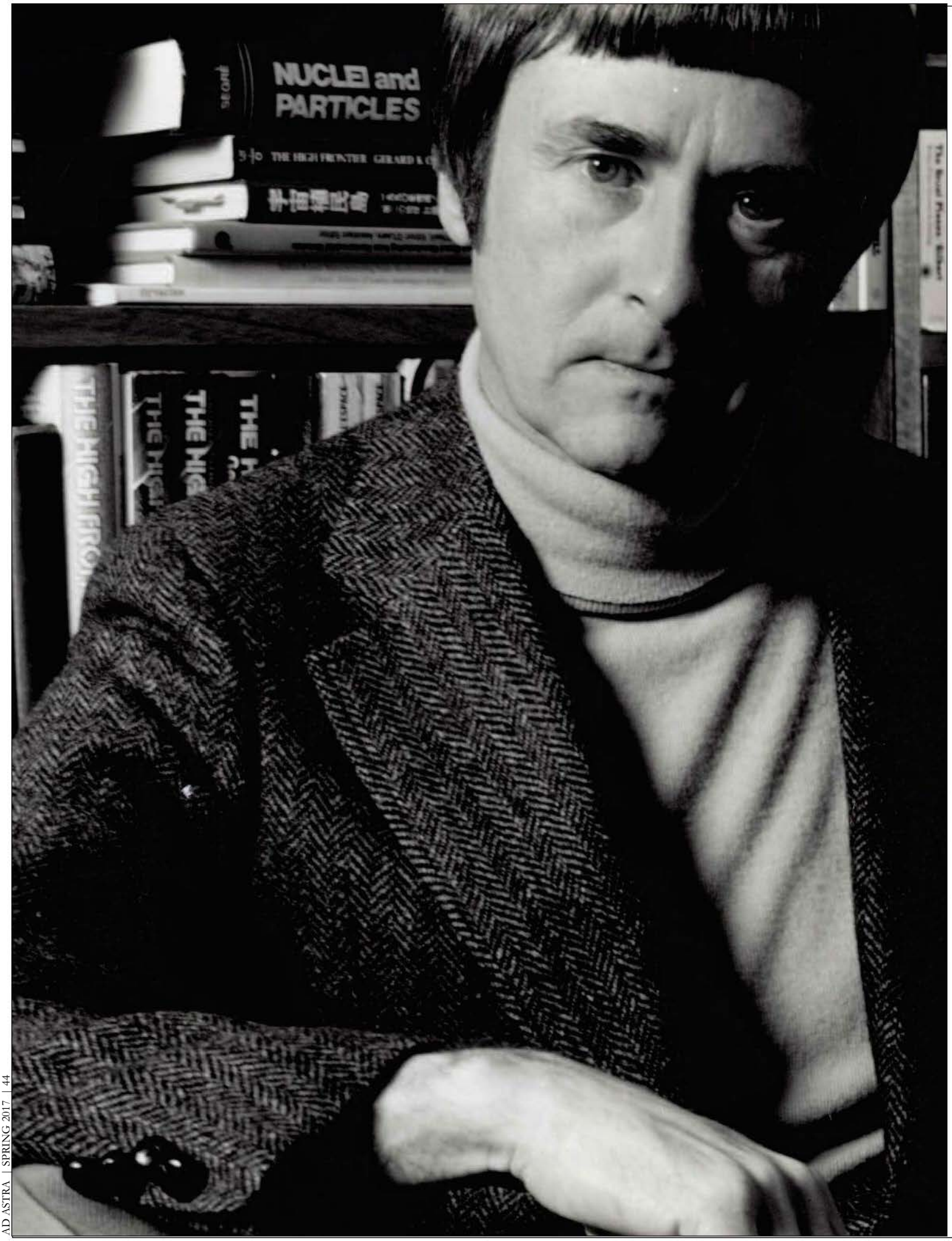
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THE DREAM AT 40:

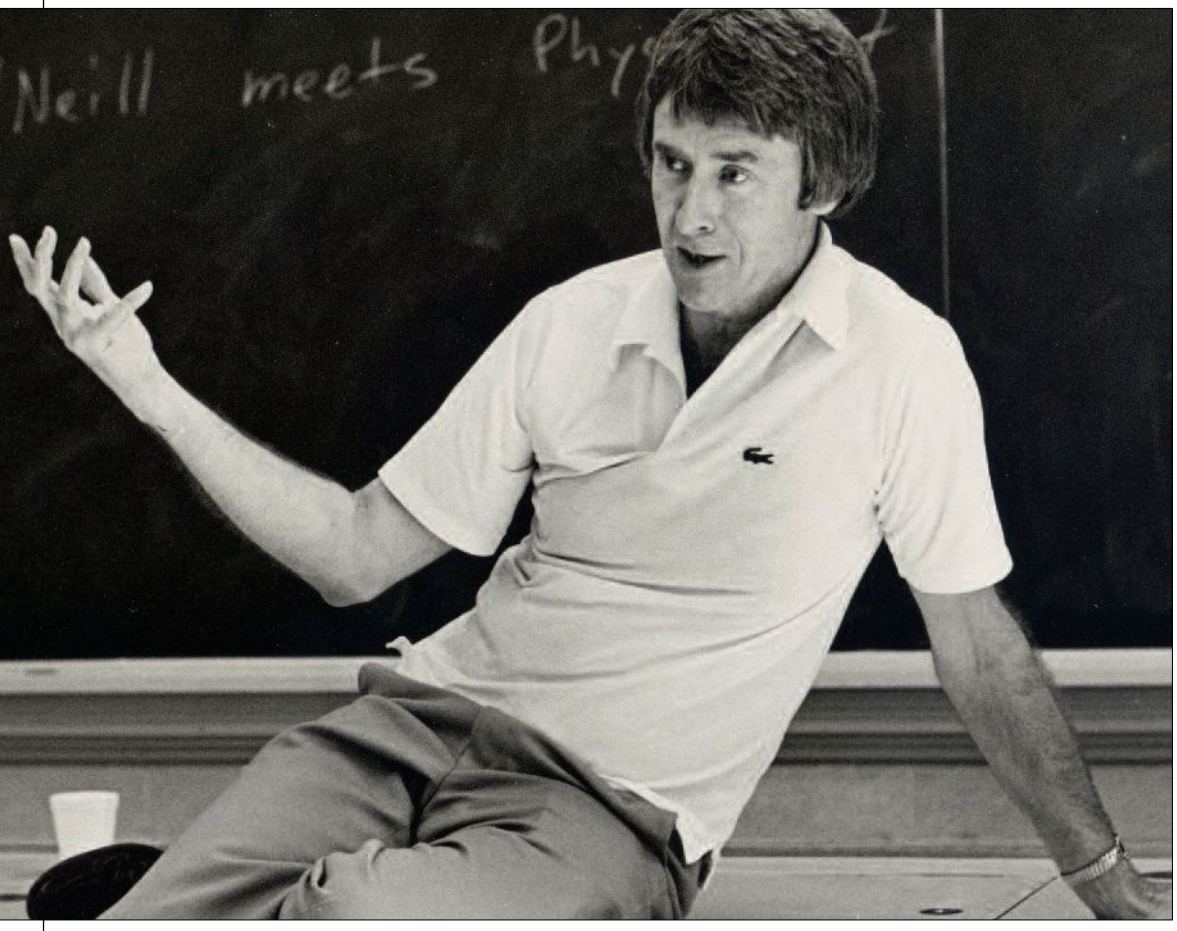
GERARD O'NEILL'S VISION FOR SPACE SETTLEMENT

by Clifford R. McMurray

In the years immediately following the Apollo 11 Moon landing, hope dueled with fear in the American imagination. Apollo had just offered a glimpse of the possibilities of technology to conquer "impossible" problems, but the optimism of one set of dreamers had to contend with the darker visions of thinkers who projected the rapid increase of the human population and use of natural resources and saw oncoming disaster. "The Limits to Growth," a book published in 1972 and commissioned by the Club of Rome, forecast unavoidable collapse unless truly draconian measures to curtail population growth were taken. This bleak result of their computer simulations, which recurred no matter what assumptions were fed into their computer program, prompted economist Robert Heilbroner to imagine humanity regressed to a primitive lifestyle, living under a global dictatorship with iron control over individual reproductive choices and limited remaining resources. "If, then, by the question 'Is there hope for man?' we ask whether it is possible to meet the challenges of the future without the payment of such a fearful price," Heilbroner wrote, "the answer must be: No, there is no such hope."

But Gerard K. O'Neill was no pessimist. This physics professor at Princeton University had put a question to his advanced freshman physics seminar in the fall of 1969, just months after the first Moon landing:

"Is a planetary surface the right place for an expanding technological civilization?"



Gerard O'Neill teaching at Princeton University. Image courtesy of Tasha O'Neill.

As he and his students attacked that question, it became clear to him that there were plenty of building materials and energy in the Solar System to construct habitats that could eventually support a population thousands of times greater than the carrying capacity of the Earth, at a high level of civilized comfort. For all intents and purposes, once you got off the Earth, there were no limits to growth. The system could be open, not closed.

The key was the increased surface area of the habitats, hollow spheres or cylinders filled with air and spun to produce artificial gravity on their interior surfaces. Just one habitat, 4 miles in diameter and 20 miles long, could support several million people on its 500 square miles of "land." Sunlight would provide unlimited, free solar energy, and asteroids and the Moon have all the metals for structural materials and shielding, and water for life support needed to build thousands of such habitats.

This wasn't an original idea. Konstantin Tsiolkovsky had talked about space colonies in his 1920 novel, "Beyond the Planet Earth." But it wasn't intuitively obvious, either. There were plenty of space stations to be found in science fiction stories, but no other space colonies. Isaac Asimov would later call this "planetary chauvinism," but when O'Neill wrote up his ideas and began submitting them to the leading scientific magazines, he spent two years and collected a lot of rejection letters before Physics Today agreed to publish the first article.

The next step was a small conference at Princeton in the spring of 1974, produced with the aid of a small grant from the Point Foundation. Only about 150 people attended the conference, but one of them was The New York Times science editor Walter Sullivan, drawn to the event by a press release the university had put out. His article on the conference made the front page of that newspaper, touching off a firestorm of publicity. The Physics Today article was published in September 1974, allowing its 15,000 professional physicist subscribers the opportunity to consider O'Neill's argument. Many tried and failed to poke holes in the idea, but their efforts sharpened O'Neill's analysis. A second conference at Princeton in the spring of 1975, and a student study at NASA Ames Research Laboratory a few months later, put still more flesh on the basic ideas. Somewhere along the way, the idea of space colonies became coupled with space-based solar power (SSP). Making solar power satellites to transmit energy to Earth could give the colonies an economic reason for existence.

Finally, in 1977, came the book: "The High Frontier." Even O'Neill's title was a clarion call to the first generation of space activists. Alongside a basic, layman's introduction to the engineering of space colonies, O'Neill painted a compelling picture of what everyday life could be like in such places. They would have plenty of open space for parks, with interiors sculpted into hills, forests, and rivers; instead of soulless huge cities, they could be dotted with villages. There would be no industrial pollution because all those messy processes could be carried out outside the colonies. Families would live in individual houses with no need for heating and air conditioning, in a perfect climate-controlled environment. The variable gravity, from whatever value was chosen for the colony's outer circumference to zero gravity at the axis of rotation, would allow for all the traditional sports and some new ones: human-powered flight and zero-g sex. Moving heavy industry into space would transform Earth's environment for the better, as well.

It was the perfect image for its time: high-tech meets hippie. "The High Frontier" didn't create the space movement, but it certainly catalyzed it. Another generation of space activists has grown up since it was published, many of whom haven't read the book. But then, they don't really have to; its ideas are now a part of the air they breathe. They should read the book anyway.

I am struck by two things in O'Neill's masterwork. One is how wildly optimistic his timeline was: he thought the first space colony could be created within 15 years, and thought it unlikely that it would take longer than 30 years. We are already a decade past his least optimistic estimate. One reason is that launch costs have remained much too high. O'Neill took NASA's $10 million cost estimate for shuttle flights at face value; reality showed them to be 50 to 100 times higher than advertised. Even SpaceX hasn't yet brought launch costs down to the levels on which O'Neill's calculations were based. Another reason, clearly, is that no nation has had the political will or economic incentive to make the investment in so large a project.

Set that aside; the basic concept is too self-evidently useful not to be carried out someday, however long it takes. For me, the most wonderful thing in the book is the encounter with O'Neill's noble spirit. His desire was for a world in which every human body, free of the need for brutal struggle for the necessities of life, could fulfill the dreams of the soul inhabiting it. He didn't want space colonies just because he wanted to go there himself (although he certainly did), but for what they could mean for his fellow humans. "For me," he said,

"THE AGE-OLD DREAMS OF IMPROVEMENT, OF CHANGE, OF GREATER HUMAN FREEDOM ARE THE MOST POIGNANT OF ALL; AND THE MOST CHILLING PROSPECT I SEE FOR A PLANET-BOUND HUMAN RACE IS THAT MANY OF THOSE DREAMS WOULD BE FOREVER CUT OFF FOR US."

He need have no fear. Those dreams are unquenchable in the minds of kindred spirits, and they will not be denied.

Thoughts on Gerard K. O'Neill from his friends, family, and contemporaries

TASHA O'NEILL

Gerry wasn't used to getting one pink slip after another. It was Physics Today that published the first article, and that gave him some more clout. It wasn't the book that was so hard to publish; it was really just to get the concepts out, to get the first technical article published. Various other publications turned him down—thought it was too crazy. The first conference put us on the map. The science writer for The New York Times came to the conference and the next day we were on the front page of The New York Times, which really changed our lives. We had to delist our phone number. When he was interviewed for Penthouse he went to his colleagues and said "I just wanted to warn you…" but they were all excited. It gave him some more cachet than he had before.

If he were alive today, I think he'd be pretty proud of the people who've pushed forward—the young people who've continued to develop his dreams.

KEITH HENSON

The original mailing list for starting the L-5 Society was mostly the people who were at the 1975 conference. The L-5 Society didn't get space colonies going, but it did serve as a point to get people who were interested in a positive future together—a lot of them.

There was a huge mismatch between O'Neill and people like me who were almost effectively hippies from out west in Tucson. There was a cultural divide which was well-nigh unbridgeable. But we did anyway.

FREEMAN DYSON

He was basically an experimenter who also had dreams—not a theorist. We were very good friends because we were so different. He was an experimenter; I was a theorist. He built things and I did calculations. So we made a good team. Certainly the numbers were all correct. There were all sorts of details which were right about it, and made the thing attractive. The only thing that was wrong about it was the high cost. I always had big arguments with him about his way of organizing space colonies. He wanted always to do it on the grand scale, with a huge project which would involve big money and big politics, and I always thought we'd do much better with small groups of people doing it as cheaply as possible, independent of governments. So we never agreed about the details, but of course I admired him very much. So I was happy to help him as much as I could.

What was remarkable about him was that he got things done. He didn't just teach students about space. He got the students to build a mass driver, which would have been an extremely useful instrument if one had a colony on the Moon. I think it's still sitting somewhere in the Physics building at Princeton University.

It's always impossible to predict when things are going to happen, so any estimate of the date [for the first space colony] is unreliable. I'm sure it's going to happen. It could take as little as 50 years; it could take 500 years, or anything in between. I would say more likely than not, it will be more than 100, but I could be wrong. It requires, I would say, a big advance in biology. Biology is more of a problem than engineering. The engineering of space is pretty well in hand.

I'm still very skeptical of the benefits [of space-based solar power] on the ground. So I think the main motivation is not economic. It's much more political or social. People would like to be free to set up their own communities and get away from the tax gatherers.

MARK HOPKINS

I was a founder of the Harvard-Radcliffe Committee for a Space Economy in 1972, when I was a student at Harvard and we were discussing how to do big things in space. And then this Physics Today article came out. I called O'Neill up, literally out of the blue, being a brash young grad student, and said this is pretty cool; this could be the huge project we were looking for. But then I asked him, "How are you going to pay for it and make it economically viable?" And I still remember, there was this long pause…

The book was important. I think the more important thing was the general ideas. There was also a book by Tom Heppenheimer which came out a few months after O'Neill's book. In fact, Heppenheimer told me he could have gotten it out faster, but he figured O'Neill should have the first shot at it. The 1975 summer study was important, and the book was written off the results of that study. The summer study sort of locked stuff in, because it wasn't at all obvious to a lot of people, including myself, that this was really real, in the sense of being technically feasible.

Putting on my economic hat, it's virtually impossible to stop it, short of something like nuclear war that kills everybody. It's only a matter of time until we go where the vast majority of the resources of the Solar System are, in terms of material and energy, and that will be pushed by a combination of resource exhaustion on Earth and increasing technical change.

His ideas were of fundamental importance to the movement for ideological reasons. They presented a pathway where one could plausibly argue that the American dream need not be dead because we can build a hopeful future for everybody where things keep getting better—this time not only for America, but for the world as a whole. That fact, and the realization of that, led me to redirect my career into the movement. O'Neill made the movement possible. Without O'Neill, probably the Space Movement wouldn't have happened, at least not for a long time.