QUESTIONING 'DUAL USE' CONCEPT

(Work Paper)

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Summary

Three main concepts – 'dual-use development', 'spillover', and 'spin-off' will be the central points of my efforts to define the cross-relationships between them within the framework of technology policy. In the investigation of these concepts, some hypotheses provide questions about methodological relevancies of the 'standard view' for technology's potential duality, as well as, about the empirical verification of the theory in the case of developing countries and especially in the case of Bulgaria.

Describing the technology as an entity in itself nether military, nor civil, nor both of these at once, and thus, the technology depends on its social network to appear or disappear its potential duality. The secondary goal of this paper is to explore the 'character' of the technology in regard to the organizational and informational conditions required to realize this potential. In addition, the elaborated framework of the analysis does not discuss the political reasons for the existence of military expenditure because of the national security's need, but the role of military R&D for civilian sector's development as justified only on the basis of economic-technological capabilities.

Both 'West and East' countries' technology policies between the late 1940s and 1990s were motivated more by national security concerns than by any comprehensive economic strategy. The end of the Cold War emphasized the importance of a new technology policy, concerning the restructuring of former military industrial base on macro (international, national and regional) and micro (inside the units – firms, government laboratories, R&D centers, etc) level. The new realities not only sparked a reorientation of technology policy, but also have created persistent dilemmas for the design and implementation of these policies. The first dilemma is the tension between trade and technology policies, because the liberalization of the global trading system has broadened the agenda of trade policy to include many items of technology policy (e.g. domestic R&D subsidies, intellectual property protection, and even domestic competition policy). The second dilemma concerns the relationship between defense-related R&D programs and civilian technology development. *(Ham & Mowery, 1995; p. 90)* The developed western countries have committed themselves to redirecting national R&D spending toward non-defense activities with greater emphasis on the dual-use concept while the former socialist countries like Bulgaria paid more attention to conversion policies[1].

[1] In some cases Russia is an exception to the rule, but this is not central point of the present analysis

This policy framework puts the problem of the 'dual use' concept as a central point of theoretical and empirical investigations[2]. The only one real consensus of many studies is that "while military R&D may have been of value to the civilian sector in the past, this is no longer the case." *(Cowan & Foray, 1995; p. 851)* Definitely, there is no consensus on the notion of 'dual use technology', but the way we define it is important because it will focus our attention on specific aspects of the problem under investigation. One of the problems with the common use of this notion is the lack of agreement on the meaning of the term 'technology'. The confusion often is due to the use of the term in different domains involved in the problem under investigation. The two main 'visions' about the meaning of the term 'technology' coincide with the two main collectives, engaged in the 'work inside' and 'work on' technology, namely engineers and social scientists. A narrow concept of 'technology' "with its cognates is largely reserved by engineers for more direct involvement with material construction and the manipulating of artifacts. […] This 'materialist' or practice-oriented usage is also the foundation of the term 'technological sciences' as systematic *knowledge* of making, or science of the industrial arts." *(Mitcham, 1994; p. 147)* Historically, this usage has etymological and sociological connotations to the term 'engineer' (the Latin *ingeneratus* is associated with *natura* as well as with *ars* or *techne*), "which first appeared in the Middle Ages to designate builders and operators of battering rams, catapults and other 'engines of war'". *(Mitcham, 1994; p. 144)* Until late 18th century[3] military educated 'engineers' were been employed in public funded and utilized projects like designing, constructing, and maintaining of roads, bridges, water supply, and railroads – that is what we called now 'large technical systems'[4]. In this narrow concept of 'technology', the potential duality will by definition "refer to ways by which items (products and artifacts) used in one area of activity can be adapted and used in others." *(Molas-Gallart,, 1997; p. 369)*

"At the opposite end from the narrow definition of technology, are the views that see 'technology' as including the social relations and the 'mode of production' in which the development and production of artifacts occurs." *(Galtung, 1979; cited in Molas-*

[2] The relationships of 'dual use' concept with the 'conversion' one will be consider in brief in the paper below.
[3] John Smeaton (1724-1792) was the first person to call himself a "civil engineer".
[4] The relationship between historical practices of military staff in maintaining of large and sophisticated technical systems and the direction of modern technological change, in regard to technology transfer mechanisms as dual potential, is subject of analysis in the paper below.

Gallart, 1997) This much broader meaning of the term 'technology', typical for social scientists and "stimulated by recognition of the social significance of making activities allied with modern natural science, has extended the term even further to refer to all making of material artifacts, the objects made, their use, and to some extent their intellectual and social context." *(Mitcham, 1994; p. 151)* Indeed, technology has been defined so as to include even the making of nonmaterial things such as laws and languages. In this sense Nathan Rosenberg prefers to write about technology as "technological phenomena", taking "diversity and complexity" among such phenomena "as axiomatic." *(Rosenberg, 1976; p. 1-2)* Therefore, "the duality of a technology is not typically inherited in the technology itself. Technologies are not a priori either military or civilian or both. Their character depends on the social network in which they are developed or used." *(Smit, in press, cited in Cowan & Foray, 1995; p. 851)* […] The duality can disappear, or it can appear very late in the development and evolution of the social network of the technology.

Most of the authors[5] concerned with the problem of the 'dual use concept' which use the term 'technology' as economic-technological category, stand-up between the narrow and the broad term's context. "The concept of technology adopted in [the analyses of Jordi Molas-Gallart] will stand half-way between the two opposing views of technology as artifacts, and technology as comprising a whole system of social relations, and it is more attune with the common use of the term." *(Molas-Gallart, 1997; p. 369)* The worked out thesis is that 'technology' is not a univocal term, it is often and in significant ways, context dependent. When we summarize different analytical approaches, we can direct our attention to three basic modes of the manifestation of technology: technology as knowledge, technology as activity (making and using) and technology as objects (or artifacts). "In this conceptual framework, however, there is one arguable oversimplification. The anthropological interior need not, and in truth should not, be restricted to cognition. The will is an equally real if subtle aspect of the human. Technology as volition must thus be added as a fourth mode of the manifestation of technology." *(Mitcham, 1994; p. 159-160)*

In order to elaborate this framework in the case of the 'dual use' concept, it is useful to make distinctions between:

[5] David Mowery, Jordi Molas-Gallart & Tom Sinclair, Robin Cowan & Dominique Foray, John Alic, Lewis Branscomb, Nathan Rosenberg

- "potential duality and realization of this duality
- different stages in the technological lifecycles [or technological trajectories] (military R&D has properties which imply that results produced {knowledge, information, competencies} are of general value early in the lifecycle of the technology, but the general value of these properties may decrease as a technology matures)
- different types of R&D programs, namely product-oriented and process-oriented" *(Cowan & Foray, 1995; p. 852)*, if it is possible to distinguish between them, because "in some very important dual-use fields like advanced materials and chemicals it is exceedingly difficult to separate process from product technologies." *(Molas-Gallart, 1997, p. 374)*
- economic, technological, and economic-technical frames of analysis (for instance, economic analysis in the neo-classical tradition tend to separate technology as material assets from other non-material assets like know-how, licenses, trade marks, etc., and on the other hand these analyses do not admit the skills and tacit knowledge as a form of assets because of the impossibility of their codifying)
- technology as politic-free entity and technology policy. I agree with an idea of Langdon Winner that "to choose certain kinds of technology is to choose a particular form of political consequences. The adoption of a given technical system actually *requires* the creation and maintenance of a particular set of social conditions as the operating environment of that system. In other words – technologies are in some sense inherently political." *(Winner, 1980; p. 31)* In the case of dual use technologies, the redirection of R&D spending toward non-defense activities instead 'demilitarization' a 'remilitarization' of policy may occur in view of greater emphasis on dual use technologies in civil sphere. The existence of dual use concept requires advanced development first of all of military activities.

"When duality is seen as a relation that sits not in the technology itself but rather in a networks in which the technology is designed and used, one can distinguish between duality and spillovers." *(Cowan & Foray, 1995; p. 852)* In economic meaning "spillover" is "any indirect effect of public expenditure". (AnsMe Economic Dictionary, 2001) In narrow meaning 'spillover' refers to a situation in which

"particular research is done exclusively in one domain and adopted more or less without change in other. The existence of spillovers, therefore, is not evidence of duality, and might in fact be evidence of its absence. Thus, promotion of spillover can be viewed as a policy designed to correct the 'duality' failure of a program of R&D." *(Cowan & Foray, 1995; p. 852)* Nevertheless, many economic studies argue that the civil importance of military R&D has declined significantly, and that a kind of reversal of the respective roles of civilian and military R&D has occurred. "In the 1950s, defense research in jet airframes, semiconductors and computers yielded important civilian applications. These were examples of technologies that could be applied directly to civilian needs, so a direct and almost immediate spillover took place. Because military technology was more advanced than civilian, defense R&D was highly relevant to commercial industry, and defense R&D created breakthroughs that advanced US industrial performance." *(Cowan & Foray, 1995; p. 854)* In the present, after the late 1970s, the size and even the direction of spillovers appear to have changed. The generic similarity of civilian and military technologies has declined. It induces a significant diminution of the possibilities of the direct and indirect spillovers from military to civilian products.

These concept premises military and civilian technologies as clearly defined, contrasting entities, with dual use technology somewhere between them. In reality, there is a diversity of military products with varying degrees of similarity with civilian goods, and a common base of generic technologies that can be indistinctively applied to military or civilian development. "Often the dual use potential of many technologies is not fully realized." (Molas-Gallart, 1997; p. 370) If we see a technology in its broader meaning as created in the process of its realization through the interactions of the equal non-human and social actors, as entity itself neither military, nor civilian, nor both of these at once, spillover processes become a statute of a particular kind of dual use transfer. In this case, 'spillover' is a positive externality from research and investment in knowledge, and we can make differences between embodied R&D, where spillovers occur through intermediate or investment goods, and disembodied - knowledge spillovers. *(Weyant & Olavson, 1999)* The spillovers refer to a kind of output with dual use potential in different directions: codified knowledge, management principles, techniques and systems, learning and

teaching practices, skills and tacit knowledge, embodied in the research and management staff.

- Codified knowledge in the form of patterns, blueprints, and designs, which can then be the object of transactions through direct sale or licensing agreements[6].

- Management principles, techniques, and systems. Large military systems are characterized by their extreme complexity, and the ensuring management problems emerging from organizing and co-ordinating intricate networks of suppliers developing, manufacturing, and supporting long life-cycle products. In the 19th century, for example, military officers were hired to organize the construction of railways as they were the only 'managers' with sufficient experience to organize and lead complicated management hierarchies. The main problem here is usually the managing of technical change in both spheres: the military is willing to spend a lot to achieve marginal improvement, since a "small edge in performance can mean survival" *(Alic & all, 1992; p. 144)* in development of defense-related technology. Many economists argue that this implies a sort of negative spillover, by which scientists learn bad habits from working on military projects, so the apparent rational response of commercial firms is to keep these two groups separate. "Such learning spillovers may reduce the effectiveness of R&D personnel in competitive commercial markets where the close attention to cost considerations can be a matter of commercial success or failure." *(Mowery & Rosenberg, 1990; p. 143: cited in Cowan & Foray, 1995; p. 855)*

- Learning and teaching practices are one of the basic effects of military R&D toward general research environment. By subcontracting research to private firms and universities, the military is doing two things. First, it is creating a positive intellectual environment through the establishment of a new field of research and possible innovation. The second effect is that of training a core of researchers and generating a critical mass from skills and know-how. The new trained staff can introduce the new technology into the civilian market and in this way the spillover effect decreases the cost of future innovations in that technology. Further, the trained scientists teach the next generation.

[6] Licensing is one of the forms preferred by defense laboratories to exploit the dual use potential of results of defense-sponsored work.

- The last but not least form of spillover is skills and know-how, embodied in managers, researchers and employees. In the course of carrying out their duties labour accumulates skills and know-how, assets that have dual potential but can not be codified. This non-codifiable tacit knowledge is recognized as an important component of technology. The dual potential can be realized when the staff works on both military and civil projects, or when it moves from a job in one sphere to another.

In response to cross-related tendencies of the two main dilemmas in technology policy and the advances of the civilian branch towards military, arises a new form of spillover and namely 'spin-off companies'. The 'spin-off effect' combines the advantages of defense-related and civilian R&D programs on one hand and commercial trade and technology policies, on the other. Many defense companies and laboratories are aware of the dual use potential of some of the technologies they use or generate, yet they feel unable to develop and commercialize the technologies in unfamiliar markets. Usually, defense companies and laboratories in cooperation with private firm establish a new enterprise, which is created by former employees of the both sides to develop and commercialize the ideas and technologies. *(Molas-Gallart, 1997)* The definition of a 'spin-off company' is very restrictive with respect to economic impact, in that it requires the company to obtain a technology license relating to a particular patent. This notion for 'spin-off company' refers to the 'spillover' not only in form of codified knowledge as licenses, blueprints and so on, but also in forms of embodied knowledge as skills and know-how, management principles, techniques, and systems and learning practices. The broader definition of 'spillover' effect refers to the less formal induction or penetration of knowledge/science-based industry into the economy as a result of both basic and applied research and unplanned technology transfer. Economic impact results from the tendency of knowledge intensive enterprises to locate themselves in a region with a strong research activity. These 'spillover companies' can not be classified as 'spin-off companies', but they "gain" from processes of job mobility, education and teaching activities, informal communication in communities of researchers, engineers and producers.

Because of the relationships and diversity of dual use, spillover, and spin-off concepts, it becomes very difficult and maybe meaningless to choose between them in

the creation of national technology and trade policies. Our pursuit should be better understanding of their interactions and better usage of their beneficial advantages.

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