Dual-use as Knowledge-Oriented Policy: France during the 1990–2000s

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Abstract: This contribution aims at demonstrating that dual-use policies represent now a dimension central to military R&D policies and should not be understood only as a transfer mechanism between the civilian and the military. The paper investigates the concept of dual-use policies in the framework of Knowledge-Oriented Policies (KOP). Il will elaborate on the conditions of the emergence and development of dual-use policies. From a conceptual perspective, it will point out the difficulty associated with sequential and linear interpretations of innovation processes associated with armaments programmes. The main important critic developed in this contribution relates to the simplistic view associated with armaments life cycle, which hardly accounts for the complexity of exchanges and the reality of decision-making in military R&D.

Keywords: dual-use policy; KOP; knowledge-oriented policy; knowledge articulation; absorptive capacity; France.

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1 Introduction

Dual-use policies rely on a framework of technological artifacts bridging the military and civilian spheres. Technology is not specifically oriented towards military or civilian uses; it is integrated into specific products used for determined purposes, and supported by specific innovation networks and institutional framesets. Specific mechanisms are required to transfer technologies between the military sphere and civilian markets. Dual-use policies imply a specific and deliberate management of knowledge and technology transfers between these various networks. As developed by Cowan and Foray (1995), Molas Gallart (1997) and Gansler (1995), these policies cover a great range of interventions aimed at transferring civilian technologies to the military (spin-on), military technologies to the civilian markets (spin-off) or at fostering shared innovation projects at the intersection between militarian and civilian networks (Stowsky, 2004). The importance of dual-use policies has increased in the framework of knowledge-based economics. The knowledge base is now more diverse, complex and specialised as ever (Foray, 2004; Gibbons et al., 2005). The acceleration of technological change is now supported by diversified networks making dual-use policies become a compulsory pathway to keep defence- and security-related technologies in contact with R&D investments and incentives associated with commercial markets. Whatever the strategy decided for defence policy, it is always important that military programmes remain technologically up-to-date.

This contribution aims at demonstrating that dual-use policies represent now a dimension central to military R&D policies and should not be understood only as a transfer mechanism between the civilian and the military. This contribution will elaborate on the conditions of the emergence and development of dual-use policies; it will investigate on the content of specific measures. From a conceptual perspective, it will point out the underlying difficulty associated with the sequential and linear interpretation of innovation processes associated with armaments programmes. The main important critic developed in this contribution relates to the simplistic view associated with armaments life cycle, which hardly accounts for the complexity of exchanges and the reality of decision-making in military R&D.

This contribution will elaborate on the French experience as a case study relevant to assess the evolution of dual-use policies over the last 20 years. The French case will help to point out the reasons why dual-use policies are loosely developed.

This contribution reads as follows:

The next section investigates the concept of dual-use policies in the framework of Knowledge-Oriented Policies (KOP). It articulates the emergence and development conditions for these policies with the main important aspects of military innovation policies. Section 3 deals with our methodology. Sections 4 and 5 evidence the French case along two time periods complementing the analysis: the Syrecide project exemplifying shared innovation in the 1990s and the various contributions of the French R&D and procurement agency (DGA) to the national innovation networks (for instance RRIT) in the 2000s. Section 6 discusses dual-use policies on the basis of the institutional context prevailing in such policies and of the organisational capacities required for ministries of defence to benefit from them.

2 Knowledge-oriented features in dual-use policy-making

Interpreting dual-use along the microeconomic lines of knowledge management will help pointing out how dual-use policies interact with the dynamics of technological change. The reference to knowledge-based mechanisms introduces specific ways to assess the articulation of defence networks with the stakeholders to civilian innovation trends. This section will investigate the improvement in dual-use policy assessment following the analysis of KOP.

2.1 Dual-use policy-making in the linear and sequential reference to innovation

The first approach to dual-use policies relates to the traditional view of innovation policies and refers to the management of externalities and market failures (Arrow, 1962). Developments about spin-on, spin-off or shared innovation represent a set of incentives aiming at creating positive externalities between civilian and militarian markets (Molas Gallart, 1997; Cowan and Foray, 1995; Stowsky, 2004). Technology transfers between civilian and military networks are mobilised at specific milestones during the innovation cycle to foster scientific and technological development. In this perspective, transfer mechanisms have to be appraised in the framework of the life cycle of technological assets (Cowan and Foray, 1995; Reppy, 1999). When innovation activities are close to a final user and to the introduction on a market, limitations to duality and to the variety of uses exist de facto because of the specification process. On the contrary, dual-use is potentially present more in the upward phases of R&D and obviously prevails in exploratory research phases. The closer the specifications locate to a (commercial) market, the more difficult for the dual-use policies to intervene in real-life economics. Such an approach singularises two milestones in the management of R&D policies and introduces automatically strong limits to potential transfers from the military to civilian markets because it is conceived of as the sequence of two different actions. The first sequence is made of shared innovation projects, and exploratory R&D projects may mobilise together civilian and military actors on the basis of common or separate budgets. The second sequence takes advantage of the outcomes of the R&D projects and organises the transfers of mature technologies from one side to the other one. In this perspective, dual-use policies mobilise standardisation and property rights public policies in the frameworks of separate economic dynamics featuring some classic tools borrowed from traditional innovation economics (Blind and Thumm, 2004).

In this domain, standardisation policies focus on the issue of the diffusion of technology on a variety of markets. They make mass production easier and more (cost-) effective (Mowery, 1998, p.536). This may be exemplified by the spin-on policies introducing mature technologies available on civilian markets into military programmes, ruling here an adoption grounded in the management of time during the military programme. The very same applies to intellectual property rights and to the importance attributed to patents in the interaction between the civilian world and the military. Whereas patents represent the inventors' ultimate protection (both at the level of individuals and of organisations) in the traditional approach of innovation processes, they endorse a pivotal role allowing for technological transfers when dealing with the interaction between the civilian and military worlds in the framework of dual-use policies. These interactions rely on the management of property rights rules protecting the inventors' rights and fostering the exploitation of patents at the same time, which is

not always easy in the case of spin-off and shared innovation. Current instances taken from the management of software-related property rights[1] have clearly pointed out that the industry cannot always afford the negotiation of such an interaction today (Le Texier and Versailles, 2008).

As a matter of fact, it is therefore possible to address an important criticism to such a description of the innovation process, both in the military and in the civilian frameworks: R&D processes are pictured as a succession of distinctive steps, shaping the innovation process as a sort of linear and sequential interaction between the various moments associated to exploration, conception, development and then incorporation of the new technological options into production or commercialisation of new products. Neither the military process associated with the development of armament programs nor the elaboration of civilian major innovation may conform to a sequential approach to innovations: such phenomena are much more characterised by the complex imbrications of all actors and by constant interactions with researchers on the one hand, and with end-users on the other one. This criticism relates in reality to the reference to knowledge-based economics, which has shifted substantially the way to understand and appreciate innovation policies (Nyholm et al., 2001).

2.2 From traditional innovation policy towards Knowledge-Oriented Policies

At present, scientific analysis also locates in the various ways used for knowledge creation and dissemination among the contributors to the networks of innovation: heterogeneous actors interact, exchange and enrich their own approaches to complementary issues. End-users, researchers, engineers, bankers all contribute together to the very same innovation process. In the context of knowledge-based economics, the large variety of technological trajectories, the acceleration of the rhythm of innovation itself makes it quite obvious that the life cycle of technology cannot be interpreted along a linear perspective, because knowledge, incentives and end-user motivations overlap and complement each other.

In this framework, the previously evocated milestones of dual-use policies cannot entail the same relevance. Dual-use policies cannot be understood as specific instances of intervention at precise moments of the development of technologies anymore because the budget directly spent in favour of R&D, the budget associated with development indirectly available through procurement contracts, the measures in favour of patents, intellectual property rights or standardisation all contribute to the improvement of the innovation process as a whole. Knowledge-based economics would therefore lead to an appreciation of the overall consistency of the set of mechanisms associated with innovation policy, without any strict reference to a single feature of the technological development. In this framework, the core issue relates to the articulation of knowledge sets present in the civilian and military worlds. Dual-use policy should then relocate at the heart of innovation policy. In knowledge-based economics, innovation is not considered as a phenomenon singularising some mechanisms associated with a specific outcome; it investigates collective processes and individual interactions and pictures a range of weak and strong ties within a frameset of networks. Inventors clearly fear never to see their invention understood and mobilised (Amin and Cohendet, 2004). As a consequence, public policies should not only focus on the protection of intellectual property rights, but also favour diffusion mechanisms and collective adoption processes as well. Efforts should significantly stress the individual and collective capacities for

re-appropriation within the innovation networks (Foray, 2004; Gibbons et al., 2005), bridging skills, competences, competencies, knowledge of technologies and processes prevailing on each side. Armaments remain for sure specific because of the importance of political and strategic motivations, of the originality of the military mission, and of the strategic commitment of the industry (prime contractors and lead-system integrators), researchers and end-users to the success of long-lasting armament systems and architectures (Versailles, 2005; Mérindol and Versailles, 2007). Yet the conception and the development of military systems lead also the associated networks towards closure as soon as they will narrow the end-user specifications, and the basics for operational superiority. This introduces a tendency towards the attenuation of appropriation potential for knowledge and technology between the civilian and military worlds. Context-embeddedness explains these situations.

Dual-use policies represent therefore a case for KOP as proposed by Cohendet and Meyer-Krahmer (2001). The main goal of dual-use technologies lies in their aptitude to articulate knowledge between civilian and military innovation networks: in creating the conditions for the interaction between individuals, organisations and communities and in inquiring the various possibilities for re-using technologies in other frameworks, dual-use policies are intended to foster the emergence of a series of connections. Knowledge articulation may root in two main different pathways:

- Working for the emergence of languages, rules and common codes which reduce the cognitive distance between the participants to the various networks (Nooteboom, 2000); in this perspective, codification plays an important part (Cowan et al., 2000). This strategy aims at shifting the whole frameset of codes, representations, technology classifications and processes in a form of common system allowing for a better articulation of the civilian and military realms.
- Creating the exchange platforms which make the emergence of interaction easier; the aim is also associated with the installation of stable interfaces benefiting from competences suited for the translation of the artifacts associated with the civilian and military networks, and therefore improving the quality and the variety of emerging connections.

This interpretation of dual-use policies along the lines of KOP lead to another interpretation of the policies associated with standardisation and intellectual property rights. Two different instances remain for the codification required in these processes. Standardisation refers to the articulation of common projects at the level of end-users, scientists and the industry (Tassey, 2000). In the framework of dual-use policies, codification is not only meant to serve spin-on effects but also to create or restrain the variety of technological trajectories, to foster or refrain the emergence of shared informational and cognitive reference sets in the networks. Measures associated with intellectual property rights may also constitute a tool in favour of knowledge diffusion inasmuch as they cover the dissemination of technical data which may represent the basis for further research and for new cooperation inside existing or emerging networks (Amin and Cohendet, 2004). In this perspective, patents and scientific publications may be also interpreted as signals advertising for relevant competencies, which may ground the interaction between civilian and military in strong/weak ties.

2.3 Emergence and development of dual-use technology policies

The conditions of the emergence and of the development of KOP have now to be applied to dual-use policies. These conditions refer to institutional and organisational aspects.

Interpreting dual-use policies as KOP implies a substantial shift in the way policies aiming at military innovation are organised and managed at the institutional level. When duality becomes a central reference for military innovation policies, the management of the interaction between all actors committed to the various uses and purposes lying being the various uses remain crucial. Nyholm et al. (2001) explain that innovation policies are now coordinated and managed in the framework of an interaction between an increasing number of ministries and departments. Ministries of defence remain central to it, yet their role focuses now on bringing into play policies implying an array of stable institutional arrangements between public agencies and specialised ministries: collectively accepted references and inter-departmental commitment remain a prerequisite to success. These dimensions and the request for coordination pervade all levels of innovation policy (budget and targeted spending, standardisation, intellectual property rights) and all phases of their elaboration and of their management (prospective, planning, budget adoption, policies assessment and evaluation). Institutions provide a set of stable patterns ruling the interaction between the various actors committed to defence-related projects and the references bridging the subparts of the society about such issues (Edquist and Johnson, 1997). Dual-use policy-making becomes more efficient when these patterns and references are shared and assessed along stable and converging lines by the decision-makers representing the institutions committed to the process. The interaction between all actors' real power and their influence in the preparation of policies is also integrated into decision-making and into the implementation of these arrangements.

How is the defence customer to be shaped to successfully refer to dual-use policies? The organisation of defence requires specific competences when it deals with dual-use policies. Decision-makers and policy experts need to elaborate on specific capacities suited to identify the various options and transfer relevant knowledge towards the innovation paths; defence officials need also to develop the competences suited to the identification, the transfer and the exploitation of innovation results issued in non-defence networks towards the military uses. In the end, defence need to interact with the industry and with researchers to develop military programs: the main important program relates to the conception and to the development of new technological architectures in the framework of armament systems. Defence need therefore to develop and maintain internal competences associated with absorptive capacities in the sense developed by Cohen and Levinthal (1990). The level of absorptive capacities (high/low) impacts the nature of the knowledge set identified, exploited and recombined by the organisation to investigate the forthcoming innovation paths (Mangematin and Nesta, 1999). It depends on the nature of R&D activities developed internally by the actors of defence networks, and on the variety of the technological and scientific knowledge base already available. The scope and ambition of dual-use policies therefore directly follows MoD's capacities to develop 'high absorptive capacities', i.e., to maintain and foster research and development competences allowing for the preservation of interactions, of sensoring and assimilating the knowledge assets available (Mérindol, 2005b). These processes are complex, because knowledge management insists on the strategic importance of the transfers of tacit and unarticulated knowledge assets at these stages

of the innovation process. Tacit knowledge exchanges mainly relate to individual connections and interactions.

The capacity to mobilise knowledge issued in networks requires also managerial and organisational flexibility: Defence needs to be able to catch opportunities both from the exploration of new paths and from the exploitation of sound and validated options, and combine them. To work out these projects, MoDs need suited procedures and flexible management modalities; project teams have to exercise decentralised responsibilities, ranging from budget, evaluation, standardisation to intellectual property rights management. Defence organisations have to endorse the contextual ambidextrous model, as defined by Gibson and Birkinshaw (2004): Defence should be able to articulate and re-combinate activities oriented towards exploration or exploitation, depending on the variety of options available in the technological trajectories and according to the trends of technological change.

3 Methodology: France as a case study

This contribution investigates the French case on the basis of case study methodology and interviews. It is developed as a qualitative analysis based upon abductive research.

Case study is aimed here at uncovering relationships and explanatory links between the various actors and institutions committed to the management of dual-use projects (Yin, 2003). France remains a significant case because it reveals typical features and extreme situations about dual-use projects, suited to the inquiry of the interaction between the various actors in charge of projects coordination or in charge of the articulation and recombination of exploration and exploitation actions. The French case is revealing because it allows for an inquiry of current theoretical elements about KOP on the basis of dual-use projects. The authors benefited from a privileged access to meetings, data and people, thanks to their positions as scientists and managers in the French MoD, both in the joint administration and in the Air Force.

The analysis is grounded in 25 semi-directive interviews realised (between 1999–2002; 2005–2007) with R&D program managers, procurement decision-makers and officials working for standardisation and normalisation offices inside the French MoD and civilian ministries (in charge of budget, R&D, industry, transports). Officials working for the patent administration were also interviewed, as well as managers of basic research offices and innovation agencies (Commissariat pour l'énergie atomique, CEA; ONERA; CNRS; ANR, Agence nationale pour la recherche). This research is also grounded in the participation to three experts groups inside the French Ministry of Defense (2000, 2003, 2007) and to the economic evaluation program for dual-use projects organised by the French MoD in 2003.

4 France during the 1990s: first initiatives and ruptures

Until the beginning of the 1980s, France clearly exemplified the 'spin-off paradigm' (in the terms defined by Alic et al., 1992). Innovation policy was structured at a national level around major scientific and technological programs, always aiming at civilian or military precise purposes. In France, the aeronautic, space and ICTs industries emerged as a result of such a voluntarist planning. The French administration did not

clarify at that time the potential for joint development and did not seek for a joint development of civilian and military innovation R&D policies. At that time, defence was considered as the scientific and technological locomotive for the whole national innovation system: its dynamics centred on spin-offs.

The place of defence in the innovation system progressively shifted during the 1990s (Versailles, 2005; Mérindol and Versailles, 2007). The context of knowledge-based economies and the reduction of military budgets following the end of the Cold War re-oriented the innovation policy towards other priorities. Following Ergas (1987)'s definition, France shifted from a mission-oriented innovation policy towards a diffusion-oriented policy. Dual-use policies were introduced in the 1990s in France. Their implementation remained always a difficult task because it occurred in a highly volatile environment, where the defence mission was constantly reassessed and affected by a series of decisions associated with major armament programs: a form of chaos emerged from the absence of a 'big picture' prevailing for all decision-makers in France. Until the end of the 1980s, France had experienced a very stable situation where the content of political platforms and the repartition of roles and contributions of all the actors (administration and political parties) reflected the stability of the world before the collapse of the Soviet Union. The 1990s in France was characterised by new alliances (the French socialist party built up for instance a coalition with the Greens at that time), new strategic questions (mainly following the evolution of NATO and the introduction of US missiles in Europe) and new commitments for the armies (the focus on humanitarian missions).

Dealing with dual-use policies, the 1990s may be separated into two different phases. Until 1997, dual-use R&D projects emerged progressively with a budget equally funded by the MoD and by the ministry in charge of R&D (ruling for civilian projects). This represents the very first instance of dual-use policy in France. The second phase starts in 1996–1997 when innovation policy stops focusing on the development of major technological programs. The year 1996 witnessed the starting point of a major reform inside the Délégation générale pour l'armement (DGA) and the progressive reorientation of its activities towards procurement. The year 1997 remains as an important moment because the socialist party, after winning the legislative elections, introduced a new defence programming law (Loi de programmation militaire) and started managing the arbitrages between budgets in postponing several investment decisions for major defence programs owing to the end of Cold War. After five years (1997–2002), the budget associated with these non-decisions will amount the investment budget of a whole year for the French defence. Duality policies will be officially abandoned in 1997, as an instance of technological programs.

4.1 First initiatives: the Syrecide program

The Syrecide program was launched in 1994 by the ministries in charge of R&D and of Defence. It follows the conclusion of a joint experts group working on the consequences of the new economic context since the early 1990s, when R&D managers presented in the French MoD delegation. The Syrecide program aimed at developing synergies between civilian and military R&D and funded initiatives of common interest on both budgets. It represents a major initiative illustrating shared innovation projects (cf Stowsky, 2004). Syrecide was officially created on 25th January, 1995. Its budget was doted with 20 MF by each ministry and common R&D themes were pragmatically

chosen and made public in calls for proposals. The program was supposed not to impact the respective priorities of each ministry. To raise the attention towards the project, proposals were heavily selected and Syrecide advertised about the research of excellence, making the selection process a signal worth of interest for the scientific community. Syrecide themes mainly focused on technological bricks: materials, computer sciences (microelectronic and optronic components, software, automatics, robotics, telecommunications) and life sciences (radiology, parasitology, biotechnology).

Projects were spanning over periods from 12 to 18 months, and received between 2 and 10 million Francs each. Public budget was supposed to cover at the minimum the half of the total expenses for each proposal. The industry part to the proposals was supposed to demonstrate a valorisation of the outcomes of the project for both the civilian and the military markets. Proposals were examined by officials from both ministries and submitted to a consultative board of experts taken in the industry and in basic research. The final attribution of the grants was decided at the level of a plenary commission made of the directors in charge of these budgets. At the beginning of 1998, 30 projects were going on about materials (8.25 MF), informatics (16.8 MF), telecommunications (3.3 MF), optronics and microelectronics (18.66 MF).

Syrecide was abandoned suddenly and without notice in the early 1998, after two rounds of selection. The DGA reform initiated in 1996 had made this process impossible because it was now inconsistent with the priorities and methodology ruling in both ministries: each ministry refocused on specific actions. The civilian-aimed R&D ministry gave the priority to the action in favour of SMEs and of new partnerships between the industry and universities. For this purpose, they developed the projects described in Section 5. The situation inside the MoD was different: R&D budget has decreased of 30% between 1992 and 1998, for reaching 10.903 MF in 1998. The repartition of the projects financed by the MoD changed sharply, which may be exemplified by the budget of exploratory research projects being cut 40% during this time. The redefinition of DGA's priorities with regard to R&D budgets explains why the MoD withdrew from Syrecide.

4.2 New orientations in innovation policy, against dual-use projects

In 1996 and 1997, DGA launched a reform which changed totally its role in the national innovation policy. Priority has been given to 'strictly military' projects, in association with an important reduction of R&D budgets, which are not connected to product development (Guichard, 2005). The aim of globally cutting 30% of functioning budgets in the DGA also reinforced this shift from basic research to development. A sharp distinction occurred then between technological and scientific interventions and procurement (remaining in the prerogatives of the directorate in charge of programs), in favour of the last one (Giovachini, 2000). Long-run considerations in innovation policies progressively fade away and the satisfaction of operational needs alone remains, which of course supports the improvement of cost–quality–efficiency ratios in the short run. These changes are the results of the end of the policy relying on technological programs (Laredo and Mustar, 2001). This is a radical change. Defence is not the locomotive of innovation policy anymore; it may be considered as a source of the eviction of R&D budgets from the economic system.

This reform reallocates the main part of R&D budgets towards the most important firms in the defence industrial base: system integrators, first-level contractors, main important sub-contractors. The industry is now in charge of the interface with scientific and technological research networks. For instance, basic research projects financed by the DGA to teams from the CNRS (national administration for basic research in France) have been abandoned to focus on the military end-user. As a consequence of this new orientation for the DGA, relationships have changed drastically and direct interactions between the MoD and a large variety of the world of R&D and innovation have started vanishing (Mérindol, 2005a). At the same time, DGA has started to transform the principle of the two-fold budgetisation of major R&D programs between the MoD and prime contractors into a systematic rule. Altogether, these initiatives have made difficult the MoD access to basic research results and the management of intellectual property rights in relationship with armament programs. The number of patents financed on the budget of the MoD and registered by the defence industry has considerably decreased; as a result of the same dynamics, firms contest now almost systematically the MoD intellectual property rights for co-financed projects.

In the context of the budget constraints associated with the 1990s, the R&D projects conveying potential value for military and civilian applications have been progressively abandoned, because each ministry in charge considered the projects were not in their responsibility domain anymore. This situation introduced huge ambiguities. It left a series of critical technological domains without any public support and without connection to an administration, whereas these technologies remained highly critical to defence and Security missions. Companies such as Thalès, a world leader in defence and Security electronics, demonstrated that some of the most critical technologies for these purposes (both in the military and the civilian domains) benefited from the lowest level of public support (including budget).

The remaining initiatives in dual-use policies have dealt with standardisation. The aim was to generalise the civilian standards in defence, and to limit the military standards in the case where it proved that civilian references were not efficient and satisfactory for operational use. Security purposes and technical performance were amongst the main important drivers. This evolution in standardisation has been concomitant with the introduction of certification processes based upon ISO norms. These measures have been stabilised now and the same logic prevailed ever since. It has led to a declassification of military standards and, sometimes, to their direct suppression. This process has been considered as a way to foster technological transfers from the civilian to the military, which means that spin-on mechanisms and technologies issued for civilian purposes are understood here as allowing for scale economics in the military framework.

5 France during the 2000s: the difficulty of coping with the drivers of Knowledge-Oriented Policies

The reforms introduced by the French government in 1997 favour new modalities in technology management. Priority is given to partnerships and research and innovation technological networks [Réseaux de recherche et d'innovation technologique (RRIT)] are therefore created. Other initiatives deal with the introduction of specific action plans and actors associated with venture capital; a contest awarding the best innovative company is

also installed. This framework develops well for civilian markets. In early 2000, the necessity to access a wide range of RRIT in the domains of biotechnology, nanotechnology and software has led the DGA to introduce new propositions in the framework of dual-use policies. Initiatives have required advancing with a slow progression, because it was necessary to reshape all relationships between the DGA, in charge of the dossier for the MoD, and the ministry in charge of R&D (which had in between become a part of the ministry for Finance, budget and economics).

5.1 DGA contribution to projects financed by the RRIT

The first initiative in dual-use policy dates back to 2000 as the DGA started financing precise projects in the new installed RRITs. Installing once again in the logic of shared innovation, this situation aimed at sharing budgets and knowledge while developing partnerships linking with the industry and the scientists. The DGA and the MoD were not present while governance rules were discussed among the various partners, and therefore they did not have any clue about mechanisms and rules associated with the evaluation and to the orientation of the projects. The MoD participation to thematic networks also relied on a preliminary investment to identify the projects worth the interest and the budget from the defence perspective. Several meetings have been organised between R&D projects managers belonging to the ministry in charge of R&D and the officers in charge at the DGA, all aiming at the elaboration of a list of 'interesting' projects. The identification of the technological niches required sometimes up to 18 months.

RRITs are structured around the themes structured in 1998; 16 thematic networks have been installed. In each domain, their missions cover the identification of the issues to be solved, the elaboration of new rules for governing intellectual property rights, the actions required to foster innovative projects in defining new rules for shared innovation, the gathering of public and private competences, and the evolution of normalisation and of standards associated with potential markets. Projects are always financed by several ministries, each of them being limited to 50% of the total budget. The validation and the evaluation of projects represent new governance paths, exemplified with the constitution of experts committees to orient and define the themes to be investigated, or with experts commissions (gathering the industry, scientists and administration officials) deciding the distribution of budgets and grants.

A memorandum of agreement has been signed in 2001 between the MoD and the ministry in charge of R&D to designate 30 officials in charge of technical domains inside the RRITs as 'correspondents' for the DGA and the MoD. Some of them will also become members in the strategic committee installed when the DGA will attribute a contribution for the network. Defence contributes directly to several national networks or themes inside the networks (among them telecommunications; materials and processes; supersonic R&D inside the aeronautic network). It is also associated with the governance committees without introducing MoD budgets (for instance in micro and nanotechnology, or *GenHomme* dealing with genomics). In other cases, defence will only contribute as an expert (for instance in multimedia technologies). At various levels, this participation has helped defence to rebuild relationships with the world of innovation outside the realm of defence and Security. In some projects, defence was not only able to deal with shared budgets, but also to share networks and inter-personal relations with experts and scientists, building here a network also relevant for military projects.

The results were not really positive when it deals with a global appreciation of the DGA contribution to RRITs. No sound outcome results from the MoD budget when it deals with technology or R&D results. The case of biosecurity inside the *GenHomme* network illustrates perfectly the ambiguity of the MoD contribution. DGA was supposed to attribute 9 M Euros for a three-year period to projects in the realm of biosecurity and biotechnology. Calls for proposals have been issued in spring 2002, and then renewed in 2003 and 2004. In 2002, DGA only financed one of the three projects awarded (220 k Euros) whereas the ministry in charge of R&D provided the rest of the money (700 k Euros). DGA is obviously part of all orientation committees. In fact, the difficulty to raise proposals and manage the projects on a dual basis, as illustrated by this network, has been a common situation in the RRIT process. Developing such projects should have been extended to other ministries such as Health or Industry, what never occurred. The preservation of SMEs in these domains required a clear picture of the market perspectives, which obviously would have gone way further than the only R&D budgets and projects. The MoD was never able to provide elements for strategic stocks (vaccines, medicines, types of molecules, etc.) because it was never in the realm of prerogatives of the people present in the networks.

5.2 Emergence and development of dual-use technology policies

Dual-use policies have once again been fashionable between 2003 and 2007 when the MoD R&D budget has been stabilised (around 3.5 G Euros in 2005). It aimed at making secure the technological capacities of the military on the battlefield and grounded again in open innovation, in spin-on and spin-off mechanisms. Updating the situation of the French MoD requires focusing mainly on the DGA.

DGA is now associated with the installation of the national agencies in charge of Research (ANR) or Innovation (AIR). DGA contributes to the various experts groups organised by these new inter-ministerial agencies and also contributed in positioning there several officers. In charge of financing innovation projects, these agencies follow the efforts developed in the framework of RRITs and manage the initiatives associated with competitiveness clusters, which aim at associating companies, research centres and educational institutions in specific local areas. Seventy-one clusters have been created; among them 17 have are managed on a global level. The public/private interaction emerging from the clusters focuses on technology for markets with high growth potential; conditions for development include the emergence of common strategies via projects supported by public and private budgets. DGA committed to the implementation of clusters and now intervenes directly at least in the major ones.

This process is consistent with the newly installed processes ruling the budget of the French government in the framework of the "Loi organique pour les lois de finances" (LOLF) modernising the French constitution in the area: the DGA has become the specific MoD administration of dual-use projects. It materialises through the responsibility over a specific part of the defence budget in the distribution of LOLF missions inside the MoD. Within this new system, the director of the DGA is directly responsible for the management of 198 M Euros (in 2007) aimed at dual-use projects. In reality, this framework manages the previously existing budgets of the agencies for which DGA always endorsed the 'tutelle': CNES, CEA, and ONERA. These agencies develop activities for both the military and civilian markets and their research centres animate for the MoD a large variety of connections towards the industry, universities and

the CNRS. This situation may well have occurred over the last period inquired for this research; there are now specific arrangements and new features. It may be exemplified with the case of the directorate for military affairs at the commissariat for nuclear affairs (CEA), which launched a huge series of initiatives around the recently acquired Teraflop calculator required for the simulation of the processes associated with the production of nuclear bombs. The CEA was financed the installation of experimental installations and simulators during the late 1990s, which represents now a unique opportunity in France (and also probably in Europe). The CEA directorate in charge of military affairs has therefore installed a strategy allowing for non-military related R&D and innovation actors to access these simulators for their own purposes and experiments. Such a situation obviously reflects the will to increase returns on the investment, both in terms of cost-efficiency and of social welfare. The initiative allows also the CEA to position itself as a major reference player for the projects requiring huge calculation facilities, and therefore it has become the driver to shape and standardise experiments in the area.

At the very same time, DGA has attempted to progressively introduce several research forums between the defence and the innovation networks. Conferences such as 'Science and Defense' have been rehabilitated on broad themes, worth of interest for all innovation actors; specialised reflections with the main agencies in charge of the domain (CEA, CNES, CNRS, INRIA) have been institutionalised (DGA, 2006). Inside the MoD R&D budget, an amount of 300 M Euros has been dedicated in 2005 to exploratory projects proposed by university-related teams, and carrying potentially breakthrough innovation opportunities. Applications perspectives do not necessarily relate to defence, they may also be integrated into civilian projects. In the same vein, the number of PhD grants (1450 Euros per month during three years) has increased back to 400 subventions and amounts now the same level it had at the end of the Cold war. DGA attributes intellectual property rights now in most cases to the scientist to foster the valorisation of results in academic networks. Yet the process has not lived enough to allow the reconstruction of the interfaces between defence-related and civilian innovation networks. The DGA connection to other networks remains clearly limited at the moment because the frequency and number of the conferences is too limited; these forums mainly concern individuals, firms and institutions already connected with the MoD.

Analysing exhaustively the current period leads to a last point: the valorisation of the defence patent portfolio by the DGA. This point does not deal with the patents for which firms or private owners are holders, but the ones for which Defence officers or the MoD itself are registered as inventors. An internal commission now evaluates the most promising patents. Some financial support then applies to afford consultants specialised in the identification of potential markets and in the targeting of the firms consistent with the exploitation of this patent. Such activities have proven limited success so far.

6 Discussion

The analysis of the French case for dual-use policies reads along two main points: dual-use policies are always understood as exception to 'normal' innovation and technological policies; the prevailing institutional complexity and the on-going reform process inside the French MoD make the implementation of policy aspects really difficult and specifically limited to particular objects. Globally stated, organisational competences

and the ability to design flexible interactions opportunities remain essential drivers for the success of dual-use policies.

6.1 The French case: dual-use policies as an alibi to lower the influence of the MoD

The overview of almost two decades of dual-use policies in France has shown the French case as an instance of permanent discontinuity and relative chaos in R&D and innovation policies. Yet one major point emerges from the case: dual-use policies remain exceptional both by the fact that they always represent a specific action set, almost apart from the other initiatives in innovation policy, and by the small size of the associated budgets. Although there is an explicit political will in favour of their development, this trend depicts a recurring attitude.

This may be illustrated by the approach of dual-use innovation policies along two different sets of institutional actors: those in charge of armament programs and those in charge of R&D policies. This is easy to grasp in the organisation of the DGA itself: R&D budgets, normalisation, standardisation, and intellectual property rights are managed by different offices hardly ever working or communicating together. Dealing with their coordination seems an impossible task. In the early 1990s, the Syrecide project was managed without any consistent link with the armament projects managers; recent initiatives only represent minimal progress in the domain. Projects financed in the RRIT framework or in the competitiveness clusters remain in the responsibility domain of the technology directors, who head at the same time the armaments programs and the associated basic research. One could then consider possible to overcome the previous difficulties. Fact is that there is no rupture in the innovation process because dual-use projects are still considered as exceptions to the 'normal' way of doing technological policy. Dual-use projects are still small and heavily protected; they are seen by the managers themselves as well suited to exploratory actions, which do not have to impact the 'important' major innovation programs, always directly associated with some main armament system. Dual-use projects are in reality associated with atypical governance modalities and turn out to be disconnected from both the measures ruling the Defence innovation system and market-oriented civilian processes.

The articulation of knowledge assets between military and civilian networks is hardly fostered and almost never considered in decision-making. As soon as technologies are assessed as strategically important for the technical and operational success of a specific program, dual-use projects are not prevailing anymore because strategic projects are never managed along these modalities. Such a tendency holds even when perspectives do already exist for civilian markets and when competencies and savoir-faire are easily transferable on these markets. This situation always relates to organisational features: since its main reform in 1996, the DGA did not focus on the creation of stable structures in charge of animating and developing new network interactions, or strong and weak ties between civilian and military actors. It means that the MoD introduces a strong preference to project management and does not show how to cope with the constraints associated with networking, even though the competitiveness clusters and the features of knowledge-based economics essentially rely on networking. The only contradicting instance relates to the valorisation of the calculation facilities installed by the CEA, for which the DGA animates a small network of specialised actors, exchanging on results

and methods. Globally stated, there is an incapacity to think of dual-use and innovation policies as KOP becomes obvious.

The prevailing paradigm associates technology management with typologies, languages, codes and experts specific to the military domain; they refer to specific tools, nomenclatures and classifications ungraspable for the people who never worked within the military system. There is no such thing as a correspondence table available in the MoD. Documents supposed to provide a 'big picture' such as the *30 years prospective plan* remain anyhow classified and inaccessible to the civilian ministries. The same holds for the technical and scientific journals the MoD used to manage and diffuse even if other reasons prevail here: these activities did not resist to cost-reduction and to the successive reforms. It remains obvious that these aspects convey a great importance in KOP. Reforms and reorganisations have progressively led to the increase of cognitive distance between the actors in charge of innovation policies, which therefore lower the possibility of an integrated management of duality.

6.2 Institutional complexity and the lack of inter-services coordination

The management of duality occurred in a specific institutional context where all reference patterns prevailing in France for decades were altered and affected by a major discontinuity: the French system had developed in the context of mission-orientation and had to reposition itself as diffusion-oriented. The whole strategic picture of the French system is affected and nobody cared to manage this change. This difficulty is precisely the declination of the already evocated context-embeddedness of innovation policies, even though it is now referred to it on the side of drawbacks. The evolution is easy to grasp in the sharp reduction of the budgets distributed to the MoD, especially in the domain of R&D where military-oriented basic research almost vanished. The same holds for the repartition of prerogatives between ministries: the MoD now only has to focus strictly on Defence missions. Even in the 2000s, the MoD has been set apart from major R&D policy decision-making, which is obvious in the fact that MoD does not take part to the highest committee in charge of orienting and evaluating the national policy. Current prerogatives towards specific agencies (CNES, CEA, ONERA) or at the level of LOLF processes only institutionalise in the current framework previously existing rules, without translating into the same frameset lots of other actions and practices. As a matter of fact, the DGA mainly serves here as an intermediate for budgets transfers, only used for the basic administration because the amounts are made precise in a series of memorandum negotiated and signed at very high levels in the MoD hierarchies. At the level of the organisation of the MoD, the prerogatives associated with the DGA are always competed by other actors (and often transferred to the joint chief of staff); at the level of the repartition of prerogatives between ministries, the place of the MoD is driven back in the list of national and governmental priorities (a situation to be radicalised by the new *White paper* shaping Defence strategy and assessing the related format). Dual-use policies represent a typical case where the existing prerogatives of the DGA have not been institutionalised though serving at the same time as an alibi for format and budget reduction (Mérindol, 2003).

Retrospectively, duality has always been used to lower the R&D budgets attributed to the MoD by the ministry in charge of Finances. The officers in charge of Defence in Bercy behave as if dual-use projects represented a way to transfer the responsibility of financing onto other stakeholders, mainly constraining the industry and the scientists to find the money for R&D programs anyway but in the central budget. Retrospectively, dual-use innovation policies have not reinforced the position of the MoD in decision-making processes; they should be rather understood as an argument to reduce its contribution to the issue of R&D as a whole. This situation evolved along the decades analysed in this contribution, and has now reached a point where institutional defiance and distance prevail: the officers in charge do not share their respective administrative rules, their missions and constraints. Dual-use policy-making might well be the pretext to install structures suited to exchanges and the improvement of mutual understanding. Such a description does not apply for the French case, where shared structures and patterns vanished progressively. At the level of the intermediate hierarchy there are almost no interactions between individuals.

The ambiguity described here locates also in the lack of explicit and precise objectives for policy-making. Coordination between ministries cannot apply in this framework. The Syrecide project illustrates this point again: the goals of each ministry were specific and responsibilities were assessed only inside each administration and on the basis of the documents received by it alone. Defence was, for instance, worried by short-run returns and a sharp insistence on operational success. The ministry in charge of R&D was focusing at the very same time on solutions suited to the reinforcement of academic teams. Such aims were never explicitly mentioned in the ex post evaluation of a project, yet the absence of any common appreciation canvas may already help to understand that it was impossible to make it up. The participation of the DGA to RRITs and to competitiveness clusters follows the same line: it is obviously too soon to draw any conclusion about these activities, but the same causes lead to the same effects. The situation may be more complex today as civilian ministries have started promoting the existence of a vast number of projects in open competition, whereas the MoD clearly aims at avoiding redundancies, especially when solutions already exist inside the MoD itself.

The institutional complexity reduces the chances for an organisation of the interaction between the MoD and civilian ministries participating to the R&D and innovation policies. Considering the search for consistency in public intervention and coordination paths, it has become obvious that the issue of ‘dual-use’ has never reached this level of defiance or of indifference among actors.

7 Conclusion

This paper focuses on the characterisation of dual-use technology policies and takes advantage of the concepts of KOP to point out important drivers for success.

The management of dual-use technological policies does not only relate to collective aims but also to the definition of strategic objectives. It also relates to individual competences suited to the elaboration of managers. The MoD in general and the DGA in particular only refer to low absorptive capacities because of low R&D facilities and of a very low diversity of competences. This situation explains why the competences associated to the management of projects are often externalised (cf Cohen and Levinthal,

1990), or why the evaluation of potential uses often lacks in accuracy and in imagination. It is possible to succeed in this process if dual-use policies root in relevant complementarities between the civilian and military strategic competences. Another condition locates in the need for an assimilation of knowledge consistent with the objectives of all institutional actors present in the decision process.

The French case illustrates *a contrario* the conditions of emergence of consistent decision-making: dual-use policies depend both from the institutional context and from the organisational/managerial competencies. The French case illustrates huge difficulties in the process of articulating the civilian and military knowledge bases. Mitigating the open access to knowledge with a strict control over strategic competences and information represents precisely an issue that the French MoD did not succeed to manage until now. Dual-use policies also require that all public actors share the same policy objectives; otherwise the objectives associated to the main important actor will overrule the others.

The analysis of the institutional context explains that a sound and real coordination has to occur between all stakeholders and, more specifically, between all ministries contributing to decision-making. Managerial competences are mobilised to run the process on a day-to-day basis: the individuals working in these functions need to share short-run objectives, final purposes and references. Specific points need to be addressed, such as the security of access to supply and knowledge bases. From the Defence point of view, technological and operational constraints need to be addressed, introducing here the request for a subtle arbitrage between the openness of the research networks and the closure required to avoid any inconsistent technology transfer.

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Note

[1]In the framework of the introduction of Open source software in order to manage legacy systems.