Q&A: Decadal survey sets agenda for biological, physical sciences in space

September 18 2023, by David Nutt

Credit: National Academies

The National Academies' latest decadal survey, "Thriving in Space," released Sept. 12, provides a roadmap for biological and physical sciences research, from the low orbit of Earth to the surface of Mars, through 2033.

Krystyn Van Vliet, vice president for research and innovation and a self-

confessed "space geek," served as co-chair of the steering committee that produced the survey.

Van Vliet spoke with the Chronicle about her work on the project and its potential impact.

For the uninitiated, what is the decadal survey and why is it important?

Van Vliet: There are really two purposes. First, it's to give periodic input from the research community to the government as a signal for research priorities in the coming years. So it's a very science-driven effort where you gather input from people who have all kinds of interests and expertise and you say, "These are the big shots on goal that we should take as a country in the coming 10 years."

The second purpose is to develop a consensus report of a subset of that community, the steering committee that I co-chaired with Rob Ferl from the University of Florida, with input from hundreds of researchers who contributed input papers and dozens of people on the panels that worked on the report with us. Given all that input, what are the priorities? What are the strategies and advice we want to give to future decision-makers, not just on resource allocation, but on all things that relate to making a healthy, vibrant research community in this topic for the next decade?

With so many contributors, how did you prioritize projects?

First we tried to identify commonalities among the science concepts, across communities that use different terminology and reference points. Then we framed these as many possible scientific questions to answer, not topics of study. Next we developed criteria that would up-select a

subset of questions, weighting the relative priority in terms of potential for impact on space exploration and transformational discoveries that needed space access.

Those criteria helped us articulate the relative importance of actually answering that candidate scientific question. Because, let me put it this way, there's lots of things you could do in space, and all of them are much harder to do than conducting that research on Earth. So there has to be a really, really good reason to do research in a space environment. You also need experiments and a group of people on the ground who are developing the technology, prototyping, acting as a ground reference for some of the measurements that you make in space.

We really wanted this report to be compelling. When you write reports about exploring new planets, it's not hard for us as citizens and space geeks to be immediately inspired by that, right? Who doesn't want to go learn more about Neptune or a mission to look at the big red spot on this distant planet. But it's harder to articulate the value of doing research in biological and physical sciences, which you cannot always see in a photo or use in a product. So it was very important to me and to this team that we'd be able to articulate the "so what?"

How would you describe the thematic terrain the report covers?

The report has only three themes, which is memorable and tight: adapting to space as we head toward new destinations; living and traveling in space for years-long durations, not just more people but other organisms and physical stuff that is in the harsh space environment for the long haul; and probing phenomena hidden by Earth, discovering things about how organisms, materials and our universe works that can't be revealed by using only Earth-based labs where gravity and other

normal lab conditions confound us. Each of the 11 key scientific questions to answer in the next decade fit within one of these three themes.

What are the big takeaways?

There are several. One is that the resourcing of biological and physical science research in space has to increase by an order of magnitude over the course of the coming decade. We need to ramp up funding, not only from NASA, but from the wider government and/or other sources. We need that shared investment to answer the key questions that we're going to need to go back to the moon or going to Mars, as well as contributing benefits back to society on Earth.

Another message is that we really want to laser-focus on these prioritized questions and concentrate our efforts on making headway on a subset of the things that we could do, so we don't spread the peanut butter too thin.

There are other messages, too, like the responsible use of space as a resource for scientific discovery. We need to make sure that we do our research in a responsible way—collaborative when we can, competitively when we can't—while building toward completely new capabilities in the mission of science. And this research community really needs to broaden participation, so that our U.S. research teams comprise broader technical expertise and lived experience. Also, the government won't be able to fund or do all of this research, so we need good public-private partnerships with companies, and other countries, to enable responsible and affordable space-based research.

The report also recommends two major research campaigns.

Moonshot would be the wrong word for a bunch of reasons, but these are big, hairy, audacious goals to work toward something that would be transformational in terms of science, knowledge and capabilities for the U.S. in the next 10 years. The first is called BLiSS, for bioregenerative life support systems. It's really about having closed systems that can pass and exchange fluids and gases in a way that would allow you to grow plant material in space, in part for food in multi-year missions. So you could think of it as a veggie garden for space, but it's much more complicated than that. How do you capture and recycle the oxygen and the water, or use the off-Earth materials as your "soil"? How do the plants interact with microbes that might be unique to the space environment or introduced by humans?

The second campaign is called MATRICES, and it concerns manufacturing materials and processes sustainably in space. It's fundamental science about things we don't understand about the physical world, largely in materials that are both liquids and solids, and active and passive. How do they work in space? How can we use that to process and manufacture things better in space, with minimal adverse impact on those environments? It could also result in technologies that we could use on Earth for greater circular economy and use of materials and less waste here.

What role can Cornell play in these efforts?

I think it's important to recognize that while this decadal survey is only developed and released every 10 years, there's really amazing research that is aligned with the goals of this report happening on all of Cornell's campuses right now. In fact, a steering committee member on the report is a colleague at Weill Cornell Medicine, Chris Mason.

We have the Cornell Center for Astrophysical and Planetary Science (C-CAPS). Their faculty have been involved in other decadal surveys, so

they understand the decadals and they also understand how to plan and resource missions. There's also the Sibley School of Mechanical and Aerospace Engineering, and there are researchers who are doing great work there, including Mason Peck. We have the Air Force Research Laboratory hub for the Middle Atlantic region, which works directly with the Air Force and the Space Force on engineering challenges. And then there's also research going on in the College of Agriculture and Life Sciences and the College of Veterinary Medicine and the College of Human Ecology—three colleges that you might not think have a lot in common—that have aspects of how to conduct research around food and water resilience on Earth, which often involve the same things that would be necessary in a BLiSS campaign. And there's great antimicrobial and vaccine research, and quantum communication and sensor research, at Cornell.

We plan to have a Cornell Space Day this fall, in part to amplify what was in the report, but also to highlight some of the great research and discoveries already going on at Cornell that connects to the space science challenges.

What else should people know about working on the survey?

I found it really enjoyable. You know, to lead or participate in a team like this, you're doing it as volunteer service to the nation for several years and you are synthesizing many views. So it's not easy, but I do hope that more people say "yes" to these opportunities. It is a great opportunity to understand your research community better, from the public to the private sector. When the government calls to ask if you can spend time grappling with the future, alongside other scholars whose expertise is well beyond your comfort zone, don't say "no." If you can, say "yes."