148.

602 The view policy change as bureaucratic learning process is developed by P. Sacks "The Structure and the Asymmetrical Society", Comparative Politics, Vol 12, April 1980, p. 356. See also M. Weir and T. Skocpol, "State Structures and the Possibility and the Possibility for 'Keynesian' Responses to the Great Depression in Sweeden, Britain and United States", in P. Evans *et al*, Bringing the State Back In, New York, Free Press, 1985, p.119.

independence in the electronics field is not possible because the other EEC member countries and companies rejected the PREST program.

6.8 THE EFFECT OF THE TRANSATLANTIC DISCURSIVE REGIME ON THE FRENCH ELECTRONIC POLICY DURING THE SEVENTH AND EIGHT PLANS (1972-1980)

The French government's choice of the merger between HONEYWELL-BULL and CII instead of an alliance between CII and SIEMENS or PHILIPS indicated that a European alternative to the transatlantic discursive regime was not possible and that the OECD's Secretary General, NATO and the OECD had succeeded in accommodating French military concern of control over the domestic electronic industry. In this arrangement, the DGRST was the biggest loser because it was not possible to force US companies to respect the Delegation's vision of technological independence. The choice that was left to French decision-makers was to defend their interests within the emerging regime of standardization and to catch up industrially with equivalent nations.

In 1975, the government decided that:

> *...la France doit figurer au premier rang des pays de dimension comparable par le volume de et la qualité de sa recherche. Cet objectif doit être poursuivi non seulement dans le domaine de la recherche universitaire [...] mais aussi dans celui de la recherche industrielle qui a pour objet la réalisation effective de progrès dans les domaines économiques et socio-économiques.*[603]

Indeed, according to the CCRST, the French Scientific and Technical Research Advisory Group, while France was wasting time and energy fostering a European alternative to US technological domination, the country was lagging behind Japan, Germany and England in terms of industrial research and development. Its total research expenditure (13. 5 billion FF in 1974) represented only one seventh of the US

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603 CAC 810401, Box 130, CCRST, "Compte rendu de la reunion du 27 juin 1977", p.2.

research expenditure and was barely one half of either Japan or Germany. Moreover, while much emphasis had been put on electronics, the nuclear, telecommunications and space research, sectors vital to the economy such as agriculture research, chemistry, mechanical engineering, had been given little importance.

Table 28: comparison between selected research sectors in million FF in 1975.

Nuclear research	Space research	Computer research	Oceanography	Agriculture
3.047	1118	626	188	712

References: CAC 810401, Box 130, CCRST «Compte rendu de la reunion du 27 juin 1977», p.5.

Out of the total of 13.5 billion FF devoted to research, 4.5 billion FF were allocated to nuclear, space and computer research. This imbalance led the CCRST to conclude in 1975 that :

> *D'une façon générale avec des moyens globaux relativement faibles la France a une stratégie trop dispersée. Elle s'est engagée dans tous les programmes considérés comme les plus coûteux (recherche nucléaire, militaires, aéronautique civile, informatique électronique) plutôt que de concentrer ses efforts sur des axes industriels importants* [604].

In conformity with the transatlantic regime's new science policy, the CCRST advised the government to emphasize more civilian and economic orientations in the French research policy. Thus, contrary to the French military and the DGRST who were both in favor of the French reproduction of the American military discourse and scientific and technological practice, the CCRST advised the French president to cease imitating American "big science" practice and military-oriented science policy.

The CCRST's view can be summarized as follow: the importance of scientific and technical research to France's political independence and economic prosperity was not in question. But the country could no longer afford the pursuit of military

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[604] Ibid., p. 2.

leadership that meant heavy expenditure on high technology such as computer technology, nuclear and space research and a neglect of other vital sectors such as chemistry, mechanical engineering, energy and agricultur.e. For the CCRST, French independence was threatened by weakness in these sectors and the only way to overcome this problem was to disconnect French science from the military-oriented discourse of independence. As the memorandum of the CCRST clearly indicates:

> *Nous devons donc faire pour faire vivre notre économie: importer des matières premières énergétiques mais aussi diminuer dans l'avenir les importations en développant des nouvelles sources d'énergie; importer toutes les autres matières premières en les transformant; mettre le maximum de valeur ajouté sur notre seule véritable ressource: la production agricole* .[605]

Moreover, the CCRST not only recommended a shift of emphasis from high technology to more traditional research, it also suggested that the government follow the example of Sweden, Switzerland, Netherlands, Germany and Japan as all these countries' technological dependency on the US did not prevent them from pursuing technological innovation and economic prosperity. The CCRST memorandum noted that:

> *On peut se demander si une politique scientifique plus optionnelle en matière de recherche appliquée telle qu'elle est pratiquée en Suède, aux Pays-Bas, et dans une certaine mesure en Allemagne Fédérale et au Japon ne serait pas finalement plus rentable et conforme à nos moyens. Alors que l'évolution actuelle nous conduit à perdre notre compétitivité dans tous les domaines de la science* .[606]

One can recognize here the influence of the late 1960s NATO and the OECD science policy discourse that denounced the PREST programs. This influence had created a contradiction in the French discourse of political independence where the economics of scientific research as proposed by the OECD became the CCRST position and now contradicted both the military and the DGRST perspective on independence.

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605 CAC 810401, Box 130, CCRST "Projet de mémorandum du CCRST", november 1975, p.1
606 Ibid., p.5.

At the other end of the spectrum, the French military viewed a technological division of labor between the United States and Western Europe as inadmissible, because, like their American counterparts, the French military believed that the mastery of space technology was essential for defense and (unlike the American perspective on European science policy) that space technology was necessary for the French political independence and economic prosperity. They asserted that:

> *La nécessité de la recherche spatiale apparaît si l'on considère que la technique spatiale peut résoudre des problèmes immédiats (télécommunications, météorologie, ressources terrestres navigations) faire avancer certains secteurs (propulsion, électronique, mécanique des matériaux et faire progresser la connaissance générale de l'univers. Ceci explique que la technologie spatiale constitue un avantage qu'aucune puissance n'a intérêt à partager avec d'autres sans conditions. L'exemple de la politique américaine en la matière est là pour le prouver*[607].

Despite the soundness of the CCRST suggestions, during the 1977 revision of the Eighth Plan research budget, the government did the opposite. As Table 29 shows, it increased the nuclear budget by 15% and the space research budget by 12.5%. Moreover, while the *Plan Calcul* was officially terminated in 1974, it not only continued to receive public funds (it was funded by an average of 299.5 millions FF a year between 1974 and 1976) but in 1977 its budget was increased by 117%. It rose from 299.5 million FF in 1976 to 650 million FF in 1977.

[607] CAC 80401, Box 190, CCRST "Premières propositions du CC pour une relance de la politique scientifique et technique", not dated document, p.22.

Table 29: 1976 initial research budget and change in May 11, 1977

	1976	1977	Increase %
Nuclear research	2461	2830	15.0 %
Space research	755.8	850	12.5 %
Plan Calcul	**299.5**	**650**	**117.0 %**
Other programs	2404.7	2405	0 %
Total	5921	6735	13 %

Reference: CAC 920547, Box 10, File 11, Ministère de l'Industrie et de la Recherche - DGRST - Division du Budget et des Affaires financières, "Note sur les implications financières de la notification budgétaire du Premier Ministre relative à l'enveloppe recherche", Confidentiel, N° 91/HH/DBAF/N°890, Paris le 11 mai 1976, p.2.

The CCRST protested vigorously claiming that the budget was contrary to the Seventh Plan that prioritized agricultural and food-processing research, value-added raw material and biomedical research:

> *Ces dotations constituent un abandon des objectifs du Plan qui devaient permettre de privilégier les programmes prioritaires tout en maintenant une croissance modéré des autres secteurs et un désaveu des décisions du conseil restreint...*
>
> *Les seuls secteurs sauvegardés dans ce budget minimum sont le Plan Calcul, dont le CCRST note que la part recherche a été déterminée hors de toute consultation du secrétariat à la recherche, et le programme spatial qui ne bénéficient d'aucune action prioritaire. L'ensemble des autres organisme voient leurs moyens diminuer... Il s'ensuit que la recherche sur l'énergie et les matières premières, la recherche biomédicale, la recherche agro-alimentaire, la recherche industrielle, et l'ensemble des recherches fondamentales qui les soutiennent voient leurs moyens réduits en volume*[608].

In other words, it was difficult to disengage French research from the military. Not only had the *Plan Calcul* budget been increased, in 1977, the total information and computer technology expenditure (including the budgetary and extra-budgetary expenses) had also been raised by 59.04 % (see Table 30).

[608] CAC 80401, Box 190, CCRST "Compte-rendu de la reunion du 17 mai 1977", p.6

Table 30: Initial total budgetary and extra-budgetary Seventh Plan expenses and changes on October 11, 1977.

	Initial Eighth Plan		Change of the Eighth Plan			
Research themes and systems	Each year	Five years	Each year	Suppl (1)	Total each year	Total five years
Capital equipment: CAD/CAM			2280	635	2915	14575
Industrial restructuring			645	230	875	4375
Components Research			540	280	820	4100
Scientific instrument			25	25	50	250
Total	2930	14650	3490	1170	4660	23300

(1) Supplementary budget.
Reference: CAC 810401, File 138, CCRST, "Compte-rendu de la reunion du Comité Consultatif de la RST du 11 octobre 1977", Confidentiel, p.5.

This change was aimed at three new options: an emphasis on computer aided design and manufacturing of new components, the restructuring of the French computer industry and the openness of the French research institutions, as well as private companies to European and transatlantic collaborations. As a memorandum on October 11, 1977 indicates:

> *Les opérations spécifiques de la mission recherche ...seront généralisées en 1978 selon les trois axes suivants:*
> ° *renouvellement thématique et mobilité;*
> ° *ouverture vers l'extérieur;*
> ° *concentration des moyens.*
> *La définition d'une politique sélective en matière de recherche scientifique doit comporter la mise en place de dispositifs spécifiques dans le domaine qui n'auront pas été prioritairement retenus afin de permettre en temps utile, l'utilisation par nos laboratoires des acquis des recherches effectuées à l'étranger.*[609]

Different from the previous confrontational attitude towards the US, during the Eighth Plan (1976-1980) this policy of openness established a new turning point in French science policy as France became less concerned with the growing American

[609] CAC 80401, Box 190, CCRST "Premières propositions du CC pour une relance de la politique scientifique et technique", op. cit., p.5.

influence in European industry and more preoccupied by its own problems such as the country's relatively modest research capability and its place in the international technological division of labor. These two problems led the French government to agree finally with the OECD and NATO's new science policy doctrine which asserted that a country of France's size and financial capabilities could not undertake all the research it needed on a national basis. Likewise, given that France could not compete against the US in all areas, it could however, by means of international cooperation, control its technological backwardness in sectors not covered by national research.[610]

According to this new orientation, while cooperation with other European countries would be maintained.[611] France could not afford to disregard cooperation with the US because this country represented a third of global scientific production:

> *Les États-Unis qui a eux seuls représentent un peu plus du tiers de la production scientifique mondiale, continuent d'être d'une immense richesse scientifique, quantitativement et qualitativement. Il est clair que la France ne pourrait se passer d'échanges avec eux en matière de recherche.*[612]

This discourse of openness towards the US was put into practice by the French research institutions that increasingly used American electronics data banks through an internationally standardized French and European rely telecomputing networks. The French Ministry of PT&T built its remotely-controlled data-processing system, TRANSPAC, that became operational in 1979. The Commission of the European Communities used TRANSPAC technology to built EURONET. These networks were administered by the nine EEC member countries' PT&T ministries, were

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610 CAC 77/321, File 494, Premier Ministre - Secretariat d'État à la recherche - DGRST - Division des Affaires internationales, "La Place de la France dans les échanges scientifiques internationaux", Confidentiel, N° DAI/48/jg, Paris, le 4 novembre 1977, p.1.

611 Ibid., p. 1.

612 Premier Ministre - Secretariat d'État à la recherche - DGRST, "Note pour MM. les conseillers et attachés scientifiques", Confidentiel, Paris, le 13 janvier 1978, p.2.

interconnected among themselves and with American networks TYMNET, TELENET and GENERAL ELECTRIC MARK III to form an Integrated Management and Information System.

This system was built in a manner that made the European systems the relays between European users and American data banks. In this order, the American TYMNET system covered the US territory, Belgium, Germany, Switzerland, UK, and France. TYMNET was a scientific and technical information system that had four mainframe computers:

1. Lockheed Information Systems with capacity of 15 million bibliographical references on exact sciences, social sciences and technology.

2. System Development Corporation (8 million bibliographical references)

3. National Library of Medicine (NLM) which allowed access to two systems: MEDLINE / 500 000 references on medicine and biology and TEXICON 230 000 reference on toxicology.

4. Space research documentation service (6 million references).

On the private sector side, TELENET COMMUNICATIONS CORPORATION (an American company) had formed TELENET that covered also the US territory and Western Europe via TYMNET. The services dispensed by this network were similar to those offered by TYMNET. There was also GENERAL ELECTRIC - MARK III network. This service was managed by GENERAL ELECTRIC and commercialized in Europe by HONEYWELL-BULL. It was the most extended commercial network in the world. Based in Cleveland (USA), it covered North America, Western Europe, Japan and Australia.[613]

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[613] CAC 820254. File 499 Secretariat d'Etat auprès du Premier Ministre - DGRST, "Notes documentaires sur les systèmes d'information automatisés", Paris le 5 octobre 1978.

The participation of France in the formation of these networks meant that France no longer opposed the transatlantic standardization of data-processing equipment. As building a European system of standards was no longer an issue, France began to admit the OECD's view that counted foreign subsidiaries as part of the host country's industrial base. In mid-1977 during the Eighth Plan, the French government approved a five-year program (1978-1982) with the specific objective of associating French components producers (THOMSON-CSF, MATRA and SAINT-GOBAIN) with American semiconductor leaders. This program aimed at creating in France, new French as well as **foreign-owned** integrated circuits production units that would respond to French demands in semiconductors and decrease the French deficit towards the US. Accordingly, in 1979, MATRA created MATRA HARRIS SEMI-CONDUCTEURS a 51% - 49 % joint-venture with HARRIS, an American Company. After this alliance, HARRIS transferred its Complementary Metal Oxide Semiconductor-Conductor (CMOS) technology to MATRA HARRIS SEMI-CONDUCTEURS.[614] Moreover, in 1981, MATRA HARRIS SEMI-CONDUCTEURS joined the American company INTEL to create CIMATEL. This company became specialized in semiconductors for telecommunications, computers and automobile.[615] Besides these alliances, EUROTECHNIQUE was created by SAINT-GOBAIN (51%) and the American company NATIONAL SEMICONDUCTOR

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614 In 1980, MATRA HARRIS SEMI-CONDUCTEURS created with the American company LAMINATION TECHNOLOGY Inc. a new firm whose assets were shared between MATRA HARRIS SEMI-CONDUCTEURS (53%) and LAMINATION TECHNOLOGY Inc. (47%). Assemblée Nationale - Sénat - Office d'évaluation des choix scientifiques et technolgiques, Rapport sur l'évolution de l'industrie des sémiconducteurs, Première session extraordinaire de 1989-1990, Annexe au procès verbal de la première séance après le 22 décembre 1989, Rattachée pour ordre au procès-verbal de la séance du 22 décembre 1989. Enregistré à la présidence du Sénat à Paris le 12 février 1990.

615 Rapport sur l'évolution de l'industrie des sémiconducteurs, op. cit., p.75.

(49%). EUROTECHNIQUE became specialized in High performance Metal Oxide Semiconductors (HMOS).[616]

In 1981, one year before the end of the five-year program, these new alliances added little to change France's position in the international semiconductors market. In spite of the French industry's alliance with INTEL, HARRIS, NATIONAL SEMI-CONDUCTOR and LAMINATION TECHNOLOGY, the French-owned companies and their allies controlled only 23% of the total of semiconductors produced in France with ' % still controlled by RTC-PHILIPS (a Dutch company), TEXAS INSTRUMENTS and MOTOROLA.[617]

6.9 CONCLUSION

The *Deuxième Convention du Plan Calcul*, the French-led EEC PREST programs and UNIDATA failed because all depended on the willingness of the other EEC member-countries and companies to follow the DGRST-initiated approach to European high technology common market . After many negotiations, the Europeans dismissed the relevance of the DGRST's initiatives and instead followed NASA standards, US Department of Commerce trade perspective, NATO military requirements and the OECD General Secretary standardization approach and user policy. This lack of European support to the DGRST's Plan ended the momentum created by the American embargo and put the French science policy process into a crisis: the French *Comité Consulatatif pour la Recherche Scientifique et Technique* became receptive to the new transatlantic science policy discourse and questioned the

[616] Ibid., p.76.
[617] Idem, p.76.

French military and telecommunications' authority imitation of the American "big science" practice. Despite the CCRST opposition to this practice, towards the beginning of the 1980s, French policy in ICT returned to its earlier political independence, control over the national computer industry and asymmetrical technological interdependence with the United States. In the end, there was still no French computer, the military won over the CCRST and transatlantic standards won over the DGRST-led PREST data-processing and telecommunications initiatives.

GENERAL CONCLUSION

This 'hesis has explained the French inability to develop an autonomous computer industry as a result of the participation of the French industry and policy makers - the agents of the French universe of political discourse in ICT - in a transatlantic discursive regime. In Chapter One, I defined the cor.cept of discursive regime to mean not only a set of transatlantic international norms and procedures or the congruence of views between sectors of member governments. This concept also included disputes and divergences of interest and emphasized the role of the agents in the formation and transformation of regimes. The emphasis on agents however did not entail a rejection of the concept of structure but implied the simultaneous occurrence of structure and agency in the formation of historical events within a *universe of political discourse*. Thus, I used the concept of *universe of political discourse* as alternative to structuralism in the analysis policy-making both in the US and France and the concept of discursive regime as an alternative methodological framework to neo-realism, liberal regime theory and the neo-Gramscian approach to IR. I found both concepts methodologically more productive than an abstract structuralism that leads inevitably to technological determinism and economic reductionism. Three observations are important in the combination of these two concepts: First with the concept of univ se cf political discourse, it is possible to analyze policy-making in computer technology without falling into the trap of technological or economic reductionism that negates political analysis. The point here is that objects such as computers do not manipulate institutional actors or determine their actions but rather that institutional actors determine the functions of computers through political struggle. Second, when international changes in computers are considered from the perspective of actors' perceptions within a transatlantic discursive regime, these changes become dependent variables embodying power relations and incarnating the regime's goals and priorities. Third, it is possible to investigate the effect of the latter on French government policy in ICT through public and private discourse using historical and archival materials.

Using this methodological approach, in Chapter Two I argued that from 1946 onwards, with respect to ICT, the US Air Force leadership within the US military establishment was the critical force that associated the military sphere with science, technology and industry within the US universe of political discourse in ICT. The mode of this association was provided by the US Air Force's perceptions and priorities of air power and air defense that created a technological dynamism in information and computer technology. I showed that changes in computer technology which emerged in the late 1950s were a result of the relationship between beliefs specifying doctrine, goals and decisions such as those in air defense and science policy and actions that were the implementation of these decisions. As air power became the most important arm of nuclear deterrence, I demonstrated that its development required the establishment of ***permanent*** rather than ***ad hoc*** scientific and technical research institutions whose work evolved in relation with changes in defense objectives that in the early 1960s included research in outer space. This was how the US Air Force built its science and technology policy machinery.

In Chapter Three, I showed how the US Air Force structured the transatlantic space militarily, scientifically and technologically through NATO and the OECD. Here, I adopted a relational approach to power and showed that power within the transatlantic discursive regime cannot be assessed solely in terms of US technological capabilities and economic resources. I argued that the adherence of Europeans to American defense, science and technology policy was also of crucial importance in the analysis of power in the transatlantic discursive regime. In keeping with this argument, I demonstrated how the power relations that emerged in the US universe of political discourse in ICT and its technological and political expressions within NATO and the OECD changed computing in Europe. I maintained that this change occurred when the relationship between science, technology and defense policy as perceived by the US Air Force became the model that shaped NATO requirements and the OECD's science policy. This was how in ICT, Western European nations' practices became an integral part of the transatlantic discursive regime.

Chapter Four demonstrates how in the period 1945-1965, NATO priorities in defense and the OECD science and user orientation in computer policy were internalized by French decision-makers. I showed that during this period, France's universe of political discourse in ICT adopted an Atlantic orientation by choosing American computers in order to respond to the NATO concern with inter-operability. As the French military and telecommunications authorities had chosen IBM computers, this choice motivated French electronics companies to seek alliances with American interests, in order to survive within the French defense procurement market. The building of these alliances and the government procurement of American computers made the French electronics industry structurally dependent on the US. The emphasis in this chapter was in the fact that the formation of these alliances and the French government's choice of American computers were neither given by the economy nor technology. They derived rather from NATO priorities to build an inter-operable transatlantic communications network and the French military and telecommunications authorities willingness to comply with these priorities and to provide their civilian and military nuclear research centers with American computers. Thus, seen from the French perspective, the formation of the transatlantic discursive regime appears to have shaped the French decision to embrace American views and seek the benefits of American science and technology. This was the context within which the famous French *Plan Calcul* was conceived.

In Chapter Five, contrary to neo-realists who saw the *Plan Calcul* (1966-1968), as a free ride, I argue that the policy of independence during the implementation of this plan did not imply a break in Franco-American industrial relations but signified the freedom to use American data-processing techniques to develop both the military and the civilian sectors of the industry. French archives reveal that, from the late 1950s, the statement of independence was oft repeated but it did not lead to a break in US / France technological and industrial collaboration. Despite this fact, however, "independence" was not an empty ideological statement to justify the allocation of resources for bourgeois economic projects to the French public. It expressed a perception shared by all French decision-makers who recognized US leadership but nevertheless defended France's military and political independence and maintained technological interdependence within the transatlantic regime. Thus, against neo-Marxism which explains such practice in terms of an economic dynamic or regime theory which explains this French choice in terms of the "international imperatives of technology", this chapter demonstrated that the *Plan Calcul* was shaped by NATO military concerns and the OECD science and technology objectives. Thus, in contradistinction to Zysman who argued that the *Plan Calcul* was elaborated according to the French vision of technological self-sufficiency and technological glory, I showed that this plan was conceived in terms of technological interdependence that implied an adherence of the French the military, telecommunications authorities and the *Commission du Plan* to the policy of inter-operability advocated by NATO and the user policy promoted by the OECD. In the period 1966-1968, these actors sacrificed industrial autonomy for the efficiency of using American-made computers and integrated circuits with the objective of improving the French balance of payments in electronics and developing the French nuclear, space, military and commercial aircraft sectors. I showed that the implicit *Plan Calcul* was an application software and not a components program and that it was determined by the military as opposed to civilian needs. Moreover, this meant a more important role for THOMSON-CSF in the French market and a diminished role for BULL.

Chapter Six argued that, by the late 1960s, while many argued about the American hegemonic decline, they missed the effect of more than three decades of scientific, technological and military structuring of the transatlantic space in strengthening American power over Europe in key sectors such as telecommunications, computers and electronics. In order to show this, this chapter emphasized the late 1960s American influence on NATO communications requirements and their effect on the modification of the OECD science policy. Thus, once again NATO and OECD policies maintained American hegemony and increased Western European technological vulnerability. By the end of the 1960s, the change in NATO communications requirements necessitated the adoption of global components standards that replaced interoperability by *Compatibility of Manufacture and Supply Services*. The latter meant in effect the globalization of American components standards and gave primacy to multinational corporations that in turn became the central agents in the new OECD science policy.

Rather than being characterized by hegemonic weakness and a free ride, the period 1968-1981 was marked by the reinforcement of American technological hegemony over Western Europe. The US set new standards in electronics and telecommunications, limited to the role of European governments in scientific and technological research, defined new military goals through NATO in order to shape other countries' perceptions on military communications, science and technology through the OECD. To evaluate the relational feature of the role played by the US during this period, I examined the case of the French-led PREST programs. This allowed me to assess the willingness and the difficulties of Western Europeans to challenge American views on science and technology. In 1968, the DGRST formulated the second phase of the *Plan Calcul* in order to oppose the new NATO and OECD polices and to create a European industrial specificity in electronics, computer and telecommunications in order to maintain interoperability and interdependence. To counter this program, the US and NATO formulated projects such as the NATO Integrated Communications System (NICS) and the *Integrated Management* and *Information System* (IMIS). These projects did not constitute political solutions to a technological problem but rather technological solution to the political problem of national and regional technological identity created by the DGRST to resist US, NATO and OECD standardization program.

As technological solutions, NATO Integrated Communications System, the transatlantic Information Management and Information System and CMSS embodied an attempt to reproduce the transatlantic discursive regime in a new form. Unlike the notion of *inter-operability* that meant that all Atlantic nations should adapt their communications systems to that of the United States, NICS, IMIS and CMS signified the globalization of the US technological standards that eliminated national and regional specificity. This caused the failure of the second phase of the *Plan Calcul*, the PREST programs and UNIDATA. These failures were due to the fact that while the DGRST plan depended on the EEC member countries' political willingness to challenge

American views, EEC member countries and their firms (minus the DGRST and the CII) felt that their interests were better served within NATO and the OECD, rather within a DGRST-led fortress Europe. As a result, in 1974, the notion of *Compatibility of Manufacture and Supply Services* and the new OECD science policy won out over the DGRST-led move for European interdependence. In the end, the French and European data-processing industry became even more integrated with the US research and industrial dynamic.

Rather than looking at the structure of the economy or the dynamic of technology as the cause for the French incapacity to build an autonomous ICT industry, with the concept of discursive regime I was able to show that not only was French ICT policy shaped by US, NATO military concerns and the OECD policy, but also the way in which the transatlantic discursive regime was affected by the DGRST stratagems to oppose the US, NATO and the OECD. Thus, the shortfall and re-orientation of French ICT policy through aborted programs such as the *Quatre Axes, Hexagone, and Plan Calcul* (phase 1 and 2) has transatlantic equivalents: US, NATO and the OECD's difficulty to reduce national technological particularities in order to build a transatlantic integrated military, scientific and technological space.

Further research following the methodology laid down by this thesis would show that, despite US, NATO and OECD efforts to achieve transatlantic integration, projects such as ESPRIT and EUREKA (with goals similar the *Plan Calcul*, PREST and UNIDATA) emerged in the 1980s in opposition to the US Strategic Defense Initiative and by reproducing the transatlantic discursive regime through the same concern of air power that was envisaged in the mid-1980s in terms of space defense.

In this context EUREKA was proposed by France under the Mitterrand government for setting-up Europe-wide, governments and European Community supported, mobilization programs revolving around the need of common electronic components standards, large data-gathering, and complex decision-making systems such as ground and air traffic control; surveillance to and from space; computerized production facilities and T.V. of the future. Such systems involved the development of key electronics components that implied many research projects such as Europrocessor (a top level flexible microprocessor); GaAs digital integrated circuits; Micro-wave discrete and integrated devices and associated linear integrated circuits; high density memory chips; flat-panel displays and electronic sensing including infra-red. The firms involved in these projects were GEC (UK), PHILIPS (Netherlands) SIEMENS (Germany) and THOMSON SA (France).[618]

EUREKA was considered as a major element enabling Europe to face the technological challenge, especially in view of the major efforts entered into by the US and Japan in the area of advanced electronics in order to contribute to Europe's military and technological independence. The firms involved were recommended to coordinate their research with the activities with those of the Independent European Program Group (IEPG) and the European Defense Industries Group (EDIG). EUREKA represented not only the revival of earlier PREST programs, but when it opposed to US Strategic Defense Initiative, it would appear that both programs reproduced the earlier transatlantic debate and thereby the transatlantic discursive regime. Furthermore, they explain why, in spite of changes within the regime, the French discourse of independence remained. The persistence of the French discourse of independence indicates that the context within which it originated was reproduced militarily and technologically. Through this reproduction one should not only see the renewal of the

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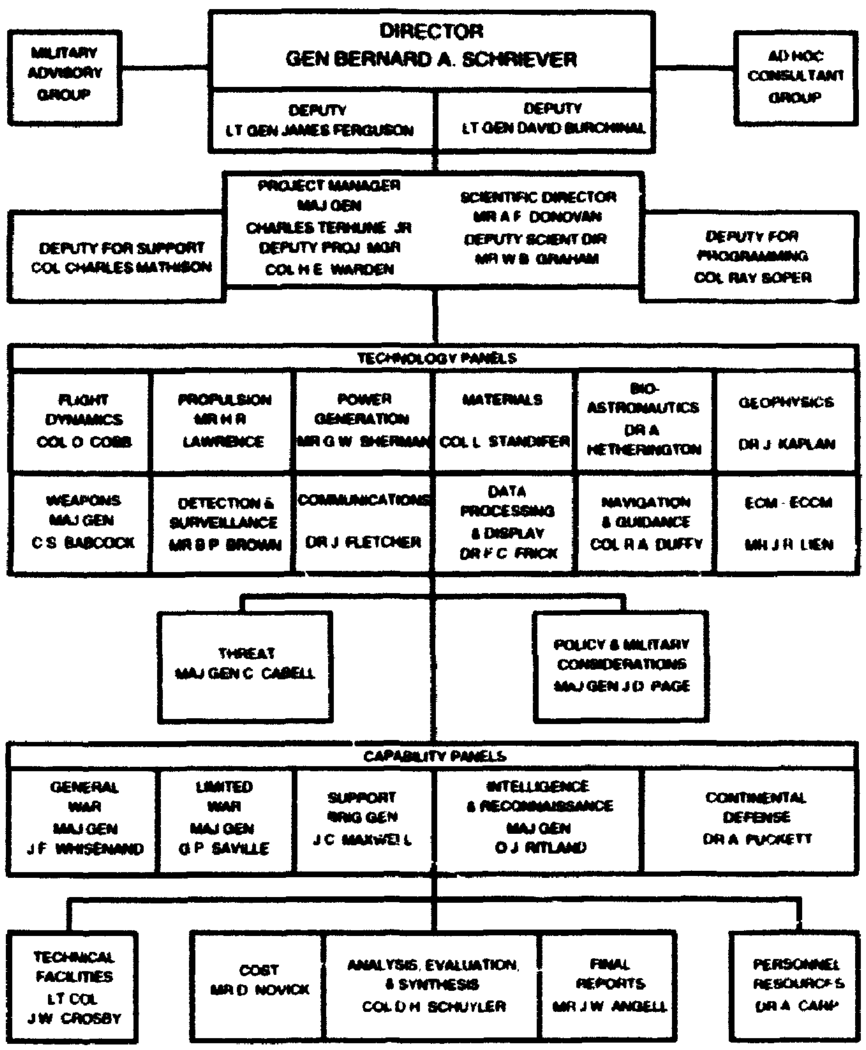
618 CAC, 92/C550, Article 4, Liasse 4, "Common Statement Concerning EUREKA", Très confidentiel, June, 20, 1986.

French/US contradiction, but, also the updating of the French universe of political discourse in ICT and within it the debate over the best way to preserve French political independence.

APPENDIX

<u>Appendix I</u>

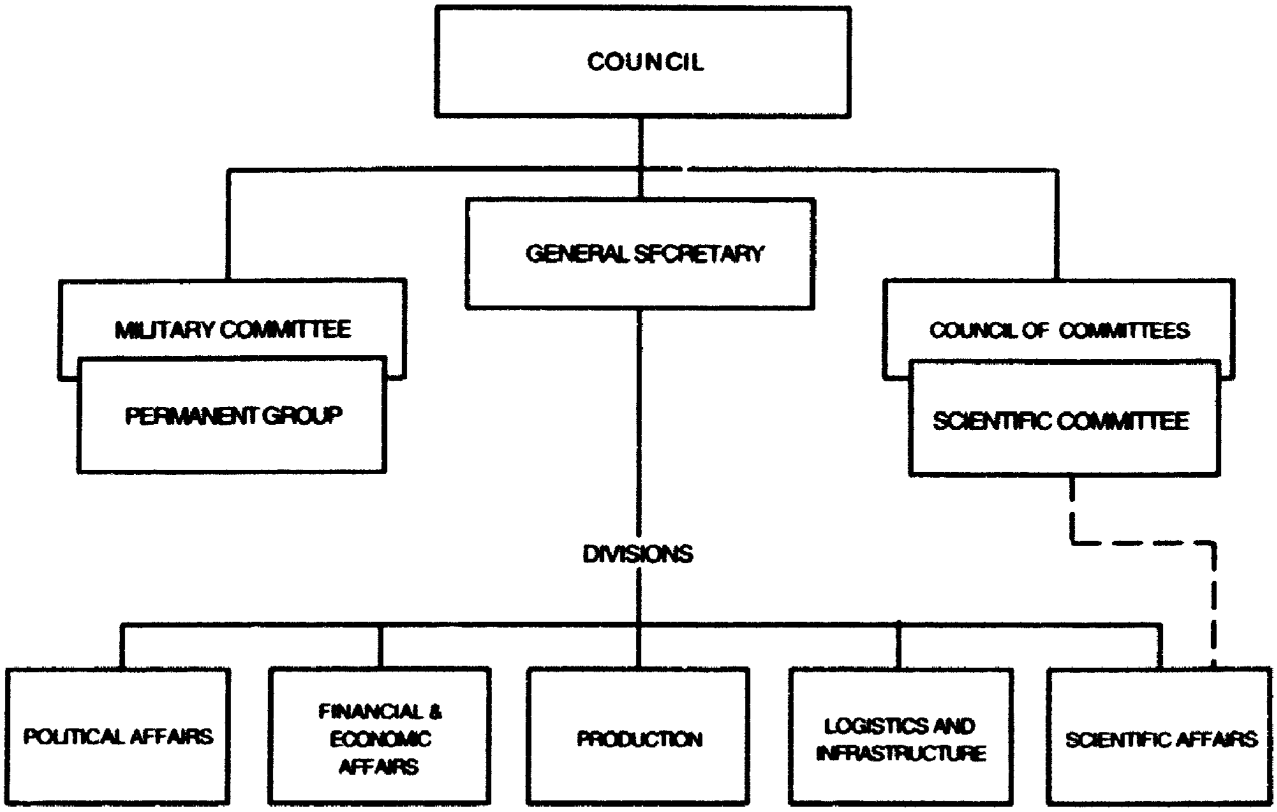
DIAGRAM 1
Project Forecast Organization Chart



<u>Sources</u>: M. Gorn, <u>op. cit</u>. p. 100

Appendix II

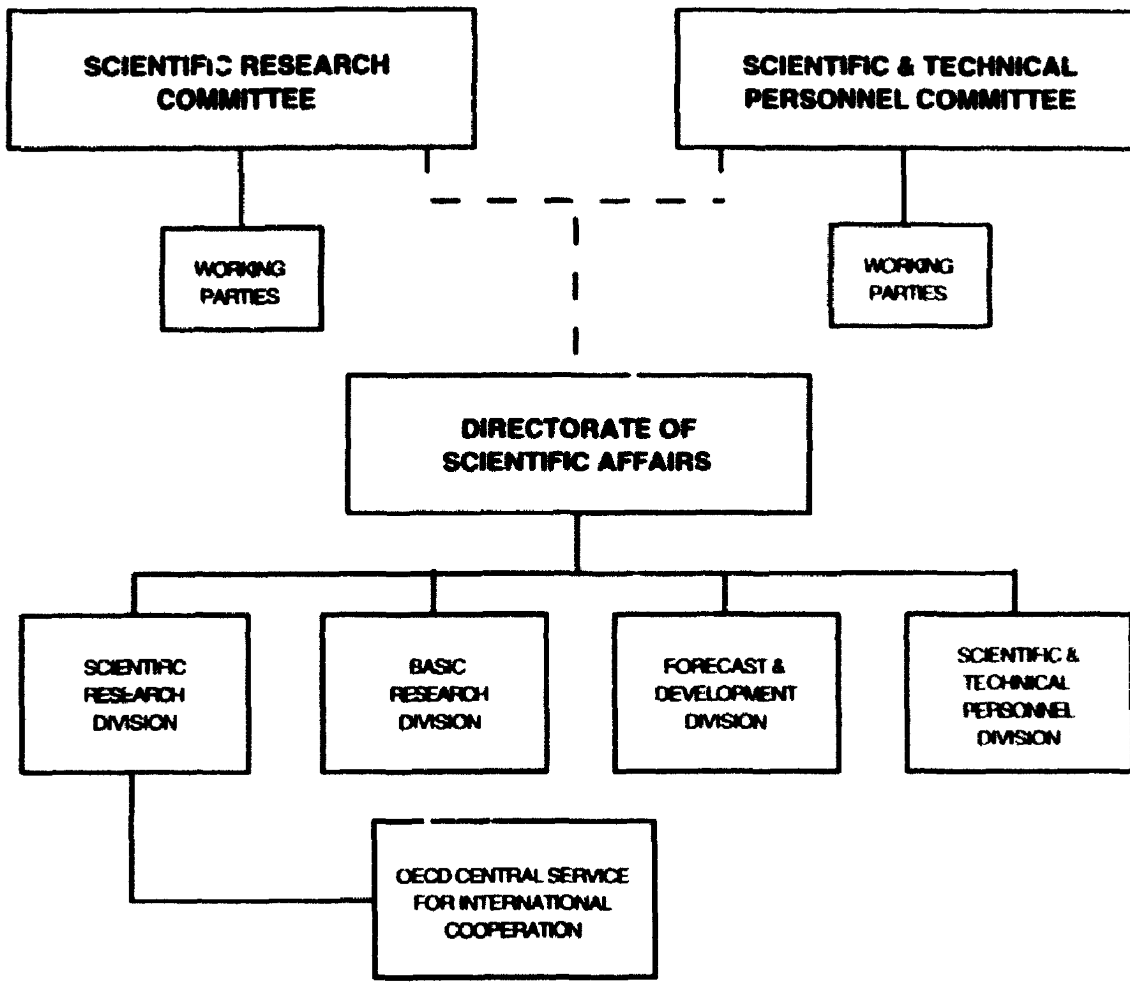
DIAGRAM 2
NATO STRUCTURE



Appendix III

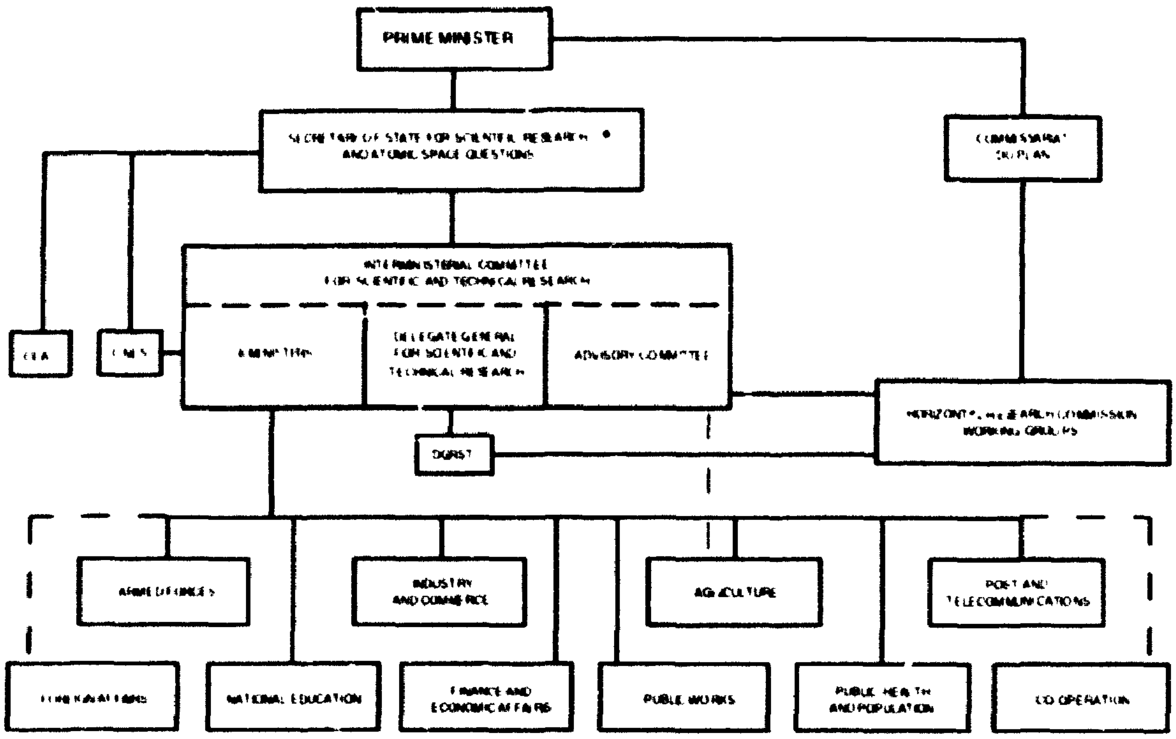
DIAGRAM 4

OECD SCIENTIFIC AFFAIRS



Appendix IV

CHART OF THE GOVERNMENT'S SCIENCE POLICY STRUCTURE



— — — These additions correspond to modifications enacted on the 16th June 1965

* Since the 8th January 1966 French Minister for Scientific Research and questions of Nuclear and space Research

Source: Secretariat

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PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT

1.0 2.8 2.5 3.2 2.2 3.6 4.0 2.0 1.1 1.8 1.25 1.4 1.6

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