Renewing industrial policy[1]

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[1] Traduction d'Eoin Coleman

Summary

The contribution of industry to national wealth is a continuing guarantee of its centrality in the French economy. However, the emergence of new competitors on the international scene and the acceleration of technical progress have transformed the conditions for the development of powerful industry. France can only find its place within the new international division of labour if it takes the initiative in the remobilization of its industrial capacities and its research potential.

France's research and industrial development effort remains weak relative to that of its competitors. Yet, this weakness is not related to a lack of R&D within individual firms. It has to do with France's industrial over-specialization in low technology sectors, which are more exposed to new international competition. The relaunch of innovation in France depends therefore more on evolving the country's industrial structure than on developing the research effort of individual firms.

The current instruments of industrial policy are incapable of bringing about a reorientation of industry towards high technologies. Public or State aid is rarely deployed outside the defence sector and some sectors related to historic large-scale programmes. However, aid directed to new sectors is essential in order to initiate industrial innovation. Good coordination between public research and firms must be put in place, and assistance must be given to firms in insuring against the significant risks that they face. These risks are inherent in all innovative activities, but they are increased by the volume of the initial investments necessary, and they are aggravated by macro-economic instability.

The state voluntarism of the United States and Japan is an example of an effective support policy for high technology industries. The US finances massively the R&D of firms through different agencies, sometimes linked to the military sector, with important civil outcomes. The Japanese Government finances relatively little corporate R&D, but plays an essential role in coordination and prospection, thereby orienting the corporate innovation efforts.

In France, the redefinition of industrial policy entails the re-bestowal of meaning on the missions of prospection, coordination and incentivization. In the recent past, large-scale programmes have guaranteed these functions. Numerous current strengths within French industry are the result of this previous policy. These include aeronautics, the space industry, the civil nuclear sector, and the electronic components industry. This approach, founded on the triptych of public research/public firm/public contract, cannot be reintroduced in the current environment, because of the opening up of the economy to international trade and the rules of European construction.

Renewal of industrial policy must be organized around the State promotion of long-term industrial technological programmes. This action must be undertaken as close as possible to pre-competitive or industrial development and in a manner complementary to the public effort directed to fundamental research. The approach that this report will recommend is based on a partnership between private firms and public authorities, who undertake to finance half of the sum of the R&D expenditure, in the form of subsidies and repayable advances. Within this framework, the firms involved finance half of the programme and play a coordinating role between the private and public players engaged in its execution. This instrument satisfies the imperatives of an effective industrial policy. Firstly, the partnership between industrialists (industrial groups) and the public authorities yields optimal profit from the information and skills of firms. Secondly, the partial financing of R&D encourages risk taking. Windfall effects, that is to say, the funding of projects that firms would have launched without public aid, are avoided by the choice of technological developments and by the selection process.

The programmes are designed to last from five to ten years, and the amounts of public finance are estimated at between 30 and 50 million euros per year and per project, for a period of approximately five years. These Mobilizing Programmes for Industrial Innovation (Programmes Mobilisateurs pour l'Innovation Industrielle) differ from historic large-scale programmes in, for instance, the coordination of public and private agents. Examples of some possible programmes are sketched in the annex.

The implementation of this industrial policy implies the selection, evaluation and accurate monitoring of the mobilizing programmes for industrial innovation. A prospection and technology early-alert function is also necessary for the definition of new orientations. These missions should be regrouped within a new structure, the Industrial Innovation Agency, (Agence de l'Innovation Industrielle), for three reasons. The first reason is that the programmes are inter-ministerial, as the examples cited show. A clearly designated structure will allow effective coordination of the action of each ministry. The second reason is the concentration of skills relating to monitoring and expertise. A third reason stems from the capacity of an agency, through its own budget, to arbitrate between different programmes in order to allocate public money optimally and to ensure continuity of funding, or, in the case of failure, the cessation of programmes

which turn out to be disappointing. The amount of public financing of the agency is estimated at one billion euros for a full year, enabling the simultaneous monitoring of a dozen programmes. In light of the importance of the issue and the inter-ministerial character of its action, the agency should be attached to the Prime Minister.

The initiative which the French Government should take in favour of industrial innovation could be common to numerous countries of the European Union. It is appropriate to envisage even now a European intergovernmental framework for this new industrial policy. Certain countries would be likely to have a special interest therein. In this way, the mobilizing programmes for industrial innovation could constitute an original mode of European cooperation, especially with Germany, if the two countries undertook the programme selection and funding conjointly.

Preamble

In a letter dated September 30, 2004, the President of the French Republic commissioned a study of the conditions necessary for an evolution of industrial policy. In this report, the examination of the modalities of new initiatives promoting scientific and technological programmes has been supplemented by an analysis of the modes of governance most likely to guarantee the coordination of public authorities and private initiatives. The aim of this report is to describe the means of selection, management and implementation of such programmes.

The report has four sections. The first section sets out the context of the French and European industrial situation. It concludes that significant public action is necessary in order to bring about an evolution of the current industrial specialization. The second section traces the contours of a specific industrial policy, organized around the framework of mobilizing programmes for industrial innovation. It provides details of the characteristics and selection criteria of these mobilizing programmes.

The object of the third section is to define the modalities of policy implementation for the mobilizing programmes for industrial innovation: the nature of the public policy instrument to be implemented, and the institutional organization of the policy around a dedicated office, the Industrial Innovation Agency. The fourth section analyses the European dimension of the project within both communitarian and interstate frameworks. In the first instance, my thanks are due to all the members of the working group and the two reporters Xavier Ragot and Pierre-François Gouiffès. I should also like to thank those who helped us in the genesis of the text, through its development to the final product: Jean-Philippe Touffut, Hans-Helmut Kotz, Evelyne Serverin, Laurent Guillot. Finally, I wish to express my most profound gratitude to Robert Solow. I thank all those, who, near and far, who have been instrumental in the elaboration of these reflections on industrial policy and in the re-affirmation of its current relevance.

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President, la Compagnie de Saint-Gobain

1 The necessity of a renewal of targetted industrial policies

This report begins with a diagnosis of the problems of industry in France. If industry continues to play a major role in the French economy, a brief overview of its strengths and weaknesses illuminates the constraints under which it cannot operate without increasing its efforts in research and development. This effort requires a renewal of targeted industrial policies.

The goal of this section is to reach recommendations that can be applied in the framework of French industrial policy, in the first instance, and subsequently, generalized to the other countries of the European Union. The difficulties that industry encounters in France are relevant to European industries generally, and the solutions to be implemented should, in time, be sought on that larger scale.

It is important first of all to recall the centrality of industry in economic development.

1.1 The essential role of industry in economic development

Even if the weight of the services sector is increasing in the economy, a solid industrial sector is necessary to the equilibrium of the balance of trade and the growth of the economy. The demand of the developed countries for industrial goods remains significant, since it ensures the basis of their living standards. If these goods are not produced, they must be bought abroad. Yet, what exportable services can be the counterpart to the purchase of foreign industrial goods? Some economists envisage a scenario in which France becomes an economy based essentially on agriculture and tourism, buying its goods from other countries that are specialized in industrial production. This evolution of France's specialization towards sectors in which value addition is weak would render France poor and would weaken its position in international trade.

Furthermore, the opposition between services and industry has become almost meaningless. The development of the service sector is essentially driven by services to firms, which are growing far faster than services to individuals (INSEE première n° 972, June 2004). Therefore, the development of industry and the development of services must be conceived as complementary and not as substitutable.

More generally, industry remains one of the principal motors of economic activity in terms of value addition and employment. It exercises a powerful tractor effect on the entire spectrum of economic activities, most notably through intermediary consumption: for 1 € of production, industry consumes 0.7 € of intermediary products, as opposed to 0.4 € consumed by the services sector (DATAR, 2004)[2]. Thus, the importance of industry must be evaluated using a boundary matching the scale of its real economic impact, in which case, industry represents nearly 41 % of French GDP and 51 % of market labour in 1998 (Postel-Vinay [2000][3]). Thus, the decline in direct industrial employment is meaningful only if account is taken of the quasi-doubling of temporary labour in industry through the 1990s and the significant externalization or outsourcing of a certain number of functions to the services sector. The labour market remains propelled in a significant way by industrial performance (Vimont [1991]; Cohen and Lorenzi [2000]). Furthermore, industry possesses a strong structuring influence on the diffusion of technological innovation throughout the entire economy, and, by extension, on its global productivity.

[2] It is true that the services sector has the peculiarity that, as a general rule, demand for services grows more rapidly than demand for goods when household incomes rise.

[3] The boundary retained by the author includes manufacturing industries, telecommunications, the postal service, corporate services, the agri-food industries, energy, and the construction sector.

1.2 France, an industrial power

1.2.1 A global industrial leader

France remains a big industrial power. It is the fifth industrial country in the world in terms of exports (DATAR [2004]). Over the past 30 years, French industry has experienced a phase of profound transformation accompanied by an efficient modernization of its productive capability. Industrial employment, strictly defined, is certainly in clear decline, but the share of manufacturing industry in the *volume* of total added value over the last 20 years is stable (Fontagné [2004]).

The good shape of French industrial capacity is based on a certain number of sectors in which France possesses first-rate firms and where it preserves its strengths and assets better, in relative terms, than do its neighbours: these sectors are, for example, the chemical and steel industries, the cement and glass industries, the aeronautic and automotive sectors, and the railway infrastructure sector.

1.2.2 A first-rate research contributor

French industry has been able to rely on high quality research in numerous fields. In a recent study undertaken by the O.S.T. and the DATAR [2004], within Europe, France holds second place in technological fields in terms of scientific publications and registered patents. In Europe, France lies in third place in scientific fields, after Germany and Great Britain (Czarnitzki *et al.* [2002]).

Research potential in France is of exceptional quality and is grounded, in the main, on public research: in 2001, 50 % of research personnel worked in the public sector. It is essential both to strengthen the public research capacity, and to construct or improve the interfaces between public research and the industrial universe. These summary recommendations however do not suffice to remedy the apathy affecting industrial dynamics in France: a precise statement of the causes of its attenuation is necessary.

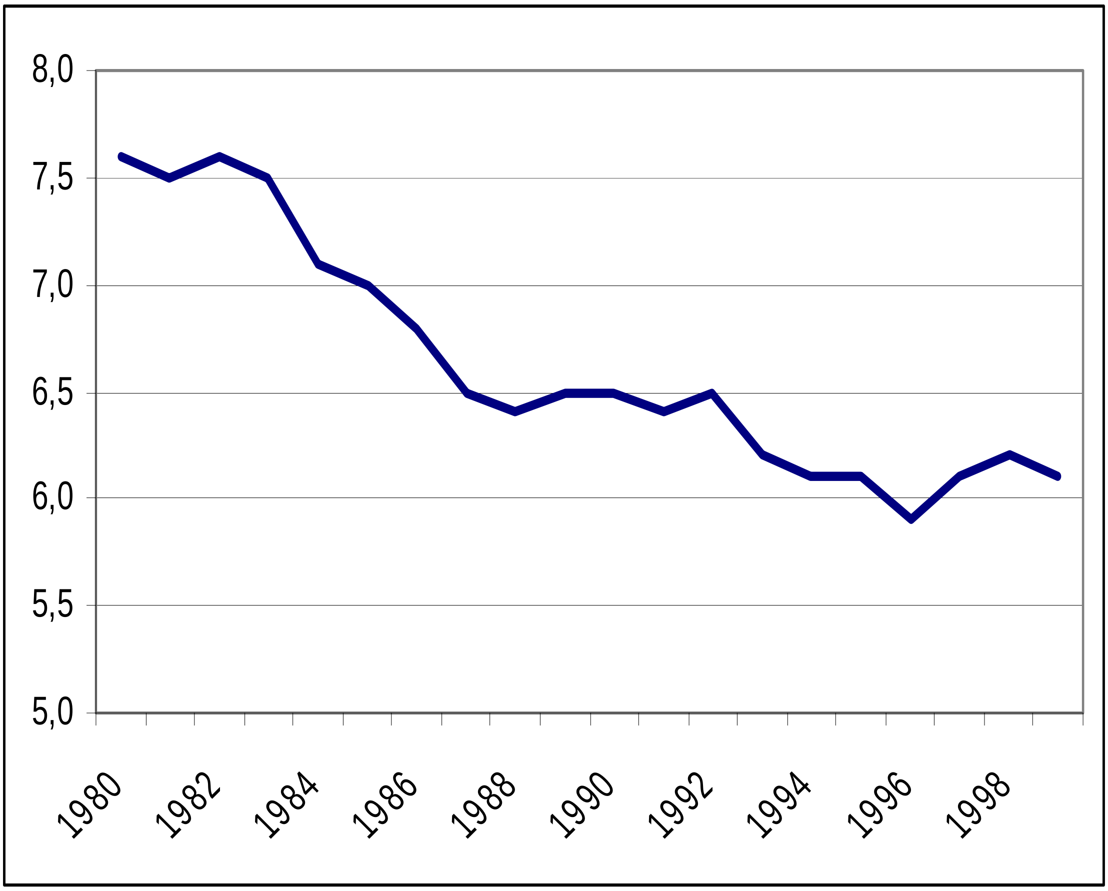
1.3 Signs of a certain decoupling in the industrial domain

The diagnosis of the enfeeblement of industry in France is widely shared (Fontagné [2004], Académie des Technologies [2004], Levet [2004]). The global lag of French industry is perceptible in employment creation, in the contribution to added value, as well as in the contribution to the balance of trade. This tendency does not result from an evolution towards services, because in this area France lags relative to other industrial countries. It is also the result of a weak French research and development (R&D) effort, which appears related, not to any lack within the individual sectors of the economy, but to an overly strong specialization in low technology industries. Therefore, in order for France’s technological position to improve, its industrial specialization must evolve.

1.3.1 Global lag in the weight of France in the value addition of manufacturing industries

The contribution of French industry to the creation of added value in the manufacturing industries of OECD countries exhibits a decreasing trend. To appreciate the evolution of French industry, one needs to compare the added value of French industry with that of other developed countries. This exercise is carried out in Figure 1. A clear decreasing trend is observable, which highlights the deficit or lag in the value addition of French industry relative to the industries of other large OECD countries.

Figure 1: Weighting of France in the total added value of manufacturing industries of 15 OECD countries[4]



Contrary to the clear trend of the preceding graph, the weighting of the United States in the total added value of manufacturing industries has increased: it rose from 33.5 % in 1991 to 37.2 % in 1999.

1.3.2 Overly weak specialization in high technology industries

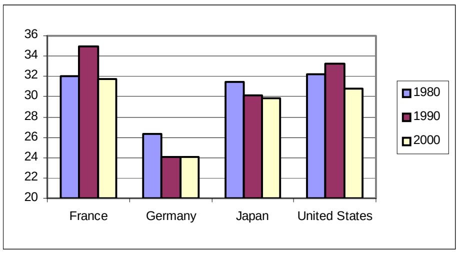
The worrying results of French industry are the result of an industrial specialization that is strong in "old economic" sectors and weak in new or high technology industries. French industry does possess global leaders in a large number of sectors, for example, primary materials, cement and glass, the aeronautics industry, the agri-food sector, luxury goods, and the railway infrastructure sector. However, French industry has few leading firms at the international level in the high technology sectors which represent strong growth markets. There are some happy exceptions, and these do not suffice to reverse the global trend.

The following figure confirms these facts. It presents the percentage of industrial added value achieved by four large types of industry, classified by technology and country. The grouping into four categories is designed by the OECD and thus makes international comparisons possible. It furnishes a useful and standardised first description of country specialization. The vertical axis plots the percentage of added value of the manufacturing industries for each country.

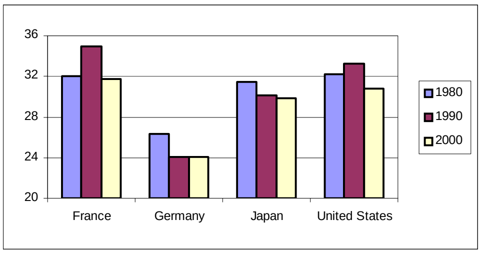
[4] The 15 OECD countries are: Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Portugal, Spain, Sweden, the United Kingdom, and the United States. Source: OECD / STAN Indicators 2004.

Figure 2: Contribution of each large industry type to industrial added value[5]

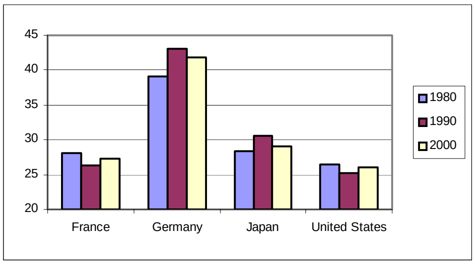
Low technology industry



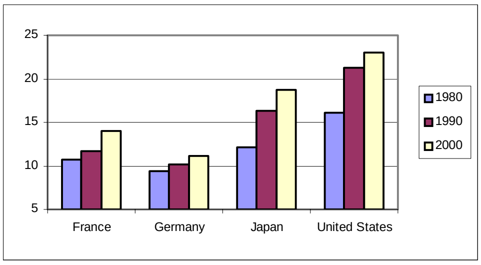
Low-medium technology industry



Medium-high technology industry



High technology industry



France's weak specialization in high technologies appears clearly in these charts. Germany also displays inadequacies in this area. However, these are compensated for by Germany's medium-high technology industries, unlike the weaknesses of France. France's mediocre industrial specialization in high technology is observable at the level of employment. The level of French employment in high technology industries is weak relative to other OECD countries. This fact is illustrated in the following figure representing high technology industrial weightings as percentages of total employment in the large OECD countries.

[5] The OECD definition of the four industry types is as follows.

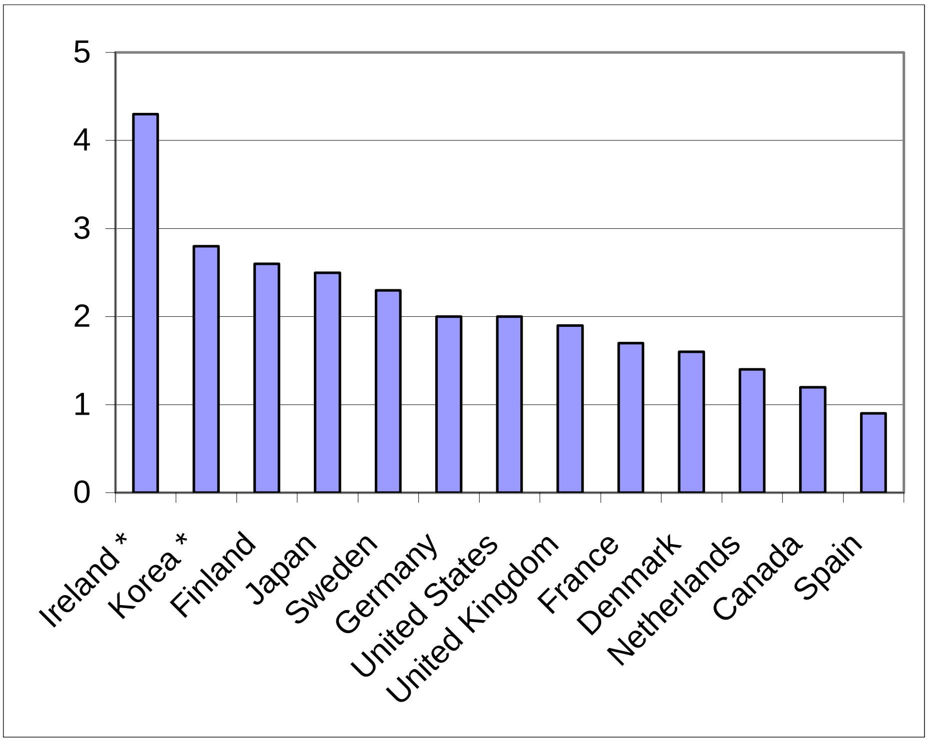
High technology industries (HT) = Pharmaceutical products, Accounting, IT and office machines, Radio, television and communications equipment, Medical, precision, optical, and timekeeping instruments, Aeronautical and space construction.

Medium-high technology industries (MHT) = Machines and material not covered above, Machines and electrical equipment, n.c.a., Automotive vehicles, trailers, semi-trailers, Rolling rail stock and transport equipment n.c.a., Chemical products not including pharmaceutical products.

Low-medium technology industries (LMT) = Coking, pertol products and nuclear fuels, Rubber items and plastic materials, Base metal products and metal assemblages, Naval construction and repair.

Low technology industries (LT) = Food products, drinks, tobacco, Textiles, articles of clothing, leathers and footware, Wood and articles in wood and cork, Pastes, paper, paper articles, printing and publishing, Manufacturing industries n.c.a., Salvage.

Figure 3: High technology industrial weightings as a percentage of total employment (2000)



(*) 1999

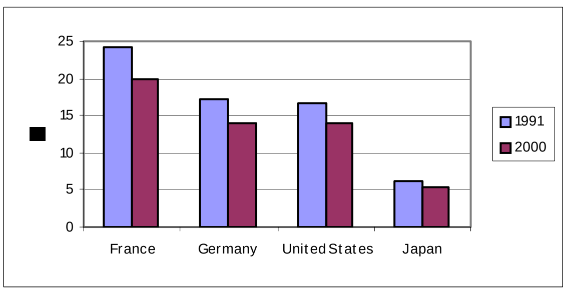
Source: OECD / STAN Indicators 2004

1.3.3 Weaknesses of French industrial specialization revealed in the trade balance

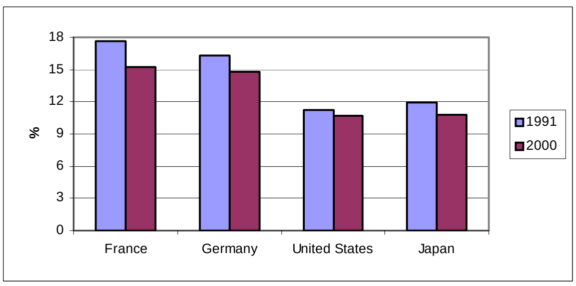
The trade balance of France reveals the competitive advantages of industry, the effects of which on value addition and employment have been shown above. The following figure represents the decomposition of the structure of exports as a function of four large technological groupings. France's export specialization is concentrated in low technology industries. Some low technology sectors, such as the agri-food industries, may constitute a comparative advantage of France in Europe. However, at the international level, these industries are set in direct competition with industries located in emerging economies, which have lower production costs. International competition in low technology sectors is manifest in the clear decreasing trend in the proportion of exports from low technology industries for the four countries (France, Germany, the United States, Japan). The consequences of this evolution are the most significant for France on account of its industrial specialization. Thus, sustainable improvement of the trade balance is only possible if high technology industries, in which products are highly differentiated, are developed.

Figure 4: Structure of manufacturing industry exports

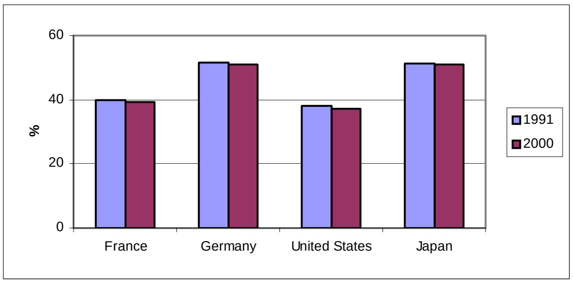
Low technology industry



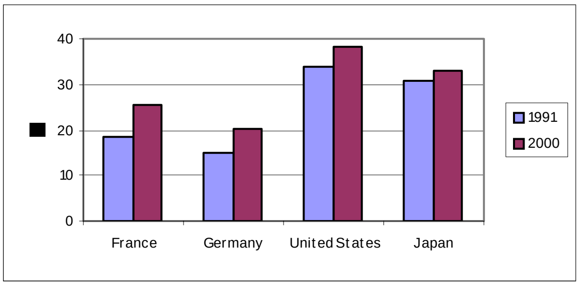
Low-medium technology industry



Medium-high technology industry



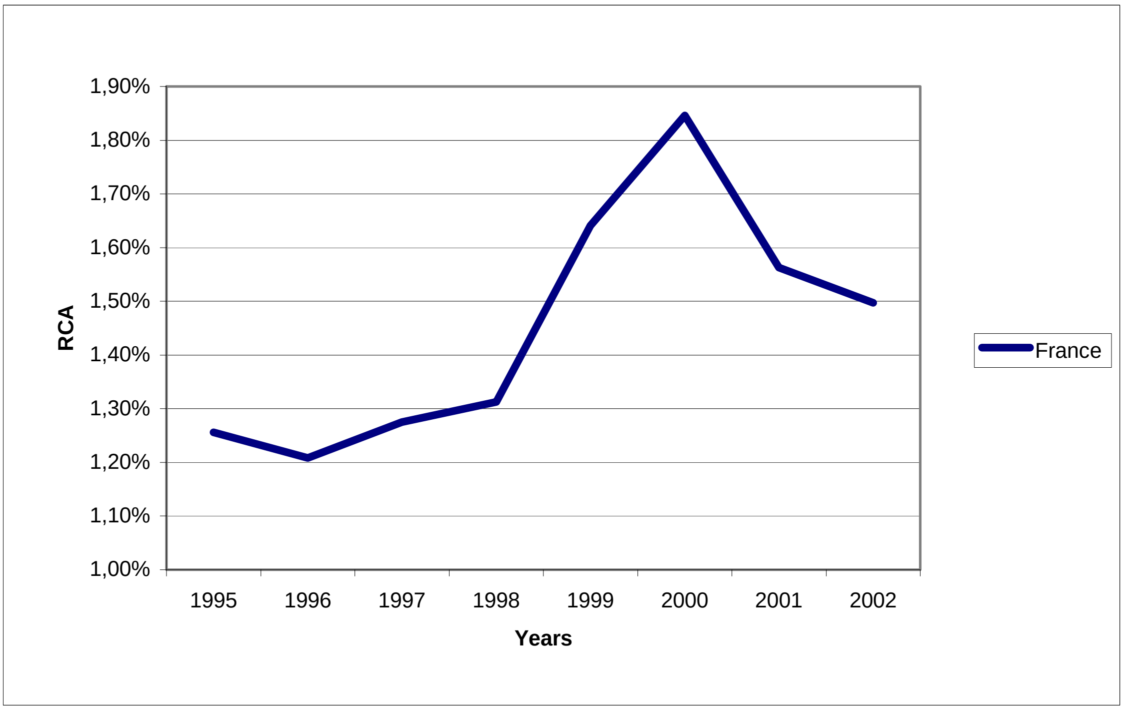
High technology industry



The vertical axis represents the percentage of the export total.

A more fine-grained approach focussing on 250 high technology products reveals the dynamics of the comparative advantage of France in high technologies. The following figure represents the contribution to the trade balance, also called the "revealed comparative advantage", of these high technology products. According to Fontagné [2004], the break in the recent trend should be emphasized. France has experienced a clear erosion of the competitiveness of its high technology products on the international plane.

Figure 5: Revealed comparative advantage (RCA) in technological products

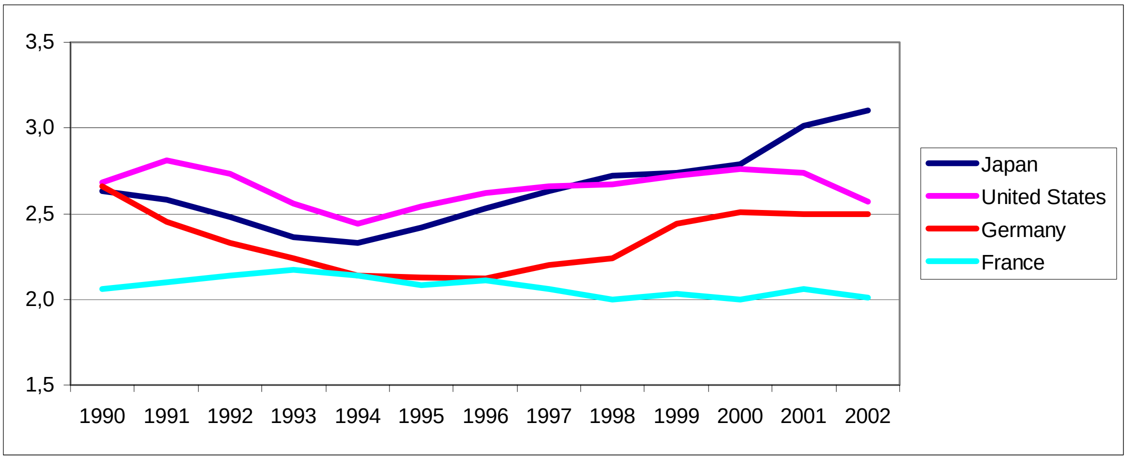


Source: CEPII

1.3.4 Weak effort of French industrial innovation relative to other countries

The sources of inadequacies in industrial specialization and the difficulties of high technology in France are located in its weak research and development effort. Figure 6 presents the evolution of internal corporate spending on research and development as a percentage of GDP. The decoupling of France, visible since 1992, has since worsened. This decoupling of the private R&D effort is not compensated for by any corresponding public R&D effort, which remains at a level in France equivalent to that of other countries.

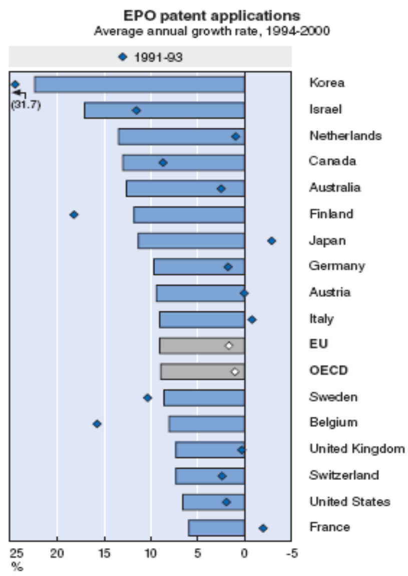
Figure 6: Internal corporate spending on research and development as a percentage of GDP



Source: OECD – STI

If patent registration is taken as an indicator of innovation (which is a debatable measure because of the strategic advantage in not registering patents), then the weaknesses in France's current innovation effort are revealed in the number of patent registrations at the European Patent Office. The growth rate of French patents is particularly weak in the period 1994-2000, as the following figure shows.

Figure 7: Patent registrations at the European Patent Office



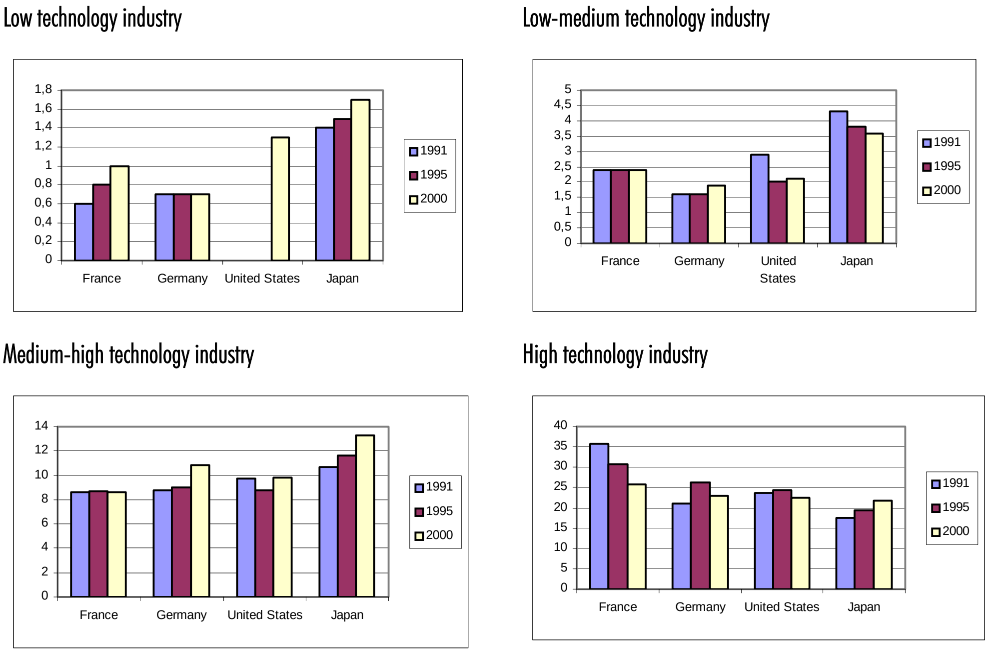
Source: OECD, Patent database, November 2003.

These figures do not contradict the good overall performance of research in France. However, they certainly underline the fact that the connections between public research and industry are inadequate.

1.3.5 French R&D weakness a result of industrial specialization

Comparison by industry type of the universe of countries shows that, for a given type, France does not undertake less research and development than other countries. France's weak innovation effort is related to its industrial specialization in low technology industries, which, structurally, engage in little R&D. In the following figure, the vertical axis represents R&D expenditure by sector, divided by that sector's added value.

Figure 8: Intensity of sectoral R&D relative to sectoral added value for different countries



Source: OECD / STAN Indicators 2004

These charts confirm that France's R&D effort in high technology industries is high relative to other countries. They strengthen the hypothesis presented above concerning industrial specialization as the cause of the anaemia of French R&D. Furthermore, the decreasing trend in France's R&D effort in high technology industries should be noted, confirming the diagnosis formulated above on the basis of 250 products.

This section establishes that French industry suffers from a weak research effort which has to do more with sectoral problems than with microeconomic issues. Therefore, the goal should be a reorientation of France's industrial specialization in order to improve its position in high technology markets, rather than an increase in corporate R&D intensity, for which there is no evidence to show it is too weak.

1.4 R&D support policy in France: weakness of instruments promoting industrial redeployment

The previous findings reveal that the manifest emergent difficulties of industry in France stem from the country's industrial specialization, which remains too concentrated on old economic sectors pursuing weak R&D efforts and increasingly standardized products. This section will show that the structures of the currently implemented industrial policy are not adapted to deal with the new issues.

1.4.1 Diversity of the structures of public support for industrial innovation

This section provides a global overview of the French system of R&D aid, and then proceeds to an analysis of the system. As Levet [2004] notes, it is difficult to present public aid to firms in all its dimensions. Nevertheless, the data of the office of statistics on research enable one to distinguish six structures of public aid for industrial innovation[6]. These structures finance 14 % of research undertaken by firms in 2002, or 3.1 billion €[7]. The number underestimates public aid because the aid coming from local authorities, such as the repayment of local corporate tax, is not taken into account.

In 2002, the breakdown of public aid for these six types of financing was as follows.

1 – **Defence** financing represents **1.5 billion €**. It has decreased since the beginning of the 1990s and tends to be focussed on purely military applications developed by a limited number of very large firms, with little fall-out in the civil area.

2 – **Large-scale programmes** of the 1970s and 1980s continue to receive financial support, in aeronautics, space research, nuclear energy and the micro and nano-electronics sectors, which constitute the continuation of the old components plan, with subsidies (**575 million €**) and *ad hoc* aid (repayable advances for Airbus, regional aid for the Crolles project). The only recent Programme involves **micro and nano-electronics**. The Ministry of the Interior supports this field particularly. Thus, the **DIGITP** devotes 80 % if its **158 million €** of R&D aid to the nano-technology sector. 60 million € are devoted to the Crolles II project, 60 million € are devoted to different thematic networks (*clusters*) such as MEDEA+, PIDEA+ and EURIMUS II, which form part of the Eureka project.

3 – **Ministerial actions (200 million €)**, outside large-scale programmes, are of greater benefit to SMEs and are characterized by **geographic** and **sectoral sprinklings**: the distribution of the budgets for the principal initiatives across a multitude of fields (16 RRIT, 19 CNRT, Eureka, …), the dispersion of skill centres (7 oncology poles, 8 genetics poles).

4 – The funding of the **ANVAR** is directed towards SMEs and works according to a **subsidy system (80 million €)** and **repayable advances (190 million €**, with a 60 % repayment rate).

5 – The **Research Tax Credit (489 million €)** favours the SMEs in the main, because of its ceiling. It is said to reach 1 billion € in 2008.

6 – Finally, France benefited from approximately 10 % of the financing for the 5th European R&D Framework Programme (ER&DFP), of which 45 % went to firms (122 million € in the framework of the 5th ER&DFP). European funding of firms is again on the rise following an increase in the budget of the ER&DFP (+17 % from the 5th to the 6th ER&DFP) and an increasing focus on development (integrated projects) and SMEs.

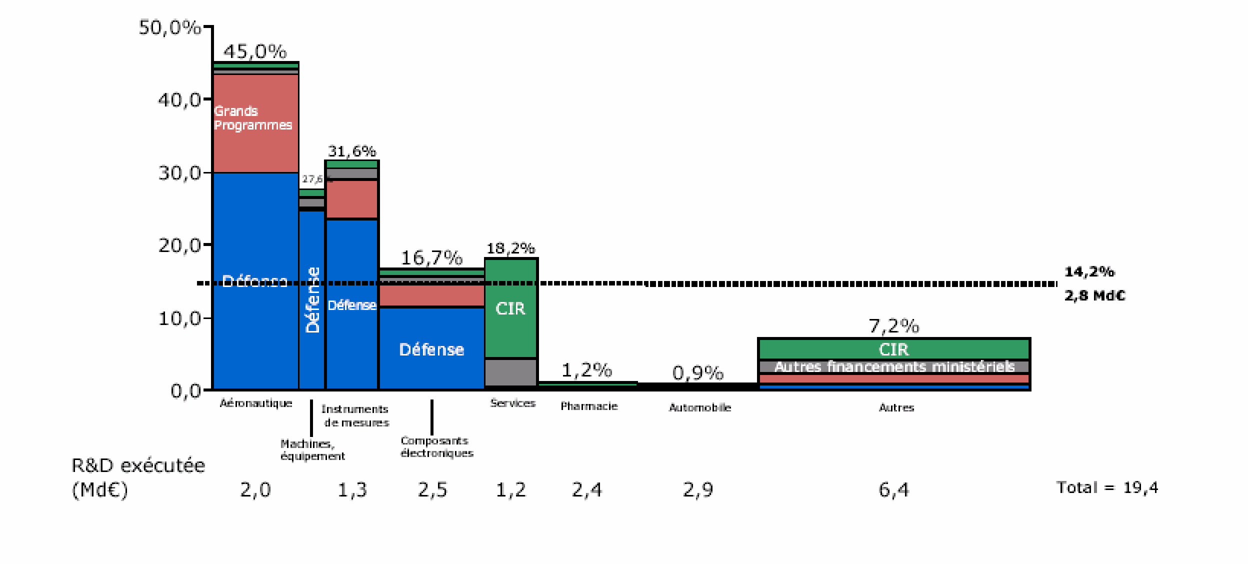
1.4.2 Concentration of public aid for R&D within the defence sectors and historic large-scale programmes

Public aid related to defence and large-scale programmes represents nearly 80 % of all public aid.

[6] Innovation is understood here as the phenomenon at the origin of production routine change. It is conceived as one of the key determinants in the evolution of techniques, the raising of living standards, and, consequently, growth (Boyer [2003]).

[7] This number is better in its construction than the one given by the OECD, since the latter excludes fiscal incentives, like the research tax credit and aid from the European Union. The OECD gives as an example a total of 8.4 % in 2001 for public financing of private R&D.

Figure 9: Public financing of corporate R&D outside the R&D Framework Programme in 2000



Sources: Office of Statistical Studies on Research, National Report of the CIR (2002, reworked for 2000).

This chart shows that the sectors receiving aid correspond to the sectors involved in historic large-scale programmes, which are aeronautics, space research, nuclear energy, and the nano-electronics sector. That is not to suggest that these sectors receive too much aid, but to point out the weakness of resourcing in other sectors.

1.4.3 Weak public aid in the technological domains of the futures

The absence of any focus on sectors of the future is further illustrated by examining the amounts mobilized in technological domains related to high technology industries. The choice of these domains does not come simply from international comparisons, but from a review of the literature on those technological domains that are most important for industry.

Table 2: Comparison of corporate R&D spending (including public funding) and public spending for some sectors and domains related to high technology (2000, base 100 = United States)

	France	Germany	Great Britain	European Union (1999)	Japan	United States	Source	
Life Sciences								
Pharmaceutical products	20	18	34	92 a	37	100	(1)	
CBPRD: Public health (2001)	4	3	7		4	100	(2)	
Biotechnology (jobs within firms, 2001)	3	9	12	39 b	4	100	(4)	
ITC and nanotechnology								
Accounting, computing and office machines	3	7	2	25	73	100	(1)	
Information services and related activities	4	6 c	6	26	9	100	(1)	
Tubes, valves and other electronic components	8	10		34 d	51 e	100	(1)	
Radio, television and communication equipment n.c.a.	14	21		65 d	51 e	100	(1)	
Medical, precision, optical and timekeeping instruments	7	9	4	25	16	100	(1)	
Public spending: nanotechnology (2003)	17 f	23 f	12 f	98 g	76	100	(5)	
Information technology and computer science (2003)	8	10	6	40 g	37	100	(6)	
Transport materials								
Automotive vehicles, trailers and semi-trailers	15	60	7	88	47	100	(1)	
Aeronautics and space construction	20	25	16	75	5	100	(1)	
Rolling railway stock; transport equipment n.c.a.	6	26	19		12	100	(1)	
CBPRD: Space exploration and exploitation (2001)	17	9	2		18	100		
Energy								
Electricity, gas and water	275	75	160		385	100	(1)	
CBPRD: Production, distribution and rational use of energy	62	52	4	192	553	100	(2)	
Public R&D spending: Nuclear energy (2002)	103			147	442	100	(3)	h
Public R&D spending: Fossil fuels (2002)	46			20	20	100	(3)	h
Public R&D spending: Renewable energy (2002)	20			94	92	100	(3)	h
Public R&D spending: Energy efficiency (2002)	8			39	100	100	(3)	h
Public R&D spending: Hydrogen and fuel cells (2002)	25				125	100	(3)	h

a) for the European Union: in the absence of data, it is assumed that the distribution between chemical products (24-2423) and pharmaceutical products (2423) is the same as for the total Germany + France + Great Britain. For the chemical sector overall, EU R&D represents 95.1% of that of the US.

b) 2001

c) 1999

d) for the European Union: in the absence of data, the assumption is made that the distribution between "Tubes, valves and other electronic components" (321) and "Radio, television and communication apparatus n.c.a." (32-321) is the same as the total for Germany + France. For the sector overall, EU R&D represents 49.8% of that of the US.

e) for Japan: the whole sector of radio, television and communication apparatus (citi rev3 32).

f) these figures do not take into account credits coming from the European Commission. For France, if one includes the ER&DPF in the total spending, then a spending figure of 51 (instead of 17) (see Billon et al [2004]).

g) 2003

h) for France, this includes the spending of research organizations; they include corporate and ER&DFP funding; for Japan and the United States, only public spending is included.

Source:

(1) OECD (ANBERD db)

(2) OECD (MSTI db)

(3) "Report on new energy technologies" (Rapport sur les Nouvelles technologies de l'énergie), Thierry Chambolle and Florence Méaux, report to the Ministry of Economy, Finance and Industry, the Ministry of Ecology and Sustainable Development, the Ministry delegated to Research and New Technologies, and the Ministry delegated to Industry, 2003.

(4) P. Kopp (director) "The French biotechnology sector" (Le secteur français des biotechnologies), France Biotech, December 2003.

(5) European Commission communication "Towards a European strategy in favour of nanotechnologies" (Vers une stratégie européenne en faveur des nanotechnologies), European Commission, Luxembourg: Office of Official Publications of the European Communities, 2004.

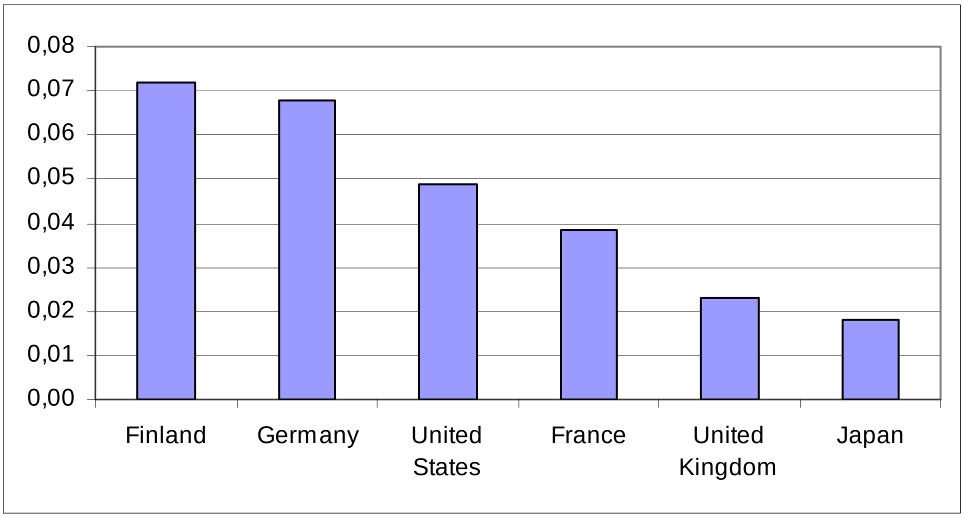
(6) "R&D in information technology and science in the large industrial countries" (RD en Sciences et technologie de l'information dans les grands pays industriels), Information Technology Strategic Council, 2003.

The preceding table shows the weakness of the amounts of R&D spending. The table confirms the weak role of public money in the evolution of French industrial specialization.

1.4.4 French funding of corporate civil R&D is weak

The defence sector plays a special role in the financing of R&D. To study exclusively civil R&D funding induces a predictable bias into the results. In the United States, for example, organizations like the DARPA contribute to the elaboration of military research with numerous civil applications. The following chart shows the proportion of the contribution of civil funding to corporate internal R&D spending in different countries.

Figure 10: Contribution of State civil funding to corporate internal R&D spending relative to GDP

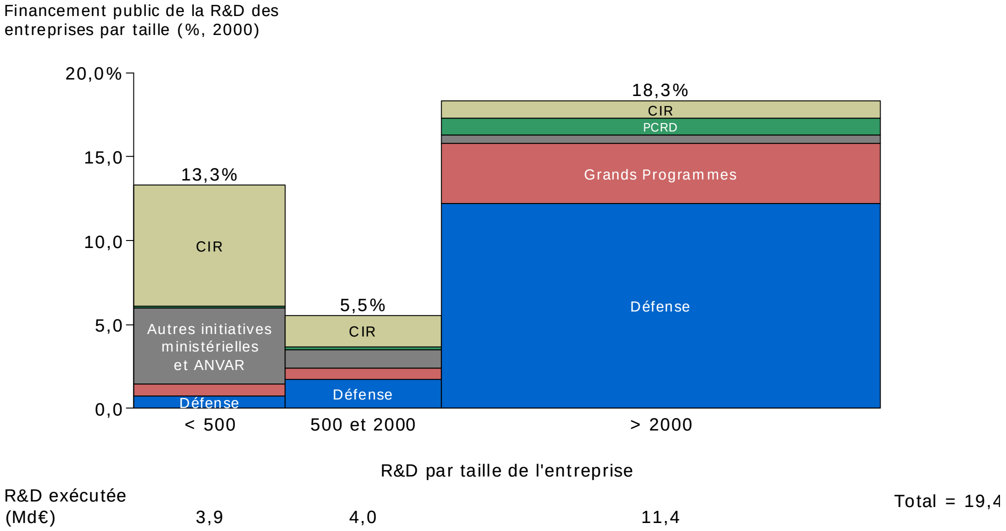


Source: calculations based on data obtained from the OECD, except for the criteria for defence funding exclusions, determined from the databases of the Z.W.E. (Germany), MEN (France, United States, Great Britain), MSTI and the OECD. (Japan, Finland).

1.4.5 Aid to large firms outside defence and historic large-scale programmes

The following graph represents the proportion of corporate R&D financed by public funds excluding defence and the historic large-scale programmes (aeronautics, space research, nuclear energy, and the nano-electronics sector). The exclusion of these sources of financing is useful because it enables one to highlight the proportion of funding that is used in industrial redeployment beyond the historic large-scale programmes.

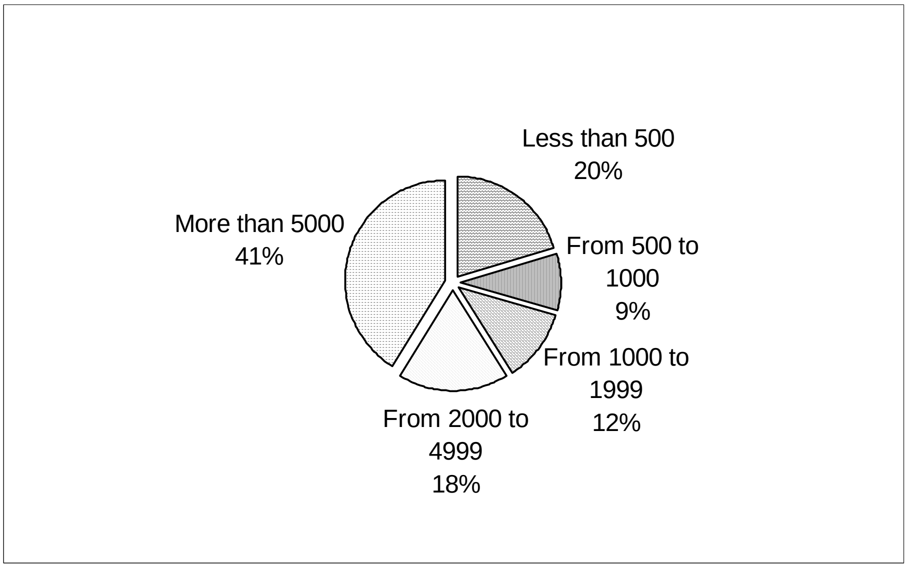
Figure 11: Proportion of R&D financed in 2000, as a function of corporate workforce (CIR = Research Tax Credit)



Sources: Office of Statistical Studies on Research, National Report on the Research Tax Credit (2002, reworked for 2000).

This chart shows that French industrial policy certainly helps large firms, but essentially through spending related to the defence sector. The second source of funding comes from historic large-scale programmes, which do not contribute to the current transformation of France's industrial structure. Thus, public funding provides little incentive to large firms to engage in R&D on new products. However, large firms play a determining role in the national R&D effort of the majority of OECD countries (Sheelan and Wyckoff, OECD [2003]). In the case of France, the following graph shows the contribution of firms to the R&D effort as a function of their workforce.

Figure 12: Distribution of corporate internal R&D spending as a function of corporate workforce



Source: Ministry of National Education, DEP B3

The weakness of the contribution to the R&D funding of firms employing more than 50 salaried workers is damaging to any industrial redeployment towards high technology industries. In order for internationally competitive firms creating a high number of jobs in the high technology sectors to emerge, it is necessary that large firms be constructed that are capable of confronting international competition. This can happen either through the transformation of medium-sized firms into larger firms, or through a process of technological differentiation within large firms. France's industrial policy does not promote these two processes, since it finances little R&D in firms having more than 500 salaried employees, outside the historic large-scale programmes. The rise to power of research tax credits, which are capped at 8 million € per firm per year in 2004 has the mechanical effect of increasing aid relative to small firms.

There is a common belief that small firms, grouped in clusters facilitating the circulation of information, lead efforts at innovation. This notion is certainly not without foundation. However, the role of large firms at the hub of these clusters is often important. Agrawal and Cockburn [2002] adduce some evidence tending to confirm, in the United States, the role of large firms within these clusters, where small high technology firms are particularly active in R&D. These hub-firms are large enterprises with significant volumes of R&D spending. The authors advance the idea that the role of these firms is to create the externalities of demand from which small firms profit. Another explanation is that large firms play the role of coordinator and guarantor underwriting the specific investments of small firms.

1.5 Two examples of focussed industrial policies: Japan and the United States

Before envisaging proposals relating to France's industrial policy, it is valuable to analyse the industrial policies that are actively pursued in Japan and the United States relative to industrial specialization in high technology sectors. The comparison will be made from two angles. Both the global amounts and the forms of public aid to the private sector for financing innovation are examined. Analysis of the industrial policies of the United States and Japan shows that focussing of public aid is used in order to improve the industrial specialization of the country.

1.5.1 United States: massive funding of private research and targeted interventions of the public authorities

In 2002, United States R&D spending reached more than 290 billion $. The United States accounted for more than 38 % of global public and "private" R&D[8], as compared with 5 % for France, 7 % for Germany, and 14 % for Japan (OECD, 2004). This weighting explains in a large measure the dominant position that the United States occupies in the peak sectors such as information and communication technology and biotechnology (U.S. Department of Commerce, 2003).

Industry is at the core of the research system in the United States, since it funds 63 %, and undertakes three-quarters, of all US research. Since the « Bayh-Dole » law of 1980, patent registration for the results of research financed by public funds is permitted. Furthermore, it is possible to dispose of patents through exclusive licences to private firms or to set up joint ventures with them, whose aim is to benefit from the licensed intellectual property, either through trade, or through exploitation leading to product commercialization.

Public financing of corporate R&D is considerable in the United States. It accounts for between 11 % and 21 % of R&D underwritten by firms (191 billion $). The uncertainty over the precise value stems from the data provided by the agents themselves. Firms and administrations calculate public financing of corporate R&D in very different ways[9]: in 2002, 16.5 billion $ according to the former, and 36 billion $[10] according to the latter. The deviation can be explained by the different definitions of the boundaries of R&D, in particular for defence. The real figure for public aid lies probably between these two bounds. Moreover, the tax credit for R&D spending stands at 5 billion $ in 2002[11], while the bounds of public aid are 21.5 and 41 billion $. Beyond the mere percentages, the actual sums involved are very significant, as is the effect on the increase in corporate R&D efforts.

In the 1970s, the United States could be characterized by the existence of a certain partition between federal research and the world of industry. Believing that this created a structural problem for its technological competitiveness, in the beginning of the 1980s, the United States gradually enacted a coherent legislative framework in order to stimulate technology transfers from the public sector to the private sector and to commercialize existing federal technologies.

Through subsidies to SMEs and SMIs[12], the *Small Business Innovation Development* Law of 1982 seeks to stimulate research and technological innovation within small firms, to use the resources of the latter for federal R&D needs, to encourage technological innovation by ethnic and social minorities, and to promote the commercialization, within the private sector, of technologies coming out of federal R&D. This law is at the origin of the creation of the *Small Business Innovation Research Program* which in 2002 subsidized 4500 programmes for more than 1.6 billion $. The granting of federal financing is not conditional on any equivalent co-financing on the part of the recipient firm, as is the case in France for the policy promoting SMEs.

The regulatory framework also involves universities. Thus, one of the objectives assigned to the universities of the United States is the promotion of the development of existing firms and the creation of start-ups or embryo firms within strategic sites. These technology transfers are significant. The *Association of University Technology Managers* (AUTM[13]) estimates the economic activity induced by technology transfers at 40 billion $ and the number of jobs created or saved at 271 000, in the United States (Michel [2003]). Generally speaking however, studies undertaken since the promulgation of the « Bayh-Dole » Law find the appearance of a displacement of the boundary between discoveries and inventions (Orsi and Coriat [2003]), to the detriment of knowledge production

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[8] In this context, the term "global" means the OECD countries, Argentina, Roumania, Russia, Singapore, Slovenia, and Taiwan.

[9] The source for firms is the *Survey of industrial R&D*, produced annually by the Division of Science Resources Statistics of the National Science Foundation (NSF). For administrations, the source is the *Federal Funds for Research and Development*, a document published for each tax year by the NSF. The difference between the two sources can be explained in part by the fact that the former is a survey of firms (the survey coverage is exhaustive for very large firms) while the latter is based on the declarations of the administrations and federal agencies. The spending boundaries understood as involving research and development are *de facto* calculated in quite different ways, in particular for military orders requiring R&D spending.

[10] The figure of 36 billion $ is the sum of the 34.2 billion $ of spending undertaken by firms, and the 1.5 billion $ of spending undertaken by the FFRDC (Federal Funded Research and Development Centers) administered by firms.

[11] NSF/ NSB, *Science and engineering indicators 2004.*

[12] Each federal agency with a budget over 100 million $ must devote 2.5 % of its budget to financing research projects undertaken by SMEs.

[13] This association federates approximately 3 200 members from more than 300 university or federal research institutions and the same number of private sector firms.

and in favour of commercial exploitation of discoveries (Dasgupta and David [1994]).

If regulatory and fiscal rules favour SMEs, federal funds are principally concentrated in very large firms (more than 25 000 salaried employees). Taking all sectors together, the first four companies received more than 8 billion $ of federal funds or 43 % of the total. In general, public funding is concentrated on a small number of sectors and more particularly on the aerospace industry (33 %), measurement and precision instruments (26 %) the activities of R&D scientific services (17 %) (in 2000 (source NSF)).

Federal research in the United States is underwritten by several governmental research agencies; in 2004, their total R&D budget was 105 billion $, of which 51 % was devoted to the research side. Nearly 90 % of the federal R&D budget is assigned to six of these agencies: *Department of Defense* (DOD), *Department of Health and Human Services* (HHS), *National Aeronautics & Space Administration* (NASA), *Department of Energy* (DOE), *National Science Foundation* (NSF), *US Department of Agriculture* (USDA). Added to these is the *Ministry for Homeland Security*, created in 2002. These thematic agencies allocate funding to the projects of universities, industries and diverse research organizations.

The role of the *National Institute of Health* (NIH) is determining in the health sector. Its total budget is 28 billion $. 1 billion $ is devoted directly to the R&D undertaken by firms; the remainder finances research within public laboratories and universities, on the basis of projects emanating directly from these laboratories. The results of this research are of benefit to firms for the most part (for example, in the undertaking of medical clinical trials).

If the agencies have their own projects and their own priorities, there also exist interdisciplinary programmes corresponding to government priorities. The principal interdisciplinary programmes involve[14]:

- ✓ information technologies (high performance computation, network security, software and systems reliability, capture technology, architecture miniaturization and human-machine interface) equipped with an R&D budget of 2.179 billion $;
- ✓ global climate change (*Global Change Research Program* (US-GCRP): the ozone layer, climatic changes, evolution of the earth's surface; the *Climate Change Research Initiative* (CCRI): evaluation of scientific data on climate change; the *National Climate Change Technology Initiative* (NCCTI): the fight against the technical greenhouse gas effects of fuel cells, geothermic centres, endowed with an R&D budget of 1.749 billion $ in 2004];
- ✓ nano-sciences and nano-technologies (a research family enabling the manipulation and control of matter at the subatomic level), for which the R&D budget is 849 million $;
- ✓ homeland security, with an R&D budget of 3.422 billion $.

65 % of federal government funding of corporate research is destined for industry sectors and 35 % goes to service sectors. The majority of funding (58 % in 2000) comes from the Defence secretariat, through the intermediary of the *Defense Advanced Research Projects Agency*, the DARPA. Any firms thus supported must organize into consortiums and invest at least as much as the government. The best-known consortiums are SEMATECH (*Semiconductor Manufacturing Technology Consortium*[15]) and the NCHP (*National Consortium for High Performance Computing*). In this way, the electronics sector receives more than 5 billion $ of financing coming from the Defence secretariat.

1.5.2 Coordination of firms/universities/State at the heart of the Japanese system of innovation

Since 1995, the Japanese government has had available legal competencies for the promotion of science and technology. Public R&D spending will not exceed 1 % on average within the framework of the 2001-2005 Plan[16]. This low percentage does not contradict the idea that governments choose Japan's paths in technology (Rosenberg [1994]). Scientific policy and industrial policy are coordinated

[14] Hagège [2003].

[15] The members of SEMATECH are: Advanced Micro Devices, Freescale Semiconductor Inc. (Motorola SPS), Hewlett-Packard, Intel, IBM, Texas Instruments, Infineon, Philips, TSMC.

[16] In 1999, 42 % for the Ministry of Education, 24 % for the Science and Technology Agency, 16 % for the Ministry of Industry; the remainder is spread among the other ministries.

at the governmental level through the policy on technology. Since the publication of the White Paper in 1948, the government has equipped itself with the means of intervention in order to solicit the intervention of university personnel in technology transfers, to support the training of engineers in the public domain, to confer fiscal advantages on technology transfers coming from public laboratories, and to fix the rules of standardization, normalization and measurement.

In 1998, the policy on innovation was reorganized on the initiative of the Ministry for International Trade and Industry, the MITI (today called the METI), following a schema that is singularly reminiscent of the plans of the "scientific method" of 1948 (Harayama [2001]). This method has three key points: "a global approach to a social structure favourable to innovation; the management of the objectives of industrial policy; an inventory of policy structures in order to improve the coherence and completeness of the means of innovation". The similarity between the post-war programme and the programme coordinating innovation currently stops at the new objectives that the MITI now sets itself: "the social contribution of technological innovation" (Masuda [1998]) becomes the goal of technology policy and not technological advance. The idea of *national* strategies for industrial technology appears for the first time, organized around the triangle of State, industry and university. Finally, in May 2004, the report of the Minister for Industry Nakagawa defines seven industrial sectors of the future in four regional networks, benefiting from a total of 1 billion □ in public aid, of which 500 million □ is for firms.

The dichotomy between fundamental research and the elaboration of public science on the one side, and applied research aimed at innovation on the other hand, is guaranteed by the sharing of tasks between the Ministry of Education and Research and the Ministry of Industry. Coordination amongst the ministries and agencies in science and technology thus constitutes the cornerstone of the Japanese system of innovation (Harayama [2001]). It rests on a policy of planning within which the agency for science and technology (integrated within the Ministry of Education since 2001) must construct and implement scientific and technological policy (Israël and Loc [2004]).

1.6 Mobilizing programmes at the heart of industrial policy renewal

The signs of industrial decoupling in France coincide with a policy marked by a dispersion of means outside defence and the "historic" large-scale programmes. This policy is in stark contrast with that of countries pursuing targeted industrial policies in new technologies of high industrial potential. Therefore, a more focussed industrial policy seems necessary. The following sections redefine the conditions of effective sectoral aid and a refocusing of French policy.

1.6.1 Defining the State role as guarantor and incentive provider for the funding of long-term innovative projects

Whether in the domains of nano-electronics, biotechnology, or fuel cells for example, there exists significant potential for innovations of large magnitude possessing every chance of changing future living conditions and creating important technological externalities (Kopp [2003]). These new perspectives necessitate high levels of investment and gestation periods of several years. It is difficult for firms to invest against horizons that are so remote. Numerous macro-economic risks exist, involving exchange rates, financial fluctuations, energy price fluctuations, against which firms can only partial insure. Consequently, the State has a role to play in order to promote industrial investment in projects that contain significant technological risk. This role is all the more useful when projects are risky, the amounts of investment significant, and the technological externalities great.

The State alone can contribute to the financing of large risky projects: it should play the role of guarantor and incentive provider, diversifying the risks across different projects. There may be different modes of State support for long-term innovative projects. Either the State itself undertakes the launch of new projects, as was the case in the historic large-scale programmes, or it can contribute to reducing the risks to which firms are exposed. It can provide stable and incentivizing finance or enable the existence of a public market. The modalities of insurance and incentivization of private agents can therefore take different forms, the goal being to increase strongly investments in projects capable of changing France's technological specialization.

1.6.2 Organizing the coordination of different agents around a production project

The second function of the mobilizing programmes is to enable the coordination of private and public agents around a production project. This function should allow the resolution of certain defects of coordination among industrialists, subcontractors, and public research agents.

Research agents, both public and private, agree on the necessity of transfer of knowledge and methods of fundamental research into applied or purpose-oriented domains; in fact, this transfer helps the valorization of the public research effort (États Généraux de la Recherche, 2005). One function of the mobilizing programmes might be to contribute to ensuring the coordination between knowledge and processes elaborated within public research and private resources around a production project. This role of coordination and mobilization is very important in other countries, notably in Japan. It is necessary in France, where interfaces are rare and interactions are not always successful. It is important to emphasize that the coordination of public and private research must happen without subordinating one to the other, and in full respect of their respective logics. For example, the principles of the constitution of scientific knowledge mandate respect for the free circulation of knowledge (*ibid.*).

Insert 1: Economic justifications for targeted industrial policies

The economic analysis of industrial policy is often founded on the identification of market failures, that is to say, reasons for which the market cannot allocate resources efficiently. The preceding two analyses introduce three justifications.

- The first justification relates to problems of coordination and information dissemination amongst all the agents, that bedevil the industrial analysis of technologies. The fine-tuning of large-scale industrial innovation requires the coordination of the skills of different firms and different public research agents. An institutional framework is most often necessary in order to guarantee this coordination.

- The second justification is the existence of externalities, that is to say, global outcomes related to research into new technologies, that are not taken into account by firms. R&D efforts have secondary outcomes, that are difficult to forecast, but that increase the productivity of numerous industries.

- The third justification is the existence of very heavy initial costs, long-term horizon, and high risks of research and development activities. Financial markets are not efficient in enabling the financing of such projects under these conditions, because the risks cannot be hedged over the time horizons involved.

These three justifications are well known in economic analysis (Rodrik [2004], European Commission [2004c], Krugman and Obstfeld [1995, chapter 12]). Moreover, the argument about the inefficiency of financial markets for long-term financing is widely developed in the economic literature (Allen and Gale [1997] and more generally Shleifer [2000] or Boyer *et al.* [2004]). The three effects highlighted above induce under-investment in long-term projects with high R&D intensity. The State must therefore play an incentivizing role.

Furthermore, the Japanese and American systems of research, which have continuously increased their publication references since 1994, have converged in their public research thanks to free access to scientific publications (Branstetter [2001]). The very strong increase in citations, linked in part to the rise to power of the Internet, seems to be a sign of greater closeness of public research and industry, which is presented as a cause of the leap in productivity between 1994 and 1998[17]. In general, it appears that the increase in patent citations is related to the knock-on effects of public research (Branstetter, Nakamura [2003]).

Moreover, the programmes may allow the coordination of different public institutions which often work on connected domains (for example, the function of forecasting and technology monitoring is scattered amongst different ministries and agencies: Foreign Affaires, Interior, MINEFI, etc.), while setting caps for example, in the areas of training and the careers of young researchers and engineers.

1.6.3 Answering the criticisms of targeted industrial policies

The nature of the information available to determine priority sectors and type of intervention lies at the heart of the first series of arguments against industrial policy. The amounts in play are very significant and it can be difficult to affirm that the industrial gain is

[17] In the United States, the sanctions relating to citation omissions have also been strengthened (Jaffe, Fogarty, Banks [1998]).

greater than the opportunity cost of the public money invested, that is to say, the social use of that sum employed for other purposes. The State may misjudge its action and support projects that the evolution of demand does not validate, whereas firms would never have thrown themselves into such investments. The State might just as well give unfounded industrial advantages to certain firms, causing a damaging distortion of competition, by creating monopolies of uncertain industrial dynamism.

A second line of critical arguments against targeted industrial policies points to the political agenda of the State. The State may, for purely political ends, support for too long an industrial project whose failure appears manifest, as the case of Bull shows; alternatively, it may stop the financing of socially profitable but as yet incomplete projects, for short-term budgetary reasons. Even if the State can envisage useful economically targeted interventions, the State management of industrial projects can lessen their interest.

These criticisms of State sectoral intervention do not invalidate industrial policy in general. They are often used in order to justify the putting in place of "horizontal" aid benefiting certain agents, for example, small firms or innovative firms, without determining the focus of industries[18]. Theoretical arguments and international comparisons show that focussed aid is not always wrong, either theoretically or empirically: heavily industrialized countries do not exclusively favour horizontal aid. In the case of a country the size of France, where economies of scale are weaker than in Japan and *a fortiori* in the United States, resource autarchy and relative independence from foreign investment bolster the choice of an industrial policy oriented towards innovation. Criticisms of targeted aid often simply summarize the lessons of failed industrial policies in different countries. Therefore, the proposals of this report will take these points of view into account when determining the modes of intervention of an effective industrial policy that is coherent with these objectives.

1.6.4 Re-evaluating the concept of large-scale industrial programmes

In order to contribute to the strengthening of industrial specialization in France, industrial policy must once again take on its functions of incentivization and coordination. These functions had as their previous frameworks the large-scale industrial programmes launched by the State, and whose effects have been described in section 1.4. The historic large-scale programmes cannot be conceived today as they were in the past. They were founded on the coordination of public research, public firm, and public contract (order placement). This coordination made possible the convergence of long-term industrial and research efforts around a "demonstration model", destined for a public client (Minitel, Concorde, TGV (high-speed trains), etc.). The regulatory and competitive context of that epoch allowed a policy of constituting national champions, born out of political will alone.

The coordination of these three types of agent has been called into question by the internationalization of the economy and the desire of public authorities to position themselves within a properly European space. Exposure to the European Union orients the set of recommendations of the present report. On the side of public research, it is imperative to respect the autonomy required for the elaboration of knowledge and to create at the same time an interface capable of mobilizing the knowledge necessary to private research. On the side of public demand, an important role can be played in supporting industrial projects. Once there is consent about the technological initiative, the use of public demand should be clearly defined and economically justified. High definition analogue television, launched at the European level, is an example of the failure of a public technological choice due to non-existent demand. Finally, the creation of public firms within the framework of large-scale programmes cannot be entertained, simply because of the fact of the increase in international competition. The presence of immediate competitors renders this strategy dangerous and costly. Reliance on adequate industrial potential appears necessary in order to confront current competition and to define appropriate industrial orientations.

The success of the nano-electronics sector illustrates the correct conduct of a targeted industrial policy. The concentration of resources and geography enabled large firms to associate; these large firms invigorated the local industrial fabric, stimulating a network of SMEs. The public effort made improvement of French industrial specialization possible by creating a global pole in nano-technologies. Thus, a firm like STMicroelectronics went from fifteenth place (in terms of market share) in 1987 to global 4th position in 2002. The sites of Crolles and Rousset now attract foreign firms (Motorola and Atmel, in particular, have decided to locate significant research and

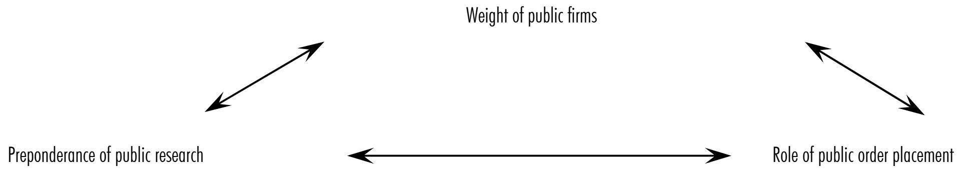
[18] Fiscal exemptions for all firms who incur R&D expenses are a common example of horizontal aid.

development sites there).

Insert 2: Horizontally aided Large-scale Programmes

The policy of large-scale programmes was marked by the complementarity of three characteristics strongly linked to public intervention.

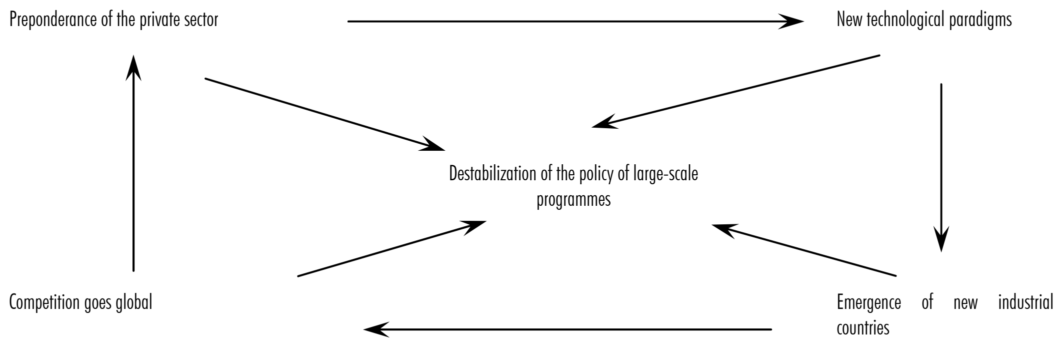
Figure 1: The industrial policy of large-scale programmes



The effectiveness of this form of industrial policy has been eroded progressively due to at least four major changes:

1. Privatization has reduced the weight of public firms.
2. The renewal of technological paradigms has been associated with the end of a catch-up phase by Europe and Japan.
3. The rules governing competition at the European and global levels have forbidden public subsidies as a distortion of a supra-national principle of competition.
4. The internationalization of production has affected the form of the complementarities guaranteeing the competitiveness of (national) territories.

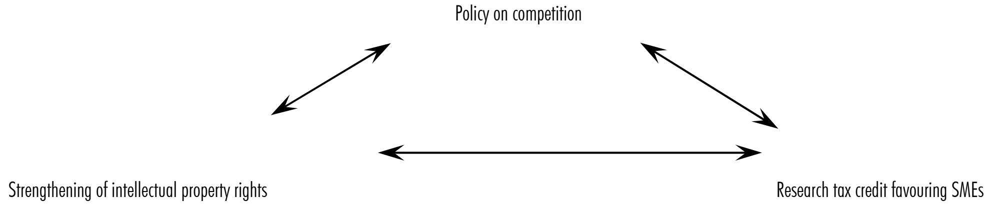
Figure 2: An epochal change: the destabilization of the policy of large-scale programmes



Consequently, most targeted industrial policies have been abandoned in favour of a *horizontal approach* aimed at developing fields favourable to innovation:

1. the adoption of the assumption that the degree of competitiveness is the essential determinant of innovation ;
2. the evolution of a patenting policy and the extension of intellectual property rights with the aim of favouring research and development initiatives in the private sector.
3. a generalization of the research tax credit in order to favour innovation, especially in SMEs.

Figure 3: Horizontal industrial policies



This policy has not delivered any renewal of specialization and competitive advantages, at least in Europe.

1.6.5 Characteristics of a new targeted industrial policy

The economic analyses presented in preceding sections and the assessment of the historic large-scale programmes lead to the proposal of a programme in the sense of an action plan for a targeted industrial policy.

1) The goal of the Programme is to result in a product that both involves private agents of the Programme, and corresponds to an expected demand in a European or global market. The choices of the sectors and products should be grounded in an economic justification, in a way that makes clear evaluation of the Programme's results possible.

2) The Programme should combine R&D efforts leading to a demonstration model in which a strong technical component is present; it must bring solutions to major scientific and technological questions.

3) The Programme should bring together private agents right from the elaboration of projects in order to use fully any existing industrial capacities. An industrial project should be based, from the start, on an evaluation of the potential in manpower, production capacities and the research of public and private agents. The potential knock-on effects of the conclusion of the Programme, at both the French and global levels, must be taken into consideration when the Programme choices are made.

4) The Programme should be organized on a medium to long-term horizon, in order to play the role of guarantor fully. The scale of projects must enable a sustainable contribution to the improvement of French industrial specialization.

The implementation of the Programme might take the following form:

1) public aid would guarantee partial funding of R&D expenditure; involvement of potential clients in the Programme would make it possible to find a substitute for public order placement in an incipient market, when the latter is not envisageable;

2) the mobilization and close coordination of different agents should contribute to the clear definition of expected needs: industrialists capable of carrying out projects, partner-firms, scientists able to evaluate the technical issues, users, potential clients and representatives of public organizations;

3) regular evaluation according to criteria defined at the beginning of the project should allow transparent management of public money, making simultaneously possible continuity of funding for projects that are evaluated positively, and the cessation, in agreement with the partners, of programmes that are not reaching their objectives.

These principles differ from those of the "Large-scale Programmes", as they were thought of previously. If the importance of public order placement is not actually excluded, it does not play a central role: the existence of potential clients associated with the development of the Programme can enable the definition of a private substitute for public demand. The European dimension is, moreover, constitutive of these mobilizing projects. Thus, the expression "mobilizing programmes for industrial innovation" (MPIIs) will be used to refer to targeted industrial projects conforming to these principles. A more precise and operational description of these programmes is given in the following section of the report.

Insert 3: MPIIs as a response to contemporary problems

1. Purely horizontal aid has had a weak effect on industrial specialization in France:

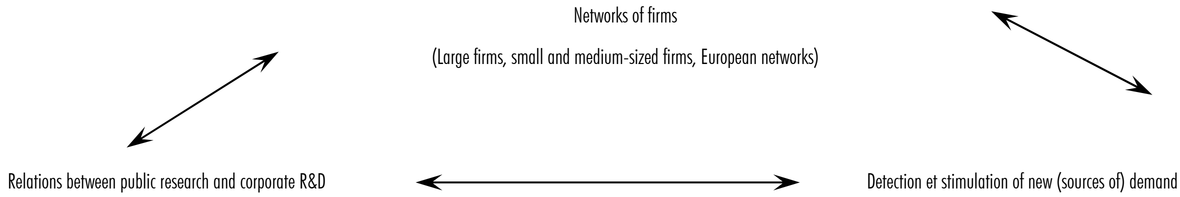
Contrary to what has been observed in the United States, few start-ups have become large firms.

The toughening up of the defence of intellectual property rights has penalized the diffusion of innovations, to the point that unusual coordinating structures have appeared (pooling of a set of patents within a consortium, for example).

The dispersion of research and development efforts has not initiated the renewal of industrial specialization in countries like France and Germany.

2. As a consequence, there is a manifest interest in the *renewal of industrial policies*, or at least the adjunction of new instruments enabling determinate action to evolve industrial specialization. The principle consists in constructing synergies analogous to those that the industrial policies of the 1960s targeted, in a context where the vocation of public intervention is to encourage private agents to develop these synergies themselves.

Figure 4: MPIIs as incentivization of the coordination of public and private agents



In a sense, this rediscovers the synergy between firms, the research sector and market dynamics, but the public sector is no longer the puppet master of this configuration. The public sector is the *catalyst*. The differences from French large-scale programmes must be emphasized.

Public contract (order placement) is only one of the modalities in the creation of new demand, because the objective of the MPIIs is to satisfy first of all a demand at the global level.

A clear distinction is evident between the purpose of public research (to elaborate and develop new fundamental knowledge without pre-judging the possibility of deriving innovations for the private sector) and the R&D undertaken by firms or better still consortiums mobilized around the production of a prototype or demonstration model.

These programmes are open to all European firms and are therefore not limited to national firms.

3. The MPIIs must "create a school" and stimulate *European initiatives*, since it is at this level that the objective is predicated of a redeployment of industrial specialization in the direction of high technologies, and towards sectors and products with high added value.

2 Redefinition of industrial policy around Mobilizing Programmes

The report recommends a redefinition of France's industrial policy so that it has a long-term focus and is capable of contributing to the improvement of France's industrial specialization. The object of this section is to define MPIIs more precisely and to determine their selection criteria.

2.1 The definition of Mobilizing Programmes for Industrial Innovation

The technological, industrial and social dimensions of the MPIIs are shaped by four assumptions:

- the existence of a European and global market of significant size, sufficient to justify the temporary and pre-competitive nature of public aid;

- strong technological innovation, the essential element for the evolution of industrial specialization in the Programme outcome;

- a driving role and financial involvement of one or more industrialists, responsible for the implementation of the Programme and for the coordination of a cooperative system including public research laboratories, other corporate partners, large clients and planners;

- a medium-term horizon of five to 15 years depending on the projects.

2.1.1 Existence of a market

In order to contribute to change in industrial specialization, the Programme must target production levels and markets that are significant. The commercial objective should be to reach sales of approximately 1 billion €, in a total market of up to 10 billion €, that is to say, an important share in a significant market.

From this, the Programme should contribute to the creation and permanence of high value additive employment.

2.1.2 Focus on object possessing high component of technological innovation

The Programme is designed for a product that includes important innovations. It covers research and development work and leads to the fine-tuning of demonstration models to specifications and clearly defined performance measures.

Innovation and technological break-throughs are a major objective, in order to stimulate the evolution of the specialization of an industry, on the one hand, and, on the other, to justify in economic terms the fact that these projects require public funding.

The Programme is different from transversal research initiatives aiming to promote the development of a knowledge base in technological domain, although it may be supported by such initiatives. It is also different from corporate RD projects aiming at the market delivery of products and services in a short-term horizon. These elements guarantee the pre-competitive nature of the Programme, and are also a guarantee against windfall effects.

2.1.3 The role of industrial agents

The Programme relies on accountable industrial agents, who guarantee the governance of the management of the programme. The high level of involvement of an industrialist is an essential validating element of the fact that the products made possible by the Programme will be able to constitute a market, satisfy a significant demand, and in addition be competitive in the end with comparable product offers originating from other territorial areas.

The industrialist is committed to providing financial guarantees out of his own funds amounting to half of the R&D costs of the Programme. This constraint guarantees the real involvement of the industrialist receiving public money.

As a beneficiary of public aid, the industrialist also undertakes the mission of coordination with the public research laboratories to federate in a cooperative manner the vertical chain, including the other partner firms, the clients and the designers of the products resulting from the developments of the Programme.

The Programme must associate small and medium-size firms insofar as they are responsible for part of the R&D. This association enables them to acquire competitive levels of specialization

2.1.4 A medium to long-term temporal horizon allowing the mobilization and sustainable federation of multiple players

Depending on its individual characteristics, the expected length of a Programme lies between five and fifteen years. Within this horizon and around a single objective there should converge an appropriation and a shared vision in the medium term of all the skills necessary for the realization of the project, in particular, those skills from the public sphere and the research sphere. This convergence will happen through the effective coordination of applied fundamental research and the sphere of the industry with the economic sub sector around the product.

2.2 Selection criteria for MPIIs

Current European programmes, launched in previous decades (nuclear energy, aeronautics, space research, micro and nano-electronics) should be pursued. Projects in the defence sector do not come within the framework of this analysis, since they fall outside the terms of reference of the mission. The elements of definition of MPIIs enable one to determine selection criteria for large-scale programmes from the global list provided previously

2.2.1 Scale of demand

This criterion analyses in a predictive manner what might be the scale of the new market made possible by the development of the Programme, at both the European and global levels within its temporal frame. The criterion also takes into account the size of the likely potential population (for example, within the framework of a health-related Programme, the population for which a therapy is relevant). It may happen that significant issues may concern a limited population.

2.2.2 Strong component of innovation

The objective of the Programme is differentiation through technological innovation. It follows that it can retain only those projects having medium to long-term horizons with important new scientific discoveries or integration requirements concerning multiple complex technologies enabling European agents to gain prime positions.

2.2.3 Identification and mobilization of industrial agents capable of undertaking the project

The existence of an existing industrial base is an indispensable condition for the success of the MPIIs. It should be possible to identify motivated European industrial operators that are capable of co financing and managing projects, and of becoming leaders in the new market made possible by the Programme.

2.2.4 Economic criteria

This criterion consists in evaluating the Programme as a function of its ultimate purpose, the improvement of European competitiveness and its direct consequences in the area of sustainable qualified employment. Employment stability, the nature of the jobs created (research and development, very high added value production), and the retention of those jobs within the European territory, constitute the essential elements of evaluation of Programmes on this theme.

2.2.5 Role of the public authority

The final criterion is one of the most important. It concerns the necessity for public intervention, when the mobilizing Programme has satisfied the preceding criteria.

The intervention of the public authority may prove necessary at three stages of the rollout of projects. The first stage involves the necessity for coordination of the project agents, in particular the coordination of private agents with public organizations, such as research laboratories. This coordination may be geographical or thematic.

The second form of public intervention concerns direct financial support for research and development. The concrete modalities of this support depend on the specific Programme.

The third form of public intervention relates to the end market, where the public authority can intervene either by public contract (order placement), or by the enactment of regulation.

2.2.6 Synthesis of the criteria

The table below summarizes the different criteria and qualifies them in terms of their capacity to support a Mobilizing Programme.

Evaluation of a Programme	Weak	Acceptable	Strong
Significant market potential	Restricted target population. Global market of average growth over 5-10 years and of size $<$ 4–5 billion €.	Global market of rapid growth over 5-10 years in the size band 5–30 billion €.	Strong specifically European component. Global market exploding over 5-10 years and of size $>$ 30 billion €.
Innovation component	Short technological horizon $<$ 4–5 years. Low associated technological bottlenecks. Weak externalities in other fields. Low level of technological integration.	Technological horizon between 5 and 10 years. Significant but accessible technological bottlenecks. Possible externalities in other sectors. Technological integration within a prototype.	Technological horizon $>$ 10 years. Very strong scientific and technological bottlenecks. Strong fundamental research necessary. Complex integration. Very strong technological externalities.
Franco-European industrial forces	Absence of a European industrial operator. Chronic weakness of Europe in the field. Low density associated industrial fabric. Unrecoverable lag.	European industrial operator with mid-sector position. Medium density industrial fabric. Insufficient European initiatives. Recoverable lag or possible domination.	European industrial operator with dominant sector position. Competitive advantage of European industry. Vigorous associated industrial fabric. Reinforcing primacy.
Added value per job	Weak added value jobs. Low sustainability. Easily delocalizable.	Potentially value additive jobs. Mainly European localization on a 5–10 year horizon.	High added value jobs (R&D, highly qualified production, …). Stable European localization on a 5–10 year horizon.
Public authority	Weak need of support upstream from public research. Low level of R&D financing required: $<$ 20 million € per year. Downstream public role not critical.	Support from public research necessary. Public coordination of the R&D effort necessary. Significant financial support necessary: 20–100 million € per year. Downstream role for the public authority possible and desirable (regulation, standard setting).	Support from public research in the sector indispensable. Research programme impossible without public coordination. Major financial support necessary: $>$ 100 million € per year. Downstream role decisive: regulation indispensable, public contracts (order placements) important.

3 Implementation of Mobilizing Programmes for Industrial Innovation

This section presents in a more detailed way the organization and management of the MPIIs, which will be entrusted to a new structure, the Industrial Innovation Agency, dedicated to the participating projects.

3.1 Organization of the MPIIs

The MPIIs are based on R&D aid and the organization of a contract between the public authorities and the lead industrialist.

3.1.1 Financial framework of the policy of the Mobilizing Programmes for Industrial Innovation

Aid for research and development

The financial instrument for the Programme is constituted as aid for research and development in favour of the industrialist guiding the Programme, who is accountable for the implementation of the Programme's objectives. It is made necessary by the focus of the programmes on break-through technological content and recourse to innovations inducing a significant level of risk.

This aid complies with the directives of Community law in the area of State aid, and more particularly, the Community framework on State aid for research and development (96C/45/06), specifically via the concepts of industrial research and pre-competitive developmental activity.

Aid type	Definition
Industrial research	"planned research or critical investigation aiming at the acquisition of new knowledge, the objective being that this knowledge may be useful in the fine-tuning of new products, procedures or services, or bring about significant improvement of existing products, procedures or services"
Pre-competitive developmental activity	"concretization of the results of industrial research in a plan, schema or design for new, modified or improved products, procedures or services, be they intended for sale or use, including the creation of a first prototype that cannot be used commercially. It may also include the formulation and the design of other products, procedures or services, such as initial test models or pilot projects, on condition that these projects cannot be converted or used for industrial applications or commercial exploitation."

The aid respects the ceilings on public intervention defined in the Community framework. It must be notified in advance to the Commission. The scale of each Programme envisaged also presupposes an individual notification for each MPII.

The financial instrument: repayable advance and subsidy

According to the phase of development of the project, the aid takes the form of subsidies or a repayable advance. Subsidy is the preferred form for the upstream (early) phase of the Programme.

The repayable advance is the instrument used for developments that are closest to downstream pre-competitive realization. The aid is repayable in the event that the Programme is successful. This limits the risk for the industrialist. In any case, the industrialist's involvement is confirmed by his financial contribution, at least equal to the level of public financing granted.

The order of magnitude established for a significant Programme is 30□200 million □ per year over an average period of five years, adaptable to the specificities of each Programme.

3.1.2 Contractual relation between the firm and the public authority

As indicated above, the logic of the Programme implies that the European industrialist or group of industrialists should be entrusted with the role of project leader in the fine-tuning of demonstration models or products expected from the Programme and in the running of the partnership-based organization enabling these realizations.

The pivotal role played by the industrialist responsible for the Programme is expressed in a formal contract struck between the industrialist and the Industrial Innovation Agency. The principal elements of the contract are defined below.

The Programme must be presented as a series of clearly defined stages. For each stage, the contract records the principal obligations of the industrialist in the field of research and development and the realization of a demonstration model. The cooperative framework of the Programme managed by the industrialist is also specified (consortium with different partners, modalities of involvement of SMEs and subcontractors, modalities of association of public research).

Naturally, the contract defines the financial framework of the Programme: level of public financial contribution, payment schedule, amount of co financing secured, repayment conditions of repayable aid. The rules relating to the intellectual property of the Programme are also fixed. The industrialist's obligations in the area of control/ownership are equally included in the Programme.

3.1.3 Relation of industrialists and other agents, SMEs and salaried employees

The goal of the Programme is also to constitute networks and to enable other firms, in particular SMEs, to profit from the Programme, in order to acquire new technological skills. Th contract might include a clause specifying that some fraction of the public aid be used for the financing of SMEs. This fraction, earmarked for small firms, is determined for each Programme as a function of the relevant industrial sector.

Finally, the public financing of the Programme could serve as a tool for the evolution of the qualifications of salaried personnel, by allowing another fraction of the public aid be used for staff training.

3.1.4 French public directives on support for R&D and MPIIs

Three characteristics distinguish MPIIs from other structures existing in France and Europe. The first feature is the very downstream character of the Programmes which runs right to the pre-competitive stage. The second feature is the existence of one or more steering industrialists. The third feature is the significant amount of funding. For these reasons the MPIIs might interconnect easily with other structures, such as the RRITs, CNRTs or ER&DFPs.

The RRITs and CNRTs are networking structures that mobilize low funding for different topics. The thematic areas of certain RRITs or CNRTs may overlap the technologies lying within the MPIIs. Firms mobilized within a MPII can then draw on the experience and strengthened cooperation of the RRITs and CNRTs. Thus, the MPIIs contribute to the valorization of the coordination of the RRITs and CNRTs. Finally, the technological domains of the European Research and Development Framework Programmes (ER&DFPs) are in general further upstream than those of the MPIIs. The European Research and Development Framework Programmes can therefore provide support for firms that are developing upstream technological solutions, necessary for the realization of the MPIIs.

3.2 The Industrial Innovation Agency

3.2.1 Justifications for an Agency

Economic analysis shows that the instances of industrial policy implementation matter as much as the definition of the methods used (Rodrik, 2004). This part of the report defines a structure, the Industrial Innovation Agency, whose purpose is the management of the MPIIs. It is a necessary pre-condition for the success of the programmes presented above haut.

Specialization and professionalization: a single structure concentrating skills

In the first place, it is important to concentrate skills and monitoring capabilities within a single structure. Since the Mobilizing Programme is undertaken by an industrialist or small group of industrialists, part of the management effort rests in the hands of private agents. The role of the office concerns the definition of the Programme, the organization of the contractual relation between the different parties, and finally a monitoring and evaluating function. Many of these skills are common to all the Programmes. Therefore, a single structure is desirable that allows the acquisition of these skills and, in particular, the putting in place of an evaluation and Programme monitoring framework, is desirable.

Another essential role of the agency is to concentrate the capacities of analysis and industrial prospection. Since the horizon of an SME is five to 15 years, the agency must manage the MPIIs in a dynamic manner, that allows the renewal and reorientation of certain projects in response to any evaluation results. In addition, the agency should have a prospecting mission and must be able to study in depth the interest of new technological and industrial projects, lying beyond the operational horizons of firms, but which may be of interest to them once the financing and technological relevance have been studied.

Involvement of all stakeholders

The second function of the agency is the centralization of inter-ministerial management of the Mobilizing Programmes. Each Programme involves cooperation between the designated Ministry for the particular industry and the designated Ministry for the specific research. Furthermore, Programmes may require coordination with other ministries, such as the Ministry for Solidarity, Health and the Family, the Ministries of Agriculture, Food and Fisheries, and Rural Affairs, the Ministry of Defence, the Ministry for Infrastructure (Équipement), the Ministry for Foreign Affairs.

The organization of the agency enables one to take into account all the stakeholders necessary for national mobilization around the programmes: parliaments, administrations, industrialists, trade unions, the Senior Scientific Council (SSC) (on the basis of the proposals of the Etats Généraux de la Recherche, 2004).

Involvement for the duration, continuity of funding

The Industrial Innovation Agency thus manages the portfolio of MPIIs, thereby making possible arbitration between different industrial programmes, as far as the use of pubic resources goes. Therefore, the arbitration is not made between a Programme and other different possible uses of public money according to the constraints of the ministries involved. An independent budget of the inter-ministerial office is thus a means of guaranteeing continuous support for the Programmes.

Clearly, continuity of funding is essential for the MPIIs. R&D activity necessitates stable continuous funding, with criteria for the cessation of funding clearly defined at the outset of the Programmes. A global budget for the MPIIs, by reducing the arbitrage space, best guarantees the continuity of funding for the most promising Programmes.

Risk sharing

The global management of the MPIIs allows the agency to diversify projects. The agency manages several projects, of which some will not bear fruit. The failure of a project does not invalidate the MPII type of approach. MPIIs are structures whose purpose is to bear non-zero risk. If all the projects are successful, then the agency has not taken enough risks. It is not the result of an individual Programme that matters, but the global return of the Programmes. The indivisibility of the management function is the simplest condition enabling proper evaluation of the portfolio of MPIIs.

3.2.2 Missions and attachment

In summary, the missions of the agency include:

- technological and industrial prospection for the definition of new large-scale Programmes;
- the identification, selection and launching of Programmes;
- the periodic monitoring and evaluation of the Programmes.

In light of the importance of the issue and the inter-ministerial character of its action, the agency should be attached to (the office of) the Prime Minister.

3.2.3 Organization of the Agency

The management responsibilities of the agency are shared between a supervisory board and a directorate. In addition, the agency is endowed with a scientific committee and a prospection unit.

The supervisory board

The supervisory board is responsible for overseeing the agency generally and its management of the policy.

The board's composition should allow the representation of stakeholders in the policy of the Programmes. From the missions of the Office, five classes of representative can be identified, yielding around 20 members in total.

Composition of the supervisory board
Parliamentarians
State representatives (Prime Minister, Ministry of Research, Ministry of Industry), Senior Scientific Council[19] and the public research institutions
Industrialists
Trades Unions
National and international experts(sciences[20] and technology)

The directorate

The directorate is responsible for the operational management of the agency under the control of the supervisory board. In the main it is composed of officers experienced in the management of technological and industrial programmes. The directorate also coordinates

[19] As defined by the États Généraux de la Recherche (2005).

[20] Including the "hard" sciences as well as sociology and economics.

the different monitoring units for each of the MPIIs.

The scientific committee

The role of the scientific committee is to contribute to the scientific evaluation of the Programmes. The presence of foreign experts ensures the most pertinent evaluation of the Programmes.

The prospection unit (cellule prospective)

The prospection unit brings together industrialists, scientists and administrators in order to define future Programmes. This unit is a cooperative structure allowing the circulation of information and experience. It also makes possible the study of industrial projects that are not driven by a lead industrialist. Appropriate means could be allocated to the study of these more speculative finalized projects.

3.2.4 The Agency's resources

The resources enabling the realization of the Programmes are concentrated in its means of intervention. The operating costs are modest.

Financial resources

An annual amount of **one billion euros over the average period** is the appropriate order of magnitude. That sum makes the management of four to six large-scale Programmes possible, as well as perhaps some more modest programmes. Together with the expected investment of comparable magnitude from the industrialists participating in the project, **the total amount, public and private, will be two billion euros per year over the set of the Programmes** over the average period.

The effort is actually rather modest. For the sake of comparison, the French effort necessary to comply with the Lisbon agenda (an increase from 2 % to 3 % of GDP) requires an annual effort of 15 billion euros.

The means of the agency are programmed in a multi-annual way in order to guarantee the regularity of the effort for a policy clearly oriented in the medium and long term.

Human resources

The human resources involve making available the skill sets enabling the governance of the Programme, in particular those concerning the control of relations with the lead industrialist. Other necessary skills include financial management, legal monitoring, and communication. Some skills could be outsourced by contract, for example, to the Caisse des Dépôts et Consignations.

3.2.5 Management of an individual Programme

Nature of management

The conception and management of a specific Programme include the definition of the precise objectives of the project (length, costs, resources), the setting of intermediate stages or milestones, monitoring with the possibility of reorienting research if market needs or technological constraints have altered both the disposition of the resources necessary (public and private financing, flow of national and European resources to be channelled into the Programme, definition and activation of other resources: law, training, communication) to the good execution of the Programme. Management of a Programme runs right from the research effort through to industrial deployment.

The elementary missions therefore include:

- a prospective study of the nature of the end market within the framework of the Programme;
- detailed analysis of the segmentation of the Programme into subsets that are coherent on the technical and financial planes and consistent with the associated calendar;
- control and evaluation of the implementation of the Programme, for example through the realization of financial and technical audits;
- management of relations with the lead industrialist or group of lead industrialists.

The Programme monitoring unit within the Industrial Innovation Agency

This unit is organized around the executive officer for the Programme. It includes:

- the selection structure for detailed Programmes or sub-Programmes: this structure ensures the elaboration of technical content, the launch of calls for projects and the selection of projects and the subsequent funding decisions;
- the structure of evaluation and control: the evaluation/control function is a key Programme management function. It must enable regular, independent and competent monitoring of the Programme, destined particularly for the recipients of public aid.

3.2.6 The relation of the Agency with public research directives

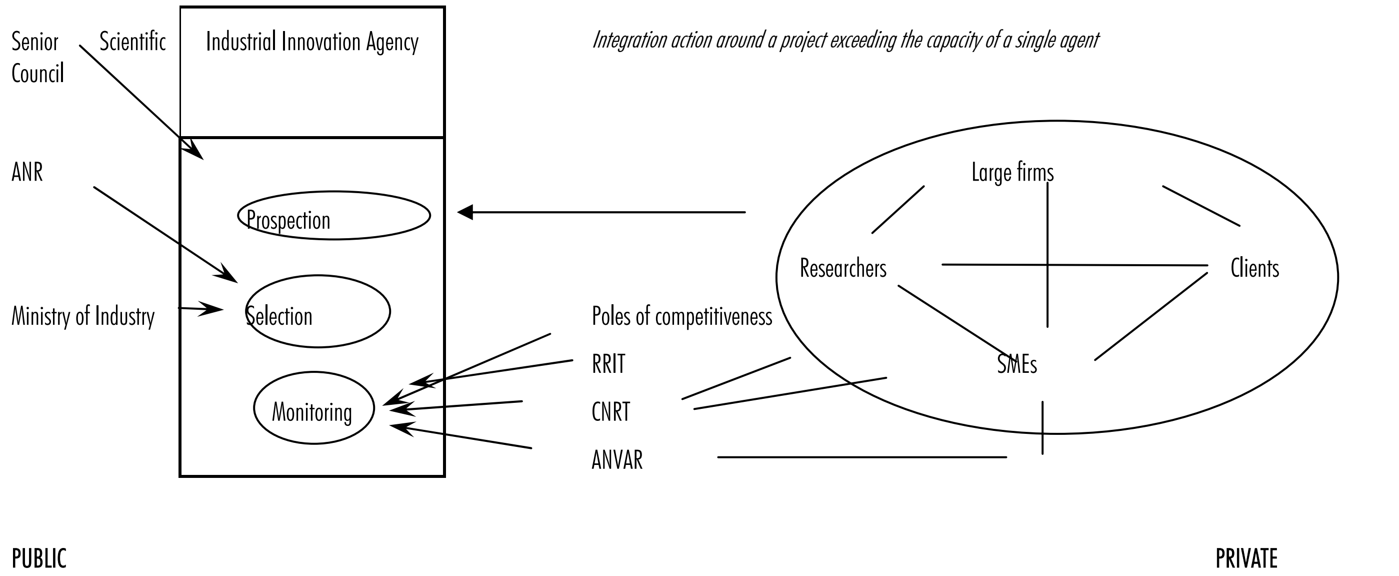
The Industrial Innovation Agency should coordinate its action with the other structures of French public research directives: universities and *grandes écoles*, establishments (EPST, EPIC), foundations (the Pasteur Institute, the Curie Institute, etc.), as well as the French Innovation Agency (ANVAR) and the future National Research Agency (ANR), which are different on account of their specific objectives.

The ANVAR promotes innovation within SMEs and SMIs. This agency makes possible the funding of innovative SMEs. An important aspect of the MPIIs is to favour small and medium firms by associating them with innovative large projects. The ANVAR can favour the development of the SMEs associated to an MPII. Within the framework of the definition of MPII stakeholders, the linking of the policy of the Industrial Innovation Agency and ANVAR could prove useful in order to facilitate the innovation of SME and SMIs and to ensure that they are taken into account within the framework of the Programmes.

Furthermore, the Senior Scientific Council (SSC), as defined in the report of the Etats Généraux de la Recherche (2005), is naturally the appropriate interlocutor in order to ensure effective concertation of the Industrial Innovation Agency and the other agents of French research directives. Members of the SSC, who have a global vision of the scientific fields involved, could contribute in a very active way to the management of the scientific part of the MPIIs, as well as to the prospective activity for the MPIIs which requires coordination of industrial policy and scientific policy.

Finally the Industrial Innovation Agency should coordinate its action, within the framework of the recommendations of the SSC, with the Research Agency. The latter must thus allow the concertation of the different operators of pubic research with private research. Without interfering with the role of a Research Agency in the promotion of autonomous fundamental research, the most upstream parts of the MPIIs could be proposed and evaluated within the framework of the thematic programmes set up within this National Research Agency (ANR). When projects managed by the Research Agency lead to a potential innovation, development could be undertaken reciprocally by the Industrial Innovation Agency. Coordination of this sort should facilitate the mobilization of public research agents within the MPIIs.

Insert 4: The place of the Industrial Innovation Agency amongst public and private agents involved in innovation



4 Integration of the Mobilizing Programmes for Industrial Innovation within Europe

The scale of the projects leads one to envisage the policy of these Programmes at the European level. Extension of the policy to the supranational level must guarantee coordination with European R&D efforts.

4.1 Coherence of the Mobilizing Programmes with French and European social systems of innovation

The analysis of economic institutions shows that industrial mobilization in the framework of targeted programmes, which make possible cumulative innovations within a stable horizon, corresponds to the French social system of innovation (Amable, Barré, Boyer [1997]). Study of the social construction of innovation, a phenomenon that cannot be reduced to the spheres of science and technology, reveals numerous common points between the French system and the systems of Germany, Ireland and the Netherlands (Touffut, 2002). France and Germany are close from the perspective of scientific specialization but different from the perspective of technological specialization (Amable, 2002). In the area of technical progress, France and continental Europe possess a comparative advantage "in technology-accumulative activities, which make up an attractive area for large firms and for workforce management favouring internal labour markets") (Debonneuil and Fontagné [2003]). The MPIIs can therefore be thought of as an instrument of industrial policy that encourages the valorization of the comparative advantages of France and Europe in institutional resources.

4.2 European vocation of the MPIIs

Within the framework of compliance with Community Rules in the area of competition, the Mobilizing Programmes described and financed by the French State are by definition European, that is to say, all European firms can participate in an MPII. Furthermore, it cannot be ruled out that non-European firms might participate in MPIIs, either through partnerships with European firms, or as counterparties to a commitment to the creation of jobs within the European territory.

Sited at the core of European R&D support structures, the MPIIs are distinct from the European R&D Framework Programmes in two ways. Firstly, the mission of the MPIIs is far more focussed than that of the European R&D Framework Programmes, which organize tenders in relatively broad technical fields. Secondly, the MPIIs cover simultaneously research and development right up to the pre-competitive stage. They are thus further downstream than the European R&D Framework Programmes, which often organize European research at level further upstream. However, a recent inflexion in the framework of the 6th European R&D Framework Programme should be stressed. The MPIIs and the European R&D Framework Programmes are not contradictory and can possess numerous complementarities.

Finally, the Industrial Innovation Agency should be coordinated with the intergovernmental EUREKA initiative. The latter initiative encourages cooperation between firms and research institutes, in the framework of market-oriented research projects, where the research property belongs to the industrialists. Thus, the implementation of a European MPII could be based on EUREKA initiatives when the technological fields of the MPII and of a EUREKA project intersect.

4.3 Other States may be interested in industrial cooperation around the MPIIs

It may prove more relevant to posit an intergovernmental framework for MPII policy, rather than a direct Community initiative. Other European countries may be interested in MPII funding, with the cooperation among participant countries authorizing access to their public resources thereby serving as a cooperative voice for European extension.

Some European countries may have a special interest in MPIIs, since they share similar industrial difficulties. That is probably the case for Germany, whose industry is specialized essentially in high technology sectors and which is facing relative standardization of its industrial goods. The MPIIs might revocalize in an original way the voice of Franco-German cooperation, if the definition and selection of programmes are made conjointly and in correspondence with the German system of innovation.

5 Annexes:

5.1 Commissioning letter from the President of the Republic of France

LE PRÉSIDENT DE LA RÉPUBLIQUE

Paris, le 30 septembre 2004

Monsieur le Président,

L'industrie est essentielle pour l'avenir de la France et de l'Europe, car l'industrie demeure la base du dynamisme économique, par son effet d'entraînement sur les autres secteurs d'activité. Elle représente 20% de notre richesse nationale - 40% avec les services qui lui sont liés. Elle est à l'origine de 80% de notre effort de recherche et de plus des quatre cinquièmes de nos exportations.

Et il n'y a pas de politique de croissance et d'emploi sans action résolue en faveur du développement de l'industrie. Le Gouvernement a déjà adopté de nombreuses mesures pour répondre au défi immédiat des délocalisations et, à plus long terme, pour renforcer l'attractivité et la compétitivité de notre territoire.

Dans ce cadre, je crois aujourd'hui nécessaire d'engager une redéfinition d'ensemble des objectifs, des outils et des moyens de notre politique industrielle, tant au plan national qu'au plan communautaire. L'enjeu, pour la France et pour l'Europe, est d'amorcer un puissant effort d'innovation, pour ne pas laisser apparaître ou se creuser un retard dans des secteurs essentiels pour l'avenir, comme les technologies de l'information, les biotechnologies, les nanotechnologies, les technologies de l'environnement et l'énergie ou les matériaux de haute performance. L'enjeu, c'est la création de nouveaux emplois industriels et de services aux entreprises, durablement ancrés sur le territoire et dans des secteurs à forte valeur ajoutée.

Monsieur Jean-Louis BEFFA
Président Directeur Général
Compagnie Saint Gobain
Les Miroirs
92096 LA DEFENSE CEDEX

C'est dans cette perspective que j'ai souhaité, en plein accord avec le Premier ministre, vous demander d'examiner dans quels secteurs et selon quelle méthode pourrait être engagée une relance ambitieuse des grands programmes scientifiques et technologiques.

Votre mission consistera à :

1) Procéder à un inventaire des programmes et projets mobilisateurs qui pourraient être retenus, de par leur intérêt économique et social et compte tenu des atouts de l'industrie et de la recherche française et européenne.

2) Faire des propositions en vue de définir la meilleure méthode de sélection, de gestion et de mise en œuvre de ces grands programmes en vous attachant en particulier à identifier les modes de pilotage susceptibles d'assurer la meilleure coordination possible entre l'intervention des pouvoirs publics et l'initiative privée. Vous devrez également veiller à assurer la cohérence de vos propositions avec les politiques publiques adoptées en matière industrielle, notamment le plan innovation, le plan attractivité, les pôles de compétitivité ainsi que la loi d'orientation et de programmation de la recherche, en cours d'élaboration, ainsi qu'avec les actions menées au niveau européen.

Nous attendons de votre part des propositions opérationnelles, ayant vocation à être mises en œuvre dans un très bref délai par le gouvernement. Votre rapport définitif devra m'être remis, ainsi qu'au Premier Ministre, pour le 15 janvier 2005.

Pour mener à bien votre mission, vous pourrez constituer autour de vous un groupe de travail dont vous assumerez la présidence. Vous disposerez du plein concours des services de l'État.

En vous remerciant à nouveau d'avoir accepté cette responsabilité, je vous prie d'agréer, Monsieur le Président, l'expression de ma haute considération et de ma bien cordiale reconnaissance.

Jacques CHIRAC

THE PRESIDENT OF THE REPUBLIC OF FRANCE

Paris, September 30, 2004

Dear Mr Beffa,

Industry is essential for the future of France and Europe, since it remains the basis of economic dynamism through its tractor effect on other sectors of the economy. It represents 20 % of our national wealth, a share that rises to 40 % if services related to industry are included. It is at the root of 80 % of our research effort and of more than four-fifths of our exports.

No policy on growth and employment can exist without resolute action in favour of industrial development. The Government has already adopted numerous measures in order to respond to the immediate challenge of delocalizations and, in the longer term, to improve France's attractiveness and competitiveness.

Within this framework, I think it necessary today to undertake a redefinition of the set of objectives, instruments and means of our industrial policy, at both the national level and at the Community level. The issue for France and for Europe is to initiate a powerful effort of innovation, in order to obviate the danger of any lag appearing or developing in those sectors essential for the future, such as information technology, biotechnology, nano-technology, technologies for the environment, energy, and high performance materials. The issue is to create new industrial employment and services to firms, anchored sustainably within France and in sectors of high added value.

It is within this perspective, and with the full agreement of the Prime Minister, that I am asking you to examine in which sectors and according to which method an ambitious relaunch of large-scale scientific and technological programmes might be undertaken.

Your mission will be:

(1) to draw up an inventory of mobilizing programmes and projects that might be considered, both on account of their social and economic interest and in light of the assets of French and European industry and research;

(2) to make proposals aimed at defining the best method of selection, management and implementation of these large-scale programmes with special attention to the specification of the modes of governance that are likely to ensure the best possible coordination between the intervention of the public authorities and the initiative of the private sectors. Equally, you should pay attention to the compliance of your proposals both with public policy adopted in the industrial sphere, in particular on innovation, attractiveness, and poles of competitiveness, and with the law under elaboration relating to the direction and programming of research, as well as with actions taken at the European level.

We expect from you operational proposals, which the Government can implement promptly. I expect your definitive report, with a copy to the Prime Minister, to reach me by January 15, 2005.

To accomplish the mission successfully, you may constitute and preside over a working group. You have at your disposal the full cooperation of the services of the State.

Thank you for your acceptance of this responsibility.

Yours faithfully,

Jacques CHIRAC.

5.2 Members of the working group and reporters

Patrick ARTUS
Director of Research and Studies, CDC IXIS
Robert BOYER
Director of Studies, École des Hautes Études en Sciences Sociales
Gaby BONNAND
National Secretary, Confédération FD Travail
Gerhard CROMME
President of the Supervisory Board, Thyssen Krupp
Lionel FONTAGNÉ
Director, Centre d'Études de Prospectives et d'Informations Internationales
Pierre GATTAZ
Vice-President, Fédération des Industries Électriques, Électroniques et Composants
Jean-Christophe LE DUIGOU

Confederal Secretary, Confédération Générale du Travail

Alain MÉRIEUX

Chairman and Managing Director, Bio Mérieux

Grégoire OLIVIER

President of Board of Directors, SAGEM

Denis RANQUE

Chairman and CEO, Thalès

Reporters

Pierre-François GOUIFFES

General Inspector of Finances

Xavier RAGOT

Research Executive, Centre Nationale de la Recherche Scientifique

5.3 The historic large-scale programmes: an overview

The concept of large-scale programmes has long been at the heart of French industrial policy. Whether it be Concorde, the TGV (high-speed trains), civil nuclear energy or Minitel, a sizeable amount of public funds has been invested in order to create new objects, yielding important technological advances. The following table presents the different large-scale Programmes that have been launched in the past.

Figure 16: the large-scale programmes (1962-1989)

Programme	Launch date	Technological break-through	Principal industrial group	Amount invested
Concorde	1962	Electric flight controls	Aérospatiale	3.8 billion € between 1970 and 1990
Computing	1966	Digitalization	UNIDATA, Bull	8 billion € of support for Bull [1]
Telecommunications	1968	Digital commutator		Not available
Civil nuclear energy	1968	Nuclear subsector	CEA, EDF	Not available
Airbus	1969	Motorization, steering, maintenance, costs	Aéropsatiale, Airbus	3 billion € of repayable advances for Aérospatiale from 1971 to 1997 (all programmes)
Space research	1973	Ariane	Aéropsatiale, Air liquide	Not available
Reactors	1973	Airbus motorization	CFMSG	Not available
Train à Grande Vitesse (high-speed train)	1974	Doubling of commercial speed	Alsthom, SNCF	2.1 billion € of public investment for the launch of the first TGV line
Minitel	1978	Telematics	France Telecom	1.2 billion € of investments for PTTs

Components	1989	Miniaturization	Thomson, then STMicroelectronics	Not available

Sources: DPAE; Court of Accounts (Cour des Comptes)

The table highlights important successes, like Airbus, civil nuclear energy and the components programme. On the other hand, the computing programme is considered a failure. In this last case, it appears that the public authorities financed for too long a Programme the difficulties of which were patently evident. As the first section showed, the success of previous large-scale programmes contributed largely to defining French industrial assets in high technology.

France continues to support these large-scale programmes of the past. The following table presents some current large-scale programmes.

Figure 17: Different current large-scale technological programmes

Programme	Activities	Means of public support	French public budget
Nuclear energy	3rd generation reactor: EPR Participation in the international programme ITER for nuclear fusion	Public research (CEA) and aid for AREVA	~ 550 million € of piblic research spending (2003) **30 million** € of public funding for private R&D (essentially AREVA)
Space research	Terrestrial observation (Envisat, Calipso, Champ, GMES, etc.) Space observation: Cluster, Mars express Telecommunications: Galileo Space flight: Ariane V and ISS	Public research (CNES, ESA) partially outsourced	Budget 1.7 billion €, of which 0.6 billion € for the ESA (2003) **150 million** € of public funding of private R&D
Aeronautics	Development of new commercial aeroplanes (A 380, A 350, A 300-0G)	Repayable advances to Airbus	Repayable advance of 1.2 billion € for the A 380 (2004 -) Request for repayable advance of 1 billion € for the A 350

Sources: CNES; Chambolle & Méaux Report; CEA; MINEFI.

The sole ambitious new Programme in France today involves nano-technology. This project received nearly 80 %% of DIGITPI aid. Geographical concentration is organized around the Crolles II pole, which is the largest French industrial investment project of the last ten years. It represents an investment of 3.5 billion € for the period 2002-2007.

5.4 Potential fields for MPIIs: some suggestions

The following list is the result of a study of the themes summarized in the table, based on some pointers, the relevance of which remains to be confirmed. A prospection exercise enabled the definition of some MPII options in terms of broad themes. What will the demand be for new products with high technological content within the temporal horizon of the Programmes (5 to 15 years)? A list of themes fitting the MPII framework is proposed below.

This preliminary exercise should be revised and detailed in the event of an in-depth study of the policy of Mobilizing Programmes. It nevertheless confers a concrete aspect on the general framework of the policy. Further precise identification would be indispensable in the next stage of the mission.

The process of identification relied on three principal sources:

- an examination of French and foreign prospective studies;

- interviews with firms; on this last point, the Commission limited its meetings to French firms, and the enlargement to European firms is desirable in the pursuit of the exercise;

- a review of the initiatives, close to the MPII concept, undertaken of foreign countries.

5.4.1 Coverage of different domains of potential demand

Five thematic areas were retained for the initiation of different projects appropriate to treatment within MPIIs.

Broad thematic areas
Energy
Transport
Environment
Health
Information Technology

5.4.2 Identification of potential Programmes

The classification above is then used to organize the large-scale programmes and products that have potential promise in the medium and long term.

Energy	Transport	Environment	Health	Information Technology
Economic building construction Renewable energy: - Photovoltaic solar electricity - Bio-fuels - Wind 4th generation nuclear energy Radioactive waste management Deep sea exploitation	Safe intelligent automobiles Clean automobiles: - Fuel cells - Bio-fuelled hybrid vehicles - Electric hybrid vehicles - Nano-materials for the car of tomorrow Aeronautics of the future: - New airships - Automation of air traffic control Next generation TGV (high-speed trains) Fast maritime transport Next generation automatic metro	Control and repair of environmental irritants and pollution Clean agriculture Water management CO_2 sequestration and capture Management and monitoring of ecosystems and biodiversity	Bio photonics Cancer Non-invasive surgery Fertility Infectious diseases Degenerative diseases Food safety and quality	Very high-speed networks: - High-speed TV - Very high-speed Internet - 4G mobile New interfaces: - I. radio frequencies - Digital signature/identity Micro-electro-mechanical systems (MEMS) Network security Tele-medicine

5.5 Pointers for Mobilizing Programmes for Industrial Innovation

As examples and subject to a more detailed analysis of the initial findings of the mission, the criteria yield the following nine pointers for Mobilizing Programmes.

Three pointers signal directions in the energy sector, within the perspective of fossil fuel resource exhaustion and the control and reduction of greenhouse gases: fuel cells and hydrogen technology, photovoltaic solar electricity, bio-fuels. One pointer concerns directly the preservation of the environment and the reduction of polluting emissions: capture and sequestration of CO_2. Two pointers involve transport: clean economical cars, automation of air traffic control. Two pointers bear on health care, in particular in the framework of an ageing population: treatment of degenerative diseases, treatment of infectious diseases. Finally, one pointer involves information and communication technology (ICT): high-definition contents and services over very high-speed secure networks.

5.5.1 Health: infectious diseases and degenerative illnesses

This Programme aims to counter the proliferation of infectious diseases, whether viral (AIDS, SARS, avian influenza, etc.), bacterial (tuberculosis), parasitic (malaria) or other (spongiform encephalopathy). In each domain, developments would treat both prevention (for example, vaccines) as well as therapeutic solutions. The first applications could involve the fine-tuning of antibiotics against super bugs (often found in nosocomial diseases), preventive treatments against malaria and new treatments against tuberculosis.

The ageing of the population (in 2020, 26.8 % of French people will be over 60 years old) makes degenerative diseases in particular a major challenge (Alzheimer's disease, Crohn's disease, multiple sclerosis, …). Thus, more than 100 000 new cases of Alzheimer's disease are diagnosed in France each year. Technological advances make it possible to envisage, in the medium to long term, the development of diagnostic and therapeutic solutions for these pathologies (in particular, the fine-tuning of anti-oxidants and active composites slowing down cell degeneration). Despite world-class public and private research in the field of pharmacology and the life sciences, France has been little involved in this area, thereby running the risk of missing out on a very significant market (estimated at several tens of billions of $ by 2020).

5.5.2 Energy: the fuel cell and hydrogen technology

Fuel cell technologies, enabling the generation of electricity from the chemical energy of a fuel (without the production of thermal energy), represent a pointer that would contribute in particular to the reduction of greenhouse gases and the dependence on fossil energies. They would then enable a structural mutation in the energy sector, including the automotive industry. Very large efforts on this subject are made in the United States (350 billion □ per year on the Hydrogen Fuel Initiative) and in Japan. Ultimately, a technological gulf risks appearing with Europe and France, who nevertheless possess structural assets in the hydrogen technology domain.

Foreseeable applications involve both stationary applications, perhaps the most accessible in terms of market introduction (electricity generation based on hydrogen or fuel transformable into hydrogen by recomposition, co-generated fuel cells), as well as longer-term applications in the domain of transports, in parallel with all the activities related to the production, storage and distribution of hydrogen.

5.5.3 Transport: clean economical cars

The automobile currently constitutes a key industrial sector in Europe, by reason of its central place within the industrial fabric and its weight in consumption (15.5 % of household spending was devoted to transport in 2001). In any event, the exclusive use of exhaustible fossil energies and the strong contribution of the transport sector to environmental degradation (the sector is projected to account for 27 % of greenhouse gas emissions in 2010 against 21 % in 2001), make certain technical evolutions necessary. Different programmes are therefore desirable in the automobile industry, in order to put in place "clean" technologies, while still obeying the sector constraints (most notably, those of costs).

Two examples are furnished below:

- the development of vehicles equipped with very low consumption combustion engines, complying with very severe pollution standards;
- the development of hybrid dual propulsion vehicles, combustion (diesel, in particular) and electricity (enabling very weak emission of CO_2 and pollutants), in which the related elements would be optimized (structures and materials, tyres, windscreens, …)

5.5.4 Energy: bio-fuels

The field of bio-fuels, constituted by the set of carburant production activities from biogas and biomass, represents one contributory solution for reducing greenhouse gas emissions and installing an energy system based on the diversification of the agricultural assets of France and Europe. The European bio-fuel domain, despite its structural assets (competent public research, competitive industrial agents in the sectors of chemicals, energy and transformative industries, and its very significant agricultural capacities, …) is not at the same level as the bio-fuel domain in the United States or Brazil. The development of the sub-sector should be based on regulatory evolution and the strengthening of the rules of incentivization, as well as on a profound effort of coordination of the set of agents involved.

5.5.5 Energy: photovoltaic solar electricity

The domain of photovoltaic solar electricity constitutes one of the sub sectors of renewable energy that should be explored. The technological issues bear currently on the improvement of energy yields. Strong development of this sub sector is nevertheless possible if the key agents mobilize with European partners (in particular German partners) having already acquired significant technological positions.

5.5.6 The environment: the capture and sequestration of CO_2

Until a technological break-through such as the fuel cell and the formation of a hydrogen sub sector, the capture and sequestration of CO_2, applied to industrial units in heavy industry and also to energy production, could prove an option in the effective fight against the greenhouse effect. France and Europe possess the assets necessary to form a world-leading sub-sector in this domain. The large industrial groups are directly interested in the capture of CO_2, while the large gas, petroleum and para-petroleum groups are active in sequestration technologies, with advanced research in every aspect of the technological chain … Nevertheless, the high bottlenecks and costs associated with CO_2 capture suggests reinforcing the rules on incentivization, R&D support and pilot projects. United States initiatives, on the other side, such as *Clean Coal*, or the pilot project *FutureGen* appear very advanced. Their objective is to position the United States at the head of this probably large-sized market by the horizon of 2015.

5.5.7 Transport: the automation of air traffic control

New technologies in the fields of data transmission, security and processing, make it possible to envisage the progressive integration of guidance systems, air and ground control, eventually leading to greater automation of air traffic control. A Programme of this kind, involving all the agents of the air sector in Europe, on the model of the programme already launched by the United States on the same subject, would allow the tripling of air traffic by 2020, while complying with environmental constraints and improving the security and global economic efficiency of the system.

5.5.8 ICT: secure high-speed networks

The Programme would involve the entire broadcasting chain of audiovisual content and electronic services: production, management and distribution of content and services, very high-speed network, network security, network architecture, domestic or nomadic terminals equipment.

The Programme would consist in developing network components and advancing architecture for these convergent networks. Associating very high volume/speed and mobility through very high-quality radio networks, it would be necessary (1) to develop the components of a chain of production and diffusion of high-definition secure digital content across these networks, (2) to develop these components using a secure network architecture for firms and individuals, and (3) to organize, if possible, strengthened cooperation between France and Germany on these projects in order to have the critical mass necessary to cerate global standards.

Applications involved would be high-definition television, video and music on demand, amusements and online games, public and private interactive services via fixed or nomadic terminals.

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