Innovation and Research Policy in France˚(1980-2000) or the disappearance of the Colbertist state

Philippe Mustar and Philippe Laredo
Centre de Sociologie de l Innovation, Ecole Nationale Sup rieure des Mines de Paris,
60, Boulevard Saint Michel, 75006 Paris, France

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Corresponding authors. Tel.: +33-1-40 51 91 91
e-mail: mustar@csi.ensmp.fr laredo@csi.ensmp.fr

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Abstract:
This paper is concerned with the dynamic of intervention by public authorities in the domain of research and innovation. It has a dual objective. On the one hand it seeks to challenge the stereotyped image of the French system, presented in the literature as completely characterised by the dominant role of a Colbertist state (that is to say an interventionist model which places emphasis on the dominant weight of large civil and defence programmes, on the division between the universities and the CNRS, on the congenital separation between research and firms, on the monopolisation of public support by certain large industrial groups). The evolutions described prove that this classic image is no longer relevant in describing the current dynamic of the French research and innovation system. On the other hand, this paper seeks to show that this challenge is a consequence of close examination of the relevance of the notion of national policy for research and technology itself. Alongside national policy, regional and European policies are emerging. The effects of these are so important that public intervention can no longer be seen only in terms of national policy.

1. INTRODUCTION

In the collection *National Systems of Innovation*, the editor, Richard Nelson (1993) defends the idea that the Second World War led to reform in national research systems, and that, subsequently, their principles and characteristics have endured. It is this hypothesis that, in the case of France, we seek to challenge. Over the past twenty years, analyses of French science and technology policy have returned a unanimous verdict, namely that the French model is characterised by the dominance of a centralising, Colbertist state. The chapter by Francois Chesnais in the Nelson collection describes the three principle characteristics of this model of the French system:

˚The system has several features that are quite specific to France: (1) the organization and funding of the largest part of fundamental research through a special institution, the CNRS, distinct from the higher education sector entities ( ), (2) a dual higher education sector producing at least one type of senior technical person little known elsewhere, namely the Grandes Ecoles˚ technical experts elite of engineers cum industrial managers, cum high level political and administrative personnel , and (3) a pervasive element of State involvement in the production not just of general scientific and technical knowledge, but often of technology per se in the form of patentable and/or immediately usable products or production processes. (p. 192, Nelson, 1993).

Chesnais takes up elements of a description popularised by numerous authors, who have attempted, since the 1970s, to analyse research and innovation in France (Gilpin 1970, Salomon 1986, Ergas 1987). This body of work on the French research system - to which it is possible to add numerous papers and works written by science policy makers - uses a common diagnostic approach, with emphasis on the absolute power of the state in the domain of science and technology. This diagnostic approach can be summarised in terms of four principal traits, which go to make up the stereotyped image.

-The first is the major role of large programmes. These are not solely concerned with the defence sector, but encompass the majority of leading edge civil sectors (as described by the OECD). The objective of this mode of public intervention is to push back the technological frontiers and to attain the objectives of national independence (nuclear, civil, space, aeronautics, telecommunications, defence). Large civil and defence programmes absorb the majority of the French public research budget.

- The second trait of the stereotyped image of the French system is the organisation of fundamental research. It is the work of two distinct organisations: on one side, the CNRS and on the other, the Universities. The latter are completely absorbed in the training of battalions of students and remain little involved in research activities. This divide between research and teaching is reinforced by the existence of the Grandes Ecoles , uniquely French higher education institutions, training the elites and providing little space for research activities,

- Third trait, France is characterised by a multiplication of the number of mission oriented public research institutes (government labs) intended to respond to the research needs of different government departments and, more broadly, public authorities (in domains ranging from health to exploitation of the sea, via agricultural development). The French research system can be divided between, on one side, fundamental research conducted by the universities and the CNRS, and on the other applied research, which is the work of these other public institutes. These latter, in contrast to the CNRS or the Universities, have strong

relations with professional circles linked to their domain of competence and for which they fulfil roles as technical centres.
- Finally, the fourth trait of this vision of the French situation is the fact that public support for industrial research is monopolised by a number of large companies oriented towards high technology sectors. Analysts underline the active role of the State with regard to the capacities for industrial development of these large firms, in helping France catch up in matters of research and innovation. Also emphasised is the fact that this support ignores the web of SMEs, which have few connections with research activities.

These four *leitmotiv* continue to inhabit the works and the papers dedicated to research and technology policy. In the following sections, we would like to challenge this Colbertist image of the French system. This monochrome description was probably pertinent twenty years ago (although historical works are beginning to show its weaknesses) but it remains blind to the evolutions and the changes which have since characterised the French research world. In the course of the 1980s and 1990s, the French research system - in both its public and private dimensions - has, in effect, experienced profound transformation, which brings into question the relevance of the description above (Mustar, 1994 and 1998a).

Leaving to the historians the task of showing that the situation is infinitely more complex, more simply, the intention is to examine, in the following four sections, the major evolutions which, since the beginning of the 1980s[1], have marked each of the four traits of the stereotyped Colbertist French model. These changes mean that today this image, which recurs throughout the literature, has categorically lost its relevance. Section 6 pursues this analysis, showing that if national policy has lost a large part of its room to manoeuvre, this is not solely due to the almost complete disappearance of certain traits of the Colbertist model. This is also linked to the emergence of new actors - the regions and Europe - which require a new perspective to be adopted on public intervention in research and innovation.

2. THE END OF THE LARGE PROGRAMMES

[1] It is necessary here, without overburdening the description, to make explicit and justify the fact that we have seen the beginning of the 1980s as a turning point in the forms of state involvement. France experienced a second instance when a strong policy discourse on research emerged. This came with the arrival to power of a left wing President and Government. A broad concertation exercise, the Regional, then the National, Research Conferences were organised by the new government. A ministry of research and technology was created. All the resources for public-sector civil research were brought together under the Civil Budget for Technological Research and Development . A law on technological orientation and planning (LOP) was passed by Parliament. All these changes characterised the desire of the new government to reverse the trend of decreasing funding, which had prevailed in the 1970s and to make research a budgetary priority: From 1981 to 1990, the ratio of GERD to GDP climbed from de 1.9 % to 2.4%. Together with the decisions which led to the creation of new institutions, other, less spectacular decisions were taken, such as according civil service status to public sector research personnel and the change in the status of public research organisations and universities. For these reasons, we consider that the beginning of the 1980s constitute a key moment in the organisation of the French system of research and innovation, as it institutionalised earlier trends, and it initiated trajectories which have progressively been transforming pre-existing organisations and structures.

The major trait of technological Colbertism is the dominance of public funding of research in favour of large civil and military programmes, funding which characterises the power of state controlled interventionism in the domain of technology. The development of large technology programmes is a marked feature of the research policies implemented in France since the end of the Second World War. From the Second World War to the 1970s, France responded to the large technological and political challenges of the time by constructing a specific mode of organisation for research and innovation. This construction results from its historical antecedents and a strong political will, with the impetus provided by the Fifth Republic to France s research effort. A General Delegation for Scientific and Technological Research (D l gation g n rale la recherche scientifique et technique — DGRST) was created. The structures of this institution, the concerted actions implemented, and the research envelope[2] instituted have been judged by the OECD as important institutional innovations (OECD, 1966). In a twelve year period, from 1959 to 1971, the level of the national R&D effort, as measured by the ratio of GERD/GDP increased from 1.15 % to 1.88 %. Many of the changes occurring in this period had begun to take root under the Fourth Republic (Jacq, 1996). However, the asserted political will of General de Gaulle allowed the French Colbertist model of research and innovation to be constructed and to prosper. The French public authorities concentrated their efforts and their budgets on large programmes, which had been considered crucial for national independence and for the global position of France.

The Second World War elevated the importance of science and technology, with advances ranging from the radar to the V2. The Manhattan Project symbolised how a concerted mobilisation of all scientific, technological and industrial actors, enabled a decisive advantage to be obtained. Consequently, it was not surprising that one of the first decisions of the new French government was the unprecedented creation of the Atomic Energy Commission (CEA). Initially, this institution was not set up with military objectives, but rather to endow France with a capacity for the production of nuclear energy. Thus, the basic model for the French version of the large programme came into existence (large programmes existed in various countries, but they were most widely and systematically implemented in France). This model involved a public pilot, which was located within the administration (as in the case of aeronautics), took the form of an agency (as in the case of space) or was suitable for a public research institute (such as in the nuclear domain). The large programme relied on the support of one or more national champions, responsible for the industrial exploitation of the programme and for taking it beyond national borders. This always involved the development of scientific capabilities, and generally led to the creation of a dedicated public research institution. Finally, public services or national operators (such as the national airline or the electricity state monopoly, EDF) were called upon to support the first full scale applications, and to demonstrate the relevance of the complex objects developed by these programmes. All the civil programmes shared a similar rationale: genuine long-term risk-taking, at the frontier of knowledge and technology, where no capacity for the generation of new markets was foreseen. Who could have imagined the development of telecommunications satellites when

[2] It regrouped all civil R&D budgets from the State, whatever department was in charge of executing it, in order to foster coordination between, and of better allocation of public funds.

France launched the first Diamant rocket? Who could have judged the market potential of a supersonic aircraft, when France and Great Britain (evidence that the large programmes approach was not specifically French) embarked on the Concorde adventure?

These large programmes assumed central importance during the 1960s, with General de Gaulle s return to power. They were concerned with information processing technology (the Plan Calcul), civil aeronautics (Concorde and subsequently Airbus), and space (CNES). In addition, there were programmes for marine exploitation, through CNEXO, and, during the 1970s, telecommunications, (with the Direction G n rale des T l communications, which later became France Telecom). This model was also applied, with much more significant resources, to the development of new weapons technologies (aeronautics, missiles, communications etc.) limiting recourse to the pure strategy of the arsenal (where the State is itself responsible for their conception and production) to traditional terrestrial and, in particular, naval armaments. Each large programme was organised in a bespoke manner, according to the pre-existing situation and, in particular, its military connections. A history of the large programmes is sadly lacking, even though some evaluations are available and a number of historical works are beginning to appear (Teni re-Buchot, 1982, Lebeau, 1985, Loridant, 1991, CNER, 1994). Certain characteristics are sufficient to underline both their budgetary significance and their enduring impacts on the French economy and on French research.

The civil nuclear programme was entrusted to the CEA. During the 1950s, its responsibilities were extended to military nuclear activities. The history of the civil activity of the CEA has been eventful. During the 1960s gas graphite reactors were abandoned in favour of Westinghouse pressurised water reactors in the civil sector, while the industrial producers went through troubled times. However, the oil crisis and the decision by France and its state monopoly, Electricit de France (EDF), to rely completely on nuclear energy, led to the emergence of two world leaders, Framatome in boilers, and COGEMA in the combustion cycle. The termination of the fast breeder programme and debate over the management of waste contributed significantly to the reorientation of action centred solely on the CEA. The nuclear programme no longer exists as a programme: it gradually developed into the funding of one institution, the CEA, of 18000 persons (of whom 11000 are on the civil side, and of which a significant proportion only have a distant relationship with the nuclear domain)[3].

Civil aviation represents another organisational format based on the existence of both civil and military industrial producers[4]. Contrary to the situation in the nuclear sector, activities were under military control, in the form of a ministerial directorate, with firms active in both civil and military equipment carrying out the work. This directorate relied on a military research organisation, ONERA, for its research. When the first civil programmes were

[3] In the 1960s, the same model was also used for the exploitation of the oceans (aquaculture, polymetallic nodules, and marine thermal energy) centred on CNEXO. However, success was not forthcoming and the CNEXO merged with the ISTPM, which was responsible for fishery research, to create IFREMER, responsible for France s large marine research equipment (including the well-known submarine *Nautile*).

[4] These were both public, (following nationalisations in 1936 and after the war) and private (Dassault).

launched, this organisational format was preserved, with the responsibility of the military leadership extended to civil programmes. The difference between military and civil programmes stems from the nature of their funding: for civil programmes, the state pays for neither research nor equipment, but partially subsidises research and provides reimbursable advances on the sales of apparatus or engines developed. There have been numerous debates, at the international level, concerning these arrangements. Several studies (Giget, 1979) have shown that American public support was of comparable significance to French support, but was linked to the different forms of intervention employed by the Department of Defence (for example the funding of design and devolpment of a long range large carrier to several aircraft manufacturers largely financed the development of the Boeing 747, or the construction of strategic production facilities rented out at low price). Success was finally forthcoming in the framework of international alliances (both European and transatlantic). The increasing strength of product output (the AIRBUS family and CFM56 engines) and of the producer firms (A r ospatiale and SNECMA) led to the role of the state currently being eclipsed both as a pilot and as a financer.

At the beginning of the 1960s, with the American refusal to sell large computers, the question of national independence in the data processing area arose. Under the aegis of the Ministry of Industry, the Plan Calcul (plan for computation), was launched, based on the development of national champions[5]. This plan was accompanied by the creation of a research institute, INRIA, which has remained modestly sized. This particular story is too sinuous for it to be summarised in a few lines. All things considered, since the end of the 1980s, while the core of public research funding has moved towards community programmes, and recognising that BULL is a modest producer on the international level, only ST Microelectronics, on the basis of the European JESSI programme and stemming from a Franco Italian merger, has succeeded in making an impact on the international level.

When, during the 1970s, telecommunications were becoming a national imperative , activity was organised in yet another, different way. The national operator, the Directorate General for Telecommunications, later to become France Telecom, and which already had its own important research institute, CNET, was entrusted with this mission (Atten, **???**). Once again, progress was not linear, but was sufficiently quick for ALCATEL to become one of the major global industrial actors in the sector and for firms such as SAGEM to assert themselves on the international level. The privatisation of France Telecom included its research centre, and this is the sole exception, leading to a total disengagement of the state.

The examples of the nuclear, civil aviation, computer and electronics and telecommunications sectors demonstrate the progressive phasing out of large programmes. However, the 1980s only witnessed a modest decrease in state funding of large civil programmes (taken together).

[5] The Ministry of Industry also piloted another quasi large programme on the exploration and exploitation of oil resources (particularly marine resources). Its originality relied on a specific tax on gas sales which both provided funding to support research (conducted for the most part by companies) and financed a research organisation, the IFP, which, like the CEA, has generated numerous powerful industrial subsidiaries and is a major actor in petroleum engineering.

This is explained by the increase in the significance of the space programme, which was delegated to an agency, CNES, and which was largely conducted under the auspices of the European Space Agency (ESA). Currently, the space programme is still important, since, for over a decade, it has represented more than 10% of the French public research budget. There are numerous studies on the direct and indirect effects of this situation (Beta, 1988, Bach et al., 1997). It is also necessary to underline that the success of Ariane Espace and its launcher have yet to have any repercussions for funding requirements. In addition, the new challenges of satellite positioning have led to the first direct interventions by the European Union (with the financial participation of the competing European GPS system, Galileo). In fact, it remains the only large programme that is still significant, but it is not specific to France. There are similar programmes, organised in the same way, in the majority of the large western nations, (notably the United States).

In fact, the 1990s have seen a drastic reduction in the mode of public intervention labelled as large programmes . Certain of these have disappeared completely from the scene, such as the T elecoms programme with the privatisation of France T elecom and, of CNET within it[6]. Others have become of secondary importance and are limited to marginal reimbursable advances, such as civil aeronautics[7]. The nuclear programme now only covers the internal expenses of the CEA. Currently, two out of the five operational directorates of the CEA are concerned with non-nuclear domains (life sciences and advanced technologies), and a third covers a broad disciplinary spectrum of upstream research in physics and materials sciences. The electronics fili re and its heavy commitments (the capital endowments to Bull and the JESSI programme within the EUREKA initiative) almost no longer exist. The set of state actions aimed at new information and communication technologies (from multimedia to information highways via microelectronics and including telecommunications and the European MEDEA programme) represents barely 1.5 Billion Francs.

Of course, the situation is different in the case of military programmes since the state is a favoured or unique client (as is currently the case of the Dassault RAFALE aircraft). However, two points must be emphasised. First, the rise of European firms (formerly through limited alliances such as EUROCOPTER but now through the formation of truly European entities, such as EADS, which arose from the merger of Aerospatiale-Matra and DASA) and the joint definition and order of military weapons (as is the EUROFIGHTER, competitor to RAFALE, and in spite of the failure of the European frigate project) are considered by all analysts as inevitable. Next, in contrast to the United States, where the decrease in defence budgets has not affected military research (this represents a secondary share of total military

[6] The Ministry of Industry has recently created a national network for telecommunications research to support the projects of operators and parts manufacturers... in association with public laboratories . This network is putting out calls for tender (funds committed in 1998: approximately 200 Million Francs).

[7] It is difficult, taking into account French budgetary practices, to obtain the exact net total of public financial commitments. In 1999, the total resources budgeted reached approximately 1.4 billion francs. Reimbursable advances are made according to sales, but the total of effective reimbursements has not been identified as they are mixed with various state revenues. However, according to estimates, the successes of AIRBUS, of the CFM56 or of the FALCON 2000 have generated returns, which match new supports allocated.

expenditure, which has fallen), France, has experienced a regular and pronounced decrease of public expenditure on defence R&D since 1992[8].

The total impulse effect of military programmes is greatly reduced and is centred on specialised firms in the defence sector. The large civil programmes, with the exception of the space programme, which has experienced this same specialisation phenomenon (Bach et al. 1997), no longer exist. The 1990s have thus seen the near disappearance of what has been a central mode of state intervention in research during the post war period: the first central trait of French technological Colbertism has thus, with the exception of space, disappeared. On the other hand, the state has inherited a set of public research institutions from this policy, which have undergone the same transformations as those institutions born out of sectoral policies (which will be further discussed in section 4).

3. THE HYBRIDISATION OF THE CNRS AND THE UNIVERSITIES

Another dominant trait of the stereotyped view of the French research and innovation system is the strong separation between the large fundamental research organisation that is the CNRS and the higher education system. By looking back at certain historical elements it is possible to understand the current dynamic of French fundamental research.
Before the Second World War, the question of support for scientists had already been addressed, notably with the transformation of the National Office of Science (Caisse Nationale des Sciences) into the CNRS in 1939 (Picard, 1999). The choice had yet to be made between what is today referred to as a project funding agency, in the style of the Anglo-Saxon research councils and a public research institution, employing professional researchers. This choice was made only after the Second World War, and clearly marked out France from other western countries. Of course, there are other public fundamental research institutions in Europe, particularly the Max Planck Gesellschaft in Germany, but none are of the same size as, or have the central role of the CNRS. Currently, with more than 26000 persons, of which 14400 are researchers and engineers, the CNRS currently accounts for one quarter of national expenditure on civil research.

The creation of the CNRS, justified by the weak state of university research at the time[9], developed the model of the full time professional researcher (which can be differentiated from the university model which entails the dual activities of teaching and research).

[8] Thus the share of military R&D in public R&D expenditure has decreased from 36% in 1992 (an all time high, with the average in the 1980s standing at 30%) to less than 25% in 1996 (actual expenditures) and to almost 20% committed for the year 1999 (in current Francs this is a decrease from 35 billion Francs in 1990 to less than 20 billion Francs in 1998).

[9]However, historians underline that the universities have always been engaged in research activities (notably in the field of chemistry). They question the idea of a sharp division between the universities, uniquely dedicated to teaching and the CNRS, entirely taken up with research (Jacq, 1996). At the end of the 1940s, university research was relatively unstructured and its organisation could not command the critical mass necessary for big physics.

However, far from reinforcing university research, the creation of the CNRS accentuated its weaknesses. From the middle of the 1960s, to help the structure of university research, the CNRS put in place a system of partnership between its personnel and university groups, on the basis of a periodic evaluation by its committees. These associated teams were consequently able to host CNRS personnel. This mechanism, which became increasingly extensive, has had two lasting effects, which distinguish the landscape of French academic research. On the one hand, it dissociates, within the universities, teaching departments from research structures. On the other hand, a growing proportion of CNRS personnel have been working in these groups. Currently, four out of five CNRS units are joint units (unit s mixtes) between the CNRS and universities, and these incorporate four fifths of the organisation s personnel.

The hybridisation between the universities and the CNRS is widespread (one aspect of current debate is the extent of the adoption of this mixed system throughout the institution). This situation is reinforced by the growth in the research potential of the universities. In the 1970s, the number of CNRS researchers was at a similar level to that of French university researchers (in full time equivalents). This relationship has progressively reversed as a result of the strong and continued growth in recruitment in higher education. At the end of the 1990s, 10 new positions were created in universities for each one in the CNRS. Currently, in full time equivalents, the research potential of the universities is more than double that of the CNRS. The proportion of individuals, and no longer in full time equivalents, is 1 to 4 in favour of the universities: 14,000 researchers and research engineers (ing nieurs de recherche) to 45 000 teacher researchers (enseignants-chercheurs).
Another striking phenomenon concerns the grandes coles . Among these, the engineering schools are heavily involved in research. Currently, across all disciplines, one thesis in every five in France is produced in the research centres of these schools, although they contain barely 6% of all teacher-researchers (Mustar, 1998b).

With these transformations, two characteristics of the Colbertist model have disappeared: the separation between the CNRS and the universities, and the existence of the grandes coles without research activities. Current reality is an overlapping between the universities, the CNRS and the grandes coles. Higher education is playing an increasingly central role in the public research system. Taking this analysis to the extreme, the CNRS could be considered, following the example of the Anglo-Saxon research councils or the NSF, as a research support agency, but more specifically an agency concerned not with projects, but with structures, and which makes its contributions in the form of human potential and large technical resources rather than financially.

4. THE CONVERGENCE OF MISSION ORIENTED RESEARCH INSTITUTES AND THE ACADEMIC WORLD

Another characteristic of French public research is the clear division between, on the one side, what is labelled fundamental research conducted by the universities and the CNRS, and

on the other what is labelled applied research and which is the task of public research institutes. The latter, in contrast to the CNRS or the universities, have strong links with professional circles linked to their domain of competence, and for which they function as technical centres. The developments that have affected these organisations mean that this view is now no longer tenable.

In various countries, government departments, confronted with various problems over the course of time, have developed their own research structures, which have progressively developed degrees of autonomy, in the form of government laboratories (to use the recognised Anglo-Saxon terminology). France has not escaped this type of activity, and since the Second World War has progressively structured these various mission oriented public entities into a series of public research institutions . In 1946, INRA was created, followed by a whole series of institutes associated with agricultural activities: CEMAGREF for forestry and agricultural mechanisation, CNEVA for veterinary research,[10] and ISTPM for fishery research, which was later merged into IFREMER. ORSTOM (recently transformed into IRD) was created during the Second World War for colonial research, before focusing on the problems of developing countries. Later, the various institutes specialising in tropical agriculture were brought together in CIRAD. Infrastructural ministerial services were incorporated into LCPC (for civil engineering) and CSTB (for building). Over time, INSERM was set up for health and medical research (reorganised into its current form in 1962), along with INRP (for research in education), CEE and CEREQ for employment and qualifications as well as INED for population. BRGM, the state mining organisation, also has a research service. The 1960s saw the practice of government departments setting up their own specialised research institutions become widespread. Among the last to be established were the Institute for Transport Research (created in 1971 and becoming the INRETS at the beginning of the 1980s, following the absorption of the national association for research on road safety) and INERIS for the environment and industrial risks (from the former French Coal board research centre). The mission of these organisations is to respond to the needs of different sectoral ministries. They mix three logics in unequal proportions. The first is that of the needs of innovation associated with their domain of competence or intervention. The key words are: the safety of goods and people, quality, standards and regulation. The second corresponds to the activity of producing public services for these ministries: this is particularly the case for State-managed infrastructures (for example the road network). The third logic is deployed in dispersed sectors where individual actors are both too numerous and too small to innovate. The State, through its institutions, substitutes as innovator (for example in agriculture).

The 1982 research act (LOP) profoundly questioned this articulation of responsibilities and activities between the ministries and the research institute placed under their supervision. The legal framework of operation of these organisations, as well as their involvement in the public

[10] Currently integrated into the recently established Agence fran aise de s curit sanitaire des aliments (AFSSA) - French Health and Food Safety Agency.

system, were modified. Two central elements can be recalled to understand the changes that the majority of these institutions have experienced over the past twenty years.
The first is that the majority of the organisations were given a new status, that of EPST - public scientific and technological establishment (tablissement Public caract re Scientifique et Technologique). This status resulted in all employees, including researchers, becoming civil servants. Procedures for recruitment and career development adopted the competitive examination system, as in the rest of the French civil service. For reasons, which deserve detailed historical studies, the CNRS model of recruitment at a young age, (following postgraduate study), by discipline specific committees and based on academic career criteria, was imposed across all organisations. It is not surprising that almost twenty years after the Research Act (LOP) was passed, the academic visibility of these organisations is very strongly reinforced. This trend is illustrated by the case of INRA, which, at that time, had numerous groups engaged in the process of innovation, interacting closely with the agricultural world. This was the case for the group which developed a new variety of chicory *Zoom* which transformed national and European markets for this vegetable, or the researchers who participated in the re-creation of the Beaufort traditional cheese (INRA, 1998). Currently, such units, labelled by Joly and Mangematin as technical centres serving particular professions are rare within INRA (Joly and Mangematin, 1996). The majority of units are concerned with other logics of research, and are linked to the development of generic tools or specialised basic research , and most of the other laboratories were considered by Joly and Mangematin at the time of their study as in a state of transition , emphasising the importance of on-going transformations. This trend is not about the disengagement from research areas within the domain of activity of the institution, but a marked reorientation and a progressive replacement of professional associations as favoured partners by large firms (either individually or as members of clubs˚). The links between institutions and the economic world are increasingly centred on contractual relations, which take account of the professional˚ specificity of both partners. This leads to the development of co-operative forms, with industrial partners using their own research capabilities to capture and mobilise internally the academic work of researchers in public institutions.

The second element of explanation of these changes concerns relations with the public authorities: these are increasingly involved in research of collective interest, which is carried out on a contractual basis. This is linked to the combined effects of two changes. On one hand, the 1982 Act brought about a financial division between organisations and their parent ministries with the transfer of budgetary responsibilities to a single ministry in charge of research. Even if the parent ministries had preserved joint guardianship , the unwieldy nature of the budgetary mechanism is too well known for the eventual impact of such a separation not to have been weighed up. The second stems from incorporation into the civil service and from its associated budgetary constraints, which have become more and more cumbersome in budget allocations. Currently, salaries represent 85% of the annual grant to INRA, leaving units and researchers to obtain the majority of their research funds from outside. At the same time, the parent ministries have not been given significant financial operating resources and have struggled to follow the contractual orientation of the famous

customer-contractor˚relationship promoted by the Rothschild report. There are other public actors, the regions (an important lever in support of the technical centre role of INRA entities) and European programmes (the principal proxy customer for a number of new collective challenges), which play a central role in the promotion of the functions traditionally devoted to these mission-oriented organisations.

The development of academic research, the use of classically configured relationships between public research and companies, and an increasing role of incentives for research oriented towards public missions are all part of the spectrum of activities covered by these public research institutions. Together with their modes of financing, this spectrum points towards reconsideration of the position of the institutes in the national research system, where they are no longer simply categorised according to some notion of mission-oriented research . While their frequently central role in research in particular domains should be recognised, their activities are becoming only slightly differentiated from the research conducted by the CNRS and the universities. Mixed units, combining professional CNRS researchers and teacher-researchers, have also seen their activities evolve in the same way. Following closely on from the 1981 National Research Conferences, an extraordinary development in public-private research relations took place, the significance of which is all too often underestimated. The number of contracts between laboratories linked to the CNRS and firms increased 10 fold between 1984 and 1996: climbing from 350 to more than 3200, while the sums received by the laboratories currently exceed those from national funding schemes. Taking all disciplines into consideration, these relationships affect half the laboratories of, or associated with, the CNRS. Several surveys carried out on the laboratories in particular regions showed the extent of the links with the economic world (links which provide them with almost 30% of their budgets, salaries of permanent staff apart) (AURA, 1999). The deployment of these relationships relies on renewed modes of cooperation. Cooperations are increasingly set up as equal partnerships between public researchers and industrial researchers, which entails a concentration of relations with firms with their own research capabilities (leading large firms and high technology firms), and no longer focused on assistance or technical centres for specific professions. The survival of the latter type requires strong incentives for the professionals or the corresponding government departments. Valorisation and transfer have thus become missions for researchers, at universities, within the CNRS or in the world of research organisations. The multiplication of research exploitation offices or transfer services, an increasingly active patenting policy (with new rules promoted by the 1999 innovation law for the sharing of licence income between public research institutions and inventors), the creation of subsidiaries aimed at furthering the diffusion of results (such as INRIA Transfert), emphasis on the creation of firms by public sector researchers (currently encouraged by a change in the status of the researcher, policy for increasing the number of incubators and a national competition for firm start-ups). All these activities provide an indication of a trend towards convergence of public research institutions. The increase in importance of the research potential of universities (see above) and the ongoing debate on the systematisation of mixed research units further reinforce this trend towards unification. They explain why it is misleading to continue to differentiate between an

applied pole and a fundamental pole in public research. Increasingly, the public research sector is guided by a dominant focus, which can be described as collaborative academic research.

5. PUBLIC INTERVENTION IN INDUSTRIAL RESEARCH

The Colbertist approach to French industrial research emphasizes three specific characteristics. The first concerns less the total volume of R&D expenditure than the share financed and executed by the public sector relative to that of industry. The second is the importance of State subsidies and orders for firms and the fact that this public support for industrial research is monopolised by a limited number of large firms and does not concern the web of SMEs (most of which are not engaged in research activities). The third point is the "instinctive overcautiousness of our manufacturers, their fear of risk, their ignorance of the how to take advantage of university research, in sum the ignorance of the benefits and processes of innovation (Salomon, 1986). This picture, which was relevant 20 years ago, has today radically changed. The developments that will be presented in the following section show the strong involvement of small and large French firms in innovation activities, the strong disengagement of the State from supporting industrial research by large firms and the place of SMEs in public support. Finally, a new mode of intervention of public powers in the domain of research and innovation will be emphasised: technological programmes.

Four reorientations in the industrial research effort

In 1980[11] there were 1300 firms carrying out R&D (according to the Frascati definition). Their expenditure had risen to 31 billion Francs, representing 1.12% of GDP and 2.4% industrial added value, they employed 126,000 persons, including 34,000 researchers. Analyses drew attention to three principal characteristics of this activity: a very strong concentration on the one hundred or so firms employing more than 50 researchers (representing three quarters of the effort); a strong sectoral concentration (five sectors - aerospace, electronics and data processing, chemistry, pharmacy and automotive - were carrying out 70% of the total effort); and a progressive increase in their own funding (their share went from 55% in 1965 to 70% in 1980), public funding being concentrated on two sectors (aeronautics and electronics accounted for 85% of the sums paid out).

Two decades later (1997 figures[12]), the concentrations observed in 1980 endure: the top one hundred firms are still carrying out two thirds of the total effort, and the same five sectors[13] have a similar significance (64%). This stems, in part, from the weak overall increase in resources dedicated to industrial research: even if the number of researchers has doubled

[11] source: annex to the Finance Act (*projet de loi de finance*), 1983.
[12] source: annex to the Finance Act (*projet de loi de finance*), 2000.
[13] The terminology has evolved: aerospace is now used in preference to aeronautic . An important part has been transferred to the sector of instruments for control, navigation, measurement and precision. This sub-group (which was marginal in 1980) also combines a part of the electronic equipment sector, which has now been relabelled the communication equipment sector.

(70,700), total employment has clearly progressed less (+30%) as has the share of GDP (1.37%, representing a growth of 22% in 17 years). However, these continuities conceal four major changes.

The first stems from the more important relative growth of R&D expenditure compared both with GDP and with tangible investments. This is all the more significant because firms themselves are funding an increasing share of their research investments: between 1980 and 1997 the share of public contracts decreased from close to 25% to below 15%, including defence funding, as well as those for the large programmes. The third change, is evidenced by a four fold multiplication of the number of firms with an organised R&D effort: 5600 in 1997. This reflects a near doubling of the role of SMEs (firms with less than 500 persons) in the national research effort: in 1983, they employed 17% of researchers, while in 1996 this figure was 28% (OST, 1999). The public policies implemented continuously since the beginning of the 1980s (see the following paragraph) have certainly played a decisive role in this increase.

The final major change is that it is no longer possible to speak of a separation between private and public sector research, as in the 1981 Conferences. On the contrary, there is an abundance of indicators emphasising the explosion of links between the two. The tenfold multiplication between 1983 and 1996 of the number of contracts between the CNRS and industry has already been mentioned (increasing from a few hundred to more than 3000, representing around 3 contracts per CNRS associated laboratory per year). Over the same period the total number of industrial contracts let to public research institutions has increased eight fold (from 500 million Francs in 1983 to 4.1 billion Francs in 1997) and currently represents 4% of firms research expenditure. The annual survey carried out by two major French journals shows that, on average, the large firms surveyed co-operate with 70 different laboratories, hosting or funding around forty doctoral researchers and publishing, usually jointly, thirty or so articles in the most prestigious scientific journals (Lar do and Mustar, 1999). The change in these relationships is not only quantitative. This period has also seen the appearance of new forms of relationships, which intimately mix public and private laboratories. These mixed laboratories, jointly established by research institutions and companies, together with CIFRE agreements, explain, to a large extent, the increasing involvement of firms in research training[14]. National programmes, launched at the beginning of the 1980s, have also played a role in this trend, despite their eventful existence (see subsequently). However, it is, without doubt, the other public actors, who have appeared since the 1980s, European programmes and regional research policies, who have played a central accompanying role in this development.

[14] The Industrial agreements on training through research (CIFRE) organise a partnership between a company and a research laboratory to allow a young researcher to prepare a thesis, dividing his/her time between the two partners. These young researchers are recruited by the companies in return for fixed financial support by the State (today estimated at a third of the salary costs of the young researcher). 200 million Francs are allocated in the 2000 budget, which corresponds to undertaking 800 new theses a year.

SMES, beneficiaires of public support for industrial research

The French technological gap is a recurrent aspect of policy debate on industrial research. This started with the productivity missions financed under the Marshall plan, leading to the creation of technical centres[15]. At the end of the 1960s, procedures for pre-development then for innovation assistance were created. At the end of the 1970s, their resources and management were delegated to the National Agengy for the Valorisation of Research (ANVAR), progressively becoming its core activity[16]. Since the mid-1980s, ANVAR s activities have been focused on SMEs. Each year, more than 2000 SMEs are beneficiaries of this reimbursable form of aid. Since the end of the 1980s, young SMEs (less than 3 years old) have represented a quarter of the firms supported.

This effort towards SMEs was stepped up in 1982 with the introduction of research tax credits, a fiscal arrangement which reimbursed firms one half of the increase in their R&D expenditure[17]. Using a broader definition of R&D than that of the Frascati manual and with specific dimensions favouring SMEs, tax credits have contributed considerably to the development of R&D activities in SMEs. In 1987, 3500 firms submitted applications to the scheme, ten years later, this figure had doubled, exceeding 7000 firms. Half of these (3400) had effectively benefited from a tax reduction or a reimbursement[18] equivalent to 3 Billion Francs, a sum more than two times greater than the advances provided by ANVAR.

There are other complementary procedures of a less financial scope, which are largely oriented towards SMEs. In particular, these include assistance for the diffusion of techniques to SMEs from the Ministry of Industry (ATOUT)[19] and EUREKA[20]. Although, to an extent,

[15] 50 years later, there are still almost 50 of these, covering different traditional industrial sectors. These technical centres, the most important of which are CETIM, for mechanical industries, and IFP for the oil industry, represent 1.9% of domestic expenditure on R&D by firms (BERD). Two thirds of this effort is funded by supplementary taxes deducted from sales in the sector. Taking into account the new rules of the EU this mode of financing is due to evolve, with the abolition of the taxes and the integration of this funding into public research expenditure.

[16] Created in 1974 to promote the exploitation of the results of public research, ANVAR has progressively transferred this particular activity to research institutions and their own exploitation services (see section 4), while concentrating its activities towards supporting SMEs. It has also progressively extended the range of its procedures: on top of loans granted for supporting innovation projects, it supports the contracts let by SMEs to contract research societies (SRC) agreed by ANVAR, the recruitment of PhDs and qualified research engineers by SMEs. In 1998, ANVAR has accompanied the recruitment of more than 1000 researchers, which is some 5% of the total of researchers in French SMEs.

[17] It is deducted from the tax on benefits and takes the form of a repayment by the treasury, when the amount deducted exceeds the taxation. This latter arrangement is particularly important for new technology based firms.

[18] In order to be able to benefit from this measure for the years when they increase their research efforts, firms are obliged to submit an annual declaration.

[19] Several procedures (micro-electronic components, computer aided design and manufacture, machines and facilities of advanced design and new materials), which were created in the 1980s, modelled on those set up by the BMFT in Germany, have been brought together in a single procedure, the ATOUT procedure, under the management of the regional services of the Ministry. In 1998, this represented almost 170MF of support.

[20] EUREKA includes certain strategic projects, in particular those linked to information and communication technologies. These are included in what remains from the large programmes (cf. section 2). However, the accent is increasingly on EUREKA s second mode of intervention, bottom-up projects put forward by firms. All the discussions and all the analyses emphasise the role of EUREKA for SMEs. Thus out of the 43 new projects which were proposed at the June 1999 EUREKA ministerial conference in which there was French participation, 42 were SMEs (annex to the *Loi de finances pour 2000*, p. 39).

distinct from it, these procedures must be associated with the invitation to tender for projects in the key technologies (technologies cl s) initiative, created in 1996, closely following the study of 100 key technologies (Ministry of Industry, 1995), and launched annually by the Ministry of Industry in association with ANVAR[21]. In total, these various different measures represent less than half of ANVAR s annual commitments.

Support for innovation and tax credits, which have been implemented on a large scale since the beginning of the 1980s, have since become well established in the landscape of French industrial research. These two procedures are characterised by a bottom-up approach (where firms take the initiative and submit proposals), by clear mechanisms of attribution[22] and broad coverage, in terms of both types of firms and sectors of activity. These characteristics can be seen, on the one hand, as contrasting with those of large programmes described in section 2, and on the other as characterised by strong continuity. This continuity conflicts with the erratic life of the efforts to mobilise national potential to meet priority aims, through another state mode of intervention: national technological programmes.

From national technological programmes to the emergence of regional and national actors.

The technological programmes implemented in the wake of the oil crisis, largely anticipated the results of work on innovation in the social sciences. Their objective is to encourage heterogeneous actors (scientific research laboratories, centres for technical research, firms) often competitors (two firms or two laboratories) to jointly identify, on specific geopolitical levels (regional, national, European), competences of future strategic significance and to develop cooperative activities which will allow them to acquire and exploit these competences (Callon *et al.* 1997). Activities, such as the Plan Construction ˚(launched in 1971), and agencies, such as COMES for solar energy, foreshadowed this trend in France. However, it is the British ALVEY programme which analysts consider to be the precursor of this new form of public intervention. After the White Paper on Research initiated by P. Aigrain (Secretary of State for research, 1980), which advocated such activities, the 1982 Research Act created seven mobilising programmes and a series of priority programmes. These gave rise to missions . As a result of their success, twenty or so programmes were launched, although few of these survived the change of government in 1986. The only programmes to last concerned non-nuclear energy (conducted by an agency, AFME which subsequently became ADEME with the expansion of its responsibilities to environmental technologies), land-based transport (through PRD3T and then PREDIT), and, through a lesser measure, agrofood industries (the Aliment programmes). The imperative to develop synergies between actors has remained under modified labels linked to the successive changes in government. Currently, it takes the form of thematic research and technological innovation networks , which carry only marginal

[21] In 3 years, ANVAR has retained 240 dossiers (308 MF of support awarded) and the Ministry of Industry 81 (497 MF of support awarded).

[22] ANVAR s activities are decentralised: decisions are taken directly by its 24 regional delegations. Over a decision period of three months, a threefold examination (technical, commercial and financial) is carried out and the result communicated to the firms.

weight in state intervention[23]. The recent Innovation Act, passed in 1999, is another example of this continued focus: while still reinforcing the fiscal arrangements in favour of innovating firms, it focuses on the development of relations between public researchers and companies and collaborations between public sector research and companies (presentation of the Act on the Ministry website, February 2000).

This changing attitude towards firms is also visible in the changing governmental approach to industrial R&D policy. The Ministry of Industry has been merged into a vast Ministry of Economy and Finance. Industrial policy is less and less a matter of direct, targeted interventions (through large programmes or policies supporting some national champion, and particularly nationalised companies). It has become the construction of a framework favouring competition and the competitiveness of firms. It goes hand in hand with the progressive and continued trend in the privatisation of public companies. It first affected those companies nationalised in 1982 (such as Rh ne Poulenc or Saint-Gobain), then spread to other public industrial companies, including symbolic firms such as Renault. This trend is currently spreading to the large operators of collective services: after television and telecommunications, it is the turn of air transport before energy. The increasing internationalisation of these firms, the multinational mergers which affect them (e.g. Rh ne Poulenc into Aventis) also pose the question of the opportunity for public intervention in research: what for a nation state is the relevance of the notion of nationality of a global firm? What is a national company? De facto, the national policy has been disengaged from the support of large companies, and most the issues affecting them - from competition policy to technological development - have de facto been transferred to a new public arena: the European Union.

6. THE GROWING ROLE OF NEW PUBLIC PARTICIPANTS: THE EUROPEAN UNION AND THE REGIONS

The four preceding sections have brought under scrutiny the main features of the stereotyped view of French Colbertism, moving from the image of a strong State to one of a state which has lost a large part of its room to manoeuvre. A state in which interventionism is far from being omnipresent since it is now mostly concerned with public sector education and research. This stems not only from the near complete disappearance of certain characteristics of the Colbertist model, it is also linked to the emergence of new actors - the regions and Europe - which necessitate an alternative view of public intervention in research and innovation (Paillotin, 1993, Dodet et al., 1998, Papon, 1998).

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This section shows that public intervention is retracting, not only because French research and innovation policy is concentrated just on public sector education and research. New

[23] PREDIT (2150 MF of public support over 5 years distributed between 4 ministries and 2 agencies) and the national telecommunications research network (RNRT, 1300 MF over 5 years and distributed between 2 ministries and 1 agency) are the two principal networks mentioned. New networks concern micro- and nano-technologies, civil and urban engineering, and fuel cells (respectively 55MF, 20 MF and 10 MF in 2000 budget).

participants, Europe and the regions, challenge the earlier integration (in France at least) of public intervention and national government. Today, after fifteen years of experimentation, progressive sharing of responsibilities between the State, the regions and Europe is taking shape.

New public participants

The beginning of the 1980s saw the simultaneous appearance of two new public actors: the regions with the Decentralisation Act (1982) and the European Commission with the creation of the Framework Programme (1984). These two initiatives have two antecedents: France has experienced a progressive decentralisation after the failure of a first attempt at regionalisation (1969). Similarly the first EEC research programmes[24], on renewable energies date from 1974.

In these two cases, the development of research policies was through the impetus of national governments. For the regions, this involvement relied on the contrats de plan tat—r gion which have allowed them to extend their sphere of activity to the domain of innovation and support for SMEs[25]. European research policy has witnessed a rapid growth, from 4 billion ECU for the First Framework Programme (1984-87) to 14 billion EURO for the Fifth Framework Programme, which began in 1999. This discussion will not return to the tormented history and the complex negotiations, which led to the elaboration of successive framework programmes (Guzzetti, 1995).

It is possible to hypothesise that these regional and European interventions have been conceived as outgrowths from national policy that have been allowed to deepen. We stated in 1989 that it was not possible for the European programme for non-nuclear energies to leave aside the national priorities of any member country. This has led to this programme becoming a veritable catalogue of activities (Callon et al, 1989). This is manifestly not the case today, as can be demonstrated by two indicators. The first is organisational, it is linked to the procedures for preparing and implementing actions, the second is financial, and is related to the relative weight of the participants.

The regions, which were asked by the State in the 1980s to supplement its investments (for example by participating in funding large facilities or in co-financing transfer centres), are putting forward, in the framework of the preparation of new contracts, their own projects and policies, often following evaluations of previous activities or strategic analyses of the challenges facing them. They see these contracts as a means of obtaining multi-annual commitments from the State (notably for the creation of jobs) and an enlargement of the

[24] Apart from the CECA and EURATOM which are based on different characteristics, even if they were eventually directly integrated into community activity.

[25] Decentralisation takes place by total or partial transfer of competences. Economic support and innovation fall into this second category. Decentralised competences only bear on investments, all forms of direct action based on public services remains with either the state or the departments (the administrative structure of France since the Napoleonic period). Two aspects of this process of decentralisation can be stressed. On one hand, resources are transferred on a global basis and can be affected according to the good will of the regional council (democratically elected). On the other hand, among the transfers carried out under the decentralisation act (1984) are investments in roads just when investment was at its peak. They are rapidly offering regions real room to manoeuvre, with significant possibilities for redeployment.

effects of their own actions[26]. The Framework Programme has witnessed the same trend in investment. This is due, first, to its growing significance, notably with regard to equivalent national interventions[27]. Next, this is linked to the exigencies of transparency in the allocation of budgets (and the generalisation of very formalised selection procedures). They have limited the importance of the unacknowledged practices of juste retour ˚(i.e. obtaining a percentage the contracts equivalent to the share of national finance contributed). Finally, the Fifth Framework Programme broke with the previous committology by moving the management committees to the level of four general priorities. This shift of an operational entity (the specific programme) towards a general priority (for example the information society) widely transformed the conditions of national control. Even in preparation, the influence of national administrations has been significantly diminished: clearly they made their contributions to future orientations, but this was supplemented by a vast consultation exercise, which has received more than a thousand contributions (several French research organisations, for example, made their own contribution). The consultation also affected economic partners, who are very much present in Brussels in their own right, but are also represented there by European associations. One can thus see a movement towards Brussels of those preparation processes, previously, largely conducted and refereed in Paris (or in each of the capitals of the member countries).

The financial orders of magnitude are a second indicator of this transformation. Financial incentives provided by the state[28] can be estimated at around 3 billion francs, regional budgets (which are increasingly dedicated to the provision of incentives) at 1.5 billion francs, and contracts from the European Union at 3 billion francs. The available data also underline the direct relations between public research and firms, relations of which the total amount is equivalent to that of public incentive actions. The 7 billion Francs or so of public incentive actions thus identified address both public and industrial actors, can actually be compared to some 4 Billion Francs worth of contracts let by industry to public research (MENRT, Annex to the *Loi de finance* 2000).

The strategic exercise carried out by the *Commissariat G n ral du Plan* on French research comes within the scope of this movement, underlining the importance of necessary coordination between the three public participants. It suggests that the driving force of the national level lies less in its financial intervention than in the strategic impetus it can promote through the development of foresight actions, the promotion of public debate on new technologies, and the evaluation of the effects of past actions (Duby, 2000).

Towards a progressive specialisation of public intervention

The relative importance of regional and European actors is a primary element. It is probably not the most decisive. Taking the hypothesis further, it can be suggested that there is currently

[26] Cf. Lettre de l OST n¡17 (Automne 1999) providing an account of the colloquium regional research policies: tools and strategies˚ (Paris, 31 Mars 1999).

[27] For the NTIC (the only programme to have a national equivalent), the accumulated interventions of public ministries is estimated to a maximum of 250 Million EURO for 2000, hardly more than the return estimated for France from the equivalent European programme.

[28] This figure excludes the one remaining large programme, in space, as well as reimbursable advances for civil aeronautics.

emerging a complementarity or a specialisation in interventions. It has been shown that national research policy is progressively becoming policy for public sector research . Its action then bears primarily on the importance of human potential and on the good configuration of public research competences. The contents of French debates on research are symbolic of this focus. In 1999 the main controversy was about the systematisation of mixed units between research institutions (particularly the CNRS) and the universities. Similarly recent policy measures (1998-99) bear principally on the role of public researchers and teacher researchers (enseignants-chercheurs) in the transfer of research results and particularly in the creation of firms. The same report of the *Commissariat G n ral du Plan*, mentioned above, suggests that, in order to encourage these priorities, it would be necessary to look again at the relations between the central administration and actors (particularly the universities) giving them genuine autonomy [29].

Regional policies have been the object of numerous individual evaluations, but we are still lacking a global overview. Despite this, there is agreement on two large trends. In a first period, the regions have put a strong accent on public research facilities. This priority remains, taking into account the situation of the French universities, but it has been progressively supplanted by more active policies for the support of the innovation capacities of SMEs. The latter rely first on the activities and regional structures of ANVAR. Their activity has progressively become more specifically focused on intermediation structures, which, in a change of direction, no longer focus on the laboratories and their stock of knowledge to exploit, but on the problems of regional firms. Currently, it is possible to count around one hundred and twenty technological resource centres (CRT), a name which is symbolic in its abandonment of the notion of transfer of its former title CRITT. A recent evaluation (CNER, 1997) shows the existence of two types of structures: interface CRTs and platform CRTs, which combine intermediation activity with the development of targeted technical services. It underlines the importance of the links woven by the CRT to successfully carry out their activity of supporting regional SMEs: among an average of ten public structures they mobilise, seven are university laboratories, and nine situated in the same region. These few data convey the choices progressively made by the regions: to focus their interventions on the creation of networks of regional innovation actors. Certain regions, such as Alsace, utilise the concept of fili re to underline the incentive for significant interactions not only between public and industrial research, but also between regional economic actors in the same domain. This trend towards the definition of truly regional research and innovation policies is further reinforced by the unprecedented success of the experimental Community programme aimed at supporting the regions˚in the formulation of their own policies: initially limited to about twenty regions, the RITTS/RTP programmes have had to be extended in the face of pressure from regional executives. This direct connection between the regions and Europe is continuing through the structural funds, which accompany the development of the

[29] A university president recently underlined that the autonomy of the universities granted by the 1984 act has given them neither control of their budget nor financial accountability, nor management of their buildings. Universities do not have any responsibility on the management of their personnel, including recruitment and promotion. Similarly, the National Committee for the Evaluation of the Universities regularly emphasises, in its reports, the question of the government of the universities˚ which seems to him to render any strategic choice difficult.

less favoured regions (around half of Europe s regions). Those responsible in Europe consider that they will devote a sum at least equivalent to that of the Fifth Framework Programme (14 billion EUROs) to the accompaniment of research and innovation policies of these regions for the five corresponding years.

These elements emphasise the growing importance of European intervention. Work on the effects of European programmes are both numerous and have given rise in France to two systematic analyses of their effects in 1990 and 1995 (Lar do, 1995). These analyses have been able to show that these programmes concern the core of France s research potential. They have next underlined the major role of projects in the creation of networks of actors: the average network comprises seven teams from four different countries, public research was present in almost all of the networks and concerns as much (if not more) academic research as the work of research institutions. Finally, in more than half of the networks, there are industrial partners, with, always on average in these networks, three teams from large firms to every one from an SME (and even then almost always high tech — the list of participating SMEs matches very closely with that of French high tech SMEs), and two direct competitors for two vertical partners (suppliers or potential clients). This description alone underlines the central role of European programmes in the development of co-operation in all areas, and more particularly between public and private research.

These works have also drawn attention to the existence of three principle types of networks, which demonstrate the variety of interventions of a policy centred on the reinforcement of interactions between European actors in innovation (Lar do, 1998). The first type, networks of basic technological research, show how European public intervention substitutes to the large programme the development of veritable co-operative infrastructures which are focused on access to new technologies by European firms. The second type shows how, for specific problems, judged as strategic, Europe favours the setting up of innovation networks. Finally, the third type proposes a new approach to innovation in collective goods, supporting experimentation which unites public researchers, economic actors and one or several public authorities (a local community, a hospital, an electricity company etc) to demonstrate the feasibility and the potential interest of the option they are promoting. From new sources of energy to telemedicine via new instruments for measuring air quality and new systems for traffic management (such as for the p riph rique ring road in Paris), there are numerous manifestations of the already important role of European programmes in a domain hitherto reserved for national States and their governmental laboratories. These issues (the information society, environment, health and food safety) are at the heart of the Fifth Framework Programme. The role of European interventions is thus perceptibly growing in this domain. After having largely taken the place of the State in providing technological support to firms, it is possible to hypothesise that the provision of incentives to tackle the major problems of society, which is currently largely national is also swinging towards the European Union.

7. CONCLUSION°

The objective of this paper has been to dispute the stereotyped image commonly found in texts devoted to French research and technology policies. This image of a French model completely constructed around the dominant role of the state is no longer appropriate today. From the description of the changes, which the French research and technology system has undergone, four principal developments can be extracted.

- It has been shown that, on the one hand, there is strong hybridisation of the CNRS and the universities and, on the other, there is strong convergence between mission oriented research institutes and academic research. The result of these movements is the convergence of all public research institutes towards the standard of collaborative academic research.
- The 1990s have seen the near disappearance of a mode of state intervention in research, which has been central since the war: large programmes. Large civil programmes, with the exception of space, no longer exist. Defence programmes have been affected by a strong and regular decrease in public R&D expenditure on defence and by the Europeanisation of firms and orders.
- This near disappearance of large programmes has been accompanied by the privatisation of almost all public companies. De facto, national public policies have disengaged themselves from the support of large groups and have transferred most of the issues which concern them — mainly competition policy and technological policy — towards a new public space: the European Union.
- The central policy tools for supporting industrial research is limited to two major interventions: the innovation assistance of ANVAR and tax credits to promote research. These modalities of public intervention run through the 1990s without any significant change. They have two principal characteristics: on the one hand, they directly and individually address SMEs, on the other hand, their management is largely decentralised to the regional level.

However, beyond this objective, of questioning the stereotyped image of the French national innovation system, we have put forward a triple thesis. The first is that present national research policy is concentrating only on the components of the public sector. The second is that it leaves to new public actors, Europe and the regions, the responsibility for numerous aspects of what was hitherto national policy. This article thus challenges, and this is our third point, the assimilation made between public intervention and national government. After fifteen years of experimentation, we have noted a progressive sharing of responsibilities taking place between different public actors. The coordination between the three levels of public intervention (region, State, Europe) is now recognised as a necessity for the majority of policies. The major challenge for research and technology policies in Europe will be to find a complementarity, and indeed a specialisation, between these levels of intervention. Taking this necessity further, this article suggests a dual driving role for the national level, first in the configuration of the public research sector. It also suggests that with regard to technology and innovation, its capacity for intervention will stem less from direct financial interventions (the central mode of intervention within the Colbertist model), than from its role of strategic impetus and anticipation, of evaluation of past actions and of the promotion of public debate to promote common visions between innovation actors.

GLOSSARY

ADEME	Agence de l environnement et de ma trise de l nergie Environment And Energy Research Agency
ANVAR	Agence Nationale de Valorisation de la Recherche National Agency for the Valorisation of Research
ARIST	*Agence R gionale de l Information Scientifique et Technique*
BCRD	Budget Civil de Recherche et de D veloppement Civil R&D Budget
BRGM	Bureau de Recherches G ologiques et Mini res French Geological Survey
CEA	Commissariat a l nergie atomique Atomic Energy Commission
CEE	Centre d tudes de l emploi Employment Studies Centre
CEMAGREF	Centre d tude du machinisme agricole, du g nie rural et des eaux et for ts Rural, Water And Forest Engineering Centre
CEREQ	Centre d tudes et de recherche sur les qualifications The Centre for Research on Employment and Qualifications
CIRAD	Centre de coop ration internationale en recherche agronomique pour le d veloppement International Cooperation Centre in Agronomic R&D and Development
CNES	Centre national d tudes spatiales National Space Research Agency
CNET	Centre national d tudes des t l communications National Centre for Research on Telecommunications (now France Telecom Research)
CNEVA	Centre national d tudes v t rinaires et animales National Veterinary and Food Research Centre — Now part of AFSSA — French Agency for Health and Food Safety
CNRS	Centre national de la recherche scientifique National Scientific Research Centre
CSTB	Centre scientifique et technique du b timent Building Science and Technology Centre
CRITT	Centre r gional d innovation et de transfert de technologie French equivalent to Technology Resource Centres
EPST	tablissement public caract re scientifique et technologique Public Scientific and Technological Establishment
INERIS	Institut national de l environnement industriel et des risques National Institute on Industrial Risks and Safety
IFREMER	Institut fran ais pour l exploitation de la mer National Institute For Oceanic Research
INRA	Institut national de la recherche agronomique National Agronomic Research Institute

INRETS	Institut national de recherche sur les transports et leur s curit National Institute For Transport and Safety Research
INRIA	Institut national de la recherche en informatique et en automatique National Institute for Research in Computer Science and Automation
INRP	Institut national de la recherche p dagogique National Institute for Educational Research
INSERM	Institut national de la sant et de la recherche m dicale National Health and Medical Research Institute
IRD	Institut de recherche pour le d veloppement Research Institute on Development (formerly: ORSTOM)
LCPC	Laboratoire central des ponts et chauss es Central Laboratory for Roads and Bridges.
ONERA	Office national d tudes et de recherches a rospatiales National Office for Aerospace Research
PREDIT	Programme de recherche et de d veloppement pour l innovation technologique dans les transports National Transport Research and Technology Programme

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