

Luiz Paulo Fortes Putting Brazil on the Map



STORY BY MELODY WARD LESLIE

When more than 100,000 PDA-packing census takers walk across Brazil in 2010, they'll be collecting the coordinates for key features of the landscape while they count 190 million heads.

The scale of this ambitious campaign to georeference everything — which builds on a successful pilot project completed last year — approaches monumental. For geomatics engineer Luiz Paulo Fortes of Rio de Janeiro, it's the next logical step in harnessing the power of GNSS to make the world a better place.

As the director of geosciences at the Brazilian Institute of Geography and Statistics (IBGE), Fortes oversees geodesy, steers ongoing efforts to completely map his country, and tracks fine details including human geography, natural resources, and the internal boundaries of all municipalities.

During the last 25 years he has pioneered the use of GNSS in his hemisphere. Now he is leading efforts to integrate all the geoscience data into “consistent layers of information” available through the Internet for everyone. These data can also be complemented with statistical information in order to create the National Spatial Data Infrastructure of Brazil.

Fortes says the project is doable because his institute is the equivalent of three major U.S. agencies — the geodesic survey, the geological survey, and the census bureau — rolled into one.

“The geography part of my institute supplies all the maps needed for statistical surveys like the census,” says Fortes, also an associate professor of geomatics engineering at the University of the State of Rio de Janeiro. “We are starting more and more to integrate the position information into the statistical data.”

The potential benefits of melding geoscience with statistical data and displaying it in all manner of maps snaps into focus when you remember that Brazil's vast agricultural and natural resources include more than half of the Amazon rainforest, often described as

the planet's lungs.

To appreciate the enormity of this undertaking and its relevance to the rest of us, consider the main statistics. In addition to sharing borders with nine of South America's other 11 countries, Brazil is the world's 5th-largest country in size and population and the 10th-largest economy. Its 26 states and 5,564 municipalities include uncountable numbers of archipelagos dotting 7,367 kilometers of beaches.



**HUMAN
ENGINEERING**

Discovering Geomatics

As a young student in the megacity of Rio de Janeiro (6,093,472 population in the last official count), Fortes' favorite subjects were all related to math and physics. He resolved to get into one of Brazil's top engineering programs, the Military Institute of Engineering (IME) in Rio.

"It's so hard to get into this university that you have to spend a full year studying specifically for the entrance exam," he said. The preparatory course met all day Monday through Saturday, with exams every Sunday morning.

Fortes had no idea that the field of geomatics existed until he entered university. "When I found the geomatics engineering department. I became absolutely fascinated by the subject," he said.

He graduated at the top of his class and went to work as a geomatics engineer at IBGE in 1982. Within a year he was appointed head of the satellite geodesy division, responsible for positioning activities carried out using Transit (NAVSAT), the first operational satellite navigation system and precursor to GPS.

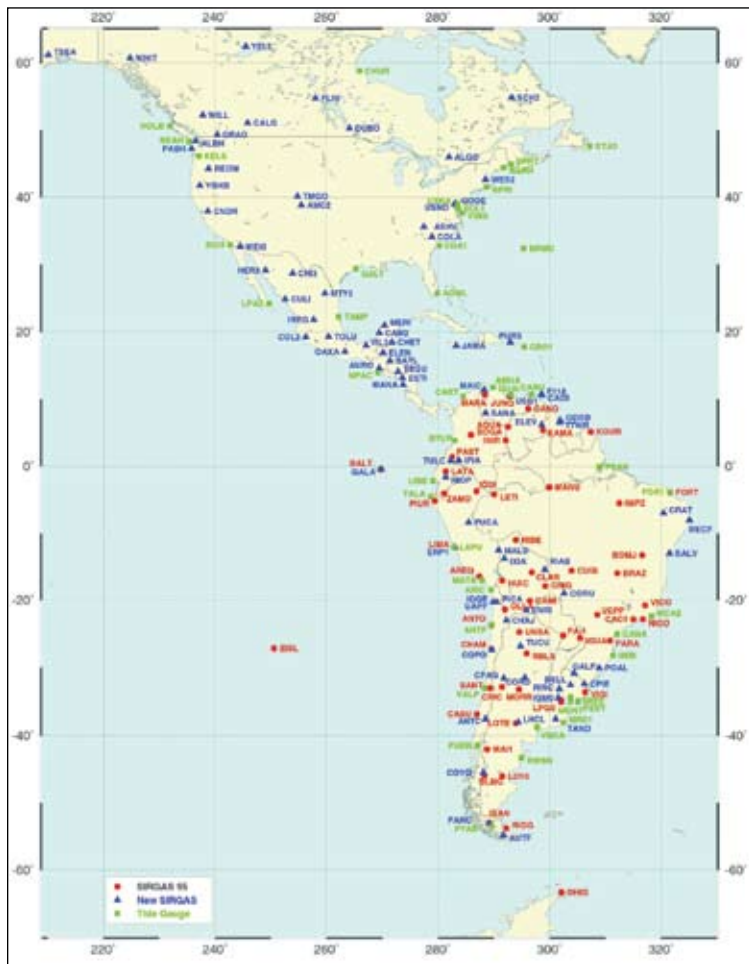
Fortes' team used Transit in projects where the use of classical positioning methods such as geodetic triangulation and traversing were not possible, especially in the Amazon region. "At that time, our field teams needed to occupy a new control station during at least seven days in order

to achieve an accuracy between one and five meters!" he said.

In 1988 they started testing "a very interesting and promising satellite positioning system named GPS." Fortes became so involved in the field that in 1998 he decided to brave Canadian winters in pursuit of a doctorate in geomatic engineering at the University of Calgary in Alberta. Within a few months of his return to Brazil in 2002, he was appointed associate director of geosciences for IBGE.



Luiz Paulo Fortes



SIRGAS2000 reference stations

Networking Latin America

In order to be more involved in research and teaching—his passions — Fortes also holds a Brazilian research scholarship for studying the implementation of a framework to support real time static and kinematic GPS positioning in Brazil.

Three projects stand out as his all-time favorites: **Brazil's Geodetic Control Network.** Fortes led Brazil to become the first South American country to establish an active geodetic control (or continuously operating reference system — CORS) network. The Brazilian Network for the Continuous Monitoring of GPS (RBMC) was set up in 1996. The first configuration of nine stations has grown to 40 and will double by the end of this year. Fortes anticipates conversion of the network from a "post-mission mode to a real-time mode," with WADGPS corrections computed and made available to users in Brazil and surrounding areas.

Geocentric Reference System for the Americas (SIRGAS). Fortes presided over this international project for 14 years, starting at its inception in 1993. Two continental geodetic campaigns were carried out, with 58 stations

COMPASS POINTS

Engineering Specialties

Geodetic surveying, high precision geodetic and GNSS positioning, mapping, geomatics engineering.

His Compass Points

- His high school sweetheart, Sandra, to whom he has been married for 26 years, and their daughters, Isabela, 23, and Luciana, 17.
- His parents, who set an example
- Teaching and research, his twin passions

Favorite Equation

The Least Squares Prediction (Collocation) Equation:

$$\hat{s} = C_{s1} C_{11}^{-1} l$$

where \hat{s} is the signals estimate vector, l is the observations vector, C_{11} is the covariance matrix of the observations and C_{s1} is the cross-covariance matrix between signals and observations

First Fell In Love With GNSS

In 1986, Vidal Ashkenazi and Wolfgang Torge presented on GPS at a Pan-American Institute of Geography and History (PAIGH) symposium in Mendoza, Argentina. "For the first time I saw that the classical geodetic positioning methods would be part of the past pretty soon."

Knew GNSS Had Arrived When . . .

"... we first tested GPS during an observation campaign early one morning in 1988, by the famous Christ Statue at the top of the Corcovado Hill in Rio de Janeiro."

Engineering Mentors

Hermann Drewes, International Association of Geodesy (IAG) representative to SIRGAS and now secretary general of IAG, and two professors at the University of Calgary: Elizabeth Cannon, my former supervisor, and Gérard Lachapelle."

Influences of Engineering Outside Work

"I have always been curious about the reason why things happen in a specific way. I like to observe natural phenomena and try to understand what is happening. I think this is the spirit of engineering. And there is the fascination of new technology—to be able to carry out a real time video conference, through the Internet, with someone located on the other side of the world is fantastic!"

Popular Notion About GNSS That Most Annoys

That a built-in GNSS chip is all that is necessary to remotely determine location. "Sometimes there is a lack of understanding that a communication link is needed to transmit the position given by GNSS to the remote user!"

Favorite Non-GNSS Activities

"Having fun with my wife and two daughters, surfing, and — of course — watching soccer!"

What's Next

GNSS signals — Galileo, Compass, and others — will be tracked by electronic devices whose main function is not positioning. Instead, the devices will use the position as input data for other applications.

Fortes's coordinates:

Latitude: 22° 49' 0.42399" S

Longitude: 43° 18' 22.5958" W

Orthometric height: 14.68 m

Brazilian Institute of Geography and Statistics (IBGE)

<http://www.ibge.gov.br/english/>

established in South America in 1995. This expanded to include all of the Americas in 2000, with 184 stations.

"The cooperation that was built has helped establish the geodetic infrastructure now used by almost all Latin American countries," he said. "I'm so proud of that project."

IBGE and ALOS Images. Fortes's institute is the exclusive distributor of images taken by Japan's ALOS satellite to non-commercial users in Brazil and a non-exclusive distributor to other users in South America. ALOS stands for Advanced Land Observing Satellite, but the Japanese refer to it as "Daichi." Without relying on points of reference on the ground, Daichi's remote-sensing equipment collects enough data — by itself — for mapping on a scale of 1 to 25,000.

"ALOS is at least three orders of magnitude less expensive than other commercial images," he says. "Realistically, I believe it is the only way we can cover the entire country's 8.5 million square kilometers."

A Sinking Continent and Climate Change

In 2005, data from a single Brazilian GPS station near the heart of the Amazon helped reveal that much of the South American continent temporarily sinks several inches under the extra weight of seasonal floodwaters.

Fortes was on the research team, and the discovery brought home another example of novel applications for GNSS. As the global grid becomes more complete, scientists will eventually be able to use it for estimating the earth's cache of fresh water, a key piece of the big puzzle known as global climate change.



Celebrating their silver anniversary, Luiz and Sandra Fortes with their daughters, Isabela and Luciana.



At the Brazilian IGS station in Brasilia in 1997


Up Next, Real Time

More than 4,000 GPS files collected by Brazil's RBMC network are downloaded each month from the institute's website, and Fortes anticipates users will quickly adopt new receivers for Galileo and GLONASS. Planning a smooth transition is part of his job.

"We are changing to a real time network," he says, "planning to broadcast GNSS corrections to users in Brazil in order to improve the real time solution from 10 meters down to a decimeter."

The Incredible Lightness of Teaching

With all this, Fortes tops off long days at the institute by teaching computer science courses to geomatics engineering undergraduates three nights a week. He enjoys teaching a lot. The students, he says, re-energize him.

"I confess that I sometimes leave my office very stressed, with my head full of problems," he says. "After class, I am absolutely light." 

Human Engineering is a regular feature that highlights some of the personalities behind the technologies, products, and programs of the GNSS community. We welcome readers' recommendations for future profiles. Contact Glen Gibbons, glen@insidegnss.com.

Inside GNSS