

In Search of Safety and Comfort

Universities and Embraer are creating a knowledge base to improve commercial and military aircraft

Claudia Izique

A little more than ten years ago, the city of Gavião Peixoto, in the southwestern part of the state of São Paulo, population 4,000, was emerging timidly from an immense sugarcane field dotted here and there with orange groves. Today, the area next to the urban center is dominated by a 5,000-meter runway, the longest in Latin America, and an Embraer factory. There, in addition to conducting test flights, the company originally known as Empresa Brasileira de Aeronautica S.A. makes the wings for the Embraer 190 and 195 aircraft and builds the Phenom 100 and 300 executive jets, as well as the Super Tucano – a multipurpose military turboprop plane. It is also there that the company overhauls fighter planes for the Brazilian Air Force (FAB), which is why the region is considered a national security area – one that the imagination of the ill-advised has dubbed “Brazil’s Area 51,” in a reference to the American military base situated in the Nevada desert.

The landscape and future prospects of Gavião Peixoto began to change early in the new millennium, precisely on June 24, 2000, when Mario Covas, then governor of the state of São Paulo, and Maurício Botelho, then president of

Embraer, announced that the city had been chosen as the site for the company’s fourth factory, an enterprise involving an investment of R\$340 million that would create 2,000 jobs.

Encouragement from the state was crucial in Embraer’s decision to set up in Gavião Peixoto: the state government gave the company a 35-year grant, renewable for 35 more years, to a 15 km² tract of land, along with the basic infrastructure: water, electricity, paved roads, etc. An influential factor, of course, was that the future factory would be close to the São Carlos and Araraquara universities and research centers. But points were also scored—lots of them—by support from FAPESP. Less than a month after the announcement of the new factory, that assistance was made available under the Partnership for Technological Innovation (PITE).

Over the past 12 years, FAPESP has spent R\$16.4 million on assistance to eight projects, also receiving counterpart funds from Embraer. “It was a strategic partnership that enabled the company to move forward in mastering technology and increase its competitive edge,” said Jorge Ramos, Embraer’s director of technological development.

Cane fields and orange groves in Gavião Peixoto (SP) gave way to immense Embraer hangars





Many of the projects carried out in partnership with universities and research institutions have produced a body of engineering knowledge that has been—or could in the future be—applied to executive aviation or commercial and military aviation. The project entitled *Composite materials in aircraft structures*, which investigates solutions using carbon fiber composites that reduce aircraft weight and improve performance when compared to conventional materials, has already identified methodology that could be incorporated into the company's manufacture of composite materials components at a factory it is building in the city of Évora, in Portugal.

The research projects cover various aviation-related topics. In three of those that have been financed and are still in progress, researchers from several universities and research institutions are looking for solutions to make aircraft more comfortable and quieter, as well as safer.

For example, under the project entitled *Cabin comfort: development and integrated analysis of criteria and comfort*, begun in 2008, researchers constructed an environment that simulates the cabins of the Embraer 170 and 190 aircraft in order to study operational parameters such as temperature, pressure, noise, vibration, lighting and ergonomics, as well as odors and materials. The intent is to evaluate and integrate the various aspects of passenger comfort and establish planning and design parameters. This particular piece of research equipment, which had never existed in Brazil, was installed at the Thermal and Environmental Engineering Laboratory (LETE) at

the University of São Paulo's Polytechnic School (Poli). It was used last year in a survey of hundreds of passengers who regularly travel by air, during which they were quizzed about in-flight comfort conditions. Jurandir Itizo Yanagihara, project coordinator, suggested to Agência FAPESP that one of the trends they identified was the inclusion, in large aircraft, of alternative spaces for passenger interaction.

Legal restrictions on aircraft noise have also spurred São Paulo research. In *Silent aircraft: an investigation into aeroacoustics*, researchers are developing noise-suppression methods and equipment. They are trying to identify the sources of noise – whether it starts in the wings, the flaps, the engine, or the landing gear, for example – and measure the intensity of the sound by using huge sets of microphones installed at the head of the flight test landing strip at Gavião Peixoto. Following completion of the project's first phase, studies resulted in submission of two applications for patents related to noise attenuators. Participating were 70 researchers from Embraer, the University of São Paulo (USP), the University of Brasília, and two federal universities: Santa Catarina (UFSC) and Uberlândia (UFU).

A RESEARCH NETWORK

All these projects, by the way, involve several universities and research institutions in São Paulo, and even some from other Brazilian states. The cabin comfort project, for example, included not only researchers from USP, but also some from the Federal University of São Carlos (UFSCar)

THE PROJECTS

1. Behavior of materials and aeronautical structures subject to impact – nº 2002/11313-5 (2003-2006)
2. Advanced Applications of Computational Fluid Dynamics for High Performance Aircraft – nº 2000/13768-4 (2002-2006)
3. Identification of Derivatives for Stability and Control of Aircraft via Non-Linear Filtering and Stochastic Optimization: Algorithms and Applications in In-flight Test Data – nº 2001/08753-0 (2002-2006)
4. Aeronautical structures in composite materials nº 2006/61257-5 (2011-2014)
5. Cabin comfort: development and integrated analysis of comfort criteria – nº 2006/52570-1 (2008-2012)
6. Development of a Differential GPS System For Positioning and Guiding Aircraft in Real Time – nº 2001/08751-8 (2002-2005)
7. Development of Aerodynamic and Two- and Three-dimensional Tests for the High Performance Aircraft Project – nº 2000/13769-0 (2001-2007)
8. Silent Aircraft: a study of aeroacoustics – nº 2006/52568-7 (2008-2011)

TYPE

1. a 8. Partnership for Technological Innovation Program (PITE)

COORDINATORS

1. Marclio Alves – Embraer and Escola Politécnica/USP
2. João Luiz Figueiras de Azevedo – Embraer and CTA
3. Luiz Carlos Sandoval Góes – Embraer and CTA
4. Sergio F. M. de Almeida – Embraer and ITA/CTA
5. Jurandir Itizo Yanagihara – Embraer and USP
6. Helio Koiti Kuga – Embraer and Inpe/MCT
7. Olympio Achilles de Faria Mello – Embraer and CTA
8. Julio Romano Meneghini – Embraer and USP

INVESTMENT

1. R\$ 367.896,00
2. R\$ 3.826.117,01
3. R\$ 587.702,23
4. R\$ 1.851.527,59
5. R\$ 3.205.550,76
6. R\$ 688.295,73
7. R\$ 4.201.476,05
8. R\$ 3.741.069,33



1. The *Cabin comfort* project simulates Embraer models in order to test temperature, pressure, noise, vibration, lighting, ergonomics, and odors.

2. The *Composite materials in aircraft structures* project studies the use of carbon fiber to reduce aircraft weight and improve performance.

and the UFSC. The project entitled *Advanced applications in computational fluid mechanics for high-performance aircraft* brought together an even larger number of institutions: the Technological Institute of Aeronautics (ITA), the Aeronautics and Space Institute/ Aerospace Technical Center (IAE/CTA), the São Carlos Engineering School (EESC-USP), Poli (USP), the UFSC, the UFU, and the State University of Campinas (Unicamp). It was expected that the investigations would result in the creation of a Computational Fluid Mechanics (CFD) unit that would perform numerical simulations of airflow, thus helping to define the aerodynamic profile of an aircraft. The Embraer director emphasized that “this project enabled us to put together a broad research network and share the mastery of that tool so essential to aviation.”

SHARED KNOWLEDGE

Well beyond its contribution to innovation at Embraer, the PITE leaves an important legacy to the partner institutions: the creation and advancement of knowledge, an impetus to the training of highly-skilled human resources, and a phy-

sical research infrastructure that is installed at the science and technology institutions (ICTs) to be used in training new personnel and also made available for use in investigation by other sectors of Brazilian industry. The noise metering technology and the attenuators developed in the aircraft noise suppression project, for example, could well become important for refrigerator manufacturers. Similarly, the passenger comfort evaluation cabin installed at USP’s Thermal and Environmental Engineering Laboratory holds important data for use by auto manufacturers in improving the performance of passenger vehicles.

The PITE virtuous circle focused on the development of aerospace science and technology will be complete when its results also serve to lengthen the chain of Brazilian suppliers to the world’s third largest manufacturer of commercial aircraft. At present, the great majority of the nearly 50,000 parts that make up an Embraer plane are imported. It is true that the aircraft company market is global. But it is impossible to ignore the fact that the supply chain in this country has not grown at the same pace as Embraer’s evolution; the company has 17,000 employees and

the domestic supplier firms employ only about 5,000. Boeing, the world's biggest aircraft manufacturer, has 170,000 employees, while the U.S. aerospace supplier chain employs more than 620,000 people.

The *Composite materials in aircraft structures* project is an example of a public policy calibrated to promote a more robust aviation production chain as well as to impact other sectors of Brazilian industry. The project involves, in addition to FAPESP, the São Paulo Institute for Technological Research (IPT), Poli (USP), the Electrotechnical and Energy Institute at USP (IEE/USP), the EESC-USP, Unicamp, the Guaratinguetá Engineering School (FEG) at São Paulo State University (Unesp), and the ITA. Plans for the project include installation of a Light Structures Laboratory (LEL) of the latest generation at the São José dos Campos Technological Park. The Brazilian Development Bank (BNDES) has put R\$27.6 million towards the installation of the laboratory and the Brazilian Innovation Agency (Finep) provided another R\$8.3 million. FAPESP and the IPT rounded out the investment, which totals R\$44.2 million.

Strictly speaking, the LEL will be organized around four structural projects, two of them oriented toward metallic materials and two toward carbon fiber composite materials. Properly adapted composites can be used to fill in spaces in the structure of a plane, advantageously replacing aluminum and steel. The challenge is to discover, test, and certify the best compositions. This new technology, vital to the aircraft industry, can also be applied in other sectors, such as aerospace, petroleum, automotive manufacturing, and wind energy, as Sergio Müller Fracino, of the Department of Aerospace Science and Technology at the ITA, who heads the project, told *Agência FAPESP* during the FAPESP-ABC Workshop on University-Company Collaborative Research held in November 2011.

FAPESP's relationship with Embraer became even closer at the end of last year, when the two partners joined with Boeing to collaborate in research and development of biofuels for aviation. That agreement resulted in a letter of intent, signed in October, calling for the development of a detailed study on the opportunities and challenges involved in creating, in Brazil, a sustainable and economically efficient industry to produce and distribute bio-derived aviation fuel.

This study is expected to help establish, here in Brazil, a center for research focused on the development of aviation biofuel in a partnership between the industry and FAPESP in order to vigorously pursue a long-term research agenda. The center would be created through a public selec-

tion procedure and in accordance with FAPESP's Research, Innovation and Dissemination Centers Program (RIDC), suggested Suely Vilela, member of the Foundation's Board of Trustees.

PATENTS

Concomitantly with the increase in its investments in pre-competitive research during the past six years, Embraer has set up a separate office to manage the intellectual property generated during the development of technology, products, services, and processes. Previously, the company preferred to resort to industrial secrecy rules to protect its intellectual creations, a method that met its needs for protection during the development of a "complex product that has a lengthy development cycle, i.e., a natural protection for solutions that are not very visible," Jorge Ramos explained. "As we intensified our focus on research, we identified other needs and opportunities for protection and exploitation of our intellectual property rights."

Since then, Embraer has filed 272 patent applications in Brazil and abroad. "These are product solution and manufacturing process patents," he explained. A committee meets every month to review the inventions. The program is getting larger every year, and is consolidating a culture of intellectual property protection among company employees.

NEW MARKETS

During the 12 years since adopting the PITE, while it was investing in its competitiveness, Embraer was growing and consolidating its position as a global company. It ended last year with sales of US\$5.6 billion, ranking third among the world's largest builders of commercial aircraft. It entered 2012 with US\$15 billion in its order portfolio. That figure includes the order from the U.S. Air Force for 20 Super Tucano planes, worth US\$355 million, but temporarily suspended after Hawker Beechcraft, another manufacturer, challenged the bidding procedure in an American court. The Super Tucano would be used in patrols in Afghanistan.

Embraer promises to go even further in the coming years. It is building two factories in Portugal, a market in which it has had a presence since 2004. There it will build metallic and composite materials components that will be used initially in logistical support for executive jets, and later will also serve the commercial aviation segment.

Another new development is the company's decision to modify its position in the Chinese market. Its first Chinese factory was built in 2002 to produce the ERJ 145, a 50-passenger plane. Because that country has changed, the company

Embraer and FAPESP joined with Boeing in 2011 in order to develop new fuels



Production of the military turboprop Tucano led the city of Gavião Peixoto to be called "Brazil's Area 51," in a reference to the U.S. base in the Nevada desert.

is now investing in the luxury market. It plans to adapt the Chinese factory to build the Legacy 650, an executive jet that uses the same platform as the 145, but carries only 12 passengers and can meet the demands from companies in a country of continental dimensions and its new billionaires.

Embraer is now getting ready to enter the satellite market. Along with Telebras, it announced, in a "notice of material fact" published on the Brazilian Securities and Exchange Commission (CVM) website, the signature of a memorandum of understanding leading to formation of a joint company to manage the Brazilian Geostationary Satellite (SGB) project. The new company is expected to meet federal government needs "relating to the satellite development plan, including the National Broadband Program and strategic defense and governmental communications," the communiqué said.

BACK TO GAVIÃO PEIXOTO

Embraer's presence is provoking huge changes in the city of Gavião Peixoto. In 2000, the year when the governor announced the installation of the enterprise, the city's revenues from the Goods and Services Tax (ICMS) totaled R\$1 million. In 2011, that figure jumped to R\$5 million. "In 2000, we had a Federation of Industries of the State of Rio de Janeiro (Firjan) Municipal Development Index of 0.66; today we are at 0.79, and our educational and health facilities are highly developed. The figures and indices show the progress we have made," said Mayor Ronivaldo Sampaio Fratuci.

Embraer is still the only company that has built a facility in the city's aviation park. "We still don't have an industrial district, but are working on establishing one soon. That will make it more likely that aviation supplier companies, or even other industrial companies, will come to this city," he said.

The low skill level of the city's population has prevented the Embraer factory from making changes in its employment structure. "A lot of the factory workers live in Araraquara or Matão. Many of them grew up in big cities and would rather live in that kind of environment. Some local people work at Embraer as janitors, food service workers, security guards and providers of other services," he reported. But most people in Gavião Peixoto still work in the sugarcane fields or orange groves.

The city is investing in vocational training in order to generate more job opportunities for its people. "Between 2009 and 2011, we awarded more than 3,000 National Industrial Training Service (Senai/ENAI) training certificates in a wide variety of fields, many of them compatible with the requirements of the aviation industry, such as electrician, hydraulic and pneumatic mechanic, auto painter, and others."

The mayor is certain that the city also has a potential to become a center of ecotourism. "We are investing in that idea. We have already started developing the project and held some events on the Jacaré Guaçu river. The project will eventually bear fruit, and Embraer, of course, will be part of that story." ■

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