

Central America

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A mission to Mars

Astronaut Franklin Chang tests plasma engines in Costa Rica

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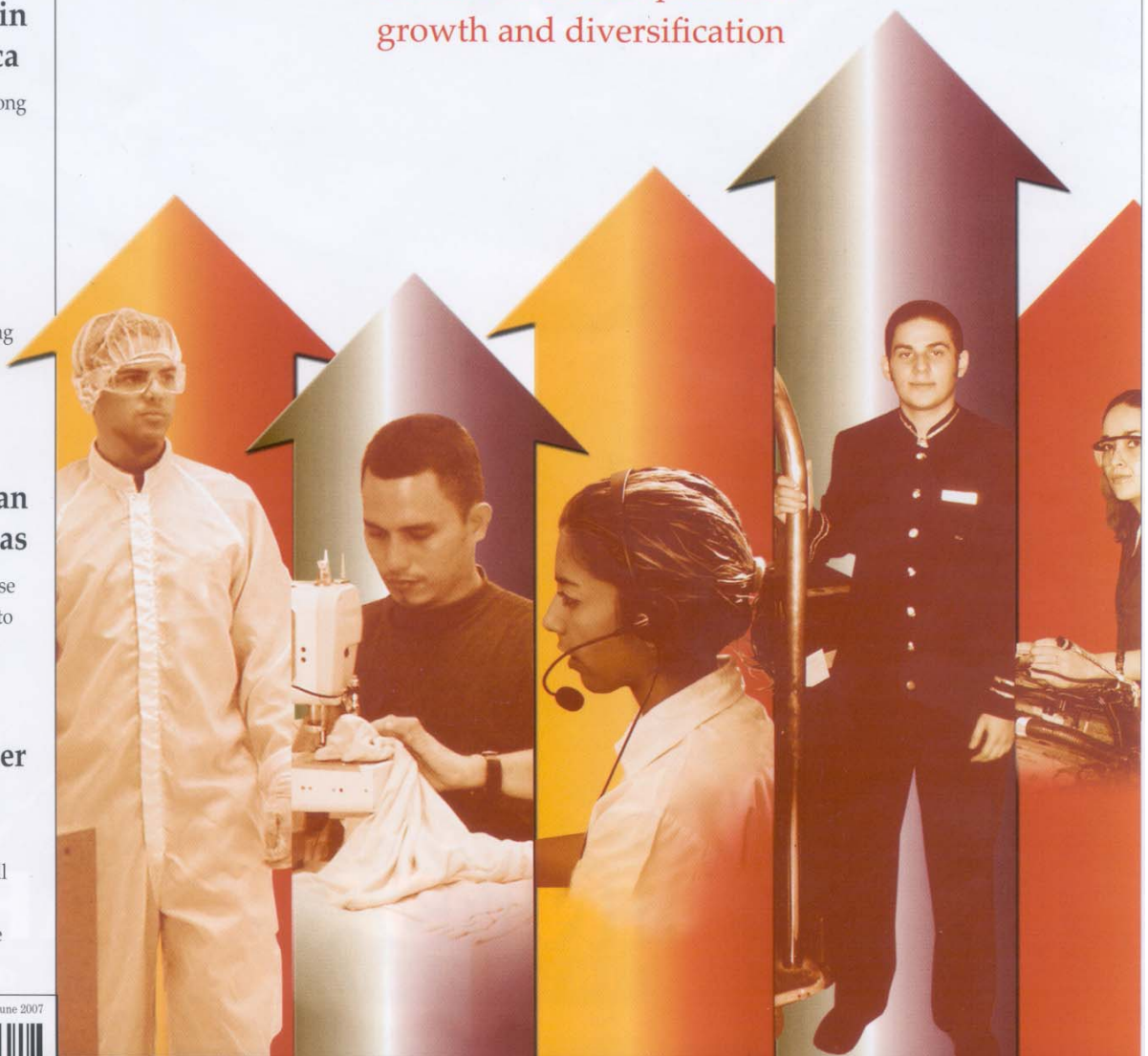
The world's two top cruise lines pour \$70 million into new ventures

Alternative power generation

A Nicaraguan sugar mill generates energy from eucalyptus and bagasse

Industries Soar

Central American industries bask in a welcome period of growth and diversification



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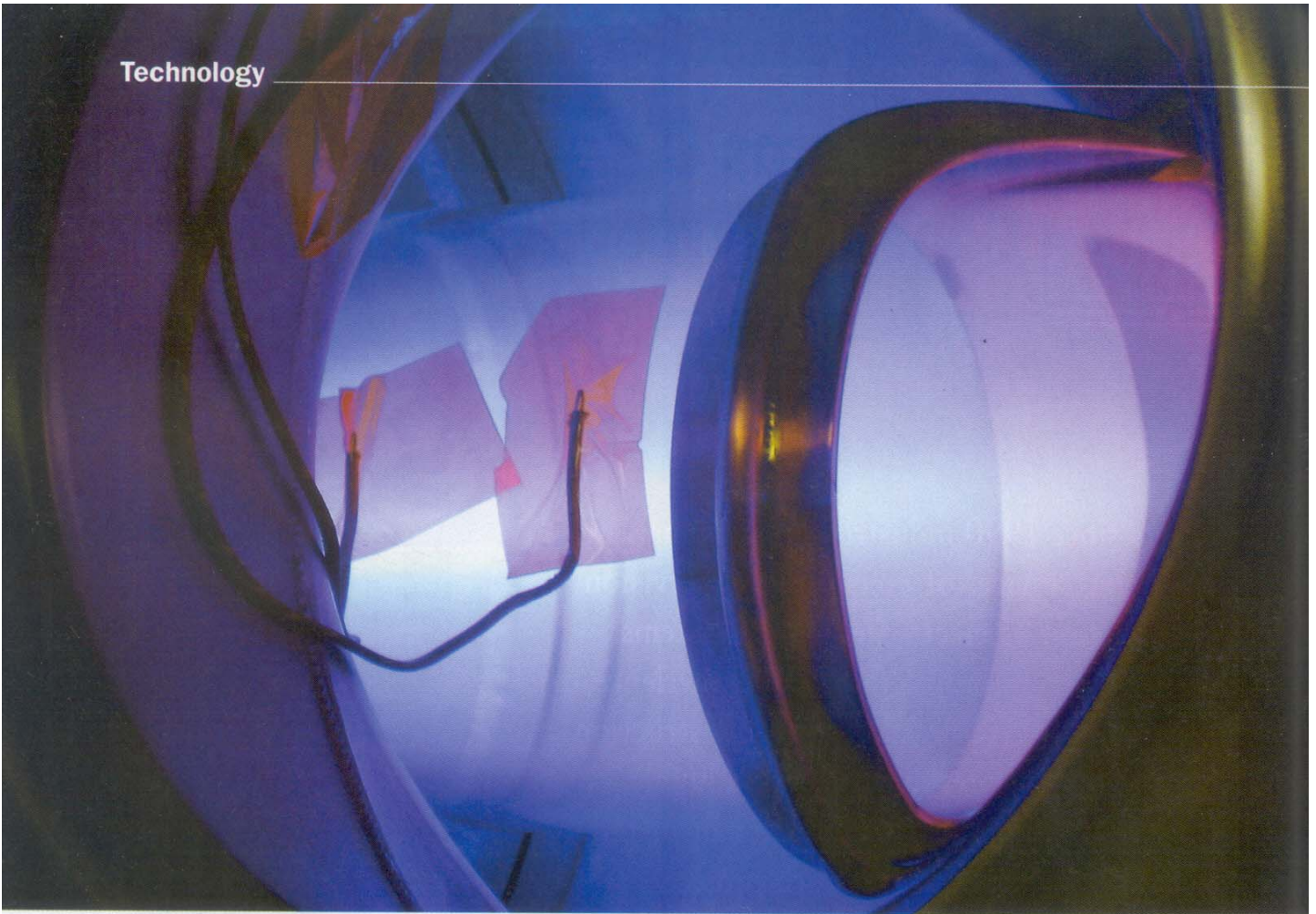


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Photographs courtesy of Ad Astra Rocket

Developing the VASIMR Engine

Costa Rica hosts lab to test plasma technology for first manned mission to Mars

By Franklin R. Chang Díaz

Half a century ago this year, the space age was born with the roar of a mighty rocket and the beeping of the first radio message from space. As children on that October day in 1957, many of us throughout the world were suddenly awestruck by the reality of space flight and the possibility of traveling to other worlds far beyond our own. The galvanizing effect was produced by a small object no larger than a basketball called Sputnik 1 that, in a manner of minutes, had become a new star in the heavens; a star made by humans. As Central American children we were no different from other youngsters gazing at the heavens elsewhere on our planet and, like countless others, we too cast our dreams into the starry night.

Today, we have gone far beyond Sputnik and the human exploration of space in the XXI century is ushering yet another space age, one in which citizens of the entire planet can think of working, touring, living or otherwise doing business in

space. We are witnessing the birth of human civilian and commercial space travel.

Yet we still lack the ships required to travel efficiently in space. Using current technology these ships are large and expensive and their fuel economy is so low that only a tiny fraction of the ship that leaves Earth manages to reach its final destination. Witness for example the gargantuan external fuel tank required to bring the space shuttle to an orbit only a few hundred miles high. A trip to the Moon implies much higher amounts of fuel and a trip to Mars even more. Many of these difficulties are due to the inherent limitations of today's conventional chemical rockets.

Plasma rockets on the other hand, open new and exciting possibilities for fast space transportation, expanding the range of rocket propulsion far beyond the limits of the chemical rocket, with fuel consumption orders of magnitude lower. One of these rockets, currently under development by Ad Astra

Rocket Company is called VASIMR™ short for Variable Specific Impulse Magneto plasma Rocket.

As its name implies the VASIMR™ works with plasma, a very hot gas at temperatures close to the interior of the sun. Plasmas are electrically charged fluids that can be heated to these extreme temperatures by radio waves and controlled and guided by strong magnetic fields. The magnetic field creates a sort of invisible duct or tube that can guide the plasma, insulating it from nearby structures. In this way, temperatures well beyond the melting point of materials can be achieved. In rocket propulsion, the higher the temperature of the exhaust gases, the higher their velocity and hence the higher their fuel efficiency. Plasma rockets feature exhaust velocities far above those achievable by their chemical cousins; so their fuel consumption is extremely low.

The development of the VASIMR™ began in the late 1970s and early 1980s at the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts. In 1981, while undergoing astronaut training at NASA, I established a small research collaboration at the MIT Plasma Fusion Center with (the late) Dr. T. F. Yang to jointly study the physics of the concept. By the summer of 1986 we had built a pilot experiment, which successfully characterized some of the basic principles of operation. In 1993 the project was relocated to a larger facility at my home base, the NASA Johnson Space Center in Houston, Texas where it operated for a decade as a NASA project. Three U.S. patents were granted for the concept and method and steady, albeit slow, technical progress was achieved mainly due to budget uncertainties at the space agency.

In 2004, facing further budget cuts, I approached NASA with the idea of forming a private company to continue the development of the technology with private funds. I surmised that such privatization would speed up development and enable the company to capture a rapidly emerging space commercial market and potentially support future NASA and international in-space transportation needs. Such "win-win" proposition quickly gained approval at the Space Agency. After months of negotiations, a Space Act Agreement was signed between a newly created Ad Astra Rocket Company and NASA, transitioning the technology to the private sector. Private investment quickly followed, bringing new life to the project. In late 2005, high power experiments in the VX-50 device, a physics demon-



Franklin R. Chang Díaz is Chairman and CEO of Ad Astra Rocket Company. He was scheduled to make his first spaceflight on the ill-fated Challenger in January 1986, but a few months prior to launch his crew was moved to the Columbia flight sixteen days earlier. Since then, he has flown seven space missions (the current world record.) Highlights include the deployment of the Galileo probe to Jupiter, the first tests of electro-dynamic space tethers, the first and last flights of the US/Russia shuttle/MIR program and on-orbit construction of the International Space Station. He holds a Ph.D in Applied Plasma Physics from the Massachusetts Institute of Technology.



strator in Houston, achieved the predicted performance and paved the way for construction of a more powerful VASIMR™ test article, the VX-100. This system is now operational in the company's Houston laboratory.

In July of 2005 a subsidiary of Ad Astra Rocket Company was established in Guanacaste, Costa Rica. Its mission is to conduct life-cycle testing of key rocket elements, offloading the Houston operation to concentrate on design and integration of the first flight-like prototype, the VX-200, due to be tested in late 2007. From its inauguration in July of 2006 the Guanacaste laboratory made very rapid progress, generating its first stable plasma on December 13 of 2006 with its VX-1.5 CR experimental test bed.

Through these activities, Ad Astra has achieved all of its 2006 milestones, ending the year on budget and on schedule. The firm has added major improvements to the original NASA patents, which have resulted in new company-owned intellectual property. The major objective for 2007 is the completion of the VX-200

flight-like prototype, considered by company officials to be the last step before construction of the VF (for VASIMR™ flight) series of two flight engines, planned to be initiated in early 2008. Space testing of these engines is planned for 2011.

With the space deployment of the VASIMR™ Ad Astra intends to play an important role in the rapidly developing space commercial market. Major planned activities include satellite refueling and repositioning, drag compensation of orbiting space stations and cargo missions to the Moon. The company is also pursuing Earth bound applications of plasma technology in the microelectronics industry and waste remediation.

Looking to the future, high power plasma engines could enable ultra-fast missions to Mars and beyond, opening the solar system to human exploration. Powerful plasma engines could also be used to nudge an incoming asteroid away from a collision path with Earth or, better yet, preposition it for mining operations, a tantalizing possibility no longer in the realm of science fiction. Also in the future, the possibility of harnessing the power of thermonuclear fusion within the plasma itself would increase the power of these rockets several-fold, leading to truly awesome capabilities. Our future generations will use these systems for rapid access to the solar system and ultimately the stars. We now find ourselves preparing the groundwork for their eventual success.

Costa Rican-American astronaut Franklin Chang Díaz, shares his views with Central America Today

Central America Today (CA Today): Why did you choose Central America, specifically Costa Rica to establish your company?

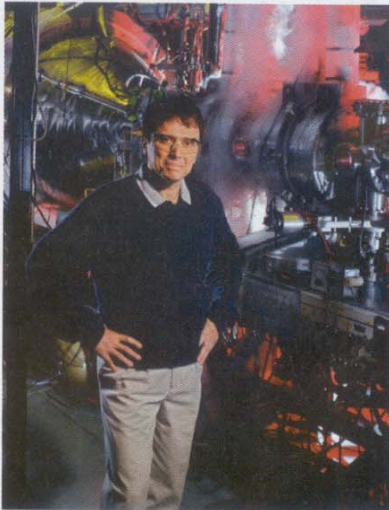
Franklin Chang Diaz (FCD): In my opinion, there are no more technology and knowledge monopolies. Forty years ago, if you wanted to dedicate yourself to science, you had to go to the United States or Europe, or to a library. Today all you need is a computer, access to Internet and you can get almost all the information you need while sitting at home. This has changed the rules of the game. You start to think why establish your company in a city with cold weather and no beaches. Nowadays, the important factors are the environment and your quality of life; therefore I thought that if I could have a research center in the most beautiful place on earth, I would build it somewhere with volcanoes, beaches and a wide biodiversity.

CA Today: What was NASA's reaction when you suggested back in 2004 moving the project to Costa Rica?

FCD: I was surprised by its positive reaction. The people at NASA had never thought about turning this project into a private company, but they liked the idea. Right now Ad Astra Rocket Company is an American company, but the majority of investors are from Costa Rica, as a matter of fact 83 percent of the stock holders are Costa Ricans. This is an American company owned mainly by Costa Ricans.

CA Today: Have you found in Costa Rica all the resources that are needed for this project?

FCD: We started developing the rocket in the United States with NASA. However, after the Columbia tragedy, NASA began to move very slowly, everything became very bureaucratic, and we were not moving forward as fast as we expected with this project. Additionally, with the war in Iraq, NASA has suffered funding cuts from the United States Federal Government. An important ingredient for this business is grey matter and we can find it here, it has been brewing with time. We have all the resources we



need in Costa Rica, and even at a lower cost than in the United States. We currently have 15 carefully selected young engineers and physicists working with us in Liberia (Costa Rica).

CA Today: Would it be then fair to say that by establishing your company in Liberia you are pursuing a social objective beyond your business and scientific goals?

FCD: Yes. My brother Ronald wants this company to have a social conscience. Moreover we want to do this here in Liberia, not in [the capital city] San José, where you can already find everything. We like to receive students here at the laboratory; everybody can see what we are doing. We even had to convince the Municipality of Liberia that we are not manufacturing weapons or developing secret defense projects here. We like to have students visit us; we want to plant a seed in them, and make them believe that all these things are possible to accomplish here in Costa Rica. We have with us an 18 year old youth named Carlos. His parents are very poor immigrants from Nicaragua, they are peasants. Carlos is very good in math, but he couldn't enter college because of his nationality so he started to work at a gas station. We found him in a talent hunt we carried out in Liberia, and subsequently invited him, as well as other young men to visit our company and ask for job opportunities. Carlos was the only one who showed up. He is now

working with us, doing a little bit of everything, and we got him to go to college.

CA Today: Do you think this project will eventually attract other similar ones to Liberia?

FCD: That's one of our goals. That's why it was decided to do this in Liberia, one of the poorest regions in Costa Rica and a place of contrasts, were you see huge inflows of money from the tourism industry. However, these inflows are not benefiting the local population as they should be. Poverty still persists. We established Ad Astra Rocket Company here in order to transform this region in the future into a place like Silicon Valley, which used to be an agricultural region, with huge contrasts between rich and poor people, just like the ones currently in Liberia.

CA Today: What part of the project is being developed in Costa Rica?

FCD: The rocket will be manufactured in the United States, but we will test the life cycle of the rocket's components here in Costa Rica. The components, which have been developed over a long period of time, will be tested at very high temperatures during several weeks and months, until they fail. Then we will determine how to correct those failures and build the first prototype. We don't have the time to do all this in the US.

CA Today: What is your opinion about the future of technology in Central America?

FCD: We have a brilliant future. All we need to do is change some paradigms, for example, providing our engineers and scientists with other skills, such as project management. In Central America we already have engineers with a strong knowledge of quantum physics, electric and plasma engineering but lacking management skills. We also need more technology schools; we have to look beyond agriculture, which is necessary, but is not the key to our future. That is why we have been talking to several Costa Rican universities, to convince them to open campuses here in Liberia and have students come to our company and study physics here with us.