



Keegan Kirkpatrick

## A NEW WORLD OF SPACE STARTUPS

As long as Kirkpatrick can remember, the only thing he wanted to do was to go into space. “I could have been a subcontractor on a space station cleaning the toilets and I wouldn’t have cared, as long as I got up there,” he said. He eventually attended Embry-Riddle Aeronautical University to study aerospace engineering, assuming he would end up at NASA. But after college, when he took an engineering job helping to launch rockets in the Mojave Desert at Masten Space Systems, he began to see the vast range of opportunities in the space industry that were opening up to entrepreneurs.

While NASA still looms large, along with established aerospace corporations like Boeing, Lockheed Martin, and Northrop Grumman, there are many new startups entering the space game. Virgin Galactic, SpaceX, and Blue Origin make headlines, but smaller, lesser-known companies are popping up to create new technologies that will facilitate space travel. [New Space Global](#), a firm that tracks the commercial space industry, has identified more than 1,000 private space companies—and expects to see 10,000 over the next decade.

Kirkpatrick’s idea for RedWorks was inspired by a challenge that NASA issued for its centennial celebration, inviting people to develop, design, and build a habitat for deep space exploration using 3-D printing technology. As Kirkpatrick was creating a team, it occurred to him that it is important for people with a wide range of backgrounds to be involved in space exploration projects. “I wanted to get beyond the notion that settling in space had to be something that only a hardcore engineering team could take a crack at,” he said. “To develop space and commercialize it yes, we need engineers. But to colonize Mars? You’d need more than just an engineering population.”

He brought together the following experts: a geologist who understood the materials available on the Martian landscape, a 3-D printing specialist who had formerly focused on movie special effects, and a designer with expertise in translating 3-D images into real-world objects. The group is influenced by the principles of the maker movement. They believe that it is possible to find solutions to hard problems—and they don’t get much harder than space travel and interplanetary colonization—using simple DIY techniques. They regularly attend Maker Faires to find new ways to tinker with and hack the technology they’ve built.

## TOOLS FOR A MARS SETTLEMENT

While Kirkpatrick’s team didn’t win the competition, he believed the technology they had developed had business potential both in the space sector and beyond. He and his collaborators have turned RedWorks into a company; they’re constantly improving the technology and developing a wide range of applications for it.

The existing 3-D printing system they’ve invented requires only a power source and dirt—or regolith, to use the geological term for the dust covering bedrock—to create any sort of infrastructure you might need to start your life on a new planet. Using a crucible, the printer heats up this dirt, turning it into a kind of concrete. “When you heat up the regolith, it comes out like a molten taffy,” he explained. “Once it cools, you can make anything you want: roads, fuel tanks, a habitat.”

Kirkpatrick believes he will soon be able to sell this technology to other companies in the space sector looking for tools for astronauts to use upon landing on Mars—or any other planet, moon, or asteroid. In the case of a Mars mission, the value of this tool is that the crew would not need to carry heavy structures on board, since every bit of weight on a spacecraft adds to the fuel costs. When the astronauts landed on Mars, RedWorks software would scan the landscape to identify existing structures such as caves, crater rims, or underground lava tunnels. The 3-D printer would then set out to close off that structure to create buildings that could be pressurized for humans to live in; the regolith walls would protect inhabitants from wind and radiation.

As the RedWorks team was developing the technology, they studied the construction principles of ancient cultures, drawing inspiration from pit houses and pueblos that use the natural landscape as a foundation. “One efficiency is to use preexisting structures so that you are building organically,” he said. “The software generates a habitat using basic architectural principles of design.”

Humans would also need a source of food. Kirkpatrick has thought of this, too. These first Martian settlements would rely on aquaponics, a system that uses waste produced by fish to grow plants, which, in turn, purify the water. “It’s a closed loop that keeps both the plants and the fish alive,” Kirkpatrick said.

Still, the first settlements on Mars would be very rudimentary compared to life on Earth. Andrew Owens, an MIT doctoral candidate in aeronautics and astronautics, points out that our civilization has established extensive interconnected chains of industry. He illustrates this by describing what it takes to eat a sandwich for lunch. “If we could see the supply chain that went into the food, then all the machines that are required to make that happen, then all the machines that are required to keep those machines running, you begin to get a sense of how vast our global network is,” he said. In some ways, it would be like dropping humans back into the Bronze Age, where they focus on surviving at a very basic level.

Professor Thanga believes that there will soon be opportunities to test out technologies like RedWorks's in Mars-like environments before the Mars mission begins. "We are trying to get to the next level of simulation now," he said. "The moon is a great example because of its relative remoteness to Earth, but we can also make use of in-orbit laboratories to simulate the gravity, lighting conditions, and regolith of Mars."

## MONETIZING EARTHBOUND APPLICATIONS

When Kirkpatrick demoed RedWorks's technology at NASA, Maker Faires, and other venues, he discovered that there are many valuable applications for it here on Earth. "What we've created is really a tool kit, something that anyone could use," he said. "We want to create tools that people want now, while developing things that will help on Mars."

Construction companies are interested in how the 3-D printer could use soil at a building site to create roads and structures, rather than having to bring in concrete. Land reclamation projects are interested in how they could use the machine to turn parts of the ocean into solid ground. The technology could also potentially be used to rebuild damaged historical artifacts. "Since you're basically printing rock, if you have any referential material of what the site looked like, you can potentially rebuild it," he explained.

While RedWorks is still working to refine its 3-D printing system for the purpose of space travel, its immediate business plan is to create various spin-off technologies for different industries. This means that the company could potentially generate short-term financial payoffs, which would make it more attractive to investors. "The mentality of investing in space has been changing," Kirkpatrick says. "Now we're no longer seeing that operations in space are a pie in the sky, but a source of near-term return on investment."

Kirkpatrick has tapped into the networks that invest in early-stage space startups. A notable one is the Washington, D.C.-based [Space Angels Network](#). In the past, funding a space project might have involved billions of dollars, but this new crop of startups is able to get off the ground with less capital. RedWorks, for instance, is not building expensive spacecraft or rockets. (Kirkpatrick declined to disclose his current funding situation.)

But for all the earthbound applications of this technology, Kirkpatrick is deeply committed to preparing for humanity's eventual journey to Mars. "Mars is the next frontier," he said. "It's fascinating to think that this is truly a new world for mankind to make its home on."

---

### ABOUT THE AUTHOR

Elizabeth Segran, Ph.D., is a staff writer at Fast Company. She lives in Cambridge, Massachusetts [More](#)

---

## IMPACT

---

### IMPACT

**Coal companies are going bankrupt. What happens to the pensions they've promised miners?**

---

### IMPACT

**We're leaving so much food on farms to just rot in the fields**

---

### IMPACT

**Is it possible to raise a carbon-neutral cow?**

## CREATIVITY

---

### CREATIVITY

**How the unseen camera crew on 'The Office' played a bigger role than you think**

---

### CREATIVITY

**After Lifetime's explosive R. Kelly docuseries, it's doubling down on the 'Surviving' brand with 'Surviving Jeffrey Epstein'**

---

### CREATIVITY

**Why the average Facebook user needs to watch Netflix's 'The Great Hack' right now**

---

## CO.DESIGN

---

CO.DESIGN

**These photos of trees surviving in cities are hopeful and heartbreaking**

---

CO.DESIGN

**Buildings made out of aerogel could help us survive on Mars "in our lifetimes"**

---

CO.DESIGN

**Kitchen makeover: The Fast Company guide to getting plastic out of your cupboards**

---

## WORK LIFE

---

WORK LIFE

**Silicon Valley is where women go to fail—unless they do these three things**

---

WORK LIFE

**Try this effective technique to keep learning throughout life**

---

WORK LIFE

**To charge or not to charge? That's the question for these startups**

---