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**COMPUTERS WITH HUNCHES**  
**CLOTHES THAT THINK**  
**CHAOS ON TAP**

**WILL THIS MAN  
BE THE FIRST TO  
SAIL INTO SPACE?**



# OPINION INTERVIEW

No fuel. No engines. Just plug into the Sun and go. That was the dream of solar sailing, so beloved of both scientists and science fiction writers. Trouble is, no one could make it work. Not any more. The technologies have come of age. And so has the commercial vision. Enter Paris-based businessman **Nersi Razavi**. He's busy turning his boyhood passion into a concrete vision NASA could envy. The agency is planning a test launch of a solar sail by 2005. But it'll probably be beaten by a consortium of European space agencies Razavi has helped organise. **Stuart Clark** asked him why the sail has such an unusual name?

## Plain sailing

**You've called it the Star of Tolerance? What does the name mean to you?**

The United Nations has a millennium resolution signed by 150 world leaders that states tolerance is one of the six fundamental values essential for peaceful international relations. I could have called this project some techno name but, instead, the mission's message has been optimised by calling it the Star of Tolerance.

**Aren't there cheaper and more fruitful ways of promoting harmony between nations?**

The creation of this solar sail is something that should be done anyway. Calling it "Tolerance" costs next to nothing. Even so, \$50 million is a very small amount to reach six billion people.

**What's the launch schedule of the test solar sail and how long will it stay in orbit?**

We are planning to launch a test sail of 400 square metres, by the end of next year. This is being co-financed by the European Space Agency (ESA) and the German Space Agency (DLR). The flight will last one month or less and we will test the deployment system and see how bright it is from Earth. We will use this result to define the dimensions of the final sail, between 1600 and 3600 square metres. This will be launched 12 to 14 months later. We think the brightness of the second sail will be something like Venus, which is the brightest celestial object in the sky apart from the Sun and the Moon. After one to two years in Earth orbit, it will sail off into space.

**What kind of space missions will it do?**

There are many missions that only solar sails can do. They can be useful for tours of asteroids, bringing samples back from Mars, going to Pluto quickly and to Mercury. There are also huge technological spin-offs. In the future, huge deployable structures

similar to solar sails will directly collect solar energy from space and down-link it to Earth.

**How will you capture photons fast enough to propel the sail at speed and over long distances?**

The size of the sail is the key. The bigger it is, the more photons are caught and the faster you go. NASA once estimated that a crewed mission to Mars would need a solar sail of 5 square kilometres. Although the push at the beginning is slow, it is constant and so the sail gets accelerated to reach speeds of 380,000 kilometres per hour. To go faster, the Americans are also now thinking about methods to push solar sails to other stars using lasers or microwaves.

**You've made your reputation building airships. What inspired your interest in flight?**

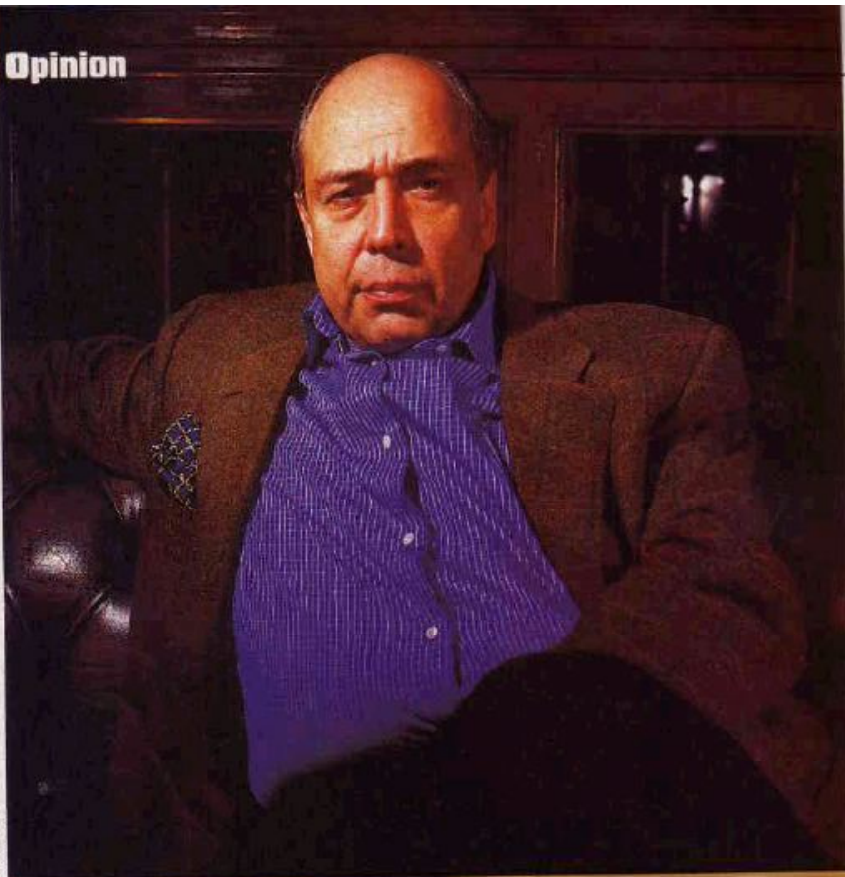
As a kid in Tehran, I spent hours watching the night skies and became fascinated by the vertical dimension. At 14 or 15, I designed and built remote-controlled model aeroplanes and joined a civil aviation club. I came to the European Business School in Paris, became interested in airships and wanted to write my thesis about them. My dean was surprised and said that I should not promote something that belongs in a museum. But I had a feeling that there were still some interesting uses for airships if I incorporated modern technology and materials. I discovered others who shared the same view and we started the company that became the Airship Industries Group. In just a few years the company went from four people to 450 people on five continents and was quoted on three stock markets.

**So how did you get from airships to solar sails?**

I was at London's City University in the late seventies, interested in airships and their future developments. In trying to learn about inflatable technology, I came across the solar sail concept. I imagined that this

Ken Jackson





## What's in a sail

It's a solar sail, but The Star of Tolerance has more in common with a parachute than a ship. If all goes to plan, the sail will collapse into a box less than a cubic metre in volume. Then it will be launched on the back of a rocket and ejected into orbit. Ground-based remote control will pull the "rip-cord", unfurling the sail, and photons from the solar wind will send it on its way.

The concept sounds simple enough. But technical hurdles scuppered early attempts at solar sailing. After a flurry of interest NASA backed away from the idea in the 1970s. Solar sailing regattas organised by a group of ex-NASA engineers also failed to take off in the 1980s.

So what are the problems? During ground-based tests in the past, the sails and their unfurling mechanisms have jammed, broken or just refused to operate. To work properly, a solar sail needs an unfurling mechanism that's compact, and both electrically and mechanically sound. It also needs light but flexible materials for its booms. That's where the people backing Star of Tolerance think their sail will succeed. They're banking on a material known as high-strength carbon fibre reinforced plastics or CFRPs.

The sail will have four hollow, telescopic, cylindrical CFRP booms for its sail masts. What's neat is that they can be squashed flat without buckling, and stored in a box. Once the box is in orbit, the booms will be assembled by remote control, one from each corner of the box, to form a cross. Then four triangular sail panels will be pulled outwards on wires and suspended between the booms, creating a square sail.

The material for the sail itself isn't new. It's Kapton, a cousin of the widely known Mylar. NASA spotted its potential for solar sailing in earlier studies in the 1970s. Both Kapton and Mylar are made by US chemicals company DuPont.

NASA, too, is about to kick-start its solar-sailing efforts. The agency is aiming for a test flight before 2005. Its ambition is to fly solar sails to other stars. At the Jet Propulsion Laboratory in California, they've developed a low-density sail material made of carbon fibres that is almost as light as air.

concept could be the future of inflatable technology in space. Back in Paris, I found other solar sail fans and promoting the concept became my hobby. In 1992, after 14 years, the Airship Industries Group had gone from zero to the very top and there was nowhere left to go. I decided to dedicate my energy to the solar sail.

## In the 1970s, NASA decided they were too difficult to make. Solar sailing regattas in the 1980s also failed. What has changed?

New technology, such as composite materials to make supporting booms, microelectronics to make lightweight instruments, sensors and really thin sail material (see "What's in a sail").

## Astronomers were initially opposed to the plans because of fears that an object as bright as Venus would pollute the night sky with light. How did you win them over?

They now understand that this thing is not going to disturb their observations because it will be under the control of the European Space Agency. They can control its visibility remotely by turning the sail and coordinating it with astronomical observations. In addition I believe that the astronomical community, for obvious reasons, is now extremely interested in seeing solar sails developed. Star of Tolerance will be their ally and not the enemy.

## How much has the project cost?

Between \$5 million and \$6 million so far, including UNESCO, ESA and DLR investment. I started the project in 1992 with my own money. Some good friends also put money in. Then I got some small financial support from UNESCO. Next, in 1996, ESA gave us technical and financial support. Finally, the DLR joined the effort. For this year's flight, the space agencies will allocate another \$5 million. When the second spacecraft is finally in space and everyone on Earth can see it, it will have cost less than \$50 million in total. I have continued to put in personal investment and I have private sector investment too.

## How are you going to recoup your investment?

My aim here is not just to make money. This project is oriented towards education. We can generate revenue from sponsors and from licensing the concept to Internet companies, multimedia, motion picture, documentary and telecommunications industries. We have also planned children's toys containing microchip receivers. We will broadcast messages from the solar sail which will be relayed to the toys in local languages.

**What will you be broadcasting?**

The messages will be sponsored by the education industry and will be specifically oriented towards the culture of peace. In our world, violence has become a profitable commercial concept. I intend to show that marketing non-violence can be as profitable as the violence industry can be. This will be a demonstration of the "peace industry".

**What about using the sail as an advertising billboard?**

I have turned down a very big cheque from a commercial advertiser. Although it was very tempting, accepting it would be the kiss of death for the concept. I do not want this turned into a vulgar commercial icon. Star of Tolerance will address the whole planet, so we are obliged to be as responsible as we can be.

**But if the launch is a success, won't this open the door to space-based advertising?**

We will be first, why would a company want to be second? Also, astronomers all over the world will be upset if this happens. No company, in my view, would dare to create a controversy by ruining the night sky. Advertising in space is for space ethics committees to decide.

**Looking back at the project, what's the biggest hoop you went through?**

The biggest difficulty has been sharing my vision with others. Although I could see how good Star of Tolerance would be, others didn't or they refused to see. Secondly, I was very sorry to have caused confusion with the astronomers. My intention was to offer the Star of Tolerance to the astronomical community so that they could use it to raise public interest in outer space.

**What will you do next if the launch is a success?**

I think the most exciting idea is to launch an Earth-Moon solar sail race. Humans are motivated by competitions and this race would contribute towards the development of technology. Imagine if there had been no competition between Russia and America, perhaps, America would have never sent men to the Moon in 1969. So, creating a solar sail race between nations, which can be viewed through the Internet, would be a good way to bring it down to Earth and into people's homes.

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