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"Meet a NASA Engineer" #3 — George Gorospe (May 16, 2019)

SPEAKER: Hello, everyone. Thank you for joining us. Give you a quick background on George.

George is a NASA research engineer, and is the manager of the Diagnostics and Prognostics Research Group at NASA Ames Research Center. He has his BA in classical studies. Classical studies at Dartmouth College, and a master's in mechanical engineering from University of New Mexico. So when he was at University of New Mexico, he worked for Pueblo News. So he's a diverse thinker.

And he started work at NASA through internships provided by Tribal Colleges and Universities Program, the NASA Robotics Academy, and NASA Academy for Space Exploration. He is now the manager of Intelligen Systems Division in the Systems Health, Analytics, Resilience, and Physics-modeling, SHARP Laboratory. He will discuss his research efforts at SHARP and tell us a little bit about his path on how he succeeded and is doing this amazing work at NASA. So with that, I'll turn it over to George.

GEORGE GOROSPE JR: Great. Thank you so much for the awesome introduction. Yeah, I-- I had a really great path to NASA, and that's the first thing I want to talk about today.

I think that when we think about engineering, we think about a hard science, people in lab coats looking at mechanical systems and doing calculations. And to some of those-- to some of us, that can be very exciting. Some others think, oh, maybe that's not my type of thing, because I'm much more of a creative person. Well, the thing is, I always thought I was a very creative person, and I eventually found that at NASA, I can use creativity and engineering to solve problems and create entirely new systems that have never existed before. So what I'm going to do today is talk a little bit about my background, and also about my-- how I got to NASA through my internship experience.

So my path to NASA started as a student through internships. My first internship actually has to do with the Tribal Colleges and University Program. As a student, I knew I really loved NASA. I knew that NASA was the place for me because I loved to solve problems. And I knew that NASA's problems were the biggest and most challenging problems on Earth and in space. So I knew NASA would be the right place for me.

After a year of study, I got a chance to internship at NASA. And it was really a life-changing experience. You see, the thing is, I applied to NASA. I applied to all the NASA centers. And I was waiting for summer to come by. And one and one by one, I didn't get the internship. One NASA center said, sorry, we need somebody else. Another NASA centers said, sorry, we need somebody else. And

Finally, I heard about this program called the Tribal Colleges and University Program. I called up the administrator of the program, and they told me that at NASA Ames, the program was really small, only lets in a couple students per year, but that there was a space for me. And I thought that was amazing, because you see, NASA is an $18 billion a year agency. That's how big the budget is. That's billion with a B-- $18 billion. And among all that money and all the people that work for NASA and all the awesome systems and robots and astronauts that they train, NASA thought it was important to create a program

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just for Native American students, to help Native American students get into NASA and get their feet wet working on some of the awesome projects that NASA has. And would you believe it, they created a spot just for me.

So here we are, getting ready to go to NASA. I was so excited but also really nervous, because I got a project at NASA Ames Research Center. So like any good engineering student, I did my homework. I looked at, what is NASA Ames like? Well, I found out NASA Ames is particular in the entire world for one important thing. NASA Ames has the highest per capita doctorates. These are people with PhDs. So if you sit at a cafeteria table and there's 10 people at the cafeteria table, guess what? It's likely that at least seven of those people have their PhD. That's incredible, because this is a really awesome place full of just really, really intelligent people.

I thought, this is wonderful. This is where I should be. But then, also, I became worried. I said, oh man, I'm just a kid from the reservation. What am I doing going out there? These guys, they think I'm some kind of genius. I hope I can live up to their expectations. This was really worrying for me.

So I arrive on my first day and I meet my mentor, who's really, really nice. We talk about space and spacecraft and sci-fi and things like that. And he leads me into the most amazing place I've ever been to-- this research lab where there's experiments going on, there's lights blinking. There's computers everywhere. And in the corner is what we see here. This is the robot. This picture was taken in 2008 of this robot.

In fact, when I got to see this robot, the robot looked just about the same. The thing is that my mentor said, hey, we recovered this robot. The group that was building this robot-- they ran out of funding and the government was about ready to auction this robot off. It sat in a dusty warehouse for the last four years. Here's the deal, George. I need you to make this robot autonomous by the end of the summer.

By the way, I'm really busy. I'm not going to be able to provide you too much help. I know you can do it. Send me an email or something like that. I've got to go. I'll see you later. Bye.

And suddenly, it was just me and the robot in this laboratory. And I'm going to be honest with you guys-- for like 30 seconds, I was panicking a little bit. And then for the next 10 weeks, I was so excited, because this is a real project. This is getting your hands wet. This is why you study math and why you study physics and why you study programming-- so that you can make use of all of those skills on a really awesome project like this.

So I want to say things went really well, but they didn't. So after about two weeks of working on this robot, you know what happened? None of the wheels were moving. I couldn't even turn the robot on. I thought I was in big trouble. I've been working two weeks on this thing. I wrote down all the part numbers. I studied everything I could about it. I read about robots as much as I could. Still, no progress.

And I went to my mentor and I said, hey, look, I think maybe you guys got the wrong guy. I don't think I can make this robot work. I can't make it autonomous. And my mentor said to me, George, hold on.

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Slow down. Look. This isn't like a physics problem set. This isn't something where your professor assigns you problems to do and you come back the next week with the problems complete. This is a 10-week project.

You have 10 weeks to figure out what you don't know. And you have 10 weeks to learn what you don't know. And you have 10 weeks to apply what you just learned to solve a problem you couldn't have solved previously. So he said, George, tell me what you don't know.

And I said, I don't know how to program this robot. The programming language I studied in school is completely different. So my mentor said, hey, don't you worry. I got you. From underneath his desk, he pulls out a big book. It says C++ the Hard Way. He says, take this book. Go read it cover to cover. And then I guarantee you're going to program that robot.

And I believed him. And I went back to my cubicle and I took this book. The thing was as thick as a telephone book-- for those of you that remember what a telephone book looks like. I went cover to cover. And in the end I said, I got this. I programmed it. I can do this.

I went to my mentor and he said, do you know how to program it? And I was like, yes. I know how to program. I can read it. I can do this. He said, well, get started.

So it was already eight weeks into my 10-week internship. The robot hadn't moved even a little bit. But I was programming, getting started. And finally, on the Monday of the eighth week, I got one of those wheels to move. On the Tuesday of the eighth week, I got two of the wheels to move-- but they were going in the opposite direction. On Wednesday, I had all four wheels moving. And by Friday, I had that robot out in the grass-- outside of the building entirely.

The next week, I was programming it to be autonomous and do what I wanted to do. And in the very end, I was able to create this GUI that we see on the side, here, with the NASA logo and the buttons. I programmed that into my phone so that I could control that big robot with my phone. All of this in 10 weeks.

But if you recall, after two weeks, I was worried that I couldn't do anything. What I realized is that all I had to do is figure out what I don't know and take that information, learn the things that I need to learn to solve the problem, and then immediately turn around and go and solve the problem.

It was such a life-changing experience. I always look back to it and think, when I'm learning still now, in my projects, this is where I got started.

So what happens if you're really good at robots at NASA? They bring you back. I proved to them that I could learn. And so what they said is, we want you back here next summer. And they invited me to the NASA Ames Robotics Academy. This was an academy for students who were really interested in robotics, self-starters, people who were really motivated.

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There also was a project to create a lunar micro rover. So the robot that we see on the left-hand side-- that robot is about the size of a loaf of bread. It's not so big. But it's designed to operate on the moon, with all the harsh environments associated with the moon. That robot-- we designed it ourselves to work there.

And part of that design process involved stress analysis. And so what we see-- this brightly-colored system on the right-- well, that's a stress analysis that I did for one of the two motors that operates that rover. I had to learn how to do that stress analysis over the summer.

No one said that this is a specific software that I need to learn. What was told to me is, hey, we need to make sure that this thing can survive a trip to space and can survive a landing on the moon. Well, what does it take? That's a wide open question. What does it take to make sure it survives? You can't do this more than one time. You need to do analysis beforehand to make sure that when it actually goes, it will survive.

So I had to learn all the skills involved with stress analysis and then put that to work to change the design or to say, yes, this is, in fact, going to work. It was a really, really exciting time. And I got to work with a lot of really motivated students.

And then, finally, it came to this-- the NASA Ames Academy for Space Exploration. I had been interning at NASA for two years. And finally, I applied for this. This was NASA's premiere leadership development academy. Part of this academy, NASA took 10 students from the US and four international students and took them all over the United States to all the NASA centers to learn from project managers, even the administrator of NASA about what makes NASA great and how to make NASA successful in the future. And they also gave us these really cool blue polos.

A part of this project, they said, hey, George, we know you really love robots. And so we've got a robot project for you. And they sent me over to this research laboratory. This research laboratory focuses on the moon. I said, OK, first day-- show me where the robot is or tell me what kind of robot you want me to build. Let's go. I'm going to make some robots this summer.

And my mentor that summer, he said, no, George. Let's take a step back. Why does NASA build robots? Well, that's an easy question, right? NASA builds robots because, well, robots are really cool. And my mentor said, no, no, no. That's not why NASA builds robots. Think about where NASA sends their robots.

I said OK, well, NASA has sent robots to the moon, to Mars, to Saturn's largest moon, Titan. And my mentor's was like, yeah. Those places, among others. What did the robots do there? And I said, well, they kind of looked around. My mentor said, no, George. They were doing planetary science.

That's what geology is called when you go to another planet and do it. Well, why is planetary science important? Well, planetary science is important because we get to see how the solar system formed by looking at planetary science on other planets.

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So let's look, real quickly, at the brightly-colored sphere on the left-hand side. Now, that's really interesting. We've got different color variations. The darker colors like the blues and the purples and the magentas-- that means that it's deeper. And the lighter colors means that it's higher. So from this image, we can see there's a really big pit on the side of this thing.

What do you think that is? Is it Mars? Is it Venus? Is it another planet? Well, that's actually our moon. That is the far side of the moon-- the side that we don't get to see regularly. And what do you think might have happened there? Yeah, you got it. A huge asteroid hit the moon and caused this humongous crater. The crater is actually about the size of the United States-- that crater that we're seeing there.

So what happened there? It hit and it pushed a lot of the material away from the deeper levels of the mantle, if you will, of the moon, exposing some of the lower levels of the material. Well, that would be a great place to send a robot, wouldn't it? I agree.

So what my mentor said is, your job is to figure out what the robot's going to do if we were to send one to that part of the moon. We want you to develop a robotic lunar mission concept design. Think about why we would send a robot there and think about how. Think about the size of the robot. Think about the type of sensors we'd want to put on the robot.

Put it together, and we're going to propose this mission to NASA. We're going to say to NASA, hey, this guy-- he wants to go there. He thinks that this type of robot's the right one. He thinks that this is the way to do it. If you agree, we want $500,000 to do it.

Well, NASA-- they said, you've got a great idea, but it's not ready yet. We need you have more experience. So what did they do? Well, they hired me. They hired me. And I got to work at NASA.

I was really excited about this part, because I got my dream job. Now, have you ever consider that NASA might have a room full of smart young people just thinking about space stuff all day? Like, hey, man, why don't we go back to Venus? Or, have we ever sent a probe to Mercury? What would it take to do that? Just people thinking about that and asking those questions all day long. I worked in that room.

Yeah, that room exists. And I was in that room. And it was so exciting. But I learned that that room has an extra name. The name is called the Prove It Room.

Now, why would you call a room a Prove It room? Well, it's like this. They said, hey, you think you're pretty smart, huh? Time to prove it. And so in this room, you have to come up with new missions. And you have to propose them to NASA. And if NASA agrees that it's a really cool mission and wants to fund it, then they're going to give you money to work on it.

If they don't-- well, sorry, kid. You're out. Time to find a different job. So it's really stressful, but really exciting.

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And so here's what I proposed. Me and my friends, we proposed super ball bot structures for planetary landing and exploration. We developed this new type of robot that no one's ever seen before and decided we wanted to send it to Titan. But we got three guys who were really, really great at building robots, and nobody who knew how to get to Titan. You can't just look this thing up on a map. So somebody had to learn orbital mechanics.

Well, yeah, I was the guy that had to learn orbital mechanics. And this is how I planned my rendezvous mission to Saturn. Hopefully, you can see the numbers here. But I planned for our robot to leave on December 12th of 2015. And then, after four years, it would arrive at Jupiter, where would do a flyby. And then after five and a quarter more years, it would finally arrive at Saturn, nine and 3/10 of a year after it first left Earth.

I had to do all the math involved with the generation of this trajectory. This is not something that I ever thought I would have to do as somebody who really loves robotics. But it's a really important part of how NASA deploys robots to other places.

So now, if you're on your way home from school or from work tonight and say, well, maybe I'll just take a left turn and go to Saturn-- well, you better plan on a nine and a half year trip. This is how to get there.

So what comes next? Bigger robots. This is really exciting, because while I was still working in the NASA Ames Mission Design Center, the Prove It Room, a much bigger robot project came down. And they said, we need engineers to work on this. So I was the third engineer to start on this project.

It was called the Resource Prospector Mission. Yeah, NASA has sent a lot of astronauts to the moon. And those astronauts stayed there for hours. But eventually, they had to come home. There's a big question-- how can we extend that? How can we send astronauts to the moon to stay there longer?

Think about that. If we send somebody to the moon and we want them to stay there longer-- let's say to stay there for a week-- what have they got to take with them? How do you pack for the moon? Well, you've got to take, probably, some food. Maybe you take your lunch, because you're going to need to eat while you're there. What about water? You're going to have to take some water. But water's really heavy. You're going to want to drink water while you're there. All of these things are really, really important.

The thing is, water is so heavy and it's so complicated to get there. What if there was water already on the moon? What if there was water that the astronauts could harvest from the land? That looks really dry, doesn't it? But what if I told you that not so far away from there is a place where a robot about the size of a golf cart could go and dig up volatile hydrogen deposits and process those deposits to produce two really, really important things-- drinkable water and breathable air?

Yeah, those are on the moon right now. And all we need is a very specific robot to go dig it up and collect it for us and to prepare it for us for when an astronaut is going to live there permanently. Isn't

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that exciting? This means that there's a pathway for us to colonize the moon, to live there-- not to visit the moon, not to go and see it and look around and then come home, but to live there.

This is pretty exciting to me, because personally, I think that the first person that is going to retire on the moon is already alive right now. The first person that is going to be living there for the rest of their life-- that person is alive right now and walking around somewhere-- maybe in class. Maybe that person is a sixth grader right now. But somebody is going to say, oh, I've worked as an engineer or a scientist or a reporter or a nurse or a doctor. And now I'm done with that work. I'm going to go to the moon and retire there.

People are going to live on the moon in the not-so-distant future. And this project was part of making that happen. I think that was really exciting. And I think that's why I joined NASA-- to be a part of something bigger like that, to solve these really huge problems that allow mankind to take a step forward, off of our planet and onto another planet or another moon.

These same kind of technologies can be used, also, in other places like Mars or on Titan to allow humans to live not on Earth, but on another planet for a long period of time. This is one of the things I'm super proud about.

After I was done with there, I went to go work at a place called the Intelligent Systems Division. And this is where we think about how to add artificial intelligence to new devices, to new systems and exploration robots. When a robot goes to explore and something happens to it or the environment's different than expected, that robot needs to be able to think about what to do differently, how to act differently, how to explore in an intelligent way, because there's not going to be somebody there to help fix it or somebody there to guide it.

It's on its own, essentially. And so we have to imbue those systems with their own intelligence. That's what we do at the Intelligence Systems Division.

And specifically, in my research group, the diagnostics and prognostics research group, we allow robots to think and reason on their own state of health. If a robot motor stops working, what is the robot supposed to do? If one of the sensors stops working, what is the robot supposed to do? We develop intelligence for robots to answer those questions.

In the past, robots on Mars had six motors. And in the early-- in 2012, one of those six motors, the one right in front, stopped working. And so NASA got all these engineers and roboticists together. And they said, hey, the robot-- its front motor stopped working. We've got to figure out what to do.

So they made some coffee and they ordered some sandwiches and they sat around and they wrote on notebooks and they got on the whiteboard and started drawing. And then, two days later, they came back and they said, we've got an answer. What do you think their answer was?

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You know what they said? Drive it backwards. Drive it backwards. The front motor's not working? That's OK. Turn it around and drive it backwards. What a solution, right? But it took all those people and all that coffee and all those sandwiches and all those whiteboards to figure this out.

In the future, there's going to be robots exploring our entire solar system. And we don't have-- well, we've got a lot of coffee, but we don't have that much coffee. And so we need to allow the robot to figure it out on its own, through artificial intelligence. And that's what I'm working on now.

[AUDIO OUT]

--became a full-time research engineer at NASA Ames, I've mentored a lot of students who have come and worked with us as interns. So what type of students does NASA need?

Here's the deal. NASA needs students of all majors. You don't have to be an engineer. You don't have to be a scientist. Maybe you like to work with people. Maybe you'd like to work with astronauts and prepare them to go to space. NASA needs people like you.

Maybe you're a graphics designer. You want to design the graphics that are going to go on the side of these robots or on our next generation of rockets? We need people like you to help us. We need curious, creative problem solvers. We need people that can learn new skills and then immediately apply those new skills to solve problems.

Me and my friends-- we call ourselves lifelong learners. We're always learning something new. And we're always excited to share the new things that we've learned. A lot of times, the research that we do results in new knowledge, new technology that has never existed before. So we're at the cutting edge.

I can tell you honestly, a lot of the people I work with-- they really like science fiction. And they really like to think about the future and what the future is going to be like. But most people would stop there. They think, oh, man, I wish I could be alive in the future.

The people that I work with-- they say, can we make the future now? Can we make that technology exist? Can we make something like that happen so that we can live on the moon? They're actively working towards that future every day. And that's so exciting. We need people that can search for and find new solutions. Sometimes finding those new solutions is so difficult. But you've got to keep searching.

So I really appreciate all your attention. This is kind at the end of the presentation. How are we doing on time, guys?

SPEAKER: Doing good. You ready for Q&A?

GEORGE GOROSPE JR: Yeah. I think let's go to Q&A. I'd love to hear some questions.

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SPEAKER: Wonderful. So let me start off with one, I think, that's a broader question. I see there will be some. But a broader question that was asked was, if you could talk a little bit about your pre-tribal college experience and your journey from this college to NASA.

GEORGE GOROSPE JR: Oh, yeah. That's actually a great question. Let me see. I thought I might have had a slide on where I-- OK. Here we go. I should have shown this the first time.

Can you guys see this? This is my--

SPEAKER: Not yet.

GEORGE GOROSPE JR: Oh. Let's hold on a second. Let me go back to this. Let's share this.

SPEAKER: OK. Now we've got it.

GEORGE GOROSPE JR: So how about now? I made it full screen. Can you see it full screen?

SPEAKER: Yep.

GEORGE GOROSPE JR: OK. So let's talk a little bit about my education and before college. So I actually got a chance to attend Santa Fe Indian School. So Santa Fe Indian School is located in Santa Fe, New Mexico. And it is just as it sounds. It was a government-run boarding school for the assimilation and education of Native American youth in the southwest United States.

In the early '70s to mid '70s, a group called the All-Indian Pueblo Council, a group of Native American leaders from all over New Mexico, banded together, got some lawyers, and requested to take control over this school from the government. That's really interesting, because why would they want to do that? Well, they said, we want to instill in the youth our values. We want to control the curriculum and teach them about our history, as well. We want to help prepare Native American youth for their future. But before we could do that, we need to show them about the past.

So at this all Native American high school, I could walk down the hallways and I could hear people speaking in Keres. I could hear people speaking in Navajo. I can hear all these languages and I can converse with them and learn new languages and talk about them, talk about Native American issues and be totally comfortable about that. And it was such an exciting experience.

From there, I was recruited to go to Dartmouth College. Dartmouth College is a really interesting place. It was founded in 1769. This is actually two years before something really important happened, in 1771. Any guesses? General George Washington was elected our first president in 1771. Dartmouth College existed before, really, the United-- well, important parts of the United States. And as such, Dartmouth was created as an environment to educate the Native Americans of what is now New England.

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So I went there. And this really amazing old school-- I studied classical studies and learned from some of the best professors in the world. After that, I went to the University of Mexico. Well, after I finished Dartmouth, I actually went back to Santa Fe Indian School, where for one year, I was the youngest full-time teacher in the history of that school.

I went back because I wanted to improve, to contribute, to help educate the youth from my local community. So I went back to Santa Fe Indian School to become a teacher. And I thought, this is pretty good, but I'm 22 years old. I'm barely a little bit older than the students themselves. Maybe I'll go and get a little bit more education.

And so I decided to study mechanical engineering at the University of New Mexico in Albuquerque, New Mexico. There, I focused on autonomous robotics research. And during my time there, I interned at NASA and did even more robotics.

Now, I'm a graduate student in the middle of my master's program studying artificial intelligence for robotic systems at Santa Clara University, which is a Jesuit university, a Catholic university, here in Silicon Valley, California.

SPEAKER: Great. And so I've got another question for you from Michele. She asks-- this is a quote-- "I know students who are infatuated with NASA and engineering at all levels, but feel they are unsuccessful in math and consider it hard. Do you have advice for them?"

GEORGE GOROSPE JR: I also think math is hard. I think physics is hard. I think computer science is hard. I think that there's a secret. Here's the big secret. It's a one-word secret, and I never realized it until-- well, actually, I started studying engineering. One-word secret. It's called repetition.

Nothing starts out easy. You have to do it over and over and over again to make it easy. Just like lifting weights-- at first that weight seems really heavy, but you lift and you lift and lift, and then suddenly, after many months, you're like, whoa, 50 pounds doesn't seem so heavy anymore.

Well, math is just like that. Physics is just like that. If that math problem was really difficult for you, if the teacher or professor assigned you to do number 7 out of chapter 3 and you did number 7 and you're like, whoa, that was really hard, you know the first thing you should do? Turn around and do number 6 and number 8, as well, because only through repetition can we become better at these skills.

I want you to think about something really important. I think it takes 3,000 hours of intense practice to become truly good at something. That's a lot of homework. That's a lot of problems. But that's part of what it takes. That's part of what it takes. And so even for me, I did really well in some math courses, and some others I struggled in. But I had to try really hard in all of them, because math is really hard.

I think that NASA, for me, represented a goal-- a reason why I'm going to devote those hours to practicing. And you know what? It really worked out for me, because now I get to do things that I absolutely love every day I work. I use that math and I use that physics every day at work to work with

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robots. And I'm so glad that I spent the time training and studying those things to become better at them. I hope that helps.

SPEAKER: Great. So I'd like to ask Wyola Robotics to ask their question. You're on mute right now, so go ahead and ask George your question. This is Wyola Robotics from Montana.

GEORGE GOROSPE JR: Hey, Montana. Where you at? Can't wait for your question.

SPEAKER: We can't really hear you. Can you speak closer to the mic? Can't really hear you. Maybe your mic is not-- I'll tell you what. See what you can do about the mic, and I'll ask your question for now.

So the question was, they want to know what you're currently building right now. You did talk about it some, but maybe if you could cover it a little bit more.

GEORGE GOROSPE JR: Well, so we're really busy right now on a new and interesting project. And this is so new, you might not have heard of it, but I think it's safe to talk about right now. In the not-so-distant future, within the next 10 years, a lot of companies, especially companies here in Silicon Valley, want to start air taxi service.

This is a vehicle that picks you up at your home, lifts you into the air, and takes you across the city or to another city on a regular basis. This is the future where, when you're going to work, you don't get on a bus or you don't get in your car. And you don't call an Uber. But you might use your phone to order an air taxi to come pick you up and take you to your office, take you to some building in downtown San Francisco or downtown Oakland or downtown San Jose.

There's a lot of technical challenges involved with that. And I'm working with a group at NASA to make sure that this can be done safely and that these kind of systems take care of the passengers, fly safely even though we have major airports like San Jose International Airport or San Francisco International Airport-- that these air taxis don't interfere with bigger aircraft like aircraft going to Japan or going to Hawaii or other places.

It's really, really exciting work. And it's fun being a part of something so next generation. I'm telling you guys, the future is coming. And working at a place like NASA, working on these technical things allows me to be a part of it. And that's one of the things that I really love.

SPEAKER: Wonderful. Wonderful. So Quincy, go ahead and unmute yourself and ask George a question.

GEORGE GOROSPE JR: Hi, Quincy.

AUDIENCE: Hi. I asked my brother if he wanted to ask a question, and he asked me, is it true that astronauts have a movie theater and movies up top, like in space?

GEORGE GOROSPE JR: Like, they can watch movies like on their computers and things like that?

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AUDIENCE: No, I think what he was trying to say was, if there's a movie that just came out, would the astronauts be able to see it up in space, or do they have to wait until it's out to the public?

GEORGE GOROSPE JR: Oh.

[LAUGHTER]

Yeah. Actually, that's a really great question. I bet you there are some astronauts in space who are like, what is Thanos going to do next? Yeah, I totally hear that. You know, I don't know. That's a great question. I don't know about that. I like that question a lot.

One thing that you might not realize about astronauts is that when you go into space, a lot of things change about your body. And one thing that more or less is important is that your taste changes. The way food tastes-- it changes. Or the way you taste food changes. And oftentimes, the astronauts end up asking for more spicy food, more bold flavors in their food.

And so here at NASA, we've got food engineers-- food engineers that develop new recipes and develop the type of food that is sent to space for the astronauts to eat. So what if you're somebody who doesn't like to do math but likes to cook? Is there a space for you at NASA? Yeah. Yeah, there is. And it's kind of exciting to work on new types of recipes that are going to go to space.

SPEAKER: Great. And so we're going to give Quincy another question, because that was her brother's question. So Quincy, you want to ask one of your own?

AUDIENCE: Sure. One of my questions was, do they have any sticky foods up in space? Like if an astronaut wants some peanut butter or Nutella or something, would they be able to have it? Or would they just be like, no, you can't have this, it's going to get in the wiring and stuff?

GEORGE GOROSPE JR: That's a really, really great question. And so what I've seen is that those more sticky foods are even preferred, because they don't generate so many crumbs to go floating around space.

SPEAKER: Awesome.

GEORGE GOROSPE JR: Yeah. Good question. Yeah, what astronauts eat is really important, but also what's really important is how astronauts get their food in space. So within the last three years, NASA has started to look at how to grow food in space.

And so I have a question for you. If we were to take a seed-- let's say it's a tomato plant. We're going to take a tomato seed-- one single tomato seed. We can take some soil into space. And we can shine a light on the soil, maybe add a little bit of water. And then we plant the seed. So now we've got all the things that the plant needs.

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But there's no there's no gravity, right? We're operating in microgravity. So how does that seed know which direction to send the leaves and which direction to send the roots if we're in space and there's no difference between the ceiling and the floor or the side and the other side, there's no up and there's no down. How does that plant know how to grow?

That's a really challenging question, right? That's a challenging question that we wanted to find out. And so how do we do it? We started to grow lettuce in space. This is the first way to start thinking about how to live in space permanently. You see, the thing is, for people who were born in the '80s, space was a place to visit. This is a place where we would send people for days or a week or so.

But for people who were born in the late '90s, guess what? Space is a place where people live. If you were born after 1995, every breath you've ever taken, every day you've ever lived, every night you've ever slept, there has been somebody living in space. That's what the future is going to be like. There's always going to be somebody living there. Space is a place to live, not a place to visit.

And that's the same way I feel about the moon-- the moon is a place to live, not a place to visit. This is a place where we will eventually be living.

SPEAKER: Wonderful. Thank you. So I'd like to ask Sylvester STEM to ask their question. You're muted. Yep. You have to speak into the mic, though. We can't hear you. There you go.

GEORGE GOROSPE JR: Hi, Sylvester.

AUDIENCE: Hi. How many robots have you worked on and how long did it take to work on them?

GEORGE GOROSPE JR: Oh. So we work on a huge variety of robots. Some of them are flying robots. Some of them are robots that drive on the road. Some of them are really, really small robots that you could even hold in your hand. Some of them are robotic arms that we use to say, hey, robotic arm, can you construct this system for us? Some of them can be considered robots, but they're more like satellites.

Every time we work on a new robot, we often have to study the core components of that robot, like batteries and controllers and microprocessors and sensors and things like that. So the really cool thing about it is that what I was able to do is study and learn some fundamentals that apply to all robotic systems. And so whenever a new robot is available for me to study and to work with, I'm able to jump right in and get started working with the robot. And so that's really exciting, because just about every day can be a different, new day with a different project.

Are any of you interested in robotics?

SPEAKER: So it sounds like Wyola, Montana is.

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GEORGE GOROSPE JR: Yeah.

SPEAKER: You want to try again? Maybe unmute yourself and see if you have a question. If we can hear you. Is your mic accessible? No? I guess we need a robot to get the sound going, huh?

[LAUGHTER]

That's OK. Maybe you can text it in, then I'll ask it. But I do have a question here-- multiple questions for you, George.

We're going to switch topics a little bit. So it sounds like autonomous robot project you told us about taught you a lot about perseverance. Can you share more about what perseverance means to you or what role you think it plays in a job?

GEORGE GOROSPE JR: That's a great question. So I think that perseverance-- it taught me a lot about myself. When I started thinking about difficult things in my life-- there are always difficult things. There are always challenges. There are always exams. There are always times when you're under a lot of stress.

Here's the deal. I found that there's two ways to think about it. When you're under stress, you're under a lot of pressure. You can change in some way. You're like some carbon, some coal, and the stress turns you into a diamond. And suddenly, you're some of the strongest material in the universe. Or, under that stress, you buckle like a bridge.

See, the thing is, you can't always become stronger. Sometimes, you buckle. But you've always got to take it as a learning experience and say, hey, what happened there? I was studying for that exam, and then I stressed out so hard and I just didn't study as much as I should have. And as a result, I didn't get a good grade.

Say, OK, well let's think about what I could have changed. Maybe I could have started studying a little bit earlier. Or maybe I needed to study with my friends, who could help me be more motivated. Or maybe I should have talked with the professor, like hey, professor, there's this particular concept that I'm really having a hard time understanding. All of those are strategies to help you deal with a particularly stressful situation.

That's what I did. In this case, I learned, hey, no one expects me to be a genius. But what they do expect me-- sorry, no one at NASA expects me to be a genius. What they do expect of me is that I can learn, and learn quickly, and then apply what I've just learned to solve a new type of problem-- the type of problems that NASA has.

And when I demonstrated that, they said, well, that's a core skill that we ask all of our researchers to have. And so suddenly, I'm no longer some student. I am someone who is being considered for a job. That part was really awesome.

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SPEAKER: Great. Awesome. So let's keep the conversation going. Here's a more science question for you-- why have we not returned to the moon to study its weather or sustainability for life? So you talked a little bit about that.

GEORGE GOROSPE JR: Oh, yeah. Yeah. Yeah, that's absolutely a great question. The moon is a really, really amazing place. And would you believe the moon actually has its own atmosphere? The moon's atmosphere is very tenuous. Tenuous is very, very thin-- not as thick as our atmosphere, and definitely not as thick as the atmosphere of somewhere like Venus. But it's really important and really interesting.

I'll tell you about two really amazing missions to the moon that helped us in a big way. The first mission was called LCROSS. And this was a mission run by where I work, NASA Ames Research Center. The goal of this mission was to answer a very, very important question-- if astronauts are going to go to the moon to live, are they going to have to take water with them or is there a place where water exists on the moon that the astronauts can go and get it?

You see that the moon has an equator, just like the Earth has an equator. And just like the Earth's equator, the moon's equator is a very sunny place, and it is particularly warm. But if you have an equator, you also have a pole, right? So just like Earth's poles, which are very cold-- the Arctic and Antarctic-- the moon also has places that have that. They're the north and the south pole of the moon.

So the LCROSS mission went to the south pole of the moon to study whether or not there is water or ice on the moon. And you know the result? Huge amounts of water ice exist on the south pole of the moon. This means that in the future, if we want to set up a colony, all we have to do is find a way to collect all that water ice, clean it, and prepare it for humans to drink. This is really exciting, in my opinion.

What's the next step? Well, we said, hey, there's a lot of water there. Can we go get it? And that's why we started this mission called the Resource Prospector Mission. If you look at that little logo for it, we can see a couple things there. We see something in the background that looks kind of like the moon. We see a robot looking thing with two wheels. On top of the robot, there's antennae to report back home.

But what else is there? Yeah, that's a drill. That robot is drilling into the surface of the moon, past a few layers of rock and other sediment, down towards something that we know is there now because of the LCROSS mission. We know that there's water ice down there. And all we need to do is go and get it.

We had to explore this part of the moon in order to better understand what to do when we want to go back. We had to say, hey, this is a big question-- should we take water or is there water there that we can get? Because that helps drive things like how big our rocket should be, how big our lander should be, what type of habitat we should take there for the astronauts. And, yeah, how much water should we pack? Now we know that we don't have to pack quite as much water-- that there is a way for us to get water on the moon. And this is a really, really great thing, because this means we can stay there much longer in the future.

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SPEAKER: Great. So I'd like to ask username Admin-- I'm not sure of your name-- if you could ask your question. Yeah, you just have to unmute, A-D-M-I-N. I think if you could just unmute and ask your question. You're still on mute. It looks like we're good-- not yet.

GEORGE GOROSPE JR: There you go.

SPEAKER: Yeah.

AUDIENCE: What tribe or-- are you enrolled in or do you affiliate with?

GEORGE GOROSPE JR: I affiliate with the Laguna Pueblo, which is located in New Mexico.

AUDIENCE: OK.

GEORGE GOROSPE JR: Yeah. So actually, Laguna Pueblo is a Keres speaking group there with important ceremonial days in September and in December. And so I've regularly taken days off from work to go back and participate in the ceremonial rituals there at the Pueblo throughout my time at NASA. So on a Friday, I could be researching AI, and then Sunday, I'll be at the Pueblo paying my respects to elders. And then on Monday afternoon, I'm back in Silicon Valley and working as a research engineer.

The thing is that there was always some question-- can you be a scientist, can you be an engineer and a Native American? Some people might think you have to make a choice, that there's some kind of betrayal of culture. No. You can do both of those things. I can be a Native American research engineer at NASA. No one stopped me from doing that.

In fact, I've been able to take advantage of my position to help encourage other Native American students to go into NASA, to go into places like Intel or Google or Apple. Because all these places need people like you-- people who are creative, think out of the box, people that bring their unique perspective to the product development cycle or the mission development cycle or the robotics research. That's valuable. And that's something that only you can provide.

SPEAKER: So that relates to the other question that came up, so you might expand on that one. It says, has your cultural experiences helped you work through some of the problems you have faced in striving to be part of NASA?

GEORGE GOROSPE JR: Absolutely. I think that one of the best parts-- I mean, community is so important. For me, it's always been respect your elders, help out, do as much as you can to support the goings on. When I arrived at NASA, I immediately found that-- I was the young guy in the room. There was a lot-- a lot-- I needed to learn. But I went to work with this idea that I'm there to help out and to learn from the older people.

This respect I had for my elders-- that turned into all these elders there at NASA saying, hey, you look like you really want to learn. Let me show you something. Or, here, come with me. We're going to go to

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this meeting. It's a little bit above your pay grade, but you're going to learn a lot there. I'll mentor you there. So in that way, I was able to learn way more than I could have ever learned from just sitting at my desk. I think that that's a unique value that has helped me a lot in my professional life at NASA.

SPEAKER: Great. Quincy, you want to ask your question?

AUDIENCE: Yeah. What do the astronauts enjoy receiving when the shuttle comes up?

GEORGE GOROSPE JR: Oh, that's a really easy one. They love fresh food. They really love fresh food. Often, NASA will put some surprise food in there. Like, I know that strawberry cheesecake was once sent up, and they were so happy about it. I think that NASA sent up some tacos for a Taco Tuesday, and they were really excited about that. I think it's food. They really love food up there.

SPEAKER: Great. And Sylvester STEM, you had a question about water and ice. You want to go ahead and ask your question?

AUDIENCE: Quincy already answered that, but we have another question.

SPEAKER: Go for it.

AUDIENCE: Are you working on anything for Mars?

SPEAKER: So the question is, are you working for anything for Mars?

GEORGE GOROSPE JR: That's a great question. So right now, there are a couple ongoing missions at Mars. We have robots investigating the geology of Mars. And some of them are actually just driving around right now, like as we speak. And truth be told, I know the guy who's the driver. And he's a really nice guy. He's actually a Navajo guy.

But here's the deal-- what happens if one of those robots has a problem, again, with one of its wheels? there's Not a service center that that robot can pull into and get a repair. So we need to think about how to make those robots more robust and how to make them more intelligent to figure out when something wrong has happened.

So in that way, the software that we're developing is eventually going to be deployed on robots going to Mars in the future, and helps those robots to be more intelligent about what's happening to them, because Mars is a really harsh environment. So we need to make the robots the best we can, because we don't get a lot of opportunities to send robots to Mars. So in that way, the work that we do in my research group directly supports the future of Mars robots.

SPEAKER: Great. So I'd like to give an opportunity to [? Collier ?] or [? Robo ?] [? Saras ?] or [? Kay ?] [? Gable ?] to ask a question if you'd like. We've got just about two minutes left. So if you do have a

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question, go ahead and unmute. If not, I will give you about five seconds, and then I'll ask him another question. Let's see. They're still on mute.

So I'll ask, maybe, the final question here. The question is, what is the weirdest thing about your job?

GEORGE GOROSPE JR: The weirdest thing about my job has got to be the conversations that we have at lunch. So in the cafeteria at NASA-- I really, truly wish some of you could come and have lunch with me, because we have some of the most intelligent people on earth just talking about plans or ideas they-- Dyson spheres, new technology, where the future could lead us. And they're thinking openly and freely and making conjectures or hypotheses. And it's just so fun to hear.

And some of those things can be really weird. Some ideas for new technology-- just a wide variety of things. It's really weird. It's really fun. And it's really exciting.

SPEAKER: Great. And if you could just leave us with a final message as we prepare for this Apollo 50th celebration-- any words of encouragement you want to give the teams, the teachers, or all the above?

GEORGE GOROSPE JR: Yeah, absolutely. Really quickly, I want to thank you, again, to the Washington Space Grant Consortium and the pipeline for bringing me in and giving me this chance to reach out to all these students.

The last thing I want to say is that there's maybe not such a well-kept secret that a lot of people at NASA think that the first person to step foot on Mars is alive today. That person may be in a classroom somewhere. That person may be in college somewhere. That person is probably alive and walking around. And they don't know that they're going to be the first person to land on Mars.

That person is going to need to represent a lot of the best about humanity. That doesn't mean that they're a scientist or an engineer. That means that they've done the best that they could to be the best at who they are.

I want to encourage all of you to be the best that you can be every day-- to strive to become better, smarter, stronger-- everything, each day. And if you do that, I think that you're going to have a great life.

SPEAKER: Wonderful. Well, thank you very much for your time. Thank you, everybody, for joining us. We hope that you are successful. We know you will be successful, as George said. So we encourage you to keep at it.

So for now, have a good evening. Have a good day. And thank you all.

GEORGE GOROSPE JR: Thank you very much. Bye. Bye, everybody. Thanks for the questions.