Latin American Research Review

Volume 26, Number 3, Pages 83-108

How Brazil Competes In The Global Defense Industry*

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The Brazilian defense industry has become the country's most dynamic high-tech industry. Its remarkable growth and development will be analyzed in this article. In the first section, the matrix of motivations behind the establishment of the Brazilian defense industry will be discussed. The second section will review its growth and strategic directions, and the third will elaborate on the industry's export drive, especially its major markets and products. The following sections will discuss the catalytic role of the Brazilian government in the defense industry, the industry's tripod strategy, and major barriers to further growth and development.

Matrix Of Motivations

In most countries, the driving force behind establishing an industrial military complex is a perceived external threat to national security (Jones and Hildreth 1984; Katz 1984; Ball 1988). In Brazil, however, a strong defense industry has developed without any external impetus. Moreover, Brazil has not increased its domestic military expenditures but has in fact experienced a real decline in such expenses since the early 1970s. At constant 1982 prices, real military expenditures decreased from 2.5 billion U.S. dollars in 1973 to 1.7 billion in 1983 (Stepan 1988). As Alfred Stepan has pointed out, "This makes Brazil the democracy with the lowest level of military expenditures as a percentage of GDP in the world, and the nation with the second-lowest level of all major nations in the world" (Stepan 1988, 75).

How, then, can Brazil boast one of the most dynamic defense industries among the newly industrialized countries? The answer to this question may be found by examining the political and economic factors that have interacted to determine the Brazilian defense industry's technological growth, development, deepening, and overall strategy.

Political Factors

Three political factors induced Brazil to create a viable indigenous defense industry. The first was a drive to free the country from reliance on military imports from industrialized countries. Between 1946 and 1970, Brazil imported much of its military hardware from the United States (Stepan 1984; Brigadão 1986).[1] This dependency gradually fueled a growing sense of uneasiness among the Brazilian armed forces and geopolitical strategists.

Second, Brazilian leaders believed that developing a strong defense industry would enhance Brazil's influence among less developed countries throughout Latin America, Africa, and Asia, and might produce political and economic benefits. Strategically, the

defense industry could provide Brazil with foreign-policy instruments to fulfill its long-term aspirations in the international arena. Arms exports would also give Brazil political and economic clout over its customers and prevent other countries from filling a similar role (Barros 1984; Perry 1986).

Third, a sound defense industry would be a highly visible manifestation of a competent military ruling elite. Indeed, the development of a defense industry created an opening or raison d'ci>etre for the Brazilian Armed Forces to assume an active role in the country's domestic and foreign political and economic spheres. Stepan, however, argued the contrary, that the presence of a strong arms industry would lessen, rather than increase, the role of the military in Brazilian politics: "The presence of a massive arms-producing and exporting capacity means that some of the ideological and industrial infrastructure arguments the military could conceivably utilize as a reason for seizing control of the government are lessened" (Stepan 1988, 84).

Economic Factors

On the economic side, a number of factors favored establishing an indigenous industry. First, a strategy of import substitution was selectively reimplemented in the mid-1970s, which helped dissolve bottlenecks in sectors essential to upgrading the Brazilian defense industry (Baer 1989). Import-substituting industrialization continued into the 1980s, with the Brazilian defense industry requiring components with high technological content. Import-substituting industrialization has also given rise to the development of the Brazilian computer industry (Evans 1986) and has provided initiatives in microelectronics and laser technology. Such a strategy necessitates strong forward and backward linkages in the domestic economy. Accordingly, the Brazilian defense industry has developed strong backward linkages in core sectors such as steel, metallurgy, transport equipment, machinery, and electrical and electronic industries.

Second, the export promotion strategy implemented in the late 1960s and early 1970s required new products (Baer 1989). By the late 1970s, Brazil was relying on exports of defense hardware to increase foreign-exchange earnings and to further diversify its export structure. The export of defense hardware also had a multiplier effect on the country's overall exports by encouraging additional exports of related and nonrelated goods and services.

Third, increasing emphasis by the Brazilian government in the 1970s on developing indigenous technologies also favored erecting an indigenous defense industry. Further, by requiring a high technological base, the industry affected the economy's overall capital intensity, rates of technical change and diffusion, and skill intensity. A related development was the strengthening of Brazil's manpower base (Dagnino 1984, 1985).

It is possible to argue that Brazilian policymakers believed that a strategy of "dual-use technology," which can be used to produce either civilian or defense products, would not force a trade-off between "butter and guns." As Edward Kolodziej said of France's defense industry: "The traditional choice between guns and butter was transformed into an opportunity to acquire both in larger quantities at reduced prices. A choice was not necessary since more guns sent abroad meant more butter at home" (Kolodziej 1987, 136). Brazilian policymakers, however, justified the defense industry by noting its

synergistic impact: merging national security ideals, geopolitical goals, economic growth, and technological innovation.

Growth And Strategy

The Brazilian defense industry, having been established following the strategy of import-substituting industrialization begun in the mid-1950s, benefited from the country's highly diversified industrial structure by utilizing "off-the-shelf" components from existing industries, such as transport equipment and machinery. Thus a mature and developed industrial base supported the adoption of a strategy of "dual-use technology" for the first phase of the arms industry by dramatically reducing the costs of developing indigenous defense technology. Within a relatively short period, Brazilian defense hardware exports became increasingly competitive. The Brazilian defense industry also benefited from the existence of a skilled labor force. Since the late 1940s, military schools had been training many engineers and scientists to develop rapidly indigenous technology for the defense industry (Brigadão 1985, 1986; ACE 1987).

Yet before the late 1950s and early 1960s, Brazil's status as a world producer of defense hardware was negligible. Military agreements with the United States provided Brazil with most of its military hardware and limited the country to refurbishing World War II tanks and producing only powder, cartridges, and light weaponry (Brigadão 1984; Perry 1986).

Between 1964 and 1967, however, the government established an industrial mobilization plan, the Grupo Permanente de Mobilização, for expanding domestic production of defense hardware and creating incentives for state- and private-sector cooperation with the defense industry. The GIPM was reinforced by U.S. reluctance to transfer defense technology to Brazil because of U.S. involvement in Vietnam at the time (Brigadão 1984).

Between 1967 and 1975, significant progress was made in domestic production of defense hardware. Brazilian companies eagerly sought new partners, and European firms responded enthusiastically. Numerous licensing agreements and joint ventures were undertaken, leading large numbers of Brazilian firms to enter the defense industry. This trend quickly diversified the Brazilian defense industry (Barros 1984; Brigadão 1984, 1986). In 1969 the state established Embraer, an aircraft manufacturer that later became the darling of the industry. Meanwhile, already established firms such as Engesa and Avibras were taking first steps toward manufacturing defense hardware (ACE 1987).

In 1974 the Minister of the Army suggested to the Brazilian President, General Ernesto Geisel, that defense production policy should be revised. The minister proposed establishment of a state-owned enterprise that would report to the army ministry and would be capable of creating, promoting, and streamlining a modern defense complex. Early on, the state had protected firms from competition by establishing specific niches in the market, which helped them avoid overlapping functions (ACE 1987). The state began to intervene more consistently in the industry after the Indaustria de Material Bélico do Exército (IMBEL) was created. Established by Law 6227 in July 1975 and placed under the direction of the Army Ministry, IMBEL performs several key functions in the defense industry: collaborating on planning and manufacture of defense

materials, promoting technology transfer, and providing technical and financial incentives for establishing new firms. IMBEL may thus be characterized as a composite planning agency, promoter of research and development, producer, and arms exporter.[2]

Because of IMBEL's wide range of functions and influence over the defense industry's development, it is integrated closely into other areas of the government. For instance, members of the administrative council include the president and the heads of the ministries of the Armed Forces, Industry and Commerce, and Planning and Finance, in addition to the president and directors of IMBEL itself. The president of IMBEL is appointed by the president of Brazil (IMBEL 1987).

The catalytic role of the armed forces in developing the Brazilian defense industry is outlined in the third Brazilian plan for national development (III Plano Nacional de Desenvolvimento): to support and stimulate the adoption of advanced technologies that are in Brazil's interest and to promote the adaptation of civil technology to military purposes by developing projects, materials, and processes; to provide incentives for producing and developing military technology; and to acquire from the private sector the material needed to equip the armed forces. These initiatives have been justified in the name of national security and the need to reduce external procurement of defense hardware.

Since IMBEL's creation, the Brazilian defense industry has mushroomed. Unilateral suspension of several military agreements with the United States in 1977 hastened indigenous technology buildup and dramatically increased the number of firms in the industry (Brigadão 1986; ACE 1987). By 1987 the industry embraced more than six hundred firms employing some one hundred and fifty thousand persons (Aviação 1987). Appendix 1 presents a sampling of these firms and their respective products. The abundance and sophistication of the firms indicate the capability and depth of the Brazilian defense industry. In the second half of the 1980s, the level of self-sufficiency of the Brazilian Army was estimated to have reached 80 percent as a result of indigenous efforts. Brazil was thus the only Latin American country in the 1980s capable of sustaining military conflict without needing to import defense hardware (ACE 1987).

Internationalization of Activities

The development of the Brazilian defense industry was partly fueled by Brazilian defense firms expanding into Europe, Africa, and Asia. In transferring its technology to developed and developing countries, the Brazilian defense industry was replicating the pattern set by Western multinational companies. This step is also a logical and predictable one for an industry that has achieved international status and technological sophistication. In addition, by moving overseas the Brazilian defense industry has been able to exploit its firm-specific advantages further and serve its customers better. This strategy also allows access to newer and more sophisticated technology via branches in developed countries.[3]

Brazilian defense firms are now actively engaging in licensing agreements, joint ventures, and foreign direct investment in less developed countries and developed countries as well. A good example is the state-owned enterprise Embraer, which established a subsidiary in the United States in April 1981 and another in France in

1983. These subsidiaries promote foreign sales and provide after-sales service (Embraer 1985). Embraer recently entered into joint ventures and licensing agreements as well. In 1985 the British Royal Air Force selected the EMB-312 Tucano turboprop as its new aircraft for basic training. Embraer will develop the aircraft jointly with Short Brothers and will manufacture it in Belfast, Ireland. Both companies plan to research a new generation of commuter planes, executive turboprops, and missiles for space explorations (Embraer 1985). In another joint-venture agreement in Egypt, Embraer will export structural components for assembly by the Arab Organization for Industrialization.

In another recent development, Brazil and Argentina, through an agreement between Embraer and Argentina's Faabrica Militar de Aviones (FAMA), began negotiations to develop a two-engine passenger plane, the CBA-123. Argentina owns one-third of the joint venture while Brazil owns the remaining two-thirds (Embraer 1988). Coproduction of aircraft and aerospace research are important items in these countries' current efforts at economic integration. In 1986 Brazil began buying Argentine parts for its EMB 120 Brasília, a pressurized turboprop plane that will carry thirty passengers. Deliveries of the CBA-123 are scheduled for 1991 (Embraer 1988). In general, Argentina is viewed as an important future partner for the Brazilian defense industry.[4]

Avibras, the largest exporter of defense hardware, created in 1989 Inscom, a joint venture with a Chinese company, the China Great Wall Industry Corporation. Inscom plans to manufacture satellites, launcher vehicles, earth stations, and antennas (Avibras 1989a).

Nor is international production restricted to the aerospace industry. Engesa is negotiating a five-billion-dollar package with Saudi Arabia to coproduce fifteen hundred Osório tanks.[5] Engesa also signed an agreement allowing the U.S.-based FMC Corporation to manufacture Cascavel armored cars and Urutu armored personnel carriers in the United States.[6]

Internationalization of Brazilian activities is not restricted to the companies known as the "four sisters"--Embraer, Avibras, Engesa, and Bernardini. Taurus, the leading Brazilian exporter of firearms, ships to more than sixty countries and has followed industry leaders by setting up a subsidiary in the United States. Its U.S. subsidiary based in Miami assembles CKD firearms kits imported from the Brazilian parent company. According to Taurus officials, the U.S. subsidiary is fundamental to the company's efforts to upgrade its own products (Taurus 1987).

Arms Trade

As indicated above, the Brazilian defense industry has adopted an aggressive strategy for marketing exports. On average, the industry exports 80 to 95 percent of its total output. In just ten years, Brazil has become the fifth-largest exporter of defense hardware in the world. The domestic content of Brazilian-made hardware varies considerably, however. That of Embraer products ranges from 50 to 60 percent, reflecting the firm's marketing strategy of ordering some parts and components from foreign companies and thereby facilitating maintenance of Embraer planes abroad.[7] The domestic content of Avibras's products, in contrast, averages around 80 percent.[8] Engesa's products also vary considerably: basic products such as the Urutu and

Cascavel armored vehicles contain many more Brazilian-made parts than EE-T1 Osório MBT tanks, which use a number of imported parts such as the turrets.[9]

The Decision-Making Process

The Brazilian government controls arms exports through a council that deliberates on the national export policy on defense material (Política Nacional de Exportação de Material de Emprego Militar, or PONAENEM). This policy is defined and coordinated by a select group of government officials: the president, the secretary general of the national security council (the Secretaria Geral do Conselho de Segurança, or SGCSN), and the ministers of each branch of the Armed Forces, Foreign Relations (Itamaraty), and Finance and Planning. All exports must be approved by this council. For instance, PONAENEM has established that no arms will be exported to South Africa, Israel, or countries in Central America.[10]

Export Marketing Strategy

A major characteristic of the Brazilian defense industry has been its strong export orientation. The industry exports 80 to 95 percent of its domestic production. Brazil exports virtually all categories of hardware and a wide array of arms in the four main weapons classifications of missiles, airplanes, armored vehicles, and ships. But the country does not compete at the top end of high-technology hardware. Brazilian exports of military hardware range from firearms to subsonic combat airplanes (Cattoni 1985; ACE 1987).

The industry's international marketing approach is a "niche strategy" that is designed to avoid direct competition with superpower producers. This strategy entails providing "tropicalized technology," customizing products, offering on-site technical assistance, providing export credits, maintaining flexibility in compensatory agreements, and having no strings attached. The niche strategy has substantially increased Brazil's share of the international arms market (see ACE 1987).[11]

This export policy occasionally conflicts with Brazil's foreign policy, however. For instance, the "no strings attached" element, which means that no end-user certificates are required, resulted in arms being sold to Libya for resale to Iran in the war against Iraq. Engresa President Luiz Whitaker Ribeiro defends his position: "I sell to one country which resells to another--that's a sovereign act that can't be controlled. . . . [This accusation is] a device invented by the big powers to limit sales by smaller countries."[12] As Thomas Ohlson and Elizabeth Skons have noted, Western countries regularly violate this principle. The Brazilian marketing strategy for exporting arms is considered quite flexible: "Arms deals today are concluded with complex financing arrangements, technology transfer, and offset agreements involved" (Ohlson and Skons 1987, 181).

For instance, trade credits, barter, and subcontracting have all been used to sell Tucano planes to Egypt, warships to Paraguay, handguns to Canada, and armored vehicles to Gabon. Arms are frequently traded for oil from Iraq. Recently, Brazil bought German submarines in a two-hundred-million-dollar barter agreement involving Brazilian iron ore (SIPRI 1986, 413).

In any marketing strategy, knowing what to sell is a central factor. Brazilian producers have achieved a high degree of flexibility in hardware design in seeking to accommodate their customers' needs as much as possible.[13] Design flexibility is frequently cited by purchasers of Brazilian hardware as a major feature, and it has created a competitive advantage for Brazil. Brazilian producers also offer on-site technical support and training. Another important aspect of export sales is a non-price advantage: in several of Brazil's major markets, cultural affinities and shared status as newly industrializing countries figure prominently in arms deals.[14]

Major Markets and Products

Exports of arms by newly industrialized countries are mainly carried out by Brazil and Israel. Together they produced almost half the arms exported between 1982 and 1986. Brazil leads newly industrialized countries as producers with the highest export growth rates in military hardware. After improved designs were successfully tested in combat in the Middle East during the 1970s, Brazilian hardware exports increased swiftly. After IMBEL was created, Brazil augmented its export of hardware in 1975. Arms exporters are highly concentrated in four firms: in 1984 Avibras's share represented 40 percent of the total Brazilian arms sales; Engesa, 30 percent; Embraer, 20 percent; Bernardini, 5 percent; and other firms combined, only 5 percent (ACE 1987). In 1975 total arms exports reached forty-six million dollars, and by 1986, these sales amounted to three billion dollars.

The accuracy of these figures, however, is compromised by the high level of secrecy surrounding arms sales and by countertrade deals. Many inconsistencies can be found among published estimates of Brazilian arms exports. For instance, estimates for 1984 range from seven hundred and fifty thousand dollars to three billion, and they may all be inflated. In addition, trade statistics from CACEX (Carteira de Comércio Exterior, the foreign trade agency of the Banco do Brasil) include records not for exports of heavy defense hardware, per CACEX's Chapter 93 or NBM (Nomenclatura Brasileira de Mercadorias), but for exports of firearms and ammunition. CACEX's statistics thus do not publicly acknowledge exports of defense hardware.[15]

While exact figures on the volume of trade are hard to obtain, the data reveal a dynamic industry that is rapidly shedding its status as an infant industry. Table 1 provides further information on arms exports by the ten largest exporters. The figures show an upward trend between 1982 and 1985, the peak of the conflict between Iran and Iraq.

TABLE 1 Brazilian Exports of Arms and Ammunitions, 1980-1986 (in millions of U.S. dollars)

Firm	1980	1981	1982	1983	1984	1985	1986	1987	1988
Engesa	54.0	18.9	128.2	179.4	194.1	159.8	53.3	87.5	74.0
Avibras	6.4	3.4	3.8	6.6	19.5	197.2	167.2	322.0	80.6
Embraer[a]	80.9	113.9	107.6	97.4	66.0	150.0	249.6	347.4	385.3

Source: Compiled by the author on the basis of data from CACEX/DEPEC.

[a] These figures represent total exports and do not discriminate between military and civilian sales.

Some sources indicate that Brazil became the fifth-largest exporter of arms in 1986 in terms of volume, with sales to over forty countries (ACE 1987). In dollar terms, however, Brazil's exports amounted to only one-tenth of total U.S. arms sales. Brazil's 1986 exports were concentrated in North Africa and the Middle East, mainly because of the Iran-Iraq war and Brazil's chronic commercial deficit with oil-exporting nations. These factors explain Brazil's aggressive export-marketing strategy toward these countries.

In Latin America, the major importers of Brazilian hardware are Chile and Colombia. As noted in appendix 2, Chile imported five hundred armored wheeled vehicles from Engesa. Argentina has also become a major commercial and technological partner in the late 1980s.

Brazilian hardware sales to Africa largely go to the North African countries of Algeria, Egypt, and Libya. Other trade partners include Nigeria, Mozambique, and especially Angola. In 1986 Algeria was negotiating an arms package worth four hundred million dollars, which included EE-11 Urutu armored personnel carriers, EE-9 Cascavel armored cars, and technology transfer. In 1988 Libya was considering buying an arms package worth two billion dollars, which included EE-T1 Osório MBT tanks and Leo and Piranha missiles.[16] Iraq became Brazil's best customer in the Middle East after acquiring thousands of Engesa's major products, like EE-3, EE-9, and EE-11 Urutu armored personnel carriers. Iraq also has made large purchases from Avibras and Embraer. It has recently come to light that the Comissão Nacional de Energia Nuclear (CNEN) sent Iraq three shipments of processed uranium and yellow cake as well.[17] Other important clients for Brazilian hardware are Saudi Arabia, China, and Far Eastern and European countries. The 1985 sale of 130 T-27 Tucano planes to the British Royal Air Force was the first sale of Brazilian-made military airplanes to a member of North Atlantic Treaty Organization (NATO). This transaction is likely to prompt first-time purchases by other NATO members. Even the United States was considering buying 500 T-27 Tucanos (ACE 1987).

The Catalytic Role Of The Government

The Brazilian defense industry, unlike many in less developed countries, is predominantly private (Mooda 1983; Wulf 1983). But the state has played an active role in its organization, development, industrial structure, and production. The state has developed and coordinated agencies that support and regulate the defense industry, including IMBEL, the military research centers, the national development bank (Banco Nacional de Desenvolvimento Económico e Social, or BNDES), the foreign trade agency of the Banco do Brasil (CACEX), and the Financiadora de Estudos e Projetos (FINEP). Domício Proença Filho has noted that the degree of interaction and coordination in the Brazilian arms industry surpasses all other public-private partnerships undertaken by the government (Proença Filho 1984).

Military research and development institutes have played a vital role in the industry's development. Since the 1940s, the air force and army have provided undergraduate and graduate programs for scientists and engineers who subsequently have enabled Brazil to produce indigenous technology (Menezes 1984). Military institutes have also supplied technology to the private sector, and most indigenous defense hardware systems have benefited from technical assistance from one of the three military institutes: the Centro Technológico da Aeronaatica (CTA), the Centro Tecnológico de Exército (CTEX), and the Instituto de Pesquisa da Marinha (IPqM).

The air force's CTA was established in 1945 and today employs approximately seven thousand workers. Five institutes report to CTA: the Instituto Tecnológico da Aeronaautica (ITA), which trains aerospace engineers and does basic research; the Instituto de Pesquisas e Desenvolvimento (IPD), a research and development institute; the Instituto de Atividades Espaciais (IAE), an aerospace activities institute; the Instituto de Estudos Avançados (IEAV), an advanced studies institute; and the Instituto de Fomento e Coordenação Industrial (IFI), which promotes and coordinates the aerospace industry. The IAE is in charge of research and development of air force defense material, while the IEAV conducts advanced studies in laser and nuclear fields, and the IFI acts as a bridge between air force centers of research and development and the private aerospace industry. The ITA has had a strong impact on companies like Embraer, having actually trained the majority of the firm's engineers.[18] The CTA too has provided major stimulus for air force research and development efforts. In 1988 the CTA helped Orbita develop the sophisticated Piranha (MA-A1) air-to-air missile.[19]

The army's research and development center, the CTEX, was established in 1977 under the umbrella of the army's Secretaria de Ciencia e Tecnologia do Ministério do Exército. The secretariat comprises the military engineering school (the Instituto Militar de Engenharia, or IME), the already mentioned IPD, the Instituto de Normas e Informaatica tecnológica (INIT), and the Instituto de Fomento a Indaustria e Controle de Qualidade. The CTEX transfers technology to the private sector free of charge. One of its top projects is developing a microchip to be used to control missiles. The army has followed a general plan for research and development (Plano Geral de Pesquisa e Desenvolvimento do Exército, or PGPDEX), a "guiding light" for the army's efforts in developing indigenous technology (Oliveira et al. 1986).

Technological development in the Brazilian arms industry has not been evenly distributed across the branches of the armed forces, however. The army and the air force have more sophisticated technology than the navy, partly due to historical circumstances. One analyst has argued that since the "navy insurgence" in 1983, the Brazilian government has downplayed the navy's role and purposely relegated it to a secondary position (Ferreira 1984). The navy is fighting to change this status by researching innovative defense projects like the nuclear submarine. The discrepancy among the three branches has other roots as well. The navy has been more resistant to external input into its technological efforts than the air force and the army have been.[20] Moreover, the navy has been hardest hit by the country's external debt crisis in the 1980s, largely due to the magnitude of naval projects.

Following the Brazilian defense industry's general lead, the Navy Directoria de Engenharia Naval (DEN) favors nationalizing defense hardware. The navy's technological motto holds that investments in defense should, to the extent possible,

stimulate the nation's economy, development, and growth. The DEN also has strict policies on foreign participation in Brazilian naval programs. Multinational companies are increasingly required to use Brazilian parts and labor and secure domestic logistical support for supplying parts within Brazil. With technical assistance from the German firm IKL, DEN has been developing two non-nuclear submarines, the NAC-1 and NAC-2. In cooperation with the IPEN/USP (Instituto de Pesquisas Nucleares/Universidade de São Paulo), the navy is also developing a nuclear reactor for Brazilian nuclear submarines. The navy has shared nuclear technology with the Argentine Navy for developing "fast-breeder" reactors.[21]

The finance and trade legs of the industry mostly consist of the BNDEs, the Banco do Brasil, FINEP, and CACEX. The BNDEs extends credit to firms in the industry. For example, in 1978 Engesa borrowed one hundred and sixty-five million dollars from two governmental agencies: the BNDEs and the Banco do Brasil. The latter loaned one hundred million dollars to Engesa, while the BNDEs provided the remaining sixty-five million at subsidized interest rates.[22]

FINEP is the Brazilian financing agency for research and scientific development, which reports to the Ministry of Science and Technology. Over the past twenty years, FINEP has financed more than ten thousand projects. At present, it is funding sectors that can alleviate supply bottlenecks in the defense industry, such as microelectronics. In the past, FINEP financed Embraer's EMB-312 Tucano plane and Avibras's Astros II, an artillery saturation rocket system. FINEP has also supported research and development projects for many other defense firms.[23] The Banco do Brasil, through its foreign trade agency CACEX, allocates trade credits to foreign buyers of Brazilian-made weaponry.

the tripod structure of the industry: the role of state-owned enterprises, the private sector, and multinational companies

The structure of the Brazilian defense industry is built on state-owned enterprises, private domestic enterprises, and subsidiaries of multinational companies. This construct spans more than 650 firms (Aviação 1987). Defense firms permeate virtually all sectors of the Brazilian economy but are largely located in four states: São Paulo, Rio de Janeiro, Minas Gerais, and Rio Grande do Sul.

State-Owned Enterprises

State-owned enterprises are found in all three branches of the Brazilian Armed Forces. As producers, they play the largest role in the aircraft industry. Embraer, the biggest state-owned enterprise in the defense industry, originally specialized in producing low-technology airplanes. By 1989, however, Embraer was designing and manufacturing a whole family of advanced aircraft ranging from crop dusters to jet fighters. Embraer also builds a wide range of single- and two-engine piston planes under an industrial cooperation agreement with the American firm Piper (Embraer 1985).

Embraer's success has been attributed to a number of joint ventures and licensing agreements established throughout the 1970s that enabled the aircraft producer to acquire large-scale assembling technology from the Italian firm Aermacchi, sales techniques from the U.S. company Piper, and inputs such as landing gear for its airplanes from the French company Eran (Embraer 1985; FINEP 1987).

Embraer was the first producer in a newly industrialized country to develop a combat jet aircraft--the fighter-bomber and ground-attack aircraft known as the AMX. This jet fighter has no real competitors and is coming on the market at a time when formerly competitive products are becoming obsolete (Nativi 1985). In 1988 Embraer officials announced their plans to produce a supersonic light fighter, the MFT-LF.[24]

Exporter to five continents, Embraer was ranked in 1985 as the sixth-largest manufacturer of airplanes in the world (Embraer 1985).

Within a relatively short time, this state-owned enterprise has managed to compete successfully in a worldwide industry with high entry barriers. Embraer's success has resulted from its flexibility in designing products that may be used for either military or civilian purposes. Its training fighter, the Tucano EMB-312, is the world's best-selling aircraft in its category, having surpassed similar Swiss, British, and Australian aircraft (Embraer 1988).[25]

Brazilian Private Sector

In contrast with defense industries in other less-developed countries like that in Argentina (Looney 1986), the private sector plays an important role in the Brazilian industry. The Brazilian defense industry has offered the private sector opportunities for higher degrees of capacity utilization (a means of offsetting downswings in the domestic market) and potentially new markets where it can sell products for the civilian market via dual-use technology. For instance, Metal Leve, which originally supplied engine pistons to Embraer, currently exports pistons to the U.S. aircraft market.

Avibras and Engesa lead the private sector in the Brazilian defense industry. Founded in 1961, Avibras developed a wide array of research in the aerospace field, an entire set of air-to-ground and surface-to-surface weapon systems, and a whole family of scientific rockets.[26] In the early 1970s, the technology and skills amassed in developing civilian rockets were diverted to military endeavors.[27] Through the years, Avibras has vertically integrated its operations, creating subsidiaries in space research and in the electronic, chemical, aerospace, and communications sectors (Avibras 1989b, 1989c).

Avibras's line of products consists of space research systems, surface-to-surface defense systems, air-to-ground defense systems, electronics and communications, and satellite-communication earth stations and radar systems. In addition, Avibras subsidiaries Tectran and Tectronis produce special transport systems and electric vehicles (Avibras 1989b). One of the main global competitive advantages of Avibras is its on-site assistance and training. Like Engesa, the company also customizes its products to customer specifications. In the mid-1980s, 80 percent of Avibras's income came from international sales.[28]

Engesa (Engenheiros Especializados) is the second-largest exporter of wheeled armored fighting vehicles in the world.[29] Originally a producer of pumps for oil fields, the company developed a unique suspension system for vehicles. In 1968, the Army noticed the four-wheel-drive vehicles that Engesa was manufacturing and contracted to convert one hundred army trucks. Since then, Engesa has developed a full line of armored vehicles (Hammond 1988).

The company also produces and exports a wide array of other products, including main battle tanks, utility military vehicles, tank transporters, weapons systems, ammunition, communication systems, and products for electronic warfare (Engesa 1989). Engesa products are renowned for their ruggedness, low cost, ease of operation, and adaptability to terrain and climates typical of less-developed countries. The company thus concentrates its sales in less developed countries, exploiting market segments neglected by major arms exporters by "tropicalizing" its technology. Engesa's most popular products, the EE-9 Cascavel and EE-11 Urutu armored vehicles, are currently being exported to thirty-five countries. Today Engesa operates seventeen plants with twelve thousand employees and a diversified production capability (Engesa 1989). The company has integrated its activities vertically and horizontally. Most of its hardware is exported through Engexco, its trading company, which exports items ranging from orange juice to tanks.[30]

As protected firms, Engesa was the sole producer of wheeled armored vehicles while Avibras monopolized the production of missiles. In 1987 Engesa joined with Embraer and IMBEL to form Orbita, a company geared toward producing an array of missiles (Foss 1987, 200).

Subsidiaries of Multinational Companies

Brazilian subsidiaries of multinational companies constitute another vital leg of the Brazilian defense industry's tripod. Although their role appears to be very restricted, it is vital because these companies supply components and technology through subcontracting and licensing agreements. Multinational companies also invest heavily in Brazilian companies.

In 1987, 159 multinational companies were involved in the Brazilian defense industry. U.S. subsidiaries constituted the largest group, followed by the Europeans and the Japanese. These companies specialize within the defense industry. French and Italian subsidiaries are concentrated in aerospace activities, while the British are primarily involved in shipbuilding (Gouvea Neto n.d.). West German, Japanese, Swedish, and U.S. subsidiaries undertake a wider scope of activities.

In the majority of cases, multinational companies produce civilian as well as military products. This dual-use capability makes it difficult to delineate specific supply functions of multinational companies (Williams 1986). For instance, in the transport equipment industry, multinational companies supply components. Engesa buys domestically produced parts from General Motors, Perkins, Mercedes-Benz, and Saab-Scania. Volkswagen and Toyota subsidiaries supply engines and parts to Brazilian manufacturers of military vehicles (Gouvea Neto n.d.).

Multinational subsidiaries are also involved in joint ventures in the Brazilian defense industry. Embraer's AMX, a sophisticated combat airplane, is being codeveloped with two Italian firms, Aeritalia and Aermacchi: 48 percent of the work goes to Aeritalia, 30 percent to Embraer, and 22 percent to Aermacchi (Embraer 1985). In early 1987, Embraer started negotiations with McDonnell-Douglas to produce a commercial jet that will compete directly with Airbus and Boeing aircraft.

Multinational companies also invest actively in Brazilian defense companies. For instance, Volkswagen is the largest single private investor in Embraer (Tuomi and Vayrynen 1982). Phillips has a joint production with Engesa in the company's Engetrónica branch (30 percent), and Aerospatiale from France has a stake in the Brazilian helicopter firm Helibras (Cattoni 1985).

Future participation by European multinational companies is likely to increase because, unlike their U.S. counterparts, they do not seek much control over end-users (Vaz Carneiro 1989). Future involvement by American multinational companies in the Brazilian industry will continue to be restricted by embargoes that prevent sales to Libya, one of Brazil's best markets.

Future Developments

In 1987 the Brazilian defense industry entered a new phase. The impetus for change came from its highly specialized niche market strategies. First, Brazil initiated a new industrial strategy that forces final producers to become more competitive by reducing protection. The recently established Orbita subsidiary is a good example of increasing competitiveness in the industry. For the first time, final producers within Brazil, like Orbita and Avibras, are competing directly in the same range of products, such as missiles.

Second, multinational companies are becoming more involved than previously, deepening the international linkages of the industry. The Brazilian defense industry is moving toward closer cooperation with European countries to upgrade its defense hardware technologically. This trend is the first sign of exhaustion of the "dual-use technology" approach. In 1987 the Groupement des Industries Françaises Aéronautiques et Spatiales (GIFAS), representing thirty-six supplier firms, promoted the first aerospace event ever held in Brazil (Beck and Lapa 1987).

Third, the growth strategy based on readily available parts and technology is evolving into a more sophisticated and elaborate weaponry, which will gradually avoid the dual-use technology approach and thereby reduce spillover effects in the economy. Also indicative of technological deepening are the navy's project for a nuclear submarine, Engesa's Osório tank, and Avibras's SS-300 and CTA SS-1000 ballistic missiles (Cohen 1987).[31]

Fourth, the Brazilian government has decided to increase the budget for the armed forces, a measure with major implications for the development of indigenous technology by the military. These trends are related to the armed forces' modernization plan for the 1990s, which was initiated during the second half of the 1980s. Referred to as the FT-90, the plan calls for a number of investments in key technological areas. The goals of the FT-90 are twofold: modernization and professionalization of the Brazilian Armed Forces. The plan also proposes to take advantage of Brazil's indigenous arms industry, which has already resulted in increased research and development expenditures in nuclear technology (Cohen 1987). In the 1980s, Brazil took serious steps toward further utilization of the atom for defense. Indications suggest that the navy is running a parallel nuclear program, and it is well known that the navy plans to initiate its project of building a nuclear submarine in the 1990s (Pesce 1988).

The Brazilian Air Force, through Avibras, is also developing a new family of missiles capable of exceeding ranges of three hundred kilometers, particularly the SS-300 missile cosponsored by the army's general plan for research and development. The CTA has already started research to build the SS-1000, a medium-range ballistic missile capable of carrying a one-ton payload as far as twelve hundred kilometers and thus capable of spanning the Latin American continent.[32]

Also expected are further involvement and interactions between the Brazilian defense industry and the Brazilian computer industry. As already noted, military projects provided the driving force behind the creation of the computer industry (Evans 1986). It is believed in Brazil that a strong and relatively self-sufficient computer industry is a sine qua non for the future of the Brazilian defense industry. Several informatics firms are already conducting military-related research (such as Scopus and Cobra). The major firms in the defense industry--Engesa, Bernardini, and Avibras--have their own research laboratories pursuing the development of indigenous software. Bernardini, for instance, recently inaugurated two computer-related units to further develop hardware and software. These endeavors have already achieved some degree of success. For instance, the integration software for Avibras's Astros II rocket system is being made in Brazil (Beck and Lapa 1987).

Brazil lacks substantial research in inertial navigation systems, however, a field that is fundamental to further developing and upgrading missiles and solid microelectronics technology (Dagnino 1984).[33] Brazil also lacks the technology to integrate the electronic systems of a supersonic jet fighter.

Future development of the Brazilian defense industry will also face external restrictions. In the 1980s, the defense industry had to contend with a number of technological barriers to expansion, including export restrictions by developed countries on sophisticated computers and military technology. For instance, the United States has restricted supercomputer sales to Brazil and has pressured Japan and West Germany to adopt similar strategies. In April 1988, an agreement was signed by Canada, England, France, Italy, Japan, the United States, and West Germany imposing embargoes on transferring military rocket technology to newly industrialized countries, including Brazil (Kapstein et al. 1988). These practices will seriously constrain the Brazilian space program.

Final Remarks

The Brazilian defense industry developed from political and economic motivations. The government and state-owned enterprises played catalytic roles in establishing the industry and in promoting the development of indigenous technology. The tripod strategy was also central to fostering the viability and maturing of the industry.

The future development of the defense industry is likely to be conditioned by four factors. First, it will be vital for the industry's upgrading that Brazil have access to more sophisticated technologies. Thus far, barriers from developed countries have limited Brazil's access to computer technology relating to defense hardware development and to missile-related technologies. Second, conflicts between the arms industry's export policy and Brazil's diplomatic policy are likely to increase in the future, possibly forcing the Brazilian government to restrict exports.[34] Third, high dependency on exports

severely affected the industry in 1989. The lack of demand from Arab countries, specifically Iraq, has had a negative impact on Brazilian defense hardware exports. Avibras alone saw its exports decline by half.[35] The result has been massive unemployment throughout the industry. For example, Avibras cut back its labor force by one-third, and Engesa dismissed twelve hundred employees.[36]

Fourth, the relaxation of political and military tensions between the East and the West in the 1980s combined with the radical changes experienced by Eastern Europe in 1989 have brought up the issue of conversion, or using military industrial facilities to manufacture civilian products. These global events will inevitably create a different market environment that will force Brazil to design a conversion strategy for the Brazilian defense industry. The lack of external demand in the late 1980s and a new democratic government in Brazil will also play key roles in the industry's future.

In sum, the Brazilian defense industry will face major challenges in the 1990s. Industry policymakers will have to devise strategies to keep the industry operational. In view of the direction in which external and internal environments are developing, conversion will undoubtedly become paramount for the future survival of the Brazilian defense industry.

NOTES

* The author wishes to thank Arun Elhance, Itty Abraham, Maario Roberto Vaz Carneiro, Susan Jessup, and Roma Arellano for their helpful comments and suggestions.

1. See also Everett Martin, "Brazil's Fledgling Arms Industry Making a Hit with Weapons-Hungry Third World Countries," *Wall Street Journal*, 4 Jan. 1985, p. 4-A.

2. Interview with anonymous IMBEL official in December 1987, Rio de Janeiro.

3. Interview with anonymous Taurus official in December 1987, Porto Alegre.

4. Several interviews with an anonymous Embraer official in São José dos Campus, December 1987, December 1988, June 1989.

5. R. Pedreira, "Líbia Oferece Petróleo em Troca de Tanque e Foguete," *Jornal do Brasil*, 21 Jan. 1988, p. 5.

6. Robert A. Manning and Melissa Healy, "New Sellers in Arms Bazaar," *U.S. News and World Report*, 3 Feb. 1986, pp. 37-39.

7. See note 3.

8. Interview with anonymous Avibras official in December 1988, June 1989, São José dos Campos.

9. Interview with anonymous Engesa official in June 1989, São José dos Campos.

10. See M. Antunes, "Engesa Reage para Disputar o Mercado Mundial de Armamentos," *Jornal do Brasil*, 29 May 1988, p. 32.

11. F. Turci, "Siglo e Tecnologia Andam Juntos na Venda de Armas," *Jornal do Brasil*, 19 Oct. 1986, p. 38; see also S. Ferraz, "Brasil Invade Fechado Mercado de Venda de Armamentos," *Jornal do Brasil*, 18 Oct. 1987, p. 22.

12. L. Ribeiro, interview with *MacLean's*, 21 Jan. 1985, p. 28.

13. Interview with anonymous Avibras official, December 1988, June 1989, São José dos Campos.

14. Interview with Maario Roberto Vaz Carneiro, the editor of *Segurança e Defesa*, December 1988, June 1989, December 1989, Rio de Janeiro.

15. Interview with anonymous CACEX official, December 1987, December 1988, Rio de Janeiro.

16. Pedreira, "Líbia Oferece Petróleo."

17. See Teodomiro Braga and Maario Rosa, "A Negra História das Relações entre Brasil e Iraque," *Jornal do Brasil*, 12 Aug. 1990, sec. 1, pp. 30-31.

18. Interview with anonymous Embraer official, December 1987, December 1988, São José dos Campos.

19. C. Accioly, "Empresa Particular e CTA Vão Fazer Míssil Piranha," interview in *Jornal do Brasil*, 27 May 1988, p. 4.

20. Interview with Vaz Carneiro, editor of *Segurança e Defesa*.

21. R. Guerrante, "Projeto Alargou Submarino para Usar Reator de Ipero," *Jornal do Brasil*, 23 Jan. 1988, p. 6; C. Malta, "Submarino Nuclear em Dez Anos," *Gazeta Mercantil*, 9 Apr. 1988, p. 6; and Pesce (1988).

22. W. Waack, "Tecnologia Superada Ameaça Venda de Arma Brasileira," *Jornal do Brasil*, 6 Dec. 1987, p. 25; and "Com a Benção do Cue," *Veja*, 16 Dec. 1987, pp. 102-3.

23. A sample of such firms indicates the many projects that have been supported: Elebra Microeletrónica (pilot plant in microelectronics), Engesa (MBT-EET1 Osório tank), Labo Electrónica (new products), Metal Leve (research center to development pilot plant for making piston molds), Coester (transport system), Tecnasa Eletrónica (new technology in radio navigation), Scopus Technologia (domestic network development), Elebra Telecomunicações (software integration laboratory), CBV Indaustria Mecaanica (new products), Cobra Computadores (operations system), Tecnasa (VDR/DME radio navigation system), Acesita (graduate training for personnel), Indaustrias Reunidas Canedo (CAD/CAM system for computer-assisted manufacture), and Fupresa Hitchiner (importing a research center for high-tech products). This list was compiled from FINEP's *Relatório Anual 1987* and the *Brazilian Defense Directory 1987*.

24. Waack, "Tecnologia Superada"; R. Godoy, "Embraer Tem Novo Projeto," *O Estado de São Paulo*, 18 Sept. 1987, p. 20; and A. Antunes, "Brasil Projeta Construção de Jato Supersónico de Combate," *Jornal de Brasil*, 22 May 1988, p. 32.

25. M. Sampaio, "O Tucano Ja Lidera Vendas do Setor," *Jornal do Brasil*, 25 May 1987, p. 14.

26. R. Godoy, "Nossa Nova Granada Made in São José dos Campos," *Jornal da Tarde*, 18 May 1988, p. 15.

27. J. Freitas, "Sarney Ve Subir o Sofisticado Sonda-IV," *O Globo*, 4 Oct. 1987, p. 11.

28. Interviews with anonymous Avibras official, December 1987, December 1988, and June 1989, São José dos Campos.

29. See Martin, "Brazil's Fledgling Arms Industry," *Wall Street Journal*, 4 Jan. 1985, p. 4-A. See also Antunes, "Brasil Projeta Construção."

30. Interview with anonymous Engesa official, June 1989, São José dos Campos.

31. See also Godoy, "Nossa Nova Granada."

32. H. Piva, "Esta é a Mais Nova Arma do Brasil," interview in *Jornal da Tarde*, 28 Nov. 1986, p. 10.

33. See also Waack, "Tecnologia Superada."

34. M. Simons, "U.S. and Brazil at Odds over Arms for Libya," *The New York Times*, 30 Jan. 1988, p. 6.

35. Interviews with anonymous Avibras official in 1987-1989, São José dos Campos.

36. E. Freitas, "Crise Abala Indaustria de Armamento," *O Globo*, 7 Feb. 1989.

APPENDIX 1

Major Firms in the Brazilian Defense Industry and Their Products

ABC Sistemas Eletrónicos	electronic components and systems
Aeromoto	aviation electronics and systems
Amadeu Ross SA Metalaurgica e Munições	shotguns, rifles, ammunition
Amazonas Motocicletas Especiais	motorbikes for police and armed forces
Arsenal da Marinha do Rio de Janeiro (AMRJ)	ships and offshore platforms
Avibras Aerospacial	sounding rockets, artillery saturation rockets
Bernardini	tanks, updated military

	equipment
Companhia Brasileira de Cartuchos (CBC)	military ammunition
Companhia Comércio e Navagação-Estaleiro Maua	ships
Companhia de Explosivos Valparaíba	hand grenades, fuses
Datanav Engenharia	radar systems
DF Vasconcellos SA	optoelectronics
Embraer (Empresa Brasileira de Aeronaautica SA)	aircraft
EDE	aviation electronics and systems
Engesa (Engenheiros Especializados)	armored vehicles, electronic systems, guns, ammunition, explosives, suspension systems
Engetrónica	aviation electronics and systems
ENARM	submachine guns and other weapons
Equitel	radar systems
Ericsoon	radar systems
Ferranti do Brasil	naval systems
Ford do Brasil SA	military vehicles
FI (Indaustria e Comércio Lida)	naval ammunition
Helibras (Helicópteros do Brasil SA)	helicopters
Hydroar Indaustria Metalaurgica SA	recoiless guns
IMBEL (Indaustria de Material Bélico do Brasil)	light weapons, ammunition
Indaustrias Reunidas Caneco SA	ships
Ishibras (Isshikawajima do Brasil)	ships
MacLaren	ships
Microlab	aviation electronics and systems
Moto Pecas SA	updated military equipment
MWM Motores Diesel	motors
Novatração-Artefactores de Borracha SA	rubber pads for tank tracks and other rubber products
Orbita	missles, aerospace systems
Pirelli	aviation electronics and systems
Prólogo	electronics
Química Tupan SA	pyrotechnics devices, ammunition
Sataurnia SA	electronic products and batteries
Siteltra SA	multichannel equipment, radios
SFB Informaatica	electronic systems
Taurus SA	firearms
Tecnasa	radar systems
Verolme Estaleiros Reunidos SA	ships

Note: This list was compiled from several sources: Military Technology, Oct. 1985:92-119; Infostrat 1, 1986; Segurança e Defesa no. 3 (Jan.-Feb. 1985):28-37; Jane's Defense Weekly, 16 Aug.1986, p. 256; and INFO, Apr. 1987:28-33.

APPENDIX 2

Major Exporters of Arms in Brazil, Their Clients, and Products Sold,

1977-1986

Engesa	
Africa	
Angola	2000 trucks, 200 jeeps (1986)
Algeria	EE-9 Cascavel armored cars (1981), Osório tanks (1985)
Gabon	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Libya	1000 EE-9 Cascavel armored cars, 1000 EE-11 Urutu armored personnel carriers (1981-1984), 1000 Osório (1984)
Mozambique	trucks and jeeps
Morocco	60 EE-11 Urutu armored personnel carriers
Nigeria	100 EE-9 Cascavel armored cars
Togo	EE-9 Cascavel armored cars
Tunisia	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Zimbabwe	EE-9 Cascavel armored cars
Europe	
Portugal	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Far East	
China	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
India	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Thailand	EE-9 Cascavel armored cars
Latin America	
Argentina	10 EE-9 Cascavel armored cars (1982)
Bolivia	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Colombia	100 EE-9 Cascavel armored cars, 100 EE-11 Urutu armored personnel carriers (1981)
Chile	200 EE-9 Cascavel armored cars, 300 EE-11 Urutu armored personnel carriers
Guiana	EE-11 Urutu armored personnel carriers (1982)
Paraguay	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Surinam	unknown products (1983)
Uruguay	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers, EE-3 Jararaca armored reconnaissance vehicles
Venezuela	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Middle East	
Cyprus	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers, EE-3 Jararaca armored reconnaissance vehicles
Iran	EE-9 Cascavel armored cars
Iraq	1300 EE-9 Cascavel armored cars (1979-1986), 1000 EE-11 Urutu armored personnel carriers (1978-1984), 500 EE-3 Jararaca armored

	reconnaissance vehicles (1982-1984), 300 Osório tanks (1986), 400 Ogum howitzers (1986)
Kuwait	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Qatar	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Saudi Arabia	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers, Osório tanks (1981-1985)
United Arab Emirates	EE-9 Cascavel armored cars, EE-11 Urutu armored personnel carriers
Embraer	
Africa	
Angola	2 Bandeirante Patrulha surveillance planes (1986), 1 Bandeirante Carga cargo plane (1986)
Egypt	120 Tucano planes (1984)
Gabon	3 Bandeirante aircraft (1980), 1 Bandeirante Patrulha surveillance plane (1980)
Togo	6 EMB-326 GB Xavante jet trainers (1982)
Europe	
France	41 EMB-121 Xingu transport planes (1982)
United Kingdom	135 Tucano planes (1985)
Latin America	
Argentina	11 EMB-326 GB Xavante jet trainers (1982) 2 EMB-111A Bandeirante Patrulha surveillance planes (1982), 30 Tucano planes (1986)
Chile	3 EMB 111A Bandeirante aircraft (1986), 6 Bandeirante Patrulha surveillance planes (1977-1979)
Honduras	12 Tucano planes (1984-1986)
Panama	20 Tucano planes (1986)
Paraguay	10 EMB-32;6 GM Xavante jet trainers (1979)
	Bandeirante aircraft (1983)
Peru	25 Tucano planes (1986)
Venezuela	30 Tucano planes (1985)
Middle East	
Iraq	80 Tucano planes
Avibras	
Africa	
Lybia	15 Astros II-SS-40 missile systems being negotiated, Astros II-33-60 missile systems (1987) being negotiated
Middle East	
Iraq	38 Astros II-SS-30 missile systems (1985-1986)
Saudi Arabia	Astros II-SS-40 missile systems (1986, unconfirmed)

Note: This list was compiled from several sources: Segurança

e Defesa, no. 3 (Jan.-Feb 1985):31-35; Infostrat no. 1; ACE 1986; Embraer 1985; SIPRI Yearbook, 1986, 1987; Journal do Brasil, 18 Oct. 1987, p. 22. To provide some idea of the costs involved, the following items are estimated in U.S. dollars: one EE-9 Cascavel armored car and one EE-11 Urutu armored personnel carrier each, $500,000 to $800,000; one EE-11 Osório tank, $1.5 to 2.0 million; one Tucano plane, $1.3 to 1.5 million; one Astros II missile system, $10 million.

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