

Humans on Earth and Mars Over the Next 5,000 Years: An Interview with Planetary Society Co-Founder Louis Friedman

By David Warmflash

Louis D. Friedman is Executive Director Emeritus of The Planetary Society, which he co-founded with Carl Sagan and Bruce Murray in 1980. His career over more than half a century shows a knack for bringing space researchers from multiple nations together on ambitious projects. He has played a role in the Mariner-Venus-Mercury project, the Voyager missions, the Venus Orbital Imaging Radar (Magellan), the Halley Comet Rendezvous, Mars exploration, and has brought the idea of solar sailing from a dream to actual testing in space. During the late 1970s, he was an American Institute of Aeronautics and Astronautics (AIAA) fellow for the subcommittee on Science, Technology, and Space of the Senate Committee on Commerce, Science and Transportation. Since that time, he has testified before Congress on various issues of space exploration and space technology. As an astronautical engineer with degrees from the University of Wisconsin, Cornell, and the Massachusetts Institute of Technology, Friedman has always tempered his optimistic vision of the future of human space activity with a dose of reality.

That mixture of optimism and engineering reality underlies the topic of a new book that Friedman has published by the University of Arizona Press under the title: ***Human Spaceflight From Mars to the Stars: A new paradigm for human space exploration***. To help provide a glimpse of the new book, I interviewed Friedman. What follows is a discussion that we had touching not only Mars colonization but on a range of issues from robots to the human desire to explore.

DW: What is the central message of the book?

LF: Human space exploration will continue well into the future. It will be exciting, focused on exploration and settlement of Mars. But humans themselves will never travel beyond Mars.

DW: Yes, that's where you divert sharply from many others who envision human spaceflight continuing beyond Mars, into the Solar System to asteroids, outer planets and their moons. Before we delve into that, can we talk a little about why Mars should be a location for humanity's second home? As you know, there are critics of human Mars colonization within the space community itself. I'm not talking about conservatives who say we need to fix everything on Earth before planting ourselves anywhere else, but proponents of off-world colonization, who advocate building human colonies in free space –on structures either in the Earth-Moon system, or in their own orbit around the Sun. They have some good reasons. First, there's radiation. With such a thin Martian atmosphere and no magnetic field, Mars colonists will live underground. Second, surface gravity is only .38 that of Earth. That could be a benefit for an older person with a heart condition who might retire to Mars and have a longer life, but what

happens to future generations of humans conceived and born on the Red Planet? For them, Earth would be a super-gravity world that they may not even be suited to visit. Free space colonies, on the other hand, you could rotate to make full Earth gravity. You could give them thick shielding against radiation, maybe even their own magnetic fields. For humans, we know there's an emotional attachment to Mars, but from a pragmatic standpoint, is there anything that makes it better than free space colonies? Or maybe, do you see a future in which we have Mars colonies, free space colonies, and maybe cities on the Moon and other bodies?

LF: What you describe is not impossible, but to me it makes little sense. The space colonies you imagine are vast engineering projects much bigger than the enterprise of adapting ourselves to the surface of Mars. They would have to be built with material brought from Earth at much pain at much cost. On Mars, we would protect ourselves from radiation with Martian materials –the dirt of the planet. A 1-g space colony for thousands of people would be huge: impractical to build, and more impractical to supply. The space colony ideas of science-fiction are largely discredited for human's real future now. They certainly do not appear in any space agency or private space plan.

DW: Do you anticipate that we'll terraform Mars?

LF: Yes. Of course I don't know exactly how or when, but I see it as part of human evolution to eventually adapt ourselves to living on Mars and then to make it better and better. And, I must note, we are already terraforming Earth – so we know it is something we are capable of. That said, I must also emphasize that I will I THINK that will happen, I don't know it. We have not settled underwater in the oceans, nor have we settled even in the Antarctic. They are much easier to reach and have many more resources than Mars. I am not sure of their future even here on Earth. But I am an optimist and I think Mars represents an unlimited future for human endeavor.

DW: When you say that humans will *never* travel beyond Mars, do you mean not to colonize other worlds, or do you mean not even for a quick visit? If we build up enough of a space infrastructure to support Mars colonies, if we have propulsion and life support systems capable of handling that, at some point later this century or in the next, wouldn't a human mission to the outer Solar System be a lot easier than sending the first astronauts to the Moon was during the 1960s when we had no human space flight experience and had to create everything from scratch?

LF: Human exploration and colonization of Mars will keep us busy for hundreds, even thousands, of years. During that time, there will be advances in nanotechnology, space sailing, robotics, biomolecular engineering, and artificial intelligence. These advances are occurring even now affecting our outlook about what it means to be human and engage in human activity. Those technologies will not merely ALLOW us to stay home on Earth and Mars, but our minds will extend our presence throughout the universe so that we will not need or want to extend our bodies there – even if we could, which I think is doubtful.

DW: So are you saying that sending humans, say to an interesting moon of Saturn, like Titan or Enceladus, or Jupiter's Ganymede or Callisto (not Europa, because of intense radiation), would be pointless, since we could get the full experience from our machines, through something like virtual reality, or even uploading data from deep space missions into our brains, so it will really seem as though we went in person?

LF: Yes, that's right. I think we'll be doing that before the end of this century whereas if we had to wait for human life support on Titan it would many many centuries are far more limited.

DW: Even so, do you think that will be enough for *everybody*? Wouldn't some daredevil take a human mission to points beyond at some point, just to show that they could do it? As long as it's *possible* for people to go beyond Mars, don't you think that factors outside the realm of practicality, cost, or danger could lead to human expeditions to somewhere else, for reasons related to prestige of some government as in the 1960s, or publicity for some corporation? You're talking about the evolution of human society over the next centuries and millennia. We can't predict what sort of political states will exist Earth and Mars, much less the relations between those states, over the centuries to come any better than the ancient Romans could have predicted our current geopolitical milieu. Plus, in very recent history, we have experienced a Space Race characterized by two superpowers competing to put men on the Moon basically to show off. Mixed in with that was President Kennedy's speech with line about about going to the Moon and doing other things not because they're easy, but because they're hard. Is it so unrealistic to think that China, India, Brazil, Russia, the United States, the United Nations, or for that matter a government that has yet to exist on Mars, could find itself in a new space race where the goal is to get people –live people– where no one has gone before, for that prestige factor?

And what about individuals deciding travel further out? I don't know if it's for a sense of achievement or bragging rights, but today, there are many people who climb Mt Everest, at great risk to their personal safety and great financial cost. I know an astronaut who climbed it, Scott Parazynski. I think you know him too. After he retired from NASA, he went on an expedition to the Everest peak and tweeted from there. There are also people today who have purchased tickets on Virgin Galactic for more than \$200,000 to get 6 minutes of weightlessness and the ride of their life, but there are ways to get close to that experience on Earth. Wanting to do these things just seems to be part of human nature, maybe not for the vast majority of people, but we always produce people who want to visit new places, even if there's no logical reason, don't you agree? Do you think artificial intelligence and other technologies will change something about us, so that NOBODY will ever take a distant, dangerous space voyage that has no practical value?

LF: You have raised several questions here. You are right about the possibility that if we can do something, someone might just want to. We have all kinds of extreme sports here on Earth. I don't rule out some daredevils or tourist extremists from our Earth – Mars home trying a daring mission to the asteroid belt or Ganymede. But it won't be very relevant or even as

much a part of our Society as those extreme trips to Mt. Everest. Somebody jumped out of a balloon from the edge of space a year or so again – interesting, but not relevant to human development. Humans will already feel present on Ganymede (and lots of other places) and the development of human life support to engage in those extreme efforts will be expensive and pointless – if even possible. One comment on Scott Parazynski – what he did was truly great. I watched his adventure for hours and it was gripping. But what he got little attention because no one knew why he was doing it. It was a fix on the space station but the purpose of the space station is not understood. If, like Apollo 13, it was about moving humans to a new world then it would have been far more appreciated. I think NASA has it right now – their Journey to Mars puts into context why we have human spaceflight. In my opinion there is no other purpose to human spaceflight.

DW: You wrote the book from the perspective of engineering, but I'm seeing this from a biomedical perspective. Nanotechnology, artificial intelligence, robots –all of these things make space exploration easier without human going physically through what's a very unfriendly environment. But they can also make future humans tolerate the space environment way better than we can today. Gene editing is advancing too and we might be able to make ourselves more durable. In parallel with robot technology there's bionics and human enhancement. Human hibernation may become possible, but an egg-ship will almost certainly be possible. We could send frozen embryos on an interstellar voyage lasting centuries, and with the kind of advances that you're talking about in artificial intelligence, they could be raised at the destination -a planet around Alpha Centauri for instance- by robot nannies. You'd need an artificial uterus, but that's coming soon, probably within this century, and with embryos you could send thousands in a small volume. In our society there are people who would have ethical objections, but there are people who would have no problem with it, and as we said early we don't know the future geopolitical situation. Somebody, somewhere, at some time might want to send human seedlings somewhere really far. Is there a reason why this wouldn't happen?

LF: I understand you and admit that most of my space friends agree with you. Certainly my friends in the astronaut corps do. My point isn't that we couldn't do those things with embryos and life, it is that we won't want to. By the time we can do it, we'll be doing it in other ways. We can travel by covered wagon today from St. Louis to build a home in California – but we don't.

DW: You know how some insightful people like Stephen Hawking, Elon Musk, and Bill Gates have warned that we should be careful about artificial intelligence, about how we develop it and how we let it evolve. In researching and writing the book, did you develop any concerns along these lines? Do you think that eventually, machines might replace humans entirely?

LF: I don't go that far – perhaps I just don't have their insight or enough imagination. I think their warnings are right on – the technology might be dangerous and misused. We should be careful. But it would be impossible to ban it. Similarly, I don't subscribe to Ray Kurzweil's singularity theory – that humans will evolve into their electronics. It is Mars that will save us

from that gloomy idea – it is a world for unlimited human development and evolution. You might ask what about in 10,000 years; won't we have to confront our limits there. My vision isn't so great – ask me in 5000 years and I'll give you a better answer. Look where we were on Earth 10,000 years ago and imagine a discussion of inhabitants then predicting their evolution.

DW: You describe yourself as wanting to make space exploration missions happen. What missions are you trying to make happen now?

LF: There are two I am working on now – both addressed in the book. The first, of highest priority is the Asteroid Redirect Mission – a very clever and innovative idea to grab a large piece of an asteroid and move it to a place where our astronauts can reach – years before they could go to any other celestial object. It will restore science and adventure to the human space program and be the first milestone for human space flight beyond the Moon on the way to Mars. NASA is preparing to do this within the decade and to make it a literal stepping stone on the Journey to Mars. The second is at the other end of the scale – a small robotic mission to go deep into the interstellar medium to the focal line caused by the Sun's bending of light from an extra-solar planet. In theory the solar gravity lens focus can magnify the planet by a billion times – making a 10 cm telescope there equivalent to a 80 kilometer telescope here. It may be the only way to obtain high-resolution images of a potentially habitable world in our lifetime. These two missions illustrate the point of my book nicely – human space flight nearby, robotic spacecraft far away. Extending the human presence together.