TRANSCRIPT

Key Conversations with Phi Beta Kappa

Why Dr. Dava Newman Will Be Among the People to Get Humans to Mars

Dava Newman has spent her career figuring out how to get humans to space, and helping them not only to survive there, but also to thrive. She is the Apollo Program Professor of Aeronautics and Astronautics at MIT and the former NASA Deputy Administrator. Her multidisciplinary work combines aerospace biomedical engineering, control modeling, biomechanics, and human interface technology, and she is a leader in advanced spacesuit design. In this episode, she talks about her journey from her childhood in Montana to college at Notre Dame to her research at MIT to a leading role at NASA, in addition to how close she thinks we are to getting humans to set foot on Mars.

Fred Lawrence: This podcast episode was generously funded by two anonymous donors. If you would like to support the podcast in similar ways, please contact Hadley Kelly at hkelly@pbk.org. Thanks for listening.

Thank you for joining us for Key Conversations with Phi Beta Kappa. I'm Fred Lawrence, Secretary and CEO of the Phi Beta Kappa Society. On our podcast, we welcome leading thinkers, visionaries, and artists who shape our collective understanding of some of today's most pressing and consequential matters. Many of them are Phi Beta Kappa Visiting Scholars who travel the country for us visiting campuses and presenting free public lectures that we invite you to attend. For the Visiting Scholar schedule, please visit pbk.org.

Today, it's a pleasure and honor to welcome Dr. Dava Newman, Apollo Professor of Astronautics and Engineering Systems at MIT. As the first female engineer and scientist to serve as NASA Deputy Administrator, Professor Newman focused on articulating the human journey to Mars, highlighting scientific missions, and advocating for diversity and inclusion at NASA.

She is a leader in advanced spacesuit design, leadership development, innovation in space policy, and was a terrific Phi Beta Kappa Visiting Scholar in the 2018-2019 academic year. Welcome, Professor.

Dava Newman: Thank you. Great to be here.

Lawrence: You know, when somebody says that something is complicated but not that complicated, they say, well it's not rocket science, but your work kind of is, or actually more accurately, astronautics. There are a lot of interesting questions I want to ask you about your work at NASA, the Mars journey, the spacesuit. But first I want to take you through your own journey a little bit. Before we get to Mars, let's get you to MIT and NASA. You grew up in Helena, Montana, right?

Newman: Sure did, Big Sky Country.

Lawrence: Big Sky Country. Tell us some stories about growing up in Montana.

Newman: It was a great place to grow up. I think that's where my love of nature came from. You do look out the window, the door, and you're always playing in the mountains and literally people have to go to Montana to understand what Big Sky Country is with the vast skies.

I was always looking up at the stars. I was five years old when Apollo 11 landed and I remember it like it was yesterday. I think it really taught me to dream—anything was possible. Here I was a young girl in Montana, who would've thought I'd become an aerospace engineer. It's that vastness, that wonder and always really pretty grounded in terms of nature and the beauty that surrounds you.

Lawrence: So was it really Apollo 11? Tell us about that moment for you.

Newman: I think it was. I was always outside exploring. I think I'm almost a born natural explorer, whether it was running up the mountains or looking in this cave or that cave. Also just thinking that there was no bounds, no limits. That's really what Apollo... “Really people got to the moon?” And just showed us that with focus, determination, great leadership that anything was possible.

It was probably my first lesson in turning the impossible into the possible. I'm not sure I got all of that when I was young growing up, but when reflecting on it, it was really inspirational. I also always had the sense to look beyond the horizon to explore. Look up at the stars, go around the horizon, climb up that mountain. Just because, just in wonderment.

Lawrence: So when you look at your classes today, there are obviously many young women who were aspiring in physics and astronomy and in all of the technical areas that

you might be involved in. But let's go back to your childhood, not such a common path in the ‘60s, ’70s, even early ‘80s for a young woman to become a scientist. Did you get encouragement along the way?

Newman: I got encouragement. My folks were teachers. My father was involved in politics a bit as well. From a family of teachers, that was really important to me. There was always encouragement to learn more, to study. I love school and sports. If I wasn't out doing sport, then I'd be thinking about, well, what's the next step?

I didn't know what an engineer was. To this day, I've never been taught by a female engineer. So there were also those environmental signs that, well girls don't do this. Girls do something else. First I was going to be a football player. I have two older brothers. Girls don't do that. Really? Why not?

So, I had to...I learned all those lessons, but I think with the right amount of encouragement and I was pretty persistent, and just said, I didn't listen to no a lot. That's the advice I still have today. Don't listen to no, that's an easy excuse.

Lawrence: No is on the way to getting to yes. Right?

Newman: Exactly. Always yes first and then, and then give someone a try. Especially when it's a young person with a big dream.

Lawrence: There certainly are plenty of universities out West, including in the Big Sky state of Montana, but you went to Notre Dame. What was that experience like coming at least that far East?

Newman: Notre Dame, I think maybe I credit my older brother for that. I think maybe he wanted to go there. I ended up there and it was... I really was looking for a liberal arts college. It was perfect for me. Truth be known, I loved philosophy. I studied philosophy. Then was very practical, knew I wanted to get a job and-

Lawrence: You're in the right place to talk about philosophy as well as engineering.

Newman: It's great. Because I was with my college friends and we'd stay up all night and say, is there anything like a just war? Can we rationalize that? Can anyone rationalize that? We would stay up with all kinds of fantastic, I think pretty important, weighty questions, especially for college students. I became an engineer, that was practical. And it was also a challenge. It was really problem solving. I had to be introduced to it later.

My freshman year, I was a pre law major and I became an engineer not till sophomore year. I really didn't know what the opportunities were, but I had... I was very good in science and math and I just looked at them as tools. I didn't know what my passion was yet, so I was looking around for what my passion

was going to be and then that goes full circle back to exploration. That's why aerospace engineering in particular.

Lawrence: So take us along that path. At some point you go from what is a just war and pre law to aerospace engineering.

Newman: It was a bit of a flip and again it's good advice. I got to say, wait a minute, we'll use your technical skills. But really it was very little mentoring, no counseling. I went to a public high school and I knew I was going to go somewhere and try to learn as much as I could. I had a lot... and I also walked onto the women's basketball team. That was a big part of my college career.

Lawrence: Now wait a second. We're going to go back to the other stuff in a second. You were a walk-on on the women's basketball team at Notre Dame?

Newman: Right. I was going to stay home in the West. You mentioned Montana or even Washington or in California. I had some fellowships to play basketball, but I knew it was always going to be academics first. Look, I was realistic. I'm a female, I'm short, but I did want to play at the Division 1 level to play sports. Kind of just to prove it to myself really. See if I could do that.

Lawrence: That's very serious women's basketball, Notre Dame.

Newman: It was fantastic. I learned a lot. Although I only played... I was on the team for two years. Then I started coaching at a high school. That was an interesting transition as well. I walked on, of course I wasn't a starter, but it was just great to be with the team. Those are still some of my best friends, lifelong friends from the women's basketball team at Notre Dame. I'm still a big fan. The Lady Irish. Those are the games that I watch. I don't know if you saw the movie *Hoosiers*?

Lawrence: Of course.

Newman: Well that bus, I know all of Indiana. That was us. We were on that bus. You would go to a rural town, varsity women's high school basketball and the whole gym would be full. Full. Friday night full and you were in the middle of nowhere. Really living the Hoosiers. It was really fun.

Lawrence: So from Notre Dame you find your way to MIT and in a certain way, never left. I mean we'll talk about the NASA years, obviously, but you've been at MIT as a graduate student and then staying on with the faculty really, right?

Newman: My first faculty job was in Houston. Actually, I went to the University of Houston. That was another great experience. For a year and a half, I was away. Then I did come back to the MIT faculty.

Lawrence: Let's start your graduate work at MIT. When did that start to take shape in terms of the projects you'd be taking on?

Newman: When I went to MIT, I joined a laboratory that specialized in human space flight and that was... I had looked at other schools. I thought I would go home, back to the West. That was more of my comfort zone.

Lawrence: Right.

Newman: I consider myself from the West. Also looked down in Texas because there's great opportunities in aerospace in Texas.

Looked at Stanford and UT Austin and I ended up at MIT and first I thought it'd be my third place, but it ended up being my number one school because I could go to a lab that specialized in human spaceflight and that really put together, not just the engineering, but my love of human performance, biomechanics. I didn't even know you could do that in graduate school and then work on experiments to train astronauts and flight experiments for the space shuttle. That was the key. I said, boy, what a great opportunity.

Lawrence: And did you go to MIT to do that or you discovered that when you were in MIT?

Newman: I went to MIT. I was introduced to that laboratory where I could specialize in astronaut performance and work on space flight experiments. That really helped me make the decision of where to go for graduate school. Now I'm in that lab today. New name, we call it the Human Systems Lab, but it's great. I've been involved with that lab for a long time now. Almost 30 years.

Lawrence: You also served as director of the Technology and Policy Program, TPP, which is this extraordinary interdisciplinary research and graduate program that brings together not only the scientists but the policy people and political scientists, economics. Tell us a little bit about that.

Newman: I was an MIT graduate student in aerospace engineering and loving it. But then I had a friend, actually a great friend, now, Mike Massimino, astronaut, he's at Columbia University now. He said, Dava, I'm in this thing called technology and policy. I had never heard of it. It sounded so fantastic. I said, "What are you studying?" He said, "Economics and law with my technical subject." I said, "Well how do I get in?" I applied and did a dual master's degree, thanks to his great advice we remained buddies ever since.

It was really interesting because it went full circle for me. It was these other things I was so interested in, in policy and law and tried to make my deep dive into engineering and aerospace, but much more tangible and relevant and hopefully applicable to leadership and maybe policy in the long run.

It was expanding for me, kind of broadening. I had to take microeconomics, a law course, things like that. That was really a great program. It was a lot of work because it was two master's degrees, but it kind of went full circle back to my humanities, arts, social science. I got to dabble in that. I felt like I had put a little bit of that on hold going into the deep engineering classes, and I really was desiring to take more breath and kind of go across some of the different disciplines.

Lawrence: Right. Kierkegaard said “Life has to be lived forward and understood backward.”

Newman: I love it.

Lawrence: Doesn't always look like a straight line when we're living it, but there was an arc to it as we look back on it. Let's talk a little bit about the NASA years. First of all, how did the opportunity to be the number two, the Deputy Administrator of NASA, which I like to say the Deputy Administrator plays the role of creating the illusion that the Administrator actually runs NASA. You probably can't say this, but Deputy Administrator really runs the organization, doesn't she?

Newman: It was an amazing opportunity. I worked with administrator Charlie Bolden. We made a great team and all of the civil servants that we had the great pleasure really, and honor to work with and lead. But our team was really phenomenal.

Lawrence: And this is a job that involves running essentially an enormous corporation, if you will. An enormous institution. Right?

Newman: Right. We were just under 18,000 people at NASA, civil servants across nine centers. If you count the contractors, that's 75,000 people and you have communications with all. You have 120 international partnerships. So when I was either up at the Hill or Congress and said, Okay, that was maybe one of the more challenging parts. But I said, I have this. I'm just there to educate.

I'm just there to make sure they understand what NASA's doing. Because everyone loves NASA. Everyone loves NASA. It's completely bipartisan. It's actually a great agency to be from because you walk in, think you have a lot of credibility going in and you're just there to educate, to make sure they understand what the needs are, what the priorities are.

Lawrence: Well, is it as simple as saying that everybody loves NASA? I mean, I remember where I was when men landed on the moon and I can still picture it on my parents' black and white Zenith TV set in their living room. But at the other hand, by the time you become Deputy Administrator, which is 2015?

Newman: Right.

Lawrence: There are plenty of other draws on the federal budget and on governmental concern. So how do you make the case that there should be resources for space exploration at a time when we've landed on the moon—we've done that—and now there are other needs and other concerns?

Newman: That's a great point. That is really the job. I like to say everyone supports NASA. Everyone loves NASA in terms of across the whole Congress and the executive but who are the advocates? Are you on someone's top three list? That's the hard part. There's so many pressing issues that even though NASA has general broad support, it doesn't pop up usually to someone's top three list. That's the work to do.

Lawrence: How do you do that? How do you get onto somebody's top three list? Just because that's an expression that people inside Washington would understand, but not everybody would. Tell me what you mean by that, that top three list.

Newman: For any Congressman, Senator, they have their constituents. They have what state they're from. They have their district. And so they're going to have just a few really top priorities that are going to take care. Typically it's healthcare, jobs, the economy, things like that. Science and technology don't tend to be at the top of folks' list.

Newman: Jobs do, the economy does, but science and technology.... So you really have to have a discussion to say, first of all, it's a long-term bet and this investment in science and technology.... Now of course I'm biased, but it's proven out pretty well in history. Ever since World War II and the science and engineering model is really invest and how do we get our innovation going in the U.S., these long-term bets in education, first and foremost, in science and technology, the STEM fields, and medicine have really paid off, but you have to have that discussion.

Lawrence: Do you remember a time in a Hill meeting or maybe even a hearing where you felt, "There. I just got through." You can either mention the Senator or Congressperson's name or not as is appropriate. But do you remember a moment where you felt you've found the key that turned the lock?

Newman: Usually it was in, again, back to education. Usually it was in talking to them at just about.... Let's say, we have a hundred science missions going on at NASA. I'd say, "Do you know we just got to Pluto." "What?" Or "Do you know we're at Jupiter today with our Juno mission?" The eyes would just open up, "Are you kidding me?" Because they don't have time. They're busy people and say, "Yes, that's the wonderment." "What are we doing there?" You can bring them in. I helped write and put out the journey to Mars, the human journey to Mars. That's a horizon goal.

They would say, "Why do we want to do that?" You would start with these amazing stories that are this is what we're doing today. Can you imagine we're on Mars today with seven assets. NASA has five current missions at Mars. This is what we're learning, the evidence of flowing water.

So you're telling them these stories, which are the scientific, factual information. I would get full attention. "Tell me more." That was a good meeting. Since you have 15 minute meetings, you really have to be pretty concise and just tell them a few points, and at end of the day it's really about people making that relationship, talking to someone. They also had to be really relevant probably to that Congressperson's district, what's happening in the West or the Southwest.

A lot of times it was about what's happening with the weather, natural disasters, climate change, agriculture and weather and planting, things like that. Really tangible things that essentially NASA and a lot of the other science agencies are providing the data, really important data and in this case of natural disaster. Real time data to keep people safe and out of harm's way.

Lawrence: So let's go from Washington out into the world. How much is the Deputy Administrator involved in the international aspect of space exploration and America's role in that?

Newman: It was wonderful to have the broad international portfolio of NASA. I worked with Administrator Charlie Bolden. We worked together, but he was very glad when I joined him as deputy, we split up that portfolio. First, we would go together and he really mentored me and I saw his leadership and from all those cues. Then when I went out and visited our international partners on my own getting, representing all of the agency, you have a huge support from the professional NASA people that run the international organization.

There's a program for international interagency. You're there with your NASA colleagues who are experts. You're incredibly well briefed. And we had hard work to do. For instance, it was a European ministerial. They were going to vote to either remain and continue partners on international space station or not. In all of Europe, this is 22 European nations make up the European space agency at the time. That is quite a coalition and they all have their different interests and also budget concerns.

They're really saying, what's the return on investment of these science investments? I was from the German Bundestag to the French parliament to you name it. All over Europe.

Lawrence: Did you think of yourself as part of American foreign policy or is that happening someplace else and you were doing science?

Newman: Absolutely. Soft diplomacy, critically important, especially with Russia.

Lawrence: I was going to ask are there nations that might surprise us? You're talking about the European nations and sort of our traditional allies, but tell us about working with the Russians in space exploration.

Newman: So with Russia, the US and Russia have been working very well together. Again, go back to the personal level. I think it's from Apollo Soyuz. That handshake more than 40 years ago now. That handshake, US and Russia shaking up. Then it was the Soviet Union. Personally, I've been working with Russians for 30 years. Since the 90s. I flew my experiment, that's as a principal investigator, a NASA funded principal investigator, on Mir. The Russian space station, Mir meaning peace. It's Russian for peace.

From 1996 through 1998 I had my experiment of training astronauts, training cosmonauts at the engineering and sciences level. We just worked together wonderfully because we're so curious and people are people. We want to know their techniques. They might do something different. I might do it a different way, bring in some technology to understand the astronaut performance.

These are really personal relationships and they're also scientific. We want to share the data. We've talked to each other. So, kind of regardless of high level politics, things are going really well in human space flight. I think is the best example we have of US Russian cooperation and, again, I call it soft diplomacy. When I was at NASA, I was very clear on what my role was and that was to foster any way we could a good relations and beneficial relations and positive relations with Russia and we really do that through human space flight.

Lawrence: Are we going to get to Mars? Are we going to land someone on Mars in the near future?

Newman: Absolutely. That's my life's work. Realistically, it's 15 years out. We always say, it's 20 years out, but we're getting so close now. We're going to go back to the moon. Just super exciting. That's the 2020s. We need the technologies. We need the heavy lift launch. We have to go to the moon. It's actually a great testing ground. We just have to be really strategic.

All the investment for the technology and the knowhow to get to the moon, that also has to help get us to Mars. We can't fund things that are just moon specific. Frankly, I don't want us to get stuck on the moon for 50 years. We've been in low earth orbit exploring and I love low earth orbit—but it's only 400 kilometers out, 250 miles—for 40 years.

That's too long. We need to get to deep space. Deep space is beyond low earth orbit when you get back to the moon. The moon is in what we call deep space,

so is Mars. That's where we need to go. I hope we can get to the moon, but more mobile. Let's not be there for 50 years. If we have permanent settlements, great. But Mars is our horizon goal. Just as Apollo was 50 years ago. It was so hard, so audacious.

Now Mars is out there and the reason for Mars is... You saw *The Martian*, the movie, it was great. We worked with them at NASA. We helped them do...

Lawrence: Were you involved in that?

Newman: Oh yes. Very involved. We have a space act agreement. They really wanted to get all the technologies right. They tried really hard with the story as well. At first, it was a great book by Andy Weir. Shout out there and then Ridley Scott produced a great movie and we worked really closely with them giving them all kinds of science advice and whatever they wanted, we would work with them.

Back to Mars. Why Mars? Because this is where we'll probably find the past evidence of life. 3.5 billion years ago, Mars very likely had life. It was wet, warm, and wonderful with rivers, and it lost its atmosphere, lost its electromagnetic protection, if you will. Today, it no longer has life, but we have the evidence of organics. We have the evidence of water.

When you're looking for life in the universe, we say follow the water. The evidence is mounting. I actually think it's very likely we might find past life, fossilized life. When you go to the beach and find this amazing fossil, well, we might find that at Mars too and that would be phenomenal. That's really why Mars is, we're looking for life in the universe.

There's all these other... There's other beautiful places in the solar system called... We call them... We say when you're looking for life again, look for the water. We call them ocean worlds. Most of them are moons of planets, but they have oceans. They have oceans. It's just amazing. So Enceladus, it's a moon of Saturn. We have Europa, a moon of Jupiter. And these places are water worlds. We really think that they could be teaming with life.

Lawrence: Could we get people there? And actually more to the point is it worth it or is it better to do the unpeopled probes that we're doing right now?

Newman: Right now it makes sense to go with the scientific probes. With people, Mars is probably what we call the horizon goal. It really does make sense. It's so hard and it's so far, but going to Mars with people, the first human mission, I hope I can have four, six people. It's going to be one of my students, boots on Mars. That first mission is going to, in terms of range and what we can discover, will surpass the 50 prior years.

We're there with our rovers, we're there with orbiters and we're getting great data every day on Mars. But just that first human mission will surpass, will go further. It's really humans and all of our machines. In the next decade, the 2020s, we'll be on the moon practicing and learning and discovering. And there are these amazing ice reserves we think now in the South pole of the moon.

And we have to figure out, okay, what do you do with ice? Well, ice is water and people need water to live. We call that in-situ resource utilization. What can you use? How do you live off the land? Successful exploration always lives off the land. You can't bring it all with you.

Lawrence: Right, and if you can actually get water, the secret element of life.

Newman: You need fuel, you need water, you need life support systems. These are all the elements. Again, that's what we're practicing and technology development for the moon. However, when we get to Mars then it's real likely that Mars once had past life. That's what we are going there to find out.

Lawrence: So spacesuits is something you know something about, having designed the biosuit, you and your team at MIT. Tell us a little bit about that.

Newman: Well, first I want to tell you about the team. The team is fantastic. It's engineers, it is designers, and architects. It's really a diverse team and that's important. We don't want to be at the table with just rocket scientists and aerospace engineers because we solve a problem one way.

So we have designers, architects, other folks, even biologists and people to say, how can we do this? It really is inspired by biology and human performance. We're trying to couple that. Let me start with a spacesuit. The current spacesuit is a gas pressurized suit. It's 140 kilos. It's big, heavy, almost 300 pounds.

Take a spacecraft and you shrink it around. I call it the world's smallest spacecraft. Take all of the functions of a spacecraft, provide oxygen, scrub your carbon dioxide, and now you shrink it around a person. That's an engineering marvel. But it's big, heavy, clunky, not very mobile.

Lawrence: Although it doesn't weigh much in space, right?

Newman: In microgravity. Exactly. We're going to the moon and Mars. We have one sixth gravity on the moon, three A's gravity. That's what I think about. This is a future capability for planetary exploration, but our design philosophies, and I want to take the human emotion, the human body and enable that. I think of then, how do I design a spacecraft basically from the human body out.

It's really literally a second skin approach. Different design. I can take a spacecraft and try to shrink it down, but that's pretty hard to do and that's the system we have today. Otherwise, I can take the human body in motion. It probably goes full circle back to my loving sports and being an athlete, growing up and saying here's all this wonderful function. Biomechanics, performance, why would I want to inhibit that with a suit?

I want to make sure that you have all of your abilities. That's a different design philosophy. Designing from the human out in this case. It's hard and we have to make sure it's technically feasible and that's why it's research and development. So far it seems technically feasible. It's called mechanical counter pressure. You're pressurizing directly on the skin.

Lawrence: You know, I think in my past life and different academic positions, I once calculated that I read something north of 10,000 course evaluation forms. And I think the common thread of all successful teachers of all kinds, seminar, lecture, blackboard, PowerPoint, all different styles is if you can communicate, there is nothing more important I could be doing right now than communicating this information to this audience. And I think you have done that with your students. You did that for us at Phi Beta Kappa. You did that on Capitol Hill.

I think we are all the beneficiaries of the enthusiasm you've had for the mission that you do and we'll continue to do and I'm persuaded that we're going to get to Mars and when we are, I want to find out from you how we got there. Thanks so much for joining us today in the studio.

Newman: My honor, my honor. And just thank you so much and that's it. That's a great summary. Just to be excited every day and passionate about that, about the possibilities for all of us. Thank you.

Musical interlude

Lawrence: Thank you. This podcast is produced by Lantigua Williams & Co. Paola Mardo is our sound designer. Hadley Kelly is the PBK producer on the show. Emma Forbes is our assistant producer. Our theme song is Back to Back by Yan Perchuk. To learn more about the work of the Phi Beta Kappa Society and our Visiting Scholar program, please visit pbk.org. Thanks for listening. I'm Fred Lawrence. Until next time.

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