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Paper prepared for the conference on « Innovation in Europe: Dynamics, Institutions and Values », Roskilde University, Denmark, 8th-9th May, 2003

How can Intellectual Property Rights be incentives for civilian-military integration?

Abstract

We are now entering an age where questions of military research and innovation are growing in scale and complexity, from a point of view that is both thematic (dual-use) and geographic (European dimension).
The setting of a European "dual-use" system of innovation indeed affects the competitiveness of the economy, as it generates synergies, economies of scale and economies of scope at the scale of a continent. It contributes to narrowing the technology gap between Europe and the USA and has consequences on the level of dependency of European countries in terms of innovation.
Piloting duality can be resumed as creating (or forcing the creation of) integration opportunities or transfers, and thus developing adequate active procedures. A first look at present dual-use policies reveals that so far the weaker point lies in the spin-off aspect. Although this apparently is a low-risk strategy, such technology brokering has, in practice, proved to be a difficult, labour-intensive process; this transfer mechanism is more of a long and complex process of "co-development" which requires substantial modifications and additional developments for the commercial introduction of the former military invention.
A rationale for creating IPR clearly appears: commercial firms would be unwilling to support a part of these costs without some assurance of protection from competition. Thus, patents and exclusive licensing will facilitate the transfer from the military system to the civilian system by providing exclusive rights to preserve the profit incentives of firms.
The US and the UK are actually the only two to have though of this issue within the framework of dual-use policies. Their examples provide us with an overview of the difficulties encountered in trying to match a commercial and a more "public" culture of IPRs, but also of the major outcomes and successes to be expected.

Keywords

Dual-Use policies, Technology transfer, IPR, Collaboration

1. Introduction

One of the main orientations conditioning the dynamics of the European economy in the near future concerns the effective integration of its civilian and military innovation structures. Such

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"dual-use " policy consists of a mode of managing research, innovation and production of defence systems that seeks to generate economies of scale, economies of scope and spillovers with the civil sector. We characterize this concept in the following three ways:

- The scope of dual-use policies is vast since it extends from the totally specific (and therefore intrinsically "non-integratable") to the totally common (generic);
- Dual-use must be analysed as a property of National Systems of Innovation (NSI) and of national competitiveness. By contrast, it is often perceived as a mechanism that distorts and biases budgetary decisions;
- Dual-use is not an intrinsically technological issue, even if technology makes it possible to build bridges between the civil and military spheres. Basically, exploiting dual-use is a matter of organization, i.e. coordination, collective action and incentives.

There are therefore many economic opportunities for dual-use policy, not only in research but at all stages of the innovation process. The setting of a European "dual-use" system of innovation indeed affects the competitiveness of the economy, as it generates synergies, economies of scale and economies of scope at the scale of a continent. It contributes to narrowing the technology gap between Europe and the USA and has consequences on the level of dependency of European countries in terms of innovation (Section 2).

Among the different pillars that constitute dual-use policies, it seems to us that spin-off policies, dealing with the transfer of military technologies into the commercial sphere, are the less achieved (Section 3). We will see that meeting success in such a technology brokering activity proves to be a difficult, labour intensive process, which requires substantial modifications and additional developments for the commercial introduction of the former military invention (Section 4). Because active collaborative partnership is required, which rests on a strong commitment from both parties, a rationale for IPR clearly appears, as an incentive for collaboration (Section 5). We will then review the examples of IPR management strategies in the US and in the UK (Section 6). These countries are actually the only two to have though of this issue within the framework of dual-use policies. These examples provide us with an overview of the difficulties encountered in trying to match a commercial and a more "public" culture of IPRs, but also of the major outcomes and successes to be expected.

2. Dual-use as an engine of the national dynamics of innovation

The level of a country's military R&D funding illustrates national choices concerning security and alliances. It also impacts on national science and technology policies. A relevant issue is therefore the contribution of military R&D not only to security objectives but also to general economic performance.

Many econometric studies have tried to establish or disprove that defence R&D impacts on economic growth. Since the main purpose of military R&D is to develop more efficient weapons, programmes have to be judged in terms of their success or failure in that respect, above all. However, given the amplitude of the resources involved, it is impossible to disregard more general economic considerations. Empirical findings show that spin-off from military expenditure is not uniform; it differs from one country to the next and over time, so that no clear pattern emerges[2] (Hartley and Singleton, 1990: 155).

Based on the model developed by BETA in the framework of space programmes, spin-off can be analysed from an evolutionary point of view (Bach *et al*., 1991). The findings (initial study in 1988, completed in 1991) tend to prove the existence of a ratchet effect of the programme structure on industrial activity[3]. Yet more recent studies show a weakening of the effects of

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[2] The recent study by the CEPREMAP and EUREQua (OED, 2000) establishes, for example, that military research has a positive impact on growth in the US, a negative impact in the UK, and no significant impact in France. To add to the difficulty of interpreting these results, note that an analysis of the role of military funding on the economy is hindered by the lack of reliable and systematic data (i.e. standardized, coherent and comprehensive) (Molas-Gallart, 1999).

[3] Indirect spin-off has been identified regarding technology, commerce, industrial methods, industrial organization, and the knowledge and expertise bases determining the economic heritage of firms – and consequently their innovativeness in the medium and long term.

military research on the civil economy. They mark the end of what was called the "spin-off paradigm" (Alic *et al*., 1992). Consequently, the organization of the production of military innovations in the form of a programme structure is now being called into question in many Western countries (Ergas, 1992; OECD, 1999).

In light of these considerations, the US innovation system has shown a strong capacity to adjust in order to maintain defence R&D at its centre, through dual-use policies. After the disappearance of the Soviet bloc, the US federal government tried to promote the decompartmentalization of the civil and military spheres, for a better exploitation of existing resources and programmes in all departments. Implementation of this plan was characterized by a strong will both to increase cooperation at all levels between government, industry and universities, and systematically to ensure efficient diffusion of technological innovations to and from the military sphere. The Clinton administration thus reassigned federal R&D funds from defence to civil programmes in order to reduce the costs of new key technologies (the new civil-military ratio was 56% - 44%). The Pentagon's policy was set squarely into the broader framework of an overall research and innovation policy formulated by the White House, linked to a national security strategy and no longer only a purely defence strategy. The military institution thus evolved in parallel with other institutions, illustrating the switch in the government's role from client to partner. Yet, although the federal government was less directly involved in corporate strategies, the Defence Department provided substantial aid to industry. Feldman (1999) illustrates this aspect in a report on the Pentagon's role in the emergence of biotechnologies in the US. Between 1983 and 1997 the Defence Department provided some 280 billion dollars in grants to start-ups, most of which were developing applications that were not specifically military and were sometimes even purely commercial.

The dynamism of the US system thus stems primarily from its capacity to easily transfer knowledge and innovations from one area to another (Mowery & Rosenberg, 1989; Nelson, 1993; Guichard, 2000). This fluidity is also found in modes of financing, with complementarity (and sometimes substitution) between civil and military funds[4], as in biotechnology. This is a crucial aspect of the innovative capacity and economic competitiveness of the US which has given military programmes a key position in the Knowledge Economy.

In Europe, the issue of dual use policies is still considered as a budgetary bias, rather than as a central element of the innovation capacity. Nonetheless, if Europe is to become a major actor of the knowledge economy, it is clear that the opportunity offered by dual use policies is a great chance that is not to be missed. However, the question of a European Defence Initiative, like that of a European Armament Structure, remains wide open. We are clearly entering into an age in which questions of military research and innovation are growing in scale and complexity, from a point of view that is both thematic (dual-use) and geographic (European dimension).

These questions become far more meaningful in the current context of renewed arms budgets, following the events of September 11 2001. The US defence department's budget has risen more steeply in the past year than it has in two decades, up to 3.3% of the US GDP. Other large countries have initiated a similar trend although it has not yet been translated into such substantial budgetary increases.

Trends in national innovation systems towards dual-use are crucial since the efficiency of defence R&D expenditure is contingent on them. The setting up of dual-use policies, like the

[4] The *Federal Cooperative Technology Programs* have enabled the federal government to redefine its role, outside of traditional financing of R&D. These programmes include Sematech, the *Technology Reinvestment Program,* the *Small Business Innovative Research Initiative* and the *Advanced Technology Program*. For further details see Guichard (2000).

emergence of a European scale will help to determine the future of the technology gap with the US, and consequently European countries' dependence in terms of innovation.

3. The four pillars of dual-use policies

Dual-use policies differ substantially, depending on the dominant sector. When military technology "pulls" the market (for instance computer technology or aerospace in the 1960s, cooled Infra red technologies nowadays), it is the civil sphere that tries to adjust its systems in order to benefit from spillovers generated by military demand. In the opposite case (predominant today), it is the steering of dual-use and the implementation of proactive procedures by industry and the defence administration that become necessary to "force convergences".

In short, steering dual-use means creating (*forcing* the creation of) opportunities for integration or transfer, and developing active procedures for that purpose. Based on Metcalfe and Saviotti's model of technology output indicators (1984), we can identify the three main (relatively) invariant integration and networking structures (Guichard, 2002):

Fig. 1. Structures of dual-policy action, based on Metcalfe and Saviotti (1984)

The three structures of action of dual policy are integration (upstream), transposition, and convergence (downstream). These three structures are interdependent: the probability of integration (manufacturing or R&D) will be stronger when an action has been undertaken on the $\{X_i\}$. The same applies to the probability of creating modules of common characteristics. We can also mention that the chances of success of any dual-use action are enhanced by initiating collaboration and coordination processes *ex ante* and by planning them in advance, that is, by envisaging dual-use from the very beginning of the programme and the design of technologies.

From these structures, we can deduce the four principles of action (so-called "pillars") on which dual-use policies can be based.

- The first pillar of dual-use policy concerns the convergence of the characteristics of performance (at the extreme, making certain characteristics common). Such action determines opportunities for economies of scale and scope, and spillovers. Behind this idea we find that of aligning civil and military norms and standards, bringing together processes of certification and qualification. We conceive of standardization as a real "force of dualization";
- Integration, at the other extreme, is envisaged when products are relatively disjoint. It is then possible to try to pool technical processes and R&D (economies of scope are possible). Key actions will take place within firms and within the research system. At the corporate level, these will consist in creating common steps in the production process, or in reducing the costs of variety (promoting mechanisms for rapid reconfiguration of systems; developing flexible manufacturing systems). Within the research system, they will correspond to the development of collaborative structures in basic research and R&D;
- The last two structures concern transposition. This consists in using the technological modules of a civil or military product for an application in the other sector. Here actions vary, depending on whether the shift is from civil to military or vice-versa. This structure corresponds to two pillars of dual policy:

Applications from the civil sphere to military systems reveal the importance of preparing the latter for the incorporation of civil components. This means that the attendant risks, constraints and acquisition processes must be taken into account.

On the other hand, in the case of military to civil, problems of access to commercial markets appear; hence, proposals for technology brokering companies.

A first look at present initiatives regarding dual-use policies, whether in the US, the UK or France, reveals that so far the weaker point lies in the spin-off aspect (Guichard, 2002). We will therefore focus on that pillar and the mechanisms and incentives that can help technology transfer from the military to the civil sphere. In our analysis technology transfer is defined as « the process by which technology, knowledge, and/or information developed in one organization, one area, or for one purpose is applied and utilized in another organization, in another area, or for other purpose" (Winebrake, 1992, p 54).

4. The spin-off exercise: Collaboration wanted

Spinning-off apparently is a low-risk strategy. As Baron states: " The national labs are clearly a "candy store" of goodies that should excite any scientist or engineer" (Baron, 1990, p 42). Nonetheless, such technology brokering has, in practice, proved to be a difficult, labour-intensive process, which has rarely generated large-scale profits: Technology or product transfers from defence to civilian applications are hardly "simple processes" where the military invention can be commercialized or incorporated in a private firm after "light" modifications. More realistically, this transfer mechanism is more of a long and complex process of "co-development" which requires substantial modifications and additional developments for the commercial introduction of the former military invention. Baron (1990) describes the case of the US Department of energy public laboratories, which are visited by venture capitalists who wander in with hopes of finding a technology nugget but realize that products are not sitting on the shelf waiting to be moved into the commercial sector. Some of these venture capitalists have no appreciation of the technology nor the effort required to bring a good idea into the marketplace. He analyses that "These disappointments are not surprising; many industry research people work at our laboratories and even though they come from large companies they have no idea how to transfer technology within their own organization. There is as much a cultural difference between the research and applications departments within a company as there is between the Government and industry" (Baron, 1990, p 39).

Thus, in many cases the results of these processes will differ substantially from the initial transfer goals. Indeed, one study of the technology transfer process at federal laboratories (Winebrake, 1992) identified two of the major barriers of transfer: the expectations of one party are not always shared by the other party, and there often exists a lack of awareness of the value of the existing technology being transferred.

In that respect, most experts have agreed on the effectiveness of close collaboration between industry and national laboratories. Because adaptation is usually difficult, collaborative partnerships require a strong commitment from both parties, which must be ready to invest substantial time and effort in a medium to long term initiative. The effort required is even bigger here, because of the profound differences that separate military and civilian industrial activities (the so-called "wall of separation" of Markusen and Yudken, 1992).

Winebrake encourages "active collaborations" under the structure of "advisory groups". According to him, advisory groups would seem to solve both of these problems by giving a consensual direction or focus to the research and development process (Winebrake, 1992, p 57). This "team concept", which encourages scientists, engineers, marketing agents, and technology users to work together in R&D planning, has been influential in successful technology-development project.

Hobday (2000) also calls for "project-based organisation" as best suited for managing increasing product complexity. He defines the "project" as "a focusing device which enables different types of innovation actors to agree the fine detail of complex product development and production" (Hobday, 2000, p. 874). Thus, this type of organisation offers crossfunctional business expertise and hence adequate competences for the management of customer-focused innovation and market and technological uncertainty.

Here, we are clearly expressing the fact that spin-off mechanisms must be envisaged as a real "joint venture" between the defence laboratories or defence firm units and the commercial firm. The laboratories must emphasize cooperative research and development agreements, and actively solicit private industries to participate in marketing their discoveries. Hence, to justify the substantial future expenses that industry will have to incur, a supportive licensing agreement is required to offer motivation for collaborative technology development.

5. IPRs at the rescue of the spin-off pillar

At this stage of the article, we understand the major role that IPRs can play as an incentive to active and fruitful collaboration in the spin-off experiences from the military to the civilian sphere. They can actually act as a trading "commodity" or "currency" in the agreements between the military "unit" (whether the business unit of a firm or a defence laboratory) and civilian commercial firms. Several economic studies (e.g. surveyed by Winebrake, 1992) have shown that the confidentiality of company data and research results are normally among the first issues of concern when these businesses begin exploring opportunities of collaborative research and development. It acts as an assurance of protection from competition. A rationale for creating IPR clearly appears: patents and exclusive licensing will facilitate the transfer from the military system to the civilian system by providing exclusive rights to preserve the profit incentives of firms. Arora *et al.* (2000) also attest of this aspect in the "usefulness" of patents. They recently investigated the belief that patent encourages R&D investments, and concluded that the critical factor to incentive firms to engage in R&D is the degree to which a firm controls the complementary technologies needed to commercialize an innovation. According to Barros and Stoneman (2002, p. 21), out-licensing is even more important for smaller companies because their existence might depend to a certain degree on their ability to convince other companies to in-license their technology. As it is necessary a huge investment to launch a new product on the market, smaller companies might not be able to cope alone with all the expenses. They tend to approach larger companies in order to out-license their invention, which might not be completely successful at that time but that might be a promising one. If their inventions are not well protected by patents it is more unlikely that larger companies will in-license them. If a patent is still pending it may be more difficult to persuade larger companies but it is still possible to reach an agreement. However, if a firm has an invention that is neither patented nor has a patent application being prosecuted, they tend not to approach other companies. This is not so only because other companies are less likely to in-license the invention but also because they need to settle nondisclosure agreements, which were mentioned to be risky.

A close related activity to out-licensing is cross-licensing. Small companies may consider putting their intellectual property into joint ventures. The possibility of settling cross-license agreements is also considered and patent, again, is said to be commonly used as an asset during the negotiation.

What seems obvious to some economists is nonetheless far from real life practices. A recent study by the OECD (2002) stresses that even though policies of ownership of IP generated through public research funds are being redefined, inconsistencies remain within national research systems and OECD across countries. In other words, despite the fact that the main focus of the legal and policy changes has been to grant public research organizations title over the IP generated with public funds, public research organizations have not yet had enough incentives, whether legal or institutional, to disclose, protect and actively commercialize IP. Empirical data illustrate that patenting of publicly funded inventions is on the rise but remains marginal in most OECD countries. As Davis (2002, p. 4) mentions it « the fruits of government-funded research were traditionally largely placed in the public domain", and the tradition is hard to displace. We will illustrate the moves experimented in the US and in the UK in the next section.

What we want to emphasize here is that the tendency of not allocating time and attention to IPRs is even stronger in the defence sector than in other publicly funded domains. As stated in the OST report on military research contracts (OST, 1997), there is a general trend for the industrial groups which work for the defence sector to patent less than in other sectors. For instance, in France, these groups account for 34,5 % of the overall French industry R&D budget, but their patents only amount to 12,9 % of the total number of European patents claimed by French firms (1994 figures). By comparison, the groups that have no relations to the Ministry of defence have about the same weight with regards to both indicators (around 54 %). It is clear then that in these firms that work for the defence sector, IPRs are not currently used as a strategic asset for active collaboration with commercial firms, thus hampering the fruitful commercialisation of potentially dual use goods.

6. The US and the UK examples: Rich experiences of flexible IPR management rules

This section is dedicated to the exposé of the pioneer experiments undertaken in the US and in the UK. These examples provide us with an overview of the difficulties encountered in trying to match a commercial and a more "public" culture of IPRs, but also of the major outcomes and successes to be expected.

The US: Flexible IPR management rules and "other transaction types"

Very early, the US government became aware that new technologies developed under federal research projects were not being properly translated into practical use. It then became clear to them that intellectual property was a major issue in that respect (Davis, 2002). As such, they realised that any transaction that affected the ownership, control or transfer of intellectual property could have enormous implications for parties on both sides of those transactions:

- Improperly defined rights to intellectual property in a government contract can result in the loss of an entity's critical assets or in limiting the development of application critical to public health or safety;
- Conversely, successful contracts can spur economic development innovation, and growth and dramatically improve the quality of delivered goods and services.

In response, the Congress has made attempts through legislation over the past 2 decades to ensure that federally sponsored inventions were being transferred to the private sector where they could be commercialized (GAO, 2001, 2002a, 2002b).

In 1980, the Congress passed two landmark pieces of legislation: the Stevenson-Wydler Technology Innovation Act and the Bayh-Dole Act. The Bayh-Dole Act[5] was passed in 1980 to address these concerns by creating a uniform patent policy for inventions resulting from federally sponsored research and development agreements. The act applied to small businesses, universities, and other non-profit organizations and generally gave them the right to retain title to and profit from their inventions, provided they adhered to certain requirements. The government retained nonexclusive, non-transferable, irrevocable, paid-up (royalty-free) licenses to use the inventions. In 1983, the act was extended to large businesses and to inventions made in the performance of federally funded research and development contracts, grants or cooperative agreements to the extent permitted by law. The Stevenson-Wydler Act has common objectives, but it focuses on inventions owned by the federal government.

[5] The Bayh-Dole Act is the common name for the Patent and Trademark Laws Amendments of 1980 (P.L. 96-517, Dec. 12, 1980).

More recently, the Congress passed the technology transfer Commercialization Act of 2000 in an attempt to improve the ability of federal agencies to license inventions created in federal facilities.

Department of Defence (DOD) officials view IP requirements and the manner in which these requirements are implemented as significantly affecting their ability to attract leading technology firms to the (DOD) research and development activities (see *infra*). DOD is also advocating greater use of its “other transaction authority”. This authority enables DOD to enter into agreements that are generally not subject to the federal laws and regulations governing standard contracts, grants, and cooperative agreements.
By using this authority, DOD can increase its flexibility in negotiating intellectual property provisions and attract commercial firms that traditionally do not perform research for the government. There are two basic types of Other Transactions. The first type had its origins in 1989, when Congress enacted legislation to provide the Defence Advanced Research Project Agency (DARPA) temporary authority to enter into cooperative agreements and « other transactions » for advanced research projects. The legislation did not define « other transactions », thus giving DARPA flexibility to deal with unique situations encountered when fostering technology, especially dual-use technology. The legislation only required that recipients should provide at least 50 percent of the project’s funding. In 1991, Congress made the authority permanent and subsequently extended it to military services. In 1993, Congress authorized a second type of other transaction to carry out prototype directly relevant to weapons or weapon systems proposed to be acquired or developed by DoD.

The US experience of the Technology Reinvestment Program (TRP) gives a good illustration of how much this evolution in the rules affecting property rights benefited both industry and the government (Potomac Institute, 1999). In particular, by allowing industry to retain rights to the intellectual property generated during the TRP, government gained early access to some of industry's best ideas. Interviews confirmed that IPR was a major issue, and is likely to remain so. Resolution of this issue enabled industry to insert ideas and technologies into the project, rather than withholding them or introducing them only after the TRP project was over. These comment clearly assess the role of IPR as a strong incentive for the commercial industry to work on military technologies. It allowed the program managers to work with companies which normally do not work on government contracts, such as IBM (Potomac Institute, 1999, p. 49) or Hewlett Packard (GAO, 2001, p.6). This IPR approach was one of the "business-like" approach and practices used in the TRP, which were well received and proved to be crucial to program efficiency and to attract the interest of commercial industry.

The UK: A rich and still on-going experience

The case of the UK is relevant not only because its Defence Research Agency, the DERA, was one of the largest research establishments in Europe, but also because it was one of the first explicit attempts in Europe to articulate defence research policies around the concept of dual-use. The UK Ministry of Defence (MOD) understood as soon as in the early 1980s that it had to consider its IPR strategy. As a first approach, selling patents was the most common means to exploit outside the defence area, and occasionally it had proved very successful, like for instance in the case of the liquid crystal technology developed at the defence research establishment at Malvern (Molas-Gallart *et al*., 2000).

The creation of a technology brokering company was achieved in 1984. The firm Defence Technology Enterprise (DTE) was set up by UK financial and investment institutions, with the support of the MOD, to identify technologies emerging from defence research establishments and to market them to commercial clients. The company ceased to operate in

1990, despite rapidly building a large database of transferable technologies. Its failure has been attributed, amongst other problems, to the inadequacy of the technology transfer concept underlying such "technology brokerage" ventures (Molas-Gallart and Sinclair, 1999). The main problem that was that DTE was implicitly based on an underlying concept of technology transfer that was wholly inadequate. It assumed that once a blueprint, patent or idea had been located, this was easily transferable through a straightforward commercial transaction. This experience thus provided an important lesson, confirming that effective technology translation therefore requires careful handling of the tacit knowledge of its developers (Spinardi, 1992, p 205). In the context of dual use technology transfer, this need for collaboration is reinforced by differences between the research and manufacturing cultures in the military and civilian domains.

The exploitations of the capabilities of the UK defence research establishments for other civilian objectives has been the subject of further official experiments. The next step was that of the Dual Use technology Centres (DUTC). They have been implemented by the DERA in 1994. They were considered as a means of bridging together industry and academia with the DERA to work together on mutual benefit. But their strategy was in tension: on the one hand, the DUTC's goal seems to emphasize the need for change in the traditional practices; on the other hand they were standing within the DERA organizational and its structural, contractual, and programmatic goals (Molas-Gallart *et al.*, 2000).

At the same time, while DERA was increasing its emphasis on civil exploitation, the Labour opposition was developing its policy for the UK defence industry. Labour's proposals for a Defence Diversification Agency (DDA) were set out in the 1995 document, *Strategy for a Secure Future*, in which the emphasis was very much on diversification as a means for the defence industry to adjust to post Cold-War reductions in defence budgets. Inaugurated on January 1 1999, the DDA has three main ways of interacting with industry:

- it is establishing a network of Technology Diversification Managers around the UK ;
- it is organizing seminars, mainly aimed at the defence industry, to discuss technology trends ;
- investigating the potential of major defence companies in diversification (constructing a database);

The role of the DDA is thus to provide knowledge, stimulate transfer of MOD's IPR and seek partnership with companies for programmes of co-development and adaptation. The model favoured by DDA is of defence firms spinning off technology into start-up companies. The dilemma at the heart of the spin-off issue is that the firms (or company divisions) with which the UK Defence Research Establishments have the closest relationships, and the best prospects for technology transfer have typically been part of the defence industry and are thus not well suited for adaptation to commercial markets (Spinardi, 2000). The DDA has nonetheless provided a new focus point for technology transfer initiatives.

Since the recent split of the DERA into Qinetiq and the DSTL (respectively private and public entities), the DDA has developed its own methodology of technology transfer, the "Synnova® system", which appears to be more flexible than the former technology transfer procedures. This system is not a linear one-off process but involves cyclical, continual engagement between the DDA, its clients and the technology providers. This first move seems encouraging, but it is still too early for any assessment of its efficiency.

7. Conclusion: The open field of IPR agreements for dual-use purposes

Bridging commercial firms and the defence laboratories (whether public or private labs) will require persistence and creativity. Successful collaborative technological development requires a deep understanding of the technical context of application and relies on the organizational environment in which scientists, engineers and technicians, often coming from different disciplines, work and interact. This labour intensive process is often long and complex, reinforced by the profound differences that separate military and civilian industrial activities. The US and the UK examples nonetheless suggest that IPR are a clear incentive for such a process. They can be of real interest to commercial firms, even to those that usually avoid contracting with the defence industry.

The floor is now an open to defining and experimenting IPR strategies. The few examples that we have cited are just samples of what can be implemented. The future dual-use collaboration agreements should be open space for institutional creativity in the sense that the actors will have to imagine their own rules of knowledge sharing and appropriation so as to face the multiple tensions between private property and collective learning (Cassier et Foray, 1999, p. 10).

We strongly believe that a wide spreading of these examples of flexible IPR strategies throughout Europe could help implement dual-use policies, under their spin-off aspect. In turn, we also believe that these policies are a crucial contribution for Europe to become the "most competitive and dynamic knowledge economy in the world". Indeed, as Baron states it for the US: "competition is not between GE and Westinghouse but rather between our auto industry and the Japanese auto industry and our industrial high-tech versus those in Europe and the Far East. The market is not a US market but a world market, and technology is a worldwide competitive product" (Baron, 1990, p. 38). The setting up of dual-use policies, like the emergence of a European scale will help to determine the future of the technology gap with the US, and consequently European countries' dependency in terms of innovation.

Figures

Given a military technology: $T_m = (Z_{m1}\ldots Z_{mn}) + (Y_{m1}\ldots Y_{mp}) + (X_{m1}\ldots X_{mm'})$;
and a civil technology: $T_c = (Z_{c1}\ldots Z_{cn'}) + (Y_{c1}\ldots Y_{cp'}) + (X_{c1}\ldots X_{cm''})$;

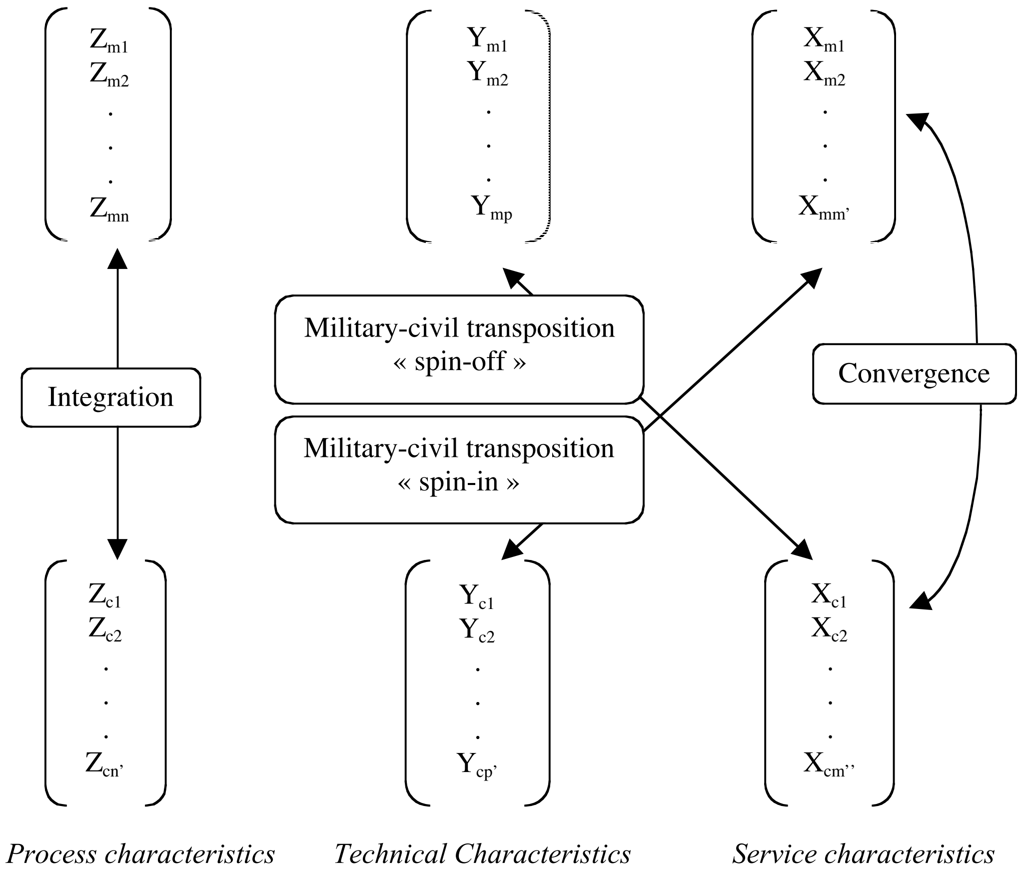

Fig. 1. Structures of dual-policy action, based on Metcalfe and Saviotti (1984)

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