

# Science Focus

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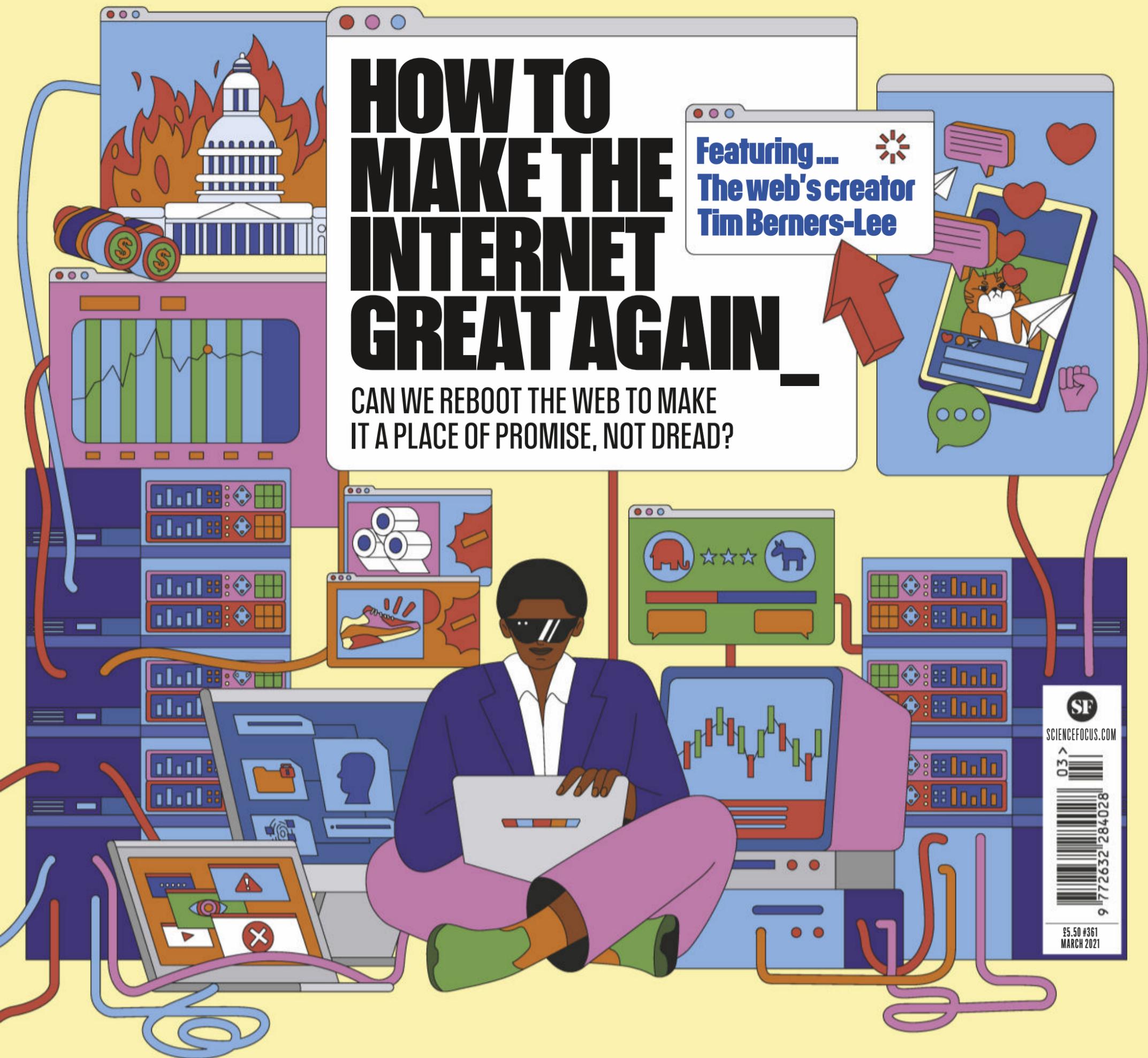
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HOW TO BUILD A

# MARTIAN MEGA CITY

**WITH MORE MISSIONS REACHING THE RED PLANET, A HUMAN LANDING GLINTS ON THE HORIZON. BUT WHAT COULD THE FIRST PERMANENT MARS METROPOLIS LOOK LIKE? WELCOME TO NÜWA CITY**

WORDS: DR STUART CLARK

ILLUSTRATIONS: ABIBOO STUDIO

Nüwa City, designed to be home to between 200,000 and 250,000 citizens, is named after Nüwa, creator and protector of humanity in Chinese mythology



**T**here can be no mistaking that interest in Mars is growing. Last month, three brand new spacecraft arrived at the Red Planet. The first was the UAE's Emirates Mars Mission, also known as Hope, which entered orbit on 9 February to study the planet's atmosphere. Just days later China's Tianwen-1 settled in, and is now getting ready to deploy a lander that will carry a rover to the surface in May. The third visitor, NASA's Perseverance rover, is carrying equipment to look for the chemical traces of past life.

However, it may just be the UAE's mission that history remembers as the most significant. It is nothing less than the first step in the country's stated ambition to establish an international human settlement on Mars by 2117.

And it's not just the UAE that is thinking about living on Mars.

In February 2020, The Mars Society, an organisation dedicated to the human exploration and settlement of the Red Planet, launched an international competition to design a Martian city. Entries came from 175 teams from more than a dozen countries.

"Reading them, I was struck by the ingenuity displayed by the teams in coming up with extremely clever technical, economic and aesthetic solutions to the problems of designing a practical and beautiful Mars City state," says Dr Robert Zubrin, founder and president of the Mars Society.

One of the teams that entered was the Sustainable Offworld Network (SONet), a community of professionals in the academic and private sectors dedicated to the development of sustainable human settlements on other worlds. Their entry: Nüwa city.

### THE MARTIAN MINDSET

Nüwa is a Martian city made of tunnels built up to 150 metres deep into a cliff face. The tunnels would house residential and work areas, as well as urban orchards and green domes. Like communal gardens in cities today, they would include plants, animals and even small bodies of water. As many daily activities would be completed below ground, these lushly planted domes are designed to provide a psychological lift for colonists, offering spectacular views out across the Martian terrain.

What made the Mars Society challenge stand out was that it wasn't asking the teams to determine

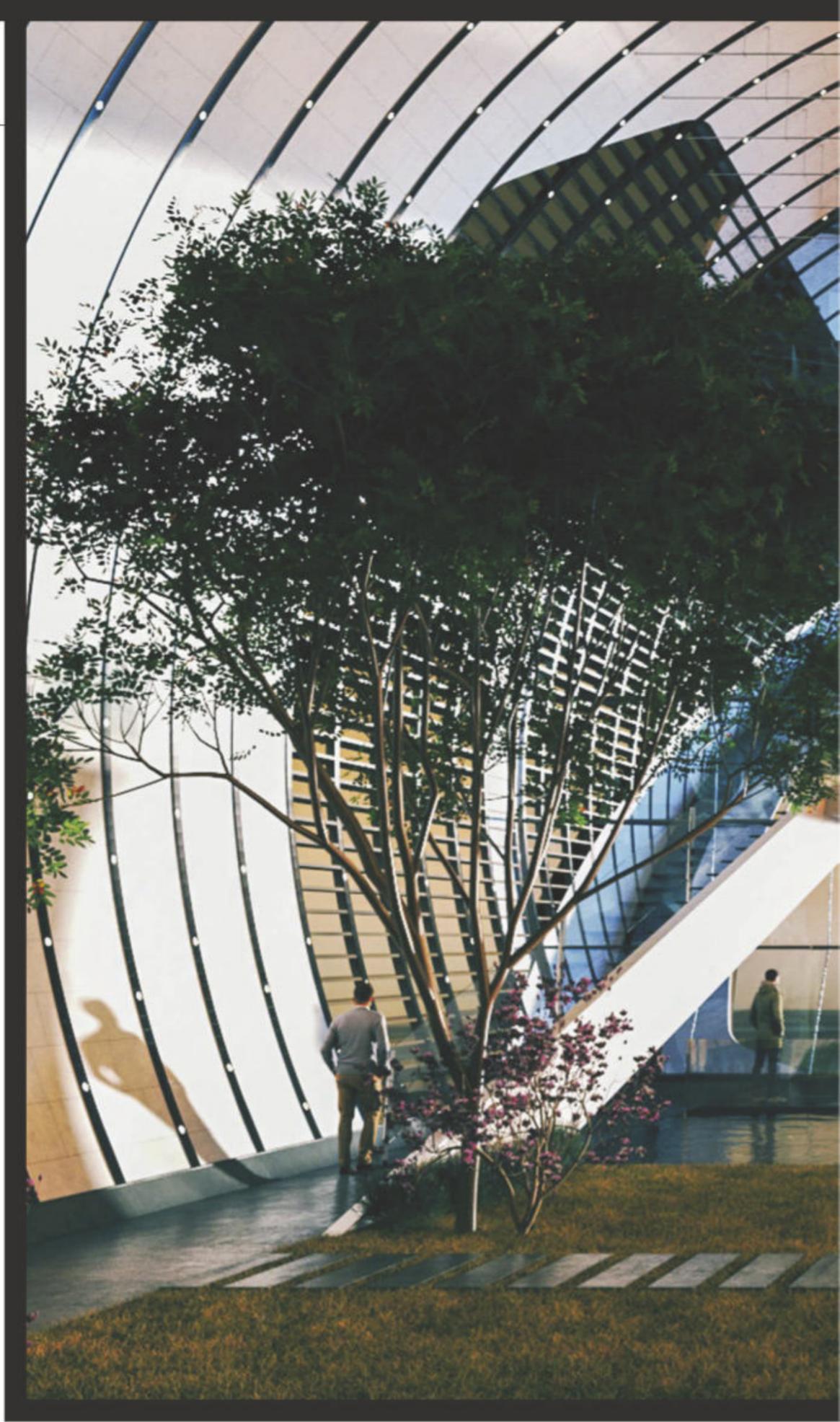
how to make a scientific outpost for an extended but ultimately temporary habitation. Instead it was asking specifically for a 'city state' that would be capable of housing a million people, providing schools, shops, hospitals and even facilities to process the dead.

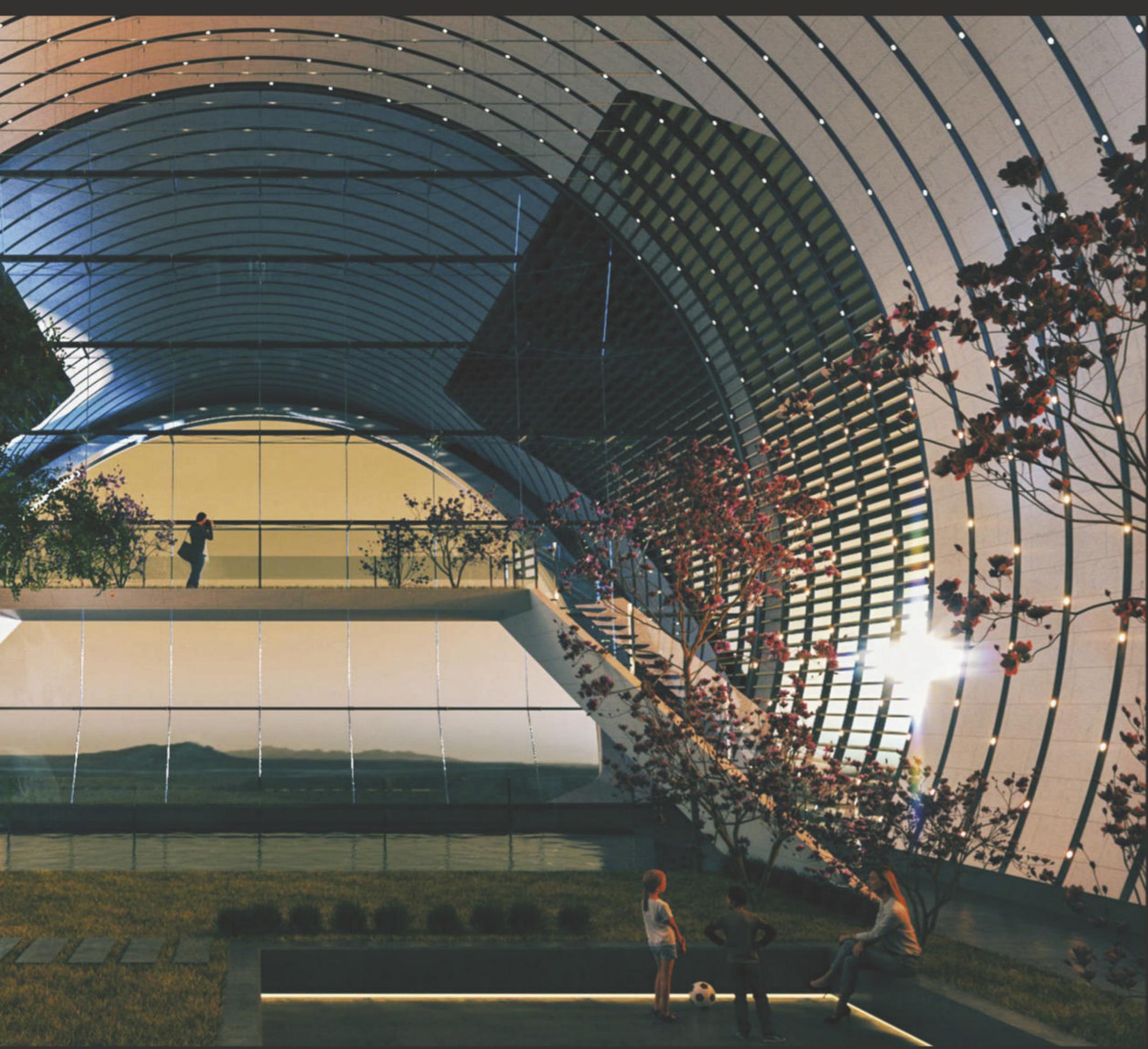
The city also needed to be self-supporting as much as possible. It would have to produce all the food, clothing, shelter, power, consumer products, vehicles and machines for a million people. With Earth so far away, it would only be possible to import a small amount of key components, such as advanced electronics.

"The approach was very different to a temporary settlement," says architect and

**ABOVE** As it will be a permanent residence, extra care was taken with Nüwa to provide for the inhabitants' psychological wellbeing. This is the view through a Martian green dome, and out across the Martian planes.

**RIGHT** The cliff tunnels are just one part of Nüwa city. On the cliff top, agricultural modules and solar panels are situated. Further away is the city's nuclear power station. Down in the valley is the rocket pad for new arrivals.





**“THE TUNNELS WOULD HOUSE RESIDENTIAL AND WORK AREAS, AS WELL AS URBAN ORCHARDS”**





➤ urban designer Alfredo Muñoz of Abiboo Studios, who also serves on the SONet board.

In a temporary base, where a limited number of people live for months, or even years, doing their work and then returning home, the only real concern is keeping them alive. But somewhere that is going to be home for the rest of their lives is a different matter altogether. It required thinking about a much wider variety of issues.

“We started thinking, ‘Okay, how do we ensure the right psychological environment to ensure that people are having a happy and enriching life? How can we create a beautiful experience and a life around the community in a place that is pretty harsh?’” says Muñoz.

This meant Nüwa not only had to protect its inhabitants from the deadly Martian climate of temperatures as low as  $-103^{\circ}\text{C}$ , but also allow a new civilisation to flourish. In other words, a lot of planning was needed for the project.

#### **CELESTIAL CITY**

Nüwa city was designed by a 35-strong team that worked for four months to perfect the concept. It would be the capital of five such cities spread across the Red Planet, each one

**“HOW DO WE ENSURE THE RIGHT PSYCHOLOGICAL ENVIRONMENT TO ENSURE THAT PEOPLE ARE HAVING A HAPPY AND ENRICHING LIFE?”**

capable of sustaining between 200,000 and 250,000 people. The SONet team even identified the places where Nüwa and its sister cities would sit on Mars: a site located 225,000km from the extinct volcanoes of Mars’ Tharsis region, near the planet’s equator. The cities would be separated by a couple of thousand kilometres, ➤



**ABOVE LEFT** Crops will be cultivated in the agricultural modules in an atmosphere rich in carbon dioxide. With an 'air' pressure just one-quarter that at sea level on Earth, it will not be breathable for humans. Cultivation must therefore be fully automated.

**ABOVE** Green domes will be built where the tunnels reach the cliff face. Some of these green domes will function as parks, others will be used to run experiments to see if vegetation can be adapted to Martian conditions. All will feature views of the Mars landscape beyond.

**RIGHT** By building Nūwa city into tunnels in a cliff face, the habitation and work modules can be placed under layers of rock, shielding the citizens from the radiation that reaches the surface of Mars.



# “WE COULD START NÜWA BY 2054, AND HAVE IT FINISHED BY THE END OF THE CENTURY, IF THERE ARE THE RIGHT RESOURCES AND WILL”

and they would be accessed by the Martian equivalent of a light railway. Only Abalos City would be further away. Located towards the Martian north pole, it would be the water-mining settlement.

You would be forgiven for thinking that building not one but *five* cities on Mars is somewhat overambitious. Key materials required for everything from rocket fuel to manufacturing need to be extracted from natural Mars resources.

**BELOW** Select citizens may be permitted to study the Nüwa valley in pressure suits containing enough air to sustain them for at least 10 hours. Due to the harsh night climate, this exploration will only be possible during day.

For instance, graphite and ultra-high-molecular-weight polyethylene (used for construction) can be obtained through atmospheric CO<sub>2</sub>. Similarly, native sulphur found in deposits on the Martian surface can be used to create cement.

But to astrophysicist Guillem Anglada-Escudé, Institute of Space Sciences/CSIC, Spain, and the founder of SONet, once he broke it all down he realised that he was facing the same set of problems that city planners have on Earth with just one major twist. “Everything that you need to run a city on Earth, you need on Mars as well, the only extra thing you need on Mars is air,” he says.

Quite a bit of air, in fact: the Nüwa designers estimate 187,500,000m<sup>3</sup> of it would be required to maintain the city’s 200,000 inhabitants (about 240kg of oxygen and 490kg of nitrogen per person). The traditional approach to this problem has been to build vast domes that trap air. But for Nüwa, the team came up with the idea of building into a cliff face. Not only would this help them trap air in the 30-metre diameter tunnels and caverns they planned to excavate, but the cliff would also protect the residents from harmful solar radiation that can reach the surface of the airless planet. Plus, the cliff rock



provides low-cost protection from the massive pressure difference inside and outside the city. The mesa at the top of the cliff is where the large solar arrays and a nuclear power station would generate the 37kW per citizen needed to maintain life-support systems. Areas for food production would also be based here, providing the crops that will make up half of citizens' diets (the other half consists of insects, cellular meat and atmosphere-revitalising macroalgae).

#### A NÜWA REALITY?

Construction of this 'vertical city' would take place in phases. The first 10 years is when there would be substantial input from Earth. This would be in the form of machines and components that the colonist workforce would use to begin the construction. At the end of the first decade, SONet estimates that the city will be home to 10,000 people. Colonists would be required to pay \$300k for a one-way ticket to Mars and a 25.5m<sup>2</sup> residential unit. They would be required to become a member of the working force. Around Nüwa's 50th anniversary, the colony would become large enough that it could become an independent state from Earth.

"It seems realistic that we could start Nüwa by 2054, and have it finished by the end of the

century, if there are the right financial resources and the right will," says Muñoz.

Yet at present, Nüwa city exists only on paper. However, the construction of a series of Nüwa demonstration facilities on Earth to test the concept and its various technological solutions is currently being planned. "These will be experiments not only on planetary exploration, but experiments on architecture, material sciences, biology, ecology, economy, people living together and their psychology," says Anglada-Escudé.

Reflecting on the Mars Society competition, in which Nüwa finished in the top 20, Zubrin says, "What moved me most of all was the glowing idealism of the teams in striving to define a new and better way for humans to live together in a new world. To be sure, the teams did not agree on the specifics, and their ideas ran the gamut from concepts that could be broadly described as social democratic to libertarian.

But what they all had in common was a passionate commitment to the search for something better. What could be more important?" **SF**

by **DR STUART CLARK**

*Stuart is the author of* Beneath

The Night: How The Stars

Have Shaped The History Of

Humankind (£14.99, Faber).

