The History of the Formation of the Greek Aviation Military Project: Technical Protocols Competition and the role of Boeing Company in the History of the Greek Air Force Military Project.

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***Abstract*— (which flight has changed the world, there are still new frontiers for aviation to explore. Many issues still remain under investigation, such as how did it become possible to build protocols in the air? How have technical protocols been produced and worked in the aviation market? How has the technical-natural relationship been perceived when it came to draw and redraw agreements in the competitive international aviation military market?**

***Index Terms*— Aviation, technical protocols,boeing, doctrine**

I. INTRODUCTION

"Progress stalks with warhead and prosthesis, stopwatch in hand and glory in its heart". [i]

Karl Kraus

At the end of a hundred years in which flight has changed the world, there are still new frontiers for aviation to explore. Many issues still remain under investigation, such as how did it become possible to build protocols in the air? How have technical protocols been produced and worked in the aviation market? How has the technical-natural relationship been perceived when it came to draw and redraw agreements in the competitive international aviation military market? In attempting to offer answers to such questions, especially in

Europe and Greece, I here focus specifically on changes (or lack of changes) during the recent decades, which were mainly technologically defined by the transformation of information and communication technologies by the availability of the electronic computer, a machine perceived as global. The research presented in this paper was undertaken at international and Greek aviation-related archives, including archives related to military aviation projects in Greece. This analysis tries to compromise the study among technological change, improvement, innovation, adoption, rejection, and conflation of particular stories of invention/innovation/use, and cultural history, all this from a contextualist perspective.[ii]

This paper is written by bringing together the following historiographical concerns: A concern to study the history of the Greek aviation military project from a perspective that takes into account the history of technology, that is processes that linked, de-linked and re-linked various technical protocols of USA and Europe through technological relationships.[iii] Finally, it is a historical call to study the history of technology and the history of Europeanization-Americanization in reference to big military projects.[iv] More specifically, I here present the conclusions of findings on the history of the introduction in use of military aviation and electronics in Greece.[v]

Also a first approach in the formation of the Greek aviation - military project after the cold war period is presented in relation to aircraft types which dominated each period. Similarities and differences of the software and hardware localization in the formation of the Greek aviation project are presented, taking into account the findings of the research of the sixth period of the history of the military aviation projects of Greek Air Force (Table.1).

My thesis focuses on aspects of the history of the appropriation of aviation electronics and related technologies in Greece, as a result of the arguments of the military – industry - political – economical actors/complex.

The terms "technology protocol competition", "technology adaptation" become often inadequate as analytical tools to cover all the processes involved. Caught up in complicacies that make military-operational considerations a factor that could not be neglected, the Greek military aviation project has put the assumption about the globalization of technology into a strong test (Europe-USA).[vi] Also the definition of terms such as product life cycle, avionics compatibility, standardization become often useful as analytical tools to cover all the processes involved.[vii] The thesis in this paper is focused on the evolution of a large system – as the Greek aviation military project. The small size of the country and population, the absence of large scale defense industry, the role of Boeing company, the membership in EU and NATO, the Greek-Turkish relations and the after cold war effects, are factors that put the assumption about the globalization of technology into a strong test (Europe-USA).

II. GREEK MILITARY AVIATION PROJECTS

As is well known, Greece in the 20th century was involved in a series of wars, including the First and Second World War, an extremely harmful civil war, and crisis episodes with Turkey, throughout the post WW II period (due to disputes over Cyprus and Aegean Sea).[viii] This has resulted in a situation where a great amount of the Gross Domestic

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Product (GDP) of Greece has been spent into armament projects.[ix]

I here focus especially on aviation military projects of the Greek Air Force. I split the history of the armament projects of the Greek Air Force into eight periods and four huge military aviation projects (Table 1). In this paper, I concentrate on the periods after 1974, underlying the strong presence of Boeing company.[x] More generally, the important military aviation armament projects of these periods functioned as a vehicle for introducing crucial new technologies in Greece.

PERIOD	PROGRAM / PROJECT	DURATION	REMARKS	DOMAIN REGION /COUNTRIES OF TECHNOLOGY TRANSFER
1		1912-1916	GREEK FUNDS	EUROPE/FRANCE
2		1917-1922	FRENCH-BRITISH HELP	EUROPE/FRANCE GREAT BRITAIN
3	FIRST	1923-1934	GREEK FUNDS	EUROPE/FRANCE GREAT BRITAIN
4	SECOND	1935-1940	GREEK FUNDS	EUROPE/FRANCE GREAT BRITAIN/ GERMANY/POLLAND
5		1941-1950	BRITISH HELP	EUROPE /GREAT BRITAIN/USA
6		1951-1973	AMERICAN HELP	USA
7	THIRD	1974-1987	GREEK FUNDS	USA/CANADA EUROPE (FRANCE-POLLAND)
8	FOURTH	1988-2002	GREEK FUNDS	USA/CANADA/BRAZIL EUROPE/ FRANCE/

Table.1 History of the military aviation projects of Greek Air Force.

My major finding in respect to the intersection of the history of Europe and the history of technology before the 1974 is that USA have been the exclusive suppliers of aircrafts to Greece.[xi] Boeing company in its general term domains as aircraft and technology supplier. However, after 1973, the Greek Air Force introduced state-of-the-art electronic technology also from Europe with the purchase of European (French) aircrafts (Mirage F-1 CG) negotiated during the dictatorship period (1967-1974).[xii]

During the 1980s, Greece devoted 6.5per cent of the GDP to defense expenditures on an annual average basis, which is the highest percentage in Europe and one of the highest in the world. The 1970s were marked by the Turkish invasion in Cyprus and the occupation of the northern part of the island by Turkish troops, which determined both the Greek and Turkish defense expenditures. Even though Greece as a NATO member had to focus its defence to Eastern Europe countries (Albania, Bulgaria, Yugoslavia), main concern for the Greek headquarters was the Turkish activity and the establishment of a new air defence doctrine. As a result we have an increase in armament projects since 1974.[xiii] In this period (1974-1987), the history of electronics development and military aviation projects were tightly combined (Table 2).[xiv]

PERIOD	PROGRAM /PROJECT	DURATION	AIRCRAFTS
7	THIRD	1974-1987	Avions Marcel Dassault- Breguet Aviation Mirage F.1CG Bell B.212 Boeing-Meridionali CH-47C Chinook Dornier Do 28D-2 Skyservant Grob G.103 Twin Astir Grumman /Schweizer G.164A/G Ag-Cat Ling-Temco-Vought A-7H/TA-7H Corsair II Lockheed C-130 H Hercules McDonnell Douglas F-4E Phantom II McDonnell Douglas RF-4E Phantom II NAMC YS-11A-520 PZL M-18 Dromaider Rockwell T-2 E Buckeye

Table.2 Airplanes of the third program of the Greek Air Force
Red colored aircraft types indicate Boeing origin.

In the post dictatorship period, which overlaps with the Greek application and eventual admittance into the European Union, the USA lost the privilege of the basic provider of military aviation projects, due to the competition from European actors.[xv] The field of electronics upgrading programs and the history of the cooperation of European-

USA industries is discussed in this paper as the key factor in the formation of the final decision from the view of purchasing rather than promising intentions.[xvi] In this paper, I discuss specifically how Europe was presented in the context of choosing between purchasing from Europe or USA, and, also, in the context of technology protocols relationships developed while using the airplanes and rebuilding them via avionics upgrading programs.[xvii] Intention of this paper is to integrate the history of Greek military aviation projects technology into history compromising the wider public interest in technology rather than history; the policy concerns of historians of technology who tend to be in the area of technology policy and exceeding the borders of technology of consumption, technology – in – use and history of innovation.

Military projects in Europe face future challenges such as the adaptation of critical electronic innovations, the rising strength of new competitors and the globalization of the aerospace industry**.** [xviii] Military industry complex, development of military aircrafts and their electronics capabilities are still focused on gaining access in foreign countries and especially in those considered as target markets. It is argued that such big technological projects as the military aviation projects have characteristics distinct from national ones and that they have, in different ways, contributed to the creation of Europe in the 20th century.[xix]

The thesis in this paper is focused on the evolution of a large system – as the Greek aviation military project. The small size of the country and population, the absence of large scale defense industry, the role of Boeing company, the membership in EU and NATO, the Greek-Turkish relations and the after cold war effects, are factors that put the assumption about the globalization of technology into a strong test (Europe-USA).

III. THE TECHNICAL PROTOCOLS IN MILITARY PROJECTS

Writing of the USA, Ruth Schwartz Cowan claims explicitly that 'four technological systems have dominated twentieth century history: automobiles, and their attendant roads and fuel sources; aircraft, spacecraft and also rockets; electronic communication devices; from wireless telegraphy to personal computers; and finally, biotechnologies, new foodstuffs, medications, and contraceptives'. [xx] In the 1950s many believed that there had been a 'scientific revolution' in the early to mid 20th century, associated with airplanes, electronics, and atomic power, which followed on the industrial revolution of the early nineteenth century.[xxi]

The innovation-centric definition of technology is central to most work in the social construction of technology (SCOT) and actor-network theory (ANT) traditions. Studies of users and innovation, going back to the 1970s, and later developed under the SCOT tradition, and recently extended, are similarly primarily concerned with users and changing technologies. Of course, there is nothing wrong with focusing on the history of early use of new technologies. It is indeed a very interesting topic. The danger comes when this particular topic becomes conflated with the study of technologies in use, or indeed the history of invention.[xxii]

The competition of the aviation industry is focused mainly today on Boeing and EADS (alphabetically mentioned).[xxiii] They have long been embedded in political discussion, in museums, in books and cover a wide variety of historiography focused in the aviation technology. This paper is focused on the competition of technological protocols, widely used and formulated mainly nowadays by these two industries, trying to explain how technology itself competes via them. [xxiv] We start with a brief international overview of the history of the technical protocols concerning the development of competing technical protocols for the formation of the military aviation project which formulates the content of evaluation of large systems!

The term "technical protocol" describes a set of technical rules which are used by devices to communicate with each other across a network.

A protocol is a convention or standard that controls or enables the connection, communication, and data transfer between the connected parts. In its simplest form, a protocol can be defined as the rules governing the syntax, semantics, and synchronization of communication. Protocols may be implemented by hardware, software, or a combination of the two. At the lowest level, a protocol defines the behavior of a hardware connection. By the early 1970's, Silicon Valley had become a major technological center supported many times generously by military funds.[xxv] The digital opening year of the technical protocols in this research is the 1974.[xxvi], [xxvii] This is the approximate period when the logic gates that make up a typical digital computer for aviation exceeded one million – one hundred times the number in a typical 1960's computer. These technical protocols cover a range of companies that produce a wide variety of goods and services for the armed forces.[xxviii] The military technical protocols which are examined in this research are the avionics technical protocols. The classification of modern jet combat airplanes in five generations is examined from the avionics influence in their characteristics.[xxix]

The timeframes associated with each generation are inexact and are only indicative of the period during which their design philosophies and technology employment enjoyed a prevailing influence on fighter design and development. These timeframes also encompass mainly the peak period of service entry for such aircraft. [xxx]The defense industry is also characterized by increasing investment in Research & Development (R&D) to guarantee that its technological advantage will be maintained.[xxxi] Because this investment constitutes a major expenditure, large economies of scale are produced. [xxxii]The size of a country's armed forces is thus a determining factor in both the sizes of its defense industry and the technologies that are feasible from an economic point of view.[xxxiii] It is also obvious that the effort of every country is to decrease the deficit in the balance of payments, thanks to the increase in exports and an equivalent decrease in imports and also to ensure a productive activity for the domestic industry, ensuring at the same time employment positions.[xxxiv]The role of the technical protocols is vital in the development of the military project and the purchase of the project from foreign countries. After the initial phase of development each generation, foreign countries face the problem of accessibility in the whole spectrum of the systems capabilities. The technical protocols's role in the choice of the third Greek military project was not vital. [xxxv] In the fourth Greek military project and the upgrade efforts the technical protocols' role was increased.

IV. THE ROLE OF BOEING COMPANY IN THE PRODUCT LIFE CYCLE, AVIONICS COMPATIBILITY AND STANDARDIZATION.

Critical factor in the adaptation / rejection of technology is the avionics compatibility.[xxxvi] Many times state of the art hardware/software equipped systems cannot communicate properly. Designers of avionics hardware components must comply with certain safety specifications under specific certification much the way software providers must certify their code for flight operations under this operational environment. As more and more embedded electronics get added to cockpits the number of designers needing to get familiar with the technology will only increase.

According to my thesis, taking into account all the above described theories, we have to extinguish the aviation technology product cycle life as follows:

- From the designer / producer view the aviation technology product cycle life ends with the closure of the production line.
- After this point, the aviation product cycle life is supported as far the spare parts production line / maintenance support exists.
- The closure of the official spare parts production line / maintenance support DOES NOT mean the end of the aviation technology product cycle life. Patents, local operational / technical procedures can extend the life of the aviation product. Depending on the level of technological culture of each country, the military –political - industry complex and the standardization limitations, a country can deviate from the "fixed technology adaptation proposal" of each industry / country / alliance and follow a different innovative path.

Critical factors in the above described thesis are the consequences which refer to the impact of an innovation on those other than the actor, while private consequences refer to the impact on the actor itself. Public consequences usually involve collective actors, such as countries, states, organizations, or social movements.[xxxvii] Also we have to take seriously into account the costs and benefits of the adaptation of technology or the extension of the aviation technology production cycle life out of the "normal path". The benefits of an innovation obviously refer to the positive consequences, while the costs refer to the negative. Costs may be monetary or nonmonetary, direct or indirect. Direct costs are usually related to financial uncertainty and the economic state of the project. Indirect costs are more difficult to identify and may have cumulative effects in the whole economy of an actor / country.[xxxviii]

The Boeing company formed the Greek military aviation projects with the airplanes / systems as described below:

PERIOD	PROGRAM / PROJECT	DURATION	AIRCRAFTS -SYSTEMS
6		1951-1973	North American Aviation F-86 D Sambre Dog North American Aviation F-86 E,M Sambre
7	THIRD	1974-1987	Boeing-Meridionali CH-47C Chinook McDonnell Douglas F-4E Phantom II McDonnell Douglas RF-4E Phantom II Rockwell T-2 E Buckeye
8	FOURTH PHASE I	1988-2002	McDonnell Douglas F-4E Phantom II (USAF) McDonnell Douglas RF-4E Phantom II(Luftwaffe) Raytheon T-6 Texan II PATRIOT missiles AH-64 Helicopters
	FOURTH PHASE II	2002- …	F-4E Phantoms IIs(Piece Icarus 2000 program) (EUROPE) JDAM[xxxix] JHMCS[xl]

Briefly, the presence of Boeing company is dominant in the sixth and seventh period decreasing in the fourth phase as a result of events that lead the Greek military – industry – political complex to change orientation. Despite of the dominance of Lockheed Martin F-16 and Mirage 2000, the Boeing company still hold a significant share of the market with Raytheon T-6 Texan II and Patriot system. Also the introduction of JDAM and JHMCS in the Greek tactical air force doctrine changed the operational plans and sustained the critical role of Boeing philosophy in existing aircrafts via the upgrading programs. For many countries the satisfaction

of their defense programs, is closely attached to the access and adaptation of the new technology (for example with the concession of primary codes - source codes - that allows reprogramming and adaptation of systems in advanced requirements of user).

V. CONCLUSION

Aviation culture in Greece for half century was Boeing oriented. Olympic airways had been a "full Boeing company" for 30 years of its operation. Boeing brand name in public opinion was synonymous to safe flight operations. According to my review of the coverage of military aviation in the relevant open archives, to sustain an effective operational capability, European armed forces required high technology and cost effective equipment at a price that the European nations could afford.

On contrary to my first approach of the theme in Rotterdam 2007, the picture of the European military industry as it is presented by the open archives is not fade but it is improved! Boeing company shows a decreasing influence in the formation of the Greek military aviation project and only the training department holds its dominant position. The technical protocols competition in the electronics field is intense and there is rapid adoption of the electronic trends worldwide. When compared to its main competitor, the US industry, the present European defense industrial base was found to be many times fragmented and inefficient. On the other hand Boeing origin JDAM and JHCMS systems managed finally to connect Boeing and Greek Air Force in the formation of the air doctrine and the effort of adaption of technology. According to F.Karaiosifides, managing editor of Ptisi & Diastima, *the timeline of the huge technology gap and the strong competition in the development of defense related systems including, of course electronics, coincides almost completely with the timeline of the cold war*.[xli]

This worldwide situation was retained, at least until the mid-seventies that we have the first serious cooperation efforts in Europe. On the other hand, with the heightening of the Cold War, the related propaganda war was also raging, by all available means, including the Press, both general and specialized. Most military technology developments in Western Europe, lag the United States by at least a generation and the situation is improving by a very slow pace.

According to A.Tsagaratos, editor of *SPECIAL PROJECTS*, studying the competition between the two sides of Atlantic, *we do realize that traditionally USA was pioneer in the research and development and consecutively in the application of high technology in military projects*. [xlii] Characteristic example of this technological supremacy constitutes the program of American airplanes F-15,F-18,F-22 Raptor and Joint Strike Fighter (JSF). These airplanes for the time being constitute unique representatives in the category of fighting planes of 5th generation.[xliii]

In all that were mentioned before, the USA maintain without doubt the technological supremacy, being the only country which has brought in the level of production, with the significance of application (and not simply in level R&D) the relative technology. Europe as the competitive part, we must admit that the last 15 years it has made important steps in the sector of developing technology for use in military applications, moved in corresponding direction with that of American projects.[xliv]

Europe continues constituting - as traditionally as always interesting alternative source of supplying military technology to countries which face problems of importing high technology from the USA. For many countries, the satisfaction of their defense programs, far away from any political, economic and diplomatic dimensions of such supply, is not based on which side of the Atlantic allocates the best technology, but which side allows access and adaptation of the new technology (for example with the concession of primary codes - source codes - that allows reprogramming and adaptation of systems in advanced requirements of user). We have to emphasize also that the existing segmentation of forces inside the European Continent results in the weakness of achievement of required economies of scale that is answered at the other side of Atlantic. This problem is arising also in the American Continent with the blooming of Embraer company (Brazil). For example, returning in the case of F-22 Raptor and F-35 Lightning, where in the growth and manufacture participate, significant number of European countries, the main theme is the accessibility level of the user of such platforms and the time they will become "administrators than simply users" (restriction of know-how and infrastructure). [xlv]

At the moment, the picture of the European military industry as it is presented by the open archives is improved as anyone can easily make out of the countries' decision for their armament projects. As stated before, in the analysis of the Greek's experience, technology is the key factor of the evaluation of the purchase. Small countries like Greece without large scale defense industry seem to be extremely cautious to European projects, preferring secure solutions in the final phase, as the USA military projects.[xlvi] European projects still seem to act as alternatives (when USA restricts weapons exports and knowledge or upgrading programs) rather than as symbols for a unified Europe, collaborating towards a common industrial goal and competing on the global market. The history of the military aviation periods/projects in Greece according to open archive shows that European projects are welcomed from Greece in their presentation.[xlvii] In the period of negotiations for the final agreement, the interest is decreasing and finally even though Europe seem to be able to cover ground in most fields of military technology developments including electronics, USA many times hold the monopoly and maintained it by closely guarding the necessary technology.

Boeing company the last two decades lost important battles in the Greek armament arena as a result of military –political –industry complex reasons which covered in detail on the above described phases of the Greek experience.

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works on a project in the history of the appropriation of aviation electronics and related technologies in Greece. He retired from Hellenic Air Force in 2008 and is now a commercial pilot. As a pilot he has a 7500 total flying hours experience with aircraft types such as McDonnell Douglas F-4E Phantom II, Lockheed C-130 H/B Hercules, Gulfstream G-V, Premier 1/A (RA-390), Airbus A-320, A330, A340, A-380. During his service with Hellenic Air Force, he was trained as an electronic war officer and also as a flight safety investigator officer. He was Head of Training in Flight Training Organizations / Type Rate Training Organizations, Flight Instructor, Type Rate Instructor, Crew Resource Management Instructor in Greece and U.A.E under JAR / EASA He has also taught courses in the History, Technology and Doctrine Program in Hellenic Air Force Academy.

NOTES AND REFERENCES

[i] "With Stopwatch in Hand" in Harry Zohn (ed.), *In These Great Times: a Karl Kraus Reader*(Manchester, nd), p.141.

[ii] According to Friedel's new Culture of Improvement the subject matter is the "nature of technological change", why and how technological change has changed, and how the changes have changed. It promises to be a history of invention and innovation, and most particularly and interestingly of 'improvement' in technology. As Edgerton states the term is well chosen, for it avoids the usually misleading, and almost always post-hoc distinctions between radical and incremental inventions, and such-like distinctions. Improvements can be small or large, and apply to all technologies, whether old or new. Also he thought that histories of the English airplane were de-contextualized. But as he confesses, "I was wrong: it would have been pointless to contextualize the history of the English airplane in national history using the usual histories, for the airplane was already there. The problem was one of rethinking the already contextual history of the English airplane, and the history of England as conventionally written".

[iii] Thomas J. Misa and Johan Schot, "Inventing Europe: Technology and the Hidden Integration of Europe", *History and Technology*, 2005, Vol.21, Issue 1.

[iv] Helmuth Trischler and Hans Weinberger, "Engineering Europe: Big Technologies and Military Systems in the Making of 20th Century Europe",*History and Technology*, Vol.21,2005, Issue 1.

[v] The first round of findings on the history of the introduction in use of military aviation and electronics in Greece was presented in Dimitrios Ziakkas and Theodore Lekkas, "Has software development softened rigid European borders? What about electronics?, *Third Plenary Conference of the Tensions of Europe Network , 7-10 June 2007, Rotterdam, The Netherlands.*

[vi] Primary sources for this paper are the archives of the Hellenic Parliament, Economic Chamber of Greece, military press, and opinions of the actors of each project, including open archives related to the doctrine of the Greek Air Force. The articles discussed in this paper come mostly from the period between 1979 and 1997. Instead of simply introducing to emerging technological developments in military aviation, many archives offer evaluations about previous periods of the history of aviation. They provide also useful details on the reconstruction of the Greek Air Force.

[vii] Main topics are the periods of the related aviation military projects, adoption problems in the Greek Air Force, synthetic Vs real training, economical approach, accidents and flight safety. The description of the formation of the Greek aviation military project (technological change) is focused on the perspective of how the use of the adopted technology linked – de-linked and re-linked the Greek air doctrine and the relationships of the militant participants with the other related – actors.

[viii] Greece in the 20th century has been embarked in a series of wars, including the First and Second World War, the Balkan Wars and an extremely harmful civil war. Also Greece found itself in the middle of several hostile contexts, real or imagined, such as the context formed by the struggle against the Ottoman Empire, against a set of Slavic states during the interwar period, against the castellation of Balkan states representing various forms of post WW II socialism, and against Turkey, throughout the post WW II period (due to differences over Cyprus and Aegean Sea).

[ix] Greek defense expenditures remain on the highest level within the EU and NATO. Greece places almost 5 % on average of its GDP in expenditures of defense and military nature, during the last decades, while those employed in the Greek Armed Forces reach the 5.9% of the total labor force.

[x] During the 20th century, five companies charted the course of aerospace history in the United States. They were the Boeing Airplane Co., Douglas Aircraft Co., McDonnell Aircraft Corp., North American Aviation and Hughes Aircraft. The companies began their journey across the frontiers of aerospace at different times and under different circumstances. Their paths merged and their contributions are the common heritage of The Boeing Company today. Visit : http://www.boeing.com/history/narrative/n001intro.html

[xi] Δ.Κ Βογιατζής, *Ανακατασκευάζοντας Αεροπορική Ιστορία στην Ελλάδα*, Μουσείο Πολεμικής Αεροπορίας, (Δεκέλεια, 2003). The post-1950s decades have been very important for the rebirth of the Greek Air Force, after the WW II destruction.

[xii] Παρουσίαση Dassault Breguet Mirage F-1, *Πτήση & Διάστημα*, Τεύχος 39, σελ.42, 1984.

[xiii] H. J. Kranzle , The Perspective of Defense Industry in the European Union, *Defencor Pacis*, Issue 2 , April 1999.

[xiv] This period is the beginning of the third armament program with NO aircraft manufactured in Greece, mainly bought from USA except the French Mirage F-1 CG.

[xv] Η Ελληνική Πολεμική Αεροπορία στον δρόμο για τον 21ο Αιώνα, *Πτήση & Διάστημα*, Τεύχος 25, σελ.36, 1984.

[xvi] Α. Τσαγγαράτος, *Eurofighter*, Hellenic Air Force Yearbook, Vol.1, 2005

[xvii] Το νέο μαχητικό αεροπλάνο της Ελλάδας, *Πτήση & Διάστημα*, Τεύχος 15, σελ.28, 1982

[xviii]Pierre Tran, Trade groups: Sales Up for French , *Defense News* , 19/3/2007.

[xix] H. Trischler , Hans Weinberger, Engineering Europe: Big Technologies and Military Systems in the Making of 20th Century Europe, *History and Technology*, vol 21, March 2005, pp 49-83.

[xx] Ruth Schwartz Cowan, 'The Consumption Junction: A Proposal for Research Strategies in the Sociologyof Technology', in Wiebe E. Bijker, et al., eds., The Social

Construction of Technological Systems (Cambridge: MIT Press, 1987), pp. 261-280. Harry Elmer Barnes, a noted US historical sociologist, thought in 1948 that the world had gone through three industrial revolutions, the first of iron, steam and textiles; the second of chemistry and large industries, steel, and new communications; and the third, still occurring in 1948, was 'the age of electrification, automatic machinery, electric control over manufacturing processes, air transport, radios and so on. Harry Elmer Barnes, Historical Sociology: its origins and development. Theories of Social Evolution from Cave Life to Atomic Bombing (New York: Philosophical Library, 1948), p. 145'.

[xxi] Samuel Lilley, Men Machines and History second edition (London: Lawrence & Wishart, 1965)

[xxii] There are of course many studies of technology-in-use, indeed many studies by economic, military, business historians are exactly of this sort. Although it should be noted that very many accounts involving technology written by economic historians, especially those of a Schumpeterian inclination, tend to be very innovation-centric, for example, the works of David Landes and Joel Mokyr. Among self-proclaimed historians of technology such studies are rarer, though they are becoming more common.

[xxiii] D. Ziakkas "Has software development softened rigid European borders?" What about Electronics?" Third Plenary Conference of the Tensions of Europe Network and the Launch of Inventing Europe: ESF EUROCORES Program, Rotterdam, The Netherlands, 2007. In this paper there is analysis of this competition focusing on the Europe-America competition. For more, visit: www.esf.org/index.php and http://www.phs.uoa.gr/ht/dziakkas_el.html

[xxiv] Airbus / EADS Vs Boeing is a fascinating, informed and insightful tale of success, and failure in the turbulent, do-or-die world of aircraft industry. See more for this:J. Newhouse, "Boeing Versus Airbus", A.A Knopf, NY,2007 and
M. Lynn, "Birds of Prey: Boeing Vs. Airbus: A Battle for the Skies", Reed Intl. Books Ltd, London ,1995.

[xxv] Ibid, p10-22.

[xxvi] Even though 1970 is considered as the opening year of digital avionics, due to harmonization with the third Greek military aviation project, the year 1974 is considered as opening year in this research.

[xxvii] The application of dual-use technologies makes it ever more difficult to distinguish between civilian and military proyear ducts and companies. On a global basis we can consider defense companies to be those that produce goods and services exclusively for the use of the armed forces.

[xxviii] L.F.E Coombs,Control in the Sky:The Evolution & History of the Aircraft Cockpit, (Pen &Sword,2005), p.243

[xxix] It has become common in the aviation community to classify jet fighters by "generations" for historical purposes. There are no official definitions of these generations; rather, they represent the notion that there are stages in the development of fighter design approaches, performance capabilities, and technological evolution. The timeframes associated with each generation are inexact and are only indicative of the period during which their design philosophies and technology employment enjoyed a prevailing influence on fighter design and development. These timeframes also encompass the peak period of service entry for such aircraft.

[xxx] The competition of the technical protocols after the initial phase is very interesting. After the purchase of the military project the phase of adoption and the decision of upgrade of the military system is complex.

[xxxi] Editorial, Fixed Price , R&D Don't Mix, *Defense News* , 19/3/2007, pp28.

[xxxii] The cost per unit falls when the number of units being produced is high, and given their destination -the armed forces themselves- exports are very limited.

[xxxiii] Editorial, Fixed Price , R&D Don't Mix, *Defense News* , 19/3/2007, pp28.

[xxxiv] I. Parisis, The Defense Industry: Evolution and Perspectives, Defensor Pacis, Issue 3

[xxxv] Many political analysts claimed that Greek government usually announced the participation of Greece and purchase of European military systems so as to achieve diplomatic alliances in Europe.

[xxxvi] D. Ziakkas " Adaptation to international aviation trends and competition of technical protocols in the Balkans: ESF Eurocores/ 4th Tensions of Europe, Sofia,Bulgaria, 2010. In this paper there is analysis of the role of product life cycle, compatibility, standardization focusing on the Europe-America competition. For more, visit: http://www.tensionsofeurope.eu/Dissemination.asp?wh=Working%20Papers

[xxxvii] The results are usually concerned with issues of societal well-being. Private consequences usually involve individuals or small collective entities, such as a community. The innovations are usually concerned with the improvement of quality of life or the reform of organizational or social structure.

[xxxviii] The long term armament race of the Greek Air force, part of the Greek military project as already stated from the writer in previous presentations, had been for years a significant factor in the increasing dept. The country suffers from high levels of political and economic corruption and low global competitiveness relative to its EU / NATO partners, also in the military industry and armament projects.

[xxxix] The Joint Direct Attack Munition -- or JDAM -- is a low-cost guidance kit that converts existing unguided free-fall bombs into accurately guided "smart" weapons. The JDAM kit consists of a new tail section that contains an Inertial Navigation System/Global Positioning System. McDonnell Douglas developed the JDAM kits under a contract first awarded in 1988. In actual use these weapons have proved to be very accurate and highly reliable. They can be accurately delivered in virtually any weather conditions. JDAM can be launched miles from the target and safely rely on the navigation system to update the weapon all the way to impact. Visit also: http://www.boeing.com/history/boeing/jdam.html

[xl] The Boeing Joint Helmet Mounted Cueing System (JHMCS) combines a magnetic head tracker with a display projected onto the pilot's visor, giving the pilot a targeting device that can be used to aim sensors and weapons wherever the pilot is looking.With JHMCS, the pilot can aim the radar, air-to-air missiles, infrared sensors and air-to-ground weapons merely by observing the target through the helmet's visor and pressing a switch on the flight controls. Additionally, the pilot can view any desired data (airspeed, altitude, target range, etc.) while "heads-up," eliminating the

need to look into the cockpit during visual air combat. Visit also: http://www.boeing.com/history/boeing/jhmcs.html

[xli] Η Σοβιετική Ένωση ετοιμάζει εκπλήξεις, *Πτήση & Διάστημα*, Τεύχος 1, σελ.10, 1979.

[xlii] A.Tsagaratos "*HELLENIC AIR FORCE YEAROOK A*", Special Projects, 2006 , p. 6

[xliii] As F.Karaiosifides argues, this category is distinguished by characteristic traits, such as: more widely known as the stealth characteristic and the faculty of high speed of treatment of enormous volume given (data fusion) in a wider mesh of operational exploitation of these airplanes that is called "network-centric operational environment". The first characteristic, the faculty stealth, provide in the planes of 5th generation unusual possibilities with regard to the faculty of dissimulation opposite in the rival radars, which change dramatically the philosophy of the air battle. The second characteristic places the plane not any more as an individual arming system that executes autonomously air enterprises, but as a piece of a wider jigsaw puzzle which via the electronic sensors that uses, draws and shares the information that collects with third collaborating platforms (air, marine and land), while simultaneously becomes recipient of critical information for his mission of information that has been collected by third platforms, Φ. Καραϊωσηφίδης, Το F-35 ανοίγει τα φτερά του,, *Πτήση & Διάστημα*, Τεύχος 25, σελ.14, 2007.

[xliv] A.Tsagaratos "*HELLENIC AIR FORCE YEAROOK* ", Special Projects, 2005 , p. 48.

[xlv] Φ.Καραϊωσηφίδης, ΕΜΠΑΕ 2006-2010 &2011-2015, Αποκρυπτογραφώντας το γρίφο, *Πτήση & Διάστημα*, Τεύχος 253, σελ.116, 2006.

[xlvi] For many analysts, the "glacial speed of procurement means European countries are just now getting weapons conceived when the Berlin Wall was still standing. The bipolar power system may have shifted, but the fiscal burden is being felt by West European exchequers paying for platforms- late, complex and costly- conceived 20 or more years ago". Greek Air Force headquarters insist on that the Mirage / C-27 projects were risky due to the event that Greek Air Force participated alone in the early phase of development.

[xlvii] Also, HAI is intensifying its efforts on the formation of long lasting strategic alliances and strong business ventures with leading defense and aerospace companies.

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[2] "*HELLENIC AIR FORCE YEAROOK* ", Special Projects, is a review of the Hellenic Air Force activities and the relationship with technology and other countries armed forces. It is printed every six months from 2005.

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