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The conflicts of the future: new scenario for the Defense Industry

Los conflictos del futuro: nuevo escenario para la Industria de Defensa

Abstract: Technological innovation is the source of major industrial changes. The defense industry does not ignore this fact. The entry to the defense market of civil companies, with cutting-edge technologies, sometimes disruptive, implies substantial changes in aspects such as the definition of the industry, the level of existing competition, changes in supply chains, forms of financing for research and development (R&D), the performance obtained, and industrial policies. This study analyzes in a synthetic way the main changes in these aspects together with the needs of the ministries of defense to prepare themselves for future conflicts.

Keywords: Disruptive technologies. Defense industry. Market. Industrial policy.

Resumen: La innovación tecnológica es fuente de importantes cambios en el seno de las industrias. La industria de defensa no es ajena a esto. La llegada al mercado de defensa de empresas civiles, con tecnologías punteras, a veces disruptivas, implica la existencia de cambios sustanciales en aspectos tales como la propia definición de la industria, el nivel de competencia existente, los cambios en las cadenas de suministro, las formas de financiación de la investigación y desarrollo (I+D), el performance obtenido y, finalmente las políticas industriales. Este trabajo analiza de forma sintética los cambios en estos aspectos unidos a las necesidades que tienen los ministerios de defensa para prepararse para los conflictos del futuro.

Palabras clave: Tecnologías disruptivas. Industria de defensa. Mercado. Política industrial.

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1 Introduction

The technological changes happening in the world, their speed and the extensive set of applications in different fields are a challenge for the defense industry. Although this industry is highly innovative, most of the new technological developments today come from the civil world. Its military application – with the developments in the world of defense –, implies important changes in the industrial structure and in the dynamics of all kinds.

The new technologies generate important advances in aspects such as the productivity of companies, the speed of data transmission and the efficiency of decision-making, which implies a significant increase in the possibilities of improving security of all kinds. However, they are also sources of risks and threats and, in the case of disruptive technologies, they represent a change in the ways we approach and solve problems. Therefore, new opportunities arise.

The analysis made in these pages tries to show to what extent these technological changes linked to the military world and oriented to "cleaner and more surgical" conflicts but also of high intensity and continuous along the time – for example, the cyber-attacks –, impose changes in the defense industry.

To this end, after analyzing the concept of disruptive technology, the need to reconvert the defense industry is studied from various perspectives: the definition of the industry, the level of existing competition, changes in supply chains, forms of financing research and development (R&D), the performance obtained and, finally, industrial policies. The article closes with some conclusions.

2 New risks, threats and disruptive technologies

The extent of risks and threats coming from various fields – social, economic, environmental, geopolitical or technological, among others[1] –, forces decisions oriented, in most cases, towards technology as a factor that can solve or, at least, mitigate these risks. It occurs both in the civil and in the military sphere because many risks are common to both spheres. This has led to a change of paradigm in the generation and dissemination of military technologies since the 1980s until today.

If initially a large part of the technological innovations was originated in the military world, nowadays most of them are produced in the civil field, due to the greater amplitude of the market and a growing demand for products and services with a high technical sophistication. Therefore, there is a change from a closed innovation model[2] in the military world to a more open one, with the participation of civil companies, generally innovative, which contribute to satisfying the demands coming from the defense field. Obviously, this

1 See World Economic Forum (2020) for an analysis of major risks.

2 According to Adams (1981), the "privacy" in which the defense industry operated was moving towards an opening with lower entry barriers and increased competition; at least in some dual and pure defense technologies and subsectors.

gradual change implies the redefinition of roles in the generation, acquisition and exploitation of new technologies, as well as the pronounced dual character of many of them.

Nevertheless, the problem is not in the generation of new technologies, occurring at an accelerated speed and responding more to the need for supply than demand, which is often dominated by the speed of technological expansion. In other words, the balance between demand-pull and supply push is based on the last one[3]. In the case of defense, the reasons for this situation can be explained in the urgent need for traditional defense companies to stay in the market, offering more sophisticated systems to ensure that the competitive capabilities of countries' armed forces can face the risks.

In addition to the factors aforementioned, it should be noted that the knowledge that companies have about new technologies is greater than the knowledge of the armed forces, so that they have the ability to guide technological development in specific ways, together with the operational needs of the army. Moreover, in general terms, there is usually more than one technical solution to the same problem, so there is an element of technology substitution – according to Howells, 2003. Finally, the armed forces of the most developed countries often set the pace for technological advances linked to security needs. The new weapons systems are instruments for solving risks and threats that each country can approach differently depending on its technical and economic capacity, geopolitical situation and many other kind of priorities. However, these devices tend to be standard and are characterized by a series of technological trajectories[4] (NELSON; WINTER, 1977; FREEMAN; PEREZ, 1988), which originate in the most developed countries.

One of the most important problems that arises when considering adopting a technological path, a direction to solve a problem or a set of problems, is the cost involved. This cost has several prisms. On the one hand, obviously, the economic one, but also the one derived from the risk of having to abandon the path due to lack of results. This last case implies the search for new solutions that require more efforts of all kinds. There is also an opportunity cost when it is possible to choose among different paths. The less developed countries try to imitate the leaders, so they do not incur the costs of generating new technologies – in addition to the aforementioned opportunity costs –; they only have the expenses to adopt, imitating (WIETHAUS, 2007) and learning them, which also implies a cost, although lower.

This situation becomes even more complex when the objective is to generate or use disruptive technologies that change the technological paradigm –the conceptual framework of solving problems–, and revolutionary ways are sought to generate new solutions to problems that involve technological leaps. As stated by Kostoff, Boylan and Simons, 2004, these technologies can modify the structure of an industry and even create

3 See Van den Ende and Dolfsma (2005) for an intensive analysis of this aspect.

4 A technological path is a way of solving a problem or a set of problems in a specific direction, considering both the technological state of the art and the position in which companies are placed. On the other hand, a technological paradigm poses the problems and solutions within an analytical framework, which is developed by means of trajectories.

new industries by introducing new processes and products[5]. Usually the combination of several technologies – what is not obvious at first – is needed to generate a new one that provides cheaper and better performing services or products. Obviously, in the face of the emergence of a disruptive technology, the response must be a specific training focused on the exploitation of its current and potential capabilities, which implies modifications in business training processes and in the public sector. Therefore, the learning curves are substantially transformed, as well as the time needed to put the new technology into force.

However, the generation of disruptive technologies requires significant cultural, managerial resource allocation – economic, human, infrastructure, and adjacent technologies –, technological and industrial policy changes, and a broad concurrence of factors that motivate the usual way of acting. In short, it implies changes in the different routines of the parties involved. This situation also imposes modifications on the behavior of other agents who, initially, may not be affected by the new technology, but who, due to their subsequent developments, may use its benefits to obtain a better performance in their activity or are directly affected over time[6].

Therefore, in contrast to the incremental innovations oriented towards maintaining the existing model, with small changes aimed at improving business productivity or the performance of products or services (PAVITT, 1984), the changes produced by disruptive technologies modify the knowledge bases, even altering social and power relations at the international level, leading to a rebalancing of powers as well as the emergence of new actors and the appearance of risks and threats not considered until now. Aspects such as security and defense are involved or affected by the new scenario and must respond to previously unspecified strategic contexts. This situation requires profound changes in doctrines, materials, weapons systems, strategies and forms of collaboration between national and international armies, among other aspects.

Faced with this change of scenario, both the business sphere linked to defense and the armed forces have to modify their behavior and structures. The key question is in what direction these changes should be aimed.

3 Need for restructuring the industry[7]

3.1 Definition of defense industry

The analysis of the defense industry requires primarily a definition of it. This is not simple, since this industry shows a high heterogeneity in terms of the type of goods and

5 A classic example is the introduction of computers, which generated significant changes in the morphology of industries and generated a new industry.

6 Depending on the level of horizontality of a new technology, this effect can be more or less intense. The more horizontal the new technology is, the more intense it will be.

7 At the end of this study, a summary table is presented sowing the current characteristics and the expected changes, as well as others that can be projected given the transformations that will be exposed along these lines.

services developed. Some authors have defined the defense industry as the one that refers the criterion according to the demand side, which would be the factor that gives homogeneity to the set of heterogeneous companies. Thus, the definition would be focused on the satisfaction of the demands of the ministries of defense by a range of companies, giving them the character of "defense companies," which in an aggregate way would make up the defense sector or industry (GARCÍA ALONSO, 2010). Other authors propose a definition that distinguishes companies that produce lethal equipment and those that do not produce it, and exclude post-production, as Hartley describes (2018).

On the supply side, it could be assumed that the type of production distinguish the boundaries between what is and is not a defense industry, so that those companies producing goods unequivocally linked to national security and defense will belong to it. Among the examples we have: fighter planes, armaments, frigates, among hundreds of other systems. However, numerous producers of software, communications, armored vehicles on wheels, simulators, etc. are also suppliers of highly specific defense products (FONFRÍA, 2013).

In addition, there are also non-specific products, such as insurance, food, logistics operations, and fire-fighting systems, as a substantial part of the offers to the ministries of defense and of their demands. Therefore, a possible distinction, diffuse, would be the one that considers the specialized suppliers versus the general ones.

However, in both cases it is important to note that it is only from a specific volume of turnover that a company can be considered part of this industry. For example, if an aeronautics company carries out 90% of its production for the civil market and the rest for fighter planes for defense, is it a defense industry company? On the contrary, if an insurance company obtains, for example, 75% of its turnover from the military market, is it a civil company, as it is not specialized in a specific defense good? What about a cybersecurity company? In short, duality is a characteristic that is clearly linked to this industry, making its delimitation more complex[8] (FONFRÍA, 2013).

It would even be necessary to include the activities that have traditionally been carried out by the armed forces, such as maintenance or system modifications, which are developed by companies through outsourcing methods (HARTLEY, 2018).

Finally, and as an additional problem to the definition, the scarcity of homogeneous data and statistics by country, related to the economic activities of companies in the defense markets, is a severe restriction for an adequate knowledge about them.

The intensity of technological change, along with the emergence of new weapon systems and other needs such as cyber defense or artificial intelligence, implies a redefinition of the defense industry. The entry and exit of companies, including the emergence of new sectors that are basically dual, associated with new technologies, leave, again, this industry without a satisfactory definition.

8 Even in the case of the large global defense companies, the percentages of civil-military production vary significantly, even over time. Some examples: McDonell-Douglas, over 70% of its production goes to the military market; Finmeccanica, 60%; British Aerospace, 40%, Airbus 17% or General Electric, 15%. See SIPRI, various years.

3.2 Level of competition

Traditionally, competition is not the fundamental characteristic of the defense industry. Initially, and for decades, the industry of each country has been the main supplier of defense systems of all kinds, being closed to new entrants from other countries (MARTÍ, 2015). Thus, a certain industrial and technological autonomy was achieved alongside the security of supply of inputs and maintenance of the systems, that is, sovereignty. The "defense industrial autarchy," based on the concept of Hamilton's nascent industry of the 18th century, became diluted due to the need to incorporate systems and technologies that were not within the reach of the country, for these were imported from foreign countries.

The international arms trade has grown substantially in recent decades[9] with the entry of new relevant actors and the diversification of the supply of all types of systems for military and dual use. While most countries try to keep their market closed, internationalization has also reached the world of defense. This greater internationalization brought a substantial increase in competition between defense companies, although due to the markedly oligopolistic nature of some large systems – such as submarines, or fighter and transport aircraft – the market is restricted to a small number of firms that compete at a global level.

However, it must be emphasized that national and international competition works in different ways. Thus, at the national level, countries with industrial capacities try to protect their market for national companies, generating monopolies and oligopolies, many of them of public capital. At the international level, competition has traditionally been based on several aspects, many of them not linked to prices. Some of these include:

- The negotiating capacity and the political, economic and geostrategic power of some countries to export their systems to third countries. The US is a typical case.
- The technological level of the systems.
- The power of large multinationals from developed countries.
- The offset agreements that have substantially benefited many less developed countries and have become a bargaining power far from the price with positive results, for exporters of defense material and for importers[10].

While these factors remain and continue to be relevant in the procurement of military systems, it should be highlighted that price and competitive procurement are increasingly seen as key factors in decision-making. Significant budgetary restrictions are changing the importance of the various factors and the entry of new international producers,

9 As shown by data from the Stockholm International Peace Research Institute (2019), during this century the arms trade has grown by 7.8% between 2009 and 2013, reaching the highest level since the Cold War from the latter date until 2018.

10 See Fonfría (2019) for an analysis of the application and optimal evaluation of offset agreements.

such as China, Brazil, India and Russia, pressing both the rising competition and, in some cases, falling prices.

We must add to this situation the increased entry of civil companies – in many cases SME (Small and Medium Sized Enterprises) – into the defense market, which develop new low-cost and high-value technologies – cybersecurity, small drones, C4ISTAR, among others – that intensify the competition in increasingly larger market niches. In addition, and with its smaller size, the entry and exit of the military market does not suppose important costs for these firms, which maintain their orientation towards the civil market as the base of their business, given that civil markets are much more dynamic, using the technological duality as a focus.

In this regard, governments are allowing the entry of new competitors because of their reduced bargaining power, due to forms of procurement based on price and not on cost-plus fee – which was a significant burden on defense budgets – and by increasing competition.

3.3 Supply chain

Supply chains are the core of the defense industry's activities. Although the general case is to appoint a main contractor who is responsible for selecting suppliers and subcontractors – tier 2, tier 3... –, these involve at least two fundamental aspects for the correct development of a contract. The first is the quality of the products and services they deliver to the main contractor in the stipulated time. The second is security of supply, so that the supply chain is not broken and coordination between suppliers and the contractor is adequate.

As supply chains become more global, their complexity increases and the demand for value added increases as well. If in the past value was placed on the services and products delivered, nowadays this is based on the process of change, something that will intensify and expand in the future. The value of use, oriented towards the consumer – ministries of defense – must be the main objective of suppliers. Therefore, changes in demand must find a flexible and rapid response in supply, even if it involves costs. How to minimize these costs? According to Bellouard and Fonfría (2018), it is possible to minimize them by making polled demands, by expanding the market, in such a way that different countries are involved in shared development with a single supply chain.

Thus, an option in the new scenarios may be the Outcome-based Service Contract (OBC), which allows the customer to pay only when companies delivery results, not simply for activities or tasks (NG; NUDURUPATI, 2010). Obviously, the adoption of these contracts requires changes in the behavior of companies and in the supply chain, as the relationship with the customer must be very simple in a co-creation process in which the connection of responsibilities and risks can change significantly.

In short, adjustments to variations in demand, confidence in the supply chain as a whole – a key aspect – and lag times must be the basic factors on which

supply chains are based in order to be efficient and reduce costs (CHRISTOPHER; PECK; TOWILL, 2006), combined with a high capacity for innovation that raises medium-term and long-term objectives.

3.4 R&D Funding

For the acquisition of major weapon systems, governments fund the main contractor's R&D activities necessary for the development of appropriate technologies to meet defense needs. This is due to the scale of many programmes, as a private company would not itself make such investments. Ministries of defense expect that the costs incurred by such funding are less than the return they get from the contracted system; this is a specific characteristic of the defense market and it is not common in civil markets[11].

Given the trends in the type of systems currently being developed and that will be implemented in the future along with the budgetary limitations faced by defense, it is necessary to seek alternatives to the current systems of R&D funding that decrease pressures on the budgets of the ministries of defense. In this respect, one of the options is co-financing or financing with costs and avoiding non-refundable subsidies or zero rate credits.

The reasons for this change of perspective can be found in the need to share risks between the Ministries of defense and the contractor, so that it is a stimulus to increase efficiency in the use of both public and private resources. Faced with this changing situation, companies must adapt their behavior in relation to R&D carried out in connection with defense contracts, which implies the proposal of new strategies that include the search for greater efficiency and its repositioning within the country's innovation system.

Among these strategies is that related to property rights, since co-financing may involve the sharing of these rights between the administration and companies, which requires negotiation between the two parties in terms of both ownership and exploitation (MOLAS-GALLART; TANG, 2008). Something similar occurred in France with changes in defense R&D funding policy in recent years, which have led to companies being less dependent on public funds, using tax credits as the main funding instrument in the defense field (BELIN et al., 2019). Other countries such as the United Kingdom emphasize other ways of procurement in order to regulate technological aspects and business financing channels (HARTLEY, 2011).

3.5 Performance

According to Hartley (2018), there are several ways to measure business performance: prices, profits, productivity and exports. However, in the case of the defense industry these parameters must be qualified, due to the peculiarities of this market,

11 There are some exceptions, such as in the case of European satellites or in the development of positioning systems.

since the results are often not comparable to those obtained in the civilian market. A clear example of this is the financing of R&D activities by governments. Another example is the pricing when there is only one customer – monopsony –, and when there are oligopolies or monopolies in the supply side. A third example is the ability to shift cost increases into the final price of the product – cost-shifting hypothesis, initially raised by Rogerson (1989).

In general terms, profitability in this industry must be qualified by considering that national markets – mainly in developed countries – have been closed to international competition and their companies have benefited from contracts with low or no competition on many occasions – as shown by some studies, such as those by Bower and Osband (1991) or Fonfría and Correa-Burrows (2010)–, which have resulted in profitability above the industrial average in many countries[12].

However, there is a need to expand the range of options, in terms of factors that influence company performance due to the changes mentioned above. These factors will be more and more linked to the increase in competition from two different areas. The first is international, through the entry of new competitors. The second is the change of paradigm in the generation of dual-use civilian technologies, which implies the entry of civil companies in the military market, increasing competition – as Watts (2008) states for the case of the United States. Essentially, the newcomers are SME with small capacity to negotiate with the ministries of defense, which imposes rules close to the market. In addition, due to the growing importance of technologies and developments linked to the world of cybersecurity and artificial intelligence, among others, the number of micro-firms – those with less than 10 workers –, that have these capabilities is increasing, so the number of suppliers tends to rise[13].

Another aspect to emphasize is the performance derived from the operation of the supply chain, since by increasing the added value of the goods and services delivered to the customer, as mentioned above, and by using new technologies. That productivity can be increased by generating a greater volume of output per unit of input. If we add to this the growing importance of the reduction in delivery times demanded by the ministries of defense, it is clear that the agility of companies is a key factor in satisfying new demands, which can give advantages to small companies compared to large ones that are usually more bureaucratic.

3.6 Industrial policy

Public sector intervention in the economy and particularly in the industry, responds to the need to reduce or eliminate market failures and to model the type of market required according to some political, economic and strategic orientations. In the case of defense industrial policy, market failures vary widely, ranging from the

12 Even, the productivity of the companies shows peculiar characteristics, as explained in the works of Martínez-González and Rueda-López (2013) and Duch-Brown, Fonfría and Trujillo-Baute (2014), both for the Spanish case, but very similar to other countries in this aspect.

13 This advantage could be reduced if there is a significant effect of mergers and acquisitions of innovative SME by large companies.

aforementioned lack of competition to different forms of asymmetric information, control of product characteristics, efficiency in the supply market and control of prices and costs, to highlight some – see Hartley (2011) for a broad analysis of these aspects.

To this end, the ministries of defense use part of their budget – that related to investments –, to carry out their industrial defense policy. Thus, the continuity of funding and predictability in the budgets are fundamental in the share that corresponds to investments, in order that the potential contractors and, therefore, the supply chain behind them, can provide the value demanded by the ministries of defense. Along with this, the questions of what and how the contracts are made by the ministries of defense is the cornerstone of industrial policy, since they define the type of systems needed – therefore the technologies – and hence the companies capable of meeting those demands.

However, it seems more appropriate to speak about "industrial defense policies" rather than industrial policy in the singular. There are two reasons for this. The first is the aforementioned heterogeneity of this industry, which requires different approaches to industrial policy due to the different problems that sub-sectors face, such as aeronautics, weaponry and ammunition or shipping, to mention just some examples. The second refers to the high changes that are occurring, as mentioned above, which involve the entry and exit of companies, the modification of entry barriers, the incorporation of disruptive technologies or the long acquisition periods (ARNOLD; HARMON, 2013).

A substantial part of industrial policies is concerned with R&D policies, beyond the funding programmes mentioned. According to Schons, Prado Filho and Galdino (2020), the development of these policies in the field of defense must be linked to the national innovation system and has an effect on both the economic growth and the security of countries, based mainly on the formation of human capital. It was the basis of some successful industrial policies in the 1980s in some countries, such as South Korea, or Japan, as Sakakibara and Cho (2002) point out in a comparative analysis between the two countries.

In this sense, it is fundamental to develop analyses that consider innovative culture as a basic, necessary and intrinsic feature of the capacity to generate new processes and products. However, as shown by Azevedo (2018), one of the difficulties lies in making innovative culture compatible with military doctrine, since the vertical hierarchy usually makes the horizontal flow of information more complex.

For all these reasons, defense industrial policies must have long-term objectives that can be combined with changes in the short-term, in order to adjust it to new operational, technological, economic and strategic scenarios. Flexibility – keeping the objectives, at least in the basics – is a fundamental characteristic since without it, opportunities will be lost, both for industry and for an adequate use of budgets and the improvement of the armed forces' capabilities.

Thus, governments need to use the tools they have in order to achieve industrial policy objectives. In this sense, their role as customers contributes to policy, but due to budgetary restrictions, this role is weakened over time, because the companies have to export and get foreign customers who can buy more than the national one, consequently, it is necessary to use other instruments. These include the

role of governments as legislators, as main shareholders in specific companies and as R&D activities funding.

However, industrial defense policies can only be understood in the context of a country's industrial and technological system as a whole – increasingly internationalized –, which imposes the need to consider these industries as part of the national innovation system (NIS), and therefore users of the horizontal stimuli that are articulated within the NIS.

Table 1 – Summary: Current situation and changes in the face of new scenarios for the defense industry

Main aspects	Situation at present	Main changes
Definition of the industry	Heterogeneous, supply and demand perspectives	Increased heterogeneity. Greater mobility: entries and exits. New sectors
Level of competition	Traditional monopolies and oligopolies and markets closed to competition	Greater international openness and new competitors: "newcomers" countries and civil companies. Greater price competition
Supply chain	Focused on services and products. Security of supply	Greater value creation. Service contract based on results. Focused on the customer.
R&D funding	Soft credits and subsidies. Low or no risk assumption by companies. Property rights generally owned by the company	Co-financing. Risk sharing between client and contractor. Tax credits. Shared property rights
Performance	Ability to shift cost increases into prices. Lack of competition by oligopolies/monopolies generates higher returns, but not a higher performance.	Increased competition for entry of new civil and smaller companies in key technologies. Increased value added in supply chains. More agile response of the SME
Industrial policy	Alleviating market failures. Promote a concrete industrial structure. Encourage innovation	Situation at present and articulate policies (in plural) for defense industries, given their heterogeneity

Source: Own elaboration.

4 Conclusions

Major technological changes and the continuous emergence of risks and threats imply the need for industrial responses that provide added value to countries' armed forces. Disruptive technologies are one of the greatest challenges for their incorporation into the military system and the incentives for their adequate use must be guided by industrial, economic, strategic and technological policies.

However, all these changes focused on the near future raise numerous questions. How the industrial structure will be in the future? Which capacities the armed forces will need in the coming years? What will be the role of the large multinationals in the face of the

irruption of new countries and companies –many of them coming from the civil world, as exporters that accentuate competition? What will be the effect of the new conflicts – hybrid, in the grey zone...– on the countries? To what extent business collaboration and joint demands are a solution to the growing unit costs? This text tried to outline from a broad perspective some of these issues, but they require additional detailed studies over the next years.

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