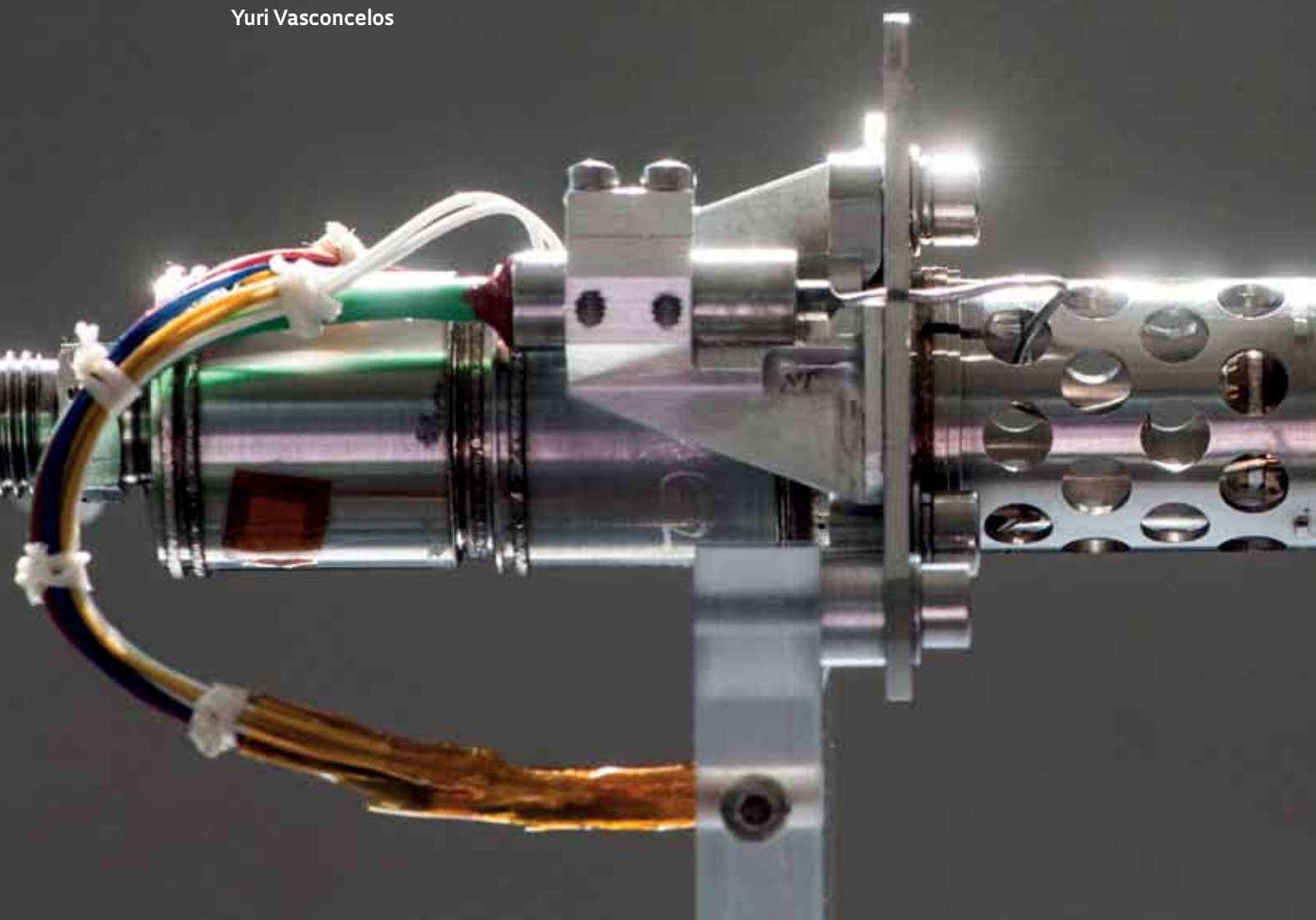
# Spatial impact

Fibraforte is developing satellite thrusters in partnership with INPE

**Yuri Vasconcelos**



In a few years' time, Brazil could become a global supplier of satellite thrusters. This equipment performs the role of engine for the satellite and is responsible for most of the maneuvers made in space. Thrusters are activated so that the satellite remains correctly aligned with the Earth, the Sun and other targets of astronomical interest, or in order to conduct orbit corrections during the useful life of the device. These corrective and maintenance maneuvers are necessary for countering orbital disturbances due to the gravitational effects of the Earth, Sun and Moon. The knowledge used to manufacture thrusters is limited to a dozen companies, all of them non-Brazilian. Fibraforte Engenharia, whose headquarters are in São José dos Campos, in inland São Paulo state, is ready to join that team.

"Designing, developing and manufacturing thrusters is an important step for increasing the nationalization rate of our satellites," says physicist José Leonardo Ferreira, a professor at the Physics Institute of the University of Brasília (UnB). "Fibraforte's initiative is helping Brazil gain a foothold in the space market. Even if we're unable to sell a complete satellite, we can provide its components," says Ferreira, who was also once a researcher at the National Institute for Space Research (INPE).

Fibraforte was founded in 1994 by three engineers, alumni of the Technological Institute of Aeronautics (ITA), in São José dos Campos, to work in developing mechanical systems for the Brazilian space program. Average sales revenue in recent years has been R$6 million. Today, the company dominates the manufacturing process for a type of thruster classified as monopropellant, which uses only one fluid to operate– in this case, liquid hydrazine, the most common chemical propellant used in rockets and satellites. It is referred to as a monopropellant because the chemical energy of the thruster is released through a decomposition reaction instead of a combustion reaction, a situation that requires one fuel and one oxidant. Propulsion systems, composed of a propellant tank, piping and valves cost around $2 million and are used in low orbit satellites, such as those used in remote sensing, Earth observation and data collection. They are medium-sized devices that can weigh as much as 1,000 kilograms (kg) and orbit Earth at an altitude of between 300 kilometers (km) and 800 km.

A few months ago, company researchers began working on a new type of thruster that is stronger and features more complex engineering, and which employs a combination of two liquid propellants, one fuel and one oxidant in a combustion reaction. These propellants are converted in a gaseous mixture at temperatures of nearly 3,000°Celsius. The mixture is expanded, accelerated in a nozzle and expelled at speeds of approximately 3 kilograms per second (km/s), generating thrust on the satellite. They are intended for geostationary satellites that can weigh up to 7,000 kg and be positioned 36,000 km from the Earth's surface.

Geostationary satellites are used primarily by the communications sector to transmit telephone, internet, television and radio signals. Unlike low orbit satellites, the launch vehicle does not inject the satellite into final orbit, but instead into a transfer area. The navigation to the operating band is done by its own propulsion system. In those cases, approximately 40% of the satellite's total mass is composed of propellants used in the transfer maneuver.

In May 2017, Fibraforte received funding from the FAPESP Innovative Research in Small Businesses Program (PIPE) and the Brazilian Innovation Agency (FINEP) Program to Support Research in Small Business (PAPPE) to develop four projects to produce a

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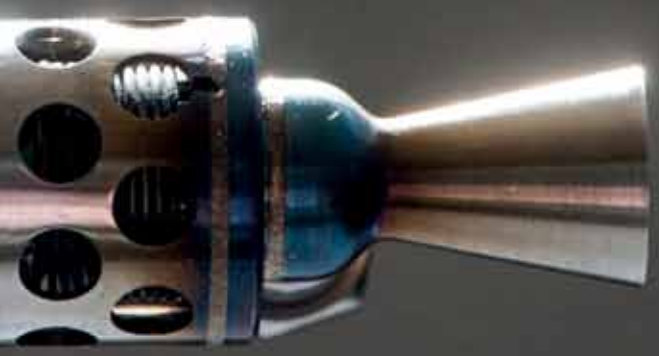


Testing of the thruster qualification model to be used on the Amazônia-1

## COMPANY

**FIBRAFORTE**

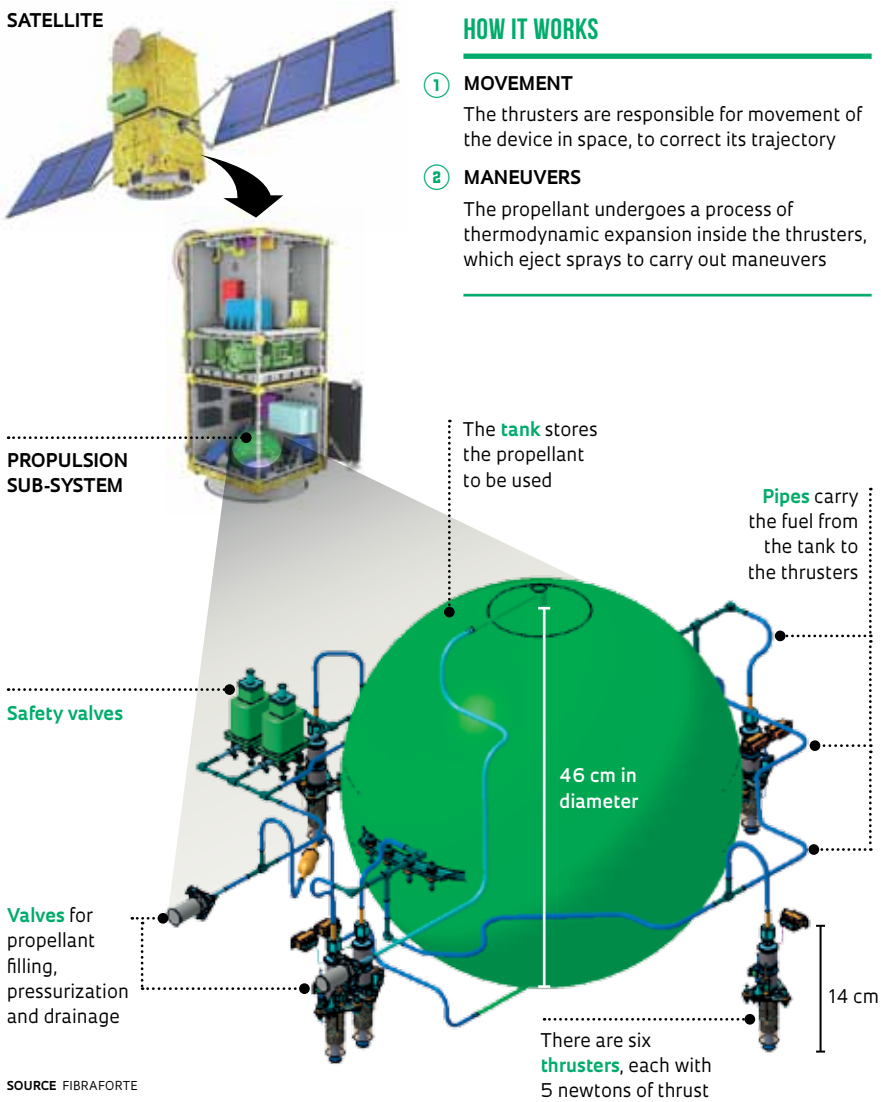
**Headquarters**
São José dos Campos (SP)

**Number of employees**
15

**Principal products**
Thrusters and mechanical systems used in satellites

# Satellite engine

Learn about the propulsion sub-system developed by Fibraforte for Amazônia-1




SOURCE FIBRAFORTE

## HOW IT WORKS

1. **MOVEMENT**
The thrusters are responsible for movement of the device in space, to correct its trajectory

2. **MANEUVERS**
The propellant undergoes a process of thermodynamic expansion inside the thrusters, which eject sprays to carry out maneuvers

## RESEARCH TEAM

Check out some of the professionals who conduct R&D at Fibraforte and see the institutions they graduated from

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|---|---|
| **José Nivaldo Hinckel, mathematician, manager of Research and Development (R&D)** | Blumenau Regional University Foundation (FURB): undergraduate<br>Technological Institute of Aeronautics (ITA): master's<br>Rensselaer Polytechnic Institute (United States): doctorate |
| **Leonardo Lara Tajiri, electrical engineer, development engineer** | Federal University of Itajubá (Unifei): undergraduate and master's |
| **Luciano Bontempo, mechanical engineer, development engineer** | State University of Maranhão (UEMA): undergraduate<br>ITA: master's |
| **Jadir Gonçalves, aeronautical engineer, commercial director** | ITA: undergraduate |
| **Thomas Shaw, aeronautical engineer, industrial director** | ITA: undergraduate |
| **Lauro Benassi, mechanical engineer, director of quality** | São José dos Campos School of Industrial Engineering (EEI): undergraduate |

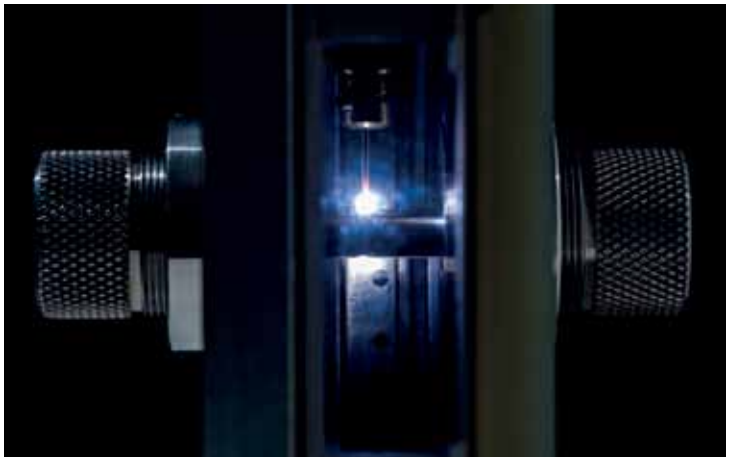
bipropellant thruster. The company's research and development (R&D) team is working to create the subsystem components (flow control valves, injection plate and thrust chamber) and fuel injector test benches.

"Different propulsion technologies may be used to control altitude [satellite positioning in relation to Earth] and to correct satellite orbits, as well as for electric, plasma or solid fuel propulsion. But monopropellants and bipropellants are the most traditional and have the greatest reliability. The difference between the two lies in the thrust, which is the force used to move a satellite," explains aeronautical engineer Jadir Nogueira Gonçalves, a founder and commercial director of Fibraforte. He says that the company began conducting research in the field of space propulsion in the late 1990s, when it accepted an invitation from INPE to develop a 2-newton (N)-thrust monopropellant thruster for the institute's suborbital platform—the thrust being equivalent to the force necessary to elevate an object weighing 200 grams from the ground.

In 2005, again in partnership with INPE and using FAPESP funding, Fibraforte completed work on a more powerful propulsion module, this time with 5N of thrust, designed to equip the Multi-Mission Platform (PMM), a generic platform created by INPE over the last decade as the basis for 500-kg-class-satellite manufacturing. The system will be used for the first time on the Amazônia-1 remote sensing satellite, whose launch is slated to occur in 2019. The propulsion module of that device, the first medium-sized domestic satellite designed and built entirely in Brazil, is composed of six thrusters (*see infographic*).

"We also created valves for filling, draining fuel and pressurized gas, and piping, in addition to assembling all the items of the sub-system," says mathematician and space propulsion specialist José Nivaldo Hinckel. Previously employed by the INPE, Hinckel is now R&D manager at Fibraforte and one of the propulsion research team leaders. "Among the main components of the module, the only thing we did not make was the fuel tank, but we are working on designing it now. Soon, we'll be able to manufacture it." Fibraforte received

**INFOGRAPHIC** ANA PAULA CAMPOS **IMAGES** INPE / FIBRAFORTE



Welding process for thruster nozzle

Fuel injector test

R$2.6 million in funding from FINEP to develop the propellant tank and the company has already built a model that has undergone initial structural and performance tests.

**TECHNOLOGY TRANSFER**

With experience acquired over the course of two decades in the field of propulsion, Fibraforte was selected in January 2015 to take part in the Space Technology Transfer Agreement included under the contract to manufacture the Geostationary Satellite for Defense and Strategic Communications (SGDC). Purchased by the Brazilian government from the French multinational Thales Alenia Space (TAS), the SGDC was launched into orbit in May 2017 (see *Pesquisa FAPESP* Issue No. 256). The technology transfer agreement signed between the Brazilian Space Agency (AEB) and Thales provided for the transfer of 20 satellite technologies from the European manufacturer to domestic industries. Fibraforte was selected to receive development-cycle training for a monopropellant propulsion system for small satellites, weighing between 100 kg and 300 kg.

"With just 1N thrusters, that propulsion model will be capable of handling more precise orbital adjustment maneuvers," says Gonçalves. "As a result of that program, we'll be in a position that qualifies us to provide Thales and other satellite integrator companies with complete thruster systems, individual thrusters and the propellant tank." The researcher goes on to say that in three years, the company will be able to manufacture monopropellant thrusters for space programs in the United States and Europe.

The global satellite industry reported sales of $260.5 billion in 2016, $13.9 billion of which were directed to the manufacture of the devices–remaining revenue was obtained through the operation and launch of the satellites and the production of ground-based support equipment. The U.S. and Europe dominates that market. In the past 25 years, Brazil has designed and built some 10 satellites. None of them used propulsion systems made in the country. "Since the Brazilian satellite market is restricted, becoming a global supplier is the natural route," Gonçalves believes.

Fibraforte has a research, development and innovation section (R&D&I) made up of 12 technicians and researchers, out of a total of 15 employees. "Innovation is spread throughout the departments. We're a company of a few highly specialized employees," notes aeronautical engineer Thomas Shaw, Fibraforte's industrial director. According to Shaw, the simpler stages of manufacturing and other low-intensity R&D activities are generally outsourced.

Although Fibraforte's focus is on propulsion sub-systems, the company is also dedicated to developing other satellite components. Together with Cenic Engineering, a space industry company headquartered in São José dos Campos, Fibraforte was responsible for the structure of CBERS-4, launched into space in 2014. The structure constitutes the body of the satellite, the "closet," which holds all its components and sub-systems (propulsion, thermal, communication and telemetry).

For Petrônio Noronha de Souza, director of Space Policy and Strategic Investments at the AEB, companies like Fibraforte are essential for enabling Brazil to have a production chain in the space industry with a minimum of autonomy. "Having a consolidated industrial base with the capacity to supply equipment and sub-systems for satellites, in addition to assembling these devices, is essential to the Brazilian space program," Souza points out. ■


Project

Development and qualification of 5N satellite monopropellant thruster (No. 03/07755-5); **Grant Mechanism** Innovative Research in Small Businesses Program (PIPE); **Principal Investigator** Humberto Pontes Cardoso (Fibraforte); **Investment** R$590,007.79.


PHOTOS LÉO RAMOS CHAVES