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## ***Past Event: 2023 NCSBN Annual Meeting - Keynote: The Sky is Not the Limit*** **Video Transcript**

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### **Event**

Past Event: 2023 NCSBN Annual Meeting

More info: <https://www.ncsbn.org/past-event/2023-ncsbn-annual-meeting>

### **Presenter**

Capt. Scott Kelly, Astronaut (retired)

♪ [music] ♪ - [Scott] Throughout history, people have done things that are risky. Even though it is a risky thing to be doing, and I think it's a lot more risky than some people might think.

So I still think it's worth it.

- [Woman 1] Astronaut Scott Kelly will try something no American has ever done before. This spring, he will leave for a mission and spend a year in space. His twin is former astronaut Mark Kelly.

- [Man 1] Genetically, the brothers are almost identical, so scientists will be able to measure how Scott and Mark change physically and emotionally as months pass.

- [Stephen] Warm up a little bit. This one's a bit of a Hail Mary. Here we go. Boom. Astronaut Scott Kelly at the International Space Station.

- [Man 2] Scott Kelly has been working toward this mission his entire career. He's been working toward this mission his entire life in some respects.

- I decided that the challenges of staying in space for a whole year presented was appealing to me even considering the sacrifices.

- [Man 3] The human body was made for living in gravity. Strange things happen to us when we spend long periods of time without it. But that never deterred the former Navy test pilots from dreaming of becoming astronauts.

- Pretty much anything we've ever put our mind to, we've been able to accomplish. Doing pretty good. I do feel like I've been up here for a really long time, and I look forward to getting home soon.

- [Woman 2] Interesting to watch. What a great... - [Woman 3] A cool story.

- Great story and a fascinating experiment.

- Space is still the most exciting thing I can imagine. And talking to someone in orbit still, it's like I am an astronaut right now.

- [Man 4] Are you concerned about the physical toll that this will take on you?

- I do think about the effects of radiation. You know, the reason I'm here is to learn more about it so someday, we can travel further from low Earth orbit than we ever had before. A year is not short, but it was very rewarding, it was enjoyable, it was something that I feel privileged to having got to do.

♪ [music] ♪ Thank you very much. It is great to be here with all of you today.

Actually, after a year in space, it's great to be anywhere with gravity. You know, on the space station, I changed positions so many times, you would have thought I was running for president. So to those of you in the audience that do not appear to be aliens, like the ones from space, I'd like to say good morning.

The rest of you guys, I come in peace. So on the space station, we have to learn to live with very little stuff. I actually wore the same pair of pants for an entire six months in space, but I'm adjusting to life very well here back on Earth. I've only been wearing these pair of pants for a month now, so I apologize to you guys in the front row.

You know, people often ask me, "What is the best part about flying in space and having the privilege?" Because I do believe this job has been a privilege for me. But, "What is the best part about it? Is it the launch, the landing, the floating around in zero gravity? Is it looking out at planet Earth?"

Which is incredibly beautiful. "What is the best part about it for you?" And for me, all those things are great, but really what I liked about flying in space and being an astronaut working at NASA, is that it was a really, really hard, and challenging job, a hard and challenging thing to do. And that's what I want to talk to you about today, is about doing the hard things.

Not the easy stuff. Anyone could talk about that. I want to talk about the hard stuff and how I was able to do that in my career, certainly at NASA, but also a little bit in the U.S. Navy. And for me, doing the hard things involved some other skills, and other things I had to keep in mind. It was about always having a goal and a plan to get there.

It was about taking risks, being willing to make mistakes, at times even being willing to fail. It was about focusing on the things that I could control and ignore what I couldn't. It was about testing the status quo. And about working as a team, because in my experience when I was able to put all these things together, what I learned is that the sky is not the limit.

Cliche, I know, but absolutely true in my case, right? So I told you the secret about my pants, and I'm going to share another one with you. And that is, when I was a kid growing up, I was a really, really bad student. You know, a lot of you might think, you know, that guy's an astronaut, he must have been the smartest kid in the class, the overachiever.

That was not me. I was a kid that, you know, from kindergarten through my first year in college, I sat in the back of the room, either looking out the window, or looking at the clock just trying to make it go faster for me to get out of the classroom as quickly as I possibly could. So being an astronaut was not

something that I ever even considered, thought was possible, never even considered working at a place like NASA.

I did grow up, however, at the...in New Jersey, height of the Apollo Space Program, and the TV show "I Dream of Jeannie." And because I didn't do my homework, I watched a lot of television, so space was something very exciting to me and important in my life. But never, like I said, in the million years did I ever think I could do something like being an astronaut someday.

I do remember, though, the first time I said I wanted to be an astronaut. True story. First grade, boys' bathroom, standing next to one of my first-grade classmates, standing right in front of the urinal, and doing what first-grade boys do in there, both peeing on the floor.

This kid turns to me, and he says, "Hey, Scott, what are you going to do when you grow up?" I said, "I don't know, play baseball for the Mets." I was a Mets fan. This kid says to me, he goes, "I'm going to be an astronaut." So I thought how cool that was, so I said, of course, "I'm going to be an astronaut, too." And he says to me, he goes, "You can't be an astronaut, because I'm going to be an astronaut."

This wasn't my twin brother, Mark, by the way, who also went on to fly in space. I actually wish I could find this kid today, not to humiliate him or anything. Just kind of curious what he ended up doing. Like I said, I grew up in New Jersey, 1960s, '70s, graduated from high school in 1982.

Our father was a police officer in our hometown of West Orange, New Jersey, right outside of New York City. And he was one of these very stereotypical, like, Irish cop guys that you'd see on television during, like, the '70s and the '80s. Once a year, he'd come home with a cast on his arm, tell my brother, Mark, how he broke his fist fighting crime.

Years later, we learned that there was a lot more bar fighting going on than crime fighting. And our mom was a secretary and a waitress and had all kinds of odd jobs when she could get them. But by the time my brother and I were becoming teenagers and needed less supervision, she decided she wanted to have more of a career like my dad's and decided she was going to become a police officer in our hometown, which never had a female police officer before, very few in the state in the 1970s.

And she had to go through all the same tests and qualifications, particularly the physical fitness test that was really designed for men at that time. And she wasn't a very physical person. She stood all about, like, four feet, 13 inches tall, never did any exercise before. I never recall her doing any kind of exercise.

So to help her, my dad built this whole obstacle course in our backyard that she would have to do for this physical fitness test, including building a wall that was seven feet, four inches tall. He actually built it an inch taller without even telling her. So she could practice.

And I remember the first time she got to...tried to get over that wall, and she got her foot about a foot high and just fell off into the dirt. And I thought, oh, this is done. It's not going to...no way she can ever get over this thing. But she picked herself up. She brushed herself off and she admitted that she can't get over this thing now. But eventually, she'll be able to touch the top.

And once she can do that, she'll see how long she could hold on for. And she says, you know, "If I don't give up by the end of the summer, I am going to get over this wall." And she had to do some other tests. And we had this really long backyard. And one of the tests was carrying a 130-pound dummy 100 feet. And at the time, I just happened to weigh 130 pounds.

And with a little bit of my help, not much, but really with a lot of hard work, when my mom went to take that test, she got over that wall in half the time she was supposed to. Did better than a lot of the men did on this test just through her grit and hard work and became the very first female police officer in our hometown and one of the first in the entire State of New Jersey.

And this is the first time in my entire life that I saw the value of having this goal you can't...you think you might not be able to achieve. A plan to get there. And then just working really, really hard at something that is incredibly important to you.

Now, unfortunately, this did not inspire me to become a better student. And I still struggled throughout my years of school, meandered through middle school and high school. I graduated from high school in the bottom half of my class. Not proud of that. But I did go to college because all my friends were going to college and I didn't know what else to do, so I went to college.

I actually went to the wrong school, though. Now, I don't mean I went to this school over here thinking that this one was a better fit for me. What I mean is I actually applied to and showed up at this college thinking that I was going to this other one over here. I am quite possibly the first person to ever go to the wrong college.

And I get there and one of the first days, I say to my classmates, I'm like, "Hey, when's the football game?" And they're like, "Football game? We don't have a football team. That's that other school in Maryland." And I basically was doing the same thing I did in high school.

I couldn't pay attention. I wasn't doing well. Eventually, I'm not even going to class anymore, but somehow, they let me live there at that college. And one day, I'm walking through the campus, and I just happen to go into the college bookstore to buy, like, gum or something or a snack. Not a book.

I was not a big reader at the time. But I walk in there and I see this book on the end of the aisle and it's got this really cool cover and title, has red, white, it looked very patriotic. It looked like it showed, like, motion in a positive direction, which I guess I felt like I needed at that time. And I picked up the book, I read the back. I was interested enough that I took my gum money, purchased the book, went back to my dorm room, and just laid there basically for the next three days on my unmade dorm room bed, just fascinated by the stories of the fighter pilots that became the test pilots that became the original Mercury, Gemini, and Apollo astronauts.

And the book was "The Right Stuff" by Tom Wolfe. And I recognized, you know, traits that these guys had. They were all guys at the time, not anymore, of course. But at the time, they were all men. But I recognized traits that they had that I felt like I had in myself, actually. With only one exception and that is I was a bad student, and I didn't do well in school. But I actually thought and believed that if I could just fix that one thing about myself, you know, maybe I could go on and graduate from college someday, maybe as an engineering major like they all were.

Maybe I could go into the Navy and fly airplanes. Maybe if not the Navy, maybe the Air Force. It's generally easier. Some Air Force, former Air Force people here. They generally like that joke the most.

Maybe become a test pilot, maybe quite possibly even an astronaut someday. I actually believed this. And I know you might think, you know, 18-year-old kid reads book, decides he or she's going to become an astronaut. Well, that's a giant leap, right? But for me in retrospect, what it was, was a much more smaller manageable steps, just one built upon the other.

I could never imagine really me going from college student to astronaut. But it's a lot easier to imagine a test pilot becoming an astronaut or a fighter pilot becoming a test pilot or a college student, you know, getting into the Navy and to learn how to fly airplanes. So I did something that was really hard at the time for me in an era where you didn't get much help. You know, I probably had ADD or ADHD because it was impossible for me to pay attention.

I actually remember, as a kid, my brother and I had...we slept in the same room in an old New Jersey house in the 1970s, or actually really in the late '60s too. And I can remember my bed was up against the window, right? And I would eat the paint chips.

Which I've heard causes, you know, ADHD. So who knows if I actually had that or not? So I did something really hard and that was, you know, becoming a better student. It took, you know, a little bit over a year, but eventually, I did better. I changed colleges, I changed majors. And about five years from when I read Tom Wolfe's book, I'm graduating from college with an engineering degree and a commission in the United States Navy and a slot in Navy Flight School to learn how to fly airplanes.

I get in my white BMW 320i and head down from New York to Pensacola, Florida to go to flight school. And one of the first things I realized when I get there is I am not a particularly good pilot. I know it's hard to believe, you know, for a guy who landed the space shuttle.

But I was not very good at this at first. And I've recognized, you know, throughout my career, how good we are when we start something has no relationship whatsoever with how good we can become at anything with focus, hard work, and just never, ever giving up on yourself.

And I know this for a fact, because when I was a young pilot in flight school learning how to fly airplanes, the guys that did really well, the guys with previous flight experience, they did really well in the beginning, those guys didn't become astronauts. And I know this for a fact, because sometimes I see them at the front of Southwest Airlines. Somebody work at Southwest Airlines here?

So I was not particularly good at this, but I worked hard, didn't give up, and eventually, I got better. You know, good enough to get assigned to fly, learn how to fly jet airplanes, which was what I wanted to do.

Got my Navy wings. Didn't do great, but did good enough to get assigned to fly the F-14 Tomcat, which was an airplane that was basically famous for being in a movie in the 1980s, you know, "Top Gun." Also famous for killing a lot of people. Unfortunately, not the enemy, but the people that flew the airplane.

Some friends and colleagues and almost myself on a number of occasions, including the first time I actually went to land the Tomcat on the ship, the aircraft carrier. And I can remember like it was yesterday, flying over that ship, looked like kind of a small postage stamp thing in the middle of the Atlantic Ocean. We weren't in the middle, seemed that way.

And I fly overhead the ship. I turned downwind, I put my landing gear, my flaps, my hook down, and getting ready to come in for my first arrested landing. And I landed so low that the arresting hook, the tail hook, actually hit the back of the ship, the part that goes down towards the stern of the ship, basically. And I slid into that first wire and I stopped.

I actually used to do this talk with my brother sometimes. But, and this is when he would say, "Well, that's crashing." It's close, probably as close as you can get. But I stopped, raised the hook. They started

taxiing me forward. I thought I was going to the catapult again to do my next arrested landing, you know, on my way to qualifying.

And all of a sudden, I see these guys with chains come out and they chain the airplane down. They had me shut the engines off. I open the canopy up. I jump out. The instructor that grades the landings, he's standing right there. And the first thing he says to me is, "Are you sure this career is for you? You almost crashed, scared the crap out of us. We're not letting you do this again."

Get back in the airplane and they sent me home. And I had disqualified the very first time I tried to do this. And I get back to the beach and over the course of the next couple of weeks, the commanding officer of the squadron talked to me a few times and said, you know, "You really scared us. We don't want you to hurt yourself or anyone on the flight deck. We're not sure we're going to let you do this again. How about you consider flying, you know, a big airplane that doesn't land on a ship, like a cargo plane? That would probably be easier for you."

So I had an option, you know, try to talk them into letting me try the harder thing or do the easier thing. And I didn't know if I could do the easier thing anyway. You know, I thought, well, what if I fail at that too? But then I thought, if I'm going to fail at something, I'm going to fail big. I'm going to fail at something I think I might not be able to achieve rather than something that's easier. At least that way, I'll know what I'm capable of doing, of accomplishing.

You know, I think people that are willing to take risk and fail are some of the most successful people out there. You know, oftentimes when we're successful the first time, you know, it could just be, luck, maybe you don't learn anything.

But when you fail, that's when you learn what you need to do to become better. Elon Musk, who, you know, I'm a fan of for certain reasons, not a fan of for other reasons, but certain reasons, you know, he has this philosophy at SpaceX. When they were going to try to land that first stage of the rocket on the ship, they weren't ready. And he says to his employees, he goes, you know, "We're going to do this, we're not ready. We're going to fail. We're going to fail big. And then we're going to learn something from it. And in the end, it's going to put us ahead."

So I decided to, you know, try to convince the guy to give me another chance at landing on the ship. And he hooked...he teamed me up with a RIO, like Goose in "Top Gun," you know, the guy that sits in the back. This guy was particularly good at, you know, helping people that had trouble landing on the ship. He was actually, seemed like more of a psychologist than a back seater, really.

And we practiced on land for a while. And eventually he says to me, he goes, you know, "You're an okay pilot. You can fly this airplane okay. But what I recognize about you is you're too comfortable with the status quo." And I don't even think I had ever heard that word before.

I was like, "What's that?" He goes, "You're too comfortable with, you know, how things are. You're not making at least very, very small, positive corrections all the time. And because you're not doing that, pretty soon you're going to go from being a little off altitude airspeed heading, whatever you need to fly the airplane, to really far off, and it's going to make it so much harder to correct back."

He taught me if you're not making very, very small, positive corrections all the time, things are going to get worse. We live in a dynamic world, nothing ever stays the same in this universe, right? Things are always changing. If we're not trying to make them at least a little bit better, they're going to get worse.

So I went back to the ship with this new attitude that I actually took out the rest of my career and life until...since then.

But I went back to the ship, and I didn't do great, but I did good enough. And I wasn't the best fighter pilot at first. But eventually, I became good enough to become a test pilot, to go to test pilot school, become a Navy test pilot, graduated from that. I was working for...as a test pilot for about a year. And one day, I'm sitting in my office at the Patuxent River Naval Air Station in Maryland, where we do Navy flight test.

And my cube mate, another test pilot, had this big stack of papers. And I knew, you know, this isn't a flight test report. And I asked him, "Hey, what is that you're working on?" And he says, "This is my astronaut application." And I had not really thought about it much actually, because I didn't feel like I was qualified, I didn't have a master's degree, I didn't have a whole lot of flight test experience.

But I said to him, "When is that due?" And he says, "Tomorrow, I think." And I thought to myself, you know, this might be a good opportunity, right, taking some risk and getting rejected, because I'm not going to be able to fill out an application this big. I'm going to fill out a one-pager, I'm going to send it down to NASA, they will absolutely reject it.

But at least they'll will know, A, there's this guy out here that, you know, is interested in being an astronaut someday. And I figured maybe 10 years in the future I might have a shot at this, right? So I figured, never hear another word about it. My twin brother, Mark, who had a much different path into the Navy than I did, because when we were going into high school, all of a sudden, he started doing much better in school.

He went from below-average student to straight A's, somehow, over the summer. Never knew how that happened. And a few years ago, I said, "How'd that happen? What did you do? What was your mindset there? How did you become such a great student when we were, like, this our whole lives?" And he says, he goes, "You don't remember when our dad sat us down right before high school and said, 'We're going to start, you know, thinking about a vocational education or, you know, some kind of alternate career path for you two guys.'" And that's what motivated my brother.

And I said, I was like, "No, I don't remember that at all." Probably only because there was a squirrel running outside the window. Had it not been for that squirrel, I'm pretty sure I would have went to Harvard. In any case, my brother, Mark, comes to me and he says, "Hey, NASA called me and they want to interview me to become an astronaut."

I thought, oh, how cool is that? My twin brother might be an astronaut someday. I congratulated him, wished him well. Then he asked me, he goes, "Hey, can I borrow your suit? Because, you know, I don't have a suit." He didn't own one at the time. And I guess he knew I had recently been to a wedding or something. So I loaned him my suit.

He goes down to NASA, comes back a week later. He gives me my suit back. Then a month or two goes by and eventually, I get a call from NASA, and they want to interview me too. I'm absolutely shocked that they would call me for an interview. And I tell my brother, Mark, and, you know, he's sort of happy for me. Not as happy as I was for him.

I actually think he thought I would go down there and ruin his chances, I guess. But anyway, I said, you know, "By the way, you got to buy me a new suit, right? Because how ridiculous would that look, me

showing up in the same clothes?" I'm the guy with the gum in his mouth, by the way. But he was a cheap Navy lieutenant and he said something I'm not going to share with you here, but it basically ended up with me having to wear the same suit to the interview.

Which was actually kind of a blessing in disguise because you walk into this room and there's all these astronauts there, the Chief of the Selection Board, John Young, walked on the moon, Apollo 16, First Commander of the space shuttle, all these astronauts, engineers, like, 20 people. And the way this interview works is you walk into this room and basically you just tell your story and you can kind of get to talk first and then ask you questions about what you're talking about.

The first thing I say is, when I walk into the room, I go, "Bet this looks really familiar. You've seen this suit before." So I have the only suit to be selected to be an astronaut twice. As my brother points out, probably due to some kind of clerical error.

In any case, in 1996, me, my brother Mark, 33 other Americans, nine international astronauts show up in Houston, Texas to learn how to fly the space shuttle, which is, without a doubt, the most challenging, complicated aerospace vehicle ever built, the most challenging thing to operate, not even the most challenging airplane, but just thing.

It's that complicated. And I get to Houston, and you know, for a kid that probably had, you know, ADHD or something, this was not easy for me. But I worked really hard at... To compete against all these people that went to military service academies, and I went to the State University of New York Maritime College, which no one's probably heard of, but, you know, to compete with these guys from Harvard and MIT and Yale and all these places, my strategy was just to work harder than everyone else, and that's what I did.

And almost 18 years to the day of when I read Tom Wolfe's book, "The Right Stuff" at 18 years old, I'm getting ready to fly in space for my very first flight as the pilot of STS-103 mission to the Hubble Space Telescope, the first American of 35 people in my class to fly. Ten other... Thank you.

Ten other pilots in my class. And this was a mission to the Hubble Space Telescope. Hubble was spinning out of control at the time, right before Y2K. And NASA actually had this come back right before New Year's Eve because they were worried if we were in space over, you know, Y2K that the computers were going to divide by zero and I don't know what was going to happen.

We were going to go through a wormhole or something, end up on the other side of the galaxy. Yeah, so I flew that mission, came back from that flight, and my second flight, I was assigned to be the commander of a mission to the International Space Station in 2007. Actually, had Barbara Morgan, Christa McAuliffe's backup was one of our crew members. So this was the teacher in space mission to the International Space Station.

You get out to the launch pad of the space shuttle. You get out there about three hours prior to launch and the space shuttle is fully fueled. That giant orange external tank, fully fueled liquid oxygen, liquid hydrogen, two solid rocket motors. Basically, a bomb on the top of this hill which is the launch pad ready to explode. The place is completely abandoned of people with the exception of you and your crew.

There was seven of us, three or four people to help us get strapped in. We get inside the space shuttle about three, three and a half hours prior to launch. They strap us in tight. They bolt the hatch closed. They get away, they run away, they get about five miles away and it's just you and your crew out there



on this fully fueled rocket that just seems like it's alive, ready to launch off the pad and the clock is counting down towards zero.

Two thousand switches and circuit breakers in the space shuttle that have to be all in the right position, all these systems, electrical systems, hydraulics, APUs that power the hydraulics, all the different engines the space shuttle has, the environmental control system, the computers all have to be perfect.

You know, whenever I see this picture, it kind of reminds me of when I was a kid. I was in the Cub Scouts and our den mother used to take us on field trips. And one time we go to Newark Airport to see an airplane. And I can remember like yesterday walking into that cockpit as a fifth grader looking around, seeing all these dials, knobs, levers, screens, whatever, and thinking to myself, there is no way I would ever be able to operate something like this, not possible.

And a few weeks later she took us to where she worked. She worked at Burger King. She showed us the freezer, the fry machine, how they make the burgers and I thought to myself, oh yeah, I could see this. I was actually excited for working at Burger King someday, didn't...never thought about the airplane.

So the clock is counting down towards zero at nine minutes, it stops, give you time to catch up if you happen to be behind in what you're doing. It's also the moment you think to yourself, man, this is really stupid, flying in space. You've never done it before.

You don't know what to expect, but you can't get away, you're strapped and tight, the hatch is bolted closed. Plus, it would look really silly to be the first astronaut to ever run away from the rocket. Probably live in meme hell for the rest of your life. But the clock picks up at nine minutes.

- [Man 5] [inaudible] copy, visors, and suit in two.

- Six seconds, the main engine's, like, three giant main engines, a million pounds of thrust. But you don't go anywhere because you're bolted to the launch pad by these eight giant bolts. Then the clock goes five, four, three, two, one. At zero, those bolts are exploded open. The solid rocket motors light. And it feels like the hand of God is just lifting you off that launch pad and throwing you into outer space. And I know if you've seen this shuttle launch on TV, maybe in person or just here, it looks like the space shuttle lifts off slowly.

When you're inside, there is nothing slow about this. You get the feeling you're going somewhere. You're not sure where you're going, but you know you're not coming back to Florida. With eight and a half minutes, you're flying around the Earth at 17,500 miles an hour in a vacuum of space.

And people sometimes ask me, "Hey, what does it look like when you, like, punch a hole in the sky or fly through the atmosphere? However you want to describe it." I'm like, "I don't know. I don't know what that looks like. I never looked out the window. Two flights, front of the space shuttle, launching off planet Earth, never even dawned on me to look out the window. You might wonder, well, how is that possible?"

Compartmentalization, something NASA taught me, the Navy. Focus on the stuff you can control and ignore everything else. And the stuff outside did not matter to me. It was 2,000 switches and circuit breakers, all these systems, that is what I can control. And that's the same thing, you know, in your industry.

There are things that you can control, but there are stuff like, you know, the economy, government regulations, all other kinds of stuff that if you can't have any influence on it, if it doesn't matter to your job, there is absolutely no point in paying attention to it. Even in our personal lives, I find that. There are a lot of things that happen in today's world I don't have any control over it. So why am I going to put my energy into that?

Let me put my energy into something I can control. On my first flight, it wasn't until I was in space for about 20 minutes that I looked out the window, first time in space, and I said something to the commander, like, "What the...is that?" And he said, "Well, that's the sunrise." And as the sun came up, I just saw how breathtakingly beautiful our planet Earth is.

Almost like someone took the most brilliant blue paint and just painted it on a mirror right in front of my eyes. And I knew right then and there, I would never, ever see anything as beautiful as our planet Earth again. On the second flight, we went to the space station, delivered some hardware, resupplied it, helped build the International Space Station.

I came back from that flight, and NASA assigned me to fly what I used to call a long-duration flight of 159 days, I think. And this is when that mission was over that NASA and our Russian partners started talking about sending two people in space for a year. And somehow, they came up with me, the guy who couldn't do his homework, and a guy, Misha, that I used to call my Russian brother from another mother.

Not so much recently, because he and I haven't been talking for the last year or so. He has a different opinion about what's going on in Ukraine. But in any case, we're going to spend a year on the space station because someday we want to go to Mars. And Mars is really far away. When we're in space for a long time, bad things happen to our physiology. We lose bone mass at 1% a month, and muscle mass at 1% a month if you didn't do anything about it.

So, you know, after 100 months in space, you'd have no skeleton left. There's effects on our immune system, our microbiome, our vision, cognitive effects. The effects of radiation that we get anywhere from 10 to 20 chest X-rays equivalent of radiation every single day. So, we're trying to understand, you know, how these effects impact our human health and physiology.

Because when you get to Mars, you want to be able to work and be able to see and be able to function. But we also need to understand the procedures, the operational concepts to resupply the space station, so, you know, we're prepared to go to Mars someday. If you're on the way to Mars and the toilet breaks and you can't fix it, you're going to die from a broken toilet.

So, in March of 2015, the second time in my life I'm launching in this place called Baikonur, Kazakhstan, Central Asia, middle of nowhere, really. Which is a great place to be if you're launching into space for a year because you actually feel like you're already halfway there. And we get out to the launch pad, me and two cosmonauts, and the place isn't abandoned like it is in Houston.

There's, like, 100 people at the base of this fully fueled rocket, all this vapor coming off of it. Fully fueled, you're trying to get to the crowd. Some of them are smoking cigarettes. Swear to God. Smokers, base of a fully fueled rocket. This is Russia after all, it kind of makes sense, I guess, in retrospect. So you want to get out of there as quickly as you can because there's an emergency escape system on the top.

So I'm like, you know, let's go. Let's get up there in the elevator. Get in this rickety elevator up to the capsule. We get inside the Soyuz, and it's about as small as it possibly can be. And you can fit three grown people in there, you're elbow to elbow, your knees are up your chin. It's hot, it's loud, your visor's fogging up. There's no countdown clock in the Soyuz like in the space shuttle.

After a while, some guy comes up on the radio after a few hours and just says, "Ignition." And I could just picture one of the smokers with a match lighting this cartoon rocket. Soyuz does lift off slowly, actually, but still within nine minutes, flying around the Earth at 25 times the speed of sound.

It takes about six hours to rendezvous and dock with the International Space Station. Another couple hours, and eventually we open the hatch, and Misha and I float through that hatch together because we're in this together as a team. Thirteen other people will come and go over the course of the year, but every day, it'll be me and Misha. And I get inside the space station, I'd been there four years prior, the place looks the same, sounds the same, smells the same.

Day one of a year in space and I think to myself, man, this is a stupid thing to be doing. Spending a year in space. I mean, this is probably the only job in the world that you can't quit. I mean, you could probably quit, but you're not coming home, so it probably wouldn't matter, right?

Can't call an Uber. Not yet anyway. I think someday we'll probably have Uber Space. Not yet. You might wonder what the space station is like. It's really big. Weighs a million pounds.

Put it on the ground it'll be cover a football field. Got these giant solar rays that take energy from the sun and power all of our hardware on board, operates all the life support systems. We take our urine on the space station, we turn it into water to then drink, then we turn it into urine again. Then we drink it again.

Actually, we drink it after we turn it into water. I know what you're thinking. That guy drank his pee for a whole year. Actually, I drank everyone's pee. It's all mixed together. But it does taste better than the water in Florida. You know, some of that water we use to make oxygen through electrolysis, scrub the atmosphere of carbon dioxide, all these things we're going to have to know how to do very, very well if we're going to go to Mars someday.

Like I said, if you're on your way to Mars, the toilet breaks, you can't fix it, you're dead. A broken toilet, something as simple as that. The space station has two distinct sections. It's got a U.S. side, that's European and Japanese, very open, bright, scientific modules, very sophisticated. And then you float right into the upper, the Russian segment, it gets darker, narrower.

In retrospect, a little bit more sinister looking, I think. But we share the whole place, astronauts and cosmonauts. Astronauts from around the world share this whole scientific laboratory that is mostly there to do science.

And the type of science we do, it's the type of science that governments can do. You know, a company wouldn't do this because the return on the investment is so far in the future the shareholders wouldn't like it. But it's stuff in biology, chemistry, physics, material science, combustion, research, and a lot of medical experiments. Like I said, the reason we were up there so long is to understand our physiology and how that's affected by being in space for that period of time.

And one of the experiments that got an awful lot of attention was this twin study between my brother and I, Mark. Actually, he had left NASA, so he was a volunteer. He was actually, for a while, the

lowest-paid U.S. government employee as a volunteer test subject. But it was mostly a comparative study between Mark and I, mostly in genetics.

What they found, interesting results, 7% of my gene expression changed while I was in space as compared to my brother, Mark's. And, you know, our gene expressions change all the time, but they thought this was particularly a result of living in that environment.

Also, my telomeres and I probably don't have to explain to you guys what telomeres are, but my telomeres actually got better. And the hypothesis was they would get worse, radiation, stress, microgravity really messes with your physiology. They actually got better than my brother's did while I was in space, which is interesting results when it's completely opposite what you're expecting.

And NASA actually thought, well, maybe this is due to the very controlled diet and the exercise. And that was their conclusion. But six months after I got back, we learned that the Japanese had a telomeres experiment on the space station at the same time I was there on these little worms. And their telomeres got better too.

And I never once saw these guys working out on a treadmill, doing any type of exercise. So there's actually more to this than we thought. What we think is a certain amount of radiation is good for certain things like your telomere length. It might be bad for other things. Hopefully, I'll never find that part out.

But the best part, maybe the only good part about having an identical twin brother is the spare organs. On this flight, I had the opportunity to go outside for the first time and do the space walk. I had never done that before. And I'll tell you what, when you open the hatch and the Earth, there's 250 miles below, and you're going 17,500 miles an hour, there is nothing more important than what you're doing right now, which is basically holding on, making sure your tools don't float away, compartmentalizing as best as you possibly can, focus on what you could control, ignore everything else.

Which is really hard to do, because the Earth is spectacular looking when you're inside the spacecraft, when you're outside, order of magnitude, more impressive. Scary, though. I mean, the Earth, despite its beauty, can be scary to look at sometimes. I remember on my first flight, one of the first times I looked out the window and saw Earth, I said to one of my more experienced crewmates, I was like, "Hey, what is that film over the surface?"

And he goes, "Oh, that's the atmosphere." So small and fragile. It looks like a contact lens over somebody's eye is how thin our atmosphere looks from space. Parts of the planet almost always covered in pollution, Asia, Central America. The rainforest in South America looked much different in 2016 than they did in 1999. A lot less forest, a lot more burning fields.

Actually, pretty scary stuff. So on this mission, I had the opportunity to do my own experiment, I guess you could call it. And we'll just show it. And then I'll explain it. ♪

[music] ♪ So it really was an experiment just to see if NASA had a sense of humor. And they did, sort of.

But actually, the reason I did that is my brother, he says to me one day, I'm talking to him on the phone, he says, "I'm sending you a gorilla suit." And I'm like, "What?" He says, "I'm sending you a gorilla suit." I'm like, "Why?" He goes, "Well, there's never been a gorilla in space before. Of course, you have to have a gorilla suit."

Launches on SpaceX. The first one blows up. Talked to him a few days later. He says to me, "I'm sending you another gorilla suit." And actually, towards the end of my flight, I... This guy's a U.S. Senator now, by the way. A lot of people think he smuggled a gorilla suit to space.

NASA absolutely knew it was there. What they didn't like was when he sent the video to "NBC News." My boss calls...tell...sends me an email that day, chief of the astronaut office, former Navy SEAL guy, and he says to me, he goes...he emails me, he says, "Hey, give me a call." This is the day it was on the news.

He says, "Give me a call later today." And so I call him and he says, "Hey, I saw that gorilla video." And I'm like, "Yeah?" And then he goes, "What else is going on up there? Are you doing okay?" Apparently, his boss said, "Hey, you got to call him about that gorilla video. Talk to him about it."

So he did. Actually, the reason I did this and show it now is sometimes, I'll go to schools and there's always that kid that's one or two kids in the back of the room that can't pay attention to anything like me, like I was. Even an astronaut in their classroom, cannot pay attention. Well, there is one thing that is impossible not to pay attention to I've learned, and that is a gorilla in space.

So I use it for the kids. So after being there... You know, on the space station, we have, like, basically three different main jobs, right? You might be the commander or one of the other crew members, but basically, you're the scientist, you're the engineer. We spend about a third of our time fixing things, about a third of our time just basic, you know, taking care of the house, maintenance, about a third of our time doing science experiments.

But you have to do all the jobs. I mean, the space station never comes home, unlike the space shuttle. So not only you're the scientist, the engineer, you're the doctor, the nurse, perhaps the dentist, you're the IT person, you're the plumber, the electrician. You got to do everything. You got to fix a lot of stuff. But after being there for nearly a year, did a lot of science experiments, over 400 different experiments over the course of that year, some I was very involved in, some I didn't even know what they were, but eventually it's time to come home.

And me and my cosmonaut crewmates, we get two...three of us back in the Soyuz. It's small, like I said. Close the hatch, undock, get about five miles away from the space station, and we fire the deorbit engine. And it only slows us down by a few hundred miles an hour, really, of our 17,500 miles an hour. Maybe slow you down by 400 miles an hour.

It's enough to get you to hit the atmosphere, and the rest of that speed is taken out by friction with the atmosphere. Similar to how the space shuttle comes home. But the space shuttle's really big. You know, when you're in this 3,000-degree fireball, it's really far in front of you or behind you, very risky. I mean, three of my astronaut classmates died on Columbia, along with four of their colleagues.

But still, you know, it's more like driving a Rolls Royce down Park Avenue as compared to the Soyuz, which is a much more medieval experience, actually. When the engines shut down on the Soyuz, the three sections are exploded apart, and you're in the middle one. And pretty soon you're hitting the atmosphere, and you're in this, like I said, 3,000-degree fireball.

It gets hot inside. You're sweating. The window is actually burning to a crisp. Eventually, you can't even see out of the window anymore. Your head's like right here, right? It's kind of like going over Niagara

Falls in a barrel, but while you're on fire. And as soon as you realize you're not going to die, it's the most fun you've ever had in your entire life.

Had I hated flying in space for a year, I'd do it all over again for the last 20 minutes. And the parachute opens, and you're thrown around like crazy. And then eventually, you just drift gently down to planet Earth, and then you crash into it. It's like a car crash.

It's actually pretty violent, believe it or not. This is not from my landing, that inside view, but the cosmonaut had to have his spleen removed after that normal landing in the Soyuz. Russian rescue forces show up and they open the hatch, and fresh air rushed inside, and it smelled almost like the first time I had ever breathed fresh air in my entire life.

So space station air is not that great. Carbon dioxide's high, smelly. Pulled me out, didn't feel great, but I had this big smile on my face. Only because I was trying to look better than the two Russian guys I was with. They put us in these chairs, take us over to this big medical tent they set up in the high desert steps of Kazakhstan, middle of nowhere.

And that's when you get to see how you can walk for the very first time after being in space where people often wonder, "Hey, can you walk?" My first walking experience. I feel like Jar Jar Binks. I said, I feel like Jar Jar Binks.

I guess I thought he was an astronaut too, maybe. I don't know. You know, in 24 hours I'm back in Houston, Texas after being in space for a year, and I get to see my family for the first time. In some cases, over a year. And I go to the Johnson Space Center, do some medical checks, 4:00 in the morning, I get back to my house right near the Space Center.

I wasn't supposed to go home, but I forced them to take me home, and I walk in the front door, out the back door, jumped right into the swimming pool because I had not had water around me in such a long time. It's something that Misha and I both craved. Jumped into the swimming pool. There we go. Oh. Man, that feels good.

It felt great for about 30 seconds and then I, like, almost went into shock even though the pool was heated at, like, 90 degrees because I had not had any kind of water. It was just...it got really cold. But I came inside the house, had a beer and an apple pie that was sent from the White House. Both made there too, even the beer. Took a shower for the first time in a year, slept in a bed, which is great.

You know, sleeping in space, comfortable. I prefer the heavenly bed. All those things were great. But the best part about coming back after being in space for years is knowing I think I had done the hardest thing I will ever have to do in my life, I hope. And then be able to share that experience with my family, my friends, and you folks here today. I learned a lot in my time at NASA.

Actually, let me talk about how I felt first. I didn't feel great, right? I was nauseous, I was dizzy, I was sore and stiff. I would stand up and when I would stand up, I would feel all the blood just rushing out of my head down to my ankles. My ankles would swell up like water balloons. I would go...if I didn't know what the cause was, I would immediately have gone to the emergency room, because my heart and cardiovascular system was so deconditioned.

You can imagine, you know, our heart is pumping against gravity all the time and when you don't have to pump against gravity anymore, I lost 25% of my heart mass over the course of the year. Like I said,

nauseous, dizzy. I was...had hives and rashes anywhere my skin had touched anything with any kind of pressure because I did not have any pressure.

It was almost like an allergic reaction to pressure. Cognitive effects from being in space for a long time. There's actually one good thing that happens to us physically when we are in space for a long time. After about a few months, over the course of a few days, all the calluses fall off your feet because you're really not using your feet much anymore. Actually, kind of, it's a little gross when you take your socks off and you get this big cloud.

If you're ever in space for a long time, don't take your socks off around your crewmates. Really bad manners. But eventually, you have baby feet. Like really, really soft, super soft feet. And when I was...after my first long-duration flight, no one knew I was an astronaut or anything. I go to one of these massage places because it was so sore.

You know how at the end of the massage they sometimes, you know, rub your feet? This masseuse says to me, she goes, "You have the softest feet I've ever felt in my entire life." And all I said to her was, "Thank you. I'm very proud of them." Then I just left. She's probably still talking about that bald guy from 13 years ago with the really soft feet, maybe.

You know, I learned a lot at NASA in this privilege of a job and a career that I've had. You know, learned a lot about diversity, right? When I was in the Navy, basically, this was not the current Navy, but the Navy in the 1990s, it was a bunch of middle-class white men flying airplanes.

And it wasn't until I got to NASA that I got to work with a much, much more diverse team, people from different cultures, different countries, different languages, different educational systems, different sexual orientation, different races, basically different whatever. You know, what I learned is, when everyone's the same and has the same background, they look at things through the same lens and the same perspective.

And when you have people that are different and just evolved and developed, you know, in a much different environment, they have different solutions to problems. They have different perspectives. It really was like a superpower at NASA, I think, our very, very diverse culture that we had. Learned a lot about leadership.

You know, people used to say to me, "Hey, what kind of leader are you? Are you like George Patton or, you know, George Washington?" And I was like... You know, which are much different kind of extremes. And it wasn't until I left NASA that I thought about it. And for me, you know, leadership and decision-making was very much dependent on the situation we were in. You know, sometimes I would just recognize my crewmates knew more about some particular thing than I did, and I would just defer to them.

And I would say, "You decide what we're going to do. You know more about this than me." You know, other times I would...you know, we would vote on things if it was really, you know, something minor that seemed like a democracy was better. You know, as the commander of four different crews in space, you know, sometimes I would just get everyone's opinion and I'd make a decision.

Very rarely though, very rarely, was it the time to be the dictator. You know, one person deciding what to do and just telling everyone else. And that was always in an emergency, fire, depress. If there's a fire in space, right, you can't run out to your neighbor's house and call the fire department, right?

You gotta deal with it by yourself and you can't leave. Those are the type of things that take...took that, I think, style of leadership. So for me, leadership was very much a, you know, situationally dependent thing. You know, learned a lot about planet Earth, incredibly beautiful, but also, you know, our planet has challenges.

I'm a big believer in going to Mars. Unlike Elon, I don't believe Mars is a lifeboat for Earth. I don't believe we're all going to Mars. I don't believe many of us are going to live on Mars, at least anytime soon. We gotta take care of this planet. You know, sometimes people say, "Well, why don't we go to that nearest Earth-like planet, the closest one that the Kepler planet finder found, or James Webb found?"

If we went as fast as we possibly could, it would take 80,000 years to get there, the closest place. The people that arrived would be a different species than the ones that left. They'd be like Gumby with really soft feet, maybe. And of course, teamwork.

I mean, flying in space, team sport. And I just don't mean that your team on board, I mean everyone that supports the crew, the instructors, the engineers, the scientists, all equally as important in my mind because it's not one individual that makes anything challenging or hard happen. It is a team.

So when I was leaving the space station, it's a place I've spent over 500 days of my life on, worked the majority of my working life on the ground on this program, and I'm looking out the window in my Soyuz, and I'm looking at the Truss, the part I could see out the window as we're back and away. And I'm thinking, you know, we built this International Space Station while flying around the Earth at 17,500 miles an hour in a vacuum, in extremes of temperatures of plus or minus 270 degrees, built by an international partnership of 15 different countries, different languages, different cultures, different technical ways of doing things, connecting modules together, some of which had never touched each other before on Earth.

The first time these rooms are being connected, built in different countries, they're seeing each other in space, put together by astronauts and cosmonauts in these impossible-to-work conditions. The space station, this is the hardest thing we've ever done, harder than going to the Moon, in my opinion. And if we can do this, we can do anything. You know, if we want to go to Mars, we can go to Mars.

If we want to cure cancer and put the resources behind it, I truly believe we can do that. You know, fix the problems with our environment, you know, challenges we have in this country, right now and around the world. You know, challenges in your industry, or even your personal lives. After spending a year in space, I was absolutely inspired that if we can dream it, we can do it, if we have a goal and a plan, if we're willing to take risks, make mistakes, at times being willing to fail, if we focus on the things that we can control and ignore what we can't, if we test the status quo and we work as a team.

Because teamwork makes the dream work. We can choose to do the hard things. And if we do that, then the sky is definitely not the limit. Thank you very much, ladies and gentlemen. Thank you.