Science, Technology, and Iinnovation for Defense in Brazil - An Analysis of Transfer of Technology and Challenges of Brazilian Defense Programs

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DOI - 10.25160/v5i2.ga.9

Introduction

The Brazilian insertion in the international system reflects the characteristics of a regional leader State seeking "autonomy through diversification" (Vigevani, 2007) to become a world player. After advancing social inclusion and poverty reduction programs in the past 20 years, Brazil now seeks a new positioning in the 21st century international system. And for that, as an emerging, industrially developed country, it strives towards structuring and advancing its science, technology and innovation system in order to achieve an autonomous development capacity.

Notwithstanding these tendencies, Brazil presents serious gaps in its public administration/public policy institutions and systems in terms of fundamental strategic matters of national defense and international security. This paper analyzes patterns in obtaining, absorbing and developing technology from major strategic defense projects, aimed at increasing Brazilian industrial-technological capabilities to conceive and develop defense products autonomously. This paper summarizes Transfer of Technology (ToT) policies and program *outputs*, intended *outcomes*, as well as results achieved so far, and the upcoming prospects and challenges of major defense projects. These considerations are partially drawn from research findings taking place at the Defense Policy Research Group at UFF.[1]

The methodology selected was the use of case studies evaluation for two structuring research elements: major interventions in defense programs and embedded ToT in the FX 2 – Combat Aircraft Program (Gripen NG BR) and the PROSUB - Brazilian Navy Submarine Development Program. The ToT model was used to evaluate intended and preliminary

[1] I would like to thank participant members of the UFF-INEST Research Group *Defense, Science & Technology and International Politics.* I am thankful to Capes (Young Talents Program), PROPPI-UFF (CNPQ-PIBIC) and Faperj (PIBIC) for their scholarship grants and research support grants to members of this Group since 2012. Faperj has also sponsed Evert Vedung Course on Evaluation for this Research Group.

results of both programs, probing into major challenges and analyzing the implications for the Brazilian defense sector.

1. Policy analysis and evaluation

Policy studies began with careful scrutiny of the sequence of steps taken in the policy decision making process analyzed systematically by the pioneer work of Harold Laswell[2]. From the 1960s, policy analysis turned into policy advising to governments, influenced the public debate over issues, and even changed political power and influence configurations in many societies. Policy analysis addresses

> causes of public problems, alternative approaches to addressing them, the likely impacts of those alternatives, and the trade-offs that might emerge when considering appropriate governmental responses to the public problems (Mintrom and Williams, 2015, p 4).

Policy evaluation is a mechanism for monitoring, systematizing information, and assigning value to government interventions (policies, organizations, programs, activities, etc.), their *outputs* (results from the decision-making phase), their *outcomes* (results after the implementation phase), or *impacts and effects* after intervention has been finalized (Vedung, 1997, 2015, p 387 and Pedone, 1985).

In this sense, the analyses of defense programs in this paper will focus primarily on their *outputs*, the intended results deriving from decision making process, and the preliminary results of the ongoing implementation -- *outcomes* evaluated at an initial stage.[3]

Evaluating Transfer of Technology (ToT)

Barry Bozeman (2000) summarizes the discussion of Transfer of Technology, posing key questions for its effectiveness and criteria to measure it. Leaving out important points, Bozeman´s model chiefly focuses on domestic technology transfer from universities and

[2] LASSWELL Harold Dwight - The Decision Making Process, College Park, University of Maryland Press. 1956.
[3] Evert Vedung and Luiz Pedone – Course on Evaluation of Governmental Programs, 2013/2014/2015, Laboratorio Defesa&Polí tica[s]-UFF.

government laboratories to private firms, including some novelties such as political effectiveness and capacity building. [4]

For the purposes of this research, Bozeman's model was modified to include two additional dimensions in addition to the issues of ToT: Human Capital Training and Economic Development. One deals with the Democratic dimension, that is, the effects of ToT in defense programs on fostering democracy, the security of the population, and protection of natural resources in emerging democratic States like Brazil. The second includes an International Strategic dimension, particularly important in view of Brazil´s Strategic Partnership with developed countries – Sweden and France - in the two cases analyzed here. [5]

Therefore, our Modified Bozeman Model of analysis includes these major dimensions:

1. Technology itself – "hardware" transfer of technology
2. Economic development regional/ national
3. State-Society fostering of democracy by defense modernization
4. International Political Strategic Partnership
5. The Human Capital Science & Technology "software" transfer

To bring to stage the relevance of the programs adopted dealing with Transfer of Technology the following questions are offered:

- What is the technology actually transferred to Brazil or adopted, and absorbed (changed, developed) in Brazil, the receiving country? Does it express the needs of the armed forces? Is it relevant to the Armed Forces? Does it solve the problems posed by strategic goals of the existing institutional framework (END -National Strategy of Defense, 2008; LBDN - White Book on National Defense, 2012)?
- What are the effects on the national or regional economy, rather than on an individual firm? What are the economic development implications, such as job creation or increase of income? What are the effects of formation of cluster of companies around

[4] BOZEMAN, Barry – Technology transfer and public policy: a review of research and theory. *Research Policy* 29 (2000), 627-655. See especially table 4, p. 638 and table 5, p. 645. See discussion on Appendix.
[5] Discussions with Evert Vedung

major projects (S. José dos Campos, SP – Embraer and others, Itaguaí, RJ – Nuclep, ICN, DCNS, Marinha do Brasil and others)?

- What are the State-Society effects from defense actions? Do defense policies and programs adopted by Brazil foster democracy? What is the effect on Brazilian society and the economy, and on its natural resources? Are society and economy more protected in view of the technology obtained and absorbed through defense programs?
- What are the international strategic advantages and disadvantages flowing from defense programs and their inherent ToT dimension? (geopolitical considerations)
- What is the impact on Scientific and Technical Human Capital (from Bozeman´s criteria)? Can we measure enhanced scientific and technical skills, technically relevant social capital, infrastructures (Networks, users-groups) supporting scientific and technical work as a result of training and learning processes to Brazilian personnel?

Flows of Transfer of Technology

Longo and Moreira (2012) cite the fact that many advanced countries' governments or companies are not inclined to transfer power, effectively embedded in knowledge, thus leveraging technologically a future competitor in world affairs. Longo (2007) points out that particularly the United States has policies of limiting access to modern technology, making technology transfers incomplete in many cases. Similarly, Krause (1992, p 88), looking at economic factors and techonological endowments, determined *first-tier states* as centers of military production and innovation, leaving to *second-tier and third-tier states* respectively the roles of barely producing arms at the technological frontier or merely producing low-tech weaponry.

Current globalization of the arms industry uses this stratification as an important analytical tool. Richard Bitzinger (2003) describes the *second-tier* producers such as Russia, India, Sweden, and Brazil, among others, as facing a challenge: cost increase and difficulties of qualitative or quantitative expansion for *second-tier* industries in view of high technological demands of manufacturing advanced weapons. Deficiencies remain at various levels: i) infrastructure of national science and technology; ii) R&D of advanced components, or its development or production. These shortages pose serious barriers to the development, absorption, and exploitation of technology for military use (Bitzinger, 2003,

p. 69) by identifying a number of adjustments in *second-tier countries* in which defense industries sought rationalization and globalization. Thus global production of weapons now happens where industry has become: a) *smaller*, with a *declining number* of manufacturers; b) *more concentrated*, through the consolidation of arms production in a few companies; and c) *more integrated*, due to the globalization process and the current transnational character of armaments production. Developing, emerging countries are part of this process. Increases in the intensity of cooperation agreements between emerging and developed nations reflect Bitzinger's (2003) predictions. The technology transfer agreements are an important mechanism for the establishment of partnerships. The table below summarizes the three international flows of technology transfer:

Table 1: Three Flows of International Technology Transfer

Flow A	Knowledge (including that embodied in capital goods)	Product Design / Specifications
		Materials / Components Specifications
		Process Design and Blueprints
		Production Procedures / Chronograms and Organization
Flow B	Know How	Production / Organization Know How
		Operation / managing skills
		Maintenance skills and procedures
Flow C	Know Why	Process / Production Design and Engineering, Know Why, Skills, Procedures and Experience
		Product / Market Design and Engineering Data Skills
		Project Management / Engineering Procedures and expertise
		Technology Development and Research skills, data procedures, etc.

LUCENA SILVA, A. H. and PEDONE, L. (2011) - Adapted from Baark, E. (1997). - Military technology and absorptive capacity in China and India: implications for modernization. In *Military Capacity and the Risk of War: China, India, Pakistan and Iran*. (pp. 84-109). Oxford: Oxford University Press. *Apud TSAI*. Ming-Yen, 2003. *From Adversaries to Partners? Chinese and Russian Military Cooperation after the end of the Cold War.* Greewoog Publishing Group=Praeger. Westport, CT, 2003).

The flows related to the production of knowledge and *know-how* "A" and "B" contribute to the capacity development of the recipient country in producing weapons. The flow "C", where important scientific knowledge principles and

engineering skills are passed along, *can fundamentally contribute to the recipient country´s development of technological capabilities which lead to creating, designing, and producing weapons autonomously.* These routes are legitimate ways to acquire technology through technical cooperation. Advanced *first-tier* countries will hardly make available technology flow of the type "C", but it may be achieved through civil nature technologies agreements, which have implications for the military sector. Dual use technologies are a way to acquire knowledge for sensitive areas such as nuclear engineering and space science, which may have applications for military use.

Brazilian National Strategy of Defense—a major defense policy—outlines that acquisition programs should include project manufacturing processes to *offset* national industry and even total control of weapons systems and integral transfer of technology. From these considerations emerges an ultimate, definitive criterion to evaluate ToT, appropriate for Brazil's current strive to increase its international stance:

> ***development of technological and industrial capabilities for the autonomous design and production of weapons and defense systems.***

This coincides with Pavitt's seminal contribution (1987) which shows a central concept of technology when he specified that technology is not simply an identification with science or with information. Technology is "specific, complex, partially tacit, and cumulative in its development" (Pavitt, 1987). The same author proposes two central questions for analysis and later for the technology public policy process:

1) That the nature and reach of the interaction between Science and Technology should be well defined;
2) That accumulation occurs of technology knowledge firms, necessary not only for new and original inventions, but also for effective assimilation of technology developed elsewhere. (Pavitt, 1987)

The important concept for Pavvitt is <u>assimilation</u>. As it is for Admiral Freitas: "Technology is not transferred: it is assimilated or created". [6]

[6] Admiral Elcio de Sá Freitas, *A Busca da Grandeza: Marinha, tecnologia, desenvolvimento e defesa.* Serviço de Documentação da Marinha, 2014. 479 p).

A list of Brazilian institutions, organizations and policies related to Transfer of Technology can be seen below depicting how the Armed Forces have generally treated the issue.

Brazilian Institutional Framework for Transfer of Technology
• Technology Transfer Contract - INPI – National Institute of Industrial Property • COMAER (AIR FORCE COMMAND) — *Política de Compensação Comercial, Industrial e Tecnológica (Technological, Industrial and Commercial Compensation Policy), Diretriz do Comando da Aeronáutica (Directive of Air Force Command) 360-1*, 2005 • Brazilian Navy – *Secretaria da Ciência, Tecnologia e Inovação da Marinha (Navy Secretary of Science, Technology and Innovation)* - Normas para a proteção da propriedade industrial na MB (Norms for ndustrial property protection). SecCTI – 401, 2014. Adopts Law of Industrial Property (LPI) n. 9279/14 May 1996.

In addition, the institutional framwork regarding the defense sector has evolved in the past decades to include:

Brazilian Institutional Framework regarding Defense
• Política de Defesa Nacional – National Defense Policy - 1996 (FHC govt.) • Creation of Ministry of Defense – 1999 • Regulatory Ordinance 764/2002 • Política Nacional de Defesa – National Policy of Defense – 2005 (Lula govt.) • Estatégia Nacional de Defesa (END)– National Strategy of Defense – 2008. (Decree n. 6703, 18 Dec. 2008) • Lei Complementar (LCP) n. 136, 25 Aug 2010 • Special Tax for Defense Industry MP 544/2011 – tax incentives • Creation of SEPROD/MD – Secretariat for Defense Products, 2011 – acquisition of defense products and promotion of Science&Techology policies and R&D defense interests) • Law 12.598/2012 definig Defense Products and Strategic Defense Products • Livro Branco da Defesa Nacional (LBDN) –White book of National Defense, 2012 • Estratégia Nacional de Defesa (END), Revisada – National Strategy of Defense Reviewed – 2012 • Individual contracts on Programs

1. Project FX-2 – SAAB-EMBRAER GRIPEN NG BR PROGRAM

The project began as a renovation and modernization project FX under the Fernando Henrique Cardoso government after 2000 and 2001 visits to Brazil by the Swedish Minister of Defense, Björn von Sydow. After five years of negotiations, the project received a new scope in 2006 – FX-2 – including acquisition and development of 36-fourth and half generation New Generation NG fighters[7] in substitution of the aging Mirage 2000, at the total cost of US$ 4.5 billion.

FX-2 Program – Acquisition of Combat Fighters - encompassed a profound change starting with the requirement of complete Transfer of Technology (ToT), and the rights to production under license in Brazil and exporting to the South American market. This goal was established in the National Strategy of Defense (END, 2008) aiming at improving skills and capabilities to manufacture and to maintain fighter jets in Brazil: "Not only refers to the [...] logistic cost of acquisition [...] but also the cost of the life cycle."[8] This is why the Air Force hinged upon ToT and industrial cooperation, trying to guarantee in the long run autonomy of manufacturing and operating weapons systems.

Three suppliers were short-listed in the FX-2 Program after 2008: USA´s Boeing F/A-18 E/F Super Hornet, the French Dassault Rafale, and the Swedish SAAB JAS-39 Gripen. After announcing a pre-decision with the French Government in September 2009, Brazilian president Lula had to retreat after a Report[9] from the High Command of Aeronautics was delivered in December 2009 showing clear advantages of the Swedish aircraft:

a) final costs and maintenance costs (circa half of French Rafale), at US$ 130 million;

[7] A number of these will be jointly developed as the JAS 39 Gripen NG, standing for New Generation, possibly a fifth-generation fighter.

[8] Brigadeiro do Ar José Augusto Crepaldi Affonso, President of the Coordinating Commission of the Combat Aircraft (*Comissão Coordenadora do Programa Aeronave de Combate*, COPAC) - "Projetos estratégicos das Forças Armadas: uma contribuição para o desenvolvimento " 6 May 2014, Chamber of Deputies / Commision of Foreign Relations and National Defense, CREDN – Short Hand Notes, p 6.
Gripen NG – O voo mais alto do Brasil - SAAB Federal Senate Public Audience. Commission of Foreign Relations and National Defense. 11 August 2011. Available at www.senado.leg.br/comissoes/cre/ap/AP_20110821_Bengt_Janer.pdf. Access 27 March 2015.

[9] Eliane Catanhêde - FAB prefere caça sueco a francês. Poder Aéreo, 5 January 2010. Available at http://www.aereo.jor.br/2010/01/05/fab-prefere-caca-sueco-a-frances/ ;

b) assurance of delivery of 100% technology transfer solicited by Brazilian Air Force (FAB);

c) assurance of delivery of 100% of technologies asked for by major aeronautics enterprises in Brazil, mainly Embraer;

d) Transfer process – "On Job Training", design/engineering project learning process

In December 2013, a decision favorable to Gripen was taken after the unveiling of spying actions on Brazilian president Dilma Roussef, high officials, and the Brazilian oil company, Petrobrás. With this decision, it was also announced that at least 40% of the aircraft would be built in Brazil. Former Defense minister Celso Amorim stated:

> "The choice, everyone knows, was the result of studies and careful appraisal, taking into account performance, effective technology transfer and costs, not only acquisition but also maintenance. The choice was based on the best equilibrium of these 3 factors" ["A escolha, que todos sabem, foi objeto de estudos e ponderação muito cuidadosa, levou em conta performance, transferência efetiva de tecnologia e custo, não só de aquisição, mas de manutenção. A escolha se baseou no melhor equilíbrio desses três fatores."] [10]

Some additional reasons for choosing Sweden´s Gripen instead of French or American fighters:

1) High price of French fighter Rafale;
2) Sarkozy opposed Lula and his proposal of Iran´s nuclear fuel exchange in the negotiation advanced by Brazil and Turkey in 2010;
3) France supported the United Kingdom in voting against the Brazilian Roberto Azevedo to the presidency of the World Trade Organization in May 2013;
4) All negotiations which took place after President Obama's[11] visit to Brazil to improve US-Brazil defense cooperation unraveled due to spying activities announced by journalist Glenn Greenwald based on documents leaked by Edward Snowden (former NSA-US).

[10] Poder Aéreo – Celso Amorim acaba de confirmar: Gripen NG é o novo caça da FAB. Available at http://www.aereo.jor.br/2013/12/18/celso-amorim-acaba-de-confirmar-gripen-ng-e-o-novo-caca-da-fab/18 dezembro 2013, Access, 20 December 2013.

[11] Defense Secretary Leon Panetta and Vice President Jow Biden accompanied and met with high defense officials.

Although these are important reasons, what was paramount among principal stakeholders — the High Command of Aeronautics and the Brazilian aerospace industry—was the assurance of technology transfer. The domain over arms systems, partnership with Brazilian firms, technical-operational cooperation agreement and ToT to increase Brazilian capacities to produce parts of the aircraft in the country were preponderant reasons for the Gripen choice.

Final financial agreements between SAAB and the Brazilian Air Force /Brazilian Government were recently made in the Stockholm/Linköping State visit by Dilma Roussef. The Swedish Export Credit Agency put together a credit deal of US $ 4.7 billion at 2.54% rate totaling SEK 39.7 billion taken by SAAB as order for 36 aircraft to be manufactured in cooperation with Brazilian Embraer and its associated companies.

We will now turn to the preliminary evaluation of the 5 dimensions posed in the *Evaluation of Transfer of Technology* section (p 5-6).

Technology itself – "hardware" – Transfer of Technology

Transfer of technology and industrial cooperation in the Gripen NG BR Program signed between SAAB and the Brazilian Airforce is a paramount dimension to evaluate in the current context. Although *circa 66 offset contracts* are still in negotiations this year,[12] EMBRAER Defesa & Segurança, the major company in Brazil for producing the fighter jet will also be responsible for absorbing technology transferred, adapting, modifying, and possibly creating during the process. The intended unrestricted ToT includes arms codes allowing for integration of new systems autonomously developed in Brazil.

AKÆR Engenharia, a Norwegian engineering company located in Brazil, has participated in the Gripen NG project since 2009. It was contracted to design central and rear fuselage, wings, door of landing gear and producing under Transfer of Technology agreement with SAAB even before the Brazilian government's decision in favor of SAAB JAS-39 Gripen.

ATECH – Negócios em Tecnologia S/A, a subsidiary of Embraer, is a leading specialized firm in information technology, systems of systems, command&control, air

[12] http://www.infodefesa.com./latam/2015/06/15/noticia-brasil-desenvolveu-projetos-offset-compra-gripen-.html. Access 27 July 2015.

traffic control/ instruments and control/ surveillance systems responsible for ToT management and new technologies management.

MECTRON – missile and high-tech products manufacturer (A-Darter, Piranha, radars, satellite equipment dual use) was bought by *Odebrecht Defesa e Tecnologia*, in 2011, for BRL$ 100 million (reais). It will be responsible for the air-air missile A-Darter systems to be installed in the Gripen. It has been involved in developing this missile with South Africa in the recent past.

EMBRAER Defesa & Segurança associated with AEL Sistemas S/A (Aeroeletronica), an engineering firm connected to Israel´s Elbit Systems Ltd., will be in charge of design and manufacturing of advanced displays and software and computer technologies avionics to the Gripen NG or Gripen E ➔BR (a 4.5th generation fighter jet). In addition, Selex, GE Brasil will jointly with Embraer develop products and subsystems for the Combat plane in Brazil.

Wings, fuselage segments, doors made by Brazilian companies are going to equip all Gripen E or NG, included those manufactured in Sweden. This means that Sweden, with a long-time tradition of military independence, for the first time in history will trust to another country part of its most important defense weapon, different from what happened in South Africa. Avionics, embarked software, will be jointly developed with Embraer and the national industry will have complete technological domain of software and arms systems. Planning and organization (Logistics) of the complex program will supported by Brazilian companies. Additionally, intellectual rights will be shared with national companies. This was reason enough for Dan Jangblad´s (SAAB Senior Vice President) statement during his visit to S. Bernardo to launch SBTA US$ 150 million investment: "Because of this, value of ToT is more than 100% of the value of the contract of US$ 4.5 billion", he said.[13]

Intended Hardware Transfer

a. process and production design for wings, center and rear fuselage, door of landing gear
b. control systems
c. production procedures and organization
d. R&D technology data

[13] Available at http://www.aereo.jor.br/2014/01/31/caca-gripen-da-saab-tera-versao-com-dois-assentos. Access 23 May 2014.

Economic development, regional or national

Regarding economic development, regional or national, SAAB and Inbrafiltro Group are expected to invest US$ 150 million in São Bernardo Tecnologia Aeroespacial (SBTA), located in a 40.000 m^2 site, for building the aerostructure factory. Equity participation in this endeavor accounted for 60% by Brazilian Inbrafiltro Group, and 40% by SAAB. This São Bernardo do Campo plant is part of the supply chain for Gripen and can be considered a major additional commitment on the original offset package (with Akær, 2009). Structural parts of the aircraft (fuselage, front and rear wings) will be made in São Bernardo then shipped to Embraer´s Gavião Peixoto plant or to SAAB Linköping plant for final assembly. According to SAAB CEO Håkan Buskhe this company is expected to hire 1,000 professionals:

> It means we will transfer all that allows Brazil to develop its next generation of military jets. We will work with a huge range of Brazilian companies, including Embraer and Akaer and I believe that 80% of the order of 36 fighters may be totally fabricated on Brazilian soil. Our plan is that your country becomes an export base of Gripen - we are building a factory in São Bernardo do Campo which is part of this project, and there will be others, certainly. Depending on the success of the contract, we will create thousands of jobs. [14]

Since this investment was postponed because the delivery of the aircraft has been delayed to 2019, Inbrafiltro started production of composite material (plastic, carbon fiber) for wings and landing gear lid in its Mauá production complex.[15]

As for national development and international trade, according Celso Amorim, Brazil should have rights to commercialization with Latin American & other developing countries with which Brazil holds close bilateral ties, including defense relationships. Argentina has demonstrated interest in hosting Gripen, at which the United Kingdom immediately balked last November 2014. A world market of 5,000 fighter aircrafts is predicted for 2034. A SAAB

[14] Sheila Silva – Após a assinatura do contrato FX2 encara seu maior desafio. http://www.defesabr.com/blog/index.php/16/11/2014/apos-assinatura-do-contrato-f-x2-encara-seu-maior-desafio/. Access in 17 June 2015.

[15] Leone Farias - Partes do Gripen serão feitas em Mauá. Diário do Grande ABC. http://www.fab.mil.br/notimp/mostra/16-04-2015#n88025. Access 17 June 2015.

high official declared that SAAB-Embraer sales can reach from 6 to 9 percent (300 to 450 units) in this world market, summing a US$ 45 Billion income at US$ 100 million each aircraft.[16]

In the past ten years, the increase of defense production and correspondent offset agreement signed by the Brazilian Air Force (FAB) already generated US$ 1 billion for the industry located in Brazil in purchases of military equipment or civilian products. This is currently regulated by the Regulatory Ordenance n° 764 / MD (27 December 2002) which established for every military purchase above US$ 5 million the obligation of an *offset* clause. The Brazilian Air Force Command expanded the general compensation clause of 2002 by stating that *offset* is defined as "each and every compensatory practice negotiated between the parties, as a condition for the import of goods and / or services with the intent of generating benefits of commercial, industrial and technological nature to the buyer." (DCA 360-1, 13th Dec. 2005)

With more than sixty contracts being negotiated, future investment planned can reach a total of BRL$ 10 billion and can cause problems for companies. Current legislation only covers the reception of technologies, products and processes to companies in Brazil. It must be adapted to the role of Brazilian companies as exporters of technologies creating international markets favoring export and trade. [17]

State-Society fostering of democracy by defense modernization

Democratic (and non-democratic, for that matter) countries strive for protecting their territory, population and economy, including natural resources. Contemporary thought for security means seeking financial, food, energy, and political-military autonomy. [18]

Democracy is a value introduced in the first lines of National Strategy of Defense stating Brazil is a pacific country, and guides its international relations by non-intervention, defense of peace, peaceful conflict resolution and democracy. (END, 2012, p. 1)

[16] Diario do Grande ABC, 16 November 2014 - Saab prevê mercado de US$ 45 bi. (Sonia Braulio Pedrozo interview with vice president of Industrial Partnership-SAAB Aeronautics, Jan Germundsson. http://www.dgabc.com.br/Noticia/1056597/saab-preve-mercado-de-us$-45-bi. Access in 17 June 2015.

[17] Valor Econômico – Virginia Silveira – Transferência de Tecnologia gera US$ 1 bi. 17/09/2014

[18] See Wellington Dantas Amorim - O DRAGÃO, A RAPOSA E O TETRAEDRO DO PODER: China, Japão e o Equilíbrio de Autonomias. PhD Dissertation Political Science. Universidade Federal Fluminense, 2014.

Modernization of defense equipment acquisitions with Transfer of Technology are a means of seeking political-military autonomy, therefore making the country capable of defending and fostering democracy. Brazil´s National Objectives of Defense stated in the National Policy of Defense (PND, 2005) have as a first paramount objective guaranteeing sovereignty, national assets and territorial integrity.

Besides the political benefits directed to the Brazilian society this Gripen NG BR Program is aimed at restoring Brazilian Air Force defense capabilities according to END (2008, 2012) and White Book of National Defense (LBDN, 2012) directives, with an important component of autonomous development of aerospace defense industry in the country.

International Political Strategic Partnership – Sweden-Brazil

In October 2014, a contract was signed between SAAB and the Brazilian Air Force to build 28 single seat fighters, of which 15 were to be built in Brazil, plus 8 double seat fighters. It includes logistical support, furnishing of spare parts, training and industrial cooperation program for Transfer of Technology, and purchase of arms systems. Later, FAB announced the intention of purchasing a total of 108 Gripen in the future, 72 more than originally announced. [19] The Gripen New Generation double seat version is intended to be entirely developed by the Brazilian industry in cooperation with SAAB.

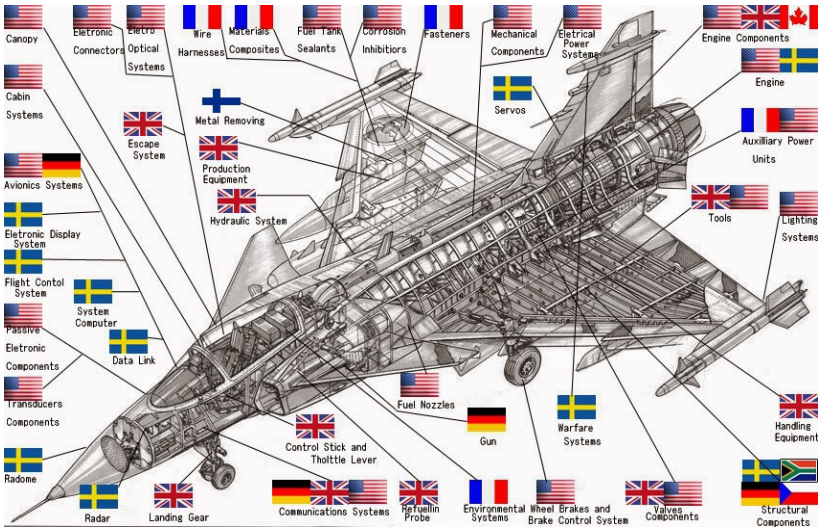
This strategic cooperation has the intended outcome of increased access to all levels of technology including Gripen Source code, hardware integration, avionics, software and aircraft systems, in addition to the Human Capital "software", that is the training and learning processes for 350-plus Brazilian engineers and other professionals in Sweden. Months before (April 2014) SAAB and Embraer had signed a Memorandum of Understanding initiating an industrial cooperation program for direct compensations of intellectual property rights and technological capacity for production.

This will contribute to make possible production of the aircraft on the medium and long run by the national industry of defense. Industrial policies and programs contained in the National Strategy of Defense (*Estratégia Nacional de Defesa, END*) have a more permanent

[19] A senior High Air Force official announced Brazil intention to acquire 108 Gripen Next Generation at the Flightglobal – Internation Fighter Conference, London, UK . Available at http://www.airforce-technology.com/news/newsbrazilian-air-force-plans-to-purchase-108-gripen-ng-fighters-4444568 20 november 2014. Access 09.08.2015.

objective of modernizing and capacitating Brazilian aerospace industry in the long run (30-40 years) not only for national defense but also to supply the needs of South American countries' Air Force programs.

Figure 1- Gripen Subsystems by Country of Origin



Source: http://www.brasilemdefesa.com/2015/01/gripen-ng-saab.html . Access 06 February 2015.

While Sweden seems to believe Brazilian authorities are trustworthy for Transfer Technology, it is important to remember that many Gripen systems are not Swedish in origin (engine from General Electric-US, AESA radar by Selex-EX-United Kingdom and so forth), which leaves Brazil vulnerable to technological blockage and/or interferences from other countries with a known bad-will to transfer sensitive technology. (See above figure showing array of countries supplying different Gripen parts and systems.)

When Sweden joined the European Union in 1995, many successful Swedish defense and security policies were *downloaded* to the EU for peace and security, both regionally and worldwide. Concepts such as *Crisis Management* were an important Swedish contribution while participating in the Balkans conflict under the *Partnership for Peace (PfP, NATO)* even without being a member of this organization, and later in other Peace Operations. Sweden´s prominence in technological innovation was key to its defense industry to merge and associate with other European defense firms. The same occurs in its internationalization of production policy to South Africa, India, and Brazil, reaffirming its capacity to adapt to a new geopolitical and geo-economics defense map.

This Sweden-Brazil strategic partnership contributes to our country´s goals of increased protection of Brazilian interests (Amazon, South Atlantic, Blue Amazon) as well as contributing to international peace and security (Middle East, Mediterranean Sea, Caribbean). Brazil, just like Sweden, is preparing for new needs emerging from the geopolitical realities of the 21st century.

Human Capital Science & Technology "software" Transfer

This dimension is probably even more important than "hardware" transfer of technology mentioned in the first dimension. This is the *know how* dimension of technology transfer. Here we deal with capabilities transferred in terms of design and creation of engineering solutions, production engineering data skills, process and product design and engineering procedures and experiences leading to technology innovation. (See Fig 1 Three Flows of International Technology Transfer, p. 7)

This Gripen NG BR Program is sending 357 Brazilian aeronautical and defense industry engineers to develop Gripen NG in Linköping. This is done through formation, specialization and *On Job Training* transfer of knowledge. Development, production and assembly of the aircraft will be coordinated by Embraer in Brazil (240 engineers). This complex work is jointly developed with SAAB/Sweden, Inbrafiltro Group (43 professionals), AEL Sistemas (8 professionals), Akær (7 professionals), Atech (26 professionals), Mectron (12 professionals).[20]

In addition to these long / short term courses, internship training, and organizing data bases, *On Job Training* is a "hands on" project, developing and putting together the first 8 fighters built in Sweden by Brazilians and 15 fighters built in Brazil. Twenty-one military specialists from the DCTA – Department of Airspace Science and Technology/ Command of Aeronautics (COMAER) are accompanying all of the processes, supervising and evaluating ToT. All these engineers, professionals and specialists will be working in Sweden between 2015 and 2021, from development, prototype testing and manufacturing the aircrafts. From the initial 36 planes, 13 will be built by Swedes, 8 by Brazilians in Linköping

[20] http://www.infodefensa.com/latam/2015/06/15/noticia-brasil-desenvolveu-projetos-offset-compra-gripen.html. Access in 27 June 2015. See also http://www.defesaaereanaval.com.br/governo-mantem-recursos-para-o-kc-390-e-o-gripen. Access 27 June 2015

and 15 in Brazil. Brazilian Air Force will receive these from the beginning of 2019 through 2024.[21]

4. **Brazilian Navy Strategic Programs**

Blue Amazon and Strategic Projects

The Blue Amazon (Amazonia Azul) concept was introduced in view of the UN Convention on the Law of the Sea (UNCLOS) to guarantee Brazilian control of a maritime territory of 4.4 million km^2, equivalent to half of the land Brazilian territory or the "Green Amazon". This extensive maritime theater (of operations), where 95% of Brazil´s foreign trade fleet navigate, more than 40 ports hold import/export activities. Offshore oil exploration and production has become paramount for the Brazilian economy (13% of GDP) since, particularly after the finding of a Pre-Salt layer, increasing daily production to approximately 2.8 million barrels per day (800 thousand barrels per day coming from Campos and Santos Pré-Salt fields). In addition to fishing, exploration of rare natural resources (nickel, copper, cobalt) is yet to be fully undertaken. Brazilian state intervention to protect this wealth was to develop policies and programs related to sea defense, spelled out in the National Defense Strategy and other policy documents.

Table 2 - Brazilian Navy major strategic programs

Projects	**Period**	**Estimated Total Value up to 2031 (Million of Reais)**
PNM – Navy Nuclear Program	1979-2031	4,199.00
Naval Power Construction a) PROSUB b) PROSUPER	2009-2047	175,225.50

[21] Air Brigadier José Augusto Crepaldi Afonso (11 June 2015)fab.mil.br/noticias/mostra/22282/GRIPEN-NG— -Brasil-receberá-9,1-bilhões-de-dólares-em-projetos-de-compensação. Access 20 Aug 2015.

c) PRONAE d) 4 Barroso Frigates e) NPa 500 Ton f) PROANF		
Recovery of Operational Capacity	2009-2025	5,372.30
SisGAAz – Management System for Blue Amazon	2013-2024	12,095.60
2nd Fleet Naval Complex / 2nd Marine force of the Fleet	2013-2031	9,141.50
Safety in Navigation	2012-2031	632.80
Personnel	2010-2031	5,015.60

Source: Federal Senate – Commission of Science and Technology - Presentation by the Secretary of Science, Technology and Innovation of the Navy, 2013.

This paper will focus on the two large-scale projects paramount to the Brazilian Navy by reason of involving scientific and technological development with transfer of technology, the subject of this paper: The Navy Nuclear Program and the PROSUB – Program of Submarine Development.

Navy Nuclear Program

Initiated in 1979, this program developed totally under control of the Brazilian Navy Center of Technology of the Navy at the University of São Paulo (*Centro de Tecnologia da Marinha na USP*, CTMSP) to control and develop autonomous nuclear technology in major areas:

1) Program development of a Nuclear Propulsion Reactor
2) Nuclear Fuel Cycle Development Program

Major accomplishments include:

2007-08 – President Lula's visit to ARAMAR reinitiates a dragging program (by "fits and starts") in a different financing level "US$ 2.57 billion to overcome deterioration of Navy

material and restart Navy Strategic Project."[22] To start, construction of two uranium enrichment plants and construction of adequate installation for LABGENE (Laboratory for Nucleoelectric Generation) and assembly of the pressure vase and internal components of a prototype reactor for the future nuclear propelled submarine were authorized.

2009-2010 - Brazil and France signed the Strategic Partnership Agreement in December 2008 to seal a rapprochement between the two countries. Brazilian geopolitics and geo-economics of defense included protection of the Amazon and South Atlantic natural resources. It included the sales/production of 50 helicopters and 4 conventional submarines and the hull of nuclear propelled submarine (at a cost estimated at € 5.6 billion with DCNS -*Direction des Constructions Navales et Services*). This was done on the wake of France´s support for Brazilian president Lula's rising strategic positioning in the world and search for a greater protagonist stance in world politics, including Brazilian aspiration to a permanent UN Security Council seat.

2012 - Inauguration of first of 4 plants of Unit Production of Uranium Hexafluoride (USEXA) and construction of the Center of Nuclear Instruction and Training ARAMAR (CIANA) by the end of 2012.

PROSUB-Submarine Development Program (4 S-Br + 1 SSN)

The final objective of the PROSUB- Submarine Development Program (*Programa de Desenvolvimento de Submarinos*) is to make the Brazilian Navy capable of monitoring the South Atlantic and guaranteeing conditions for Brazilian sovereignty and protection of natural resources and of commercial routes. The program is a result of the Strategic Partnership signed between France and Brazil in 2008. The program intended outcomes are the construction of 4 conventional submarines (Class Scorpene), and a nuclear-propelled submarine, allowing Brazil to join a small nuclear submarines club (US, China, Russia, France, United Kingdom and India) in the future.

[22] João Roberto Martins Filho – O projeto do submarino nuclear brasileiro. *Contexto Internacional*, vol 33 no 2 July/Dec 2011.

Table 3 - Time schedule for PROSUB

Conventional Submarines	S40 Riachuelo	2nd Semester 2018
	S41 Humaitá	1st Semester 2020
	S42 Tonelero	2nd Semester 2021
	S43 Angostura	1st Semester 2022
Nuclear Propelled Submarine SN-BR Alvaro Alberto SN10		 July 2025

Source: Admiral Roberto Gondim – Diretoria de Gestão de Programas Estratégicos da Marinha. Presentation, 2 Oct 2015. Inest-UFF.

To accomplish this complex objective, which includes designing and constructing conventional and nuclear propelled submarines in Brazil, it was necessary to build the Constructions Shipyard, a modern Naval Base (completed in December 2014), a Fabrication Unit of Metallic Structures (UFEM, completed in 2012), as well as the Maintenance Shipyard (expected for 2018) and the Radiological Complex (planned for 2024). These main goals were established in a series of documents, policy instruments and policy and program interventions as follows:

- Strategic Partnership signed by Lula and Sarkozy;
- Agreement signed by the Brazilian and French ministers of Defense;
- Technical Arrangements between Brazil´s and France´s ministries of Defense and signed by the Brazilian Navy Commander and the Chief of Staff of the French Navy;
- Contract between Consortium Baía de Sepetiba (CBS) comprising DCNS (*Direction des Constructions Navales et Services*), Construtora Norberto Odebrecht and Itaguaí Construções Navais (ICN) [ICN is composed by Odebrecht Defesa e Tecnologia (59% of equity) and by the French *Direction des Constructions Navales et Services* – DCNS (41% of equity)] where the Brazilian Navy has a Golden Share (1%) with veto power over decisions.

2012 - Construction of UFEM - Fabrication Unit of Metallic Structures (*Unidade Fabricação de Estruturas Metalicas*) complementary heavy engineering industrial plant nearby NUCLEP, Nuclebras Equipamentos Pesados. NUCLEP was built in the 1980s for manufacturing

metallic equipment of nuclear power plants planned in the 1975 Nuclear Accord with Germany, and holds German technology for conventional submarine construction and pressure vase construction.

EBN - Naval Base and Shipyard (*Estaleiro e Base Naval)* – where assembly, launching, operation and maintenance of submarines will take place. More than 600 companies are involved in the construction of UFEM and EBN.

We now turn to the 5 dimensions of Transfer of Technology posed in the *Evaluation of Transfer of Technology.*

Technology itself – "hardware" – Transfer of Technology

Intended "Hardware" technology transferred in this program include project development, construction employing computerized systems (CADS), combat systems development, platform (submarine) control systems development, automated control systems development, maintenance of missiles, maintenance of periscopes (including optronics periscope), and construction of the main electric motor.

DCNS (*Direction de Constructions Navales e Services*) delivered civil engineering projects and document specifications for the construction of UFEM - Fabrication Unit of Metallic Structures, and EBN – Construction Shipyard and Naval Base, in the State of Rio de Janeiro.

Nationalization Plan (Subcontract 3 of Offset Contract n. 8)

One hundred and four projects related to main systems, equipment and items of both conventional and nuclear-propelled submarines are candidates to be "nationalized", in other words, be made in Brazil. The current situation (November 2015) is the qualification of companies capable of making 54 priority projects including batteries, main electric motor, electric engines, electric panels, air compressors, combat systems, torpedoes tubes, bearings, battery monitoring systems, compression hull valves, water pumps, and more.[23] Just this

[23] MARINHA DO BRASIL, Diretoria Geral do Material da Marinha, Contrato 8 – Offset, Serviço de Informação ao Cidadão da Marinha do Brasil, 2015; interview with Diretor General Management of Strategic Projects of the Navy, 2015, in BERRIEL, Guilherme, 2016.

subcontract involved ToT in the production of systems and equipments, training for the development and integration of systems software, and technical support for Brazilian enterprises during the manufacturing of products.

Contract number 8 of COGESN (General Coordination of Development of Submarine with Nuclear Propulsion) refers to *offset* of the PROSUB in **21 compensation operations** to Brazil and to the Brazilian Navy with respect to imports done through *Direction des Constructions Navales et Services* (DCNS). Brazilian engineers and project designers were sent to France to absorb *know how/know why*:

- 19 operations directly related to conception, operation and maintenance of 4 S-BR and SN-BR
- 2 Technical Assistance operations a) maintenance of equipment & systems of NAe - Aircraft Carrier São Paulo; and b) modernization of AMRJ – Navy Arsenal Rio de Janeiro.
- 18 directly related to ToT – theoretical and practical training; professional formation courses (*On Job Training*), assistance from DCNS and technical documentation blueprints.
- Total € 500 million euros in knowledge and capabilities to be incorporated to the country.

From the summary of the process of ToT on PROSUB we find an ambitious goal of obtaining a maximum index of nationalization of products, with subsystems made in Brazil. However, the majority of the companies involved "are subsidiaries of multinational firms created to manufacture submarine components" (TCU Report, 2013, p. 44).

Nationalization intends to qualify productive chains to supply parts, equipments, and systems for conventional and nuclear submarines construction, including "an *offset* of € 400 million to increase capabilities of enterprises to absorb ToT (know-how, know-why) which will result in purchases of € 100 million internally. Ninety-four sub-projects will be done by the Brazilian Navy and DCNS certified companies (200 companies were visited), sixteen of the twenty more important certified supply companies of PROSUB are subsidiaries of foreign companies: Adelco, Atech, Axima do Brasil, Bardella, Cecal,

Cilgastech, Datapool, Ensival Moret do Brasil, J&F, Howden, Mectron, Omnisys, Pall do Brasil, Qualiferr, Sacor, Schneider do Brasil, Termomecânica, Usilider, WEG e Zollern.

Table 4 - Nationalization Plan

Contract	**Blueprints and Engineering Specifications**	**Recycling and Formation**	**On Job Training**	**Results Intended and Preliminary**
Contract 6.3 **ToT for Project and Construction of UFEM – Metallic Structures and** **EBN - Construction Shipyard & Naval Base**	**UFEM** – 254 groups of documents for civil engineering project and 83 group of documents for equipment specs. **EBN –** 175 group of documents for civil engineering project and 83 group of documents for Equipment specification Furnished by DCNS			Itaguaí Construções Navais (ICN): DCNS, Brazilian Navy and Odebrecht Defesa e Tecnologia ODT For construction of UFEM and EBN and management of Project
ToT **Project and construction of 4 Conventional Submarines S-BR**	Technology of construction; detailed Project, with Brazilian engineer/designers, obtaining torpedoes, nationalization of material, equipment, and systems, combat systems design capacitating, independent autonomous maintenance	**PN – Plan of Nationalization** Qualifying Brazilian industries in production and maintenance of equipment and systems of these submarines	Offset – ToT and Know-How 104 subprojects Brazilian Navy has given priority to 56 subprojects systems, equipment or items comprising the material package.	200 Brazilian firms were visited – to become suppliers of the subprojects.

ToT **Project and construction nuclear propelled Submarines SN-BR (1)**	Material package Logistic system, Project Management and construction SN-BR in Brazil, Construction of the Nuclear Propulsion Plant – Exclusive Brazilian technology	Capacitating in technology of SN-BR combat system, with independent and autonomous maintenance Nationalization of all materials, equipments and systems	R&D – partnership with Research Centers/universities High Tech industries, nuclear medicine IDB: electronics, naval engineering; computer science –software; heavy and precision mechanics; optronics; mecatronics; electro-mechanics; metallurgy, chemistry; nuclear engineering Spin offs to Naval Industry and Offshore Oil industry	High-tech engineering services: and industrial management: -control and monitoring electronic systems; Temperature, pressure, vibration, neutronic flux and radiation sensors; electric power components; precision mechanics components; vapor turbines; heat exchangers; pneumatic systems; gas absorption and confined atmosphere monitoring; Oxygen generation systems – dual use oil industry and hospitals Nuclear plant: condensers, vapor generators, cooling pumps, pressurizers, fuel element

				mechanical structures; uranium fuel elements, Nuclear Reactor vase, flux sensors and power control systems.

From: Serviço de Informação ao Cidadão da Marinha do Brasil (Pedido de Informação NUP 60502.00698/2015-29) – Resumo do Processo de TdT, 8 páginas.

Economic development, regional or national

The Submarine Development Program – PROSUB already spent circa BRL$ 10 billion reais –in the construction of UFEM, EBN, and a myriad of complex activities leading to the construction of 4 conventional S-BR and 1 SN-BR. These first actions have yielded income to Odebrecht Defesa e Tecnologia, a major partner at Itaguai Construções Navais, ICN (with DCNS e the Brazilian Navy, MB) of about BRL$ 104 billion in the year of 2014.[24] Economic development can also be measured by the direct employment of 13,650 technicians and professionals (various phases), and the indirect employment of 46,000 according to the table below:

[24] Odebrecht Report, 2014.

Table 5 - Expected Employment Generation, 2014

PROSUB PROGRAM	DIRECT EMPLOYMENT	INDIRECT EMPLOYMENT
Construction of EBN/UFEM	8,000	32,000
Construction of S-BR	2,000	8,000
Project SN-BR + Navy Nuclear Program	2,150	n.a.
Construction of SN-BR	1,500	6,000

From: Fleet Admiral Hirschfeld presentation to the Commission of Foreign Relations and National Defense. Chamber of Deputies (6 August 2014).

The total numbers for the Construction of UFEM / EBN complex were – 13,717 direct jobs and 6,469 indirect jobs – at the end of 2014. However, budgetary problems are gradually increasing. There were 1,500 employees laid off recently in the past months of 2015 in view of the reduction of 25% of the defense budget affecting directly the construction of the ECN (Estaleiro e Base Naval), postponing its final date by one year to October 2016.[25]

State-Society fostering of democracy by defense modernization

International Political Strategic Partnership – France-Brazil

The most important achievements are results deriving from the Navy Nuclear Program. Brazil is the sole responsible party for the "design, construction and putting into operation of on-board nuclear reactor, the installations in the nuclear reactor compartment, and equipment and facilities whose functions are primarily concerned with the reactor´s

[25] http://www.naval.com.br/blog/2015/05/23/cortes-adiam-termino-do-estaleiro-de-construcao-de-submarinos-e-a-reforma-do-a12/ . Access 20 June 2015.

operation safety."[26] This is connected to the complex question of nuclear fuel enrichment, to be provided by the LabGene Nuclear-Electric Generation Lab (*Laboratório de Geração Nucleo-Elétrica – LABGENE*) and USEXA mentioned earlier. The prototype construction of the 48 MW-pressurized water reactors has already started, and will most likely use fuel enriched at a maximum level of 10%, subject to verification by the international agencies IAEA (International Atomic energy Agency) and ABACC (Argentina-Brazil Agency for Accounting and Control of Nuclear Materials).

This process may entail a robust defense policy together with an independent and universal foreign policy, in the words of Amorim (2013). Essential for implementing these two state policies is the Defense Technological and Industrial Base Strategy of producing advanced defense material and focusing on high technology industry and permanent innovation.

France is transferring technology to Brazil by means of structuring organizations and training technical staff to construct submarines. At the same time, this program increased France´s geopolitical influence in the South Atlantic area. France is also a South American country (French Guiana) bordering Brazil and Suriname. By this Strategic Agreement, Brazil will be the only non-nuclear power which will have the capacity to build submarines, as well as placing its defense industrial and technological base at a higher level than before. However, the geopolitical challenges concerning the South Atlantic are justified in view of new military alliances being formed, particularly with NATO over extending its limits to actions in an out-of-bounds region. For this matter, both diplomacy and defense should reinforce one another.

Human Capital Science & Technology "software" transfer

This is probably where the Brazilian Navy is most earnestly trying to obtain, absorb scientific and technological knowledge, and create an environment conducive to fostering the capabilities of generating new projects, all of this with the aim of increasing Brazil's technological capacity.

This technology transference by acquisition of means for the Brazilian Navy (corvette, submarines) was impressive in the 1980s, when engineers and officers were capable of producing means for the Navy in Brazil. However, lack of continuity and

[26] Acordo entre o Governo da República Federativa do Brasil e o Governo da República Francesa na Área de Submarinos.

irregular financing placed a severe burden on the development of the frigate, corvette and submarines in the following 20 years. In the French case, DCNS has a statute obligation to *transfer knowledge; transfer information, technical assistance services and teach know why* (Hirschfeld, 2014, p.13). Three main ares of ToT on PROSUB: i) *learning by learning and learning by doing* processes – courses and *on job training*; ii) processe of ToT for the development of productive infrastructures (UFEM / EBN) and governance instituitions; iii) processes involving ToT of foreign companies to National enterprises, directly related to Offset 3 – Nationalization of PROSUB with expected resources of €1 billion for the production of parts, machines, equipment and systems (electric, electronic, arms, propulsion, etc).

Table 6 A– Summary of Human Capital Technology Transfer on PROSUB

Contract	**Blueprints and Engineering Specifications**	**Recycling and Formation**	**On Job Training**	**Results Intended and Preliminary**
Contract 6.1 **ToT for Detailed Project and construction of S-BR**	Construction and detailed blueprints of modified submarine section.	Qualification of personnel 289 engineers and technicians in Charbourg, France Several specialties and various levels 81 professionals who participated in Submarine construction on AMRJ previously (a prerequisite) 31 navy officers + Professionals of ICN and NUCLEP	20 engineers Designed detailed Scorpene section modified to transform into S-BR Part of these group was incorporated into SN-Br design	Technical Consultancy Itaguaí Construções Navais (ICN): DCNS, Brazilian Navy and Odebrecht Defesa e Tecnologia ODT For construction of UFEM and EBN and management of Project
Contract 6.2 **ToT for SN-BR project**	Exercise: Making of technical documents and blueprints for a	Review of German technical norms on Class Tupi submarine construction – preliminary criteria for conventional submarine systems Project	ToT from DCNS Lorent, France – Ago2010-Mai2012 Project technology of	In Brazil Jul2012-Dec 2025 ToT – Technical assistance, *Know-How*, Expertise and Blueprint

Selection of 31 Navy Officers Engineers in Brazil 1 PhD, 13 master degree experienced in naval sector 17 graduate engineers 26 from COGESN 5 from CTMSP	3.000 t-conventional sub Working Groups – interface and definition of technical requisites between the nuclear and the nonnuclear part, project document propulsion of SN-Br e for Itaguai Shipyard	Radiological protection course IPEN/SP LABGENE/CTMSP systems seminars (Nuclear reactor) Exercise: complete viability Project for a 1700 ton submarine AGO2012-ul 2013 18 new Navy Engineering officers joining initial group ToT Integrated Logistics Support - courses in Lorient, France, Jun-Dez 2012 continuing in Brazil OJT	conventional subs *On JOB Training*, visits, DCNS, industry of defense, nuclear submarines Technology Project of nuclear subs – engineering studies of nuclear submarine.	transfer, Training and Support for Technical Corps of SN-Br Project – Project and construction of Sub. DCNS – 25 engineers experienced in Brazil and remotely in France (Tele-Presence) 18 Navy Engr officers AMAZUL – management of Nuclear-propelled submarine project

From: Serviço de Informação ao Cidadão da Marinha do Brasil (Pedido de Informação NUP 60502.00698/2015-29) – Resumo do Processo de ToT, 8 páginas. Also Hirschfeld, 2014.

Table 6 B – Summary of Human Capital Technology Transfer on PROSUB (Continued)

Contract	**Blueprints and Engineering Specifications**	**Recycling and Formation**	**On Job Training**	**Results Intended and Preliminary**

Contract 6.3 **ToT for Project and Construction of UFEM (Unidade de Fabricação de Estruturas Metálicas) e and** **EBN (Estaleiro de Construção e Manutenção e Base Naval) - Shipyard**	UFEM – 254 groups of documents for civil engineering project and 83 group of documents for equipment specifications EBN – 175 group of documents for civil engineering project and 83 group of documents for Equipment specification Furnished by DCNS			UFEM inaugurated in March 2013 More than 600 national enterprises involved. One hundred and ninety companies with 90% nationalization index on providng services, raw materials, and equipment.

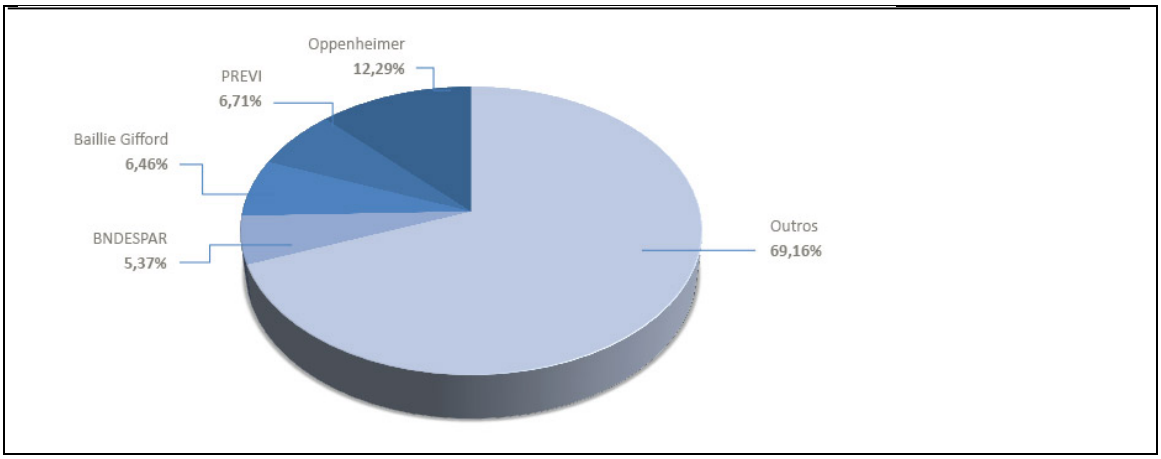
From: Serviço de Informação ao Cidadão da Marinha do Brasil (Pedido de Informação NUP 60502.00698/2015-29) – Resumo do Processo de ToT, 8 páginas.

6. Challenges

EMBRAER

Embraer was a public enterprise until the early 1990s, when it was privatized. It developed a number of military small training and specific purpose airplanes until its association with Italian Aeromacchi, AerItalia for developing the A1 subsonic fighter (243 manufactured for the Italian and the Brazilian Air Force). This meant a significant technological leap which enabled its spinoff into civilian regional airplanes production, with a worldwide market. Later it improved military planes (SuperTucano) and recently developed a medium size Carrier, the KC390, under production. Being the major company in Brazil associated to the production of the fighters, Embraer onwership is distributed in the following markets: a Golden Share by the Brazilian Federal Government, and 740 million shares of common stock shares, with the largest shareholders depicted in the graph below. It is important to note that shares are traded at two large stock exchange markets, New York and São Paulo.

FIGURE 2
EMBRAER OWNERSHIP, 2014



Source: Relação com os investidores. http://ri.embraer.com.br/show.aspx?idCanal=ltPlKaoPDWiQ1uj7aoUw6Q== . Access August 2015

Table 7 – Embraer Equity Distribution, 2014 (%)

Government of Brazil Golden share	**0.3**
BNDES PAR	5.37
Previ - Bank of Brazil Pension Fund	6.71
Oppenheimer Funds INC	12.29
Baillie Gilford & Co.	6.46
Total	30.83
Other investors include: Bozano Group Sistel Pension Fund (Telecommunication Brandes Investment Partners, LP Barrow Hanley, MeWhinney& Strauss LLC, Acadian Asset Mgt LLC , Thornburg	69.16
Public Stock Trade Bovespa - SP	48
Public Stock Trade NYSE	52

Sources: Embraer reports

"Nationalization of Defense Production" and the Question of Brazilian Enterprise

A great number of the firms participating in the Gripen NG BR Program are foreign companies acting through their subsidiaries established in Brazil. According to the law, these are admitted as Brazilian companies even if capital and stockholders are foreign. The only requirement is to be incorporated in Brazil and have its management headquarters in the country.

The Constitutional Amendment n. 6 (1995) revoked the constitutional precept of Article 171 distinguishing Brazilian companies of foreign capital and of national capital, meant to classify Brazilian companies by their effective control on residents of Brazil.

This poses a number of questions and challenges, since the foreign partners may define objectives very differently from what is stated in the National Strategy of Defense. A subsidiary Brazilian company owns property over the technology inherent to its products and its partners, independently of their nationality, and may decide where to invest and in what.

For that matter, when one thinks of "nationalization of defense products" as being a factor which guarantees sovereignty, progress and gradual independence/autonomy on production of defense equipment and the elimination of the distinction between the two kinds of companies does not help. Nevertheless, industrial learning processes from the Gripen Program will certainly occur.

An important contribution to this challenge was the enactment of the Law 12.598/2012 (BRASIL, 2012), after the Provisional Measure MP 544/2011 warranted the right to postulate special financing regimes, fiscal and other incentives to those companies yielding the national interest in "defense products, strategic defense products, and defense systems" as well as the development of national technologies.

Thus, the Law 12598 defines a "Strategic Defense Enterprise" as that which has the objective of realizing "research, project, development, industrialization, service rendering" to defense products and defense technology. Furthermore, a Strategic Defense Enterprise must have in Brazil its management headquarters and industrial plants, and to have proven to have its own scientific and technological knowledge or cooperation agreements with Science & Technology Institutions of R&D for defense products. Most importantly, article 2, item IV, line *d* states that a Strategic Defense Enterprise must assure that the set of foreign partners or shareholders and foreign groups of partners or shareholders cannot have more than 2/3 of the total votes which can be made by Brazilian shareholders present in the company´s general meeting of shareholders. This condition allows a 33.34% voice to express national

Brazilian partners and shareholders in decisions taken in the enterprise, which hardly is enough.

Economic Crisis and the Brazilian Air Force Gripen NG BR Program and PROSUB

The development of the Gripen Program is suffering delays in the chronogram in view of the budgetary cuts affecting defense programs in general. The total costs were $ 5.4 billion dollars (equivalent to BRL$ 12 billion in July 2014, but BRL$ 17.5 billion July 2015, one year later). The Brazilian Government renegotiated the interest rate with the Swedish Export Credit Corporation (SEK) set initially at 2.54%. In July 2015, SEK approved a reduction to 2.19% annually for the financing of 100% of the project, set at $4.7 billion dollars ($39 billion Swedish Kronas). Certainly, the increase of exchange rate by more than 40% in the last 12 months (July 2014-July 2015) and the budgetary cuts will affect this Project, as well as other Air Force projects. [27]

Notwithstanding the importance of these economic-financial facts, the differential is technological autonomy provided by this Gripen NG BR Program placing Brazil in the Flow C pattern of Table 1.

7. Final Considerations

This paper had the general objective of analyzing outputs and intended or actual first outcomes of major strategic defense projects in Brazil, specifically with respect to ToT. Identifying two major defense products acquisitions programs and correspondent ToT activities (Gripen NG BR Program and PROSUB) we observed the five dimensions:

- Technology itself – "hardware"
- Economic development regional/ national
- State-Society fostering of democracy by defense modernization
- International Political Strategic Partnership
- Human Capital Science & Technology "software" transfer.

[27] Tania Monteiro – O Estado de São Paulo (29 July 2015) - http://politica.estadao.com.br/noticias/geral,brasil-sela-acordo-com-suecia-para-financiamento-de-cacas,1734472. Access 28 August 2015.

It should be remembered that military production in Brazil has had its ups and downs. While it grew during the 1970s and 1980s, it was almost annihilated after the end of Iran-Iraq War. There was a new spurt of growth in the 2000s, but it is now declining again, according to SIPRI statistics (2013).

We have seen many documents, policies and strategies about modernization of means in the Brazilian Armed Forces, with ambitious acquisition and transfer of technology programs. Although we pointed at intended outcomes, many of them already accomplished successfully as, for example, UFEM and EBN, Navy Nuclear Program, the initial intended investment in SBTA Sao Bernardo Tecnologia Aeroespacial, most of them are still in the words of the contracts signed in both large -scale programs.

Many challenges remain. Implementation problems mount, from finances to politics, from science & technology limitations, and from managerial to governance institutional deficits. The current financial crisis is certainly putting a burden on budgets for the next three years to come (2016-2017-2018). Many deadlines were postponed already. The planned transformation of the defense and technological and industrial base is contingent on the continuity of high levels of military spending, which is jeopardized by the 75% sum spent on personnel payment, leaving little room for investment and R&D.

Science, Technology and Innovation has historically received little priority in Brazilian public policy, except for a few sectors of excellence (agriculture, for example). Defense ST&I has only recently received partial support from politicians and budgetary allocations, but this has been too little, too late. Except for groups in military and Research Centers, priority is low. This gets worse on account of feeble support for defense on the part of society, as recent surveys done by IPEA show. (IPEA- Sistema de Indicadores de Percepção Social – Defesa Nacional, 2012).

Another problem calls for the lack of commitment of the elites—from the state or private sector—on the development of military production, different from countries where military preparedness for geopolitical reasons is important, as in China and India, as put forth by Lucena Silva in his recent PhD dissertation on military globalization and the international military order. [28]

[28] LUCENA SILVA, Antonio Henrique - Globalização Militar e a Ordem Militar Internacional: comparando as indústrias de defesa dos BRICS (Brasil, Rússia, Índia, China e África do Sul). PhD Politcal Science. Universidade Federal Fluminense, 2015.

Even if large private sector companies from the heavy civil construction and Oil and Gás sector have opened Defense branches this does *not* follow a rationale of strengthening the national industrial base.[29] (PACHECO RAMOS, mimeo 2015)

Nor is there an industrial policy conducive to investments in defense. Their motive seems to be more connected to fiscal and financial incentives which made it more attractive to enter this industrial sector. The increasing defense expenditures turned the sector attractive just as the prospects for productivity gains from transfer of technology through partnerships with foreign companies (EMBRAER-SAAB, DCNS-Odebrecht Defesa, etc.)

A number of problems were put forth by Lucena Silva (*op.cit)* for the Brazilian defense strategy. Even if there are incentives for an increase in military spending three other factors are not present: a) a correspondent expansion of the Defense Industrial Base; b) sustained procurement for national military products; c) a reduction of dependence for military means on foreign countries - *Core Competencies*; and d) reduction of international restrictions on technology – *Sanctions*.

Most importantly only a small number of groups (the military is one of them) have a long-term development project for the country with a military-strategic dimension. Politicians and bureaucrats, industrial and financial decision-making elites have yet to make a clear long-term commitment. The country resents it.

All these major projects have a significant political impact in Brazilian international insertion. Brazil is known by its high *soft* power, or the capacity to negotiate and influence in international affairs. These projects are meant to increase Brazilian *hard power* capacity, fundamental if the country wishes to have a higher place in the international system.

Strategic partnership agreements with European countries such as France and Sweden (and Italy) are part of a deliberate policy of seeking autonomous, independent development by diversifying partnerships particularly in Science and Technology aspects.

This preliminary study shows the needs for the continuity and deepening of research, and budgetary funds for implementation phase of the strategic projects, particularly in the ToT features. The facts and analyses presented are insufficient to fully evaluate the crucial component of the strategic projects. They specifically focus in the capacitating in design, R&D, and industrial productive capabilities which would allow autonomous conception,

[29] Thiago Pacheco Ramos. O Impacto dos Incentivos na Expansão e Declínio da indústria de Defesa Brasileira: o caso da inserção de grandes conglomerados. Monograph International Relations - UFF, 2016.

development and production of defense systems. So far, we have more questions than answers to comprehend what is resulting from the decisions.

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