MARKETPLACE SHLOMO MAITAL

Satellites that tango

A growing number of Israeli start-ups are excited by the potential of the growing civilian space industry, now estimated at nearly $300 billion

IN LIFE, it takes two to tango. But in space, it takes three – three nano-satellites, that is.

They are part of a visionary project known as Samson, an acronym for Space Autonomous Mission for Swarming and Geolocating Nano-satellites. The project may help jump-start Israel's share of the large and growing civilian space industry, now estimated at nearly $300 billion, annually. Experts claim that, with sufficient initial investment, Israel's creativity and spin-offs from military satellites could generate a 3 to 5 percent share of that market, or $9 to $15 billion.

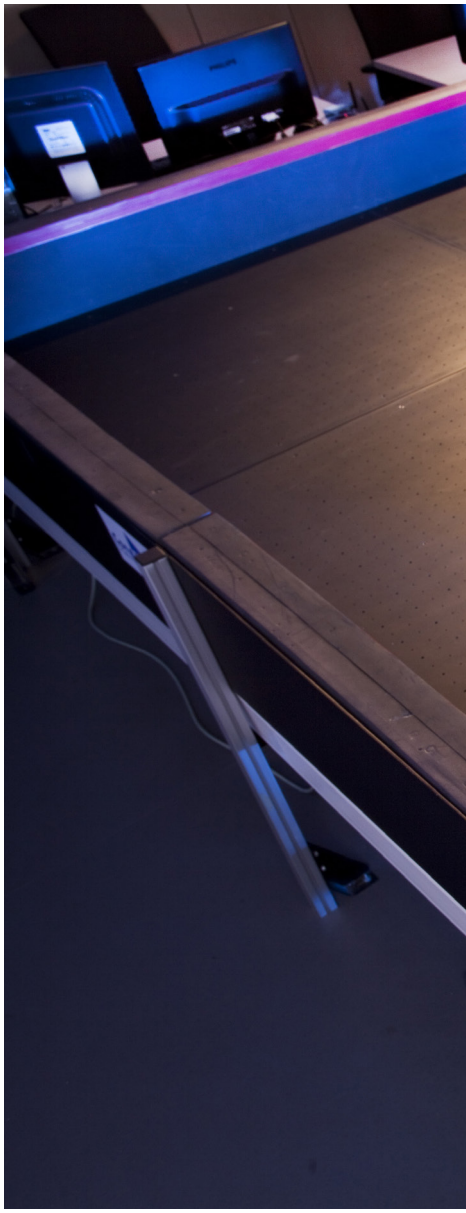
Prof. Yitzhak Ben-Israel, current chairman of the Israel Space Agency, told Reuters, "The idea is that we have a well-developed space infrastructure for our defense needs and, without a big financial commitment, we can use it to grab a few percentage points of the commercial market, as well."

Led by Prof. Pini Gurfil, an aerospace engineer at the Technion – Israel Institute of Technology in Haifa, the Samson project will place three tiny satellites in orbit in July 2016. An Ariane rocket will send the satellites into a low orbit of 600 kilometers (360 miles) above the surface from a launch pad in Guiana. Clever software will keep the three satellites in precisely the same place relative to one another. The closest will be 100 kilometers (60 miles) apart; the farthest, 250 kilometers (150 miles) apart.

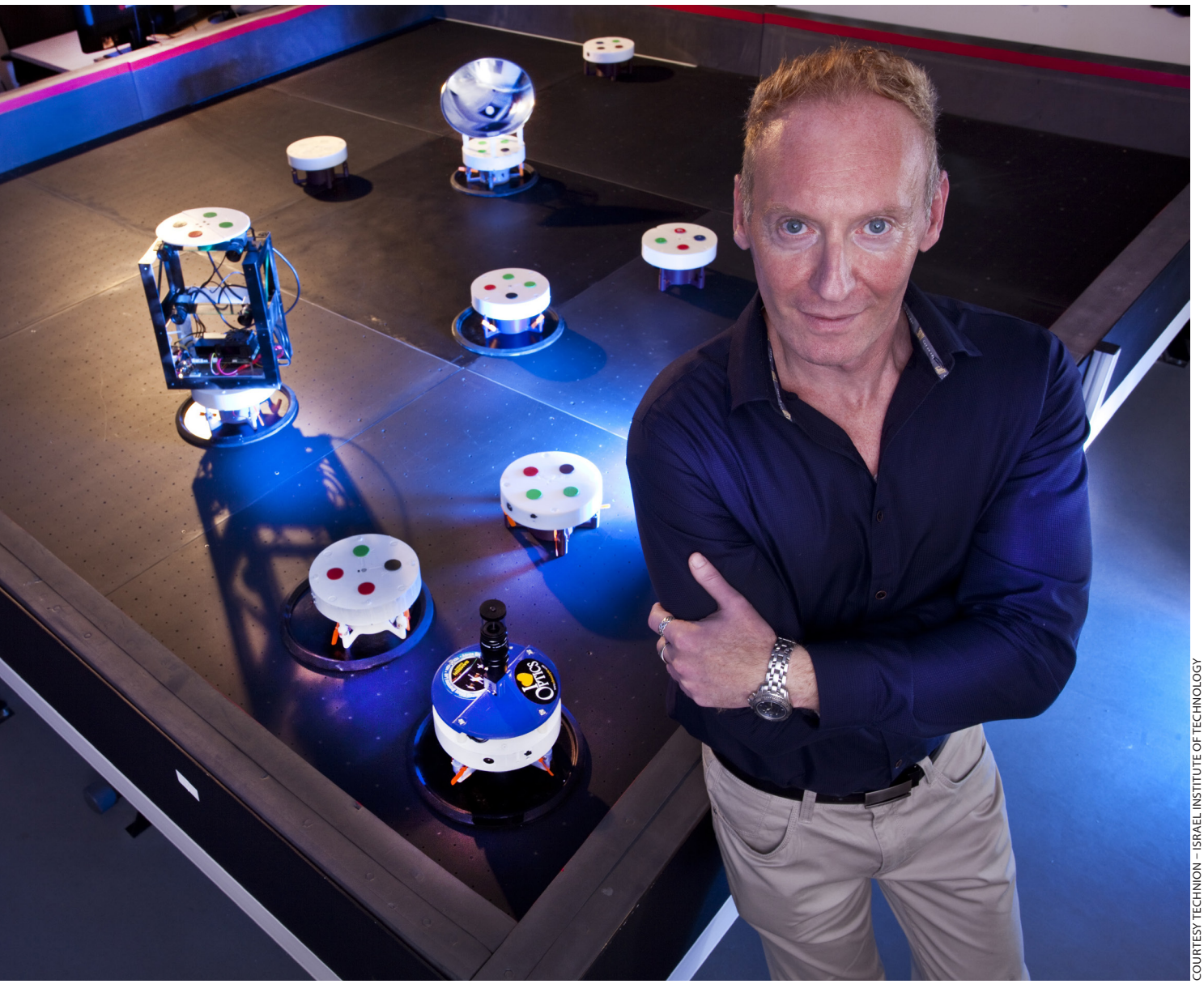
One satellite will be "leader." The two others will be "followers," moving precisely in step – similar to how the tango is executed. Unlike the tango, in which the male dancer leads, however, each satellite can become the leader, if necessary. The precise positioning will enable the satellites to determine where a 400-megahertz radio signal from the ground originates by triangulation – far more accurately than with two satellites. This could be used, for instance, for rescuing those in distress, such as the Israeli trekkers trapped by the recent earthquake in Nepal, or for very high-resolution photography.

I SPOKE with Gurfil and Prof. Chaim Eshed, who helped found the Israel Space Agency in 1981, about the future economic potential of Israeli civilian satellites. Gurfil got his PhD at Technion's Aerospace Engineering Department in 2000, then did post-doctoral studies at Princeton University. When I visited his lab, he showed me a large air table on which mock versions of the satellites, like hockey pucks, swoop and glide on cushions of air, practicing their tango steps, rehearsing for the big prom in space next year.

"A nano-satellite weighs less than 10 kilograms [22 pounds]," he tells *The Jerusalem Report*. It is based on the CubeSat standard, which requires each satellite cube component to have a volume of one liter (about a quart) and a weight of one kilo (2.2 pounds) or less. Each Samson nano-satellite has six such cubes.



Technion Prof. Pini Gurfil in front of the 4x4 meter air-bearing table, with simulated nano-satellites for testing the software used to keep them in position relative to each other



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I expressed amazement at the mighty-mite satellites – Israel's AMOS communications satellites weigh as much as 4.5 tons. The Hubble telescope, placed in orbit, weighed 11 tons. With Samson, Israel's vaunted skill at making powerful things very small will fit everything into cubes you could carry in a backpack. The tiny satellites carry fuel for tiny jets that help them stay in position. Despite the severe weight constraint, Gurfil said there was enough fuel on board to last for many years.

"The Samson project is a cooperative one," Gurfil explains, "assembled here at Technion, with Rafael Advanced Defense Systems making the propulsion systems; Israel Aerospace Industries (IAI) builds the computer components; and Elta, an IAI subsidiary, the payload. The goal of Samson is to prove that we can fly three nano-satellites in a cluster, keeping them in the same place over time relative to one another without ground intervention. Ground control cannot always communicate with satellites so they need to sense each other's position, know how to maneuver and keep from drifting apart. Why three of them? Because three can do missions that only one satellite cannot.

"WE ARE not the first to fly satellites in formation," he points out. "Three years ago, the Swedish Space Agency did this. But it has never been done with nano-satellites, and it has not been used for geolocation."

Samson began as a student project to challenge undergraduates. Fourth-year students were deeply involved in simulations, design and software. Students

from Computer Science and other faculties participated.

The Technion has a long tradition of student satellites. In the early 1990s Technion Physics Prof. Giora Shaviv, together with Eshed, who was then head of Israel's fledgling Space Agency, joined forces to initiate a program that placed a student-built 106-pound satellite in orbit on July 10, 1998. It sent signals to earth for 12 years.

THE SAMSON PROJECT WILL PLACE THREE TINY SATELLITES IN ORBIT IN JULY 2016

Eshed explains that Israel's first nano-satellite was actually developed by high school students at the Herzliya Science Center. Eshed helped initiate five such centers in Israel, including one in a Beduin town, to spur young people's interest in science.

HE STRONGLY believes in the Apollo effect. On September 12, 1962, President John Kennedy announced, in a speech at Rice University, "We will put a man on the moon by the end of this decade." The resulting Apollo project sparked the imagination of a whole generation of young Americans and led many to study science and engineering as a result. This may well be the main benefit of the very expensive Apollo program – estimated to cost $110 billion in today's dollars.

Eshed and Gurfil believe that "we will build a satellite and put it in orbit" can do the same for Israelis at a time when fewer and fewer high school students are taking high-level math and physics.

With just over eight million people, Israel is one of only nine countries (and by far the smallest of them) able to build and launch satellites. Israel's foe Iran is one of them. Unlike the other eight, Israel launches its satellites from the Palmahim launch site, from east to west, against the spin of the earth, to avoid flying over Arab countries. This requires 30 percent more rocket thrust.

The origins of this satellite capability, Eshed tells The Report, go back 34 years to prime minister Menachem Begin and the Herzl principle ("If you will it, it is no dream"). In 1981, Begin and then-defense minister Moshe Arens (an aeronautical engineer by profession) decided that Israel could and should build satellites. The IDF was opposed, but Begin gave the green light to establish the Israel Space Agency and provided an initial budget. Eshed was its first head and served in this post for three decades. He holds three coveted Israel Defense Prize awards, the first received in 1967.

Like many creative projects, Israel's military satellites grew out of an urgent need. Eshed explains that in the wake of the historic visit to Israel by Egyptian President Anwar Sadat in 1977 and the ensuing peace agreement under which Israel withdrew from Sinai, the question arose, "How will Israel monitor Egypt's compliance with demilitarizing Sinai?" Satellite reconnaissance was the only way.

"What is your biggest problem?" I ask Gurfil. "It is not money," he responds, noting that the Samson project was financed in part by a donor, the Adelis Foundation. "It is the fact that this project has never been done before. We have no prior experience. There were issues with integration. We had to learn how to assemble the satellites and to recruit industry to help us. All the technology has to be stuffed into something the size of a shoe box.

"Most of the important space companies started in universities," Gurfil adds. "But, we're professors, not recruiters or managers."

Most Israeli start-ups now focus on software and smartphone applications, but a growing number are excited by the potential of space, perhaps inspired by Virgin Group entrepreneur Richard Branson's vision to send tourists into space, Elon Musk's SpaceX rockets and Google co-founder Larry Page's scheme to mine asteroids.

For example, SpacePharma, founded by Yossi Yamin and Ido Priel, serves the booming market for zero-gravity experiments in space. Its product, called mGnify, provides a tiny lab that fits in nano-satellites, controllable from the ground, and enables researchers to do low-cost biological and chemical experiments in the absence of gravity.

SPACEIL, FOUNDED by engineers Yariv Bash, Kfir Damari and Yonatan Weintraub, will compete for the $30 million Google Lunar XPrize by building a 140-kilogram (300 pound) nano-spaceship that can land on the moon. If it succeeds, it will be the smallest craft to make a moon landing. (The Apollo lunar module weighed two tons.) American-Jewish tycoon Sheldon Adelson gave $26 million to help fund the project.

ISRAEL IS ONE OF ONLY NINE COUNTRIES (AND BY FAR THE SMALLEST OF THEM) ABLE TO BUILD AND LAUNCH SATELLITES

I wrote in The Report (November 9, 2010) about Israel's Ofek 9 spy satellite, which is able to see through clouds and darkness to track what Israel's enemies are scheming. I even composed a little poem for it: "*Twinkle, twinkle little satellite, how I wonder at your radar sight…*"

It's time to update that poem.

"T*winkle, twinkle, little Samson / You may be tiny but you are handsome / Dance the tango cheek to cheek, find lost trekkers loved ones seek / Twinkle, twinkle one as three, no one is prouder of you than we*." ■

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